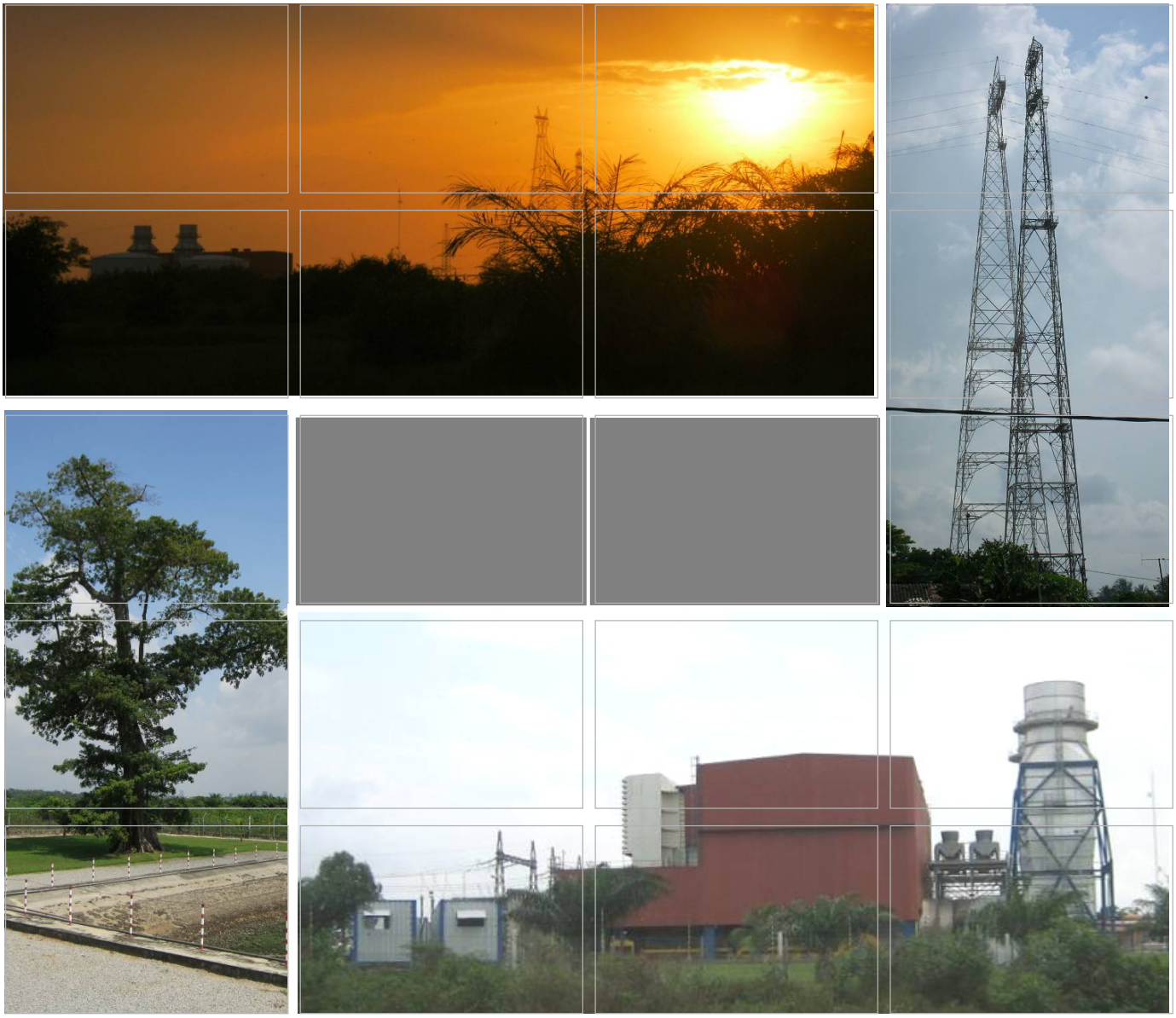

Environmental and Social Impact Assessment (ESIA) for the Phase III expansion Project of the existing Azito Power Station in Abidjan

Revision 03

5 March 2012

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DRAFT REPORT

Azito Energie

Environmental and Social Impact Assessment (ESIA) for the Phase III expansion Project of the existing Azito Power Station in Abidjan

Revision 03

5 March 2012

ERM Ref: 0120791

For ERM

Approved by: Camille Maclet, Partner

Date: 5 March 2012

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ACRONYMS

AFAQ	Association Française d'Assurance de la Qualité
AfDB	African Development Bank
ANDE	Agence Nationale de l'Environnement (National Environmental Agency)
Azito O&M	Azito Operations and Management
CBD	Convention on Biological Diversity
CCWS	Closed Cooling Water System
CDC	UK's development financial institution
CECAF	Cabinet d'Etudes, Conseils d'Assistance et de Formation
CEE	Central and Eastern Europe
CIAPOL	Anti-pollution Ivoirian Centre (Centre Ivoirien Antipollution)
CIE	Companie Ivoirienne d'Electricité (Ivoirian Electricity Distribution Company)
CIPREL	Compagnie Ivoirienne de Production d'Electricité
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNF	National Center of Floristic
CNR	Canadian Natural Ressources
CTG	Combustion Turbine-Generator
DEG	Deutsche Investitions- und Entwicklungsgesellschaft
E&S	Environmental and social
ERM	Environmental Resources Management
GT	Gas Turbine
HES	Health, Environment and Safety
EOH	Equivalent Operating Hours
ESHIA	Environmental, Social and Health Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FMO	Entrepreneurial development bank of the Netherlands
FNDE	Fonds National de l'Environnement
HP	High Pressure
HRSG	Heat Recovery Steam Generator
HV	High Voltage
IA	Impact Assessment
ICPE	Classified Installations for Environmental Protection (Installations Classées Pour l'Environnement)
IPS	Industrial Promotion Services
ISO	International Organisation for Standardisation
IUCN	International Union for Nature Conservation
IFC	International Finance Corporation
ITCZ	Inter-Tropical Convergence Zone
LP	Low Pressure
MINEEF	Ministère de l'Environnement, de l'Eau et de la Forêt
NIS	Newly Independent States

NOx	Nitrogen Oxides
PCDP	Public Consultation and Disclosure Plan
PM	Particulate Matter
PNAE	National Environmental Action Plan (Plan National d'Action Environnementale)
POI	Plan d'Opération Interne (Internal Operation Plan)
POLLUMAR	National Oil Spill Plan
PVC	Polyvinyl Chloride
PSs	Performance Standards
QHSE	Quality, Health, Safety and Environment
STG	Steam Turbine Generator
SODEXAM	Société d'Exploitation et de Développement Aéroportuaire, Aéronautique et Météorologique
ToR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
UK	United Kingdom
WHO	World Health Organisation

INTRODUCTION

Overview

This report presents the findings of an Environmental and Social Impact Assessment (ESIA) undertaken for the proposed Phase III expansion Project of the existing Azito Power Station in Abidjan (hereinafter referred to as the "Project"). The Project proponent is Azito Energie (Azito).

The Project consists of upgrading the existing Azito gas-fired power station, commissioned in January 1999, from single-cycle (two turbines, with an installed power output capacity of about 290 MW), to combined cycle, increasing the nominal installed capacity of the Azito plant by 50%, from 290 MW to 420 MW. This switch from single-cycle power generation to combined cycle will increase the energy efficiency of the Azito power plant from approximately 29,5% nowadays (Phase I and Phase II), to approximately 44% (at constant gas consumption – there is no planned increase in gas feed).

The main objectives of this ESIA are to present the Project; describe the baseline environmental and social characteristics of the Study Area; assess the associated potential impacts; and develop an Environmental and Social Management Plan (ESMP) for managing the environmental and social aspects of the Project during the construction, operation and decommissioning phase.

The Project Proponent, Azito Energie SA, is an Ivorian limited liability company owned indirectly by Globeleq Generation Holdings Ltd. and directly by Azito Energie Holding S.A.

The ESIA was developed in collaboration between Environmental Resources Management (ERM), a leading global consultancy specialised in environmental, health, safety, risk, and social services, and the Cabinet d'Etudes, Conseils d'Assistance et de Formation (CECAF) International, an Ivorian environmental consultancy firm with head offices in Abidjan.

Scope of this ESIA

This ESIA covers the Phase III proposed extension of the Azito plant.

The currently operational Phase I and Phase II installations of the Azito plant were covered by an initial ESIA developed on behalf of the Project Proponent in 1998. This initial ESIA was submitted to, and approved by, the Ministry of Environment of Côte d'Ivoire. It was also submitted to the International Finance Corporation to support the financing of the Project.

The 1998 ESIA covered not only the Phase I and Phase II installations, but also the overall planned facility, including Phase III (considering that the Phase III installations were then scheduled to be built shortly after Phase I and Phase II). Since

1998, the overall configuration of the proposed Phase III installations has remained consistent. This new ESIA can therefore be seen as an update of the 1998 ESIA.

Institutional and regulatory context

This ESIA has been prepared in accordance with applicable Ivorian laws and regulations as well as international standards. The framework is described in detail in Section 1 of this report.

Ivoirian regulations require that the project obtain an Environmental Certificate, signed by the Minister of Environment and Sustainable Development. This certificate is issued following the review and approval of an ESIA, submitted by the Project proponent, by the national agency in charge of the environment, the Agence Nationale de l'Environnement (ANDE).

The key principles of the current national environmental policy in Ivory Coast are laid-out in the Plan National d'Action Environnemental (PNAE – National Environmental Action Plan) for 1996-2010.

Decree n°96-894 (1996) defines rules applicable to the elaboration of ESIAs, their processing by the ANDE and the ministerial approval process for projects subject to ESIA. The key stages and overall timeline of environmental permitting, as established by order n° 00972 are presented in Section 1.

In application of Order 000972, the ESIA approval process must include a 2-week public enquiry, managed by the ANDE (Agence Nationale de l'Environnement). Remarks and comments from the validation meeting committee will be considered in a final version of the ESIA report before the delivery of the Environmental Certificate, signed by the Ministry of the Environment, to Azito Energie.

Further details introducing the Project, the ESIA process, Azito Energie, the study experts and the regulatory context are presented in Section 1 of this report.

Important note on applicable international standards

At the time of developing the initial Azito Phase 1 and 2 Project, in 1997-1998, the applicable World Bank guideline for environmental performance was the World Bank Environment, Health and Safety Guidelines for Thermal Power Plants, issued in October 1996 – now superseded by the 2007-2008 versions of the IFC EHS guidelines.

The existing operating components of the Azito plant are therefore designed to comply with the 1996 guidelines. This is particularly applicable to the Azito Phase I and Phase II gas-fired turbines and their nominal performance in terms of abatement of atmospheric emissions. Nonetheless, where appropriate, for new Phase 3 components, the 2007-2008 version of the guidelines has been considered.

PROJECT DESCRIPTION

The Azito power station, as planned in the initial project from 1998, consisted of building, owning, operating and eventually transferring to the State a gas-fired power station with a total capacity of approximately 420 MW, to be implemented in three phases, each of around 140 MW.

The site is located near the Azito village in Yopougon District, approximately six kilometres west of the port of Abidjan. The site is located alongside the western arm of the Ebrié lagoon, approximately 10 km from the inlet of the Vridi canal. Béago village is located 300m to the North-East of the Azito site.

Construction works began in July 1998, and the first phase (one turbine) was completed in January 1999. The second phase (similar to phase I) was commissioned in February 2000. The third phase (upgrading the plant from single cycle to combined cycle power generation) was initially planned for commissioning in 2002, but political instability in the country impeded the development plan of the Project.

The existing facility therefore currently consists of two gas turbines, each of them coupled to an air-cooled condenser. The existing gas turbines are designed to operate with natural gas (mainly) and distillate oil (back-up only – since the initial commissioning of the power plant in 1999, the turbines have essentially been operated on gas.

The "Phase III" conversion of the plant from simple-cycle to combined-cycle will be accomplished by the addition of two Heat Recovery Steam Generators (HRSG), one Steam Turbine Generator (STG), and one steam condenser with an associated closed-loop, air-cooled cooling water system. This entails no creation of a new combustion sources, and no incremental consumption of gas. The extension essentially consists in improving the energy efficiency of the plant, by recovering energy currently disposed off as heat in the warm turbine exhaust gases.

Decommissioning should not take place before 2034. As the Azito Power Station will be transferred by Azito Energie to the Ivory Coast State 20 years after the construction of the Phase III, the decommissioning work will therefore be the responsibility of the Ivoirian authorities. Decommissioning activities should be consistent with Ivoirian regulations and internationally-recognized guidelines and standards. Azito Energie will offer suggestions and assistance during the decommissioning activities, as part of the hand-over period.

A detailed Project Description, describing the Phase III expansion and associated activities, is presented in Section 2 of this report.

BASELINE DESCRIPTION

Section 3 describes the baseline environmental and social characteristics of areas potentially affected by activities in the Project's construction and operations phases. The Phase III Project will be developed within the existing Azito facilities site. The environmental and social description therefore considers the current situation, including the two gas turbines and associated installation, as the baseline situation.

Environmental and social baseline characteristics that are addressed in this section include:

- *Physical environment: The physical environment incorporates the terrestrial environment and the fluvial environment including processes such as climate and meteorology, geology, hydrology, air quality, ambient noise and geomorphology.*
- *Biological environment: The biological environment incorporates the terrestrial and aquatic fauna and flora that inhabit the Study Area, with emphasis on their habitats and/or ecological importance.*
- *Socio-economic environment: The socio-economic environment concerns characteristics of the population that inhabits the Study Area, such as demographics, socio-political organization, economy and livelihoods, health, and infrastructure and services.*

Public information and consultation reports

Section 3 also describes the public consultation process. As required by the Ivoirian regulation and as part of the IFC's environmental and social sustainability policies, the ESIA included engagement with Project-affected communities through disclosure of information, consultation, and informed participation. The extent of this engagement should be in proportion with the risks to and impacts on the affected communities. The Public consultation report developed as part of this Phase III ESIA is presented in Annex A.

IMPACT ASSESSMENT

Section 5 presents the ESIA methodology and potential impacts to environmental and social resources in the Study Area.

The ESIA methodology utilizes pre-defined assessment scales to determine the magnitude of a potential impact and prioritize those potential impacts that require mitigation. The magnitude of the potential impacts was determined by assessing all the dimensions including the extent, duration and intensity. To those criteria specified by the ANDE in the Terms of Reference, ERM and CECAF International proposed adding the criterion of likelihood; providing information on the levels of occurrence of an action that has a finite probability, but might not occur at all.

An overall grading of the magnitude of impacts, taking the above mentioned criteria into account, will determine if the impact can be considered as minor (perceptible but localised, can sometime be qualified as negligible if imperceptible or very localised), moderate (perceptible, relatively extensive continuous change or very perceptible recurring change reversible in the medium or long term) or major (obvious, extensive and irreversible change or very perceptible recurring change only reversible in the long term).

Potential Impacts from Project Activities

<u>Air quality</u>

The main sources of impacts associated with the construction activities of the Phase III are possible dust and exhaust gases arising from the traffic of construction vehicles on

the site. Quantities of air pollutant emissions from construction vehicles and generator operations are expected to be relatively minimal and are not anticipated to result in measureable impacts on air quality. The potential associated with dust arisings during construction are also expected to be minor. Airborne dust will be limited by the moist climatic conditions prevalent in Abidjan, and the residual dust generation potential is manageable through good construction site management practices.

The Phase III operation will not result in any incremental air emission from power generation compared to the existing situation. Rather, the retrofitting of HRSGs and a STG will allow optimising the fuel efficiency of the overall installation, by switching from single cycle to combined cycle power generation. A dispersion model was developed for the 1998 ESIA to assess of the potential impacts of atmospheric emissions, including the Phase III installation. Given the limited nature of changes to the Phase III Project since the 1998 ESIA, the approach taken in this modelling exercise, and the resulting modelling output, are considered to be still valid.

The result of the model shows that the impacts to ambient air quality resulting from gas-fired turbines in the Phase III plant configuration complies with the currently applicable versions of the Ivorian regulatory limits (2008) and the IFC Performance Guidelines (2007-2008). In the 1998 ESIA, the effectiveness of the atmospheric dispersion of turbine emissions was modelled for stack heights of 40 m and 50 m. The model verified that compliance was maintained in both cases. Considering technical feasibility, the base-case scenario for the plant stack height selected by the Sponsor has therefore been set to 40 m.

In the absence of new continuous emissions source, the potential impacts on the air quality during the operation of the Phase III, in comparison with the current situation in Phase I and II, are expected to be Minor.

<u>Energy efficiency and greenhouse-gas footprint</u>

In terms of energy efficiency and carbon footprint, the impacts of the Phase III project are clearly positive. By switching from single cycle to combined cycle, the nominal installed capacity of the overall facility increases by a nominal 50°% at constant fuel-gas consumption; the energy efficiency of the overall power plant therefore also increases in similar proportions, from about 29,5% to about 44%. Atmospheric emissions are unchanged, therefore decreasing the greenhouse-gas footprint per unit power produced of the facility in the same proportions.

<u>Noise emissions</u>

During construction, potential sources of noise include construction equipment and temporary increases in traffic. Noise from construction equipment has been predicted at the nearest noise sensitive receptors for the noisiest phases of construction. From this assessment, the potential impacts associated with the Phase III construction are expected to be minor.

During operation, noise emissions from the Phase 3 equipment will add a contribution to existing sources of noise from the existing operational power plant, the neighbouring Foxtrot small gas processing facility, and other noise sources in this

peri-urban environment. As part of the ESIA, baseline ambient noise has been monitored, and future ambient noise levels with the Phase III facilities have been predicted. Noise abatement measures have been identified to ensure that applicable standards will be met at sensitive receptor locations (the Azito and Béago villages). The predicted increase in ambient noise associated with operation of Phase 3 compared to the existing situation is expected to be low (within 1 dBA).

Water supply and environmental water quality

The water needed for the construction phase of the Project is mainly related to the use of domestic water on site, in the temporary camps, and water consumption for the construction works. Water consumption from construction activities will be limited in quantities and in time. Therefore, the potential impacts from water consumption during the construction are expected to be negligible.

During the operations, two main sources will cover the water requirements: potable water from the existing municipal supply and the existing well for industrial water. Potential impacts on water resources from operations are expected to be minor.

Impacts on water quality from the construction phase may result from :

- *turbid run-off from the construction site, during rainy events (mostly from stripped construction surfaces and excavation material tips) ;*
- *direct discharges of sanitary effluent; and*
- *accidental leaks or spills.*

During the operations of the Phase III plant, oily waste water from the collecting pits, sanitary waste water as well as industrial waste water will be centralised in the existing treatment system. After equalisation in the junction pit, the water is neutralised by chemical dosing and pH adjustment and directed to the evaporation pond. Rain water will be collected from building roofs and connected with the existing storm water discharge ditches, leading to the discharge point, out of the site.

Following the application of the mitigation measures presented in the section 5, the potential impact to water quality is expected to be minor.

Biodiversity

Two areas surrounding the fence line, located to the north-west and south-west from the site are planned to be used as a temporary lay-down area during the construction phase. Neither of these areas sustains any sensitive habitats. They consist of grass land and peri-urban shrub. Habitat loss from Phase III construction is considered to be negligible as no rare or endemic species were identified.

The footprint of the Phase III expansion facility will be located essentially within the existing concession area of the Azito facility. A small portion of land located outside of the fenced area (but already within the concession allocated to Azito Energie) will also be used for the construction. Potential sources of operational impact on the biodiversity of the area include the spillages or leakages of products and chemicals on site or along the transport route. Very few product and limited volumes will be used

on Site for the phase III expansion. Therefore, the potential impacts on the biodiversity during the operations are expected to be negligible.

Solid wastes

The volumes of waste produced during the construction of the Phase III has not been estimated at this stage but can be anticipated to be relatively low for hazardous wastes the order of a few cubic metres per month. Most hazardous wastes consist essentially in oil-contaminated wastes, which can be readily collected and disposed off through contracts with industrial wastes recycling and elimination contractors in Ivory Coast.

The project will produce no significant quantities of solid process waste compared to the actual situation during the operations phase. Packaging and general domestic waste will be collected by an independent waste management company and disposed of at the municipal dumping area in Abidjan.

Socio-economical environment

The following potential impacts on the socio-economical environment are described in the Section 4:

- *Employment – Up to approximately 600 workers should be hired at the "peak workforce" phase of the construction period. Construction activities will require a high number of specialised workers. Due to this need for skilled labour, a large proportion of the employee work force is likely to be hired from outside the local area. Operations employment opportunities will be limited as the number of people working on site during the operations is relatively low (approximately 50 people including Phase I and II) and the type of activities performed requires highly skilled employees.*
- *Local economy - The local economy will globally benefit from the workforce influx hired during the construction phase. However, the price of goods and products sold in the surroundings of the site might increase due to the presence of the workers. This impact will however be limited to the construction phase.*
- *In-migration - migration of jobseekers will happen in the surroundings of the site but will be limited with clear recruitment policy and as not many people will be hired for the project.*
- *Community Health & Safety - Health & Safety measures related to the working conditions will be developed in a Health and Safety Plan prior to the beginning of the work. Influx of employees and job seekers could also result in the spread of diseases, including sexually transmitted diseases and HIV/AIDS*
- *Traffic - During construction, even if a significant quantity of equipment will be brought to site from the Vridi port area across the Abidjan lagoon by boat, traffic density through Yopougon and the Azito area will be increased as equipment and workforce will also have to be transported to the site by road. Given the concentration of population in this area, this is likely to generate increased traffic risks.*
- *Security - Influx of employees and job seekers as well as working activities may potentially lead to an increase of population density in the area, potentially generating higher rates of petty crime, violence and security related problems in the area. The site is currently guarded by a police detachment. These measures will be applicable during the construction and operations of the Phase III project.*

- *Pressure on local infrastructures - Temporary increase of people in the area may lead to pressure on community infrastructure and social services (health centres, schools, water supply, markets, etc.).*
- *Land take - Land take for the Phase III expansion will essentially be located within the existing concession area of the Azito facility. A small portion of land located outside of the fenced area, already owned by Azito Energie, will also be constructed.*
- *Fishing activities - Transportation by boat could potentially disrupt fishing activities along the lagoon. Given the low number of loads compared to the traffic in the lagoon, and the fact that this option is temporary, impact from transportation of material by boat can be considered as negligible.*
- *Positive impact - The project will generate opportunities for Ivory Coast and the surrounding countries as it will increase the total installed capacity of the Azito plant from about 290 MW to 420 MW, adding about 10% to overall national capacity.*

Decommissioning and abandonment

A detailed decommissioning plan will be developed at the end of the projects lifetime. Decommissioning would involve demolition, recovery and removal of the power station installations and buildings (if they are not re-used for another purpose). This plan will be consistent with Ivoirian regulations and both Azito and internationally-recognized guidelines and standards. The mitigation measures presented in this report to limit the environmental and social potential impacts related to the construction and operations phases of the power station will be applicable for the decommissioning and abandonment.

Cumulative impacts

The environmental effects which can result from cumulative impacts and impact interactions can be significant. The objective of the assessment of cumulative impacts will be to identify and focus on the significant impacts. It will also ensure that these impacts are taken into consideration in the decision-making process

Cumulative impacts associated with the construction of the bridge (formerly called Pont Laurent Gbagbo) as well as with the urbanization of Abidjan and the area of Yopougon are presented in the Section 4 of this report.

SUMMARY OF POTENTIAL IMPACTS AND MITIGATION

Section 5 summarizes the potential impacts and mitigations described in Section 4 in a tabular format. This table will form the basis of the Environmental and Social Management Plan presented in Section 6.

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Section 6 presents an Environmental and Social Management Plan (ESMP), prepared in accordance with the applicable legislation on environmental and social impact assessment in Ivory Coast as well as the requirements of the Terms of Reference (ToR) received from the ANDE in December 2009. The overall objectives of the ESMP are as follows:

- *to provide a mechanism for ensuring that the mitigation and management measures that are identified in this ESIA are implemented;*
- *to provide a framework for mitigating impacts that may be unforeseen or unidentified until Project activities are underway;*
- *to assist in ensuring continuing compliance with national and international legislation and industry best practices;*
- *to provide a framework for compliance auditing and inspection programmes; and*
- *to encourage and achieve the highest environmental and social performance and response from employees and contractors.*

The ESMP makes specific reference to roles and responsibilities for each aspect of the Project that is subject to mitigation actions and describes the environmental and social management organization that will carry out mitigation requirements and monitoring actions during the construction and operation phases. These actions, as well as monitoring frequency, reporting requirements, and an estimated budget are presented in tabular format in Section 6.

1 INTRODUCTION

1.1 PROJECT BACKGROUND AND RATIONALE

This report presents the findings of an Environmental and Social Impact Assessment (ESIA) undertaken for the proposed Phase III expansion Project of the existing Azito Power Station in Abidjan (hereinafter referred to as the "Project"). The Project proponent is Azito Energie (Azito).

The Project consists of upgrading the existing Azito gas-fired power station, commissioned in January 1999, from single-cycle (two turbines, each with an installed power output capacity of 140 to 150 MW), to combined cycle, by the addition of two heat recovery steam generators (HRSG) to the existing turbine trains, and one steam turbine generator (STG) with an installed power output capacity of another 140 MW (approximately) – therefore increasing the total installed capacity of the Azito plant from 280-290 MW to 420 MW.

Ivoirian regulations require that the project obtain an Environmental Certificate, signed by the Minister of Environment and Sustainable Development. This certificate is issued following the review and approval of an ESIA, submitted by the Project proponent, by the national agency in charge of the environment, the *Agence Nationale de l'Environnement* (ANDE).

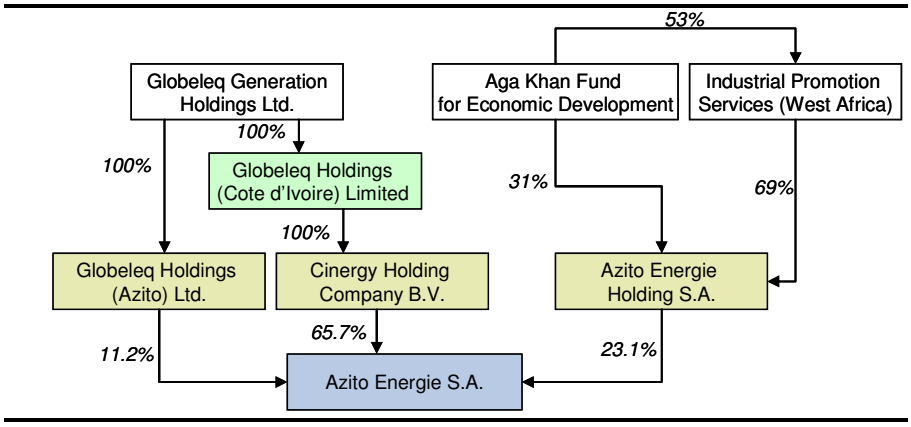
To ensure alignment with regulatory requirements and administrative practices, Azito met with the Ministry of Energy and the ANDE in Abidjan in November 2011. The ANDE confirmed that the ESIA Terms of Reference (ToR) published in December 2009, specifying the content of the ESIA as required by the ANDE, were still applicable. Therefore, the table of contents of this ESIA, including its environmental and social management plan (ESMP), reflects the structure originally specified in the ToR.

1.2 PRESENTATION OF THE PROJECT PROPONENT

Azito Energie SA is an Ivorian limited liability company, incorporated on 31st July 1997, to build, finance and operate the Azito project. As presented in *Figure 1.1*, the Company is owned 76.9% indirectly by Globeleq Generation Holdings Ltd. and 23.1% directly by Azito Energie Holding S.A.

The Azito power plant is operated by Azito Operations and Management (Azito O&M), a subsidiary of Azito Holding The shareholders of Azito Energie are Globeleq, and Azito Energie Holding SA, a subsidiary of Industrial Promotion Services (IPS) and the Aga Khan Fund for Economic Development.

Figure 1.1 Azito Energie Shareholding



Globeleq is an experienced operating power company, actively developing energy solutions for the emerging markets of Africa, the Americas and Asia. Globeleq develops economically sustainable businesses that support the continued development of the electric power sector in these regions and actively participate in the communities in which we operate.

The company was launched in 2002 when the UK's CDC Group contributed both equity capital and portfolio of power assets to the new enterprise. Over the next 5 years, Globeleq became a power industry leader in the emerging markets by operating or acquiring interest in multiple power facilities totaling nearly 4,000 MW of generation capacity in more than 20 countries.

In 2007, Globeleq divested its holdings in a number of power companies in its portfolio. Legal ownership of Globeleq was transferred in 2009 from CDC to the Actis Infrastructure Fund, a fund managed by Actis, the leading equity investor in emerging markets. CDC continues to be a key stakeholder in Globeleq's business as a material investor in the Actis Infrastructure Fund.

The company continues to safely operate electricity generation facilities and with a committed shareholder providing access to funds for new investments, Globeleq is uniquely positioned for further investment in the power industries of its target regions in Africa, the Americas and Asia

Industrial Promotion Services West Africa, IPS (WA) – owned by the Aga Khan Fund for Economic Development (AKFED), itself a part of Aga Khan Development Network (AKDN), covers social development, economic development and culture. Created in 1965 in cooperation with the Ivorian Government, IPS (WA) developed 24 projects in Ivory Coast, in other west-African countries and in Europe.

1.3 PRESENTATION OF CONSULTANCIES CHARGED WITH UNDERTAKING THE ESIA

The ESIA was developed in collaboration between Environmental Resources Management (ERM) and the Cabinet d'Etudes, de Conseil, d'Assistance et de Formation International (CECAF International).

Environmental Resources Management (hereinafter ERM) is a leading global provider of environmental, health, safety, risk, and social consulting services. Established in 1971 in the United Kingdom, ERM has since grown to 140 offices in 40 countries across the globe, and employs approximately 4,000 people.

ERM works on the African continent from its four offices located in South Africa, as well as other international offices in Paris, London, Madrid and Washington. ERM's project experience in Africa includes developing ESIAs, ESMPs and stakeholder engagement programs for a variety of sectors, including oil and gas, mining, hydropower, transportation, and telecommunications.

Key ERM experts that supported the development of this ESIA include: Eamonn Barrett (Partner-in-Charge), Camille Maclet (Project Director), Benoit Vanwelde (Project Manager), Gwenaelle Niault (Environmental and social expert), Steve Mitchell (noise specialist) and Jamie Hogg (noise specialist).

- *Eamonn Barrett* is an ERM Partner, primarily responsible for leading and directing donor-financed environmental assessments, and institutional strengthening projects related to EIA, environmental planning and management. He has twenty-five years' experience in developing countries throughout the world, and more recently has also worked extensively in the transition economies of the CEE/NIS region, and has worked for most of the major multi- and bilateral agencies as well as parts of the private sector. He has worked in over forty countries in total.
- *Camille Maclet* is a Partner in ERM's Paris office. He works for Environmental and Social (E&S) services, internationally, with a focus on Environmental and Social Impact Assessments (ESIA), E&S risk assessments, as well as Environmental and Social Due Diligence (ESDD) on behalf of institutional lenders and Equator Principles financial institutions. With a primary background in energy and mineral resources, he is also familiar with linear infrastructures, metal processing, and industrial plantations.
- *Benoit Vanwelde* is a Consultant based in ERM's Brussels, Belgium office, where he specializes in environmental impact assessments, environmental audits and soil and groundwater investigation and remediation. Between 2009 and 2011 Benoit has been responsible for coordinating environmental and social support services to the marine and terrestrial components of pan-African optic-fibre cable installation project. He has conducted extensive fieldwork in western, central and southern Africa.

- *Gwenaelle Niault* is a Consultant working on Environmental and Social Impact Assessments (ESIAs), Management Plans (ESMPs), project E&S risk assessments against international environmental and social performance standards such as those of the World Bank Group, International Finance Corporation (IFC) and other international lenders. She works especially on power, mineral resources, oil and gas, and linear infrastructure projects.
- *Steve Mitchell* is ERM UK's principal environmental noise specialist. During 22 years of experience in this field Steve has assessed environmental noise impacts from a wide range of noise sources in more than 20 countries, but he has specialised in the transport and infrastructure sectors. Following three years as an acoustic engineer Steve joined ERM in 1991. In the UK most of his project work involved the assessment of environmental noise impacts from major new developments such as power stations, waste handling facilities, factories, and railways.
- *Jamie Hogg* has extensive experience in the field of noise and vibration. Environmental impact assessments both in the UK and abroad have formed a large part of his work. He has been involved in a wide variety of projects including major transport, housing and industrial developments.

CECAF International (hereinafter CECAF) is an environmental consultancy firm based in Abidjan, working on environmental and social services, with a focus on Environmental and Social Impact Assessments (ESIA), as well as environmental and social audits . CECAF has participated in numerous ESIAs and ESMPs in Ivory Coast, in sectors as diverse as mining, transportation and telecommunications.

CECAF is approved by the National Environmental Agency (ANDE) by the Ministerial Decree n°00559 of 25 March 2008 to conduct environmental audits as well as environmental and social impact assessments for development projects in Ivory Coast.

CECAF's fields of competence covers:

- institutional support and training;
- environmental and social impacts assessments;
- environmental management systems;
- environmental audits;
- waste management;
- relocation and resettlement plans;
- drinking water unit design; and
- fire and industrial risk prevention.

Key CECAF experts that collaborated with ERM in the development of this ESIA included:

- *Prof. Edouard Kouakou N'Guessan* began his career in 1985 as an assistant at the laboratory of botanic and vegetal biology of the National University of

Ivory Coast. He is currently Director of the National Center of Floristic (CNF) in Abidjan, University of Cocody. At CECAF, he has managed the biodiversity sections of numerous Environmental Impact Assessments, focusing on forestry, hydroelectric power, telecommunication, mining and rehabilitation/construction works.

- *Dr. Benoît Kanga OGNI* is a lecturer and researcher in sociology at the University of Cocody. He worked at the National University of Ivory Coast and at the University of Cocody as the chief of the department of sociology between 1987 and 1998. Pr. Ogni works as a consultant for CECAF, focusing on the social aspect of the Projects.

1.4 INSTITUTIONAL AND REGULATORY CONTEXT

This ESIA has been prepared in line with applicable Ivoirian laws and regulations as well as international standards. The following sub-sections outline the current institutional, legal, and regulatory framework that are applicable to the Project or have the potential to significantly influence the Project during planning, construction, and operation.

1.4.1 Ivorian institutional context

The **Ministry of Environment and Sustainable Development** (*Ministère de l'Environnement et du Développement Durable*) is in charge of the definition of national environmental policies and environmental management regulations and requirements. In addition, the role of the Ministry covers the implementation of the Environmental Code and legislation for the protection of nature and the environment, protection and enhancement of aquatic ecosystems, rivers and coastal lagoons and wetlands, the management of national parks and nature reserves and the control of classified installations for environmental protection.

The Ministry of Mines, Petroleum and Energy (*Ministère des mines, du pétrole et de l'énergie*) is responsible for defining national policy regarding mines, petroleum and energy, drafting laws and regulations concerning these sectors. The role of the Ministry is to promote, guide, regulate, control and coordinate research, extraction and production of minerals, oil, natural gas and other hydrocarbons and to work for a rational and sustainable use of energy and mineral resources.

The Ministry for Public Health is responsible for defining national health policy and for drafting public health and hygiene laws and regulations.

The other relevant bodies to be considered for the Project are:

The National Environment Agency (ANDE) is a national public agency created in 1997. As outlined in Decree n°97-393 of July 9, 1997 the ANDE is responsible for implementing the procedure for impact assessment and the

assessment of the macro economic policies impact on environment. The ANDE is also responsible for :

- ensuring the coordination of the implementation of environmental development projects;
- managing and assessing projects of the Environmental National Action Plan (*Plan National d'Action Environnementale - PNAE*);
- establishing and managing a portfolio of environmental investment projects;
- ensuring the establishment and management of a national environmental information system;
- implementing international environmental conventions; and
- establishing an ongoing relationship with NGO networks.

The Ivorian Anti-pollution Ivoirian Centre (**CIAPOL** - *Centre Ivoirien Antipollution*) is a public agency created in 1991. As outlined in Decree n°91-662, the missions of the CIAPOL are to assess any type of pollution and nuisance, organise systematic sampling/analysis campaigns for water, waste and residues, collect and publish environmental data, monitor the marine and lagoon environmental conditions and develop an emergency intervention plan against accidental pollution at sea, lagoon or on coastal areas (POLLUMAR).

1.4.2 Ivoirian legislation related to the Project

National Constitution

The National Constitution of 23 July 2000 includes principles related to the protection of the environment, including Article 19 which states that:

"*Every person has the right to a healthy environment*"

Article 28 specifies that the protection of the environment and of the quality of life is the responsibility of the community and of each individual[1]

Environmental legislation

The key principles of the current national environmental policy in Ivory Coast are laid-out in the *Plan National d'Action Environnemental* (PNAE – National Environmental Action Plan) for 1996-2010. Environmental policies are implemented by the MINEEF subdivision, Direction of the Environment (Environmental Directorate).

Law n°96-766 of 3 October 1996, termed *Code de l'Environnement* (Environmental Act), establishes principles of environmental protection at national level. This law is complemented by five important decrees:

(1) [1] Constitution of the Republic of Ivory Coast, 2000.

- decree n°96-894 of 8 November 1996 determining rules and procedures applicable to environmental and social impact assessment (ESIA) for development projects;

- decree n°97-393 of 9 July 1997 on the creation and organization of a public and administrative agency, the Agence Nationale De l'Environnement (ANDE – National Environmental Agency);

- decree n°97-678 of 3 December 1997 on the protection of the lagoon and marine environments against pollution;

- decree n°98-19 of 14 January 1998 on the creation and organization of the Fonds National De l'Environnement (FNDE – Environmental National Funds); and

- decree n°98-43 of 28 January 1998 on "Installations Classées Pour l'Environnement" (ICPE – Classified Installations for Environmental Protection).

The entity in charge of leading the ESIA evaluation and approval process is the ANDE. Other services within the MINEEF and other ministries are called into the process as part of an "ESIA validation committee".

Law n°96-766 establishes the foundations of the environmental policy, based on the preservation of natural resources, protection of the environment and sustainable economic development.

Article 39 of the Act states that "*Every important project liable to have an impact on the environment is subject of a preliminary impact assessment"*.

Articles 40 to 43 provide guidance and principles on the content and validation of the environmental impact assessments.

Decree 97-678 of 3 December 1997 is related to the protection of the lagoon and marine environment. Article 17 of the decree states that *discharging objects, garbage and toxic products in marine and lagoon waters as well as in coastal zones, is prohibited*.

Decree 96-894 of 8 November 1996 determines the rules and procedures applicable to the assessment of the environmental impacts of development projects and their evaluation by the ANDE.

According to article 2 of the decree, the projects listed in Appendix 3 are subject to the preliminary environmental impact assessment, requiring approval by the Minister for the environment, after a technical review by the ANDE.

Order n°00972/MEEF of 14 November 2007 is related to the application of decree 96-894 of 8 November 1996. According to the terms of this order, "*the ANDE is the environmental authority responsible for supervising, monitoring and validating all activities related to environmental impact assessments for development projects*" (article 5).

The order gives a detailed description of the procedure for the performance and review of ESIAs by the ANDE.

Legislation on environmental audit

The key regulation related to environmental audits in Ivory Coast, as applicable to the project, is decree n° 2005-03 of 6 January 2005.

According to article 8 of the decree, environmental audits of existing developments must be undertaken by assessing "*the compliance, effectiveness and efficiency"* of a development's environmental management plan, and the environmental management system.

Internal audits must be performed every three years. It must be undertaken by a consulting firm appointed by the operator. The audit report is submitted to ANDE for approval. An external audit can be ordered by the Ministry for the environment, based on recommendations of the ANDE.

Regulations on water

The main regulatory text on water in Ivory Coast, applicable to the project, is act ("Arrêté") n°98-755 of 23 December 1998 constituting the Water Code.

This text specifies the main rules related to the preservation and rehabilitation of waters and to violations and penalties. Both the continental and territorial maritime waters are concerned by the Water Code.

Article 49 states that *"any discharge of wastewater into the environment must comply with the standards applicable*". According to Article 51: "*Any discharge into the sea, watercourses, lakes, lagoons, ponds, canals, groundwater of any used material, fermentable residues of vegetal or animal origin, any solid or liquid, toxic or flammable substance liable to constitute a hazard or cause a fire or explosion is prohibited"*.

Regulations on waste

Waste management is the responsibility of the Ministry of Environment.

Decree n° 97- 678 of 3 December 1997 related to the protection of the lagoon and marine environment against pollution, also deals with measures related to waste discharge in the sea and in coastal zones.

Order n° 171 \PM\CAB, of 18 September 2006 establishes the creation, duties, composition and operation of the Operational Coordination Cell managing the

National toxic Waste Defence Plan. Order n° 166\PM\CAB of 14 September 2006 nominated the Coordinator of the National Toxic Waste Defence Plan.

Legislation related to labour

The Ivorian Labour Code is defined by law n°95-15 of 12 January 1995 modified by law n°97-400 of 11 July 1997. Other important pieces of legislation include:

- law n°99-477 of 02 August 1999, defining the Code of Social Security;
- law n°88-651 of 07 July 1988 for the protection of the public health and the environment against the effects of the toxic and nuclear industrial waste and the harmful substances;
- decree n°98-40 of 28 January 1998 concerning the consultative technical committee for the study for questions interesting workers hygiene and safety; and
- decree n°96-206 of 07 March 1996 concerning hygiene, safety and working conditions committee.

With regard to child labour, article 23.8 of the law n°95-15 states that: *"Children can not be employed in a company, even as apprentices, before the age of 14, unless otherwise stipulated by the regulations"*.

Article 41.1 states that "*To protect the life and health of the employees, the employer is required to consider all the useful and appropriate measures to ameliorate the company's working conditions. The company must in particular adapt the installations and working conditions in order to protect the employees from accident and disease* ".

Article 1 of decree n°96-206 of 7 March 1996 related to the health, safety and working conditions committee states that "*In accordance with the requirements of Article 42.1 of the Labour Code, every company employing more than fifty persons must set up a health, safety and working conditions committee (CHSCT)"* .

1.4.3 The ESIA approval process

Decree n°96-894 (1996) defines rules applicable to the elaboration of ESIAs, their processing by the ANDE and the ministerial approval process for projects subject to ESIA. The decree includes several annexes, the most important of which are:

- Annex I : lists of projects for which a full ESIA must be submitted to the ANDE for approval (applicable for the Azito Project).
- Annex II: lists of projects subjected to a simplified environmental statement.

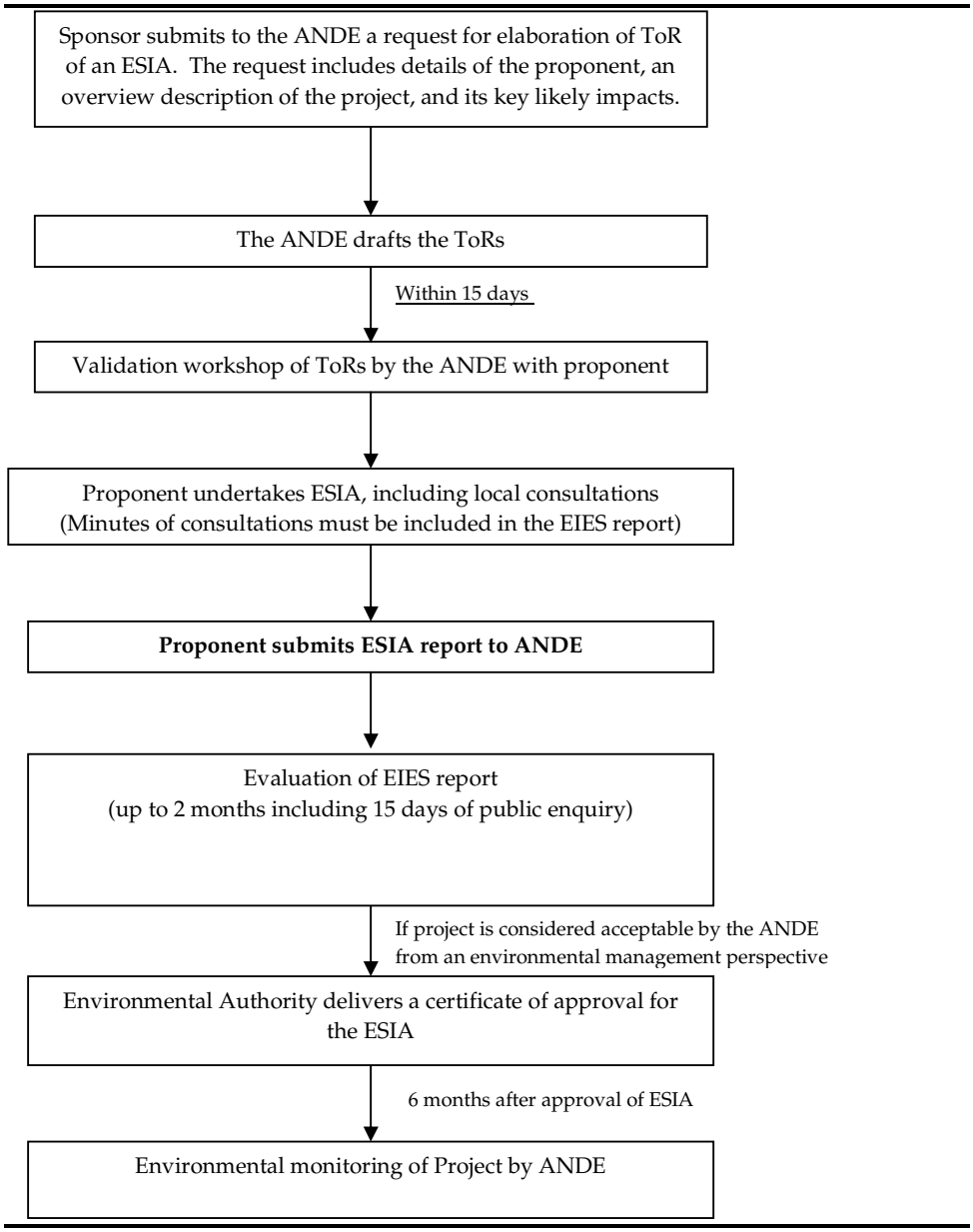
- Annex III: lists of Projects subject to a complete environmental impact assessment study.

The key stages, head-times and financial implications of the environmental permitting process are defined by order 00972 of 14 November 2007 for the application of decree 96-984.

Process and timeline

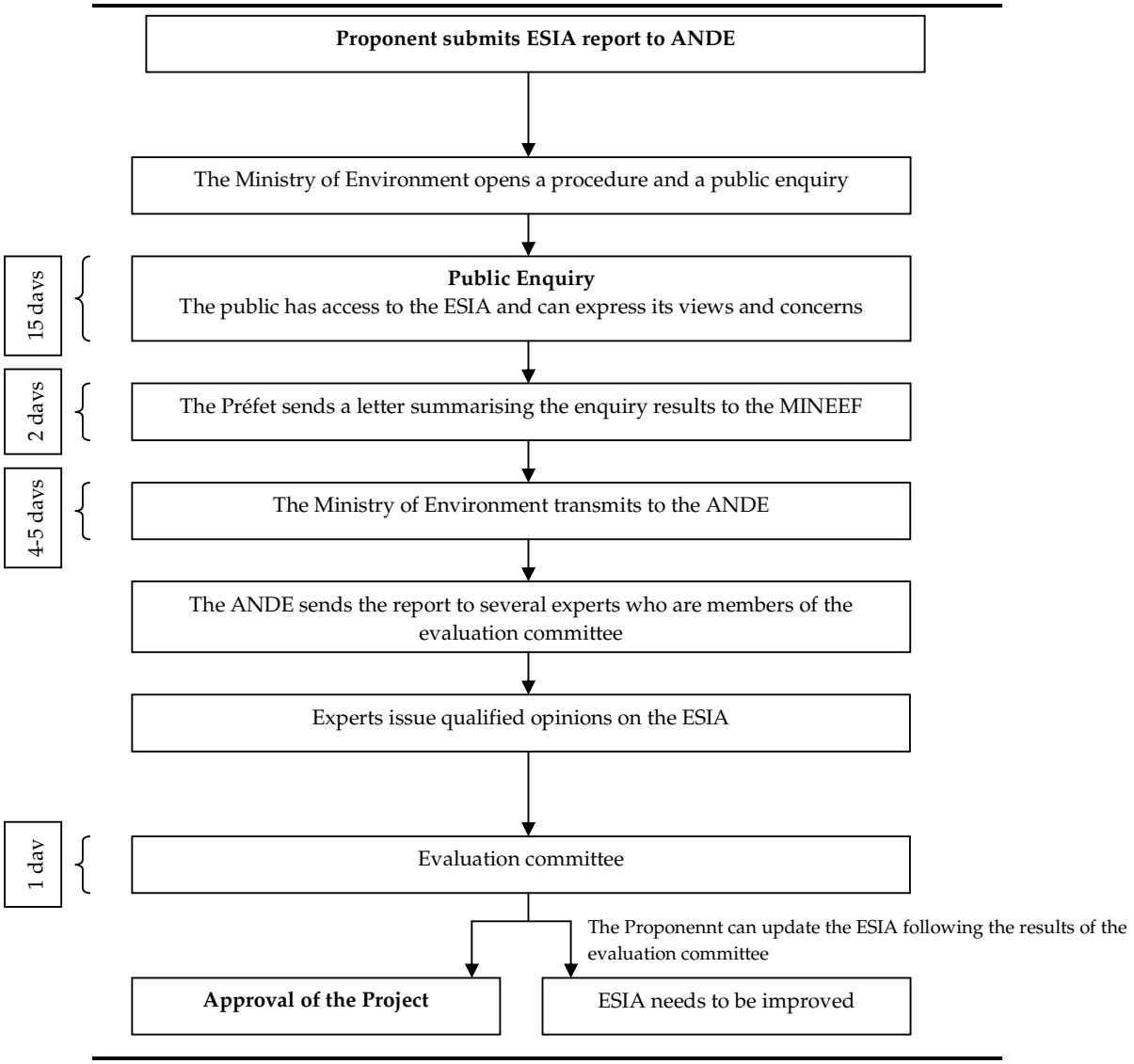
Figure 1.2 presents the key stages of environmental permitting, as established by order n° 00972. The overall timeline is indicative and depends on a range of factors: Project complexity and size, sensitivity of the Projects receiving environment (receptors) and public enquiry process managed by the ANDE as part of the approval procedure.

Figure 1.2 Key stage of permitting process



A more detailed account of the ESIA approval procedure and the public enquiry once the ESIA has been submitted to the ANDE is provided in *Figure 1.3*.

Figure 1.3 ESIA approval and public enquiry procedure



Permitting procedure applicable to the Azito project

The Azito project is already officially approved, under the terms of an environmental permit delivered by the Ministry in charge of the environment, on 9 September 1999. This initial permit covers all three phases of the Azito project development plan, including the retrofitting of combined cycle equipment also known as Phase III.

Since Phase III was not developed as per the original schedule directly following the rest of the phase I and II installations, a new ESIA covering this particular phase was requested. Official terms of reference were delivered by the ANDE in December 2009, under the reference number 32-221209/ka.

In September 2010, as part of the initial ESIA scoping visit, the Project Sponsor, ERM and CECAF met with the Sub-Director of ESIAs at the ANDE,

to present the Phase III project, and introduce the ESIA scoping study. The ANDE recognised that the Azito power plant had been authorised in 1999 by the MINEEF based on approval by the ANDE of the initial EIA undertaken by ERM.

In November 2011, ERM and CECAF met with the Director of the ANDE and the Director of the ESIAs department, Mr Kouassi, to present the Project and ESIA methodology. During these meetings, the ANDE confirmed that:

- The initial **terms of reference** issued by the ANDE in December 2009 remain applicable for the current ESIA.

- In terms of **overall scope**, the Phase III ESIA should rely on the 1998 EIA and focus on the extension project.

- Regarding the **approval timeline**: once the ESIA is submitted to the ANDE, the ANDE will issue an invoice for the fees payable. **Once the fees are paid, the overall permitting process should take no longer than two months**.

- Regarding **public consultations and the regulatory public enquiry**:
  - In application of Order 000972, the ESIA approval process must include a **2-week public enquiry**, managed by the ANDE. This is a normal process to ensure that stakeholders may express their comments and concerns prior to the approval and the ESIA, and to ensure that the final environmental and social management plan (ESMP) appropriately takes into account the stakeholder concerns expressed during the enquiry.
  - As part of the ESIA, it is strongly advised that the Project Sponsor engages with relevant stakeholders (in particular the local community) as part of **voluntary public consultations**, to ensure that stakeholder concerns are effectively taken into account from an earlier stage, therefore setting the conditions for a "smooth" regulatory public enquiry.

1.4.4 International treaties and conventions

In addition to being in compliance with Ivoirian statutory requirements, the Project should also be consistent with the international treaties applicable to the Project and to which Ivory Coast is a signatory. The international treaties and conventions applicable to the Project are presented in Table 1.1.

Table 1.1 International treaties applicable to the project

Name of the convention	Date of ratification by Ivory Coast	Objective of the convention	Aspects related to the Project
International Labour Organization Convention 182, Geneva, 1999	7/02/2003	Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labor	Working conditions and regulation on site during construction and operation of the Phase III Project
International Labour Organization Convention 138, Geneva, 1973	7/02/2003	Minimum Age for Admission to Employment	Working conditions and regulation on site during construction and operation of the Phase III Project
United Nations Vienna Convention, 1985	30/11/1992	Protection of the Ozone Layer	Atmospheric emissions (cooling installation) during construction and operation of the Phase III Project
United Nations Framework Convention on Climate Change (UNFCCC) of 1992	14/11/1994	The objective of the Convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system	Greenhouse gases emission during construction and operation of the Phase III Project
United Nations Convention on Biological Diversity (CBD), Rio, June 1992	24/11/1994	The objective of this Convention is to develop national strategies for the conservation and sustainable use of biological diversity and a fair and equitable sharing of benefits arising from genetic resources	Protection of the biodiversity in the surrounding of the Site during construction, operation and decommissioning phases of the Project
Basel Convention on the control of transboundary movements of hazardous wastes and their disposal, March 22, 1989	9/06/1994	International treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries	Waste management during the construction and operation of the Phase III Project
Bamako Convention on the Ban of the import into Africa and the control of transboundary movement and management of hazardous wastes within Africa, January 31, 1991	9/06/1994	This Convention defines strict rules concerning waste imports and movements, which have to be authorised by the authorities of each country and prohibiting the import of any hazardous (including radioactive) waste.	Waste management during the construction and operation of the Phase III Project

Name of the convention	Date of ratification by Ivory Coast	Objective of the convention	Aspects related to the Project
Ramsar Convention on wetlands of international importance, February 2, 1971	02/1993	Treaty on the conservation and sustainable utilization of wetlands, 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	Ebrié Lagoon and associated wetlands to be considered within the Phase III expansion Project development.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), also known as the Washington Convention, March 3, 1973	3/02/1993	Treaty developed to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species.	Protection of the biodiversity and species in the surrounding of the Site during construction, operation and decommissioning phases of the Project
International Union for Conservation of Nature and Natural Resources (IUCN)		Founded in 1948, the International Union for Conservation of Nature and Natural Resources (UICN) is an international organisation working on natural resources protection and sustainable use. The IUCN is the world's main authority on the conservation status of species. IUCN established a red list set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies.	Protection of the biodiversity and species in the surrounding of the Site during construction, operation and decommissioning phases of the Project
United Nations Montreal Protocol on substances that deplete the ozone layer, Montreal, September 16, 1987	30/11/1992	Protection of the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion.	Atmospheric emissions (cooling installation) during construction and operation of the Phase III Project
Convention for the protection and highlighting of marine and coastal area of West and Central Africa, Abidjan, March 23, 1981	15/01/1982	Develop scientific and technological collaboration (including the exchange of information and expertise), for the identification and management of environmental issues.	Technical collaboration on environmental issues to be developed and communicated as Ivory Coast is signatory of the Convention

1.4.5 International lender's environmental and social assurance requirements

The existing Azito project was funded through Azito Energie shareholders as well as by loans contracted with commercial banks and international financial and development institutions (IFC, CDC, AfDB, FMO, DEG, and the World

Bank). All of these institutions require that the Project comply with international-level standards of environmental and social management and performance. Therefore, the initial Azito ESIA, developed in 1998 by ERM, was undertaken with a view to support the Azito Project towards complying with the IFC environmental and social sustainability policy. For the Phase III expansion project, loans will also be contracted with IFC and therefore, the Performance Standards applicable to the Project will be considered selectively for the new, Phase III components of the overall plant.

The IFC Performance Standards

In April 2006, the International Finance Corporation (IFC) published the Performance Standards (PSs) that have become an international benchmark for the environmental and social assurance process of projects in which the IFC and other international lenders invest. These Standards have undergone a process of review after a 3 year period assessment, and the "new" version of the IFC Performance Standards has become enforceable since January 2012.

The Performance Standards are listed below.

Table 1.2 The IFC Performance Standards

N°	Title	Scope
1	Assessment and Management of Social and Environmental Risks and Impacts	Defines requirements for ensuring appropriate environmental and social management policy implementation and accountability, including Environmental and Social Impact Assessment requirements
2	Labour and Working Conditions	Defines requirements for ensuring definition and implementation of fair recruitment and workforce management policies
3	Resource Efficiency and Pollution Prevention	Defines requirements for ensuring an appropriate level of pollution prevention and abatement
4	Community Health, Safety and Security	Defines requirements for ensuring that adverse impacts from the Project on the receiving community are managed and controlled
5	Land Acquisition and Involuntary Resettlement	Defines requirements for land tenure management and community resettlement as part of Project development
6	Biodiversity Conservation and Sustainable Management of Living Natural Reource	Defines requirements for ensuring that the Project's impacts on nature, ecosystems, habitats and biodiversity are appropriately managed
7	Indigenous Peoples	Defines requirements for ensuring that the rights of autochthonous minorities are respected and that indigenous people may beneficiate from the Project
8	Cultural Heritage	Defines requirements for managing the Project's impacts on material and immaterial cultural heritage

IFC Performance Standards n°1 highlights the importance of managing social and environmental performance throughout the life of a project. It promotes the use of an effective social and environmental management system that is dynamic and continuous, 'promoting communication between the client, the workers, and the local communities directly affected by the Project'. It requires

'thorough assessment of potential social and environmental impacts and risks from the early stages of project development and provides order and consistency for mitigating and managing these on an ongoing basis.

The requirements of this Standard are:

- To identify and assess social and environmental impacts, both adverse and beneficial, in the projects area of influence.
- To avoid, or where avoidance is not possible, minimise, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment.
- To ensure that affected communities are appropriately engaged on issues that could potentially affect them.
- To promote social and environmental performance through the effective use of management systems.

Through the Performance Standards, IFC requires clients to engage with affected communities through disclosure of information, consultation, and informed participation, in a manner commensurate with the risks to and impacts on the affected communities.

The IFC Performances standards applicable to Azito power plant project are:

- Performance Standard 1: Social and Environmental Assessment and Management Systems.
- Performance Standard 2: Workforce and Labour Conditions.
- Performance Standard 3: Resource Efficiency and Pollution Prevention.
- Performance Standard 4: Community Health, Safety and Security.
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Reource.

Performance standards 5 (land acquisition), 7 (indigenous people) and 8 (cultural heritage) are not considered likely to apply for the Azito Phase III project. The Ebrié people, living in the surrounding of the Project location, are not considered as indigenous people in the sense of the IFC PS7. Ebrié people are one of the ethnic group forming the population of Côte d'Ivoire, originating from the area of the Ebrié lagoon. However, the Ebrié people are not essentially reliant on local natural resources, and can be considered as part of the economic and social "mainstream" of the population of the wider area of Abidjan.

IFC environmental, health and safety guidelines

In April 2007, the IFC issued Environmental Health and Safety (EHS) Guidelines defining operational levels environmental and social management and performance objectives, considered to be in line with best practice, and achievable for new projects, using existing technology, at reasonable cost. As part of the IFC's sustainability policy, projects are generally required to meet whichever target is the most stringent, of the host country regulations and the

IFC's EHS Guidelines. The IFC General IFC EHS guideline was adopted in 2007. The IFC EHS guideline applicable to thermal power plants was adopted in 2008.

At the time of developing the initial Azito Phase 1 and 2 Project, in 1997-1998, the applicable World Bank guideline for environmental performance was the World Bank Environment, Health and Safety Guidelines for Thermal Power Plants, issued in October 1996 – now superseded by the 2007-2008 versions of the IFC EHS guidelines.

1.4.6 Specific environmental regulations and guidelines applicable to the Project

Applicability of Ivorian regulations

The Azito facility is considered as a classified installation, subject to Order n°01164 of 04 November 2008 defining regulations of the discharges and emissions of classified installations for environmental protection. This order defines national standards particularly for noise, atmospheric emissions, and liquid discharges.

Applicability of World Bank / IFC guidelines

The Azito Project was initially developed in the late nineteen-nineties, for construction and commissioning of Phase 1 over the period 1999-2000. At this the Sponsor's policy was to develop the Project in compliance with the then-applicable World Bank Health and Safety Guidelines (*World Bank Environment, Health and Safety Guidelines, Thermal Power Plants, October 1996*).

The existing operating components of the Azito plant are therefore designed to comply with the 1996 guidelines. This is particularly applicable to the Azito Phase I and Phase II gas-fired turbines and their nominal performance in terms of abatement of atmospheric emissions. Nonetheless, where appropriate, for new Phase 3 components, the 2007-2008 version of the guidelines has been considered.

Noise

Limits for ambient noise levels generated by industrial facilities are defined in Order n°01164 of 04 November 2008. Reference is also made to the IFC General EHS guideline (2007).

Table 1.3 Regulatory limits for ambient noise levels at receptor point

Reference ->	**Ivorian Order n°01164 for new facilities (2008)***			**World Bank / IFC Guideline** (one hour LAeq)**	
Type of area ->	*Industrial*	*Urban residential (case of Azito)*	*Rural residential*	*Industrial*	*Residential (case of Azito)*
Day-time	75 dBA	50 dBA	45 dBA	70 dBA	55 dBA
Intermediate period	70 dBA	45 dBA	40 dBA	-	-
Night-time	60 dBA	40 dBA	35 dBA	70 dBA	45 dBA

** Order n°01164 was adopted in 2008, ie 10 years after the initial Azito EIA and 7 years after the commissioning of the Azito Phase I and Phase II units. These standards apply to new facilities. Compliance with the standards specified in Order 01164 , which are more stringent than those specified in the IFC General EHS Guideline, was therefore not included in the Phase 1 and 2 design.*
*** This guideline is consistent with the guideline used in the initial 1998 ESIA.*

Atmospheric emissions and ambient air quality

A comparison of Ivorian guidelines (Order n°01164) and the IFC guideline for thermal power is provided in the following table.

Table 1.4 Regulatory limits and IFC guidelines for atmospheric emissions

Determinant	**Maximum concentration in exhaust (mg/m³)**	
	Ivorian Order n°01164 for new facilities (2008)*	**World Bank / IFC Guideline*,****
Total Particulates	50	Not applicable**
NO_2	50	125 *(51)***

** Order n°01164 was adopted in 2008, and the IFC EHS guideline for thermal power was adopted in 2007, ie several years after the initial Azito EIA and after the commissioning of the Azito Phase I and Phase II units. At this time, the compliance standards used for the Azito Phase I and II facility were the then-applicable standards specified in the World Bank's Pollution Prevention and Abatement Handbook (1998), referring to the World Health's Organisation Guideline for 24-hr average concentration of NO_x applicable to European countries (1987) – this guideline was set at 150 mg/Nm³.*
**For gas-fired power plants over 50 MW. Quoting the IFC EHS guideline for thermal power (page 21, Table 6.(B) on emissions guidelines for combustion turbines): " *For projects to rehabilitate existing facilities, case-by-case emission requirements should be established by the Environmental Assessment considering (i) the existing emission levels and impacts on the environment and community health, and (ii) cost and technical feasibility of bringing the existing emission levels to meet these new facilities limits*."

In the initial 1998 ESIA for Azito, ambient air quality standards specified in the World Bank's Pollution Prevention and Abatement Handbook (1998), referring to the World Health's Organisation Guideline applicable to European countries (1987), were used. These are summarised in the following table.

Table 1.5 Regulatory limits and IFC guidelines for concentrations of pollutants in ambient air

Pollutant	Limit / Guideline (in µg/m³)[a]
NO_x [b]	
Max 1 hr mean	*(200)*
Max 24 hour mean	150
Max annual mean	100*(40)*
PM [c]	
Max 24 hour mean	110 *(25)*
Max annual mean	70 *(10)*

(a) The main value quoted is the World Bank Guideline (1988) used in the initial Azito 1998 ESIA.

(b) As a worst case it is assumed that all of the NO_x is in the form of NO_2

(c) As a worst case it is assumed that all of the particulate matter is in the form of PM_{10}

Updated from 1998 initial ESIA for Azito

Liquid effluents

A comparison of Ivorian guidelines (Order n°01164) and the IFC guideline for thermal power is provided in the following table.

Table 1.6 Regulatory limits and IFC guidelines for liquid effluents

Determinant	Maximum concentration in effluent (mg/L)	
	Ivorian Order n°01164 for new facilities (2008)*	**World Bank / IFC Guideline*,****
pH	5.5 - 8.5	6 – 9
Temperature	<40°C	• Site specific requirement to be established by the EA. • Elevated temperature areas due to discharge of once-through cooling water (eg 1 Celsius above, 2° Celsius above, 3° Celsius above ambient water temperature) should be minimized by adjusting intake and outfall design through the Project specific EA depending on the sensitive aquatic ecosystems around the discharge point.
Total suspended solids	Abatement of 80% or 150 mg/l if flux >< 15 kg/j 100 mg/l if flux > 15 kg/j	50
Oil and grease	30 mg/l if flux < 5 kg/j 10 mg/l if flux > 5 kg/j	10
Total hydrocarbons	10 mg/l if flux > 100 g/j	-
Total residual chlorine	-	0.2

** Order n°01164 was adopted in 2008, and the IFC EHS guideline for power plants was adopted in 2007, ie several years after the initial Azito EIA and after the commissioning of the Azito Phase I and Phase II units. At this time, the compliance standards used for the Azito Phase I and II facility were the then-applicable standards specified in the World Bank's Pollution Prevention and Abatement Handbook (1998).*

*** This guideline is consistent with the guideline used in the initial 1998 ESIA.*

1.4.7 Azito Health, Environment, and Safety Policy

Since the creation of the power station, Azito O&M has developed and put into place a mature QHSE and sustainable development policy.

The power station has been ISO 14001 certified since 2003 and AFAQ 1000NR since July 2006. Based on the AFAQ 1000NR certification, Azito O&M obtained a grade of 495 out of 1,000 points, putting it in the "maturity" category. Since its first evaluation in 2006, the power station has increased its grade and is now close to the 700 points needed to reach the "exemplarity" grade(1).

Since 2001, the management runs an annual satisfaction enquiry among Azito village. A sustainable development assistant has recently been hired by Azito O&M to manage the community development program and the contacts with the local populations.

Azito O&M sustainable development policy is focused around 4 axes: local economic development, protection of the environment, social equity and promotion of health. Each year, the management funds between 1 and 4 grants to local development projects. The management also supports local schools and a cooperative of women producing attiéké (from cassava). Azito O&M is also associated with development programs implemented by external agencies in the sector of health (Anti-AIDS Committee in Azito, support to the Azito health center, etc.).

Figure 1.4 Community development project supported by Azito Energie: Attieke factory

Source: Azito Site Visit, ERM 2011

On the site, Azito's environmental and social policy is well advertised, highlighting the company's leadership on environmental, health and safety as well as social management – this is particularly evident from the generally good housekeeping and absence of apparent environmental and EHS issues

(1) AFAQ 1000NR is an evaluation of the degree of integration of sustainable development principles in an organisation. The certification prepares the organisation to the ISO 26000 certification and is based on 4 levels of integration: engagement (between 0 and 200 points), progression (between 201 and 400 points), maturity (between 401 and 700 points) and exemplarity (between 701 and 1,000 points).

on the operational site, as well as abundant signposting for sensitisation on sustainable development across the site.

Figure 1.5 ***Community development project supported by Azito Energie: biogas production***

Source: Azito Site Visit, ERM 2011

Figure 1.6 ***Azito's aspiration to be a leader in sustainable development, advertised on the operating site***

1.5 ESIA OBJECTIVES AND METHODOLOGY

1.5.1 ESIA objectives

The main objective of this impact assessment is to ensure the consideration of the environmental and social sensitivities within the definition and implementation of the Project, to prevent any type of contaminations and nuisance and integrate sustainable development consideration within the construction, operation and decommissioning phases of the Project.

In order to reach this objective, the following steps should be considered:

- describe the Project ;
- define the baseline environmental and social characteristics of areas potentially affected by activities in the Project's construction and operations phases, based on existing data collection and analysis;
- evaluate and describe the potential impacts from the Project on the physical, biological and social environment and the associated risks ; and
- identify the mitigation measures and compensations needed to attenuate or prevent the potential negative effects and develop an Environmental and Social Management Plan (ESMP) that will present solutions to manage the potential residual impacts.

1.5.2 ESIA methodology

Data for this ESIA was obtained from secondary and primary sources. Secondary sources included Project-related environmental impact assessment documents previously developed by Azito, assessments for other projects conducted in Ivory Coast, statistics from local representatives of relevant Ivoirian ministries, and reports and publications from international agencies and research institutions. Primary sources were gathered in a field trip by ESIA specialists to Abidjan in November 2010, November 2011 and December 2011. An objective of the trip was to validate available data and fill data gaps related to the environmental and social aspects of the Project through observations, public consultation event, and key informant interviews.

Following data collection, the ESIA team identified potential impacts due to the presence of the Project. The team then utilized an assessment scale to determine the significance or likelihood of potential impacts and prioritize those potential impacts that require mitigation. Rating is based on professional judgment consistent with industry guidelines; regulations, agency concerns, stakeholder considerations, and industry norms are also taken into account. Section 4 presents and describes assessment scales in greater detail.

Following its assessment, the ESIA team captured mitigation measures from identified potential impacts in the ESMP presented in Section 6.

1.6 STRUCTURE OF THE REPORT

This report is organised according to the following sections:

- *Section 2* Project description
- *Section 3* Environmental and social baseline study
- *Section 4* Impact assessment and analysis
- *Section 5* Presentation of the mitigation measures
- *Section 6* Environmental and Social Management Plan (ESMP)

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

The Azito power station, as planned in the initial project from 1998, consisted of building, owning, operating and eventually transferring to the State a gas-fired power station with a total capacity of approximately 420 MW, to be implemented in three phases, each of around 140 MW.

Construction works began in July 1998, and the first phase (one turbine) was completed in January 1999. The second phase (similar to phase I) was commissioned in February 2000. The third phase (upgrading the plant from single cycle to combined cycle power generation) was initially planned for commissioning in 2002, but political instability in the country impeded the financing and development plan of the Project.

Azito Energie now proposes upgrading the existing power station by the addition of two heat recovery steam generators (HRSG) to the existing turbine trains, and one steam turbine generator (STG). This chapter describes the various Project components, and is divided into the following sections:

- description of the power sector context in Ivory Coast;
- overview of the Project sponsors;
- project location;
- project description :
    - existing installations;
    - phase III expansion Project;
- description of the activities associated with the construction, operation and decommissioning of the Project; and
- presentation of the Project alternatives.

2.2 POWER SECTOR CONTEXT IN IVORY COAST

Since 1984, unusually dry weather and ensuing hydroelectricity shortage in Ivory Coast demonstrated the vulnerability of generating electricity from hydroelectric facilities and sensitised the government to the need to define and direct a comprehensive and coherent energy policy.

In 1990, the Ivoirian Government initiated an important restructuring phase of the power sector by granting the management of the national public service for generation, transmission, distribution, export and import of electrical energy to a private company. This restructuring was aimed at securing self-financing and the sector's financial stability as well as optimising the operation of the electric utility system.

The discovery at the end of years 1993 and 1994 of the "Lion" offshore oil and associated gas field, and of the "Panthere" offshore dry gas field, gave the government the opportunity to consider thermal energy as an option for further development of its generating facilities.

With this in mind, the government signed an agreement in 1994 with a private operator – Compagnie Ivoirienne de Production d'Electricité (CIPREL), for the construction, operation and transfer of ownership of a thermal power generating facility of approximate 210 MW capacity (Vridi II, in the Abidjan area). The public-private partnership agreement reached with CIPREL, the first of its kind in Ivory Coast and in Sub-Saharan Africa, demonstrates the Government's intent to divest from the electric generation sector.

With the strength of this first successful experience in the field of independent electricity production, the Government intended to pursue and intensify its policy for cost reduction and efficiency improvement of the sector, to support the economic growth in Ivory Coast. These objectives were to be reached through the efficient use of oil and gas resources available in the country, as well as by allowing the establishment of other independent producers, thus promoting competitiveness in the sector.

Construction works of the Azito power station began in July 1998, and the phases I and II units were competed in February 2000.

The peak demand on the national Ivoirian power system was reaching approximately 910 MW in 2010, with an average demand of about 590 MW. The available generating capacity is approximately of 880 MW, consisting of the Azito Existing Plant (290 MW), the CIPREL plant (a simple-cycle gas-fired power plant with a capacity of 320 MW), the Aggrekko plant (70MW), all located close to Abidjan, plus approximately 200 MW of hydropower located a few hundred kilometers away from the consumption centers. There is therefore no power reserve available and the existing plants have to follow the load very closely.

Over the last years, there has been growing political will to resume the development of the third phase of the Azito Project.

2.3 PROJECT LOCATION

The site is located near the Azito village in the Yopougon District, approximately six kilometres west of the port of Abidjan. The site is located alongside the western arm of the Ebrié lagoon, approximately 10 km from the inlet of the Vridi canal. The Béago village is located 300 m to the North-East of the Azito site.

The site access is provided by an existing road, sufficient for truck transport of all kind of equipment.

The site is bordered by a gas treatment unit, independently operated by Foxtrot, which provides condensate-free feed gas to Azito (along the northern fence), and by an electrical switchyard operated by the *Compagnie Ivoirienne d'Electicité* (CIE – national electricity distribution company). Both units are presented in *Figure 2.2*.

Figure 2.1 General project location in Abidjan

Figure 2.2 Site-level location

2.4 EXISTING INSTALLATIONS

Facilities layout

The facility therefore currently consists of two gas turbines, each of them combined with a generator. The existing gas turbines are designed to operate with natural gas (main fuel source) and distillate oil (back-up option).

Existing infrastructures include the turbine and generator halls, transformer, control room, maintenance workshops, offices, catering, utilities and storages including a compressed air system, a firewater system, two 6000 m^3 distillate oil tanks (never used since commissioning, currently in the process of being emptied of the low-quality distillate oil they contain and refurbished), an oil bunkering system, a waste water treatment unit (mainly for the treatment of skid bund and area bund effluents, as well as sanitary effluents), and a treated wastewater collection and evaporation pond.

The overall land-take of the site is approximately five hectares.

Figure 2.3 Existing Azito facility (turbine halls and exhaust stacks)

Source of gas

The gas used to run the actual phase I and II units comes from three sources in Ivory Coast: the Devon fields (Lion/Panthere), the Foxtrot field and the CNR fields (Espoir/Baobab). However, gas is primarily supplied to the plant by the Foxtrot field. The initial gas study undertaken for the Phase I and II project confirmed the availability of gas reserves until 2022. The Sponsors have commissioned a gas supply study which will be provided to the Lenders and which will provide updated information on the gas supply in Ivory Coast and the supply to the expanded plant.

Storage of hazardous products

The products and chemicals routinely stored on site are relatively low, as presented in *Table 2.1* below.

Table 2.1 List of product stored on site and location of the storage

Product	Location	Estimated volumes
Sulfuric acid	Hazardous product storage area Demineralization area Battery storage area Fire pumps area	210 l
Caustic soda	Hazardous product storage area Demineralization area	60 l
Butane gas (bottles)	Hazardous product storage area Boiler area Restaurant Chromatography area	140 l stored in liquid form
Gasoil	Hazardous product storage area Fire pumps area Diesel generator	200 l
Solvents	Hazardous product storage area	30 l
Lubricating oils	Hazardous product storage area	2 800 l

Product	Location	Estimated volumes
Transformer oil	Hazardous product storage area	400 l
Natural gas	From the Foxtrot gas treatment unit to the gas turbines	No gas stored on site
Diesel	Fuel oil tanks, with a capacity of 6000 m³ for each train	230 m³ remaining in tank 2
Acetylene, oxygen	Hazardous product storage area Mechanical workshop	Oxygen: 22.5 m³ Acetylene: 18 m³

As mentioned previously, two fuel tanks, with a capacity of 6,000m³ each were installed during the initial construction phase in 1999. A few production tests were performed with distillated oil in 2000 but the turbines have always been operated with gas. Azito is now in the process of emptying the tanks, to safely dispose of the off-spec fuel oil that is still in storage. One of the tanks is already empty and the second one still contains approximately 230 m³ of product. The tanks are currently in the process of being refurbished. The current annual water consumption of the site is 7 500 m³ (2 500 m³ coming from the municipality and 5 000 m³ from the borehole).

Current operations of the Phase I and II generate various types of wastes. Azito O&M doesn't keep monthly records of the volumes of wastes produced but organises inventories on a regular basis. The table below shows the main types of hazardous and non-hazardous wastes generated from the beginning of 2011 and currently present on site.

Table 2.2 Waste on site

Waste Type	Volumes collected (Situation at the end of 2011)	Volumes collected (Situation of the end of February 2012)	Treatment
Non-Hazardous Solid Waste			
Non-Hazardous Solid Waste including used filters	266 m³ (including 154 m³ of air intake filters)	28 m³	Disposed by Lassire Déchets (contracted by Azito O&M, the company collects wastes every time the quantity stored exceeds 8 m³)
Special Solid Waste			
Empty containers/drums of chemicals	43	50	Sent back to the supplier
Used batteries	365	365	Disposed by OAI until 2008, currently stored on site
Toners	16	18	Stored on site
Used batteries	22	22	Stored on site
Bulbs	1492	1500	Stored on site
Electrical wastes	95	97	Given to the technical school of Abidjan for practical work of students
Soiled rags	773 kg	775 kg	Disposed by ENVIPUR
Computers	2	2	Stored on site
Electronic wastes	15 kg	17 kg	Given to the Regional Academy of Science and Technology of the

Waste Type	Volumes collected (Situation at the end of 2011)	Volumes collected (Situation of the end of February 2012)	Treatment
			Sea for the practical work of students
Silicagel	5	5	Stored on site
Contaminated sands	0	0	Stored on site
Air-conditioner	3	3	Stored on site
Oil filters	4	4	Stored on site
Liquid waste			
Industrial used oil	0	0	Disposed by SIRH FM or other registered company

Source: Azito, direct communication, February 2012

Wastes are temporary stored on site in the dedicated storage area before collection by an accredited waste management company. The storage site is clearly defined and visible and waste categories are labelled. General housekeeping of the area is considered to be good. Some of the wastes are currently stored on site since a few years (batteries, toners, light bulbs, IT material) as Azito is in the process of identifying and contracting an appropriate reprocessing company in Ivory Coast. Volumes of wastes are relatively limited.

A copy of Azito's waste management plan is presented in Annex G.

Figure 2.4 Current waste storage area

Personnel

The existing Plant currently employs 35 permanent personnel, headed by the Plant General Manager. The plant personnel are described by Azito Energie as skilled and experienced; it is apparent that the majority has been employed at the plant since Phase I in 1999.

2.5 *THE PHASE III EXPANSION PROJECT*

The conversion of the plant from simple-cycle to combined-cycle will be accomplished by the addition of two heat recovery steam generators (HRSG), one steam turbine generator, and one steam condenser with an associated closed-loop, air-cooled cooling water system.

When operating in combined cycle mode, the exhaust gases from the combustion turbine-generator (CTG) will be directed to the HRSGs, where heat will be recovered from the turbine exhaust gases, to generate steam in the form of superheated high pressure (HP) steam and low pressure (LP) steam. Steam from each pressure level will be admitted to the steam turbine.

The Phase III expansion therefore entails no creation of a new combustion sources, and no incremental consumption of gas. The extension essentially consists in improving the energy efficiency of the plant, from approximately 29,5% (Phase I + Phase II) to approximately 44% (including Phase III), by recovering energy currently disposed into the atmosphere as "waste heat" in the warm turbine exhaust gases.

The main plant components are presented on the map on *Figure 2.5* and described in more detail in *Table 2.2*. The map is also presented in larger format in *Annex B*. The installations and buildings labeled with a blue number on the map are the ones associated with the phase III expansion project. The green numbers indicate an existing building or installation.

Figure 2.5 Overall project concept including phase III expansion

Source: Azito Energie

Table 2.3 Main Phase III plant components

Expanded Plant Main Components and description	
Thermal Process	After the plant expansion, the flue gases will be led to the HRSG. Steam is generated in the HRSG by heat transfer from the flue gases to the feedwater, which is converted into steam. The HRSG is a dual pressure boiler comprising a high pressure steam system and a low pressure steam system.
Gas Turbine Exhaust System	The expansion will include the modification of the existing gas turbine exhaust system. The contractor will extract the existing elbow under the exhaust stack and replace it with a motor operated flue gas diverter damper with air sealing system. In addition, a blanking plate with a manual hoist will be included to allow the safe operation of the gas turbines during the construction period
Main Cooling System	The steam exhaust from the steam turbine will be recycled via an air-cooled condenser.
Closed Cooling Water System	A closed cooling water system will be provided to supply cooling water to the various plant equipments. Two plate type water/water heat exchangers are provided to cool the water in the closed cooling water system which is fed from the main air cooled condenser system.
Compressed Air System	The compressed air system will consist of instrument air and service air. The compressed air is generated in a centralized compressor station which supplies the two different air qualities. The instrument air is filtered and dried and the service air is just filtered.

Expanded Plant Main Components and description	
Chemical Laboratory	The chemical laboratory will include all equipment which is necessary to carry out routine water analysis. Water quality of the condensate, cooling water system, and make-up water for the cooling system can be analyzed.
Buildings	The new steam turbine will be housed in a new building with a new overhead crane. In addition a new warehouse and administrative and control building will be built on site.
Plant Electrical System	The steam turbine generator will be connected to the step-up transformers via a generator circuit breaker and isolated phase bus ducts.
Distributed Control System	The steam turbine proprietary control system will be interfaced to a new plant distributed control system to provide common human machine interface for the operator in a new central control room. The two existing gas turbine control systems will be modified to integrate them into the combined cycle distributed control system to provide integrated operation and control of the plant. A new central control room will house the workstations and the printing devices. The existing gas turbines operator station, information and engineering stations and other peripherals will be moved from the old control room to the new control room and integrated in the new distributed control system architecture.
Power Evacuation and Transmission	As part of the Project, an additional connection to the adjacent substation will need to be constructed, but no additional transmission lines are required for the evacuation of the additional power that will be produced by the expanded plant.

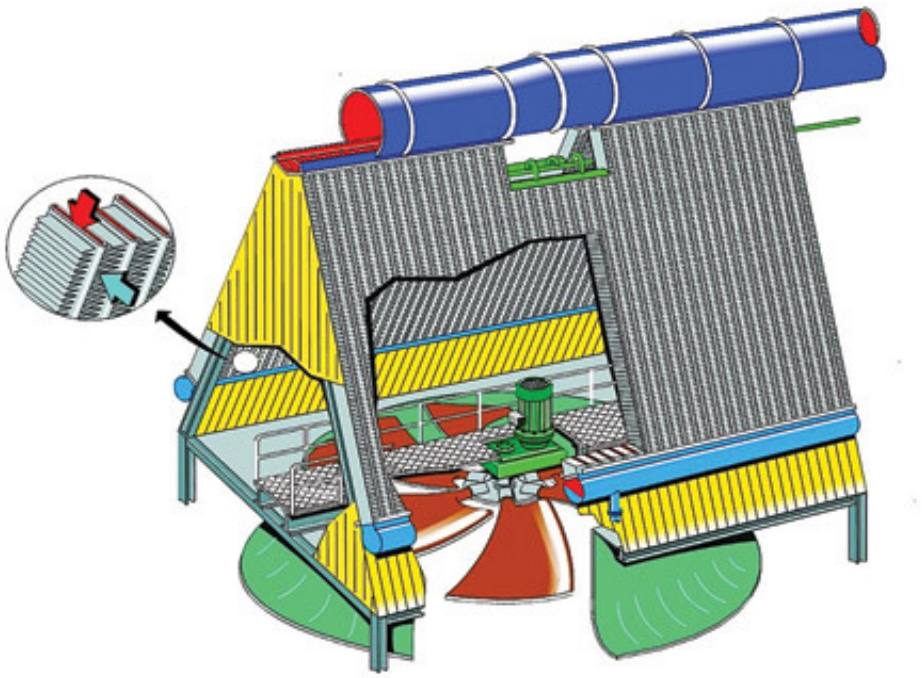
2.5.1 Cooling installations

As mentioned in the above table, the exhaust steam from the steam turbine will be completely condensed by a forced draft direct air-cooled steam condenser built in modular configuration and roof-type construction.

This direct dry cooling option condenses turbine exhaust steam inside finned tubes, which are externally cooled by ambient air instead of the lagoon water.

Steam discharged from the turbine exhaust enters a steam distribution manifold located on top of the cooling structure. The steam is then distributed into the fin tube heat exchangers. Flowing down inside the tubes, steam condenses due to the cooling effect of ambient air drawn over the external finned surface of the tubes by the fans. The fans are located at the bottom part of the A-shape framework. Condensate drains from the tube heat exchangers into condensate manifolds and then drains to a condensate tank, before being pumped to the conventional feed heating plant, or to the boiler.

Figure 2.6 Air cooled condenser



Source : http://www.powermag.com/water/Air-cooled-condensers-eliminate-plant-water-use

The closed cooling water system (CCWS) is a closed water circuit, filled with demineralised water, supplying various installations throughout the plant with clean, non-corrosive cold water. For recirculation, cooling water pumps are provided. Final heat dissipation is ensured by an air blast cooler. The recirculated water in the CCWS is treated with an inhibitor to protect the system components against corrosion. The cooling water flow to each installation is adjusted with make-up water taps, in order to match the specific temperature requirements. A head tank provides the necessary buffer volume to accommodate expansion due to varying water temperature in the CCWS. It also maintains sufficient pressure throughout the system and serves as a reservoir in case of water losses.

2.5.2 Water sources

Two main sources will cover the water requirements of the Site during the operations phase:

- Potable water for the use of staff at the facility is supplied from the existing mains supply which provides water to the nearby village of Azito.

- Raw water for make-up for the closed-circuit steam generation water system, for general use and for fire fighting purposes, will be supplied from the existing well, as filtered water. From terminal point Phase III,

the raw water will feed into an existing raw water storage tank (Phases I&II) as well as into a new raw water storage tank (1,300 m^3) serving the water treatment plant. Both existing and new raw water tanks will be linked one to the other. The existing pump and filtration unit capacity are assumed to be sufficient to feed the Phase III as well as the existing infrastructures requiring water supply.

The existing well on the Azito site was installed in 1999 for phase I and II of the Project. It was drilled to 60m deep and has a production capacity of 45m^3/h. Pumped water is currently directed to a 1000 m^3 buffer tank used for fire fighting purpose as well as for compressor cleaning after demineralisation process.

High purity water will be produced in the water treatment plant. A new demineralised water supply system will replace the existing equipment. This plant consists of ion exchanger trains, using activated carbon filters, cation, anion and mixed bed exchangers. The water produced is collected in the demineralised water storage tank. From the tank all demineralised water consumers are provided by a set of transfer pumps. Phases I&II demineralised water needs are covered by the demineralised water production plant.

2.5.3 Wastewater

Current wastewater management

Three types of wastewater are currently collected from the Azito site: operational wastewater, storm water run-off, and sanitary wastewater.

- Operational oily waste water from bunds and collecting sumps are stored in a dedicated collecting basin and treated in a de-oiling section for grit and oil removal. The resulting oils and sludge are pumped by means of two dedicated oil and sludge pumps, respectively, to the site perimeter to be collected for treatment and disposal by an independent waste management company. The water from the separator is directed to the neutralisation pond.

- The GT compressor washing water and boiler cleaning water are combined with sanitary waste water and collected into a lifting station. The water is then pumped to a biological treatment facility. All waste waters flow to the junction pit to be equalised with waste waters from other sources.

- Sanitary waste water produced in the power station is combined with GT washing water described above. The sanitary water is also directed to the biological treatment facility.

After equalisation in the junction pit, the water is neutralised by chemical dosing and pH adjustment. All waters flow from the neutralization pond to the evaporation pond (capacity of 780 m^3). When the level of the pond reaches

its maximum limit, a local laboratory is subcontracted by Azito to analyse the water. If the concentration measured for the various parameters analyses respect the Ivoirian guidelines for liquid effluents, the water is pumped out of the pound and discharged in the open land bordering the site on its eastern side.

Transformer oil spillages at the existing transformer are collected separately in an oil collecting basin (oil and water separator). Treated water is directed to the drainage circuit and discharge out of the site, in the open land located on the south western side of the site, together with the rain water.

Rain water is collected from building roofs through cast iron drains and galvanised steel down-spout pipes to the main system. The existing underground system is made of PVC pipes and standard reinforced manholes/gullies. The PVC pipes are surrounded with 150mm of lean concrete at roads and paved areas crossing. Surface water, collected by road gutters and drainpipes, is maintained separate from other waste drain and is connected with the existing storm water discharge into the lagoon, to the west of the site.

Phase III wastewater

During operations, there are no expected significant wastewater discharge, apart from occasional system purge, on-site drainage, and sanitary effluents. Wastewater from the Phase III expansion Project will be directed to the existing water treatment installations on site. *Figure 2.7* below presents the anticipated water balance of the plant once Phase III is operational. The volumes presented in the diagram have to be considered as worst case and will not be discharged continuously in the ponds.

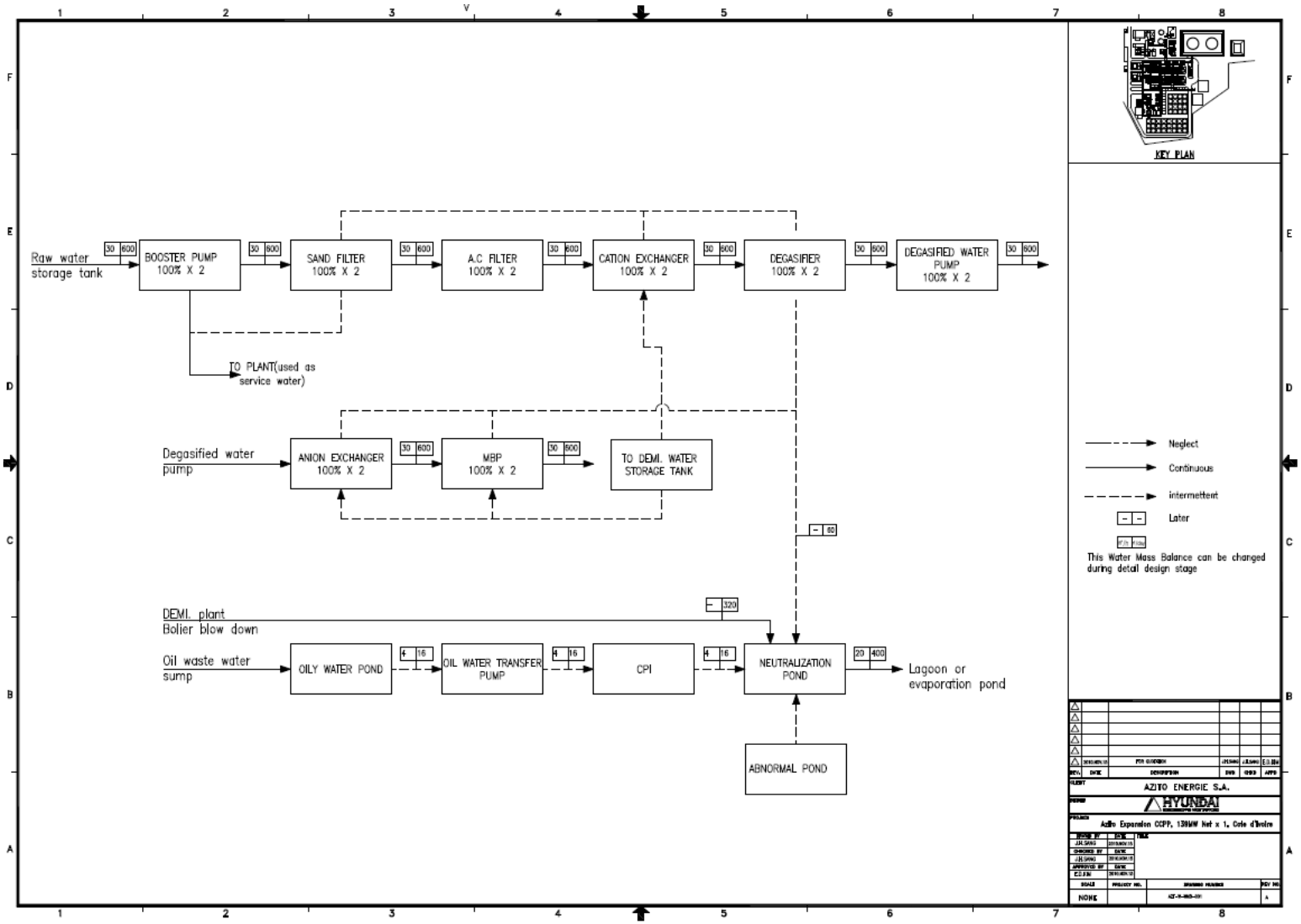
All process and sanitary waste water from the Phase I, II and III (oily waste water, boiler blow down water) will be routed to the neutralization pond for chemical dosing and pH adjustment and then directed to the existing waste water evaporation pond in the north-east corner of the site. The pond is made of reinforced concrete and is currently not protected with any specific coating. A proper lining or coating might be added to the pond as part of the Phase III construction.

A fully automatic process will control the quality of the waste water (pH and temperature) in the neutralization pond and adjust it before being transferred to the evaporation pond. The quality of the evaporation pond water will be controlled and analyzed by an accredited laboratory before the excess water is pumped out of the pound and discharged in the open land located on the south western side of the site.

During the construction phase, the key source of wastewater may be sanitary wastewater from the construction camp. Such wastewater will be collected in

a mobile treatment plant, for treatment to a quality level compatible with the IFC EHS guideline, prior to being discharged into the Abidjan lagoon.

Figure 2.7 Water balance diagram



Source : Hyundai

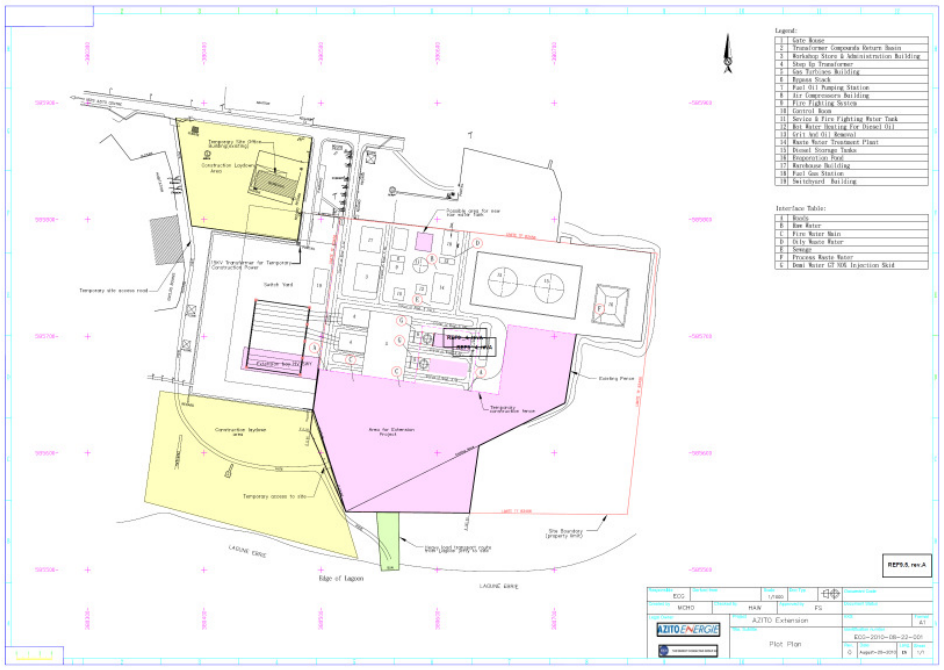
2.5.4 *Land acquisition & involuntary resettlement*

The Azito Phase III expansion project does not require any land acquisition, since the extension will be built over land already part of the Azito concession. The temporary lay down areas and workers accommodation camps during the construction phase may occupy land outside of the site limit, within the existing 300 metres exclusion zone around the existing power plant.

The map presented on *Figure 2.8* shows the existing site limit (red line), the location of the Phase III expansion area (pink) and the temporary lay down and workers accommodation camps (yellow area). A copy (larger version) of this map is presented in *Annex B*.

The original concession for the Azito project was granted by the State of Ivory Coast after relocation of the local users of land by the State, prior to the development of the Azito facility in 1997-1998. Populations of the Azito village were compensated as part of this relocation process.

Figure 2.8 Map with site limit, Phase III location and temporary lay down area



Source: Azito Energie

2.6 OVERVIEW OF THE MAIN PROJECT COMPONENT

2.6.1 Construction

Timing

As soon as the ESIA has been approved and the loan granted, Azito management wishes to start the construction. The construction phase is expected to last 27 months, leading to the commissioning of the upgraded facility in 2014.

Buildings to be constructed

The plant buildings/facilities that will be constructed for the Phase III are:

- steam turbine shelter;
- HRSG;
- air-cooled condenser installation;
- control and electrical building;
- water treatment building;
- administrative building; and
- warehouse.

Earthworks

Earthworks include only the excavations necessary to achieve the works (eg for foundations) and the backfilling after completion of these works. Except the open ditch, no existing structures and services are to be demolished or relocated. The actual average elevation of the construction area is between +1.50m and +4.50m above sea level, whereas the reference platform level of the existing power plant is at +4.50m above sea level.

Transport of equipment & workforce

The transport of the equipment will occur by vessel or barge from Abidjan port to the site in the Lagoon up to a jetty to be restored by the contractor south of the site.

As the site access is provided by an existing road, sufficient for truck transport of all kind of equipment, access shall be possible during the whole project execution time. Access to the construction area will be guaranteed via a temporary road to be built by the Contractor from the existing main road north of the site along the HV switchyard to the south-west corner of the site.

No permanent access will be granted via the existing power plant main access road. This route will only be used in exceptional cases. The construction area will be isolated from the existing plant to prevent construction personnel from straying onto the operational plant site. Access from the operational plant site to the construction area will be through a single guarded gate.

Workforce construction

Azito expects that there will be a peak construction workforce of approximately 600 workers at the peak of the phase III construction phase. Most of this workforce will be employed by the engineering, procurement and construction (EPC) contractor and will consist in semi-skilled to skilled workforce. Azito Energie expects that up to about 50 workers may be directly employed from the surrounding local communities in primarily unskilled positions (semi-skilled and skilled positions will be advertised through a normal recruitment process).

2.6.2 Operation

Maintenance programs

The Azito gas turbines are currently following 8,000 and 32,000 equivalent operating hours ("EOH") intervals between the A, B and C major maintenance inspections. The A and B inspections are done on alternating 8,000 EOH intervals, ie an A inspection at 8,000 EOH, a B inspection at 16,000 EOH, and the next A inspection at 24,000 EOH, and then the C inspections are done at 32,000 EOH intervals. The ratio of EOH to actual operating hours ("AOH") is currently running around 1.24. This ratio is expected to remain essentially unchanged into the foreseeable future since it is anticipated that the Expanded Plant will enjoy an even more favourable dispatch merit order after conversion to combined cycle resulting in its continued high capacity factor.

After conversion to combined-cycle operation, the major maintenance inspection schedules of the HRSGs and steam turbine will be integrated with those of the gas turbines. Typically, the HRSGs will be inspected annually during the A or B inspection outages of their corresponding gas turbines. More substantial inspections of the HRSGs will occur during the longer outages for the C inspections of the gas turbines.

The steam turbine will undergo minor inspections every 3 years and major inspections every 6-7 years (both coinciding with GT C inspection outages). Since the steam turbine major inspections tend to require a longer outage than a GT C inspection and also recognizing the added complexity of combined-cycle operation, the Concession Agreement availability targets have been adjusted accordingly.

Monitoring and control

Water/steam cycle chemistry will be controlled by a continuous feed of phosphoric acid into the boiler drums to control the pH of the boiler water and to avoid scaling in the drums. Ammonia and oxygen scavenger will also be fed into the feedwater tank or condensate system to control the pH and oxygen content in the water/steam cycle.

One sampling system will continuously monitor the various chemical control parameters via samples obtained from sampling points throughout the HRSG

cycle. The sampling system will condition, analyze and monitor samples of steam, blowdown, condensate, feedwater, closed cooling water, and make-up water. The analyzing equipment will be arranged on a common sampling rack.

In case of a grid failure, the steam turbine will be tripped, the HV breaker will be opened and the gas turbine generator will provide power for the house load operation of the plant. In case of loss of AC-power in the plant the battery powered DC/UPS-systems in combination with a stand-by diesel generator set provides a reliable power supply to ensure safe shutdown of the plant.

Waste production

The extended power plant will produce no significant quantities of solid process waste compared to the actual situation. Packaging and general domestic waste will be collected by an independent waste management company (currently, Azito Energie has contracted the Ivorian company Lassire as waste removal and disposal contractor) and disposed of at the municipal dumping area in Abidjan.

2.6.3 Decommissioning

Having entered commercial operation in 1999 (GT11) and in 2000 (GT12), the gas turbines and associated installation are currently 12 and 11 years old respectively. Up to May 2010, GT11 and GT12 had accumulated 128,000 and 114,000 EOH, respectively. When conversion to combined cycle is completed in 2014, the Existing Plant equipment will be about 14 to 15 years old with at least another 20 years of useful service anticipated.

Decommissioning should therefore not take place before 2034. As described in the convention signed with the Ivoirian government, the Azito Power Station will be transferred by Azito Energie to the Ivory Coast State 20 years after the construction of the Phase III and the decommissioning work will therefore be the responsibility of the Ivoirian authorities. Decommissioning activities should be consistent with Ivoirian regulations and internationally-recognized guidelines and standards. Azito Energie will offer suggestions and assistance during the decommissioning activities, as part of the hand-over period.

2.7 PROJECT ALTERNATIVES

Initial consideration of alternatives (1998)

Alternatives related to the site location, fuel supply and the no-development option were presented in the ESIA report in 1998. The conclusion of the assessment mentioned that, given the practical and logistical advantages of the Azito site, the clear advantages of natural gas as a fuel, and the disadvantages of the no-action alternative, the proposed power station site and choice of fuel was appropriate and result in minimal environmental and/or social impacts as compared to the other alternatives.

Alternatives considered for cooling as part of the updated Phase III studies

Regarding the Phase III Project specifically, different cooling options were considered. The different alternatives are presented in this section.

The original 1998 project considered a main cooling system using water, which would provide cold water to the steam turbine condenser and the cooler of the closed cooling water system. Warm water would return to the cooling tower where it would be cooled and collected in the cooling tower basin.

This alternative proposed that lagoon water would be abstracted from a submerged housing to be built 150 m from the shoreline and pumped through a 0.8 m diameter pipeline placed on the bed of the lagoon. Only the pumps, trash screens and stop logs will be located on the Ebrié Lagoon shoreline, and all other facilities will be located within the plant perimeter. The lagoon water was assessed in 2010 . The amounts of suspended or floating solids was considered as low, and therefore would be acceptable for the cooling water system with only coarse screening. The quality of the water from the lagoon was however considered as poor.

The characteristics of this tower blow down water were calculated as follow:

- temperature : 34°C ;
- flow rate : 1050 m^3/hr ; and
- total dissolved solids (TDS) : 48,000 ppm.

A preliminary assessment of sensitive receptors in the vicinity of the station and in particular in the Ebrié Lagoon as well as an impact assessment of the water discharge was developed in the 1998 ESIA report.

In 2010 a new alternative for the main cooling system was developed using an air-cooled condenser. This system is presented in *Section 2.6.1*. The main advantage of this installation is that it does not require pumping cooling water (from river, sea or lagoon) for the cooling of the steam generated by the HRSG. Nor does it require discharging warm cooling water into the environment – this option is therefore clearly preferable in terms of limiting environmental on water quality in the Ebrié lagoon.

This direct dry cooling option condenses turbine exhaust steam inside finned tubes, which are externally cooled by ambient air instead of the lagoon water.

Table 2.4 presents the selection criteria and compares the benefits of each of the two alternatives.

Around the world, many plants are being forced by changing environmental laws and public pressure to develop power generating facilities using closed-

circuit cooling water systems or dry cooling options rather than continue with once-through river or ocean cooling water.

The project developer may also select dry cooling alternative early in a project because it increases plant sitting options and the use of this alternative can significantly accelerate approval of construction permits because water use issues can delay the entire permitting process.

Based on this information and given the poor quality of the water from the lagoon, the alternative selected by the Project proponent is option 2 – air cooled condenser.

Table 2.4 Cooling options selection criteria

Criteria	Option 1 : water cooling	Option 2 : air cooling
Technical	• This option requires the construction of the cooling tower and water abstraction system development (submerged housing to be built 150m from the shoreline and associated piping)	• Installation of the air cooled condenser requires grading and levelling of ground prior to construction of the new installations
Schedule	• Extended engineering period due to the construction of the cooling tower and water abstraction system • Potential extended procurement period.	• Shorter construction schedule. • Potentially shorter permitting process
Environmental	• Water pumped in the lagoon has the potential to impact the biodiversity of the aquatic biotope (fish and plankton pumped in the water abstraction system). • Warm water discharge in the lagoon will impact the biodiversity of the lagoon by changing the biophysical characteristic of the discharge area.	• No water will be pumped out of the lagoon • No warm water discharge in the lagoon • Electricity needed for the air cooling installation (fans installed underneath the structure).

3 ENVIRONMENTAL AND SOCIAL BASELINE

3.1 INTRODUCTION

This section describes the baseline environmental and social characteristics of areas potentially affected by activities during the construction and operation phase of the project.

The Phase III Project will be developed within the existing Azito facilities site. This environmental and social description will therefore consider the current situation, including the two gas turbines and associated installation, as the baseline situation.

The first sections of this chapter describe the Study area and the data collection methodology. The third section presents the public consultation process and agenda and the key stakeholders for the Phase III Project.

The following sections handle the physical, biological and social baseline environment of the study area. Environmental and social baseline characteristics that are addressed in this chapter include:

- *Physical environment*: The physical environment incorporates the terrestrial environment and the fluvial environment including processes such as climate and meteorology, geology, hydrology, air quality, ambient noise and geomorphology.
- *Biological environment*: The biological environment incorporates the terrestrial and aquatic fauna and flora that inhabit the Study Area, with emphasis on their habitats and/or ecological importance.
- *Socio-economic environment*: The socio-economic environment concerns characteristics of the population that inhabits the Study Area, such as demographics, socio-political organization, economy and livelihoods, health, and infrastructure and services.

The final section of this chapter summarizes the key sensitivities within the physical, biological, and socioeconomic environment of particular interest to this ESIA.

3.2 STUDY AREA

The study area includes the main Azito project site where activities are foreseen to take place, as well as the surrounding area that may be vulnerable to direct and indirect impacts on the natural and human environment. Most impacts are expected to be limited to within a 0.3 km radius around the Azito site.

The extended area covers the potential zone of influence of the Project. Based on a preliminary analysis of the environmental and social sensitivities, this zone of influence roughly corresponds to a 2 km radius around the Azito site. This radius was considered as an area within which the impacts associated with the noise emissions of the Azito Power Plant are most likely.

Those areas are illustrated in *Figure 3.1*.

Figure 3.1 Proposed areas for the Azito Phase III ESIA

3.3 *DATA COLLECTION METHODOLOGY*

Data supporting this baseline study consisted in secondary as well as primary data.

Secondary sources include the review of Project-related environmental impact assessment documents previously developed by Azito Energie, assessments for other projects conducted in Ivory Coast, statistics obtained from local representatives of relevant Ivoirian ministries, and reports and publications from international agencies and research institutions.

Azito Energie provided documents such as the Environmental Report, Internal Operation Plan (POI), analytical results of the atmospheric emissions, water quality analysis for the well, pond and the Ebrié lagoon and Activity Report. Relevant information coming from these documents is included in this chapter.

Data related to the social environment have mainly been gathered from publicly available sources such as scientific literature on communities from

the Ebrié Lagoon area, results of the latest national census, development reports.

Primary data were gathered during study field missions on the Azito site, in November 2010, November 2011 and December 2011. The field work focused on social data collection, land use survey of the proposed site for the planned extension, biodiversity survey of the environment potentially affected by the Project and consultations with key stakeholders, such as national and local government, non-governmental organisations and local populations. Daytime and night-time ambient noise measurements were made, on and around the main project site.

3.4 PUBLIC CONSULTATIONS

3.4.1 Methodology and agenda

As required by the Ivoirian regulation and as part of the IFC's environmental and social sustainability policies, the ESIA included engagement with Project-affected communities through disclosure of information, consultation, and informed participation. The extent of this engagement should be in proportion with the risks to and impacts on the affected communities. *Figure 3.2* below present the requirements for the consultation process as described in the IFC policies.

Figure 3.2 Typical requirements for the consultation process

The process applied to consultation and disclosure throughout the ESIA is summarised below.

1. Identify a sufficiently broad sample of stakeholders to meet the consultation objectives and record them in a stakeholder database. The sample is chosen to ensure representative involvement of the various types of stakeholders.

2. Prepare disclosure materials for the consultations, including project information for disclosure and a meeting or focus group format/technique suitable for the specific objective.

3. Arrange and carry out stakeholder consultations, ensuring that relevant protocol is met and that the consultation format (meetings/focus groups) is suitable for each stakeholder group.

4. Document the consultation process, ensuring that viewpoints and issues of concern raised by stakeholders are included in subsequent reports for further research or assessment, and demonstrating how these have been taken into consideration in the Project decision-making process and design.

5. Ensure that all information for disclosure is disclosed early enough to allow adequate consideration prior to consultation; fully accessible; and relevant and understandable (for example, including non-technical summaries, appropriate graphics and languages etc).

Public consultations undertaken during the ESIA also facilitate preparation of the public inquiry required by Ivorian environmental permitting regulations. Two rounds of consultation have already taken place in 2010 and 2011:

- **The first round of consultation** took place during the preliminary scoping visit in 2010. The aim was to present the Project and to receive feedback from the most important stakeholders about the planned extension of the Azito plant.

- **The second round of consultation** was held in November 2011. The objective was to inform key stakeholders on the scope of the assessment and the proposed project and to obtain feedback from them.

- **A third round of consultations** is planned in 2012 as part of the ESIA disclosure phase.

Key stakeholders consulted during the first and second rounds include:

- National and local Ivoirian authorities:
    - ministry of Environment (ANDE);
    - ministry of Energy; and
    - mayor of Yopougon district.

- Local communities: village of Azito (through official meeting with village chief, and public meeting):
    - consultation of the Azito notabilities and village chief; and
    - consultation of representatives of various focus groups.

- Local communities: village of Béago (same as for Azito):
    - consultation of the Béago notabilities and village chief; and
    - consultation of representatives of various focus groups.

- Local interest groups (consulted through focus groups):
    - cooperative of attiéké producers (women); and
    - cattle farmers.

The outcomes of the consultations (held in 2010 and 2011) are presented in the Public Consultation and Disclosure Plan (PCDP) in *Annex A*.

3.4.2 Key stakeholders for the Azito Phase III Project

Figure 3.3 presents the main stakeholders in the vicinity of the Project, as well as other institutional or relevant financial stakeholders. The table does not consider the stakeholders within the Project (owners, sponsors and operators) as they are presented in the Chapter 1.

Figure 3.3 ***Main stakeholders of the Project***

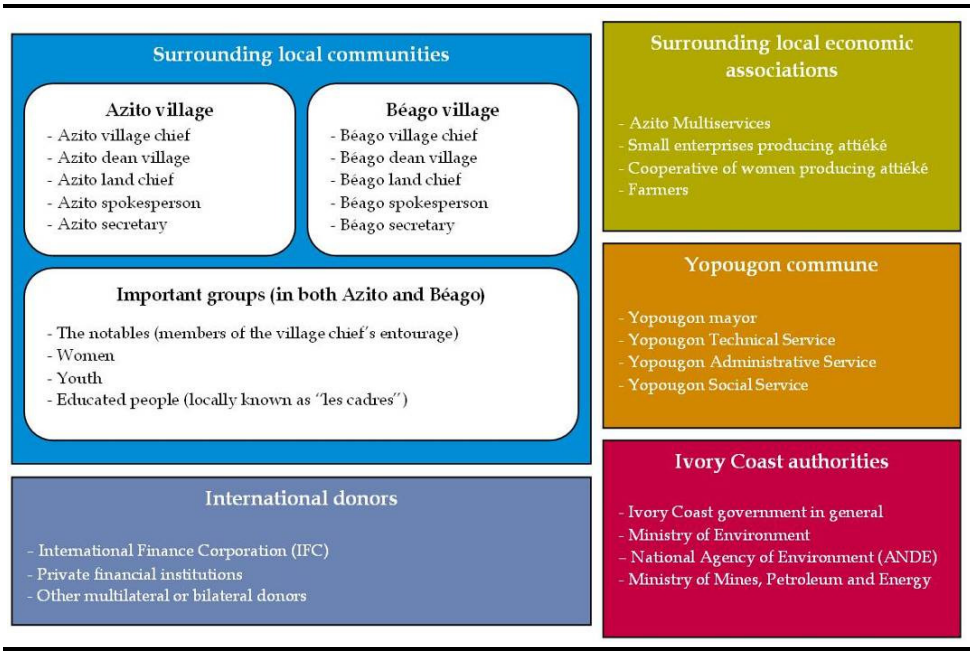
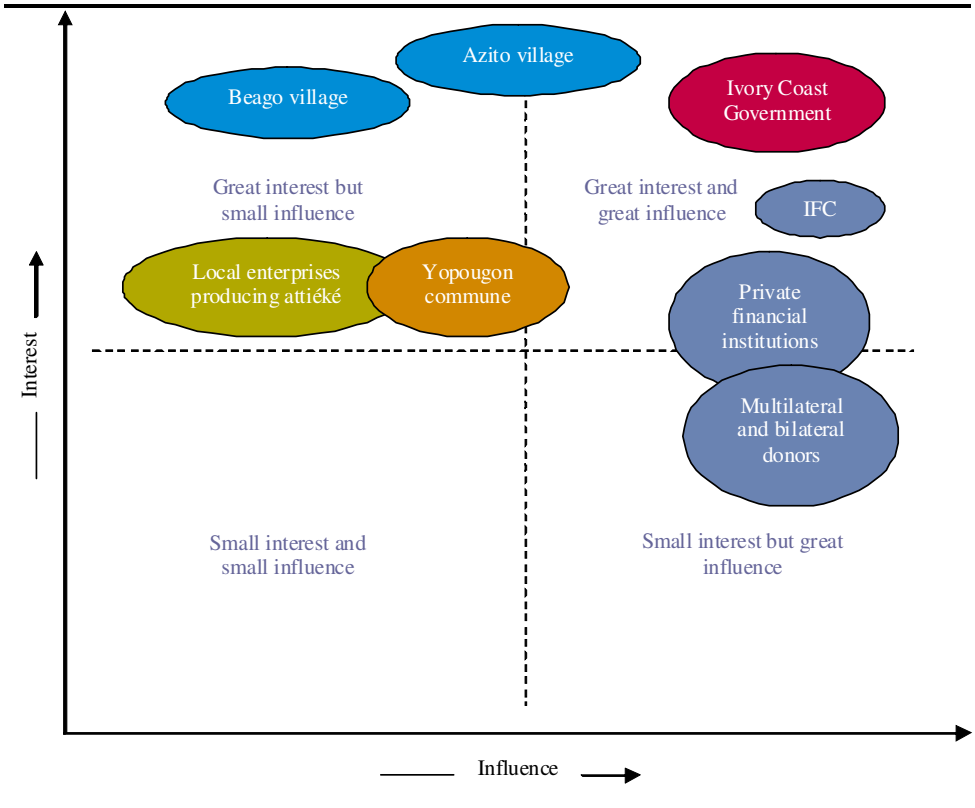


Figure 3.4 presents a map of key stakeholders, based on ERM's evaluation of:

a) their interest in the Project; and
b) their ability to influence the Project in terms of permitting, financing, implementation and operation.

Figure 3.4 ***Interest and influence of stakeholders***



The residents of Azito village are recognised traditional owners of the land prior to the development of the Azito concession. The Azito village is the nearest community surrounding the Project. The Azito residents are therefore the most significant stakeholder group, both in terms of interest in and influence on the Project. Since the development of the Azito power plant, Azito Energie has recognised that maintaining appropriate communication and a harmonious relationship with the communities at Azito is key in maintaining a social license to operate for the project. As for the village of Béago, which is more remote and not custodian of land on or around the Azito site, the proximity of the Azito plant makes residents sensitive to air and noise emissions, and likely to have an interest in potential economic benefits associated with the project.

3.5 PHYSICAL ENVIRONMENT

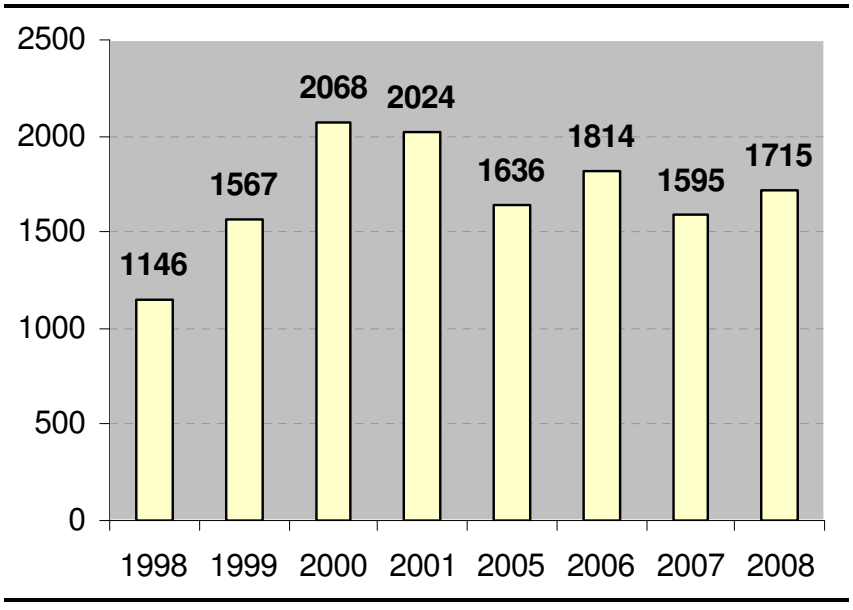
3.5.1 Climate and meteorology

Ivory Coast is situated in the equatorial tropical climatic zone. The climate of this region is influenced by the seasonal displacement of the Inter-Tropical Convergence Zone (ITCZ). The alternation of dry and rainy seasons results from the annual north-south migration of the ITCZ, which is due to the yearly positional changes of the earth in relation to the sun.

Rainfall

Precipitations vary between 1 500 and 2 000 mm per year. The average annual rainfall for Abidjan is 1847.6 mm. *Figure 3.5* below presents the annual rainfall between 1998 and 2008 (SODEXAM, Abidjan airport station).

Figure 3.5 Annual rainfall from 1998 to 2008



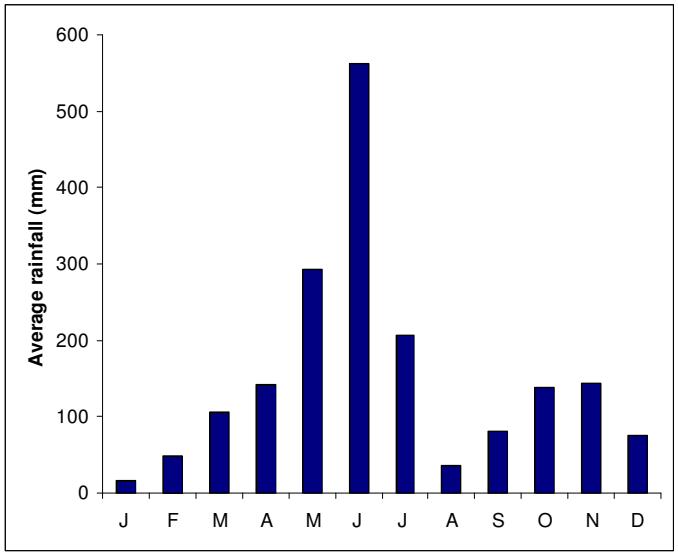
Source: SODEXAM
Caption: Annual rainfall in millimetres

Rainfall distribution in the regions is bimodal, with the maximum levels of precipitations in June and October and the minimum in January-February and August (*Colin et al, 1994*). The main rainy season generally occurs between May and July. However, intense rainfall can also be observed in April. The short rainy season occurs between October and November

The months of August and September, often named as the short dry season, are dry and cool. The main warm and dry season occurs between December and March.

Figure 3.1 below exhibits these climatic features: a bimodal structure, for the two rainy seasons. During the first wet season maximal rainfall clearly occurs in June. During the second wet season rainfall is evenly distributed over time, which results in overall similar rainfall level. Due to higher intensity, average rainfall is higher during the first wet season.

Figure 3.6 Average monthly rainfall for Abidjan



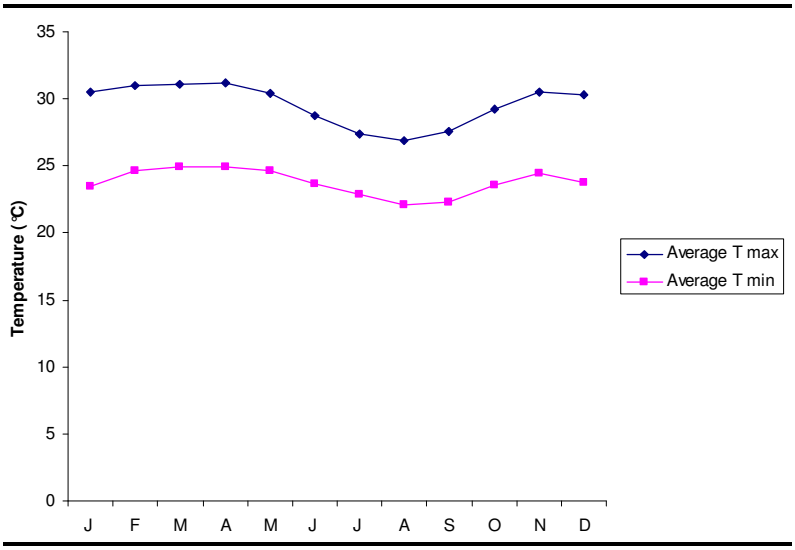
Source: Meteo France, 2011

Temperature

The average air temperature recorded near Abidjan is 26°C with a minimum temperature of 25°C in August and a maximum temperature of 28.6°C in March.

Monthly average maximum and minimum air temperatures are presented in *Figure 3.7*. The annual average minimum air temperature is 23.8°C and the annual average maximum air temperature is 29.6°C. Extreme temperatures occur in March – April (about 31°C) and in August (about 22°C).

Figure 3.7 Monthly mean maximum and minimum air temperatures



Source: Meteo France, 2011

Evaporation

Evaporation within the lagoon varies spatially; the areas near the exit of the lagoon are influenced by the intrusion and mixing of sea water, and will have slightly higher temperatures, leading to different evaporation rates compared with areas where the influence of the sea is weak, eg to the west of Jacqueville.

Wind

Ivory Coast is situated in the Inter-Tropical Convergence Zone, the area near the equator where winds originating in the northern and southern hemispheres come together. The location of the Inter-Tropical Convergence Zone (ITCZ) varies over time. The ITCZ stays near the gulf of Guinea from December to April. In May the ITCZ starts moving up to the North to reach its most northern position in August. The ITCZ reaches its most southern position in January, as shown in *Figure 3.8*.

Figure 3.8 Inter-Tropical Convergence Zone in January (left) and in July (right)

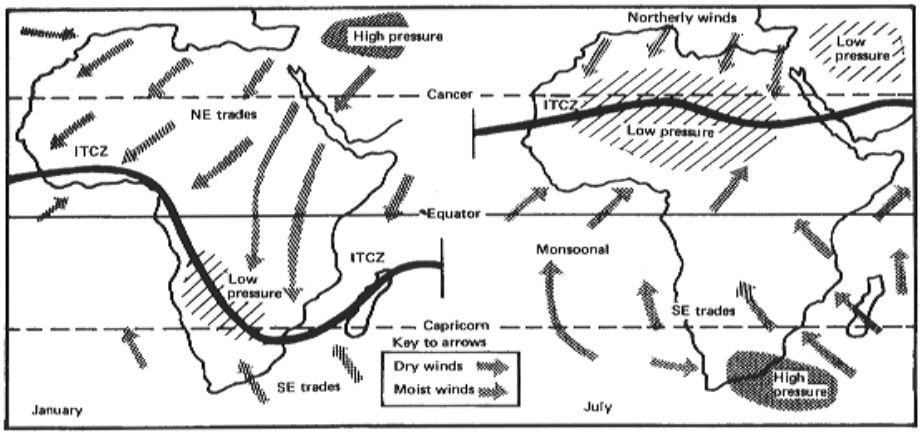


Fig. 3. Prevailing winds and approximate location of the Inter-Tropical Convergence Zone (ITCZ) over Africa, January (left) and July (right) (source: Ker et al. 1978).

Source : Ker et al., 1978

Winds from the south west are the most predominant in the Abidjan region. The most common hourly average wind speeds are in the range 7 - 10 knots (3.5 - 5 m s^{-1}), occurring for 57% of the time. High hourly average wind speeds in excess of 60 knots (30 m s^{-1}) were recorded on three days in 1993. The range of wind speeds recorded during the period 1990-1993 together with the percentage frequency of their occurrence are presented in *Table 3.1*.

Table 3.1 Hourly Average Wind Speeds Recorded in Abidjan in 1990 - 1993

Wind Speed Range (knots)	Percentage Frequency (%)
0 - 3	12.9
4 - 6	18.6
7 - 10	57.1
11 - 16	10.1
17 - 21	1.0
>21	0.6

The Ivoirian continental shelf is subject to the anti-cyclonic system of the Southern hemisphere. In the same way as the equatorial zone, it is subject to the influence of the trade winds. There is a significant seasonal and inter-annual variability in the wind field. The monsoon trade winds blow 10 months of the year from the southwest and southeast. They are generally weak (3 to 4 m/s), regular and characterised by a daily cycle. Their speed can increase during the northern summer (4 to 6 m/s).

3.5.2 Geology

The coastal zone in the Abidjan region is an area of low relief with an average altitude of 3.0 m. The altitude at the Azito power plant site varies between 0.5 m and 5.0 m over a distance of about 500 m with a gentle slope of approximately 1% towards the lagoon in the south and southeast. Towards

the east of the site two watercourses carry runoff from the town of Yopougon and other nearby urban areas. They discharge the collected water into the lagoon. Close to the lagoon and watercourses, the land is particularly flat and marshy.

The geology of the area is essentially a sedimentary basin of medium to coarse grained sandy strata with depths in excess of 70 m. and the formation contains isolated layers of clay. These sedimentary strata are underlain by a 40 m layer of limestone and sandstone, which is in turn underlain by shale and granite gneiss. The latter form the major part of the continental plateau to the north.

The 1:50,000 geotechnical map of Ivory Coast indicates the Azito power station site has soils of loose sandy clay, of between 1 m and 4 m depth, with pockets of silt and clay. Close to the lagoon, and particularly in the marshy areas, the soils are sandy with shell deposits and vegetative debris.

3.5.3 Hydrology

The study area covers part of the Ebrié Lagoon. The three main rivers discharging into the Ebrié Lagoon are the Agneby to the west of the study area and the Comoé and The Mé to the east.

The Comoé River is the major source of fresh water for the lagoon with a catchment area of 78 000 km^2. The river system drains the savannah region in the north of Ivory Coast and in the southern part of Burkina Faso. The other two major sources of fresh water, the Mé and the Agneby rivers, have catchment areas of 4 300 and 8 900 km^2 respectively. The lower annual average discharge and the seasonal runoff pattern reflect the rainfall distribution in the coastal area. The Ebrié lagoon also collects water from smaller streams and from precipitation within the lagoon area. All water discharged from the eastern and western parts of the lagoon will flow through the Ebrié Lagoon to the sea via the Vridi Canal.

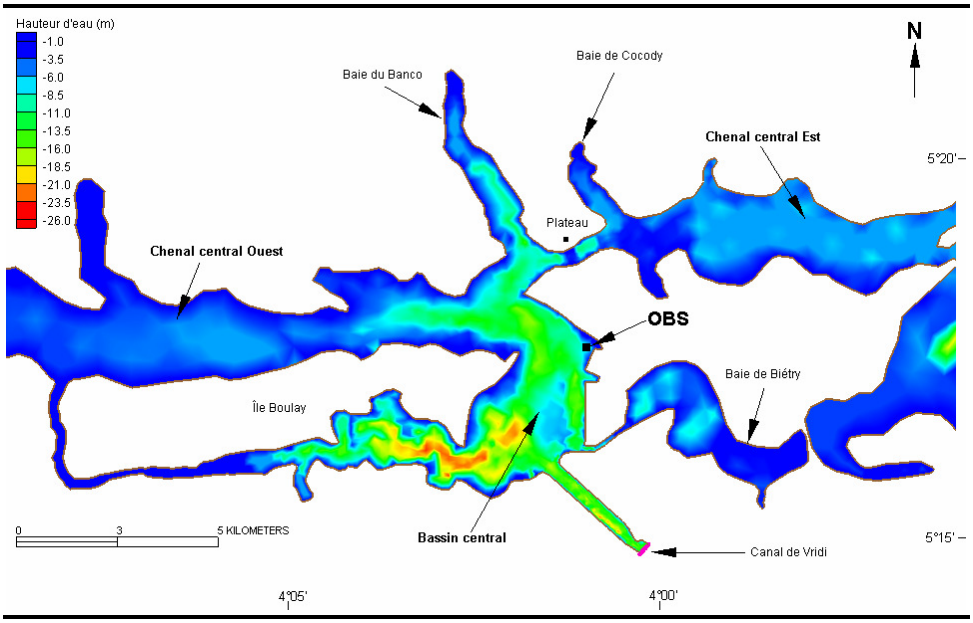
The volume of marine water entering the lagoon varies seasonally and depends on the relative hydraulic levels of the lagoon and the ocean (maximum during the dry season, minimum during flood events).

3.5.4 The Ebrié Lagoon

The Ebrié lagoon lies parallel to the coast and is separated from the ocean by a 0.8 km to 8 km wide sand barrier. The sand barrier has an elevation between 2 m and 10 m. The lagoon is approximately 140 km in length, 4 km in width and 4.8 m in depth. The total surface area is 566 km^2 and the total estimated perimeter is 644 km. The total estimated lagoon volume is $2.5x10^9 m^3$. The only connection of the Ebrié lagoon to the Atlantic Ocean is the Vridi Canal, which was opened in July 1950 to facilitate the expansion of the Port of Abidjan. The Adiopodoume, Biétri, Banco, Cocody, Marcory and Koumassi bays are located around the Vridi Canal. With the exception of the port area (Abidjan bay and

surrounding regions), the depth of the lagoon does not exceed 8 m (see *Figure 3.9* below).

Figure 3.9 Bathymetry of the Ebrié Lagoon



Source: Wango et al. 2002

Currently industrial and domestic waste waters are discharged in the lagoon. The lagoon is a resource for fisheries and is also used for navigation purposes.

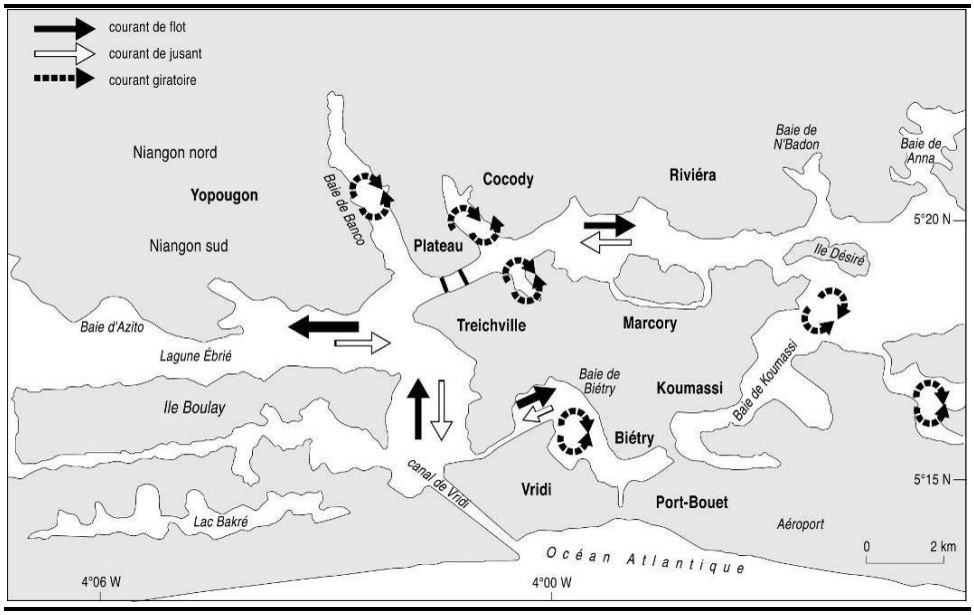
Tides and currents

The tidal variation in water levels in the Atlantic Ocean generate flood and currents through the Vridi Canal and hence into the lagoon. The influence of the tidal currents diminishes with distance from the ocean.

The influence of the tidal currents extends approximately to Agneby - 40 km from the Vridi canal. Azito, some 10 km from the Vridi canal in the western lagoon, will experience a tidal range of 55 cm for a 1.0 m tide in the sea.

The main currents in the Ebrié lagoon are represented in *Figure 3.10* (including flow and ebb currents).

Figure 3.10 Currents in the Ebrié lagoon sector



Source: Affian, 2006

Hydrodynamics

The difference in the bathymetry between the eastern and western part of the lagoon, the seasonal variation of freshwater inflow and the propagation of tidal influence will result in different spatial and temporal circulation patterns. During periods of low water, with water depths of about 5m, high freshwater inflow volumes and mixing by the wind prevent saline stratification in the main shallow channels of the eastern lagoon. Saline stratification may occur in the deeper water of the Abidjan Basin and in other enclosed basins where fresh water inflow is low.

The lagoon has a complex hydrodynamic regime, particularly due to the large fluvial inflows in the east via the Comoé River during the high runoff season between September and October. This can influence water movements throughout the lagoon. West of Jacqueville this influence is diminished by continuous freshwater inflow. This constant renewal of fresh water forms an effective barrier to the landwards movement of saline water.

The lagoon ecosystem is directly and indirectly affected by the seasonal variation in marine and terrestrial inflows and, on this basis, the lagoon can be considered to be affected by three seasons:

- Dry Season (January to April) - rainfall and runoff are negligible, evaporation is high and the influence of the marine tidal currents dominates - high temperature and saline stratification in the deeper waters near the Vridi Canal and the Abidjan Basin.

- Rainy season (May to October) - rainfall and runoff from the local catchment area is high and the influence of the marine tidal current is limited - lower temperature (reaching a minimum) and the water column is well mixed by the wind.

- Runoff Season (September to December) - runoff from the larger Comoé catchment draining the north of the Ivory Coast. In most areas there is very low or no salinity observed. Salinity gradients can occur however when high salinity water bodies are trapped in the deeper parts of the estuary near Abidjan due to fluvial freshwater overlaying marine water at depth.

These three seasons may vary each year, depending on the dominance of precipitation and fluvial flows.

Water quality

The section below presents a summary of the water quality of the Ebrié Lagoon based on the available information.

- **Temperature:** Water temperatures in the Ebrié Lagoon show similar seasonal pattern as the air temperatures with a minimum of 27.4°C in August at the end of the main rainy season and maximum of 31.2°C in April. The average water temperature is 29.5°C. These water temperatures can be considered representative for the whole water column at Azito expect between January and May. During this period there is a slight temperature difference (maximum of 3.3°C) between the surface and bottom of the water column.

- **Salinity:** The salinity of the Ebrié lagoon depends on terrestrial and marine exchanges, hydrodynamics, morphology and bathymetry. It varies from 25‰ in the Vridi canal to less than 2‰ during flood periods. Marine water intrusion occurs during the dry season between January and April. The salinity of the lagoon decreases between May and November as freshwater inflow from river catchments dominate. The available data indicate a weak salinity gradient at Azito during the period January to May. During this period stratification may occur. This is not the case during the remaining period from June to December, during which the water column is well mixed. Throughout the lagoon there are enclosed areas with a high renewal rate of fresh water which may become seasonally stratified. These areas are fed only by freshwater runoff and unstable estuarine areas with mixing and interactions with marine water. The Azito sector is complex in terms of hydrodynamics with a range of saline conditions occurring throughout the year.

- **pH:** Variations of pH evolution depend on salinity conditions. During high salinity period, pH is basic whereas low salinity periods are associated with acid conditions.

- **Turbidity:** The turbidity of the water can be very high. Average turbidity levels measured in the surface layers at Azito between January 1973 and November 1974 are 122 mg/L.

- **Dissolved oxygen:** Dissolved oxygen levels at Azito are generally greater than 80% saturation. Towards the east of the lagoon in the deeper water body of the Abidjan basin, these oxygen levels are significantly lower. The oxygen level decrease further and even become anaerobic in enclosed areas such as the Bietri basin where inflow of fresh water is limited.

Water samples of the Ebrié lagoon were analyzed in August 2010 by the Ivoirian ENVAL Laboratories. Results are presented in *Table 3.2* below.

Table 3.2 Ebrié lagoon water quality analyses

Parameter	Unit	Lagoon water sample (depth of the sample: 2m)
pH		6.43
Temperature	°C	24.8
Conductivity	µS/cm	27,000
Turbidity	NTU	4.68
Total Suspended Particles	mg/L	100
Bicarbonates	mg/L	25.96
Nitrates	mg/L	0.67
Ammonium	mg/L	0.3
Chloride	mg/L	9,998
Sulphates	mg/L	1,281
Oxydability in KMnO4	mg/L	17.6
Calcium	mg/L	1308
Magnesium	mg/L	887
Sodium	mg/L	194,920
Potassium	mg/L	500
Silicium colloidal	mg/L	7.6
Silicium molybdate active	mg/L	4.05
Iron	mg/L	<0.006
Manganese	mg/L	<0.002

Source : ENVAL, 2010

Table 3.3 Ebrié lagoon: dissolved oxygen

Depth	Dissolved oxygen	
	mgO2/L	% O2 of saturation
0.25	6.6	80
0.5	5.76	70
1	5.36	65
1.5	4.54	55
2	4.2	50

Source : ENVAL, 2010

The water from the Ebrié lagoon presents high bacteriologic contamination, mainly due to waste water discharge and the lack of sanitary networks in the city of Abidjan.

Table 3.4 Coliforms and Clostridiums in low water season

Location	Coliforms (quantity per 100 mL)	Colistridiums (quantity per 100 mL)
Boulay Island	0	75
Yop Santé	220	160
Banco Bay	1735	720

ETIALAG, 2003

3.5.5 Groundwater

Groundwater of the area flows to the south and east in the direction of the lagoon.

The city of Abidjan has a population of 3.9 millions (in 2009) and a potable water demand of 461,000 m^3/day. This water is supplied by 77 groundwater wells in the underlying sandy formations. Most of these wells are situated less than 10 km to the north of the lagoon area and are implanted parallel to the shoreline. Groundwater is abstracted at a depth of approximately 100 m.

This sedimentary formation to the north of the lagoon houses an important aquifer which represents a major source of potable water for Abidjan. In certain parts of the water body, particularly around Abidjan and other urban areas, the levels of nitrate, nitrites and ammonia in groundwater are high due to pollution from sewage sources.

Elevated concentrations of chlorine are observed, particularly in the Plateau area, east from the Ebrié lagoon. These elevated concentrations are caused by saline intrusion from the Atlantic Ocean via the Ebrié lagoon and by excessive groundwater abstraction resulting in a decrease of groundwater levels beneath the lagoon water level. These excessive abstractions are prevented in most areas due to inspection and monitoring of groundwater abstraction. Generally, saline intrusion is limited to a 1 km zone inland from the lagoon

Groundwater quality at the Project Site

A groundwater production well was installed in 1999 at the site. The well is 60 m deep and has a flow rate of 45 m^3/h. The abstracted groundwater pumped is temporarily stored in a 1,000 m^3 tank. The stored groundwater is mostly used for fire-fighting purposes and, after demineralisation, for industrial cleaning operation.

Groundwater samples were collected directly from the well and at the plant draw-off. The samples were analysed by ENVAL Laboratories in November 2011. The analytical results are presented in *Table 3.5* below.

Table 3.5 Groundwater analytical results (ENVAL Laboratoire, 2011)

Parameter	Unit	Azito well (sampled inside the well)	Azito well (sampled at the plant input)
pH	-	6.73	6.25
Temperature	°C	27.4	28.2
Conductivity	µS/cm	522	551
Dissolved Oxygen	mgO2/L %	5.4 63	3.75 44
Nitrate	mgNO3/L	00	9.68
Sulphates	mgSO4/L	25.1	37.25
Bicarbonate	mgHCO3/L	69.8	70.03
Ammonium	mgNH4/L	43	47
Chloride	mgCl/L	55.31	62.47
Orthophosphate	mgPO4/L	0.0125	0.025
COD	mgO2/L	13.33	3.81
Iron	mgFe/L	6.89	13.1
Manganese	mgMn/L	0.032	0.021
Potassium	mgK/L	19.99	18.17
Sodium	mgNa/L	58.24	68.9
Calcium	mgCa/L	25.25	25.65
Magnesium	mgMg/L	4.31	4.21

3.5.6 Waste water

Wastewater generated by the site operations (sanitary, cleaning and oily waters) are discharged into the evaporation pond, located along the eastern boundary of the site. When the level of the pond reaches its maximum limit, a local laboratory is subcontracted to sample and analyse the water. If the concentration measured for the various parameters analyses comply with the Ivoirian guidelines for liquid effluents, the water is pumped out of the pound and discharged in the open land bordering the site on its eastern side.

Site management reported that the pond is usually sampled and emptied two times per year. pH adjustments are sometimes needed before the water is discharged in the environment. Analytical results dated from 2010 and 2011 (ENVAL Laboratoire, 2011 / CIAPOL, 2010) are presented in the table below.

Table 3.6 Effluent water analytical results

Parameter	Unit	IFC	Prefectural order 09.09.1999	Pond (SW angle)	Pond (NE angle)	Pond (SW angle)	Pond (NE angle))	Pond (SW angle)	Pond (NE angle))	Pond (SW angle)	Pond (NE angle))
				Jan 2007		March 2008		March 2010		July 2011	
Physico-chemical											
pH	-	6-9	5.5-8.5	8.52	8.55	7.2	7.23	10.03	8.81	8.1	7.9
Temperature	°C	-	40	29.3	29.6	32.2	31.3	34.6	34.7	28.4	27.2
COD	mg/L	-	500 if flux < 150 kg/j 250 if flux > 150 kg/j	61	74	490	460	164	378	76.2	48
BOD_5	mg/L	50	150 if flux < 50 kg/j 100 if flux > 50 kg/j	15	20	200	200	40	150	24.88	20.5
Suspended	mg/L	50	150 if flux	3.3	8.7	38	36.4	50	91	2.4	0.02

solids			< 15 kg/j 100 if flux > 15 kg/j								
Organic micro pollutants											
Oil and grease	mg/L	10	10	0	0	5	4.75	10	20	0.3	0.06
Total hydrocarbons	mg/L	-	10 if flux > 100 g/j 20 if flux < 100 g/j	<DL	<DL	-	-	-	-	3.56	1.56

3.5.7 Air Quality

Ambient air quality

The Azito site is located on the south-western side of Yopougon. The district is characterised by small-scale local industry and low-rise residential housing. Likely sources of contaminant emissions to air in the Project area are:

- Vehicles (private vehicles and commercial transport mainly).
- Domestic fuel and charcoal use for open-fire cooking and lighting.
- Local industry: industrial activities around the Azito site are limited to small-scale activities and crafts; the Yopougon industrial area lies some six kilometres to the North-East.

Ambient concentrations of air pollutants are not monitored in Ivory Coast.

The 1998 ESIA developed for the proposed power station project by ERM estimated the annual average pollutant background concentrations of the Project area, taking into account the potential emissions, the land use and knowledge of concentrations in similar environments. The ranges are outlined below:

- Annual mean NO_2 concentrations in the range 5 - 25 µg m^{-3};
- Annual mean SO_2 concentrations in the range 2 - 10 µg m^{-3}; and
- Annual mean PM_{10} concentrations in the range 10 - 50 µg m^{-3}.

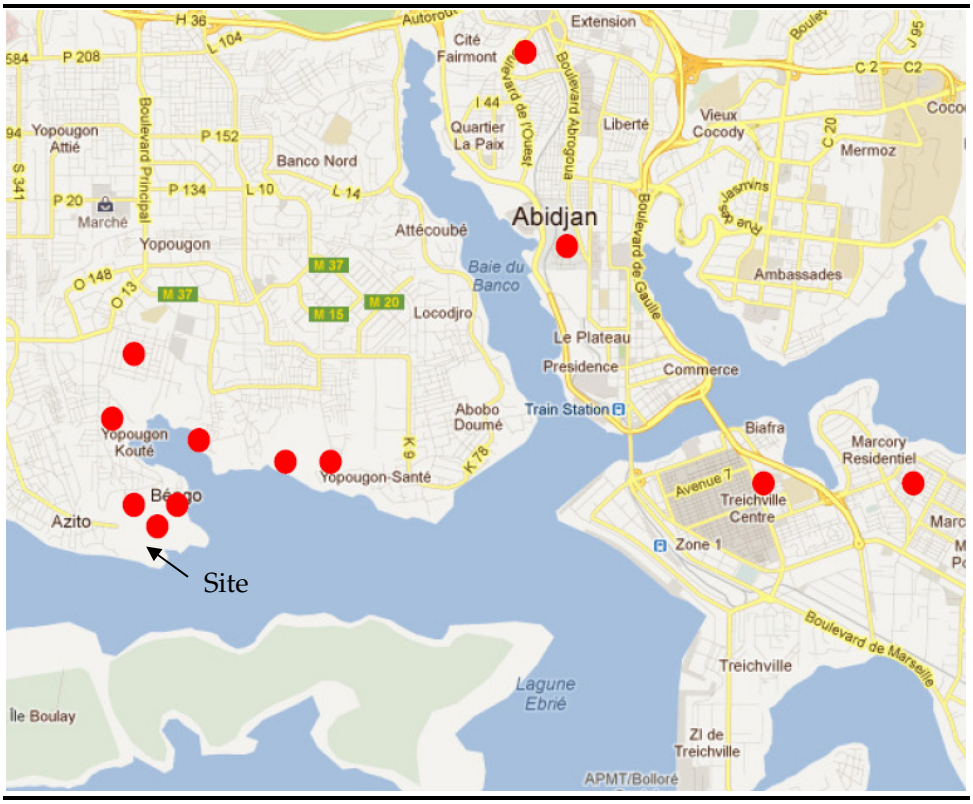
As recommended in the 1998 ESIA, Azito Energie organised a background air quality control campaign using diffusion tubes installed in the city of Abidjan with a focus on the Yopougon district. The campaign was organised from 1999 to the end of 2002. Diffusion tube monitoring of NO_2 and SO_2 offers a low cost method of obtaining average pollutant concentrations for a specific area. The diffusion tubes were all removed in 2003.

The diffusion tubes location are listed below and presented on the map of *Figure 3.11*.

Table 3.7 ***Location of the diffusion tubes***

Municipality	Location
Songon	Hospital
Kouté	Hospital Mrs Henriette Bédié
Béago	EPP
Chapouli, Yopougon	Catholic school
Yopougon	Santé II EPP
Yopougon	BAE
Banco	Forestry school
Adjamé	Sodeci castle
Plateau	B Building, Administrative city
Treichville	Catholic mission of Notre Dame
Marcory	Maternity
Bassam	Hospital

Figure 3.11 ***Location of the diffusion tubes in Abidjan***



Source: Google maps

The analytical results for the year 2001 are provided in *Table 3.8* below. Each year, the tubes were exposed for one month and then sent to a laboratory for analysis.

Table 3.8 ***Ambient air quality monitoring NO_2 and SO_2 diffusion tube analytical results for the year 2001***

Sample ID	Sulphur Dioxide (µg/m³)	Nitrogen Dioxide (µg/m³)

Sample ID	Sulphur Dioxide (µg/m³)	Nitrogen Dioxide (µg/m³)
M3S1	1.7	6.6
M3S2	1.0	2.4
M3S3	2.2	3.9
M3S4	1.5	2.9
M3S5	3.5	9.1
M3S6	*NP*	*NP*
M3S7	<0.8	3.8
M3S8	<0.8	5.9
M3S9	2.8	14.3
M3S10	8.3	36
M3S11	4.1	21.3
M3S12	**11.6**	**28**
M3B1	*NP*	*NP*

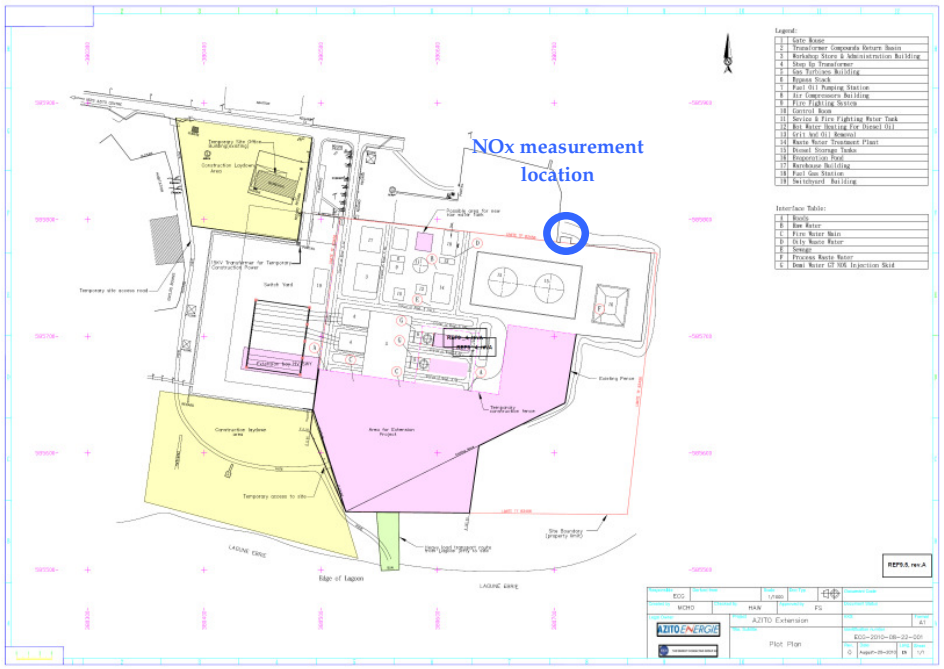
NP: Not Provided

For the year 2001, NO_2 concentrations range between 2 and 28 µg m^{-3} and SO_2 concentrations between 0.8 and 12 µg m^{-3}. No information was available regarding the analytical results of the diffusion tubes for the year 1999 to 2000 and 2002.

However, according to the results presented in the table above, no significant change in air quality has been observed after the beginning of the operations of the two gas turbines. The measured concentration remain indeed in the same order of magnitude compared to the annual mean concentrations estimated by ERM for the 1998 ESIA (5-25 µg m^{-3} for NO_2 and 2-10 µg m^{-3} SO_2)

A continuous NO_X analyser was installed in 1999 for baseline air quality monitoring. The analyser was initially installed 300 m away from the turbines but transferred in 2009 to the site following a flood event. The current analyser location is presented on *Figure 3.12* below. The maximum NOx concentration measured, presented in the annual environmental report, was observed in 2001 (6.52 µg/m³).

Figure 3.12 NOx analyser location



Souce: Azito Energie

Stacks emissions for the Phase I and II units

From the construction of the power plant, SO_2 and NOx emissions are continuously surveyed at the GT 1 and GT 2 (gas turbines) stacks. As requested in the Site environmental permit from 1999, 24h mean concentrations are recorded on a monthly base.

Annual mean results (calculated form the monthly average results), compared to the World Bank emission guidelines and the Ivoirian standards presented in the Site environmental permit, are presented in *Table 3.9* below. These results are given in mg/Nm³ and for a 15% O_2 content.

Table 3.9 SO_2 and NOx Stack emission 2006-2011

	Guide-lines		2006		2007		2008		2009		2010		2011	
	WB	Env. permit	GT 1	GT 1	GT 2	GT 2	GT 1	GT 2	GT 1	GT 2	GT 1	GT 2	GT 1	GT 2
SO_2 emissions mg/m³ (annual mean)	500 ambient air (1)	300	8.08	6.58	12.25	12.02	15.96	15.48	16.97	16.43	17.90	13.58	17.26	16.65
NOx emissions mg/m³ (annual mean)	125	150	68.57	66.80	81.86	73.36	71.06	61.86	79.14	73.17	72.40	55.65	69.94	79.39

(1) SO_2 World Bank emission guidelines are dependant on the background annual ambient air quality levels on the site

The analytical results for the year 2011 were calculated on an eight-months average because the sensor has been out of order since September 2011. The

stack emissions' analytical results are presented every year in the Annual Environmental Report.

The results of the monthly mean measurements show that SO_2 and NOx concentrations in the stack emissions do not exceed the World Bank and Ivoirian emissions standards presented in the emissions guidelines and the environmental permit. The results for SO_2 are particularly low given the fact that no distillate oil has been used to run the power station from the beginning of the operations.

Emissions of particulate matters are not surveyed on site. The threshold value presented in the Site environmental permit and that can not be exceeded is 100 mg/m^3. However, particulate matter emissions from natural gas combustion are considered to be negligible (<10 mg/m^3).

3.5.8 Noise

Ambient noise monitoring results

The Azito power plant is located to the south of the Yopougon district of Abidjan. Béago village lies approximately 285 m to the north whilst to the west lies the village of Azito, at a distance of approximately 325 m. The Ebrié lagoon lies to the south and the east.

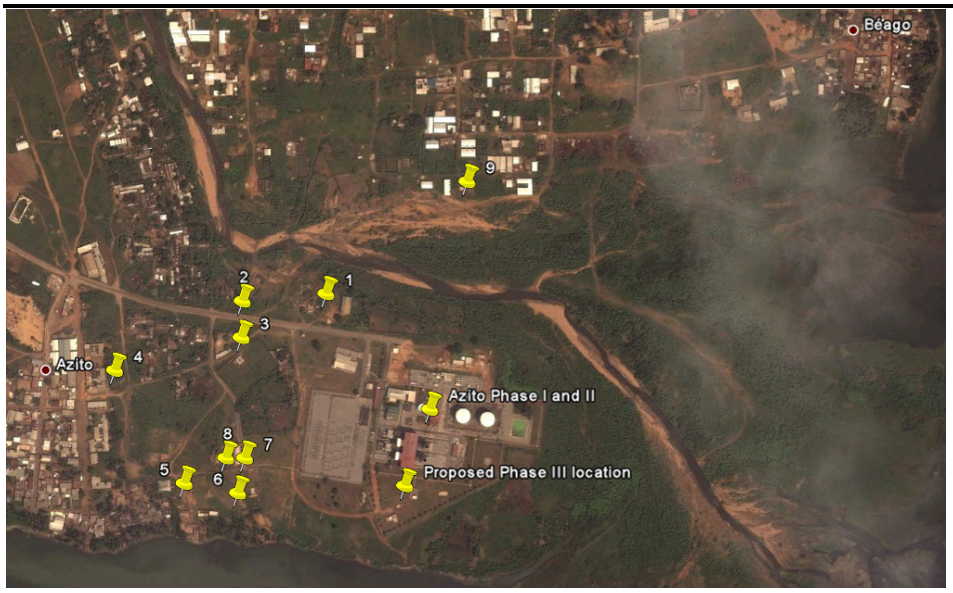
The plant consists of a turbine hall in the south of the site, with the air intakes facing east (towards Azito village), and beyond them the switchyard, consisting of multiple electricity pylons. The generator exhaust stacks lie on the west side of the turbine hall. Directly to the north of the turbine hall (the northeast side of the site) is an administration building and warehouse. Further north and west lie the Foxtrot and Afren gas supply processing facilities, and to their south, two fuel oil storage tanks.

ERM carried out a preliminary baseline noise survey in November 2011. The results of this survey suggested elevated noise levels at some locations around the plant and therefore the need for a detailed noise measurement survey.

A detailed noise measurement survey was carried out in December 2011 in order to assess the existing noise environment at the site boundary and closest noise sensitive receptors to the site. The purpose of the survey was to measure the existing ambient noise environment and also to collect data related to the northern part of the site (Béago area) that was not integrated within the initial assessment and surveys done during the plant operation.

The results of the survey are summarised below. Detailed results are presented in *Annex D*.

Figure 3.13 Map showing noise measurement locations



Details of the survey are presented in *Annex B*. They are summarised in this section along with a discussion of the conclusions of the survey.

Table 3.10 below summarises the boundary noise measurements, whilst *Table 3.2* summarises the offsite noise measurements at representative noise sensitive receptor locations.

Figure 3.14 Map showing noise measurement locations close to the Azito Power Plant

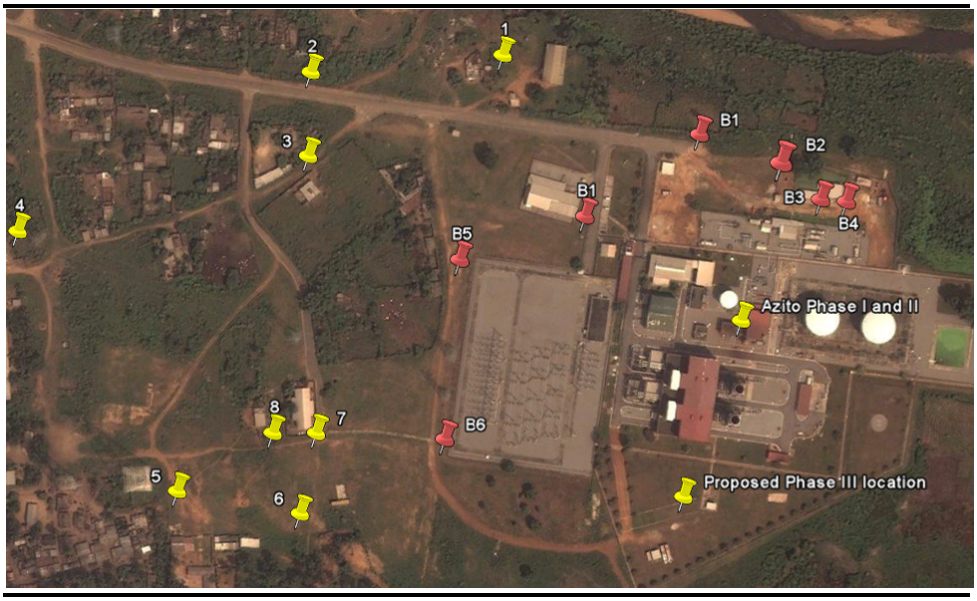


Table 3.10 Boundary noise measurements

Measurement Location	Date	Time	Duration (minutes)	Noise Level (free-field), dB $L_{Aeq,period}$	L_{A90}	L_{A10}	$L_{Amax,f}$	Significant Noise Sources
B1	20/12/2011	10.56	5	56	55	56	58	Plant
B2	20/12/2011	11.06	5	65	64	66	67	Plant
B4	20/12/2011	13.40	1	76	75	76	78	Plant
B5	20/12/2011	11.48	5	51	49	52	62	Plant
B6	20/12/2011	12.07	5	50	48	51	69	Plant

The summary table of boundary noise measurements above (*Table 3.10*), includes daytime measurements only, as these measurements were not influenced by other noise such as that from crickets. The plant operates continuously (24 hours a day) and the noise levels are continuous and constant. The plant was operating normally during the survey.

Table 3.11 Offsite measurements carried out at representative noise sensitive receptor locations

				Measured Noise Level (free-field), dB					
Measurement Location	**Date**	**Time**	**Duration (minutes)**	**$L_{Aeq,period}$**	**L_{A90}**	**L_{A10}**	**$L_{Amax,f}$**	**$L_{Aeq,period}$ filtered (2)**	**Significant Noise Sources**
1	20/12/2011	13.52	5	50	49	52	62	- (1)	Plant, TV / radio, birds
1	21/12/2011	00.30	10	46	45	47	55	46	Plant, crickets
2	21/12/2011	16.48	14	51	48	52	68	- (1)	Plant, people in churchyard, birds, distant kids
2	21/12/2011	00.44	10	47	44	46	65	46	Plant, crickets
3	20/12/2011	17.05	5	46	43	48	59	- (1)	Birds, hum from overhead cables, plant, distant music, children in churchyard
3	21/12/2011	04.49	10	44	42	45	56	43	Plant, crickets
4	21/12/2011	16.27	15	47	44	49	68	- (1)	Music playing, people talking, distant music, children playing, occasional cars
4	21/12/2011	05.20	10	39	38	40	46	38	Hum from overhead cables
5	20/12/2011	16.46	5	47	44	48	61	- (1)	Generator in settlement, plant, car passing and idling
5	21/12/2011	01.05	10	46	45	47	55	44	Plant, crickets, hum from overhead cables
6	21/12/2011	15.38	15	49	46	50	68	- (1)	Plant, wind in trees, children playing
7	21/12/2011	15.55	10	50	48	51	66	- (1)	Plant, people in yard of house, birds, distant people
7	22/12/2011	00.15	5	49	48	49	54	49	Plant, crickets
8	21/12/2011	16.07	10	49	46	51	67	- (1)	People noise in garden area, plant, distant kids playing
8	22/12/2011	00.22	5	53	47	55	63	48	Plant, crickets
9	20/12/2011	15.35	5	49	47	50	64	- (1)	Plant
9	21/12/2011	02.00	10	52	51	53	58	48	Plant, crickets
10	20/12/2011	14.45	5	45	41	47	59	- (1)	Wind in trees, plant, birds

(1) Daytime measurement, therefore no crickets noise.

(2) Cricket Noise Filtered (see *Section B1.4.3 in Annex B*)

The measurement results presented in the summary table of offsite locations at representative noise sensitive receptors have been chosen to avoid those affected by unusual or extraneous noises for example nearby dogs barking or cockerels crowing at night where they may have been disturbed by the presence of the survey team. The lowest measured value at each location has been adopted which will have the effect of excluding other less common significant noise sources such as the presence of a sound system, children playing or particularly high levels of cricket noise at night.

In addition to noise emitted by the plant, the noise environment in the survey area was characterized by birds, dogs, cockerels and people with occasional car movements. During the night, crickets produced high levels of noise.

The results of the survey have been used to investigate several aspects of the noise environment, including effect on noise levels from the process of clearing the dust filters on the air intakes, elevated levels of noise from the Foxtrot processing facilities and night-time noise from Crickets. These are discussed in the sections below.

Dust filter knocking

The effect on noise levels from the process of clearing the dust filters on the air intakes is discussed in detail in *Annex B* and summarised here.

The frequency with which the dust filter is knocked depends on the amount of dust in the surrounding air and is generally higher during the dry season. Baseline noise surveys were carried out during the end of the short rainy season, and filter knocking occurred approximately every 10 seconds. However ERM understands that this frequency can increase considerably during the dry season. Therefore the effect on average noise levels of doubling the knocking frequency has been considered. Noise from dust filter knocking is most clearly audible to the west of the site where there is little or no screening from the air intakes. Boundary measurements and noise sensitive receptors to the north and northwest of the site are not significantly affected by dust filter knocking.

Noise from the Foxtrot plant

Boundary measurements and observations made around the site showed elevated noise levels from the Foxtrot plant area, located to the north of the site. Foxtrot supplies approximately 70% of the gas used by the Azito plant (the remainder being supplied by Afren). The gas arriving from Foxtrot contains small amounts of liquid which must be separated before being fed to the turbines.

Spectrum data measured at boundary Location B1, shows a peak at 25 Hz to 31.5 Hz related to the Foxtrot plant and which was not present in boundary measurements (B5 and B6) to the west (see *Section B1.4.2* in *Annex B*).

These elevated low frequencies can be seen in measurements carried out offsite at noise sensitive receptor locations 1, 3 and 9 (see *Annex B*). This provides some indication that noise from the Foxtrot plant was a significant source at these locations although low frequencies attenuate at a lower rate than high frequencies as they diffract more freely around screening objects and are not attenuated by air absorption to such an extent. However, aural observations made at these noise sensitive receptor locations concluded that the Foxtrot plant could be heard and was a significant source.

Cricket Noise

Crickets within the survey area produced significant levels of noise throughout the night, so that measured night-time noise levels were often higher than measurements made during the day. The level of noise produced by crickets tends to reduce as the night progresses and the temperature falls. For this reason, baseline noise measurements were carried out throughout the night until 05.30. However, in many locations, local people were waking up before this time. Noise from people activity in early morning measurements was noted at receptors 4 and 5 (Azito village) and receptors 1 and 2.

Crickets can be identified by their high pitched 'chirping'. All measurements made during the survey included frequency spectrum information which can be used to identify cricket noise.

In order to estimate baseline noise levels in the absence of crickets and provide a better understanding of noise levels from the plant in isolation at noise sensitive receptors, high frequency noise has been reduced to the level recorded during daytime measurements. Although the plant may produce noise within this frequency range, this noise will also be present during the daytime measurements and so will be retained. In some cases, not all cricket noise will be 'filtered out' as the high frequencies involved are only reduced to the level measured during the daytime at each location. If there is significant high frequency noise present during the day, then the cricket noise will be reduced by a smaller amount. This is discussed in more detail in *Section B1.4.3* of *Annex* B.

Results of the assessment per location

Azito village

At Azito village (Locations 4 and 5), noise levels ($L_{Aeq,period}$) during the day ranged between 47 dB and 49 dB. Significant noise sources at Location 4 included music, people and children, whilst further south at Location 5, noise from the plant was more prominent as well as a generator in the nearby settlement. During the night, noise levels ($L_{Aeq,period}$) at Location 5 increased for much of the night compared to daytime levels as a result of cricket noise, ranging between 46 dB and 53 dB, however this latter measurement, carried out at 05.00, was influenced by the noise of people in the nearby settlement rising. Excluding this measurement, night-time noise levels ($L_{Aeq,period}$) ranged

between 46 dB and 50 dB. After filtering cricket noise from these measurements (see *Section B1.4.3* in *Annex B*), they ranged between 44 dB and 45 dB, suggesting that cricket noise significantly influenced noise levels for periods of the night. At Location 4, night-time noise levels ($L_{Aeq,period}$) ranged between 39 dB and 40 dB, falling to between 38 dB and 39 dB after filtering cricket noise. Noise from dust filter knocking was clearly audible at Location 5 (see *Section B1.4.1* in *Annex B*) and not at Location 4. An increase in the frequency of knocking during the dry season may have the effect of increasing plant noise levels at this location by up to 0.7 dB.

In between Location 1 and Azito Village, there are further potentially noise-sensitive receptors to the north and south of the road leading to the plant, consisting mostly of residential properties but also including a church. Location 2 was chosen to represent the closest properties to the north of this road, whilst Location 3 was chosen to represent the closest properties to the south of it. During the day, noise levels ($L_{Aeq,period}$) ranged between 46 dB and 51 dB. Significant noise sources consisted of people activity and at Location 3, included bird noise and hum from overhead power cables. During the night, noise levels ($L_{Aeq,period}$) were lower at Location 3, ranging between 44 dB and 49 dB, compared with a range of 47 dB to 49 dB at location 5. Filtering cricket noise from the night-time measurements (see *Section B1.4.3 in Annex B*), reduced the noise level ($L_{Aeq,period}$) to 46 dB at Location 2 and 43 dB at Location 3 and suggests that cricket noise significantly influenced noise levels for periods of the night. Observations suggested this may have been due to increased screening from the Foxtrot plant at this location (see *Section B1.4.2* in *Annex B*). Noise from dust filter knocking was not significant at this location.

Slaughterhouse and surroundings

A small group of properties lie close to the slaughterhouse to the northwest of the site (Location 1). These are understood to be used as housing at certain times of the year only, and were populated during the survey. During the day, noise levels ($L_{Aeq,period}$) ranged between 50 dB and 52 dB. TV or radio noise could be heard from these properties, which were of lightweight, timber construction (see *Figure 1.24* in *Annex B*). Birds and plant noise were also significant noise sources. At night, noise levels ($L_{Aeq,period}$) fell to 46 dB and significant noise sources were the plant and crickets. The range of noise levels ($L_{Aeq,period}$) at night (ignoring measurements containing significant extraneous noises), ranged between 46 dB and 50 dB. After filtering cricket noise from these measurements (see *Section B1.4.3* in *Annex B*), levels were reduced to between 46 dB and 49 dB, suggesting that cricket noise significantly influenced noise levels for periods of the night. At this location, noise from the Foxtrot plant was clearly audible (see *Section B1.4.2* in *Annex B*).

South-west from the site

In between Location 5 (the south end of Azito village) and the power plant switchyard (the southwest of the site), lie a group of three residential properties. The eastern two of these (Location 7) are owned by the

Compagnie Ivoirienne d'Electricité (CIE) substation operators and are well constructed buildings with air conditioning facilities. The other property lies directly behind them to the west (Location 8) and was built after the Azito plant began operating. During the day, noise levels ($L_{Aeq,period}$) ranged between 49 dB and 50 dB. Significant noise sources were the plant, noise from the people living in these properties and distant people noise. At night, noise levels ($L_{Aeq,period}$) at Location 7 fell to 49 dB, whilst at Location 8, they increased to 53 dB. Cricket noise was noticeably louder at Location 8. After filtering cricket noise from these measurements (see *Section B1.4.3* in *Annex B*), the noise level remained at 49 dB at Location 7, but reduced to 48 dB at Location 8, suggesting that cricket noise significantly influenced the measurement at Location 8, but not at Location 7. Plant noise was also a significant source at these locations. Noise from dust filter knocking was clearly audible at here (see *Section B1.4.1* in *Annex B*). An increase in the frequency of knocking during the dry season may have the effect of increasing plant noise levels at this location by up to 0.7 dB.

To the south of these properties, along the bank of the lagoon, there are several recreational facilities (including bars). These premises are not used for sleeping and are therefore only noise sensitive during the day. A noise level ($L_{Aeq,period}$) of 49 dB was measured during the day at the closest property to the site (Location 6; this location is marked in the satellite image in *Figure 3.14*, however, the building cannot be seen as it has been built relatively recently). Noise from dust filter knocking was clearly audible at this location (see *Section B1.4.1* in *Annex B*). An increase in the frequency of knocking during the dry season may have the effect of increasing plant noise levels at this location by up to 0.7 dB.

Béago village

Measurements were made at the southern end of Béago village, at the closest property to the plant (Location 9). The noise level ($L_{Aeq,period}$) during the day was 49 dB. The dominant noise source was the plant. During the night, noise levels ($L_{Aeq,period}$) ranged between 52 dB and 57 dB. In addition to plant noise, high levels of noise were produced by crickets. After filtering cricket noise from these measurements (see *Section B1.4.3* in *Annex B*), levels ranged between 45 dB and 48 dB, suggesting cricket noise significantly influenced noise levels at this location. Noise from the Foxtrot unit was clearly audible at this location (see *Section B1.4.2* in *Annex B*). Noise from dust filter knocking was not significant at this location.

Measurements were also carried out further to the northwest of Béago (Location 10). Daytime noise levels ($L_{Aeq,period}$) ranged between 44 dB and 45 dB. Night-time measurements were not carried out at this location as noise from the plant was clearly low.

3.6 BIOLOGICAL ENVIRONMENT

Data collected from the existing reports as well as a desktop review were completed by an on-site reconnaissance of terrestrial biodiversity of the study area by a fauna and flora expert in November 2011.

3.6.1 Terrestrial environment - flora

The biodiversity assessment carried out on the site and surroundings resulted in the identification of the following ecosystems:

- Open lands with ruderal species (ie species that commonly develop naturally in areas inhabited and transformed by humans): This area is located within the 300 m exclusion area surrounding the site. The flora observed within this area consists of small trees, herbaceous, and ruderal species. The ruderal species observed during the assessment are: *Amaranthus spinosus, Amaranthus viridis, Ricinus communis, Cyperus rotondus, Boerhavia diffusa, Euphorbia hirta, Lantana camara, Tridax procumbens, Sida acuta, Boerhavia erecta, Ageratum conyzoides, Croton hirtus, Dactyloctenium aegyptium, Emilia sonchifolia, Emilia sonchifolia et Portulaca oleracea.*

- Pond and mangrove area: this ecosystem, located on the southern side of the site, between the lagoon shore and the site boundary is highly degraded (see *Figure 3.15*). Mangroves are characterised by the presence of *Rhizophora racemosa* (only a few young trees within the Study Area), and are generally located in the interstitial zones of tropical coastlines. Species observed in this area during the site assessement are; *Dalbergia ecastaphyllum, Acrostichum aureum, Flagellaria guineensis, Drepanocarpus lunatu and Paspalum vaginatum.* A few species observed in the former wetlands during the 1998 ESIA are still present (*Chrysobalanus icaco, Cnestis ferruginea, Baphia nitida Bambusa vulgaris, Baphia bancoensis et Elaeis guineensis*).

- Human habitat, activities and ornamental plants; the site and surroundings are directly influenced by human activities. Extensive crop and vegetable fields were observed around the site. Ornamental plants were also identified on site and surroundings during the assessment.

Figure 3.15 Fauna of the Study Area

Source: ERM, 2011

Floral composition of the site

The botanical survey carried out for the Study Area in November 2011 and presented in *Annex C*, resulted in the identification of 121 species of plants spread between 101 genus and 51 families. The most represented genus are *Cassia* (4 species), *Cyperus* (4 species), *Annona* (3 species), *Sida* (3 species).

The majority of the species recorded are African taxons (inter-tropical Africa) and pantropical taxons (common to all tropical countries).

Rare, endangered and endemic species

None of the species identified during the assessment within the Study Area are listed on the IUCN (International Union for Nature Conservation) as being rare, threatened or endemic.

3.6.2 Terrestrial environment - fauna

Due to the low biological diversity of the area and the strong human pressure (see *Figure 3.16* below), there is very limited terrestrial fauna in and around the site area.

Figure 3.16 Low biological diversity due to human pressure around the site

Source: ERM, 2011

Dominant species within the subject site are:

- **Amphibians and reptiles**: The common agama, or red-headed agama *Agama agama* (in French "margouillat" or "agame des colons") is observed throughout the site. Villagers interviewed in 1998 for the ESIA also mentioned that a colony of varans was living in the study area. The hunting of this reptile is regulated since 1965 by the law 65-255. The presence of varans could not be verified in 2011.

- **Crustaceans**: crab (*Cardisoma*) nests were observed along the shore of the lagoon.

- **Rodents:** the Gambian rat (*Cricetomys emini,* in French "rat géant d'Emin") is reported in the area.

- **Birds:** the Study Area, located along the lagoon is a suitable habitat for water birds. The cattle egret (*Bubulcus Ibis*, in French "Héron Garde Boeuf"), various Trochilidae (colibris) and ravens species (*Corvus spp*) were observed on the site during the assessment.

- **Insects:** termite colonies were observed within the Study Area. Additionally, various types of ants, butterflies and coleoptera were identified.

Rare, endangered and endemic species

None of the species identified as part of the field surveys are known to be listed as threatened by the UICN.

Animal rearing, nesting sites and feeding areas

Local farmers are using part of the study area for cattle grazing, especially grassy open land in the exclusion area immediately beyond the site fence. These aspects will be developed within the socio-economical baseline and impact assessment chapters.

A significant amount of *Chrysobalanus icaco* shrubs are present within the proposed site. The seeds of these plants constitute a source of food for birds. These shrubs are common throughout the West African coastal region.

3.6.3 The aquatic environment

Due to the balance and interaction between diurnal variations from sea water intrusion and seasonal freshwater inflows, the lagoon is made of a range of biotopes from estuaries, to brackish and freshwater, depending on the distance from the connection with the sea.

Figure 3.17 The Ebrié Lagoon seen from the village of Azito and Béago

Source: ERM, 2011

The dynamic physico-chemical conditions of the lagoon, resulting from the interaction between different water masses, play an important role on the ecology of the lagoon in terms of species composition, the spatial and temporal structure of communities and also population dynamics (migration, reproduction, growth rates etc.).

Plankton and pelagic systems

Many of the fish species of the lagoon are dependant on the source of an abundant food supply of phytoplankton and zooplankton. The population of planktons varies seasonally with temperature, salinity and the source of water.

Benthos

Three groups comprise the majority of the benthos in the lagoon: polychaetes, molluscs and crustaceans.

The molluscs present in the lagoon include edible species such as the mangrove oyster *Crassostrea gasar* and the clams *Iphigenia delesserti* and *I.truncata*.

The crustaceans include several commercially important species of penaeid shrimps which have great economic importance, and constitute an important part of the lagoon biomass. Prawns of the genus *Macrobarchium*, particularly *M. Vollenhovenii,* are prevalent close to the river and stream outlets.

Fish Diversity

The lagoon houses numerous fish species which have adapted to the changing chemical characteristics of the water over the last 40 years. These include *Ethmalosa fimbriata*, which is of great importance from an economic and ecological point of view, comprising 70% of the total fish catches. This fish is able to adapt to large variations in salinity and temperature.

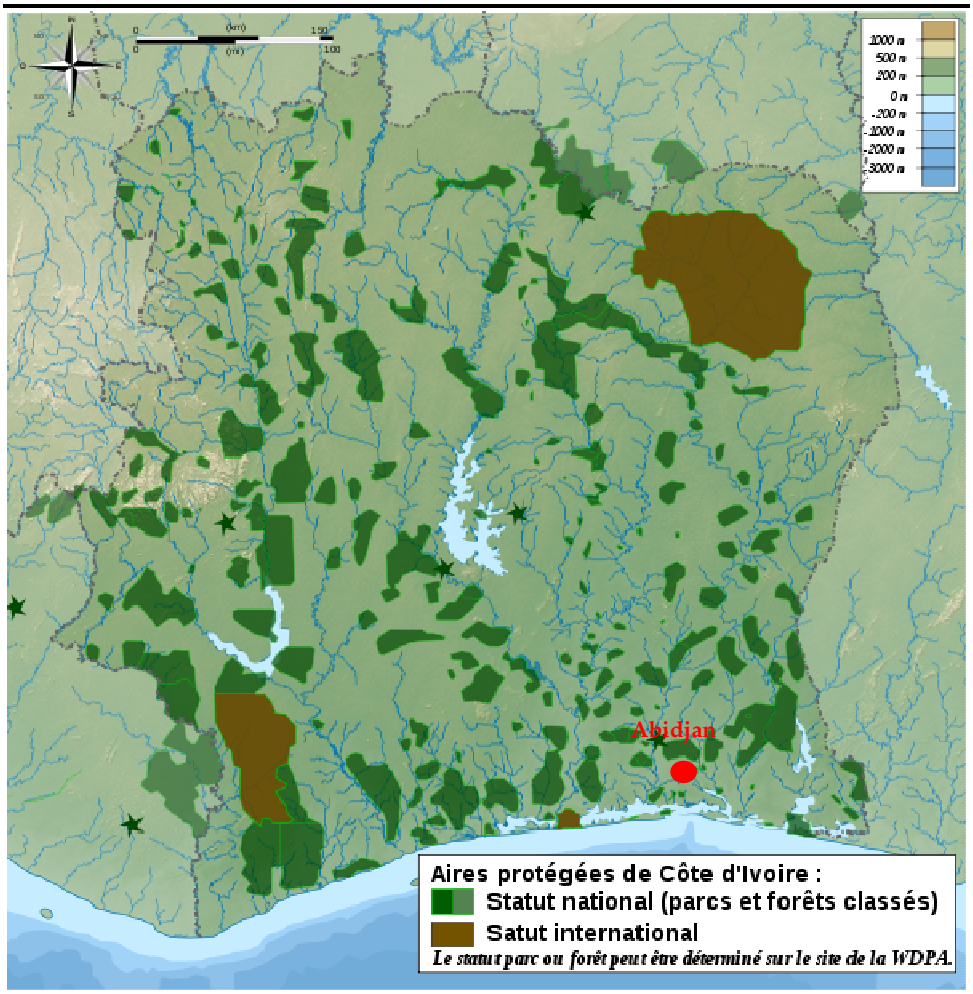
Most of the fishing in the Azito area and Abidjan basin is dominated by seine netting from boats (les sennes tournantes) and seine netting from the shore (senne de rivage) mainly by collective fisherman. Due to a decline in fish catches, probably due to over-fishing of undersize fish, managed aquaculture has been introduced to the lagoon for species such as the catfish *Chrysichthys nigrodigitatus*, *Heteribranchus longfilis* and *Sarotherodon melanotheron.*

3.6.4 Protected areas

Figure 3.18 shows the protected areas in Ivory Coast.

The protected areas located around the Site are shown on *Figure 3.19* and listed in *Table 3.12*. The closest protected area is the Anguededou forest (orange in the figure below) located about 10 km north-west from the Site.

Figure 3.18 Protected areas in Ivory Coast



Source: WDPA
Translation of the legend: Protected areas of Ivory Coast
Green areas: National status (parks and classified forests)
Brown area: International status

Figure 3.19 Protected areas near Azito

Source: protectedplanet.net 2010

Table 3.12 National parks around the Site

Name of the protected area	Description of the area	Distance from the site
Anguededou	Protected forest	10.5 km
Banco	The Banco National Park is located along the Highway North in the district of Attécoubé (Abidjan). The Banco is a National Park since 1953, covers 30.00 km² and is an example of primary forest.	11.1 km
Audoin	Protected forest	11.8 km

3.7 SOCIAL ENVIRONMENT

3.7.1 General description

The Azito power station is located at the end of an access road coming from the Yopougon municipality, situated to the north of the study area. The power station is surrounded by:

- the Azito village to the west and Béago villages to the north ;
- remote shacks to the west;
- a slaughterhouse to the north-west (near the entrance road to the Azito plant); and
- some recreational resorts and bars along the shore of the Ebrié lagoon, to the south-west.

Municipality of Yopougon

Yopougon covers an area of 153 km² and includes eight districts divided into 32 neighbourhoods and 14 villages. The 8 districts are:

- Yopongon-Attié;
- North Banco;
- South Banco;
- Kouté;
- Zone Industrielle;
- Hôpital;
- North Niangon Nord; and
- South Niangon.

The 14 villages within the Yopougon area are:

- Azito ;
- Yopougon-Santé;
- Sikasso;
- Konan Ferrand;
- Béago;
- Kouté village;
- Ayakro;
- Petit Bouaké;
- Yopougon-Attié;
- Niangon Adjamé;
- Niangon Attié;
- Adiopodoumé;
- Niangon Lokoua; and
- Île Boulay.

The eastern parts of the Yopougon municipality houses residential neighbourhoods. The industrial area is located in the north. In the West of Yopougon, natural areas dominate the landscape together with several villages such as Kouté village, Yopougon-Santé, Azito, Béago, Niangon Lokoua, Niangon Adjamé and Adiopodoumé.

Azito village

The closest village to the power station, just outside of the study area, is Azito village. Azito is one of the 14 villages of the Yopougon municipality and is located 300 m to the west of the Azito Power station. .

Béago village

The Béago village is one of the 14 villages of the Yopougon municipality and is located to the north-east of the study area. The village is predominantly downwind of the power plant site. Based on the document review, Béago appears to be about the same size as Azito.

3.7.2 Demographic trends

Yopougon covers an area of 153 km² and is the largest of the ten municipalities of the city of Abidjan. It is bounded to the north by the municipalities of Abobo and Anyama, to the south by the Port of Abidjan and to the east by the municipality of Attécoubé.

Information related to the latest national census that took place in 1998 was obtained from the National Institute of Statistics in September 2010. These figures are likely to be outdated due to significant displacements since 1998. Over the past 10 years, significant migration from all over the country towards Abidjan has taken place. On the other hand many native inhabitants decided

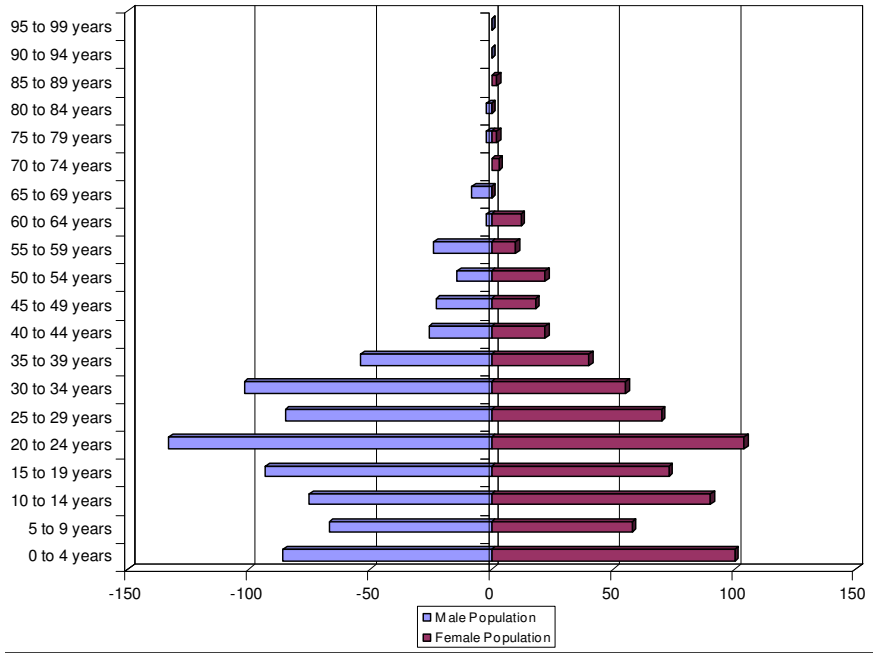
to leave Abidjan and the country following the latest political events. This information is not reflected in the available data.

Based on the 1998 census data, Yopougon had a population of 688,235 inhabitants, representing 24% of the population of Abidjan.

In 1998 the population of Yopougon was mainly composed of Ivoirians. The foreign population represented about 27.3%. Within the Ivorian inhabitants of Yopougon, the indigenous Ebrié represented the largest ethnic group (15.4% of the population), followed by the Baoulé (12.4%) and the Agni (12.2%). Smaller communities or ethnic groups were also observed in 1998 such as the Bete community (4%), the Appolonien also called Nzima (3.9%), the Dida (2.9%), the Malinke or Dioula (2.8%), the Attié (2.7%) and the Senufo (2.5%).

Based on a recent estimation obtained from the National Institute of Statistics, the current population of Yopougon is about one million inhabitants with 51% men, 49% women and 56% children aged less than 20 years. The town of Yopougon is mainly populated by native inhabitants (88.6%). This native population consists mostly of indigenous Ebrié. Approximately 11.4% of inhabitants of the town are foreigners, mainly originating from 15 ECOWAS member states. Since the socio-political crisis in September 2002, the population of Yopougon has rapidly increased due to the migration of people towards the city of Abidjan.

Figure 3.20 Demographic distribution of Azito



Source: INS Abidjan

According to the available data of 1998, the population of Azito village was 1,479 inhabitants – of which 54% were men. Assuming a population growth rate of 2.13% (based on 2009 data) and taking into account the increased demographic pressure in Abidjan over the last 10 years, it can be realistically estimated that the population of Azito village would now be close to 2,000 inhabitants. According to the Technical Director of Yopougon city council, Azito village, and more generally the municipality of Youpougon, have become a "*dormitory suburbs*" for population commuting to work in the city centre of Abidjan (mainly the Banco Plateau administrative area, Zone 4 and Vridi industrial areas).

According to the 1998 data, about 43% of the Azito population was less than 20 years old. Three ethnic groups represent 40% of the population of Azito: the Ebrié – recognised as the original inhabitants of the area, the Agni and the Baoulé.

In 1998, Azito inhabitants were mainly fishermen and cattle farmers. The main employment and economic activity for the local male population were the security sector (security guarding of industrial sites and private housing) and craftsmanship – in particular tailoring, dressmaking and embroidery. Women mainly worked as market or street vendors (selling mainly fish, meat, poultry, donuts, fruits, roasted or fried plantain, and attiéké).

The village of Béago has a similar demographic setting to Azito in terms of nationality and ethnicity. The village is inhabited mainly by Ivorians of which most are Ebrié indigenous.

The demographic distributions show that the population in both villages is relatively young. In Azito, children under 5 years represent 12.5% of the total population and young people between 15 and 24 years old represent 27% of the active range between 15-49 years. The active range (15-49 years) represents 60.7% of the total population. Elderly people (over 55) represent 4.5% of the total population.

3.7.3 Housing and land ownership

Yopougon is characterized by three different types of houses: modern, villagers and precarious.

The modern type of housing is typically built by real estate projects. In some instances these can be constructed by individuals. These modern houses cover approximately 45% of residential area. In the Ebrié villages, these modern houses are found in residential areas provided with sewage and sanitation systems.

The villagers' houses cover about 18% of the residential area of the municipality. Nearly half (45%) of these habitats are ''common courtyards"

and are located in the urban center (Yopougon Attié, Port-Bouet II), in the villages and in the suburbs (Kouté village, Azito, Béago, Niangon Lokoua, etc.).

The precarious housing is generally found in slums and in areas considered as unsuitable for human settlement due to health or safety concerns (area of sewage discharge and area with high density of power lines, etc.). These are several shanty towns. The ones that are well-known are: "Yao Sehi'", "Sicobois", "Mon mari m'a laissée"(My husband has left me) and "Wassakara". These habitats are typically built with recycled (waste) materials and wood.

There is no system for sewage drainage and waste collection in the villages of Azito and Béago.

Figure 3.21 Example of village habitat in Béago (left) and Azito(right)

Source: ERM

Land ownership

In the area of Yopougon, land ownership can be of various kinds. Traditionally, local Ebrié people exercise customary rights to land. With this right, they are allowed to build housing for populations and communities. In the village of Béago and Azito, part of the land is owned by the village community, by families and by individuals. The first two categories represent ancestral lands passed down from generation to generation. The last category is land purchased by individuals.

In Béago the strip of land connecting the "Tchacha" peninsula with the Azito Power Plant, the area of the "Petit Séminaire" (Chapoulie Center) and the port site operated by ALPI-CI are considered as land owned by the village community.

National law and municipal regulations are superimposed over this traditional ownership structure. According to the national law, the Ivorian state owns all land within the Ivory Coast. According to the municipal law, since the creation of Yopougon in 1980, the land of the villages belongs to the municipality.

Even though the local village chief has a predominant formal representing role, the "chef de terres" (chief of land) holds significant local power in the village.

3.7.4 Employment and training

Yopougon is the largest industrial area of the Ivory Coast. With its port area and more than 300 companies located in its territory, this town plays an important economic role.

The Yopougon municipality houses 22 markets enabling trade of various goods (agricultural, industrial handicrafts, etc.), four banks, a hundred hotels and more than a thousand "maquis" (restaurants). This town is best known for the presence of the Industrial Commercial and Gastronomic Fair (FICGAYO).

The main occupations of the population are civil servants, traders, labourers, fishermen, students, unemployed people, pensioners and security guards.

The formal employment opportunities are mainly industry-related jobs or jobs in the public services or in the administration.

The informal sector employs a large majority of the population in the town of Yopougon. Informal employment opportunities are generally associated with small businesses, shops, bars and restaurants ("maquis"), traditional fishing, crafts and tailoring.

In the Azito village, a large part of the population (nearly 40%) is in employed in the formal or informal sector. About 25% of the population is unemployed, 20% are pupils or students, 13% are housewives, and the rest of the population are retired workers.

Women are mainly employed in the informal sector. The income-generating activities are trade of donuts, fried bananas ("alloco"), and attiéké. The latter is the main source of income for women in Azito. Each basket of attiéké is sold on the market at 3,000 FCFA, which generates an estimated monthly income of 100,000 FCFA per vendors.

Among employees in the formal private sector and public services, there are technicians, opticians, teachers and customs officers.

In terms of education, the villages of Azito and Béago each have a public elementary school and offer housing to teachers. These institutions are characterized by overpopulation and lack of desks. There is no high school or vocational training centers in the area.

3.7.5 Health context

Yopougon has several health facilities (public and private). These include:

- a university hospital (CHU);
- an urban clinic (FSU);
- eleven community-based health centers (FSC);
- a school health centre;
- a Pasteur institute; and
- several private clinics.

For their medical care, residents usually visit the local clinic in the Azito village and health facilities nearby (FSC of Kouté and the PMI of SICOGI area). In case of serious illness, they are referred to the university hospital (CHU). However, low incomes prohibit the majority of the population to access modern health care.

3.7.6 Land use and activities in the vicinity of the study area

Fishing

The traditional way of fishing in the lagoon Ebrié uses canoes and nets. Today, very few indigenous young people are involved in this activity. Professional and commercial fishing is mostly conducted by non-indigenous Ghanaians and Malians commonly called Bozo. These fishermen migrated to the Boulay Island where they live now.

Agriculture

The land of the villages is mainly occupied by residential areas. The use of land for harvesting crops is not developed in the Lagoon area. Cattle breeding are observed in the vicinity of the study area. Poultry farming is also a major activity in the area.

Small size cattle farms were observed within in the study area (see *Figure 3.22*). The cattle is owned by Ivoirian citizen and managed on the day to day bases by Malian emigrants. Although there is no formal agreement between the power station management and the farmers, the animals graze within the 300 m exclusion zone during the day.

Figure 3.22 ***Cattle near the central***

The public slaughterhouse

The public slaughterhouse (*Figure 3.23*) is the only authorised building within the 300 m radius around the Azito power station. It already existed prior to the construction of the power plant in 1998. The slaughterhouse operates mainly at night (to supply meat-markets in the morning). During the day, nearby residents are provided with potable water from the facility.

Figure 3.23 ***The slaughterhouse***

Presence of unauthorised settlements nearby

Despite the official 300 m exclusion area around the power station, unauthorised houses settled within this perimeter, or just on its outskirts.

The most recent and poorest immigrants have settled close to the slaughterhouse in temporary housing and shacks, as illustrated in *Figure 3.24*.

Recreational resorts and bars in the area

About five resorts and bars are located between the power plant and Azito village, along the shores of Ebrié lagoon (*Figure 3.25*). The resort owners rent land from land owners from Azito village.

Figure 3.24 The nearby shacks

Figure 3.25 The nearby resorts

3.7.7 Infrastructures

Roads

In the Ivory Coast the road network consists of national roads, district routes and municipal tracks. The national roads connect cities and also provide links to neighbouring countries. International routes passing through Yopougon are the Northern Highway, the road to civil prison (MACA) and the road connecting the Yopougon with Dabou.

The two district routes parts of the Yopougon network are as follows:

- a connection to Abobo passing through Doumé, part of Attécoubé municipality : 7.3 km length; and
- a crossroads used by SODECI (water Distribution Company): 5.8 km length.

As for local roads, they connect the various neighbourhoods of Yopougon. These pathways consist of:

- 91 km of tarred roads;
- 234 km of dirt roads ; and
- 89 km roads under development.

The total length of the roads network in the commune of Yopougon is estimated at 454 km.

The main road leading to the Azito Power Plant is a tarred road which is currently deteriorating due to heavy rainfall and erosion. Inside the villages (Azito and Béago), roads are not paved. They are in poor condition and worsen during heavy rains.

Dinking water – electricity

The villages of Azito and Béago are equipped with a modern system for water distribution managed by the Water Supply Company of Ivory Coast (SODECI).

Most of the households are equipped with electricity. However, the local residents complain about insufficient public lighting.

Waste Management

Waste management in the city of Abidjan is a major problem. From 1990 to 1996, the annual amount of waste produced by the District of Abidjan showed an annual growth rate of 4%. The average ratio of waste per capita is 1.04 kg / day in the shantytowns and 1.23 kg / day in more developed modern areas.

In 2000, the budget allocated by the city of Abidjan in waste management was 3 billion FCFA. Today, the budget for waste management has tripled. Despite these investments, only 70% of the generated waste is actually collected and land filled.

In addition, several areas of the city of Abidjan are not covered by the waste collection services. This is the case for Azito and Béago. In both villages, the generated waste is not collected by the companies in charge of waste collection in Yopougon. There are no formal collection points or recycling yards that can be used by villager to dispose appropriately of their waste. As a result, people burn their waste or discharge directly into the lagoon.

Maritime transportation

Transportation on the Ebrié Lagoon is provided by 24 boats managed by the Abidjan Transport Company (SOTRA). These waterbuses are limited to shuttle service between the Banco Plateau, Treichville, Cocody and Yopougon. Next to these modern vessels, other artisanal boats, called Pinasses, provide transport to the habitants.

Within the project's extended study area, there is no shipping and passenger transport taking place.

Future infrastructure

The planned construction of the bridge linking the Azito peninsula to the Boulay Island is delayed due to the post-election crisis of 2010. This bridge is planned to connect the Yopougon mainland with the Boulay Island and the Boulay Island with the coastal shore.

Plans are also developed to extend of the Port of Abidjan with the development of a container terminal on the Boulay Island and on the barrier beach along the Atlantic shoreline. Another known building project is the construction of a suspended bridge of 420 meters long, 60 m above the Vridi channel to allow the passage of large vessels.

3.7.8 Culture and traditions

Religion

The villagers of Azito and Béago are essentially divided between Christians and Muslims. There is a mosque in each village for the Muslims and, for the Christians, there are several churches: a Methodist Church, a Catholic Church, a Church of the Assemblies of God and a Celestial Church. Despite the recent spread of the Christian faith, the indigenous habitants remain attached to the worship of ancestors. Every village has a ancient cemetery which is considered a sacred place where the founder ancestors live. These cemeteries are a cultural heritage for indigenous Ebrié.

No archaeological site has been identified in the planned extension area of the power plant.

Culture and traditions of the Ebrié people

The community surrounding the study area is a mix of Ivorian and foreign ethnic groups. The indigenous Ivorian ethnic group 'the Tchaman'' have founded the Azito and Béago village. Gradually, these villages serve as dormitory towns for people working in the developed industrial area of Yopougon and the city of Abidjan.

According to traditions, the entire social organisation of the villages is based on “generational schemes”, divided into four categories:

Table 3.4 Traditional ‘Generational Scheme’ of the Ebrié people

Generation	**Category** *(from older to younger)*
TCHABA	Djehou
BLESSAUE	Dougba
GNANDO	Agban
DOUGBO	Assoukrou

Economic and social activities in the village follow these categories and the transition between them is according to prescribed traditions and rituals.

3.7.9 Known sources of conflicts

In the city of Abidjan and mainly in the town of Yopougon, the most recurrent tensions and conflicts are those regarding the ownership of land. These

conflicts usually arise when Ebrié families, holders of customary land rights, are obliged to give up part of their land to the national government, to local municipalities or to development projects. In most cases, the Ebrié families are not satisfied with the level of compensation they receive in exchange for their land.

Regarding the Azito power station, there is still an outstanding conflict between the village of Azito and the Government. Following the conflict related to the relocation of part of the village, a protocol was signed on the 20/12/2007 between the representative of the Ivoirian State and the village's chiefs for a cash compensation of 400 million CFA francs and the attribution of 25 ha to the village. This protocol is presented in *Annex F*.

The cash compensation has been fully paid by the State but the villagers are still waiting for the land.

3.7.10 Community relationships with the existing power station

For the last 10 years, the management of the power station has surveyed the Azito village annually to monitor and understand their opinions on the neighbouring power plant. The management has organised regular visits to the village and meetings with the notabilities.

The Azito power plant management has also developed several community programmes focused on the Azito village and the surrounding area. These projects are presented in *Chapter 1*.

Table 3.13 presents the milestones of the relationship between the Project management and local community.

Table 3.13 Relationship between the Azito plant and the local community

Date	Events
1998-1999	At the time of the construction, 345 persons were displaced by the Project, most of them on a temporary basis. Ivory Coast Government promises the displaced population to compensate the loss of their land with an equivalent, new, piece of land.
2001	Azito power plant management launches its annual satisfaction survey, targeting Azito village.
18.12.2007	The inhabitants of Azito village barricade the main and only road access to the power station, preventing employees to go to work. They protest against the Government for not keeping its promise to compensate them with new land.
Spring 2008	The Government and Azito village reach a settlement. The Government financially compensate the village up to 350 millions FCFA.

Overall, the results of the annual surveys show that local communities (Azito village) have a positive perception of the Project. Issues related to ambient

noise emissions and low employment levels of local communities are however frequently highlighted by the villagers.

4 IMPACT IDENTIFICATION AND ASSESSMENT

4.1 INTRODUCTION

This ESIA identifies and evaluates potential environmental and social impacts resulting from the construction and operation of the Project. The potential impacts of the Project are evaluated for different aspects of the environment.

The potential impacts will be linked to the different stages of the project which are identified as follows:

- Construction of the Phase III Project and associated buildings and installation.

- Operation of the Phase III expansion: two heat recovery steam generators (HRSG), one steam turbine and generator, and one steam condenser with an associated cooling water system utilizing an air cooled condenser.

- Decommissioning of the power station.

Table 4.1 presents an impact identification matrix for the Azito Phase III ESIA. This matrix shows the relationship identified at scoping stage between potential sources of environmental impacts caused by the Project, and environmental and social sensitivities potentially affected by the Project. Areas of cross-over between sources of impacts and sensitivities are those that will require to be treated in more detail in the present chapter.

Based on this matrix, the assessment of potential impacts during both the construction and operational phases of the proposed Phase III expansion project is presented below, with particular attention to the following:

- air quality;
- ambient noise ;
- water quality (surface water and groundwater);
- biodiversity : terrestrial and aquatic ecology;
- socio-economic environment; and
- visual/aesthetic environment.

Table 4.1 Impact identification matrix for the Azito Phase III ESIA

	Sensitivities → / Sources of impact ↓	Air quality	Ambient noise	Surface water quality	Soil & groundwater	Terrestrial habitats	Ebrié lagoon	Land use	Livelihoods	Community H&S	Local social stability[12]
Construction	Lay-down areas						X	X[1]			
	Dust from traffic	X									
	On-site power & engines	X	X								
	On-site chemical storage[2]			X[2]	X[2]		X[2]				
	Construction site runoff			X			X[3]				
	Wastes						X[4]			X	
	Workforce			X[5]			X[5]			X[6]	X[6]
	Induced traffic		X							X	
Operation	Atmospheric emissions	X[7]									
	Blowdown water from HRSG[8]						X[8]				
	HRSG and STG		X								
	Chemical storage[9]			X	X		X				
	Site runoff[10]			X			X				
	Wastes[10]						X			X	
	Workforce[11]										X
	Induced traffic[11]										

1. Land around the fence is used for cattle grazing in relation to nearby municipal slaughterhouse.
2. Assume construction chemical storage: fuel oil, lube oil, paints, and maintenance products. No bulk storage of chemicals.
3. Potential turbid runoff from construction surfaces into the lagoon – however the lagoon is a high-suspended solids environment.
4. No particularly hazardous waste stream – expect "typical" construction wastes: packaging, scrap metal, some maintenance wastes eg oil filters and empty cans.
5. Workforce camp sanitation water (if hosed on or near the site; peak construction workforce of about 200).
6. Social interactions between workforce and local population – transmissible diseases, concomitant use of local infrastructures, cultural interactions.
7. Already covered in initial 1998 ESIA for Phases I, II and III – no ambient air quality increase beyond acceptable standards – the Phase III project does not add any new source of emissions although the HSRG does change the turbine exhaust temperature.
8. Minimal blowdown since the cooling option for the steam cooling water system is air cooling, instead of water cooling (ie the water in the cooling system circulates in closed circuit). Blowdown limited to demineralised closed-circuit water blowdown from HRSG and cooling water system.
9. Limited quantities stored, mainly demineralised water treatment chemicals. Storage practices are unlikely to differ from current practices at Azito plant.
10. Unlikely to differ from current practice. Same for wastes, which will be minimal (maintenance and some chemicals packaging only).
11. Limited induced long-term employment – order of 30.

4.2 *IMPACT ASSESSMENT METHODOLOGY*

The magnitude of the potential impacts of the Project was determined by assessing all the dimensions including the extent, duration, intensity and likelihood.

- Intensity: classified as either negligible (no perceptible change), low (perceptible change but no modification of the environment or human activities), moderate (perceptible modification but environment or human activity will not be prejudiced in the long term) or high (environment or human activity prejudiced in the medium to long term).

- Extent of the potential impacts: local (limited to the site), regional (impacts that affect resources at a regional scale), national/international (impacts that affect nationally important environmental resources or resources at a national/international scale).

- Duration of the potential impact: classified as short-term (potential impacts lasting for a few hours or days), medium-term (potential impacts for a few weeks or months) or long-term (potential impacts lasting for at least a few years).

To those criteria specified by the ANDE in the Terms of Reference, ERM and CECAF International proposed adding the criterion of *likelihood*; providing information on the levels of occurrence of an action that has a finite probability, but might not occur at all.

Likelihood can be derived from historical information, modelling, industry data, stakeholder input, and professional judgment. In addition, the likelihood takes into account anticipated or planned mitigation measures, engineering controls, and procedures in place to prevent or reduce the consequence of the identified event.

- Likelihood can be considered as rare (never or very exceptionally observed on similar activities), occasional (may occur on the project during the lifecycle of the facility) and continuous.

An overall grading of the magnitude of impacts, taking the above mentioned criteria into account, will determine if the impact can be considered as minor (perceptible but localised, can sometime be qualified as negligible if imperceptible or very localised), moderate (perceptible, relatively extensive continuous change or very perceptible recurring change reversible in the medium or long term) or major (obvious, extensive and irreversible change or very perceptible recurring change only reversible in the long term).

4.3 IMPACT ASSESSMENT SUMMARY

Table 4.1 provides an overview of the potential impacts associated to the project during the construction and operation phases.

Table 4.1 Summary of impacts assessment

Potential impact	Phase of the project	Concerned area	Impact description	Impact evaluation				
				Intensity	Extent	Duration	Likelihood	**Magnitude**
Air pollution	Construction	Site and direct surroundings	Construction vehicles as well as generators used on site during the Phase III construction will emit some engine exhaust fumes.	Low	Local	Short-term	Continuous	Minor
		Site and direct surroundings	The project activities have the potential to result in impacts on the air quality due to dust emissions during the construction phase.	Low	Local	Short-term	Occasional	Minor
	Operation	Site and surroundings	The Phase III will not result in any type of new air emissions compared to the existing situation. The height of the emission stacks of the Phase III installations will however influence the pollutant dispersion.	Low	Local	Long-term	Continuous	Negligible to minor
Emissions of greenhouse gases	Construction	Global climate	Minor emissions from construction vehicles and generators – insignificant in the wider context of Abidjan.	Low	Local	Long-term	Intermittent	Negligible
	Operation	Global climate	No incremental emissions of greenhouse gases from the Phase III project; improvement of energy efficiency from about 29,5% to about 44%, thereby reducing greenhouse-gas emissions per unit power generated by the same proportions	Positive	Local	Long-term	Continuous	Positive
Ambient noise levels increase	Construction	Site and surroundings	Noise from construction activities on site as well as from construction vehicles as they pass noise sensitive receptors have the potential to produce noise impacts	Low	Local	Short-term	Continuous	Minor

Potential impact	Phase of the project	Concerned area	Impact description	Impact evaluation				
				Intensity	Extent	Duration	Likelihood	**Magnitude**
	Operation	Site and surroundings	Phase 3 will introduce a variety of noise producing equipment which have the potential to increase existing ambient noise levels at the nearest noise sensitive receptors.	Low	Local	Long-term	Continuous	Minor
Water consumption	Construction	Site and surroundings	The impacts on water resources from water consumption during the construction phase are related to the use of domestic water on site, in the temporary camps, and water consumption for the construction works	Low	Local	Short-term	Continuous	Negligible
	Operation	Site and surroundings	Impact on water resources from water consumption during the operation phase (potable and industrial water)	Low	Local	Short -term	Continuous	Minor
Water contamination	Construction	Site and surroundings	The water quality (surface and groundwater) can be impacted by • An increase of the sediment load into the lagoon. • Releases of domestic effluents into the lagoon. • An accidental spill or leakage form temporary chemical, fuel or oil storage tanks or vehicle used on Site for the construction	Low	Local	Short-term	Occasional	Minor
	Operation	Site and surroundings	Operations of the phase III can impact the water quality by the contamination of surface and groundwater from process, fire fighting and drainage water.	Low	Local	Short-term	Occasional	Minor

Potential impact	Phase of the project	Concerned area	Impact description	Impact evaluation				
				Intensity	Extent	Duration	Likelihood	**Magnitude**
Impacts on biodiversity	Construction	Site and surroundings	The construction of the Phase III unit, associated to the temporary land-take for lay-down area and material storage will potentially impact the biodiversity of the Site and surroundings.	Low	Local	Short-term	Occasional	Negligible
	Operation	Site and surroundings	The operation of the Phase III including potential spillages or leakages of products and chemicals on site or along the transport route have the potential to impact the biodiversity of the Site and surroundings.	Low	Local	Short-term	Rare	Negligible
Solid waste production	Construction	Site and surroundings	Waste production during the construction of the Phase III	Low	Local	short-term	Continuous	Minor
	Operation	Site and surroundings	Waste production during the operations	Negligible	Local	Long-term	Continuous	Negligible
Impact on the socio-economical environment	Construction	Local/ regional	Positive impact: Employment of local and national workers.	Low	Local to regional	Medium term	Occasional	Minor
		Site and surroundings	Workers immigration to the Site area.	Low	Local	Medium term	Occasional	Minor
		Site and surroundings	Workers camps development	Low	Local	Medium term	Occasional	Minor
		Site and direct surroundings	Transmission of diseases, including sexually transmitted diseases.	Low	Local	Medium-term	Occasional	Minor
		Site and surroundings	Increase of roads accidents due to the traffic of vehicles and trucks.	Low	Local	Medium-term	Occasional	Minor
		Site and surroundings	Potential increase in petty crime in the area, violence and problems of security.	Low	Local	Medium-term	Occasional	Minor

Potential impact	Phase of the project	Concerned area	Impact description	Impact evaluation				
				Intensity	Extent	Duration	Likelihood	**Magnitude**
		Site and surroundings	Pressure on local infrastructure (hospitals, schools, water consumption,…)	Low	Local	Medium-term	Continuous	Minor
		Site and surroundings	Land take	Negligible	Local	Long-term	Occasional	Minor
		Site and surroundings	Disrupting fishing activities along the lagoon from transportation by boat.	Low	Local	Medium-term	Occasional	Minor
	Operation	Country and surroundings	Positive impact : opportunities for the Ivory Coast and surrounding countries	Low	National/ International	Long-term	Continuous	Positive
Associated facilities	Construction	Site and surroundings	Impacts associated with the rehabilitation of the jetty and the possible construction of an access road between the jetty and the site (about 100 m)	Low	Local	Medium-term	Occasional	Minor
Impact from natural phenomenon	Operation	Site and surroundings	Risks associated with natural phenomenon should be considered in the design of the Phase III with a focus on the flooding	Low	Local	short-term	Rare	Minor

4.4 IMPACTS ON AIR QUALITY

4.4.1 Potential impacts during the construction phase

The main sources of impacts associated with the construction activities of the Phase III are possible dust and exhaust gases arising from the traffic of construction vehicles on the site.

Construction vehicles emissions

Construction vehicles emissions as well as power generators used on site constitute a source of air pollutant emissions during the Project construction phase. Atmospheric emissions from the exhaust gas coming from engines contain sulphur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter (PM). However, those sources of air emissions represent scattered, limited, intermittent sources, releasing marginal quantities of pollutants in the atmosphere compared to the overall traffic in the city of Abidjan.

Quantities of air pollutant emissions from construction vehicles and generator operations are expected to be relatively minimal and are not anticipated to result in measureable impacts on air quality conditions around the site where receptors are located. Accordingly, potential impacts on air quality from construction vehicles and generators are expected to be Minor.

Impact description and characterization are summarized in *Table 4.2*.

Table 4.2 Impact Assessment: air quality – construction vehicles

Type	Construction vehicles as well as generators used on site during the Phase III construction will be a minor source of pollutant emissions
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the impact is considered to be low given that perceptible change of the environment will not be observed. ***Extent*:** The extent will be within the immediate vicinity of the Project. ***Duration:*** Impacts associated with the constructions vehicle and generators used on site will be temporary and short-term. ***Likelihood:*** Impacts are considered to be continuous during the construction operations.

To minimise pollutant emissions during the construction phase, the following measures should be implemented on site:

- As a default good practice, the construction vehicles and generators will be regularly maintained and inspected by the construction contractor.
- Atmospheric emissions of all transport vehicles used during the construction (material, backfill or excavated soil, workers, etc.) will be reduced by minimizing the number of trips to the extent practical.

Dust emissions

The construction of the proposed Phase III expansion has the potential to lead to the generation of dust particles. Because dust deposition can cause soiling at properties close to construction activities, dust emissions are an important consideration with respect to air quality.

Dust emissions during construction are by their nature very variable and a qualitative methodology has therefore been adopted for the assessment of their impacts. The potential for dust to be emitted during the construction phase is strongly dependent on the type of construction activities taking place, the prevalence of hot, dry weather during the construction period, the prevailing wind speed and whether winds carry emitted particles toward potentially sensitive receptors.

The following construction activities are likely to generate dust:

- grading and levelling of ground prior to construction of the new installations;
- removal of spoil;
- site stripping;
- site excavations;
- concreting operations; and
- site reinstatement and road construction.

The nearest residential receptors with the potential to be affected by dust emissions from construction works are the slaughterhouse and a few houses located at a distance of approximately 70 to 80m north and west from the Site boundary. The first houses constituting the border of the village of Azito are located approximately 300m west from the site boundary. The Béago area is located approximately 400m north from the site.

At wind speeds above $3ms^{-1}$, particles of dust have the potential to become airborne and to be transported from their initial source. For wind speed of $4ms^{-1}$, particles of diameter greater than 100µm are likely to settle out within 6 to 10m and those with diameters between 30 and 100µm are likely to settle out within 100m of the source. Smaller particles, particularly those below 10µm, are more likely to have their settling rate retarded by atmospheric turbulence and to be transported further off-site. In case of high winds, some of the fine dust particles could be deposited at a distance of 500m from the site.

All particles with a diameter smaller 100µm and bigger than 30µm, emitted directly from the construction site, are likely to be deposited within a distance of maximum 100m. Finer particles with a diameter smaller than 30µm may be

transported further if wind speeds are above a 4ms^{-1}.

Annual rainfall for Abidjan is elevated, averaging 2100mm. Rainfall is lowest in the months December - March and August - September, and during these months evaporation exceeds rainfall. Therefore, the potential for construction dust emissions will be significantly higher during these months than at other times of the year.

Dust emissions may also come from indirect transport of particles, due to dust adhering to the wheels and chassis of vehicles accessing the site and involved in the removal of spoil. This phenomenon is dependent on several factors including:

- number of vehicles accessing the site;
- cleanliness of the on-site haul routes;
- adoption of wheel and chassis washing units; and
- weather conditions.

Further potential for dust generation exists due to blow-off and spillage from vehicles during import of aggregate and any export of surplus soil material.

Impact description and characterization are presented in *Table 4.3* below.

Table 4.3 Impact Assessment: air quality – dust emissions

Type	The project activities have the potential to result in impacts on the air quality due to dust emissions during the construction phase. As the average annual rainfall in Abidjan is high, the potential for dust emissions during the construction phase is reduced. Furthermore, the potential for impacts can be reduced by implementing good practices on site during the construction phase.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the impact is considered to be low given the weather conditions in Abidjan and the distance to the nearest receptors from the Site boundary. ***Extent*:** The extent will be within the immediate vicinity of the Project ***Duration:*** Impacts associated with the dust emissions will be temporary and short-term. ***Likelihood:*** Impacts are considered to be occasional during the construction operations.

To minimise dust nuisance on Site and surroundings, the following good practices should be implemented:

- appropriate management and maintenance of stockpiles to minimise airborne dust ;
- sheeting of lorries during transportation of friable construction materials;
- minimise drop heights for material transfer activities such as unloading of friable materials;

- enforcement of vehicle speed limits on dirt roads; and
- wheel washing for vehicles leaving the site.

4.4.2 Potential impacts during the operations phase

Approach taken to discussing operational impacts on ambient air quality

As mentioned in *Chapter 2*, **the Phase III operation will not result in any increase of air emissions from power generation compared to the existing situation**. Rather, **the retrofitting of HRSGs and a STG will allow optimising the fuel efficiency of the overall power plant**, by switching from single cycle to combined cycle power generation and recovering energy otherwise lost to the atmosphere as waste heat.

As part of the initial ESIA for the overall Azito Project, developed in 1998 by ERM, a dispersion model was developed to assess of the potential impacts of atmospheric emissions. This model was parameterised to simulate Phase I, Phase II as well as Phase III operating conditions. The results of this assessment, focused on the Phase III operation, are therefore presented below. Since 1998, there has been no major change in the technical specification of the Azito plant, including the Phase III installation. Given that the Phase III installations, on which this ESIA focuses, add no new source of atmospheric emissions, ERM suggests that the results of the model developed in 1998 remains representative.

Model used and sources of information for the initial Azito ESIA (1998)

In the initial ESIA, ERM used the Industrial Source Complex (ISC) dispersion model (Version 3) in order to predict ground level pollutant concentrations from the proposed power plant. The predicted ground level pollutant concentrations were assessed against World Bank guidelines (23 October 1996). The results of the 1998 assessment showed that, while using natural gas as a source of energy, the contribution of the power station emissions to pollutant concentrations in the area is small and will be below the guidelines threshold values.

Sources of information used for the assessment were:

- meteorological data for Abidjan;
- emissions data for the existing air pollution sources in Abidjan provided by the Compagnie Ivoirienne d'Electricité (CIE) and by the *Ministère du Logement, du Cadre de Vie et de l'Environnement*;
- emission characteristics for the proposed power station supplied by ABB Energy Ventures; and
- air quality guidelines for ambient pollutant concentrations from World Bank sources.

For the purposes of the short term (maximum 24 hour mean) dispersion modelling, 3-hourly meteorological data recorded in Abidjan in 1993 were used. For the long term (annual mean) modelling, a Pasquill stability summary of data recorded for Abidjan during the period 1990-1993 was used.

Turbine fuel use and pollutants emitted (from 1998 ESIA)

Natural gas is used to run the actual phase I and II units. Short term (maximum 24 hour mean) and long term (annual mean) ground level pollutant concentrations as a result of emissions from the proposed power station have been predicted, and compared to the World Bank guidelines. The pollutants of significance when burning natural gas are:

- nitrogen oxides (NO_x); and
- particulate matter.

Most of the NO_x released from the stacks will be in the form of nitric oxide (NO). Nitric oxide is gradually oxidised to nitrogen dioxde NO_2 in the atmosphere.

Emissions of SO_2 for natural gas use are considered as negligible and have therefore not been assessed.

Since the Azito facility has never run on distillate oil during the last 12 years, except for one test in 2000, and since the Phase III construction should not lead to any further need to use DDO as a source of energy, the pollutant emissions model developed for turbines running on distillate oil is not reproduced in the present report. This information was however provided in the ESIA developed for the initial project in 1998.

Dispersion modelling inputs (from 1998 ESIA)

Dispersion modelling for operation on natural gas has been undertaken for the following phases of operation of the power station:

- two gas turbines and one steam turbine in combined cycle;
- emissions via two main stacks;
- 100% load for 45% of the time;
- 75% load (ie, two CTGs at 75% and one STG at 75% load) for 30% of the time;
- 50% load (ie, one CTG at 100% load and one STG at 50% load) for 15% of the time; and
- shut down for 10% of the time.

Predicted concentrations have been assessed as a result of emissions from stack heights of 40m and 50m.

The results of the dispersion modelling are discussed in the next section and compared to the World Bank ambient air quality guidelines.

Dispersion modelling results (from 1998 ESIA)

Predicted ground level concentrations as a result of emissions from the power station for the different operating scenarios are described below for the 100%, 75% and 50% loads. The locations of the positions of maximum concentration with respect to the power station are also presented.

Table 4.4 Predicted ground level pollutant concentrations at 100% load (µg m^{-3}) (from 1998 ESIA)

	Ambient concentration (combined cycle mode at 50% load)		**IFC guidelines (1)**
Stack Height (m)	**40**	**50**	
Pollutant			
NO_x			
Maximum 24 hour mean	41.6 (200m ENE)	15.0 (1950m SSW)	150
Maximum annual mean	1.1 (800m ENE)	0.93 (2000m ENE)	100 *(40)*
SO_2			
Maximum 24 hour mean	negligible	negligible	
Maximum annual mean	negligible	negligible	
Particulate matter			
Maximum 24 hour mean	4.7 (200m ENE)	1.7 (1950m SSW)	110 *(25)*
Maximum annual mean	0.13 (800m ENE)	0.11 (2000m ENE)	70 *(10)*

(1) The main value quoted is the World Bank Guideline (1988) used in the initial Azito 1998 ESIA. The value in brackets and italics is the 2005 updated World Health Organisation (WHO) guidelines.

Table 4.4 indicates that the maximum annual mean concentration as a result of emissions from the Azito power station should occur approximately 2km east-north-east of the Azito site, in the southern part of the Yopougon region. The occurrence of the maximum concentration in this area can be explained by the fact that the predominant wind direction is from the west-south-west. Annual mean concentrations from the Azito power station emissions further away, in the western or northern parts of Yopougon and over the Attécoubé, Adjamé and Plateau areas of Abidjan (eastern direction) fall to approximately half this maximum annual mean.

The highest predicted maximum 24 hour mean NO_x concentrations occur to the south-south-west of the Azito power station. The highest predicted maximum 24 hour mean concentrations correspond to a 24 hour period when the wind blew continuously from the north-north-east during a period of daytime atmospheric instability.

Evaluation of impact significance

The impact of atmospheric emissions from the proposed Phase III Project has been assessed, based on dispersion modelling predictions. The assessment indicates the following:

- The location of predicted maximum ground level concentrations is influenced by the stack height. Emissions from a stack of 50m high result in minimum ground level concentrations at a greater distance from the emission point. This is because the additional 10m in stack height results in the plume escaping the influence of the building downwash effect in certain meteorological conditions. However, **emissions with a stack of 40m remain well within compliance guidelines referred to in the initial 1998 ESIA as well as the IFC Performance Standards.** Maximum annual mean concentrations for the two stacks heights are similar, although the maximum annual means for the 50m stack height are slightly lower in all cases.

- As presented in the above tables, the concentrations predicted by the model while using natural gas as a source of energy remains below the applicable guidelines for atmospheric emissions (updated from the 1998 initial ESIA, based on the WHO applicable standards from 2005).

Table 4.5 Predicted ground level pollutant concentrations at 75% load (µg m^{-3}) (from 1998 ESIA

	Ambient concentration (combined cycle mode at 50% load)		**IFC guidelines(1)**
Stack Height (m)	**40**	**50**	
Pollutant			
NO_x			
Maximum 24 hour mean	38.6 (150m ENE)	16.1 (1650m SSW)	150
Maximum annual mean	1.1 (800m ENE)	0.99 (1600m ENE)	100 *(40)*
SO_2			
Maximum 24 hour mean	negligible	negligible	
Maximum annual mean	negligible	negligible	
Particulate matter			
Maximum 24 hour mean	5.5 (150m ENE)	2.3 (1650m SSW)	110 *(25)*
Maximum annual mean	0.15 (800m ENE)	0.13 (1600m ENE)	70 *(10)*

(1) The main value quoted is the World Bank Guideline (1988) used in the initial Azito 1998 ESIA. The value in brackets and italics is the 2005 updated World Health Organisation (WHO) guidelines.

Table 4.6 Predicted ground level pollutant concentrations at 50% load (µg m^{-3}) (from 1998 ESIA

	Ambient concentration (combined cycle mode at 50% load)		IFC guidelines
Stack Height (m)	**40**	**50**	
Pollutant			
NO_x			
Maximum 24 hour mean	36.1 (100m ENE)	7.5 (1900m SSW)	150
Maximum annual mean	0.52 (800m ENE)	0.46 (2000m ENE)	100 (40)
SO_2			
Maximum 24 hour mean	negligible	negligible	
Maximum annual mean	negligible	negligible	
Particulate matter			
Maximum 24 hour mean	4.9 (100m ENE)	1.0 (1900m SSW)	110 (25)
Maximum annual mean	0.07 (800m ENE)	0.06 (2000m ENE)	70 (10)

As described in *Table 3.8*, ambient concentrations of NO_x in Abidjan were monitored using the diffusion tubes technique in the Yopougon, Plateau, Treichville and Marcory area, over the year 2001. NO_2 concentrations was found to range between approximately 2 µg m^{-3} and 28 µg m^{-3}. Whilst pluri-annual data would have provided a better representation of ambient air quality in Abidjan, and its evolution over time, this baseline information can be interpreted as long-termed average values.

As indicated in *Table 4.4*, the highest predicted ambient concentration of NO_2 resulting from Azito emissions at 100% load for a 40 m stack is 41.6 µm^{-3} on a 24-hours average basis, and 1,1 µgm^{-3} on a long-term (annual) average basis. These concentrations are predicted at one point located 200 metres east-north-east of the Azito facility; predicted concentrations then decrease rapidly further away from the plant.

The IFC EHS guideline (2008) guidelines for NO_x (essentially present in ambient air in the oxidised form NO_2) are 150 µgm-^{3} as 24 hours average guidelines, and 40 µgm^{-3} as annual average guidelines.

Predicted 24-hr average concentrations at 100% load represent less than 1/3 of the IFC EHS guideline (41.6 µm^{-3} vs 150 µm^{-3}).

In terms of annual averages, considering that diffusion tube monitoring data represents long term (annual) averages, the plant contribution to the maximal ambient NO_2 concentration at measured appears to be less than 3% of the guideline (1,1 µgm^{-3} versus 28 µgm^{-3}). Of course, this approach compares

monitored and modelled concentrations for different points in space (at some times, there could be higher ambient air concentration of NO_2 in Abidjan than the maximum measured value of 28 μgm^{-3}). However, given the scarcity of baseline data, this comparison of modelling predictions with measured data provides an indication that the overall contribution of the Azito plant to ambient air should remain limited. It seems realistic to assume that the sum of all traffic emissions (and household charcoal fire emissions) in the city of Abidjan, populated by over 4 million inhabitants, contributes vastly to the degradation of air quality across the city.

A summary of the impact is presented in *Table 4.7* below.

Table 4.7 Impact assessment: air quality during the operation

Type	The existing power station operation results in pollutant emission from the gas combustion in the surroundings of the Site. A model was developed to assess the maximum pollutant concentrations and location for different phases of operations. The Phase III will not result in any type of new air emissions compared to the existing situation. Modelling data, compared to available baseline ambient air monitoring data, suggests that the contribution of the existing Azito plant to the degradation of ambient air quality in Abidjan is very limited. A 40 m stack appears to provide an acceptable performance of atmospheric dispersion.
Impact evaluation	**Magnitude :** The magnitude of the impact can be considered as insignificant, considering that Phase 3 does not add any new source of emissions. However, this ESIA suggests ranking the impact as Minor, to highlight the importance of monitoring air emissions and periodically monitoring of ambient air quality around the facility, as part of good environmental monitoring practice and an approach to continuous improvement.

4.5 IMPACTS OF GREENHOUSE GAS EMISSIONS

In terms of energy efficiency and carbon footprint, the impacts of the Phase III project are clearly positive. By switching from single cycle to combined cycle, the nominal installed capacity of the overall facility increases by a nominal 50°% at constant fuel-gas consumption; the energy efficiency of the overall power plant therefore also increases in similar proportions, from about 29,5% to about 44%. Atmospheric emissions are unchanged, therefore decreasing the greenhouse-gas footprint per unit power produced of the facility in the same proportions.

The CO2 emission factors of the plant before and after expansion are as follows:

- Grid EF: ~0.716 tCO_2/MWh
- Plant before expansion: ~0.651 tCO_2/MWh
- Plant after expansion: ~0.428 tCO_2/MWh (assuming that the fuel consumption will stay constant but the power generation will grow from about ~2,051 GWh/yr average to ~3,061 GWh/yr)

The Phase III project can therefore be considered as having a clearly positive impact in improving the 'carbon efficiency' of the overall facility, whilst helping to bridge the gap in power generation capacity in Côte d'Ivoire.

4.6 IMPACTS ON AMBIENT NOISE

4.6.1 Introduction

This section addresses potential significant impacts from noise and vibration during the construction, operation and decommissioning phases of the proposed project. Vibration during construction, operation and decommissioning is not expected to be perceptible at the nearest receptors which are in excess of 100 m from the site, and has been scoped out on this basis.

Noise sensitive receptors have been chosen to represent nearby noise sensitive properties likely to be worst affected by noise from the Project. The receptors are as follows:

- *Receptor 1* – A small group of properties close to the slaughterhouse to the northwest of the site.
- *Receptor 2* – Noise sensitive properties to the north of the road leading to the plant.
- *Receptor 3* – Noise-sensitive properties to the south of the road leading to the plant.
- *Receptor 4* –Azito village.
- *Receptor 5* – The southern end of Azito village.
- *Receptor 6* – Recreational bars along the bank of the Ebrié lagoon.
- *Receptor 7* – Two properties owned by the Compagnie Ivoirienne d'Electricité (CIE) substation operators.
- *Receptor 8* – Recently built property (after Phase I and II began operating), directly behind Receptor 7.
- *Receptor 9* – First houses at the Béago village.

The receptor locations are shown in *Figure 3.2*.

4.6.2 *Noise assessment criteria and impact significance*

The process of defining and categorising impacts has been described in general terms in *Section 4.2* above. This section provides additional detail in the context of the relevant guidance and regulations that have been adopted. The relevant noise criteria relating to the operation of the Project are presented in *Table 4.8* below. The Ivorian noise criteria were implemented after Phase I and II of the Plant was built and would therefore only apply to Phase III operations. The IFC criteria can be considered to apply to the total noise level produced by the existing equipment and the proposed Phase III equipment.

There are no known national or international standards for noise from temporary sources such as construction but best practice (as described in the UK construction noise guidance document BS 5228 [3]) is that noise levels ($L_{Aeq,12h}$ façade) from construction activities should not exceed 75 dB at the nearest noise sensitive receptors during the daytime. Noise criteria for the Project have been summarised below in *Table* 4.8.

Table 4.8 Summary of noise criteria

	Ivorian Order n°01164 for new facilities (2008) at Urban residential receptors (L_{Aeq}), dB (the operational Azito facility pre-dates this Order by 9 years)	*IFC General EHS Guideline for residential receptors ($L_{Aeq,1h}$), dB*(2)	*Construction Criterion ($L_{Aeq,12h}$ façade), dB*
Day-time	50	55	75
Intermediate period	45	n/a	n/a
Night-time	40	45(1)	n/a

(1) Noise from the Project should not exceed this level or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

(2) *This guideline is consistent with the guideline used in the initial 1998 ESIA.*

The 'intensity' of an impact (as defined in *Section 4.2*), as it relates to the above criteria, is set out in *Table 4.9* below.

Table 4.9 Definition of intensity of noise impact

Intensity Category	**Description**
Low / Negligible	Below the level of the relevant criteria at the nearest noise sensitive receptor(1). For operational noise, this category describes low levels of noise which may or may not be perceptible at the nearest noise sensitive receptors, depending on the existing ambient noise level.
Moderate	Between 0 dB and 5 dB above the level of the relevant criteria at the nearest noise sensitive receptor(1)
High	Above 5 dB above the level of the relevant criteria at the nearest noise sensitive receptor(1)

(3) BS5228: Noise and Vibration Control on Construction and Open Sites, BSi, 2009.

Intensity Category	Description
See *Table 4.8*. For operational noise, the Ivorian criteria apply to the new plant only whilst the IFC criteria apply to the total noise from the existing plant and the new plant.	

The 'magnitude' of an impact takes into account the 'intensity', 'extent', 'duration' and 'likelihood'.

For operational noise, the 'duration' of the impact will always be long term (whilst construction noise is considered to be short term), and the 'likelihood' of each noise source is assumed to be continuous (exceptions to this are dealt with separately in the relevant section). As noise levels are assessed at individual receptors, the 'extent' has been considered in the summary table (*Table 4.3*), but not at individual receptors. Therefore, the magnitude of an impact is dependent on the 'intensity' of the impact (ie a *low / negligible* intensity is rated as *not significant*, whilst a *high* intensity impact is rated as having a *major* impact). This is summarised below in *Table 4.10*.

Table 4.10 Magnitude of noise impacts

Significance	Description
Negligible	Short and long term ('duration') 'continuous' noise levels of Low / Negligible 'intensity'. Noise may be perceptible, however levels fall below the relevant criteria and are considered to be not significant.
Minor	Short term impacts of moderate intensity
Moderate	Long term impacts of moderate intensity Short term impacts of high intensity
Major	Long term impacts of high intensity

4.6.3 Potential impacts during the construction phase

Sources of impacts

The construction phase is expected to last 27 months. This section assesses the likely noise levels and potential impacts at the nearest off-site noise sensitive receptors. Receptor locations are shown in *Figure 3.2*.

The main activities during construction that have the potential to generate noise are:

- excavation;
- grading;
- piling (bored);
- pouring foundations (concreting);
- cable trenching
- structural steel work; and
- construction traffic.

Construction works are expected to take place during the daytime only (07:00 to 18:00). In certain circumstances (for example to catch up in the event of delays in the programme), it may be necessary to work overnight. In this case, the construction works carried out at night will be limited to quiet activities which will not be capable of causing disturbance at the nearest noise sensitive receptors.

Potential impacts from construction noise

In the absence of any specific guidance or prescribed methodology for the prediction of construction noise, noise levels during construction have been calculated using the method described in BS 5228 (4). The method includes a database of noise levels from typical construction plant items. The number of plant items associated with the development, and the distance between the source and receptors is then used to calculate noise levels at the nearest noise sensitive receptor areas. For this assessment, predicted noise levels have been based on works being carried out at the closest part of the site and screening of noise sources by existing on-site structures has not been taken into account to present a worst-case assessment.

Predicted construction noise levels for each phase of construction are presented in *Table 4.11*.

Table 4.11 Predicted construction noise levels

	Predicted Façade Noise Level, ($L_{Aeq,12h}$) dB					
Receptor	**Excavation**	**Grading**	**Piling**	**Foundation works**	**Duct bank and cable trenching**	**Structural Steelwork**
1	70	67	69	69	60	68
2	68	65	67	65	58	63
3	69	66	68	66	59	64
4	65	62	64	60	55	59
5	69	66	68	63	59	61
6	71	68	71	66	62	64
7	73	70	72	67	63	65
8	71	68	71	66	62	64
9	67	64	67	63	58	61

None of the noise levels calculated for each sensitive receptors exceed the 75 dB limit specified as best practice in the UK construction noise guidance document BS 5228. The highest noise levels during the construction period are expected to be during the excavation phase, which is expected to last for approximately three month, and during piling, which is expected to last for

(4) BS5228: Noise and Vibration Control on Construction and Open Sites, BSi, 2009.

approximately four months. No driven piling methods will be used because some of the existing equipment at the power plant is vibration sensitive.

Based on this information, the potential impacts on ambient noise levels associated to the construction works are considered to be minor.

However, local government authorities and surrounding community leaders will need to be informed of the construction schedule and operations. Strong grievance procedures associated to an internal communication and follow-up plan will also need to be implemented to allow the neighbouring villagers to report any disturbance or issue related to the construction activities.

Standard best practice measures will be adhered, including the use of modern, well maintained equipment and vehicles. Measurements of construction noise should also be carried out at various sensitive locations (including receptors 1 and 7) to control that the predicted values are respected.

Construction traffic

During construction, up to 31 vehicles trips per hour are expected, the majority of which will be HGV's. Baseline traffic flow data are not available, however it is anticipated that exiting traffic flows on this route are low. Noise levels from construction traffic have been predicted according to CRTN [(5)] . The nearest noise sensitive receptors to the route and to the site may experience noise from construction traffic in addition to construction noise from the site. The receptor likely to be worst affected by this cumulative noise is Receptor 1 (a small group of properties close to the slaughterhouse to the northwest of the site), which lies at a distance of approximately 20 m from the traffic route. Peak hour traffic noise at this location is predicted to be 64 dB $L_{Aeq,1h}$ (facade). This is likely to result in a noticeable increase in traffic noise, but does not exceed the construction criteria (75 dB $L_{Aeq,12h}$ façade). The noisiest phase of construction on site is predicted to be excavation works, which is expected to produce a noise level at the nearest property of 70 dB $L_{Aeq,12h}$ (facade). The resulting total noise level, including traffic noise at this receptor is expected to be up to 71 dB $L_{Aeq,12h}$ (facade). Since this is below the construction criterion, even construction traffic combined with noise from the site is not predicted to result in a significant impact.

At receptors further away from the site, noise from on-site construction activities will be lower. However, some properties lie closer to the traffic route (at approximately 10 m), and at this distance, construction traffic noise levels from traffic are predicted to be 66 dB $L_{Aeq,1h}$ (facade). This is below the construction noise criterion and is therefore not predicted to result in a significant impact.

(5) Calculation of Road Traffic Noise. The Department of Transport, 1988.

4.6.4 *Potential impacts during the operations phase*

Noise from the existing plant

Annex B reports a detailed baseline noise survey carried out in December 2011. Existing daytime measured noise levels were below 55 dB at all locations, and therefore noise from Phase I and Phase II falls within the IFC criteria during daytime.

Measurements of noise levels at night showed that there are no significant impacts as a result of the operation of Phase I and Phase II of the Azito plant. Relatively elevated night time noise levels (48 dB) were recorded in Béago village (area located in front of the power station to the north-east of the Site). Noise at this location was dominated by the Foxtrot gas treatment plant (see *Section B1.4.2* in *Annex B*). Noise levels from the Foxtrot plant are particularly noticeable, however it is anticipated that they can be suitably controlled either through maintenance, at-source noise control measures or through the use of a barrier close to the source of noise. These options should be discussed together with the Foxtrot plant operator.

At Receptor 7 (outside of properties owned by CIE substation operators), noise levels were above the IFC criterion (49 dB, $L_{Aeq,1h}$), however these properties are associated with the operation of the Azito plant and are well constructed with air conditioning facilities and a good level of acoustic insulation – personnel present within the building cannot therefore be considered to be impacted. The property at Receptor 8 was built after commissioning of Phase 1 and 2. The IFC guidelines relate to new plant built close to existing noise sensitive properties and therefore do not apply at this property.

Potential impacts following the implementation of phase III – worst case scenario

Noise levels technical characteristics related to the Phase III installations were not available at the time this assessment was undertaken.

As a first step, a 'worst case scenario' was studied, by modelling noise source levels on the Project specification of 85 dB(A) at 1 m from plant items. In some cases, to achieve the project specification of 85 dB(A) at 1 m from plant items, acoustic control measures are included by the vendor –this has been assumed in the modelling.

Noise propagation has been modelled using the Predictor software model using the guidance set out in ISO 9613-2[6]. Noise contours have been produced which indicate the noise levels produced by items of noisy plant across the site.

[6] ISO 9613-2:1996. Acoustics. Attenuation of sound during propagation outdoors. Part 2: General method of calculation.

It has also been assumed that all sources operate continuously and simultaneously. No screening from offsite buildings or topographical features has been included, producing a conservative assessment.

The main operational sources of noise are:

- two heat recovery steam generators (HRSG);
- pipework carrying steam from the HRSG's to the steam turbine building (40 m has been modelled at a height of 30 m, and 50 m has been modelled at a height of 8 m);
- the steam turbine building;
- air cooled condensers;
- air cooled water cooler;
- two station service transformers; and
- various small pumps.

Abnormal events (such as a steam turbine bypass operation) constitute a rare and infrequent source of noise and have not been included in the noise modelling. Similarly, the fire fighting pumps are tested twice a month and at daytime only. They are not expected to influence long term noise levels and have therefore not been included in the modelling.

The results of this worst case noise modelling are presented in the 4th column of *Table 4.13* overleaf. As mention above, source noise levels have been based on equipment meeting the Project noise level of 85 dB(A) @ 1m and on equipment dimensions provided by Azito Energie. The exception to this is the noise emitted from the top of the HRSG stacks. An unmitigated noise level of 104 dB(A) has been used for this noise source, based on data from a similar development.

Potential impacts following the implementation of Phase III – realistic case

The noise levels at sensitive receptors, modelled using the worst case scenario parameters show that the predicted values exceed the applicable standards (Ivoirian and IFC standards). However, good practice in the industry associated with simple mitigation measures can easily be implemented to reduce the noise levels emitted by the Phase III various installations. These measures are most of the time implemented as a standard practice while designing the different components of the plant and the proposed solutions should therefore be considered as a realistic case.

To further reduce noise levels, design noise control measures must focus on the noisiest equipment items. Some equipment may already require noise control measures in order to achieve the 'unmitigated case' levels of 85 dBA at

1 m (for example, the steam turbine will typically require an acoustic enclosure).

Mitigation measures have been suggested in *Table 4.12* based on the current, preliminary design phase of the Project. A variety of factors must be considered when designing noise mitigation such as process safety, energy efficiency etc. Azito Energie will, as a minimum, meet the total reductions necessary for the Phase III plant to meet a level of 40 dB (L_{Aeq}) at the nearest identified noise sensitive receptors through a combination of noise reduction at source and other mitigation measures, the detail of which will be addressed in the detailed design phase.

Table 4.12 Engineering noise controls at the source

Equipment Item	Unmitigated SPL at 1 m, dBA	Further Noise Control Measures Assumed for 'Mitigated Case'	Achievable SPL at 1 m, dBA
HRSG	85	The specified reduced noise level may be achievable without mitigation being required. Lower noise versions are available if required.	70
HRSG Stack (walls)	85		65
HRSG Stack exit	104	Silencer	79
Steam Pipes	85	Lagging	70
Air Cooled Condenser	85	Substantial mitigation may be required, which may include the use of low noise fans and sound-attenuating baffles for the inlet and discharge of the ACC.	65
Air Cooled Water Cooler	85	Low noise fans / acoustic baffles.	70
Station Service Transformers	85	Enclosure	65
Vacuum Pumps	85	Low noise pumps / noise screen / enclosure.	70
Condensate Extraction Pumps	85	Low noise pumps / noise screen / enclosure.	70
Duct Drain Pumps	85	Low noise pumps / noise screen.	75
Condensate Pre-heater Pumps	85	Low noise pumps.	80
Service Water Pumps	85	Low noise pumps / noise screen / enclosure.	70
Demi Water Pumps	85	Low noise pumps.	80

The noise levels predicted by the model are presented in *Table 4.13* overleaf. These values are compared to the Ivoirian and IFC standards. The Ivorian Order n°01164 for new facilities was implemented in 2008 and therefore does not apply to Phase I and Phase II which began operating before this. These criteria have however been used to assess noise from the Phase III equipment, whilst the total predicted noise emissions from the plant (including Phase 1, 2

and 3 equipment) have been assessed against the IFC criteria. These noise levels are presented as contours in *Figure 4.1*.

Table 4.13 Predicted free-field noise levels from the proposed development and potential noise impacts with noise mitigation

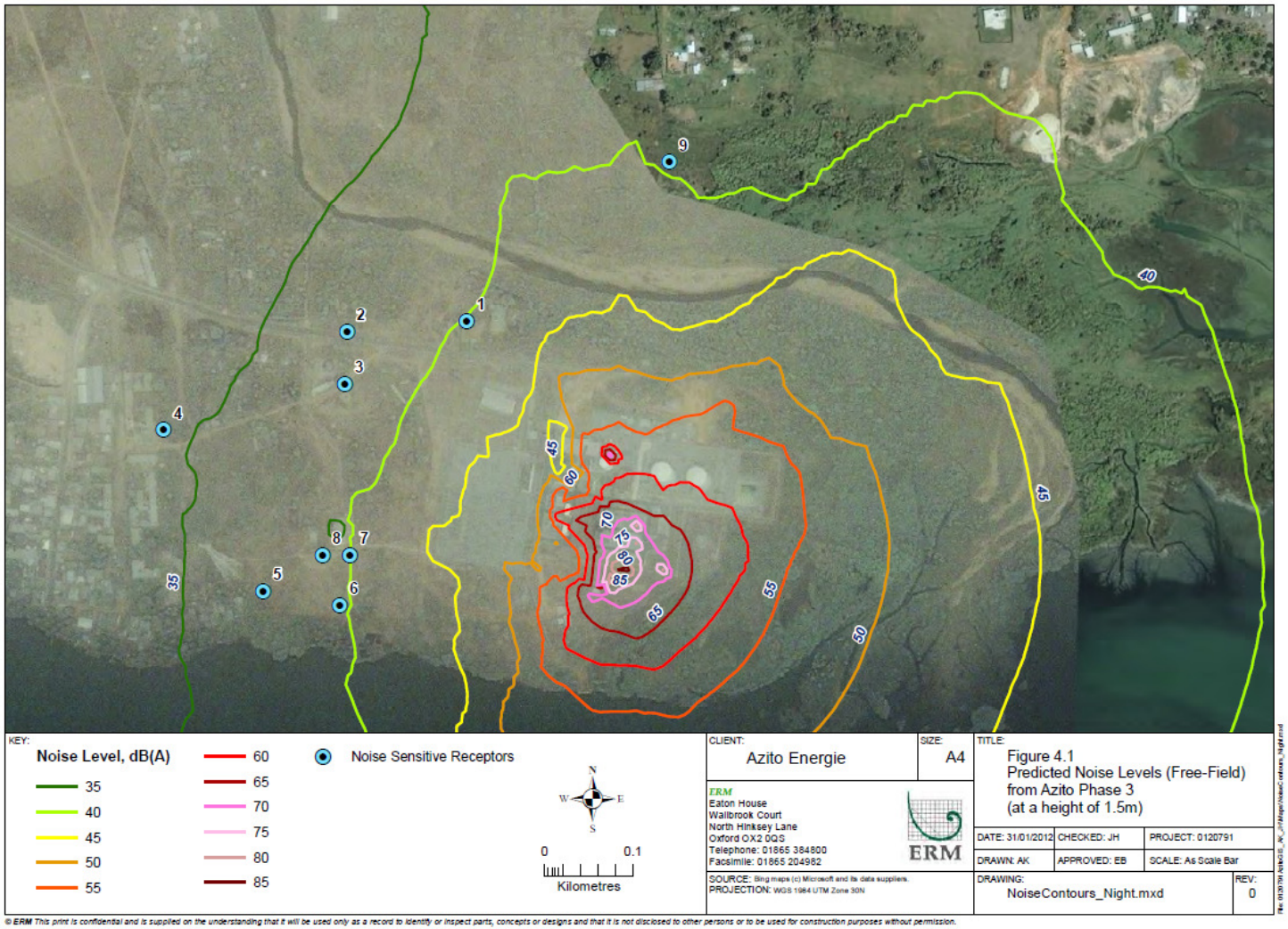
Receptor	Period	Baseline Noise Level $L_{Aeq,period}$ (Cricket Noise Filtered (see *Section B1.4.3* in *Annex B*)	Predicted Unmitigated Noise from Phase III ($L_{Aeq,period}$), dB	Predicted Mitigated Noise from Phase III ($L_{Aeq,period}$), dB	Exceedence of Ivorian Noise Criteria, dB (mitigates case)	Total Plant Noise (Phases 1, 2 and 3), dB ($L_{Aeq,period}$)[1] (mitigates case)	Exceedences of IFC Threshold Criteria, dB (mitigates case)	Predicted Increase in Existing Ambient Noise Level, dB (mitigates case)
1. A small group of properties close to the slaughterhouse to the northwest of the site.	Day	50	58	40	None	51	None	0
	Night	46	58	40	None	47 [2]	2	1
2. Properties to the north of the road leading to the plant.	Day	51	55	37	None	51	None	0
	Night	46	55	37	None	47 [2]	2	1
3. Properties to the south of the road leading to the plant.	Day	46	56	38	None	47	None	1
	Night	43	56	38	None	44	None	1
4 Azito village	Day	47	52	34	None	47	None	0
	Night	38	52	34	None	40	None	2
5 The southern end of Azito village	Day	47	55	37	None	47	None	0
	Night	44	55	37	None	45	None	1
6 Recreational facilities along the bank of the Ebrié lagoon	Day	49	57	40	None	49	None	0
	Night	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7 Properties owned by CIE substation operators	Day	50	58	40	None	50	None	0
	Night	49	58	40	None	49	4	0
8 Recently built property directly behind R7	Day	49	56	39	None	49	None	0

Receptor	Period	Baseline Noise Level $L_{Aeq,period}$ (Cricket Noise Filtered (see *Section B1.4.3* in *Annex B*)	Predicted Unmitigated Noise from Phase III ($L_{Aeq,period}$), dB	Predicted Mitigated Noise from Phase III ($L_{Aeq,period}$), dB	Exceedence of Ivorian Noise Criteria, dB (mitigates case)	Total Plant Noise (Phases 1, 2 and 3), dB ($L_{Aeq,period}$)(1) (mitigates case)	Exceedences of IFC Threshold Criteria, dB (mitigates case)	Predicted Increase in Existing Ambient Noise Level, dB (mitigates case)
	Night	48	56	39	None	48	3	0
9 Béago village	Day	49	55	40	None	49	None	0
	Night	48	55	40	None	49 (2)	4	1

(1) This value has been calculated by combining the predicted noise from the Phase 3 equipment with measured baseline noise levels (taken to be the noise from Phase 1 and 2 of the plant). Baseline noise has had cricket noise partially filtered out see *Section B1.4.3* in *Annex B*. At locations 1,2 and 9, baseline noise levels also include noise from the unmitigated Foxtrot plant.

(2) Includes noise from the unmitigated Foxtrot plant.

Figure 4.1 Noise contours at the Azito power plant and sensitive receptors (mitigated case)



As mentioned above, the Phase III should be designed to meet the Ivorian night-time criterion of 40 dB (L_{Aeq}) at the nearest noise sensitive receptors. No exceedences of the Ivorian criteria are therefore expected. As the Phase III equipment will be designed to meet this criterion, increases in existing noise levels are expected to be low (within 1 dB).

The results of the realistic case model show that no exceedence of the IFC criteria are predicted at receptors during the day.

The model also show that at night, existing total noise levels at Receptors 1 (a small group of properties close to the slaughterhouse to the northwest of the site) and Receptor 2 (properties to the north of the road leading to the plant) are slightly above the IFC criterion (45 dB, $L_{Aeq,1h}$). Noise levels from crickets and the Foxtrot plant were noted as significant sources at these locations and may have influenced noise levels. A noise level (L_{Aeq}) of 40 dB is predicted from Phase 3 at Receptor 1 and 37 dB at Receptor 2, resulting in an increase in existing noise levels of up to 1 dB. As noise at this level is not noticeably above the criterion, and given the nature of the measured total ambient noise and cricket noise, this is not considered a significant impact. Furthermore, if noise from the Foxtrot plant was reduced, it is likely that the total plant noise levels would be reduced.

No exceedences of the IFC night-time criterion have been predicted at Receptor 3 (properties to the south of the road leading to the plant), or Azito village (receptors 4 and 5).

Receptor 7 consists of two properties associated with the operation of the Azito plant which, as discussed earlier, are well constructed with a good level of acoustic insulation. Noise levels from Phase 3 of 40 dB (L_{Aeq}) have been predicted at this location, which is not expected to significantly increase existing night-time noise levels of 49 dB and is not considered to cause a significant impact.

At night, the existing baseline noise level (L_{Aeq}) at Receptor 8 (recently built property directly behind Receptor 7) was found to be 48 dB and significant noise sources were noted to be crickets and the plant. As this property was built after Phase I and II began operation, this has been taken as the baseline for the purpose of assessment against the IFC guidelines which state that noise from the Project should not result in a maximum increase in background levels of 3 dB. As the addition of Phase 3 is expected to increase existing baseline levels by less than 1 dB, no significant noise impact is expected.

At night, existing noise levels of 48 dB (L_{Aeq}) were measured at Receptor 9 (Béago village). Noise levels at this location were elevated due to noise from the Foxtrot plant. Cricket noise was also noted as a significant noise source. Noise from Phase 3 equipment is not predicted to significantly increase noise

levels at this location (by less than 1dB), so would not create a significant impact. However, noise levels for the existing situation exceed IFC criteria and mitigation measures should be discussed for the Foxtrot plant, together with the plant operator in order to reduce the ambient noise to acceptable levels.

Based on the above information, considering the appropriate mitigation measures and appropriate design of the new installations, the increment in ambient noise levels, associated with the operation of the Phase III is considered to be low.

Table 4.14 Impact assessment: water consumption during the construction phase

Type	Incremental ambient noise level associated with commissioning of the Azito Phase III facility, in addition to the existing operational Phase I and Phase II installations.
Impact evaluation	**Magnitude :** Minor ***Intensity***: As explained in detail in *Section 4.6*, the intensity of the impact is considered to be low. ***Extent*:** The extent can be considered as local as it only involves the Azito near-field. ***Duration:*** Throughout the plant operational life. ***Likelihood:*** Impacts are considered to be continuous during the construction operations.

4.7 IMPACTS ON WATER SUPPLY AND ENVIRONMENTAL WATER QUALITY

4.7.1 Potential impacts during the construction phase

Impacts from water consumption

The water needed for the construction phase of the Project is mainly related to the use of domestic water on site, in the temporary camps, and water consumption for the construction works.

The construction activities requiring the use of water are:

- general domestic use for construction workforce;
- general cleaning and control of airborne dust;
- site maintenance; and
- concrete preparation.

Potable water for the staff at the facility is currently supplied from the existing main supply which provides water to the nearby village of Azito.

Assuming that Phase III construction staff will be accommodated in a temporary camp on-site, water consumption for domestic use during construction can be estimated at about 200 litres per person per day (mostly

from sanitary use – showers, toilets). Azito expects that the peak construction workforce will reach up to approximately 600 workers, of which around 50 would be directly employed from the surrounding local communities and wouldn't need to stay in the worker camps. Assuming that all workers from outside of Yopougon are accommodated on-site, the maximum daily consumption of domestic water for the workers at peak construction workforce installations can be estimated to be 110 m^3 per day (ie 80 litres per minute). This peak water requirement can easily be supplied by water mains of the Société des Eaux de Côte d'Ivoire (SODECI), or trucked on site using tanker trucks and stored in temporary water storage tank.

Water consumption from construction activities –mostly concrete preparation, as well as area maintenance and dust suppression (if needed, during the dry season) will be limited in quantities and in time. Foundation concrete is likely to be brought on site ready-mixed from an existing concrete plant in Abidjan, using concrete mixer trucks.

Drinking water will be provided to the workers by the contractor during the construction phase. The contractor will make sure that the water provided will meet the Ivoirian requirements and international standards.

The impacts description and characterization are presented in *Table 4.15*.

Table 4.15 Impact assessment: water consumption during the construction phase

Type	The impacts on water resources from water consumption during the construction phase are related to the use of domestic water on site, in the temporary camps, and water consumption for the construction works
Impact evaluation	**Magnitude :** Negligible ***Intensity***: The intensity of the impact is considered to be low. ***Extent*:** The extent can be considered as local as it only involves limited consumption from the water supply system of the city of Abidjan. ***Duration:*** Impacts will be temporary and short-term. Note that construction workforce will not be at peak throughout the construction phase. ***Likelihood:*** Impacts are considered to be continuous during the construction operations.

As part of general good practice in environmental management, Azito Energie will require that the construction contractor:

- optimises water use efficiency and minimises wastages;
- monitors water consumption with a view to identify over-consumption and provide a basis for increasing water efficiency; and
- Provide drinking water of acceptable quality to the workers by either using bottled water or a temporary potabilization unit.

Impacts on water quality

The main surface water body in the Project area is the Ebrié lagoon. The Azito site is located within 100 m of the lagoon to the east and south. Impacts on water quality from the construction phase may result from :

- turbid run-off from the construction site, during rainy events (mostly from stripped construction surfaces and excavation material tips) ;
- direct discharges of sanitary effluent; and
- accidental leaks or spills.

Impacts from turbid run-of will be minimal, given the relatively small footprint of the construction site (less than approximately 2 ha). Good practice in site run-off management will be implemented, using site surface profiling, drainage ditches and sediments traps. Note that turbid run-off may happen during rainy events, largely during the rainy seasons; at those times of year, water turbidity in the lagoon is already high due to general run-off from streams, the city of Abidjan, an the lagoon shores.

There will be no direct discharge of sanitary effluents from the construction site. Sanitary wastewater will be treated in a mobile sewage treatment facility. The treated effluent released into the lagoon will meet the discharge criteria specified by the general IFC EHS guideline (2007).

During the construction activities, surface and ground water quality can also be affected by an accidental release of chemical, fuel or oil from temporary storage tanks or vehicles used on Site. Small changes are likely to be reversible, but larger accidental spills of fuel or chemicals could result in medium-term decreases in water quality.

Table 4.16 Assessment of impacts on water quality from the construction phase

Type	The water quality (surface and groundwater) can be impacted by • an increase of the sediment load into the lagoon; • releases of domestic effluents into the lagoon; and • an accidental spill or leakage form temporary chemical, fuel or oil storage tanks or vehicle used on Site for the construction.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the impact is considered to be low. ***Extent*:** The extent will be within the immediate vicinity of the Project ***Duration:*** Impacts associated with the constructions works will be temporary and short-term. ***Likelihood:*** Impacts are considered to be rare to occasional during the construction operations.

The following measures will minimise potential impacts on water quality during the construction phase:

- The impact from construction activities can be addressed by minimising the amount of land left bare and re-vegetating any slopes as quickly as possible. Any temporary stockpiles should be protected from erosion by using a reduced slope angle where practical, and by incorporating sediment traps in drainage ditches. This can be addressed by developing a site drainage plan.

- Good site management practices should be observed to ensure that the products are properly stored on site (secondary containment, double walled tanks, over filling alarm system, etc.) and construction vehicle are controlled and maintained properly and regularly.

- There will be no release of untreated sanitary effluents into the lagoon. Construction site sanitary effluents will be treated to meet the general IFC EHS guideline discharge criteria before being discharged into the lagoon.

4.7.2 Potential impacts on water supply and water quality during the operations phase

Water consumption

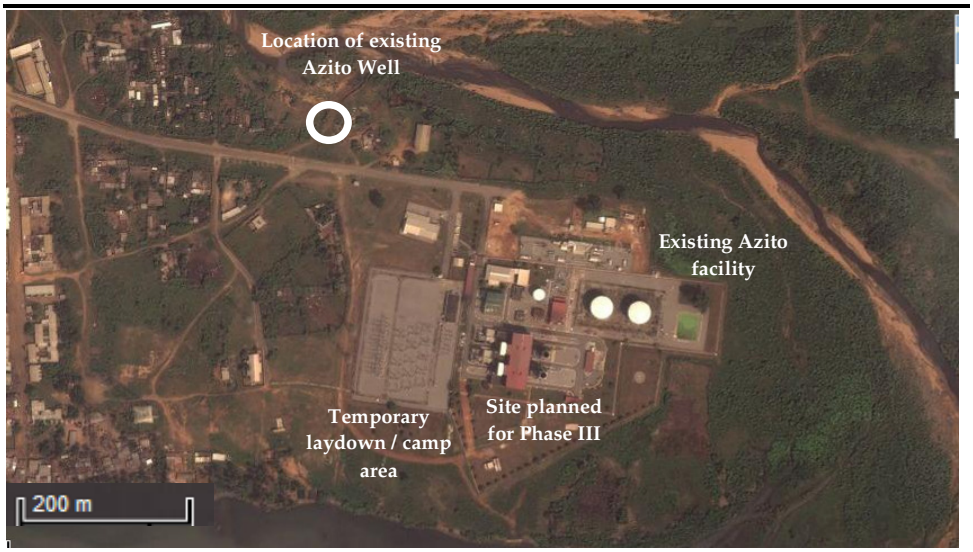
Two main sources will cover the water requirements during the operations phase:

- Potable water from the existing municipal supply. However, the volumes of potable water used on site will be very limited.

- Industrial water (make-up for the closed-circuit steam generation, for industrial cleaning and fire fighting purposes) will be supplied from the existing well used by the existing Azito facility.

The well installed during the phase I and II construction has a capacity of 45 m^3/h. Pumped water is currently filtered and directed to a 1 000 m^3 buffer tank. The current water consumption for the existing GT plant is very low.

Figure 4.2 Well location



As presented in the 1998 ESIA report, abstraction of groundwater can result in the development of a cone of depression. If the groundwater levels fall below those in the lagoon, it could lead to saline intrusion in the aquifer. This could result in abstraction of saline water at the well and have an impact on other boreholes - particularly those used for water supply for Abidjan to the north.

The SODECI (National Water Distribution Company) have developed regulations to prevent saline intrusion into the major boreholes used to provide potable water for Abidjan. These boreholes are situated 5 - 10 km from the coast. The existing borehole installed by Azito falls within a zone defined by the SODECI as requiring protection and is therefore subject to such controls. Several measures have been adopted by SODECI to ensure protection of the groundwater resources.

Preliminary calculations were undertaken in 1998 to assess the impact from the well installation on groundwater. They assume a peak continuous pump rate of 45 m^3/h (which is considered to a very high-end value), an aquifer permeability of 25 m/day and recharge of 2 300 mm/year. The groundwater levels as well as drawdown levels have been calculated for different aquifer thickness. This assumes the well will be placed 1 000 m from the lagoon, with a well diameter of 0.6 m. The data suggest that, for an aquifer thickness of 20 m, the drawdown at the well would be approximately 3.0 m and would not lead to saline intrusion from the lagoon.

High purity water will be produced from water pumped out of the well. A new demineralised water supply system will replace the existing equipment

The volumes needed for the different operation phases is not evaluated at this stage of the project but the current capacity of the well installed for the phase I and II (45 m^3/h) was estimated to be sufficient to cover the need of the phase III expansion plant and associated installation.

Impact description and characterization are presented in *Table 4.17.*

Table 4.17 Impact assessment: water consumption during the operation phase

Type	Impact on water resources from water consumption during the operation phase (potable and industrial water).
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the impact is considered to be very low. ***Extent*:** The extent will be local. ***Duration:*** Impacts may be associated with long-term operations, but impacts in themselves will be short-lived. ***Likelihood:*** Impacts are considered to be continuous during the operations, but with a very low intensity.

The following measure will minimise the potential impacts on water resources during the operations:

- The volume of water required for each phases of the project should be assessed and the well capacity should be re-evaluated to control that the volumes of water pumped of the borehole are sufficient to cover the needs.

Waste water

The waste water from the Phase III operations will be directed to the existing water treatment installations on site. *Table 4.18* summarizes the source of impact on water quality from the operations of the Phase III.

Table 4.18 Sources of impact on water quality during the operations

Discharge Type	Source	Interface / location	Potential Impact	Discharge volume
Sanitary waste water	Showers and toilets	Connection to the biological treatment unit and then directed to the neutralisation and evaporation pond	Bacterial and chemical contamination	Maximum 10 m^3 /day
Oily waste water	Operational cleaning and oil spillages	Connection to the existing system: oil-water separator and treatment unit. Directed to the existing neutralisation and evaporation pond	Oil contamination with potential secondary effects on aquatic biota such as seabirds, fish and marine mammals	Max 16 m^3/day

Discharge Type	Source	Interface / location	Potential Impact	Discharge volume
Transformer oil spillage washed by rain water	Transformers	Connection to existing transformer oil/water separator Water is then discharge out of the site	Oil contamination with potential secondary effects on aquatic biota such as aquatic birds and fish.	Very low volumes
Drainage water	Drainage from buildings, warehouses, roads, etc.	Connection to existing system : segregated open drainage ditches with discharge outside of the fence line	Hydrocarbons contamination and other chemicals with potential secondary effects on aquatic biota such as aquatic birds and fish	Depending on weather conditions
Process water	Phase III installations' cleaning, vapour recovery boilers.	Connection to the existing water treatment system and directed to the neutralisation and evaporation pond	Contamination with hydrocarbons and other chemicals depending of the origin of water	Limited volume of additional process water compared to the existing situation
Fire fighting water	Fire fighting water, depending of the fire source	Connection to the existing system	Oil/hydrocarbons/ adjuvant contamination	Rare. Maximum 2 500 m^3 in case of fire (maximum capacity of tank + estimation for intervention discharge)

The raw water treatment facility also results in surplus water being produced during the backwash of the well water pre-treatment filters. This water is discharged without treatment to Ebrié Lagoon.

The waste water produced during the regeneration of the new demineralisation plant will be neutralised in a dedicated sump and discharged to the lagoon.

As presented in the Project presentation, during the operations of the Phase III plant, oily waste water from the collecting pits, sanitary waste water as well as industrial waste water will be centralised in the existing treatment system. After equalisation in the junction pit, the water is neutralised by chemical dosing and pH adjustment and directed to the evaporation pond.

When the level of the pond reaches its maximum limit, a local laboratory is subcontracted by Azito to analyse the water. If the concentrations measured for the various parameters respect the Ivoirian guidelines for liquid effluents, the water is pumped out of the pond and discharged in the open land bordering the site on its eastern side. As presented in the baseline section, the analytical results have shown concentrations above the IFC/Ivoirian guidelines for BDO_5, suspended solids and oil and greases (2008 and 2010). The concentrations measured in 2011 were all below the standards.

Rain water collected in the transformers' secondary containment, potentially contaminated by oil, is collected separately and directed into an oil and water separator. Treated water is directed to the drainage network and discharge out of the site, in the open land located on the south western side of the site, together with the rain water.

Rain water will be collected from building roofs and connected with the existing storm water discharge ditches, leading to the discharge point, out of the site (western side).

Sludge and residual solids from oil and grit removal tank, waste water treatment plant and the evaporation pond will be collected for treatment and/or disposal by an independent waste management company.

Table 4.19 Impact Assessment: water quality – waste water

Type	Operations of the phase III can impact the water quality by the contamination of surface and groundwater from process, fire fighting and drainage water.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the impact is considered to be low. ***Extent*:** The extent will be within the vicinity of the Project. ***Duration:*** Impacts may be associated with long-term operations, but impacts in themselves will be short-lived. ***Likelihood:*** Impacts are considered to be occasional.

The following measures will minimise the potential impacts on water quality during the operation of the phase III:

- Liquid wastes resulting from the operation of the facility will be collected and treated as appropriate. Oily water will be treated in an oil/water separator before being directed to the neutralisation and evaporation pond.

- Measures currently applicable on the Site for the waste water collection and treatment will be implemented for the phase III installations. An assessment of the existing capacity of the evaporation pond will be undertaken to control that the volume is sufficient to cover the waste water flow increase coming from the Phase III expansion.

- The design and technical characteristics of the water treatment process installations will need to be adapted to the Phase III in order to cover the effluents produced by the Phase III. This should cover the evaporation pond rehabilitation and protection (appropriate coating), biological treatment unit improvement, neutralisation pond and oily water treatment unit.

- The biological treatment process of the industrial and sanitary water should be improved and adapted to the new situation to avoid any contamination of the receptors reached by the effluent water coming from the evaporation pond.

4.8 IMPACTS ON BIODIVERSITY

4.8.1 *Potential impacts during the construction phase*

Two areas surrounding the fence line, located to the north-west and south-west from the site are planned to be used as a temporary lay-down area during the construction phase. A map showing these areas is presented in *Chapter 2* and in *Annex B*. These two areas are presented on the pictures below.

As mentioned in the project description the construction phase is expected to last 27 months, for commissioning 2014.

Figure 4.3 Temporary lay-down area located north-west from the site

As mentioned in the biological baseline section, neither of these areas sustains any sensitive habitats. They consist of grass land and peri-urban shrub. An isolated mango tree (*Mangifera indica L.*) is located in the middle of the south-western lay-down area. As shown on the pictures, local farmers use these areas for cattle grazing.

On site, habitat loss from Phase III activities is considered to be negligible as no rare or endemic species were identified. Only a few ornamental species were observed within the fenced area.

Construction material will only be stockpiled in the two laydown areas presented above in the section and should therefore not constitute a potential impact for the biodiversity.

Impacts from construction works to the biodiversity of the lagoon will be primarily related to potential contaminated drainage and runoff discharge in the lagoon and disturbance of benthic communities due to marine transportation. However, the potential for such impacts is limited due to the following:

- Drainage and runoff will be treated, using the existing onsite water treatment installations, to remove solids, oils and any other contaminants prior to discharge to the lagoon.

- If the construction phase requires the use of equipment transportation by boat, appropriate marine transportation good practices will minimise sediment disturbance and subsequent re-deposition. Impact associated with the marine transportation will be localised and temporary. The benthic community of the lagoon is characterised by a number of opportunistic species that are able to re-colonise disturbed sediments very rapidly.

Figure 4.4 Temporary lay-down area located south-west from the site

Impact description and characterization are summarized in *Table 4.20*.

Table 4.20 Impact Assessment: biodiversity during the construction phase

Type	The construction of the Phase III unit, associated to the temporary land-take for lay-down area and material storage will potentially impact the biodiversity of the Site and surroundings.
Impact evaluation	**Magnitude :** Negligible ***Intensity***: The intensity of the impact is considered to be low given that perceptible change of the environment will not be observed. ***Extent*:** The extent will be within the immediate vicinity of the Project. ***Duration:*** Impacts on biodiversity associated with the constructions phase will be temporary and short-term. ***Likelihood:*** Impacts are considered to be occasional during the construction operations.

The following good practices in environmental management and biodiversity conservation will be implemented during the construction phase:

- Turbid run-off from the site will be minimised through good site drainage management (see *Section 4.6*).

- Fuel and chemical should be handled following the good practice of the industry (containment, double-walled tanks, etc.) to avoid any spillage and leakage that could affect the biodiversity of the area.

- The land that has been cleared for construction purposes will be restored to its original state.

4.8.2 Potential impacts during the operations phase

As mentioned in *Chapter 2*, the footprint of the Phase III expansion facility will be located essentially within the existing concession area of the Azito facility. A small portion of land located outside of the fenced area (but already within the concession allocated to Azito Energie) will also be used for the construction. This area is presented on the picture below.

The extension area located outside of the fence consists of a grassy area, located on the southern part of the site.

As explained in *Chapter 3*, this extension area outside the existing fence does not contain any sensitive habitat or any species of ecological interest.

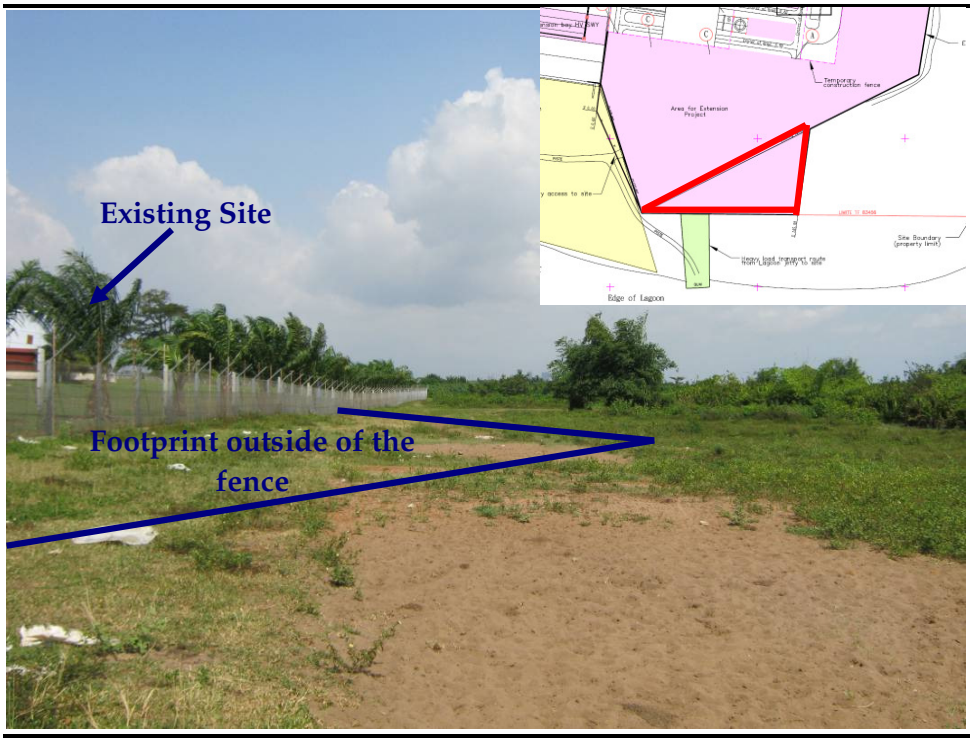
Potential sources of operational impact on the biodiversity of the area include the spillages or leakages of products and chemicals on site or along the transport route. Very few product and limited volumes will be used on Site for the phase III expansion. Chemical will mainly consist of water treatment products associated with the steam production unit as well as lubricant and oils. This issue was developed in the impact assessment to the water media.

Impact description and characterization are summarized in *Table 4.21*.

Table 4.21 Impact Assessment: biodiversity during operation phase

Type	The operation of the Phase III including potential spillages or leakages of products and chemicals on site or along the transport route have the potential to impact the biodiversity of the Site and surroundings.
Impact evaluation	**Magnitude :** Negligible ***Intensity***: The intensity of the potential impact is considered to be low given that perceptible modification would be observed but environment would probably not be prejudiced in the long term. ***Extent*:** The extent will be constrained within the vicinity of the Project. ***Duration:*** Potential impacts on biodiversity associated with the operations might affect the environment on the medium to long-term, but such impacts are of very low intensity. ***Likelihood:*** Potential impacts are considered to be very limited during the operations of the Phase III.

Figure 4.5 Picture showing the land take outside of the fence



4.9 SOLID WASTES

4.9.1 *Potential impacts during the construction phase*

The Project construction will generate the following type of waste:

- General solid waste: household waste (including organic waste), plastics, paper, food, packaging, office equipment, etc.
- Special waste: cables, scrap metal, paint cans, packaging, tin cans, glass and small amounts of other substances.
- Hazardous waste: waste oil, oily rags, filter cartridges, absorbent materials and batteries.

The volumes of waste produced during the construction of the Phase III has not been estimated at this stage but can be anticipated to be relatively low for hazardous wastes the order of a few cubic metres per month. Most hazardous wastes consist essentially in oil-contaminated wastes, which can be readily collected and disposed off through contracts with industrial wastes recycling and elimination contractors in Ivory Coast.

Table 4.22 Impact Assessment: waste production during operation phase

Type	Construction wastes
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low given that the low quantities. ***Extent*:** The extent will be constrained within the vicinity of the Project. ***Duration:*** Medium-term. ***Likelihood:*** Continuous

To mitigate potential impacts from waste production, the following measures will be implemented:

- A detailed Waste Management Plan will be developed prior to the construction phase and integrate the waste collection and management produced by the workers hired for the construction of the Phase III.

- All generated solid wastes will be collected, stored, transported and disposed off safely, in an environmentally acceptable manner, by the EPC Contractor in accordance with the Azito requirements.

- Waste management contractors will be selected based on capabilities and quality of service, and audited to ensure that wastes are being eliminated in a manner compliant with Ivorian Law, international good practice, and Azito contract requirements.

- A post-construction survey of the construction area will be conducted to confirm that all debris and wastes have been removed and eliminated at the end of the construction phase.

4.9.2 Potential impacts during the operation phase

As mentioned previously, the project will produce no significant quantities of solid process waste compared to the actual situation during the operations phase. Packaging and general domestic waste will be collected by an independent waste management company (currently, Azito Energie has contracted the Ivorian company Lassire as waste removal and disposal contractor) and disposed of at the municipal dumping area in Abidjan.

However, a waste management plan will need to be developed/updated and include the Phase III, to ensure adequate storage, collection and disposal of waste, including liquid, solid, hazardous and non hazardous wastes. The plan will describe the waste segregation, transfer and disposal strategy to suitable locations. It will include procedures for monitoring the performance of all waste management contractors.

The main goals of such a plan are to minimize the amount of waste generated, maximize re-use or recycling of any wastes that are generated, and dispose of any residual wastes with minimal environmental impact. Compliance with all legal and regulatory requirements must be ensured.

The waste management should include:

- information on the storage of liquid hazardous waste and retentions;
- sorting and separation of non-hazardous / hazardous waste ;
- promote recycling of waste, including used oil, containers, equipment, paper, plastics;
- ban dumping on lagoon;
- ban the burning of waste;
- disposal and treatment of waste properly to protect the environment by proper installations, landfill or authorized accredited companies;
- traceability for shipments of hazardous waste (from the waste, quantity, identification of the carrier and consignee of the waste).

Detailed requirements for monitoring, reporting and training have to be provided in the plan. The plan should also consider the follow-up of the waste by the accredited companies once it leaves the site.

Waste management remains an issue of concern in Ivory Coast. Currently, in Abidjan and in the main cities of the country, 60% of the wastes are disposed of in open areas and landfills. The remaining 40% is dumped in the street, gutters and sidewalks.

Collection and recycling of the wastes are organised by the town councils. Given the financial problems and absence of reaction from the municipalities, local associations and NGOs are currently developing the collection activity.

Household wastes collection and management is not controlled in Ivory Coast, despite the existence of many local waste management companies and associations involved in the pre-collection. The collected wastes are dumped in the Akouedo landfill, located 14 km from the transfer station in the direction of Williamsville Bingerville. This large landfill is now saturated. The wastewater discharge (leachate) from the landfill is directly discharged into the Ebrie lagoon, contributing to its contamination. The City of Abidjan is working on a feasibility study for the construction and operation of a proper landfill.

In Abidjan and the rest of the country, the collection and disposal of industrial or hospital hazardous waste have to be organised by the companies or hospitals that are producing the wastes. No controls are currently organised. The industrial sector has developed informal solutions for the collection and recycling of the wastes. Some industrial wastes collection and recycling

companies exist, including bottles, aluminium, plastic, rubber, paper, cardboard, textiles, ferrous and nonferrous metals. The process is however not efficient and slowed down by a lack in the collection process.

An assessment performed in 1995 (African Technopoles Services with the support of the French cooperation) on the recycling processes of different types of urban waste in Abidjan identified different industrial and commercial types of wastes coming from numerous companies that could be recycled: plastics, rubber (used shoes), aluminium, textiles, glass, ferrous metals (metals containing steel (scrap vehicles)) or non-ferrous (copper, brass, bronze, aluminium, batteries, etc.), packaging, paper etc. and the organic matter assimilated to domestic waste.

4.10 IMPACTS ON THE SOCIO-ECONOMICAL ENVIRONMENT DURING THE CONSTRUCTION PHASE

4.10.1 Employment

Approximately 600 workers should be hired at the peak of the phase III construction phase. Construction activities will require a high number of specialised workers. Due to this need for skilled labour, a large proportion of the employee work force is likely to be hired from outside the local area.

At this stage of the Project, the proponent plans to employ around 50 employees from the surrounding local communities. Workers will be hired for periods of time lasting from a few days (for specific construction tasks) to the full extent of the construction period. Peak employment is estimated to 6 months. The project construction will then lead to positive impact on the employment of the area and the region.

Table 4.23 Impact Assessment: employment during the operation phase

Type	Positive impact: Employment of local and national workers.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local to regional. ***Duration:*** Short to Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

The following measures should be considered to improve the quality of the relationship between the power plant management and the surrounding communities:

- The Project will develop a recruitment policy, and develop a recruitment plan defining details to be filled for the construction phase, and corresponding skills criteria.

- The construction workforce recruitment plan will be implemented in coordination with the national employment agency and/or external recruitment agencies, with a view to match the best candidates with the advertised positions.

- If possible in the light of their skills and personal adequacy for each particular role, to be assessed through the recruitment process, applicants from Côte d'Ivoire will be selected preferentially.

- Where possible, unskilled positions will be preferentially filled by candidates from the local community in Azito, Béago and the wider Yopougon area.

4.10.2 Local economy

Cattle and poultry farming, slaughterhouse and restoration are currently the main source of income in the nearby villages. The local economy will globally benefit from the workforce influx hired during the construction phase due to trade of agricultural, fishing product, attiéké production, restaurants (maquis), informal activities and recreational resorts frequentation.

However, the price of goods and products sold in the surroundings of the site might increase due to the presence of the workers. This impact will however be limited to the construction phase.

Table 4.24 Impact Assessment: local economy during operation phase

Type	Positive impact: Local economy development.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

4.10.3 In-migration

People usually migrate towards industrial development projects, in order to find work. Such in-migration of jobseekers can lead to negative impacts on the local communities:

- increased pressure on available land;
- increased pressure on available housing;

- increased pressure on community infrastructure and social services (health centres, schools, water supplies and markets);
- risks of increased transmission of diseases, including sexually transmitted diseases; and
- potential source of disputes and conflicts.

Such in-migration of jobseekers will be limited for the Azito project with clear recruitment policy and as not many people will be hired for the project.

Table 4.25 Impact Assessment: In-migration

Type	In-migration
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

In order to reduce the potential impacts related to in-migration, Azito will ensure that

The Project's employment policy is defined in such a way as to discourage in-migration of opportunistic jobseekers to the Azito area. In particular, Azito will:

- make clear that there will be no recruitment of workforce "at the gate", and clearly advertise the formal recruitment process, therefore discouraging the local settlement of opportunistic in-migrants; and

- work in coordination with local authorities – in particular the municipality of Yopougon and the Azito village chief and his staff, to discourage the settlement of opportunistic in-migrants.

4.10.4 Workers accommodation

At this stage of the project no precise information related to the accommodation of the workers is available. Part of the workers will be staying in houses and apartment rented by the contractor in Abidjan. Temporary worker camps might however be developed in the site surroundings to accommodate the workers during the construction period.

These camps will need to be designed and operated by the contractor in accordance with the provisions of the IFC PS2 and the relevant guidelines within the guidance document Workers' Accommodation: *Processes and Standards: A Guidance Note by IFC*. A brief overview of key provisions is provided below.

Box 4.1 Key Provisions of IFC Workers Accommodation Guidance

This guidance document provides guidance and benchmarking standards on a range of topics related to the provision and management of worker's accommodation. The topics covered are:

► General living facilities (including topics such as drainage, heating, ventilation, lighting, water, sanitation, waste disposal);
► Room/dormitory facilities (including bed arrangements and storage facilities);
► Sanitary and showering facilities;
► Canteen, cooking and laundry facilities;
► Food safety and nutritional standards;
► Medical facilities;
► Leisure, social and telecommunication facilities;
► Management of the accommodation;
► Community relations and consultation;
► Fees and charges for the facilities and services;
► Health and Safety onsite;
► Accommodation and local community security;
► Workers' rights, rules and regulations;
► Workers' consultation and grievance mechanism.

The key principles regarding the provision of worker's construction compounds are:

- Fundamental human rights of the workers and freedom of association in particular have to be respected. Workers accommodation arrangements should not restrict workers rights and freedoms.
- Housing standards must include special attention to minimum space allocated per person, supply of safe water in the workers dwelling in such quantities, adequate sewage and garbage disposal systems and appropriate protection against heat, cold, damp, noise, fire, and disease-carrying animals, and, in particular, insects.
- For facilities located in hot weather zones, adequate ventilation and/or air conditioning systems must be provided. Both natural and artificial lighting must be provided and maintained in living facilities.
- A separate bed for each worker must be provided. The practice of "hotbedding"should be avoided. The minimum space between beds should be 1 metre. Double deck bunks are not advisable for fire safety.
- Canteen, cooking and laundry facilities must be built in adequate and easy to clean materials. Canteen, cooking and laundry facilities are kept in a clean and sanitary condition. If workers wish to cook their own meals, kitchen space will be provided separate from sleeping areas.
- There must be management plans and policies especially in the areas of overall operation of the facility, health and safety (with emergency responses), local community and security.
- A security plan including clear measures to protect workers against theft and attack is implemented. Security staff must be checked to ensure that they have not been implicated in any previous crimes or abuses.

- Processes and grievance mechanisms for workers' to articulate their grievances must be provided and clearly explained to workers. Such mechanisms must be in accordance with PS2.
- Community representatives must be provided with an easy means to voice their opinions and to lodge complaints to the management. There must be a transparent and efficient process for dealing with community grievances, in accordance with PS1.

Table 4.26 Impact Assessment: Workers accommodation

Type	Workers accommodations
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

In order to reduce the potential impacts related to the workers camps, Azito will ensure that

- A specific workers' grievance mechanism is developed and implemented to provide a transparent and easily accessible way of raising and address grievances.

- Undertake an audit of design and implementation of the worker's camps against the checklist in the IFC guidance document:
  - prior to construction of the accommodation;
  - prior to its opening;
  - on an monthly basis.

4.10.5 Community health, safety and security

The risks of accident and injury during the construction phase will mainly concern the workers employed on site by the subcontractor. Health and Safety measures related to the working conditions will be developed in a Health and Safety Plan prior to the beginning of the work. However, this plan should include recommendations and measures to protect the surrounding communities during the construction phase. These measures mainly concern the barricading of the working area as well as the development of an emergency plan including the local communities.

Transmissible diseases

Influx of employees and job seekers could also result in the spread of diseases, including sexually transmitted diseases and HIV/AIDS (especially via increase of prostitution possible in the area).

Table 4.27 Impact Assessment: Diseases

Type	Risks of increased transmission of diseases, including sexually transmitted diseases
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

To reduce potential impacts due to the increase of sexually transmitted diseases, Azito will:

- Adopt and implement an HIV/AIDS prevention policy to
    - proactively sensitise workforce on the prevention of HIV/AIDS and other transmissible diseases;
    - work with Ivorian health authorities and other investors in the area to support the prevention of transmissible diseases, through community sensitisation programmes; and
    - fight against discrimination at the workplace based on HIV status.

- Establish a "code of conduct" for Project employees to behave in such a manner as to limit the spread of transmissible diseases, and to discourage prostitution.

Traffic

During construction, even if a significant quantity of equipment will be brought to site from the Vridy port area across the Abidjan lagoon by boat, traffic density through Yopougon and the Azito area will be increased as equipment and workforce will also have to be transported to the site by road. Given the concentration of population in this area, this is likely to generate increased traffic risks.

Table 4.28 Impact Assessment: Traffic

Type	Increase of roads accidents due to the traffic of vehicles and trucks
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

To reduce potential road accidents, the following measures will be implemented during all the construction period:

- the Project will work in coordination with local authorities to defined optimum Project traffic routes and times;
- drivers will be thoroughly trained on defensive driving; thorough speed limit will be enforce for Project heavy goods vehicles and workforce transportation vehicles;
- traffic will be channelled in such a way as to avoid areas of densest population density or densest local traffic (using deviations if necessary); and
- the Project will engage communities on road risk and sensitise them through routine communications, road signals, as well as through communication with local authorities and community leaders.

Security in the area

Influx of employees and job seekers as well as working activities may potentially lead to an increase of population density in the area, potentially generating high rates of petty crime, violence and security related problems in the area. The site is currently guarded by a police detachment. These measures will be applicable during the construction and operations of the Phase III project.

Table 4.29 Impact Assessment: Security

Type	Potential increase in petty crime in the area, violence and problems of site security.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

The Project will minimise risk of increased security threats on the local community and the Project workforce through:

- Coordination with the local authority, the local police, and employ private security guards, with a view to
    - prevent crime;
    - establish a code of conduct for police forces and security guards, to prevent the use of violence, coercion or intimidation; and

- prevent the use of weapons by police and security guards in enforcing security.

- Development of security procedures for workforce transportation and accommodation, by providing appropriate levels of protections for workers against banditry or violence.

4.10.6 Pressure on local infrastructure

Temporary increase of people in the area may lead to pressure on community infrastructure and social services (health centres, schools, water supply, markets, etc.).

Due to the limited duration of the construction phase, workers employed and accommodated on or near the site will be present as "single" employees (ie without families).

The Azito village communities usually use the local clinic in the Azito village and health facilities nearby (FSC of Kouté and the PMI of SICOGI area). In case of severe illness, they are referred to the university hospital (CHU). The increase of the number of workers in the area will result in pressure on these medical centres.

Project activities will increase the demand in potable water currently supplied to the nearby village of Azito by water mains of the Société des Eaux de Côte d'Ivoire (SODECI). This increase of pressure on water supply and health centres will remain limited due to the limited number of workers and the temporary nature of these impacts.

Worker camps construction will lead to an increase of the waste production and dispersion in the environment as no storage area or waste collection system is currently in place.

Figure 4.6 Waste disposal by local communities near the Azito power plant

Table 4.30 Impact Assessment: Impacts on local infrastructure

Type	Potential impacts on local infrastructures: • local health facilities; • water supplies; • markets; • etc.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*****:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be continuous during the construction phase.

Land-take

As explained in *Chapter 2*, two areas surrounding the power plant fence line, located to the north-west and south-west from the site will be used as a temporary lay-down area during the construction phase. Phase 3 will not include any construction of new power transmission lines.

This land is part of the 300 m exclusion zone surrounding the site and is the property of the Ivorian government. No buildings, shelters or infrastructures are currently present within these two zones.

These areas are currently informally used by cattle farmers for livestock grazing around the Yopougon slaughterhouse. The extension will therefore limit the existing grazing area for the local farmers. This point was however not raised as a potential issue during the consultations with the Azito and Beago village. The Project is not going to create a significant impact on available grazing land and, in operation, will not create an obstruction to cattle accessing the shores of the lagoon for drinking. Consultations between the power station management and the Azito community will be organised in order to present the planning and extent of the issue.

Land take for the Phase III expansion will essentially be located within the existing concession area of the Azito facility. A small portion of land located outside of the fenced area, already owned by Azito Energie, will also be constructed.

Table 4.31 Impact Assessment: land take

Type	Construction work will impact the land occupation within the 300 m exclusion area.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be negligible as no population displacement is planned ***Extent*****:** The extent will be local (300 m exclusion area). ***Duration:*** Medium to long-term (construction phase). ***Likelihood:*** Potential impacts are considered to be occasional.

Impact on fishing activities

Pieces of equipment and construction material are likely to be transported to the site using boats or barges from the port of Abidjan, crossing the Ebrié Lagoon. This option will avoid an increase of the traffic in the Yopougon suburbs, and optimise the efficiency of transportation activities from the port at Port Bouët to the construction site.

Transportation by boat could potentially disrupt fishing activities along the lagoon. Given the low number of loads compared to the traffic in the lagoon, and the fact that this option is temporary, impact from transportation of material by boat can be considered as negligible. In any case, good planning practices will be implemented during the construction phase. The marine authorities and fishermen communities will be informed of the planning and transport operations.

Table 4.32 Impact Assessment: fishing activities

Type	Disrupting fishing activities along the lagoon from transportation by boat.
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low ***Extent*:** The extent will be local ***Duration:*** Medium-term (construction phase). ***Likelihood:*** Potential impacts are considered to be occasional.

Cultural heritage and traditions

No historical or archaeological sites were identified within the project area during the baseline investigations.

4.10.7 Associated facilities

At this stage of the project the decision to use barges offloading heavy material to a jetty or to use trucks by road is not yet confirmed by the contractor. A jetty was installed on the lagoon shore at the time of the construction of the Phase I and II but would need to be rehabilitated. The area between the jetty and the site (strip of land of approximately 100 m long) that would potentially be used as an access track to the site is currently cleared (this road currently hosts no vegetation of interest and no, shelter human dwelling / economic activities). These two elements can be considered as associated facilities to the main Project infrastructures. The existing jetty can be observed on the following picture.

Figure 4.7 Satellite close-up view of the existing jetty and access track

The potential impacts associated with the rehabilitation of the jetty and the temporary development of an access track between the jetty and the site would need to be assessed and mitigated if this option is chosen.

The potential impacts associated with the jetty rehabilitation would concern the direct surrounding of the infrastructure. An area of approximately 50x20 m would have to be dredged to allow a high tide water depth of about 1.70 m. This would allow the barge to come alongside the jetty to be offloaded.

No significant impact to the water quality and ecology of the lagoon or fishing and transport activities would however be observed.

The potential impacts associated with the development of the access track are also negligible given the length of this route (approximately 100 m) and the current situation of this area (open land with no sensitive habitat or human activities).

A map of the existing jetty location and access track is presented in the figure overleaf.

Figure 4.8 *Picture showing the jetty and temporary road area*

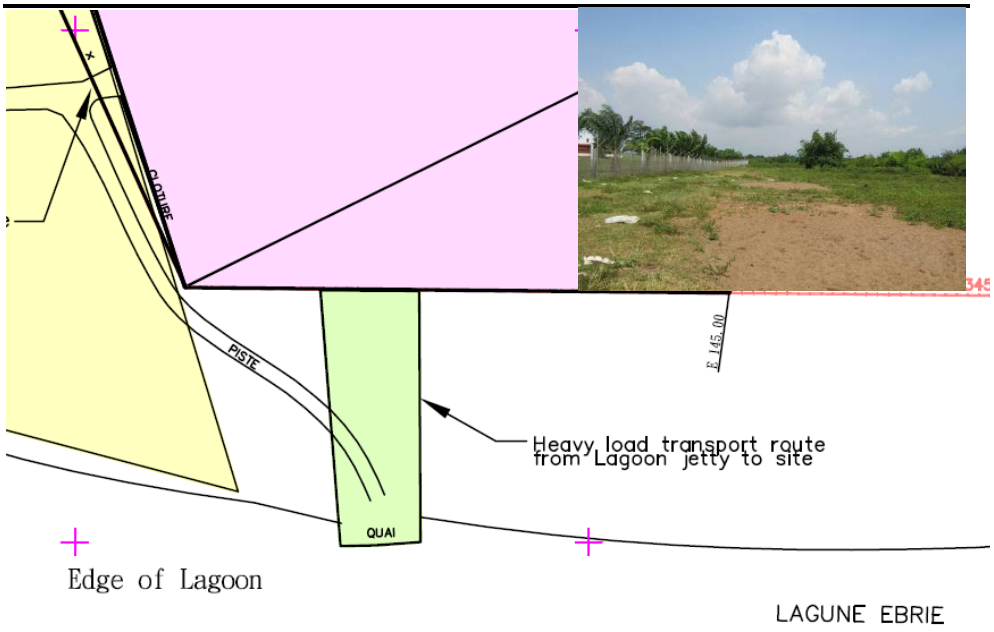


Table 4.33 *Impact Assessment: associated facilities*

Type	Associated facilities – Jetty and access track to site
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will be local. ***Duration:*** Medium-term. ***Likelihood:*** Potential impacts are considered to be occasional.

In order to reduce the impacts related to the associate facilities, Azito will ensure that the potential impacts associated with the rehabilitation of the jetty and the temporary development of an access track from the jetty to the site would be assessed and mitigated if this option is chosen. This assessment would focus on the impacts from the dredging activities for the jetty rehabilitation.

4.11 KEY SOCIAL IMPACTS DURING OPERATION PHASE

4.11.1 Employment

The project sponsor is committed to maximising local employment opportunities during both the construction and operation of the proposed

power station. Operations employment opportunities will however be limited as the number of people working on site during the operations is relatively low (approximately 50 people including Phase I and II) and the type of activities performed requires highly skilled employees.

The potential socio-economical impacts due to the operation of the Phase III will therefore be negligible as no major difference will be observed compared to the existing situation :

- limited levels of local employment;
- low levels of in-migration;
- same community development management practices;
- same guarding and security measures on site; and
- health and safety management practices incorporated in the existing Azito facility.

4.11.2 Improvement of energy supply for Ivory Coast

The project will generate opportunities for Ivory Coast and the surrounding countries as it will increase the total installed capacity of the Azito plant from about 290 MW to 420 MW, adding about 10% to overall national capacity.

In addition to the direct macroeconomic opportunities of the Phase III development, indirect social and economic benefits will be observed (increase of productivity and growth of service industries, development of small businesses due to potential decrease of the costs of electricity, improvement in educational sector, etc.).

Table 4.34 Impact Assessment: socio-economical impacts during operation phase

Type	Positive impact : opportunities for the Ivory Coast and surrounding countries
Impact evaluation	**Magnitude :** Moderate ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*****:** The extent will be national/international. ***Duration:*** Long-term. ***Likelihood:*** Potential impacts are considered to be continuous.

4.12 IMPACTS FROM NATURAL HAZARDS

Risks associated with exceptional natural hazards (storms, lightning, earthquakes and floods) should be considered within the design of the Phase III.

The proposed development does not lie within an identified area of flood. The existing power plant has never been flooded in 10 years of history. The

installations are indeed located approximately 4.5 m above the level of the lagoon. The difference between high and low tide in the lagoon is very limited.

The ambient air emission measurement container was originally located off site to the east, down into the river bed. The container was flooded in 2009 due to exceptional rains and has now been moved on site (see location on Figure 3.12). No flooding problem has been observed since this year.

Table 4.35 Impact Assessment: natural hazards

Type	Risks associated with natural hazards (storms, lightning, earthquakes and floods) should be considered in the design of the Phase III facilities with a focus on flooding
Impact evaluation	**Magnitude :** Minor ***Intensity***: The intensity of the potential impact is considered to be low. ***Extent*:** The extent will local. ***Duration:*** short-term. ***Likelihood:*** Potential impacts are considered to be rare.

In order to limit the potential flooding issues on site, the storm water drains that will be installed as part of the Phase III Project will be designed properly with a sufficient capacity to avoid flooding problems on site.

4.13 IMPACTS ON THE VISUAL AND AESTHETICAL ENVIRONMENT

Following the construction of the Phase III, the visual and aesthetical environment of the Study area will be impacted by the following:

- Construction of the 40m high stacks and the two HRSG. The two stacks will be installed in the centre of the existing facility, surrounded by the GT unit stacks (30 m high), distillate oil tanks and GT warehouse.

- The air cooled condenser unit will be installed on the southern part of the site along the Site boundary, in the direction of the Lagoon.

The associated buildings that will be constructed on site will be surrounded by the existing installations from the Phase I and II and should therefore not impact the aesthetical environment.

Given the existing power plant visual impact on the entire area as well as the existing transmission lines, and roads developed in the past, the visual and aesthetical impact of the Phase III expansion on the environment is considered to be negligible.

4.14 CONCERNS RAISED DURING THE PUBLIC CONSULTATIONS

As mentioned in the *Annex A*, public consultations took place as part of the ESIA process. Key stakeholders considered during the consultation process were:

- national and local Ivoirian authorities;
- villages of Azito;
- village of Beago; and
- focus group (women at the attiéké factory and cattle farmers).

During the consultations organised in the villages of Azito and Béago, the main concerns expressed by the villagers, related to the Phase III Project, were:

- potential impacts on the ambient noise levels in the villages (Azito and Béago);
- water volumes used for the Phase III process (Azito) and water quality reduction (Béago);
- potential impacts due to stacks emissions on the air quality in the village (Béago);
- local employment during the construction work and the operation phase (Azito and Béago);
- improvement of the quality of the relation between the village of Azito and the social committee (representatives of the companies present on the Azito power plant site) within the social development program;
- social development program implementation for Béago (nothing is existing so far); and
- health and safety issues and emergency response plan to be communicated to the power plant neighbouring communities (Azito and Béago).

The Azito villagers also mentioned that some issues related the Phase I and II were still unaddressed (relocation and compensations from the Ivoirian State). This concern is however developed in the section 3.7.9.

The technical concerns (issues related to the ambient noise levels, air emissions and water use) were addressed within the specific chapters related to each topic. The topics related to the social aspects (local employment, social development programs and social frustrations) as well as the health, safety and emergency plan communication should be considered by Azito and addressed accordingly. The table below summarised the concerns as well as some mitigation measures that should be considered by Azito Energie. This information is also included in the Environmental and Social Management Plan.

Table 4.36 Concerns expressed and mitigation measures proposed

Concern	Mitigation

Local employment	Refer to section 4.10 for the construction phase. Azito to consider the opportunity to hire local people for some operational tasks. This could be done via the existing training program in place with the village of Azito (support the training of young villagers for specific skills needed internally)
Social development program improvement in Azito	Azito Energie and the social committee should improve the communication with the local communities and develop a grievance mechanism that would be presented to the representative of both communities and allow them to communicate any frustration or problems associated with the operation of the power plant.
Social development program implementation in Béago	The village of Béago should be included in the social development program in place as they are also potentially impacted by the power plant.
Health and safety and emergency response plan communication	Azito should develop a communication program that would allow the neighbouring communities of the Azito plant (Azito and Béago villages) to understand the risks associated with the power station operation and receive a basic training about the emergency response plan.

4.15 DECOMMISSIONING AND ABANDONNEMENT

As mentioned in the Project description, decommissioning will not take place before 2034. As the Azito Power Station will be transferred by Azito Energie to the Ivory Coast State 20 years after the construction of the Phase III, the decommissioning work will therefore be the responsibility of the Ivoirian authorities.

A detailed decommissioning plan will be developed at the end of the projects lifetime. Decommissioning would involve demolition, recovery and removal of the power station installations and buildings (if they are not re-used for another purpose).

This plan will be consistent with Ivoirian regulations and both Azito and internationally-recognized guidelines and standards. Azito Energie will offer suggestions and assistance during the decommissioning activities, as part of the hand-over period. The following measures will need to be considered during the decommissioning phase:

- A detailed assessment of the different decommissioning options will be developed. This investigation will evaluate the options considering environmental, health and safety, technical and financial considerations.

- A risk assessment should be developed to evaluate the residual risk associated with potential remaining installation on site.

- Product and chemicals will be evacuated from site using an independent waste management company.

- The Ivorian authorities will be consulted and informed about the selected decommissioning option.

- A stakeholder communication plan will be developed and implemented for the decommissioning and closure phase.

The mitigation measures presented in this report to limit the environmental and social potential impacts related to the construction and operations phases of the power station will be applicable for the decommissioning and abandonment:

- ambient noise level limits;
- dust emissions control;
- waste management; and
- health and safety management system.

4.16 CUMULATIVE IMPACT ANALYSIS

A cumulative impact is an impact created as a result of the combination of the evaluated project together with other projects causing related impacts. These impacts occur when the incremental impact of the project, combined with the effects of other past, present and reasonably foreseeable future projects, are cumulatively considerable. Different options have to be considered:

- incremental impact from a number of separate projects/developments;
- combined effect of individual impacts, (e.g. noise, dust and visual, from one project on a particular receptor); and
- several developments with insignificant impacts individually but which together have a cumulative effect.

The environmental effects which can result from cumulative impacts and impact interactions can be significant. The objective of the assessment of cumulative impacts will be to identify and focus on the significant impacts. It will also ensure that that these impacts are taken into consideration in the decision-making process[7].

(1) [7] http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf

4.16.1 Construction of the bridge across the Lagoon

The construction of the bridge (formerly called *Pont Laurent Gbagbo)* is delayed due to the post-election crisis of 2010. This suspended bridge will crosses the Ebrié Lagoon twice, connecting the Yopougon mainland with the Boulay Island and the Boulay Island with the coastal shore. The connection to the land in the Yopougon area should be located in the surrounding of the Azito power plant. The date of the construction and the precise location of the bridge are however still unknown.

This bridge construction project is associated to the development of the port of Abidjan and the construction of a container terminal on the Boulay Island and on the barrier beach along the Atlantic shoreline. Another suspended bridge (420 meters long) should also be constructed 60 m above the Vridi channel to allow the passage of large vehicles. This second bridge will however not lead to cumulative impacts with the Azito Project

Given the absence of information related to the construction of the bridge and the delays associated to this project, the potential cumulative impact from the Azito Power Station and the construction of the bridge should be assessed within the bridge environmental and social impact assessment. At this stage, it is realistic to suggest that significant cumulative impacts associated with the construction of the bridge and the development of the Azito Phase III Project may be related to:

- a potential increase in ambient noise levels from bridge construction and traffic;
- waste/rain water management issues;
- visual impacts; and
- socio-economical impacts associated with the land take in the surrounding villages and economical development of the area affected by the construction of the main road.

4.16.2 Urbanization of the city of Abidjan

Abidjan is characterized by a high level of industrialisation and urbanization. Given the presence of the ocean to the south as well as the lagoon on the south-western and south-eastern side of the city, the only lands available for urban development are located the north (Abobo), north-west (Yopougon) and north-east (Riviera).

The rapid urbanisation of the area began in the 1970s, and today Yopougon is home to over one million inhabitants. The development of the urban infrastructure could not keep up with these fast population changes and the rapid extension of the area is leading to irreversible impacts on the environment.

Prior to the construction of the initial Phase I and II, the area surrounding the site was not as developed as it is the case now and the lagoon shore was considered as a natural area hosting mangroves. The city extension and development of associated infrastructure have now damaged this ecosystem.

Significant cumulative impacts associated with the extension and development of urbanisation in the city of Abidjan are related to:

- Ambient noise levels: the urbanization of the area leads to an increase of the noise levels due to traffic increase and urban activities (markets, restaurants, etc).
- Land pressure in the area due to the increase of the population.
- Impacts on biodiversity associated to the land take impacts, but also to the increase of waste production and waste water effluents.
- Water consumption.
- Waste water management : the absence of sewage and waste water collection system in the area leads to a potential deterioration of the water quality (lagoon and rivers) and of the soil and groundwater.

5 SUMMARY OF PROPOSED MITIGATION MEASURES

This section presents a summary of the potential impacts and mitigation measures described in *Chapter 4* in tabular form. The table presents the potential impacts during the Project construction as well as the operations phase.

This table will form the basis of the Environmental and Social Management Plan presented in *Chapter 6*.

Table 5-1 Summary of the mitigation measures

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
Air emissions	Construction	Construction vehicles as well as generators used on site during the Phase III construction will be a minor source of pollutant emissions	Minor	• As a default good practice, the construction vehicles and generators will be regularly maintained and inspected by the construction contractor. • Atmospheric emissions of all transport vehicles used during the construction (material, backfill or excavated soil, workers, etc.) will be reduced by minimizing the number of trips to the extent practical
		The project activities have the potential to result in impacts on the air quality due to dust emissions during the construction phase	Minor	• Appropriate management and maintenance of stockpiles to minimise airborne dust. • Sheeting of lorries during transportation of friable construction material. • Minimise drop heights for material transfer activities such as unloading of friable material. • Enforcement of vehicle speed limits on dirt roads. • Wheel washing for vehicles leaving the site.
	Operations	The Phase III will not result in any type of new air emissions compared to the existing situation. The height of the emission stacks of the Phase III installations will however influence the pollutant dispersion.	Minor	• No use of distillate fuel anticipated. • Use of a 40m stack allows the Project to be well within compliance limits applicable in Côte d'Ivoire and defined by the IFC. Additional stack height provides some benefits in pollution abatement. • Ensure monitoring of stack emissions and ambient air quality as part of good environmental management practice.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
Ambient noise levels increase	Construction	Noise from construction equipment and vehicles.	Minor	Standard best practice measures will be adhered, including the use of modern, well maintained equipment and vehicles. Local government authorities and surrounding community leaders will need to be informed of the construction schedule and operations. Strong grievance procedures associated to an internal communication and follow-up plan will also need to be implemented to allow the neighbouring villagers to report any disturbance or issue related to the construction activities.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
	Operation	Noise from the Phase III equipment	Minor	The following list sets out indicative mitigation measures which may be used to control noise from the Phase III equipment. A variety of factors must be considered when designing noise mitigation and Azito Energie should meet the regulatory standards at the nearest identified noise sensitive receptors through a combination of noise reduction at source and other mitigation measures, the detail of which will be addressed in the detailed design phase. ▪ **HRSG and HRSG Stack (walls)** : The specified reduced noise level may be achievable without mitigation being required. Lower noise versions are available if required. ▪ **HRSG Stack exit**: Silencer ▪ **Steam Pipes**: Lagging ▪ **Air Cooled Condenser**: Substantial mitigation may be required, which may include the use of low noise fans and sound-attenuating baffles for the inlet and discharge of the ACC ▪ **Air Cooled Water Cooler**: Low noise fans / acoustic baffles ▪ **Station Service Transformers**: Enclosure ▪ **Vacuum Pumps**: Low noise pumps / noise screen / enclosure ▪ **Condensate Extraction Pumps**: Low noise pumps / noise screen / enclosure ▪ **Duct Drain Pumps**: Low noise pumps / noise screen ▪ **Condensate Pre-heater Pumps**: Low noise pumps. ▪ **Service Water Pumps**: Low noise pumps / noise screen / enclosure ▪ **Demi Water Pumps**: Low noise pumps.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
Water consumption	Construction	Use of domestic water on site, in the temporary camps, and water consumption for the construction works. Drinking water will be provided to the workers by the contractor during the construction phase. The contractor will make sure that the water provided will meet the Ivoirian requirements and international standards.	Negligible	As part of general good practice in environmental management, Azito Energie will require that the construction contractor: • Optimises water use efficiency and minimises wastages. • Monitors water consumption with a view to identify over-consumption and provide a basis for increasing water efficiency. • Provide drinking water of acceptable quality to the workers by either using bottled water or a temporary potabilization unit.
	Operation	Use of domestic water on site (potable and industrial water)	Minor	• The volume of water required for each phases of the project should be assessed and the well capacity should be re-evaluated to control that the volumes of water pumped of the borehole are sufficient to cover the needs
Water contamination	Construction	The water quality (surface and groundwater) can be impacted by • An increase of the sediment load into the lagoon. • Releases of domestic effluents into the lagoon. • An accidental spill or leakage form temporary chemical, fuel or oil storage tanks or vehicle used on Site for the construction	Minor	• The impact from construction activities can be addressed by minimising the amount of land left bare and re-vegetating any slopes as quickly as possible. Any temporary stockpiles should be protected from erosion by using a reduced slope angle where practical, and by incorporating sediment traps in drainage ditches. This can be addressed by developing a site drainage plan. • Good site management practices should be observed to ensure that the products are properly stored on site (secondary containment, double walled tanks, over filling alarm system, etc.) and construction vehicle are controlled and maintained properly and regularly. • There will be no release of untreated sanitary effluents into the lagoon. Construction site sanitary effluents will be treated to meet the general IFC EHS guideline discharge criteria before being discharged into the lagoon.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
	Operation	Contamination of surface and groundwater from process, fire fighting and drainage water.	Minor	• Collection of liquid wastes resulting from the operation of the facility will be collected and treated as appropriate. Oily water will be treated in an oil/water separator before being directed to the evaporation pond. • Measures currently applicable on the Site for the waste water collection and treatment • Assessment of the existing capacity of the evaporation pond to control that the volume is sufficient to cover the waste water flow increase coming from the Phase III expansion. • The design and technical characteristics of the water treatment process installations will need to be adapted to the Phase III in order to cover the effluents produced by the Phase III. This should cover the evaporation pond rehabilitation and protection (appropriate coating), biological treatment unit improvement, neutralisation pond and oily water treatment unit. • The biological treatment process of the industrial and sanitary water should be improved and adapted to the new situation to avoid any contamination of the receptors reached by the effluent water coming from the evaporation pond.
Land take/ Impacts on biodiversity	Construction	Temporary land-take for lay-down area and material storage	Negligible	• Turbid run-off from the site will be minimised through good site drainage management. • Fuel and chemical should be handled following the good practice of the industry (containment, double-walled tanks, etc.) to avoid any spillage and leakage that could affect the biodiversity of the area. • The land that has been cleared for construction purposes will be restored to its original state.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
	Operation	Potential spillages or leakages of products and chemicals on site or along the transport route	Negligible	• Good site management practices to ensure that spills and leakages do not affect the biodiversity in the surroundings of the Site. • Good design of site drainage and run-off associated with the extension project in order to collect and control any potential spillages or leakages.
Waste production	Construction	Production of dry waste, special waste, etc.	Minor	• All generated solid wastes will be collected, and disposed by the EPC Contractor in accordance with the Azito requirements; • A post-construction survey of the construction area will be conducted to confirm the absence of major debris; and • A Waste Management Plan will be developed prior to the construction phase and integrate the waste collection and management produced by the workers hired for the construction of the Phase III.
	Operation	Production of no significant quantities of solid process waste compared to the current situation.	Negligible	• A waste management plan will need to be developed and include the Phase III, to ensure adequate storage, collection and disposal of waste, including liquid, solid, hazardous and non hazardous wastes. The plan will describe the waste segregation, transfer and disposal strategy to suitable locations. It will include procedures for monitoring the performance of all waste management contractors.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
Impact on the socio-economical environment	Construction	Positive impact: Employment of local and national workers.	Minor	• The Project will develop a recruitment policy, and develop a recruitment plan defining details to be filled for the construction phase, and corresponding skills criteria. • The construction workforce recruitment plan will be implemented in coordination with the national employment agency and/or external recruitment agencies, with a view to match the best candidates with the advertised positions. • If possible in the light of their skills and personal adequacy for each particular role, to be assessed through the recruitment process, applicants from Côte d'Ivoire will be selected preferentially; • Where possible, unskilled positions will be preferentially filled by candidates from the local community in Azito, Béago and the wider Yopougon area.
		Workers and job immigration in the Site area.	Minor	• The Project's employment policy is defined in such a way as to discourage in-migration of opportunistic jobseekers to the Azito area. In particular, Azito will: • make clear that there will be no recruitment of workforce "at the gate", and clearly advertise the formal recruitment process, therefore discouraging the local settlement of opportunistic in-migrants; and • work in coordination with local authorities – in particular the municipality of Yopougon and the Azito village chief and his staff, to discourage the settlement of opportunistic in-migrants.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
		Risks of increased transmission of diseases, including sexually transmitted diseases.	Minor	• Adopt and implement an HIV/AIDS prevention policy to o proactively sensitise workforce on the prevention of HIV/AIDS and other transmissible diseases; o work with Ivorian health authorities and other investors in the area to support the prevention of transmissible diseases, through community sensitisation programmes; and o fight against discrimination at the workplace based on HIV status. • establish a "code of conduct" for Project employees to behave in such a manner as to limit the spread of transmissible diseases, and to discourage prostitution.
		Impacts associated with the potential workers camps development	Minor	• A specific workers grievance mechanism should be developed and implemented to provide a transparent and easily accessible way of raising and address grievances. • Undertake an audit of design and implementation of the worker's camps against the checklist in the IFC guidance document: o prior to construction of the accommodation; o prior to its opening; o on an monthly basis.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
		Increase of road accidents due to the traffic of vehicles and trucks.	Minor	• The Project will work in coordination with local authorities to defined optimum Project traffic routes and times; • drivers will be thoroughly trained in defensive driving; thorough speed limit will be enforce for Project heavy goods vehicles and workforce transportation vehicles; • traffic will be channelled in such a way as to avoid areas of densest population density or densest local traffic (using deviations if necessary); and • the Project will engage communities on road risk and sensitise them through routine communications, road signals, as well as through communication with local authorities and community leaders.
		Potential increase in petty crime in the area, violence and problems of site security.	Minor	• Coordination with the local authority, the local police, and employ private security guards, with a view to o prevent crime; o establish a code of conduct for police forces and security guards, to prevent the use of violence, coercion or intimidation; and o prevent the use of weapons by police and security guards in enforcing security. • Development of security procedures for workforce transportation and accommodation, by providing appropriate levels of protections for workers against banditry or violence.
		Pressure on local infrastructure	Minor	No mitigation deemed necessary.

Nature of potential impacts	Project phase	Source / description of the potential impact and affected receptors	Impact Characterization	Mitigation measures proposed
		Land take	Minor	• Local populations will be consulted and informed by the Project Sponsor about the extent of the land used for the construction phase as well as the land take planned for the extension of the new Phase III installations. The consultations will consider the local farmers that are currently using the 300 m exclusion area for cattle grazing.
		Disrupting fishing activities along the lagoon from transportation by boat.	Minor	No mitigation deemed necessary.
	Operation	Positive impact : opportunities for the Ivory Coast and surrounding countries	Moderate	No mitigation deemed necessary.
Potential impacts from associated facilities	Construction	Potential impact from the jetty rehabilitation and construction of an access track between the jetty and the site (100 m)	Minor	In order to reduce the impacts related to the associate facilities, Azito will ensure that the potential impacts associated with the rehabilitation of the jetty and the temporary development of an access track between the jetty and the site would o be assessed and mitigated if this option is chosen. This assessment would focus on the impacts from the dredging activities for the jetty rehabilitation.
Impacts from natural phenomenon	Operation	Risks associated with natural phenomenon should be considered in the design of the Phase III with a focus on flooding	Minor	The storm water drains that will be installed as part of the Phase III Project will be designed properly with a sufficient capacity to avoid flooding problems on site.

6 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

6.1 INTRODUCTION

This Environmental and Social Management Plan (ESMP) has been prepared in accordance with the applicable legislation on environmental and social impact assessment in Ivory Coast as well as the Terms of Reference received from the ANDE in December 2009 (reference number 32-221209/ka). This ESMP is presented in draft form and will be submitted to the ANDE for validation as part of the final ESIA. The draft format of the ESMP makes provision for updating during the detailed design and planning phase, and incorporation of any relevant conditions during the validation process.

The overall objectives of the ESMP are as follows:

- to provide a mechanism for ensuring that the mitigation and management measures that are identified in this ESIA are implemented;
- to provide a framework for mitigating impacts that may be unforeseen or unidentified until Project activities are underway;
- to assist in ensuring continuing compliance with national and international legislation and industry best practices;
- to provide a framework for compliance auditing and inspection programmes; and
- to encourage and achieve the highest environmental and social performance and response from employees and contractors.

6.2 RESPONSIBILITIES

The following sub-sections describe the environmental and social management organization that will carry out the requirements of the ESMP during the construction and operation phases.

Project's sponsor

The ESMP makes specific reference to roles and responsibilities for each aspect of the Project that is subject to mitigation actions. As the Project Proponent, Azito Energie will assume overall responsibility for implementing conditions of the ESMP.

Contractor

During the construction phase, Azito will engage contractors to provide technical services and works associated with the construction of the Phase III. Contractors will be responsible for complying with all relevant legislation and

adhere to all mitigation measures specified in the ESMP. Azito should enforce measures through contractual obligations.

Contractors are also responsible for the ongoing management of potential environmental and social impacts of all contract activities, regardless of whether these are undertaken by the contractors themselves or by their subcontractors. All contractors, including sub-contractors, must meet all requirements.

HES Supervisor

Contractor teams must include a Health, Environment and Safety Supervisor (HES Supervisor) who will work closely with the Azito Project HES Manager to assist with the organization and presentation of all briefing sessions and to liaise with sub-contractors as and when required. In this regard, the contractors' HES Supervisor will take responsibility for mitigation and management of potential environmental and social issues on site.

Specific HES Supervisor duties include the following:

- take responsibility for mitigation and management of potential environmental and social issues on site;
- liaise with the Azito Project HES Manager regarding site visits and briefing sessions;
- liaise with second- and third-tier subcontractors regarding the ESMP requirements;
- organize and maintain briefing session records and mitigation and monitoring documentation;
- respond to site inspection findings; and
- receive and respond to any complaints from external parties.

6.3 APPLICABLE STANDARDS AND PROCEDURES

Environmental and social management issues during Project construction and operations are guided by a number of standards. These include standards established by good industry practice and those required by Azito policies or specifications. Procedures of particular relevance to this Project include:

- contractor Work Plan(s);
- communication protocols and records;
- incident reporting;
- health and safety plans and procedures; and
- logs and inspections records, as appropriate.

In addition to industry and internal standards and procedures, the Project must comply with any relevant norms and standards contained in the Ivoirian

legislation, as outlined in Section 1. It must also adhere to commitments made in this ESIA report, reflected in the ESMP as mitigation actions.

Prior to the construction and operation of the Phase III and in order to comply with the Ivorian legislation, Azito Energie will have to apply for all the applicable environmental permits and environmental documentation and make sure that the project is implemented in compliance with all the procedures required under Ivorian law.

Azito HSE coordinator will have to ensure that the following documents are obtained and updated frequently:

- environmental compliance certificate after the ESIA approval;
- documents associated to the Classified Installations for Environmental Protection (ICPE) status of installations :
    - updated version of the Classified Installations for Environmental Protection Decree (*arrêté ICPE*) for the phase III;
    - Internal Operation Plan (POI - *Plan d'Opération Interne*) – management tool describing the organization and means in place in case of emergency and disaster (fire, explosion, pollution); and
- Technical Requirements and Environmental Activities Study (EPTEA, *Etudes de Prescriptions Techniques et Réglementaires*), to be updated periodically. Recent environmental regulatory provisions, including Order No. 00973 of 14 / 7.11 on the implementation of Decree No. 2005-03 of 06 January 2005 from the Ministry for the Environment regarding environmental audit which mentions in his Article 9 that operation of an organization which aspects and environmental impacts are likely to harm the environment is determined by first obtaining the environmental permit to operate (PEE). This permit is issued at the end of the Study of Technical Requirements for Environmental Activities (EPTEA) in the case of business continuity.

A detailed Occupational Health and Safety (OHP) Plan will be developed by the contractor in charge of the construction of the Phase III, in collaboration with Azito Energie. The Occupational Health and Safety Plan will include requirements for:

- clear definition of the EHS roles and responsibilities of all construction staff;
- assessment of the EHS risks and hazards associated with the construction;
- risk assessments and health monitoring for workers;
- regular inspection, review and recording of EHS performance;
- appropriate training on EHS issues for all workers;
- completion and implementation of an emergency plan prior to starting construction to any part of the plant;
- management, supervision, monitoring and record-keeping as set out in plant's operational manual; and

- maintenance of a high standard of housekeeping at all times.

In addition to these topics that will be covered in the OHP Plan, recruitment procedures will include an assessment of the health and safety capabilities of the future workers. The contractors selection criteria will also consider health and safety aspects.

6.4 MONITORING

Monitoring of Project activities shall be undertaken during construction and operations to:

- establish that the ESMP is implemented;
- assess the efficiency of mitigation actions; and
- provide information on environmental and social performance to permitting authorities as needed.

Designated HES staff will undertake monitoring activities. Monitoring will be conducted when Project construction will start. During operations, monitoring periods are expected to occur more intermittently. Contractor HES Supervisors will liaise directly with the Azito Project HES Manager regarding observations and any necessary actions. The Project HES Manager will conduct intermittent checks to confirm the quality implementation of HES Supervisor activities and ESMP measures.

Where corrective actions are deemed necessary, the Project HES Manager shall issue specific instructions, including responsibilities and timeframes, to relevant parties.

All documentation relevant to the implementation of the ESMP must be maintained by Azito and its contractors in a structured and orderly manner.

Documents that should be managed and retained include:

- HES reports;
- incident reports and records of corrective actions;
- records of safe waste disposal at a licensed waste site or transfer station;
- training material and records of attendance at briefing sessions; and
- minutes of key meetings with contractors, sub-contractors, and Project team members.

The HES Supervisor will develop a report on ESMP compliance to be provided to the Azito Project HES Manager. These reports will be based on summaries of documentation compiled during the Project construction or operations phases.

The costs associated with the implementation of the ESMP are presented in the last column of the tables. The budget considers the following:

- Cost per day for an international expert : 750€/day
- Cost per day for a local employee : 70 €/day

The estimated budget does however not consider the following costs:

- costs associated with the contractor's responsibilities, as the contract has not be finalised at this stage, and the contractor will define his own responses to effectively meeting the ESMP requirement and the associated costs will be subsumed within the overall contract financial limit;
- costs that are within the norms of industry good practice, which relate to management activities which the Azito plant would in any case expect to carry out irrespective of the implementation of the ESMP;
- costs of the ultimate decommissioning of the plant, as this will be determined by a study to develop a decommissioning plan at a later date, and because decommissioning will not be the responsibility of the present owners of the plant.

The ESMP costs may therefore be summarised as:

- 6 000 € before the construction phase;
- 2 500 € per month during the construction phase;
- 6 900 € per year (2012 prices) during the ongoing operational phase.

6.5 PRESENTATION OF MITIGATION AND MONITORING MEASURES

Mitigation and monitoring measures, as well as an associated estimated budget, are presented in a tabular format below. *Table 6.1* outlines measures relevant to the Project's construction phase and *Table 6.2* outlines measures relevant to the operations phase.

All measures pertain to the potential impacts identified and discussed in the Impact Assessment detailed in Sections 4 and 5, which include:

- potential impacts on ambient air quality;
- potential impacts on ambient noise levels;
- potential impacts on water supply;
- potential impacts on surface water;
- potential impacts on biodiversity; and
- potential impacts on the socio-economical environment.

Table 6.1 Project mitigation and monitoring measures: construction phase

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Potential Impacts on air quality						
Construction vehicles and generators used on site during the construction will be a source of pollutant emissions	The construction vehicles and generators will be regularly maintained and inspected by the construction contractor.	Contractor	Contractor HES supervisor	Vehicles inspection certificate	Azito Project's HES manager 1/ month	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
	Atmospheric emissions of all transport vehicles used during the construction (material, backfill or excavated soil, workers, etc.) will be reduced by minimizing the number of trips to the extent practical	Contractor	Contractor HES supervisor	Record the number of trips per day and per activity on the HES Supervisor logs	Azito Project's HES manager 1/week	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
Dust emissions	Appropriate management and maintenance of stockpiles to minimise airborne dust	Contractor	Contractor HES supervisor	Raw material handling and management recorded in the HES Supervisor logs	Azito Project's HES manager 1/week	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
	Sheeting of lorries during transportation of friable construction materials	Contractor	Contractor HES supervisor	Transportation logs including check box for the	Azito Project's HES manager	½ man-day per month for the monitoring

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
				covering of the friable material by trucks	1/week	(35€/month) Follow-up included in the contractor's budget
	Minimise drop heights for material transfer activities such as unloading of friable materials	Contractor	Contractor HES supervisor	Raw material handling and management recorded in the HES Supervisor logs	Azito Project's HES manager 1/week	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
	Enforcement of vehicle speed limits on dirt roads	Contractor	Contractor HES supervisor	Record variance or inappropriate behaviour in the HES Supervisor Logs	Azito Project's HES manager 1/week	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
	Wheel washing for vehicles leaving the site	Contractor	Contractor HES supervisor	Transportation logs including check box for the wheel washing of the trucks leaving the site	Azito Project's HES manager 1/week	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
Potential Impacts on ambient noise						

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Noise from construction equipment	Standard best practice measures will be adhered, including the use of modern, well maintained equipment and vehicles.	Contractor	Contractor HES supervisor	Record variance in the HES Supervisor Logs	Azito Project's HES manager Audit of the practices 1/month	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
	Measurements of construction noise should be carried out at various sensitive locations (including receptors 1 and 7)	Contractor	contractor / developer (as per contract requirement	Noise level measurements to compare with construction criterion	Azito to contract an Independent qualified acoustic survey technician. Measurements to be carried out at the start of each new construction phase or after significant changes in plant location. The measurements should be performed at least at the sensitive receptors identified during the noise study. Additionally, consider monitoring during the investigation if a complaint	Implementation costs included in the contractor's budget Monitoring by Azito – estimation of 2 days every 6 month at 750€/day for an independent qualified acoustic survey technician.

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
					appears to be justifiable.	
	Local government authorities and surrounding community leaders will need to be informed of the construction schedule and operations. A strong grievance procedure associated to an internal communication and follow-up plan will also need to be implemented.	Azito Energie and Contractor	Azito Project Manager, Sustainability officer and contractor's HR	Community consultation report	Azito Project Manager Prior to construction works and Intermittent checks during the construction (1/month).	No extra cost compared to standard practice
Potential Impacts to water resources – consumption						
Use of domestic water on site, in the temporary camps, and water consumption for the construction works	Optimises water use efficiency and minimises wastages.	Contractor	Contractor HES supervisor	Record variance or inappropriate water use in the HES Supervisor Logs	Azito Project's HES manager 1/month	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
	Monitors water consumption with a view to identify over-consumption and provide a basis for increasing water efficiency	Contractor	Contractor HES supervisor	Water consumption recorded in the HES Supervisor logs	Azito Project's HES manager 1/month	½ man-day per month for the monitoring (35€/month)

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
						Follow-up included in the contractor's budget
The contractor will make sure that the drinking water provided to the workers will meet the Ivoirian requirements.	Provide drinking water of acceptable quality to the workers by either using bottled water or a temporary potabilization unit. In the case such a unit is used on site, the quality of the water will be monitored on a regular base.	Contractor	Contractor HES supervisor	In the case the water quality is monitored; Control that the results are acceptable and recorded in the HES Supervisor logs. Water to be analysed once a month for chemical/physical parameters (heavy metals, trace organic compounds, total suspended solids (TSS), turbidity), microbiological parameters (coliform bacteria, E. coli) and specific pathogenic species of bacteria	Azito HES manager to control the analytical results and compliance with the national legislation 1/month	½ man-day per month for the monitoring (35€/month) Follow-up included in the contractor's budget
Potential Impacts on water resources – contamination						
Potential increase	The impact from construction	Contractor	Contractor HES	Any variance	Azito Project's HES	No extra cost

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
of the sediment load into the lagoon / Potential accidental spill or leakage form temporary chemical, fuel or oil storage tanks or vehicle used during the construction	activities can be addressed by minimising the amount of land left bare and re-vegetating any slopes as quickly as possible. Any temporary stockpiles should be protected from erosion by using a reduced slope angle where practical, and by incorporating sediment traps in drainage ditches. This can be addressed by developing a site drainage plan		supervisor	compared to the standard practices will be recorded in the contractor HES supervisor's log.	manager Intermittent checks 1/week	compared to standard practice
	Good site management practices should be observed to ensure that the products are properly stored on site (secondary containment, double walled tanks, over filling alarm system, etc.) and construction vehicle are controlled and maintained properly and regularly.	Contractor	Contractor HES supervisor	Products/ chemical management described in the construction's technical specifications Any variance compared to the standard practices will be recorded in the contractor HES supervisor's log.	Azito Project's HES manager Intermittent checks 1/week An audit of practices should be performed once a month.	No extra cost compared to standard practice
	Construction site sanitary effluents will be treated to meet the general IFC EHS guideline discharge criteria before being discharged into	Contractor	Contractor HES supervisor	Waste water management described in the construction's technical	Azito Project's HES manager Intermittent checks checks: each time	No extra cost compared to standard practice

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
	the lagoon.			specifications Any variance compared to the standard practices will be recorded in the contractor HES supervisor's log.	water is discharged. According to the prefectural Decree, a monitoring should be performed every week and an external monitoring has to be realised every six months.	
Potential Impacts on biodiversity						
Temporary land-take for lay-down area and material storage	Turbid run-off from the site will be minimised through good site drainage management. The land that has been cleared for construction purposes will be restored to its original state.	Contractor	Contractor HES supervisor	Any variance compared to the standard practices will be recorded in the contractor HES supervisor's log.	Azito Project's HES manager Intermittent checks	½ man-day per month for the monitoring (35€/month) No extra cost compared to standard practice
	Good site management practices to ensure that the products/chemicals are properly stored on site (secondary containment, double walled tanks, over filling alarm system, etc.) and construction vehicle are controlled and maintained properly and regularly	Contractor	Contractor HES supervisor	Products/chemical management practices described in the construction's technical specifications Any variance compared to the standards will be	Azito Project's HES manager Intermittent checks	No extra cost compared to standard practice

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
				recorded in the contractor HES supervisor's log.		
Waste production						
Waste production	All generated solid wastes will be collected, and disposed by the EPCI Contractor in accordance with the Azito requirements;	Contractor	Contractor HES supervisor	Waste collection manifest	Azito Project's HES manager	No extra cost compared to standard practice
	A post-construction survey of the construction area will be conducted to confirm the absence of major debris; and	Contractor	Contractor HES supervisor	Post-construction survey recorded in the HES supervisor logs	Azito Project's HES manager Check after the construction work	No extra cost compared to standard practice
	A Waste Management Plan will be developed prior to the construction phase and integrate the waste collection and management produced by the workers hired for the construction of the Phase III.	Contractor	Contractor HES supervisor	Waste management plan	Azito Project's HES manager Prior to the construction works and Intermittent checks during the construction	½ man-day per month for the monitoring (35€/month) 5 man-day before the construction works start (contractor) 2 man-day /month during the construction for the follow-up (contractor)

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
						WMP development included in the contractor's budget
Potential Impacts on the socio-economical environment						
Employment	Local employment will be considered during the construction phase	Azito Energie and Contractor	Azito Project Manager, Sustainability officer and contractor's HR	HR recruitment policy + recruitment records	Azito Project Manager Prior to construction works and Intermittent checks during the construction	No extra cost compared to standard practice
Workers immigration in the Site area	Ensure that the employment policy is well defined, public and that the job advertisements are published in the local press. The procedure for local employment will be established in consultation with the authorities and village leaders.	Azito Energie	Azito Project Manager and Sustainability officer	Employment policy	Azito HES manager Prior to construction works and Intermittent checks during the	2 man-day before construction at 70 €/day
Development of the workers camps	Development of a specific workers grievance mechanism to provide a transparent and easily accessible way of raising and address grievances.	Azito Energie and contractor	Azito Project Manager and Sustainability officer	Grievance process documented. Follow-up time-table and grievance procedures.	Azito Project Manager Prior to construction works and Intermittent checks during the construction	Management time - 3 days to develop the grievance mechanism at 70€/day and 1 days/month for follow-up at 70€/day

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
	Undertake an audit of design and implementation of the worker's camps against the checklist in the IFC guidance document:	Azito Energie and contractor	Azito Project Manager and Sustainability officer	Audit reports	Audits prior to construction, prior to to opening and on an monthly basis.	4 man-day before the construction works start at 750 €/day 1 man-day /month during the construction for the follow-up at 750 €/day
Risks of increased transmission of diseases, including sexually transmitted diseases.	Inform its employee about risky behaviours and risks linked to MST.	Azito Energie and contractor	Azito Project Manager and Sustainability officer	Information	Azito HES manager Prior to construction works and Intermittent checks during the	1 man-day / month at 70€/day
Increase of roads accidents due to the traffic of vehicles and trucks.	To reduce potential road accidents, the following measures should be implemented during all the construction period: o apply speed limit for trucks and work related vehicles; o roads rehabilitation if necessary; and o signs on the busiest sections.	Contractor	Contractor HES site manager	Contractors terms of reference, contract between Azito and contractor An audit should be performed twice a year.	Azito HES manager Prior to construction works and Intermittent checks during the construction	½ man-day per month for the monitoring (35€/month) Follow-up responsibility included in the contractor's budget

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Construction work will impact the land occupation within the 300 m exclusion area	Local populations will be consulted and informed by the Project Sponsor about the construction agenda and the extend of the land used for the construction phase as well as the land take planned for the phase III installations	Azito Energie	Azito Project Manager and Sustainability officer	Public consultation report	Prior to construction works	2 days before the construction start at 70 €/day
Waste production	Development of a waste management plan, covering the construction works as well as the worker camps. The plan should also consider the site surroundings affected by the Project activities (Azito village)	Azito Energie and Contractor	Azito Project Manager and contractor's HES supervisor	Waste management plan	Azito HES manager Prior to the construction works and Intermittent checks during the construction	2 days before the construction start for monitoring at 70 €/day and one day per month during the construction at 70€/day 5 man-day before the construction works start (contractor) 2 man-day /month during the construction for the follow-up (contractor) WMP development included in the contractor's budget

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Health and safety	Develop and implement an Occupational Health and Safety (OHS) Plan including a risk assessment of the different tasks of the construction as well as an emergency response plan. The information that should be considered in this OHS Plan is described in the Section 6.3.	Azito Energie and Contractor	Azito HES manager and contractor's HES supervisor	Health and Safety plan	Azito O&M HES Project Manager Prior to the construction works Continuous during construction works (1/week) An audit of the Health and Safety plan should be performed twice a year.	3 days before the construction start for monitoring at 750 €/day and one day per month during the construction at 750€/day 10 man-days before the construction works start (contractor) 5 man-day /month during the construction for the follow-up (contractor) H&S plan development included in the contractor's budget
Associated facilities	To reduce the impacts related to the associate facilities, Azito will ensure that the potential impacts associated with the rehabilitation of the jetty and the temporary development of an access track from the jetty to the site	Azito energie	Azito energie project manager	ESMP update	Azito Project manager to follow up in case the option of the transport by barge is chosen	Estimated budget to be determined once the decision on material transportation has been taken and based on the design of the potential

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
	would o be assessed and mitigated if this option is chosen. This assessment would focus on the impacts from the dredging activities for the jetty rehabilitation.					associated facilities and installation rehabilitation.

Table 6.2 Project mitigation and monitoring measures: operations phase

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
The phase III operations will potentially impact the physical, biological and social environment	Control that the following documents/permits are obtained/developed and then updated: • Environmental compliance certificate after the ESIA approval; • Classified Installations for Environmental Protection Decree (décret ICPE); • Internal Operation Plan (POI); • Technical requirements and environmental activities study (EPTEA, *Etudes de Prescriptions Techniques et Réglementaires*).	Azito Energie and Azito O&M	Azito O&M HES manager	File all the updated permits and HES documentation	Azito Energie management	Management time - 10 days to control that the documents are obtained at 70€/day and 1 days/month for follow-up at 70€/day

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Potential Impacts on air quality						
The Phase III will not result in any type of new air emissions compared to the existing situation. The height of the emission stacks of the Phase III installations will however influence the pollutant dispersion.	Ensure appropriate monitoring of stack emissions as well as monitoring of ambient air within the Project's area of influence (Yopougon / Plateau areas), focussing on NO_2 and SO_2.	Azito Energie + Azito O&M	Azito Project Manager	Project technical specifications	Azito Energie management + Azito O&M Prior to construction to get baseline information continuous / daily average monitoring of the stacks emissions using automated sampler focussing on : NO_x, SO_2, Particulate Matter $PM_{2,5}$ and PM_{10} Ambient air quality to be monitored at the location mentioned in the baseline (near the site and some in the city of Yopugou). Azito will ensure that sensors are viable and the measures are recorded	No extra cost compared to standard practice

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Potential Impacts on ambient noise						
Noise from the Phase 3 equipment	The ambient noise levels should comply with the local and international standards applicable. The design of the new installations should consider the technical mitigation measures presented in the section4.6.4 of the report to control noise from the Phase III equipment.	Contractor	Contractor's engineers	Project technical specifications	Azito O&M HES and Project Manager Prior to the construction works Continuous during construction works	Included in the initial budget of the Project – Budget will be determined based on the final design of the installations
	Develop a long-term noise measurements program of the highest contributing noise equipment as well as the sensitive receptors. These measurements should be assessed against the Ivorian and IFC noise standards.	Azito Energie	Azito O&M HES manager	Results recorded in the HES supervisor logs and in the Azito's annal environmental report	Independent qualified acoustic technician. Measurement survey and prediction study to be carried out annually.	2 days /year during the operations at 750€/day
Potential Impacts on water resources – consumption						
Use of domestic water on site (potable and industrial water)	The volume of water required for each phases of the project should be assessed and the well	Azito Energie	Azito Project Manager	Project technical specifications	Azito Energie management Prior to	No extra cost compared to standard practice

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
	capacity re-evaluated to control that the volumes of water pumped of the borehole are sufficient to cover the needs				construction	
Potential Impacts on water resources – contamination						
Contamination of surface and groundwater from process, fire fighting and drainage water.	Measures currently applicable on the Site for the waste water collection and treatment should be implemented to the Phase III - Liquid wastes resulting from the operation of the facility will be collected and treated as appropriate. Oily water will be treated in an oil/water separator before being directed to the evaporation pond.	Azito O&M	HES site manager	Any variance compared to the standard operating procedures will be recorded in the HES site manager's log.	Azito O&M HES manager According to the prefectural Decree, a monitoring of the effluent should be performed every week and an external monitoring has to be realised every six months.	No extra cost compared to standard practice
	Assessment of the existing capacity of the evaporation pond to control that the volume is sufficient to cover the waste water flow increase coming from the Phase III expansion.	Azito Energie	Azito Phase III Project Manager	Project technical specifications	Azito Energie management Prior to construction	No extra cost compared to standard practice
	The design and technical characteristics of the water treatment process installations will need to be	Azito Energie	Azito Phase III Project Manager	Project technical specifications	Azito Energie management Prior to	No extra cost compared to standard practice

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
	adapted to the Phase III in order to cover the excess of effluents produced. This should cover the evaporation pond rehabilitation and protection (appropriate coating), neutralisation pond and oily water treatment unit. The biological treatment process of the industrial and sanitary water should be improved and adapted to the new situation to avoid any contamination of the receptors reached by the effluent water coming from the evaporation pond.				construction	
Potential Impacts on biodiversity						
Potential spillages or leakages of products and chemicals on site or along the transport route	Good site management practices to ensure that spills and leakages do not affect the biodiversity in the surroundings of the Site	Azito O&M	HES site manager	Any variance compared to the standard operating procedures will be recorded in the HES site manager's log.	Azito O&M HES manager Intermittent checks during the operations	No extra cost compared to standard practice

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
	Good design of site drainage and run-off associated with the extension project in order to collect and control any potential spillages or leakages.	Contractor	Azito Phase III Project Manager	Project technical specifications	Azito Energie management Prior to construction	No extra cost compared to standard practice
Potential Impacts associated with the waste production						
Production of waste on site during the operations	A waste management plan will need to be developed/updated and include the Phase III, to ensure adequate storage, collection and disposal of waste, including liquid, solid, hazardous and non hazardous wastes. The plan will describe the waste segregation, transfer and disposal strategy to suitable locations. It will include procedures for monitoring the performance of all waste management contractors.	Azito O&M	Azito O&M site manager	Waste management plan	Azito Energie	Management time - 5 days to update the WMP at 70€/day and 1 days/month for follow-up at 70€/day
Potential Impacts associated with natural hazards						
Risks associated with natural hazards should be considered in the design of the Phase III with a focus on flooding	The storm water drains that will be installed as part of the Phase III Project will be designed properly with a sufficient capacity to avoid flooding problems on site.	Contractor	Azito Phase III Project Manager	Project technical specifications	Azito Energie management Prior to construction	No extra cost compared to standard practice

Table 6.3 Project mitigation and monitoring measures: decommissioning phase

Activity / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Decommissioning works will have a potential impact on the physical, biological and social environment	Develop a detailed decommissioning plan to evaluate the options considering environmental, health and safety, technical and financial aspects. The Ivorian authorities will be consulted and informed.	Decommissioning contractor	Ivoirian State and contractor's HES supervisor	Decommissioning plan	Ivoirian State appointed HES manager Prior to decommissioning works	Management time – Associated cost to be determined at the time of the decommissioning
	Product and chemicals will be evacuated from site using an independent waste management company	Decommissioning contractor	Decommissioning contractor HES supervisor	Waste collection manifeste	Ivoirian State appointed HES manager Intermittent checks	Management time + costs associated to the collection and treatment of the wastes Associated cost to be determined at the time of the decommissioning
	Measures presented in the construction section will be applicable for the decommissioning and abandonment: • ambient noise level limits; • dust emissions control; • waste management; • health and safety management system.	Decommissioning contractor	Ivoirian State and contractor's HES supervisor	Any variance compared to the standard decommissioning procedures will be recorded in the HES contractor's log	Ivoirian State appointed HES manager Intermittent checks	Management +operational time Associated cost to be determined at the time of the decommissioning

Table 6.4 Main concerns expressed during the public consultations and mitigations measures associated

Concern / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
Local employment	Azito to consider the opportunity to hire local people for the construction phase and some operational tasks. This could be done via the existing training program in place with the village of Azito (support the training of young villagers for specific skills needed)	Azito Energie and contractor	Azito project manager, contractor and Azito sustainability officer	Azito annual sustainability report	Azito Project and HES manager Prior to construction works and intermittent audits during operations	Management time - 2 days before the construction at 70€/day and 1 days/month for follow-up at 70€/day
Social development program improvement in Azito	Azito Energie and the social committee should improve the communication with the local communities and develop a grievance mechanism that would be presented to the representative of both communities and allow them to communicate any frustration or problems associated with the operation of the power plant.	Azito Energie and Azito O&M	Azito Management and sustainability officer	Azito annual sustainability report	Azito Energie Management	Management time - 3 days to develop the grievance mechanism at 70€/day and 1 days/month for follow-up at 70€/day
Social development program implementation in Béago	The village of Béago should be included in the social development program in place as they are also	Azito Energie and Azito O&M	Azito Management and sustainability officer	Azito annual sustainability report	Azito Energie Management	Management time - 5 days to implement the development program and

Concern / source of impact	Mitigation/Management Measures	Implementation Responsibility	Follow-up Responsibility	Environmental follow-up indicators	Monitoring responsibility and frequency	Estimated Budget and source of funding
	potentially impacted by the power plant.					organise meetings (70€/day) and 1 days/month for follow-up at 70€/day
Health and safety and emergency response plan communication	Azito should develop a communication program that would allow the neighbouring communities of the Azito plant (Azito and Béago villages) to understand the risks associated with the power station operation and receive a basic training about the emergency response plan.	Azito Energie and O&M	Azito HES manager and sustainability officer	Azito annual sustainability report + Emergency response plan	Azito O&M HES manager Intermittent checks	Management time - 5 days to implement the H&S communication program and organise meetings 70€/day) and 1 days/month for follow-up at 70€/day

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