REPUBLIC OF SENEGAL

-

Un Peuple -Un But-Une Foi

Ministry of the Environment and Sustainable Development
Environment and Classified Installation Office (DEEC

Environmental and Social Impact Assessment for the ContourGlobal – Cap des Biches thermal power plant extension project

Final – 9th of March 2016

CONTOURGLOBAL

ERM

The world's leading sustainability consultancy

ContourGlobal - Cap des Biches

Environmental and Social Impact Assessment for the thermal power plant extension project

Final – 21st of March 2016

ERM reference: GMS 0335027

For Environmental Resources Management
Approved by: Camille Maclet
Signature:
Date: 21st of March 2016

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ANSD	:	National Agency of Statistics and Demography (*Agence Nationale de la Statistique et de la Démographie*)
AQS	:	Air Quality Standard
AT	:	Arrêt de Travail
BOD	:	Biochemical Oxygen Demand
BRGM	:	Geology and Mining Research Bureau (*Bureau de Recherches Géologiques et Minières - France*)
CAPEX	:	Capital expenditures
CE 50	:	Medium efficient concentration (50%)
CEP	:	Assumed environmental concentration
CL 0 or 100	:	Lethal concentration for 0% or 100% of mortality
COD	:	Chemical Oxygen Demand
CRODT	:	Oceanographic Research Center of Dakar-Thiaroye (*Centre de Recherches Océanographique de Dakar-Thiaroye*)
CT	:	Combustion Turbine (*Turbine à combustion)*
DEEC	:	Direction de l'Environnement et des Etablissements Classés (Environment and Classified Facilities Office)
DEFCCS	:	Direction des eaux, forêts, chasse et de la conservation des sols (Office for Water, Forests, Hunting and Soil Conservation)
DEIE	:	Division des Évaluations d'Impact sur l'Environnement (Environmental Impact Assessment Office)
DGID	:	Direction Générale des Impôts et des Domaines (General taxes and estate office)
DGPRE	:	Direction de Gestion et de la Planification des Ressources en Eau (Water resources management and planning office)
DIC	:	Division des Installation Classées (classified installations division)
DL 50	:	Dose létale médiane (50%) (Lethal dose 50%)
DPC	:	Direction de la Protection Civile (Civil protection office)
DPVE	:	Direction de la planification et de la veille environnementale (Environmental planning and supervision office)
DREEC	:	Direction Régionale de l'Environnement et des Etablissements Classés (Regional environment and classified installation offices)
ECOWAS	:	Economic Community Of West African States
EHS		Environnement, Santé et Sécurité (*Environment, Health and Safety*)
ERM	:	Environmental Resources Management
ESIA	:	Environment and Social Impact Assessment
ESMP		Environmental and Social Management Plan
GTDLI	:	Groupe de Travail sur les Dépôts de Liquides Inflammables (French working group on flamable deposits)
HIV	:	Human Immunodeficiency Virus
ICPE		Installation Classified for protection of Environment
IFC	:	International Finance Corporation
INERIS	:	Institut National de l'Environnement industriel et des Risques (French institute for industrial environment and risks)

IREF	:	Inspection Régionale des Eaux et Forêts (Regional water and forestry inspection office)
LAME	:	Laboratoire Africain de Métrologie et d'Essais (African laboratory for metrology and testing)
MSD	:	Musculo-Skeletal Disorders
NOEC	:	*No Observed Effect Concentration* – Concentration sans effets observés
OPEX	:	Operational expenditure
PC	:	Process contribution
PMD	:	Public Maritime Domain
PNAE	:	Plan National d'Action pour l'Environnement (National action plan for the environment)
PPI	:	Personal Protection Equipment
SAR	:	Société Africaine de Raffinage
SEI		Seuils des Effets Irréversibles (Irreversible effects threshold)
SEL		Seuils des Effets Létaux (Lethal effetcs threshold)
SENELEC	:	Société Nationale d'Electricité du Sénégal
SRTM	:	*Shuttle Radar Topography Mission*
ST	:	Steam Turbine (*Turbine à vapeur*)
TNI	:	Non-Immatriculated Title (*Titre Non-Immatriculé*)
ToR	:	Terms of Reference

NON-TECHNICAL SUMMARY

INTRODUCTION

This report presents the update of the Environmental and Social Impact Assessment (ESIA) for the extension of the ContourGlobal - Cap des Biches power plant in Cap des Biches. Two additional power generation engines providing an additional 33MW capacity will be installed (hereafter "the Extension").

This ESIA has been carried out to comply with Senegalese regulations, whilst also taking into account the 2012 performance standards of the International Finance Corporation (IFC – World Bank Group).

PROJECT DESCRIPTION

The initial project, promoted by ContourGlobal - Cap des Biches, consisted of a new 53MW electricity generating power plant (hereafter "the initial Project") to replace an existing 52 MW power plant which was in operation between December 2000 and July 2013, and which is located at Cap des Biches, Rufisque. The 53MW plant project received the certificate of environmental conformity in January 2015, following the validation of the ESIA. Construction began in February 2015 and is on-going. The commissioning phase is expected to start in May 2016.

This project was combined cycle thermal power plant comprising three 16.5MW diesel engines associated with a 3.5MW combined cycle. The plant's generation capacity (as defined contractually between ContourGlobal - Cap des Biches and SENELEC) is 53 MW, with an availability rate of 91.5% per year, i.e. generation of 425 GWh/year.

The Extension will comprise two additional power generation engines running on Heavy Fuel Oil (HFO) providing an additional 33MW capacity. The same engines (Wartsila 18V46) will be used for the initial Project and the Extension. It is designed to produce between 265 GWh (assuming a 91.5% availability, taking maintenance into account) and 290 GWh (maximum production) per year. The Extension will be located adjacent to the new 53 MW plant and within the permitted footprint (2.99ha), therefore requiring no additional land. The provisional timetable is for the construction to start at the beginning of 2016 (end of March), with plant start-up in September 2016.

The total capacity of the initial plant and the Extension combined (hereafter "the Project") will reach 86MW. This power project was defined in consultation with the National Electricity Company (hereafter SENELEC), based on projections for the demand and generation of electricity in Senegal in the medium and long term.

REASONS FOR THE PROJECT

Despite increased electricity generation supplying an increasing number of homes, the share of energy available for each home is decreasing due to the high demographic growth in Senegal. The deficit in electricity supply is resulting in a lack of stability that is affecting living conditions and the development of economic activity.

Development of the electricity plant is therefore essential for development in Senegal. The Project will have benefits both for ContourGlobal - Cap des Biches and for Senegal:

- For ContourGlobal - Cap des Biches, the project is part of a strategy to rehabilitate its energy generation assets and ensure its activities over the long term.

- At national level, the rehabilitation and modification of the ContourGlobal - Cap des Biches power plant will make Senegal's energy supply more reliable in response to increasing demand.

- At local level the Project will have direct benefits with the creation of jobs.

DESCRIPTION OF ENVIRONMENTAL AND SOCIAL BASELINE

Environmental baseline aims at characterise the Project's receptor environment and understand its sensitivity. Field data presented in the report was collected over the course of three field missions organised in June 2014, October 2014, and February 2016 during which an analysis of the physical, biological and human environment was carried out. These missions also included public consultations processes and interviews were carried out with the various stakeholders in order to describe the administrative, demographic and economic context. Monitoring of air quality in the area has also been undertaken. These visits to the site were supplemented by bibliographical research.

The following topics were studied:

- Physical environment: geomorphology, geology, hydrogeology, hydrology, seismicity, weather conditions, air quality and ambient noise,

- Biological environment, natural habitats, flora, fauna, protected and/or threatened species, protected natural areas,

- Landscape,

- Human environment, administrative organisation, demographics, planning and land use context, agriculture, socio-cultural context and infrastructure, and

- Services rendered by the ecosystems.

For each of these topics a specific study area was defined based on the Project's potential zone of influence and according to the specific physical, biological or socioeconomic characteristics of each topic. In terms of the Project's zone and the close contact study area, land use is dominated by urbanised and industrial areas (Darou Salam Azur district to the east and SENELEC power plant and estate to the west).

Stakeholders in the Project were consulted at local, regional and national level, in accordance with current Senegalese regulations. The main conclusions and concerns put forward by stakeholders during the public consultation phase are also summarised in *Chapter 7*. It should also be noted that, in general, the Project was well received by the stakeholders consulted.

PROJECT ALTERNATIVES

Chapter 6 of the ESIA presents an analysis of the Project's alternatives. This analysis has taken into account the more important elements of the Project, such as the possibilities of total rehabilitation of the existing power plant, the location of the new power plant and the technological choices for electricity production. The "no project" option has been analysed separately.

This analysis has shown that the decision to install a thermal power plant run on heavy fuel oil associated with a combined cycle (for 3 engines) represents the best compromise according to social, environmental and economic criteria (cost-effectiveness and cost of energy production).

EVALUATION OF IMPACTS

Air quality

Impacts on air quality during construction are expected to be transient and are assessed as negligible, with all the mitigation measures in place.

The operation of five engines running on heavy fuel oil will generate exhaust emissions of nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and particles (PM) into to atmosphere. These emissions could cause potential adverse impacts on local air quality at receptors located in the surroundings of the Project.
An atmospheric dispersion modelling study supported the assessment of impacts on air quality associated to the project emissions during operation. The concentrations predicted by the model for SO_2, CO and PM both in the short (1h, 24-hour concentration) and long term (annual concentration) are below the regulatory limit and do not show any criticalities at receptors. With regard to predicted NO_2 concentrations, the modelling study show that hourly concentrations of NO_2 induced by the Project operation, occasionally result in exceedances of the Senegalese and international Air Quality

Standard (AQS) at receptors. However, the number of hourly exceedances is extremely limited and account at most for the 0.72% of the year.
Moreover, 97.71% of the time, hourly NO_2 concentrations modelled are below the 25% of Senegalese and international standards.

While considering the Project emissions in conjunction with existing baseline levels, exceedances at sensitive receptors are noted only for PM10 concentration; the modelling study highlighted that the Project contribution is negligible and only accounts for 0.4% of existing PM10 concentration at receptors.

Standard of good practice along with air quality monitoring activities will be implemented to manage air quality impacts.

Overall, the importance of the residual impact on air quality linked to emissions from the engines during the power plant operation is classified as **minor.** This classification represents an average of impacts related to all pollutants and to both short term and long term concentrations.

Noise

During the construction phase, noise emissions will arise from site machinery and a temporary increase in road traffic (deliveries and employee transport). Construction activities will be performed only during daytime, and consequently noise impacts have been assessed against in force national and international noise standards set for daytime.
Noise from site machinery was evaluated at the most sensitive receptors (houses in the SENELEC estate and the Diokoul district). According to this evaluation, the potential impacts associated with the Project construction activities are expected to comply with the limits set by Senegalese regulations. Impacts at receptors related solely to the Project contribution are classified as negligible. While considering the project in conjunction with existing noise levels minor to medium impacts are expected at receptors. These impacts will occur only for a limited period only, and as such no particular mitigation measure are deemed necessary and only best practice and good operational standards will be followed.

Noise impacts during the Project operation phase are related to the 24h operation of the Power Plant. Consequently impacts at the closest sensitive receptors have been assessed both at daytime and night-time.

- Day Time Impacts: impacts at receptors related solely to the Project contribution during the day time are Negligible to Minor; while considering the Project in conjunction with existing noise levels Minor to Medium impacts are expected at receptors.
- Night Time impacts: impacts at receptors related solely to the Project contribution during the night time are Medium at two receptors, Negligible at one receptor and High only at the SENELEC housing estate; while considering the Project in conjunction with existing noise levels Medium to High impacts are expected at receptors. Main criticalities are expected at

receptors located in the SENELEC housing estate and driven by current high background noise levels (pre-project).
Cumulative Noise levels obtained during the night exceed both Senegalese and IFC standards for the majority of receptors analysed. However, the sensitive receptors identified are schools, with no activity during the night. The increase in acoustic levels above the background noise generated at night by the operation of the new installations at the Project is, on the other hand, below IFC criteria (3 dB(A)) for all receptors and the impact generated can therefore be considered to be acceptable in terms of this criterion.

In order to reduce the night time impacts at sensitive receptors, and in particular at the SENELEC housing estate, the Project has planned to implement the use of silencers on stacks, air inlets and ventilators on ventilation output, and the installation of anti-noise panels for the generators and steam turbine. These mitigations measures are expected to reduce the noise emissions and consequent impacts; residual Impacts at receptors are expected to be of Minor Importance.

Availability and quality of water resources

Water requirements for building the Project are mainly linked to water consumption for domestic purposes at the site and to the use of water for construction works. The amount of water used during the building phase will be limited. Potential impacts on water resources will be negligible.

Impacts by the building phase on groundwater quality may be due to:

- run-off from the worksite loaded with matter in suspension, when it rains;
- discharge of used water from toilet facilities; and
- leaks or accidental spillage.

During the operational phase, the Project will be supplied by the *Sénégalaise des Eaux* distribution network. Requirements in terms of cooling water will be limited because the air cooling system will be designed with a closed loop. Unlike the former power plant, the new ContourGlobal - Cap des Biches power plant will in fact no longer use sea water for cooling. No local resource will therefore be used. Potential impacts on water resources linked to operation of the power plant should therefore be negligible.

All operational waste water that is likely to be contaminated, i.e. industrial water and potentially contaminated rain water, will be collected and treated by the effluent treatment plant to reduce its contaminant content. One of the main effects of the treatment carried out will be to separate water and hydrocarbons (which are the main pollutant likely to be discharged). Analyses will be regularly performed on the effluent prior to discharge in order to ensure that Senegalese standards on discharged water are met.

Discharge will be made into the marine environment via the SENELEC discharge canal located at the western limit of the existing ContourGlobal - Cap des Biches power plant. No heated discharge will be made by the power plant in operation. Any run-off of contaminated water will be avoided by means of the drainage and rain water separation system and waterproofing of the soils.

The Project's impact on water quality during normal operation should be minor. During abnormal functioning (due to a fault in the water treatment system), a moderate impact may occur; however, this would be a temporary impact since regular analyses of discharged water would rapidly identify any malfunction.

Biodiversity

In view of the small surface area concerned and the absence of any notable habitats in the area, the impact of this work is considered to be negligible. The presence of two isolated specimens of a partially protected plant species (*Faidherbia albida*) and a protected bird (the black kite – *Milvus migrans*) has been confirmed at the site but does not require the implementation of any specific measures prior to the start of operations (*Faidherbia albida* has been found commonly in the surroundings of the Project area and no trace of any nesting by the black kite has been observed in the construction area). For the Extension, the area has already been cleared for the initial 53MW plant.

Landscape

The two main sources of visual and landscape impacts are the height and volume of the proposed structures. The main potential impacts resulting from the Project are the long term visual and landscape impacts due, on the Project's main site, to new buildings, and in particular the installation of two clusters of 40m high stacks, which will be visible from the limit of the site, and the installation of tanks, the main steam turbines block and the two engines (about 16-18m high).

In view of the low sensitivity of the landscape and the intensity of the change, considered to be low, resulting impacts on the landscape are considered to be of negligible importance.

Land use and local infrastructures

For the initial Project of 53MW, clearance of the land and the change of land use led to expropriation of a farmer who had been using the land concerned for market gardening and for fruit trees for several years. This farmer is not the owner of the land he was farming.

A land acquisition procedure was set up by SENELEC, in collaboration with ContourGlobal - Cap des Biches and a Senegalese surveyor who supervised operations. An agreement was signed with beneficiaries and planned compensation amounts were paid. There was no report of any dispute in the resolution of this issue.

Given that the Extension of 33MW will be set up on the same foot print as the initial Project, this issue is considered as resolved.

No historic or archaeological site was identified within the Project area during investigations carried out within the context of the socioeconomic study. No cemetery or place of worship is located at the future power plant site and will not therefore be affected by development of the project.

Local socioeconomic context and living conditions

The Project's potential socioeconomic impacts are described in *Chapter 8*.

- Employment: During construction of the Project, the recruitment of local workers will be preferred as much as possible. Workers will be employed for periods from several days to a few months. Numbers will therefore be variable throughout the building phase. Some construction tasks will require the intervention of qualified and specialist workers, who may be recruited from further afield if the necessary skills are not available locally. The construction work will therefore have a positive impact in terms of employment at local and regional level.

- Local economy and inflation: the local economy is already perfectly well integrated into the industrial and urban context of the study area, so that modifications induced by the arrival of workers in the area should be limited. Construction work at the plant will mean a dynamic for the local economy at different levels, depending on distance from the power plant area and the size of the communities affected. Workers working at the worksite and neighbouring communities will interact in various ways: food sales, sales of equipment and basic goods and various other services. These potential impacts can be seen as positive for the communities concerned.

- Immigration and pressure on existing local infrastructures: the development of infrastructure projects and associated building sites may also result in the phenomenon of opportunist immigration into the areas concerned by the projects, with the aim of finding a job. In the case of building this Project, the probability of migrations towards the project area is highly improbable. In fact, the relatively limited size of the Project and the fact that the site is located not only close to the town of Rufisque but also to Dakar, will dilute the arrival of people looking for work at regional level. These effects are considered to be minor.

- Agriculture: in view of the low density of agricultural activities within the study area, the creation of local jobs at the plant building site will not have any real significant impact on agricultural production due to reduction in the labour force available for work on farm land and in orchards.

Finally, no specific impact on any vulnerable group has been identified.

Health and safety of local communities and employees

There is a risk that building of the Project could lead to an increase in health problems. Health risks are those that result from poor living and hygiene conditions, sexually transmitted diseases (HIV/ AIDS) and infections transmitted by vector. An influx of workers during building and operation of the plant is likely to increase the risk of propagation of diseases within local populations; these impacts should remain limited, however, on the one hand because the number of workers from outside the local community will be relatively small and, on the other, because no official accommodation will be provided for workers on the Project (which will avoid a concentration of workers). The project is providing regular training and awareness workshops on the subject.

Risk of accident and injury during the building phase will mainly affect workers employed at the site by the sub-contractor responsible for building the power plant. Measures to protect the health and safety of workers will be established within the context of a prevention plant, prior to the start of works, and implemented and following throughout the building phase.

During the building phase, traffic around the area where the future power plant will be located will increase significantly, in view of the fact that employees and equipment have to be transported by road to the site (mainly from Rufisque and Dakar). In view of the population density in certain areas, traffic risks could be increased. The impact caused by traffic is therefore considered to be medium.

During the operational phase, impacts on health and safety will be limited and will involve mainly the risks associated with running the power plant. According to the modelling carried out during research into hazards (see below), no dwellings are located within the risk areas, such that this impact will be very limited. The other impact factors on health and safety (atmospheric emissions, noise issues, etc.) will be kept under control such that no major significant impact is expected (see above).

Services rendered by ecosystems

An evaluation of the impacts on services rendered by ecosystems has been carried out taking account of the value and sensitivity of receptors and the magnitude of impacts on ecosystems and natural resources. Impacts on ecosystems (food, traditional practices, etc.) during the various phases of the project have been evaluated as being of negligible to minor importance.

Solid waste products

During the building phase the types of waste products generated will be mainly excavated soils, domestic waste, packaging used for building materials and raw materials, materials resulting from the structural work as well as greasy waste, batteries, empty drums and other specific waste. Quantities of waste materials will be relatively low, meaning that the issue of their treatment is not considered to be problematic; the removal and management of waste materials will be dealt with by approved service providers.

During the operational phase, the main waste materials expected are domestic waste, sludge from the treatment stations, hazardous waste (lubricants and oils, filters, cloths, solvents) as well as waste from the maintenance workshop.

It is interesting to remember that ContourGlobal - Cap des Biches has the benefit of experience from the existing GTI power plant, which is the object of rehabilitation and modification. The waste materials that were produced during operation of the existing power plant were managed by approved companies. ContourGlobal - Cap des Biches will use its knowledge and local experience in the choice of collection and treatment companies for this new power plant. The impact of waste production during the building phase has been evaluated as medium. Implementation of the mitigation and control measures described below will reduce this impact to an acceptable level.

Cumulative impacts

In the case of the development of the power plant Project, no other project currently being developed was identified during preparation of this study. Moreover, existing infrastructures within the study area were taken into account in the analysis of the baseline, in view of the fact that current conditions in the study area are already under the influence of activities associated with these infrastructures as well as their impacts.

With regard to the marine environment and associated industrial activities (carried out on the shore), no data relating to liquid discharge by activities within the Project area is available. Discharge into the sea from the future power plant will be limited, however, in view of the cooling technologies that will be used. The cumulative impacts of the various infrastructures in the study area on the marine environment will therefore be below those that existed through until July 2013, when the former ContourGlobal - Cap des Biches power plant (the operation of which required drawing up sea water and the output of heated discharge) was still in operation.

Hazard study

Hazard levels were studied based on the methodological guide published by the Ministry of Environment and Nature Protection of the Republic of Senegal and DEEC (1), and with a view to compliance with current Senegalese regulations. Within the context of this study, hazards potentially presented by the installations were modelled and evaluated in terms of gravity and probability of occurrence. The scenarios were classified according to the

(1) Guide d'étude de danger, DEEC – Ministry for the environment and nature protection ; October 2005 version.

criteria given in the Senegalese guide. Domino risks (risk of a chain of successive scenarios) were also analysed. No scenarios represent any intolerable risk.

The results of the hazard study indicate that the maximum distance for irreversible effects is 155 metres from the power plant. It is important to note that urban expansion will be very limited in terms of the Project area (the area is surrounded by fenced industrial projects, where no building is permitted), thus avoiding any new dwellings being built within the security distance.

Moreover, the implementation of prevention measures and measures to control any consequences, which are adapted to the potential hazards identified for the power plant, will make risks acceptable, in view of local conditions (in particular the location of the closest dwellings).

In addition to the hazard study, an analysis of professional risks was carried out, detailing potential risks for workers during the construction and operational phases and presenting measures by which to limit these risks, specifically by the use of personal protective equipment (PPE).

Closure and restoration after operation

The contract signed between ContourGlobal - Cap des Biches and SENELEC provides for operations over 20 years. This period may be extended depending on local electricity production requirements and national production strategy. The power plant will be subject to a Closure Restoration and Aftercare Management Plan (CRAM). This measure will guarantee that ContourGlobal - Cap des Biches will not leave the site after operations in a deteriorated state compared to its state prior to occupation and that environmental or social impacts associated with site closure are controlled, in accordance with regulations and good practice.

Environmental and Social Management and Monitoring Plan

An Environmental and Social Management Plan (ESMP) was prepared after completion of the ESIA for the ContourGlobal - Cap des Biches project, with a view to complying with law N° 2001-01 of 15th January 2001 containing the environment code.

The aim of the ESMP is to provide an environmental and social management framework for the Project, by translating the mitigation measures specified in the ESIA into a plan for implementing the Project.

Thus, the ESMP proposes a reduction plan comprising mitigation measures to be implemented by the Project for each phase of its implementation, with the aim of complying with Senegalese regulations and with international standards and good practice. The plan also details ways in which measures are to be monitored and the costs and responsibilities involved.

The ESMP provides a framework for monitoring the Project's compliance with these standards and good practices. It makes specific reference to the roles and responsibilities for every aspect of the Project subject to mitigation measures and describes the organisation of environmental and social management responsible for mitigation and monitoring during the building and operational phases.

In addition to the reduction plan presented above, the report also provides essential principles in terms of the following environmental management procedures, which must be implemented within the context of development of the environmental and social management system:

- Water resources management procedure ;
- Waste management procedure ;
- Transport management procedure ;
- Procedure for intervention in case of spillage ; and
- Procedure for periodic audit and review of the ESMP.

These procedures will be designed to be adaptable to the various phases of the Project, in order to remain relevant to the issues specific to each phase.

The Chapter also includes a plan for supervising and monitoring the environment according to residual impacts revealed by the study. This plan is intended to ensure that the measures proposed are implemented and efficient, and details the responsibilities, deadlines and costs associated with internal and external monitoring (by the Senegalese authorities).

General conclusion

Based on the assessments undertaken for the purpose of this ESIA and detailed in this report, the experts in charge of this study consider that the ContourGlobal - Cap des Biches Project follows the best international practices and is acceptable with regards to the social and environmental legislation in Senegal.

1 INTRODUCTION

1.1 AIM OF THE REPORT

This report presents the update of the Environmental and Social Impact Assessment (ESIA) for the extension of the ContourGlobal - Cap des Biches power plant in Cap des Biches. Two additional power generation engines providing an additional 33MW capacity will be installed (hereafter "the Extension").

The initial project, also promoted by ContourGlobal - Cap des Biches, consisted of a new 53MW electricity generating power plant (hereafter "the initial Project") to replace an existing 52 MW power plant which was in operation between December 2000 and July 2013, and which is located at Cap des Biches, Rufisque.

The initial Project of 53MW received the certificate of environmental conformity in January 2015, following the validation of the ESIA. Construction began in February 2015 and is on-going. The commissioning phase is expected to start in May 2016.

The initial Project was a combined cycle thermal power plant comprising three 16.5MW diesel engines associated with a 3.5MW combined cycle. In total, the plant's generation capacity (as defined contractually between ContourGlobal - Cap des Biches and SENELEC) has been increased to 53 MW, with an availability rate of 91.5% per year, i.e. generation of 425 GWh/year.

The Extension will comprise two additional power generation engines running on Heavy Fuel Oil (HFO) providing an additional 33MW capacity. The same engines (Wartsila 18V46) will be used for the initial Project and the Extension.

The total capacity of the initial plant and the extension combined (hereafter "the Project") will reach 86MW. This power project was defined in consultation with the National Electricity Company (hereafter SENELEC), based on projections for the demand and generation of electricity in Senegal in the medium and long term.

1.2 PRESENTATION OF CONTOURGLOBAL - CAP DES BICHES

ContourGlobal - Cap des Biches is a private, independent producer which, in 1996, signed with SENELEC a contract for the exclusive supply of electricity for a period of fifteen years (initial contract was in the name of GTI-Dakar). A permit to operate the power plant was granted to ContourGlobal - Cap des Biches by ministerial order nº 006562/ MEPN/ MEMI/ DEEC dated 19th August 1998. In 2000, ContourGlobal - Cap des Biches obtained a power purchase agreement (PPA) for a 15 year period, and electricity generation at the ContourGlobal - Cap des Biches installation began in December 2000. The power plant was shut down in 2013 for technical reasons, investigations having revealed major deterioration of several of the turbine rotation components. ContourGlobal - Cap des Biches then decided not to re-start production but to update and renovate all the installations completely, in coordination with SENELEC.

In April, 2013, GTI-Dakar (renamed ContourGlobal - Cap des Biches in 2014) was bought by ContourGlobal, an international energy production company. The aim of the project pursued by ContourGlobal was the building of a new 53MW power plant (to replace an existing 52 MW power plant. Renewal of the PPA contract between SENELEC and ContourGlobal was signed in August 2014. This contract is part of the Emerging Senegal Plan (PSE) and aims to improve SENELEC's production, at a reduced cost and to improve direct foreign investments, with an investment of one hundred million dollars. As mentioned, by the end of year 2014, GTI-Dakar changed his name to ContourGlobal – Cap des Biches.

In December 2015, a Memorandum of Understanding (MOU) was signed between SENELEC and ContourGlobal - Cap des Biches for the 33MW extension.

1.3 PRESENTATION OF THE CONSULTANTS RESPONSIBLE FOR THE ESIA

ContourGlobal - Cap des Biches has mandated Environmental Resources Management (ERM) to carry out this ESIA. The list of the experts who have participated to this ESIA is detailed in *Annex 9*.

ERM (Environmental Resources Management)

ERM is one of the world's leading companies in environmental and social management consultancy, and has extensive experience in terms of environmental studies, throughout the complete life cycle of a project, from its conception through to cessation of activities and dismantling.

Inset 1.1 ERM's competencies

Project phase	Competencies
Identification, pre-feasibility	• Strategic studies, • Sustainable planning studies • Study of statutory, environmental and social constraints
Feasibility, engineering	• Environmental and social impact studies (ESIA) • Environmental and social management studies (ESMS) • Consultation with stakeholders, public enquiries • Plans for compensation and re-installation • Regulations files • Technical assistance for financial institutions
Implementation, operations	• Partnership in implementation of the ESMP • Environmental and social monitoring • Due diligence audit • Hygiene, safety, environment management systems (HSE) • Waste management
Cessation of activities	• Plans for the cessation of activities and dismantlement • Management of contaminated sites and soils • Site rehabilitation.

ERM employs almost 5000 people in 150 offices across the world, and has been working in Africa for several decades, from France, Spain, the UK and its three offices in South Africa.

ERM is certified for the performance of environmental impact studies under the terms of ministerial order n°002244/MEEDD/DEEC/DEIE/AG dated 10 September 2014.

1.4 ESIA OBJECTIVES AND METHODOLOGY

1.4.1 ESIA objectives

The ESIA procedure is governed by Articles L-48 to L-54 of Chapter V of law N° 2001 - 01 dated 15th January 2001 covering the environment code.

Any new project, of any kind whatsoever, implies a modification to baseline conditions of the area in which it is installed. The main objective of an ESIA is to assess what impacts will be caused by the modifications linked to this project, and to define whether these impacts are acceptable from an environmental and social point of view.

The aim of the ESIA procedure is therefore to evaluate the potential impacts of a project likely to affect the biophysical, human and socioeconomic environment. Appropriate mitigation measures identified in the ESIA procedure are intended to remove, reduce or even compensate for the negative impacts of the project.

The drawing up of an ESIA must include the following elements:

- description of the receptor environment, characterisation of the environmental and social sensitivity of the area being researched;
- identification of any statutory obligations to be complied with during the various phases of the Project;
- identification of any classified installations planned for the preparation and operational phases of the Project ;
- description of any environmental issues linked to the layout /installations ;
- identification and evaluation of the project's potential impacts ;
- drawing up of an environmental and social management plan (ESMP) to remove, reduce or even compensate for the negative impacts discovered and to optimise the positive impacts, taking account of the opinions of any interested parties; and
- definition of the major outlines of environmental surveillance and of the environmental monitoring indicators to be implemented.

1.4.2 ESIA methodology

ESIA scope

The Project's characteristics, in its construction and operational phases, have been analysed in view of the environmental conditions in the installation area, based on the characteristics intrinsic to each interaction of the Project with the environment.

The study area for each component of the environment (physical, biological and human) has therefore been defined according to the Project's potential zone of influence. For example, weather conditions have been analysed within a sufficiently large perimeter to ensure that the various climatic events that may influence the dispersion of discharge into the atmosphere have been taken into account. Details of the definition of each study area are presented in *Chapter 4.*

Data used for the ESIA

The study has been based on field data collected during a mission to the site carried out from 14th to 18th February 2016 and the initial ESIA approved by the authorities in January 2015.

The study has also been based on existing documents, particularly statistics communicated by the local representatives of competent Senegalese ministries and reports and publications produced by international agencies and research centres.

Method for evaluating impacts

Evaluation of the Project's various potential impacts has been based on an evaluation grid that takes account of the type of impact (direct or indirect), and the intensity, extent, duration, frequency and probability of the occurrence of potential impacts. Finally, the various different characteristics of each impact were analysed in view of the sensitivity of the study area vis-à-vis each theme. This classification was based on professional judgements that comply with the directives and standards of impact studies.

The concerns of the various Offices linked to the Project: Office for the Environment and Classified Installations (*Direction de l'Environnement et des Etablissements Classés - DEEC*), Rufisque Ouest municipality (*Mairie de Rufisque Ouest*), Urban Planning Management Office (*Direction de l'Urbanisme*) , Civil Protection Office (*Direction de la Protection Civile*), Air Quality Management Center (*Centre de Gestion de la Qualité de l'Air*), Coastline Management Office (*Direction de la Gestion du Littoral*) etc. The opinions of stakeholders and environmental and social regulations, as well as good practice in the sector have also been taken into account.

Depending on the scale of the Project's various potential impacts, measures to remove, reduce and compensate for them have been defined, such that residual impacts, after implementation of these various measures, are acceptable and comply with current Senegalese regulations and with international standards. These various measures are integrated into the Project's Environmental and Social Management Plan, provided in *Chapter 10* of this report.

1.5 TIMETABLE FOR THE ESIA

The initial ESIA procedure was initiated by ERM and 2iEC in June 2014 with the realisation of a scoping study as well as a mission to collect data in the field.

This study enabled the writing and deposition of the ESIA Terms of Reference with the Environment and Classified Installations Office (DEEC) at the end of September 2014.

These were validated on 30th October 2014, following a visit to the site by the DEEC on 3rd October 2014 (letter n°2720/MEED/DEEC dated 30/10/2014 is provided in *Annex 2*). The Terms of Reference were modified based on comments received; the finalised version is provided in *Annex 1*. The ESIA for the 53MW power plant received the certificate of environmental conformity in January 2015.

The ESIA update was started by ERM in December 2015. The ESIA *Cahier des Charges* was delivered to DEEC at the end of January 2016.

1.6 *STRUCTURE OF THE ESIA REPORT*

This ESIA report follows the organisation defined in Senegalese environmental and social legislation. The following sections and chapters are included in the report:

- non-technical summary ;
- introduction ;
- Project's justification ;
- description of the Project ;
- analysis of the site's baseline conditions and of its environment;
- public consultation ;
- regulatory and institutional framework of the study ;
- description and analysis of the possible alternatives of the Project ;
- identification and evaluation of probable impacts linked to the project mitigation measure and residual impacts;
- study of hazards and professional risks ; and
- environmental and social management plan.

2 PROJECT'S JUSTIFICATIONS

2.1 PROJECT'S JUSTIFICATION

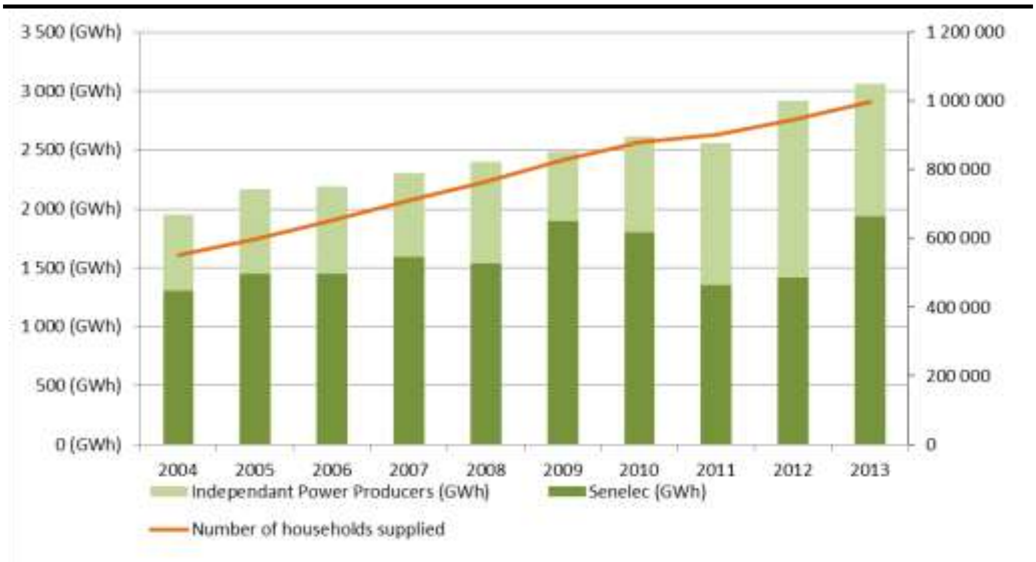
2.1.1 Electricity production at national level

In Senegal, regulation and control of the energy sector are dealt with by the State through the Energy Ministry (Commission for regulation of the energy sector). The production, transport, distribution and sale of electricity are delegated to the Société Nationale d'Electricité (SENELEC). Three private operators also operate in Senegal in public-private partnerships, including ContourGlobal - Cap des Biches, which became the leading independent energy producer in Senegal, when the Cap-des-Biches thermal power plant began production in December 2000, lasting through until July 2013.

In 2010, the total installed power of the Senegalese electricity generation plant was 686.5 MW (1), of which 493 MW generated by SENELEC and 192.5 MW by private producers. However, the relative state of dilapidation of certain installations limits electricity generation.

Figure 2.1 shows the developments in energy generation and the number of homes supplied between 2004 and 2013. Note the reduction in the share of energy generated by private producers in 2013, in part due to the shutdown of the ContourGlobal - Cap des Biches power plant.

Figure 2.1 ***Development in energy generation and the number of Senegalese homes supplied***

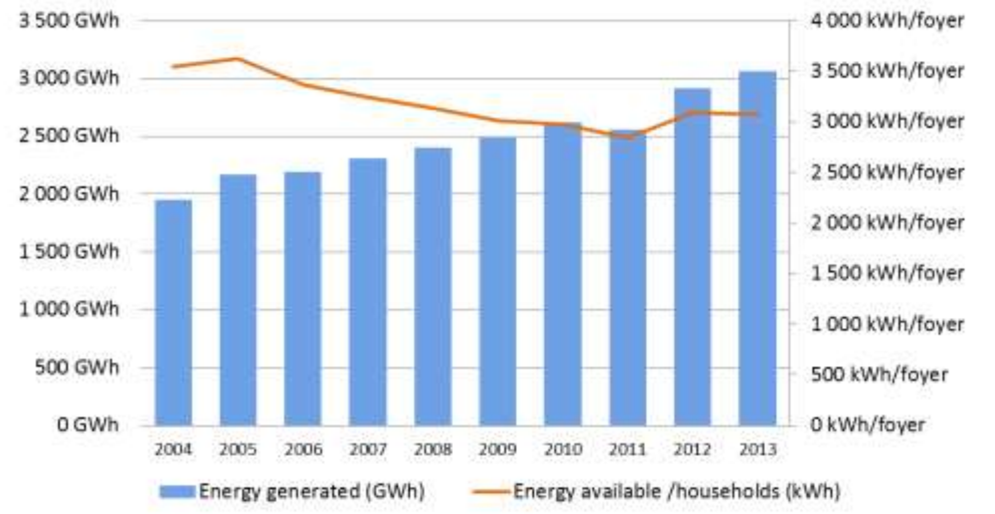


Source: *SENELEC, 2010* and *SENELEC, 2013*

(1) This figure includes generation at the Manantali dam (Mali), run by OMVS (Organisation pour la Mise en Valeur du fleuve Sénégal) 33% of the production of which goes to Senegal.

Despite increased electricity generation supplying an increasing number of homes, the share of energy available for each home is lessening due to the high demographic growth in Senegal, as shown in *Figure 2.2.* Despite an increase in 2012, the share of energy available per home remains below that in the years 2004-2005.

Figure 2.2 *Evolution of energy generation and energy available per home*



Source: *SENELEC, 2010* and *SENELEC, 2013*

This chronic deficit in the supply of electricity induces instability affecting living conditions and the development of economic activity. Development of the electricity plant is therefore essential to the development of Senegal.

2.1.2 *Expected benefits*

The initial Project and the Extension will have benefits both for ContourGlobal - Cap des Biches and for Senegal:

- For ContourGlobal - Cap des Biches, the project is part of a strategy to rehabilitate its energy generation assets and ensure its activities over the long term.

- At national level, the rehabilitation and modification of the ContourGlobal - Cap des Biches power plant will make Senegal's energy supply more reliable in response to increasing demand.

- At local level, the Project will have direct benefits, with the creation of jobs during the construction phase.

2.1.3 *Employment and local development*

The building phase (including start-up) of the Extension is expected to last for over 6 months and it will require the intervention of up to 200-250 workers in total during peak time activities.

During the operational phase, ContourGlobal - Cap des Biches will employ around 45 permanent workers in total for the whole plant.

2.1.4 *Amount of the investment*

Capital expenditure (CAPEX) associated with the construction and start-up of the plant is estimated at over 53.2 billion CFA francs. Later, monthly operational costs (OPEX), excluding fuel, will be of the order of over 240 million CFA francs; the monthly cost for the purchase of fuel is evaluated at over 2.57 billion CFA francs.

A royalty payment of around 50 million Francs CFA will be paid annually by ContourGlobal - Cap des Biches to the Senegalese State throughout the duration of operations at the plant. It is planned that this amount will be redistributed in part to the municipality of Rufisque Ouest by the General Taxes and Estates Office (DGID).

2.2 *REASONS FOR THE CHOICE OF LOCATION*

ContourGlobal - Cap des Biches's decision to rehabilitate and modify an existing plant, rather than building a new one, allows for optimisation of the use of land (cf. *Table 2.1*). The extension as well will not have any additional footprint as the new engines will be installed on the previously authorised footprint.

Table 2.1 Comparison of surfaces necessary for the implementation of a power plant

Surface	New power plant – data from ERM's feedback on similar projects	Project, reusing of some existing equipment
Power plant's boundaries	3 ha	1.5 ha
Construction site's boundaries	3 ha	1.5 ha

The choice of this location for the initial project and its extension is also justified by the location of the electric power transmission network, which is highly developed in the Cap des Biches area, due to the historical SENELEC installation at the site. Neighbouring high voltage cables provides for sufficient capacity to transport the new electric power generated.

3 DESCRIPTION OF THE PROJECT

3.1 GENERAL DESCRIPTION OF THE PROJECT

3.1.1 *Introduction*

The initial Project of 53 MW, developed in collaboration with SENELEC, has been designed to produce between 425 GWh (contractual commitment) and 464 GWh (maximum production) per year. The electricity will be sold independently for 20 years, according to a purchase agreement signed with SENELEC.

It will comprise three engines and a combined cycle, representing nominal power of 53 MW and operate continuously. The new plant will be located on a site adjacent to the existing plant; this proximity means that some of the existing equipment can be reused.

The Extension consists of two engines representing nominal power of 33 MW designed to produce between 265 GWh (assuming a 91.5% availability, taking maintenance into account) and 290 GWh (maximum production) per year. The Extension will be located adjacent to the new 53 MW plant and within the permitted footprint, therefore requiring no additional land.

3.1.2 *Location of the Project*

The area in which the initial Project and the Extension will be installed is located within the Cap des Biches industrial area, in the town of Rufisque, in the department of the same name (see *Figure 3.1*).

The former plant (shut down since 2013) is located on 2.5ha of land, edged to the west by the SENELEC installation (see *Section 5.7.5* relating to the industrial context). The new 53 MW plant is being installed on 2.99ha of land, as shown in *Figure 3.2*. The extension will not have any additional footprint as the new engines will be installed on the previously authorised area of 2.99ha. This site comprises two parcels with different land registry statuses:

- A Non-Immatriculated Title (TNI) under the jurisdiction of the town of Rufisque (surface area: about 1.84ha); this land has been allocated to SENELEC (see Appendix 3) which was transfer it to ContourGlobal - Cap des Biches on a long lease, before the works phase.

- Land of around 1.14ha, which is part of the Public Maritime Domain (PMD); procedures to grant this land to SENELEC are with the Economy and Finance Ministry.

Figure 3.1 ***Location of the Project area: overview***

Source: *ERM, 2014* Satellite image: Bing, 2013.

Figure 3.2 ***Installation site for the 53MW power plant and the 33MW Extension***

Red: site of existing installations (2.5ha) / blue: new site for the initial project and its extension (2.99ha)
Source: *ERM, 2014.* Satellite image: *Bing, 2013*

3.1.3 *Description of existing ContourGlobal - Cap des Biches facilities (now shut-down)*

Inscription on the special classified facilities register

ContourGlobal - Cap des Biches owns a thermal power plant of a capacity of 52 MW (now shut down) situated at Cap des Biches in the town of Rufisque. The permit to operate the plant was granted to ContourGlobal - Cap des Biches by ministerial order n°006562/MEPN/MEMI/DEEC dated 19th August 1998 (see *Annex 4*), and electricity production began in December 2000. This power plant was shut down in 2013.

The installation is listed under number 4221 in the special register of classified installations

Current facilities' operating principles (now shut down)

The former power plant (now shut-down) was a combined cycle thermal power plant that could be operated using diesel or naphthalene. It comprised a combustion turbine (CT) associated with a steam turbine (ST) that could operate either in single cycle (CT only) with a capacity of 35 MW, or in combined cycle (CT + ST) with a maximum capacity of 52 MW. The site covers a surface area of 2.5ha and includes the following installations:

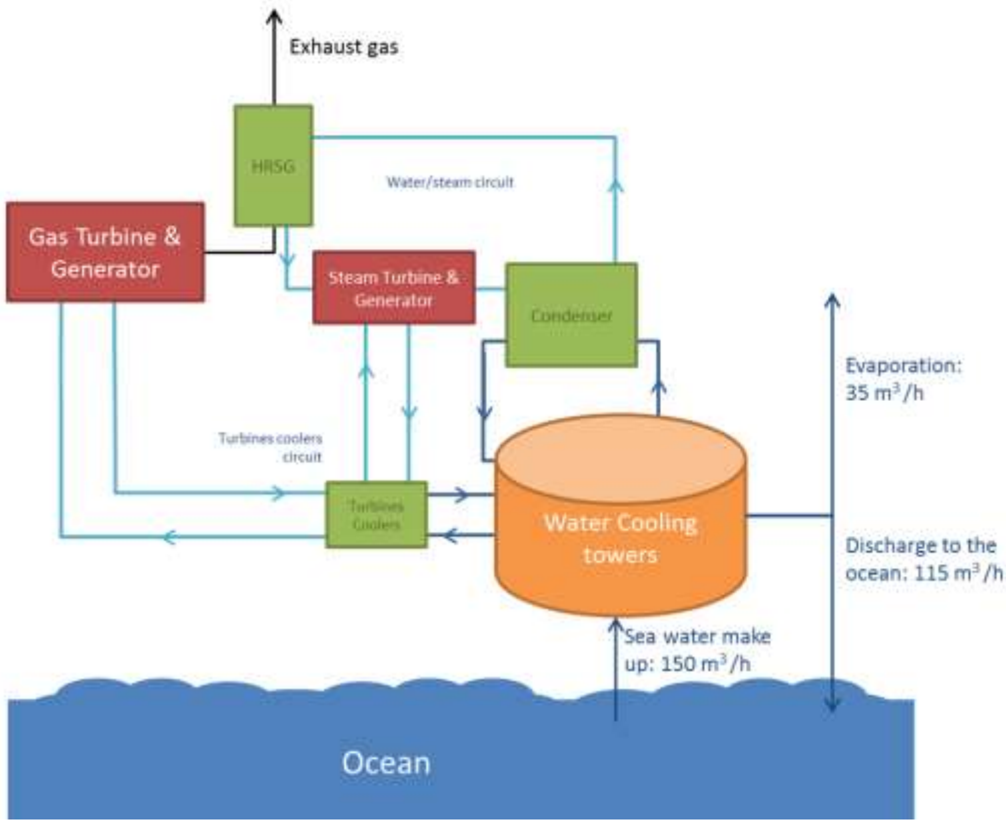
- Preparation installations: unloading and storage of fuel, raw water reservoir, and sea water pumping station.
- Production installations: combustion turbine (CT), connected to an alternator, steam turbine (ST), connected to an alternator, boiler collecting the heat from CT exhaust gases producing steam, ST cooling system using sea water, CT cooling system using air, combustion gases evacuation chimneys (one for operation in combined cycle and the other for single cycle operation).
- Auxiliary systems: water demineralisation and demineralised water storage unit, compressed air production unit, fire protection system, emergency electricity generator, water / oil separation system, prior to discharge into the sea.
- Post-production installations: 11/90 kV transformer and high voltage electricity station, for the evacuation of energy into the SENELEC network.
- Buildings comprising specifically: the control room, the electric auxiliaries' room, the protections room, operational offices, workshops, stores, chemicals warehouses.

During the operational phase, sea water required for cooling the ST was drawn from the canal bringing water to existing SENELEC plants and discharged through a discharge canal shared with the SENELEC plants. The location of these various facilities is shown in *Figure 3.3*; *Figure 3.4* shows the cooling principle used by the current plant during combined cycle operation phases.

Figure 3.3 Main facilities at the existing thermal power plant

Source: *ERM, 2014.* Fond cartographique: ©ArcGIS Online Basemap

Figure 3.4 Block diagram of the combined cycle cooling system – current plant now shut down



Source: *ERM, 2014*

Condition of current installations

The proximity to the ocean, which causes a corrosive salty atmosphere, as well as certain delays in the maintenance of installations, have led to rapid deterioration of the latter. Thus, the heat recovery boiler and the ST had to be shut down in March 2011 and the CT could only be maintained in operation with severe limitations.

In July 2013, the CT was completely shut down for safety reasons, investigations having shown major deterioration in several of the turbine rotations components. ContourGlobal - Cap des Biches then decided not to re-start production but to proceed with a complete update of the installations, in coordination with SENELEC.

3.1.4 *Planned rehabilitation*

The Project will reuse some of the equipment of the current plant, which will be rehabilitated so as to comply with current standards and good practice and to satisfy the Project's operational requirements. This equipment is as follows:

- The demineralised water production system
- Certain compressors for the production of compressed air
- Storage equipment: storage of fuel, storage of raw water, demineralised water and water for the firefighting system
- The transformer and connection to the electricity network
- The administrative buildings.

The other equipment required by the new plant and the extension will be installed on the adjacent site (see *Table 3.2*). The general map of existing facilities is presented in *Annex 5*; installations shown in grey correspond to existing equipment, whilst those shown in black will be installed for the Project; current equipment that will be reused is identified on the map.

3.1.5 *Compliance of existing facilities with Senegalese regulations*

An audit of compliance of existing facilities with Senegalese environmental regulations was undertaken by the Quartz Afrique office in March 2012, when the heat recovery boiler and the ST had already been shut down and the CT was operating intermittently in single cycle.

This compliance audit is provided in *Annex 6*. Considering the reduced activity of the power plant between March 2012 (completion date of the audit report) and July 2013 (date on which the plant was shut down), this audit is considered to be representative of the current condition of existing installations. This representativeness was checked by ERM during a visit to the site in 2014.

The 2012 audit comprised 2 levels of observation:

- observations of level A corresponding either to non-compliance in terms of Senegalese regulations, or to shortcomings that could lead to potential risks for workers, surrounding populations or, more generally, the environment (even if these shortcomings do not represent a non-compliance),

- level B recommendations, which are neither non-compliance in terms of Senegalese regulations, nor risks for workers, the public and the environment. In view of their non-regulatory nature, these level B observations have not been taken into account in this analysis.

As indicated in *Chapter 3.1.4*, only part of the equipment will be re-used for the full Project. *Table 3.1* below presents a synthesis of non-compliances that came to light during the 2012 audit, which are linked to the equipment to be retained for the Project. The other observations are not applicable to this current Project, since they concern either installations that will not be rehabilitated or management practices that concerned the plant's former configuration.

Table 3.1 Non-compliance with regulations of equipment from the current power plant to be re-used for the Project

Issue	Non-compliance	Corrective action proposed in 2012
Waste water management	No buffer tank for the storage of waste water prior to discharge into the natural environment.	Creation of a buffer tank.
	Results of water quality analyses not transmitted to the DEEC.	Transmission of water quality analysis results to the DEEC.
Contamination of the soil and sub-soil	No monitoring of soil and sub-soil contamination in the at-risk areas (fuel storage areas).	Evaluation of possible contamination of the soil and sub-soil. Implementation of a groundwater monitoring system, in case of accidental contamination.
Firefighting resources	Firefighting resources not entirely efficient.	Improvement of firefighting resources (foams, cooling rings).
	Internal organisation plan not up to date.	Up-date of the Internal Organisation Plan

Source: ERM based on the compliance audit carried out by *Quartz Afrique, 2012.*

3.2 DESCRIPTION OF THE PLANNED NEW THERMAL POWER PLANT

3.2.1 *Energy production system*

The 53 MW power plant will comprise a main building housing three combustion engines running on heavy fuel oil connected to an alternator and associated with a “Flexicycle” type combined cycle. The Flexicycle will recuperate the heat from the engines’ exhaust gases. After gradual reheating and passage through an evaporator, the steam generated will activate a turbine connected to an alternator, before being condensed and going back to the start of the cycle.

The 33 MW power plant extension will comprise a building housing two combustion engines running on heavy fuel oil connected to an alternator. One of the engines will be associated to a boiler that will be used for fuel (HFO) pre-heating.

The electricity generated will be sent to the existing electricity station, before being distributed using the electricity network already installed.

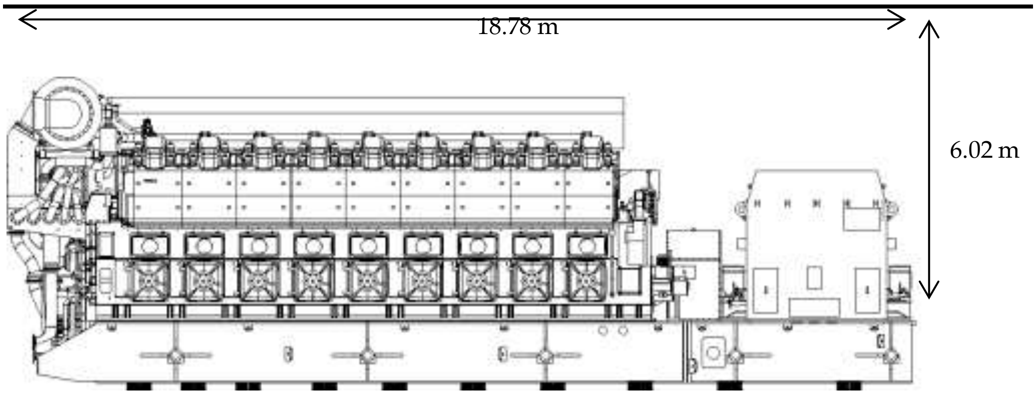
Main equipment

The main energy producing equipment at the ContourGlobal - Cap des Biches power plant will be:

- In total five Wartsila 18V46 type, supercharged, four stroke, semi-fast diesel engines (see diagram in *Figure 3.5*). These engines enjoy a very high performance rate (46.9% excluding the combined cycle), thus guaranteeing the lowest possible fuel consumption, and they will deliver individual effective power of 16.5MW. They will be fitted with radiators to cool the engine, air filters, intake silencers.
- The three engines of the initial Project (53MW) will be equipped with boilers to recycle heat before evacuation of combustion gases via the stack (Flexicycle – see below).
- One of the engines of the extension will be fitted with a boiler to pre-heat the fuel (HFO).

- A Flexicycle (linked to the initial three engines) that comprises a 3.5MW steam turbine, use of which results in a 50.2% energy performance rate. The Flexicycle comprises the following equipment :
  - A boiler including a superheater, an evaporator and a tank for storing steam; the boiler can be used to recuperate the heat from the engines’ exhaust gases and convert it into steam.
  - A steam turbine connected to an alternator, activated by the steam produced by the boiler, and
  - A condenser, used to transform water from the Flexicycle from steam to liquid, after passing through the turbine; the liquid water then returns in a closed cycle to the boiler.

Figure 3.5 ***Diagram of a Wartsila 18V46 type engine***



Source: *Wartsila, 2014*

The main equipment at the power plant is presented in *Table 3.2*.

Table 3.2 ***Main equipment at the planned ContourGlobal - Cap des Biches thermal power plant (53MW + 33MW)***

Description	Characteristics of the main components
Energy production system	5 engines of a unit power of 16.5 MW 1 3.5MW steam turbine
Storage in tanks	Heavy fuel oil • Two 1 450 m^3 storage tanks; these tanks are the ones from the existing power plant • One 3 000 m^3 tank • One 50 m^3 intermediate tank • One 100 m^3 day tank • One additional 2 000 m^3 tank for the Extension • One additional 80 m^3 day tank for the Extension • One additional 35 m^3 intermediate (buffer) tank Diesel: • One 120 m^3 tank; this is equipment from the existing power plant • One 100 m^3 tank • One additional 80 m^3 day tank for the Extension Water: • Firefighting water: 700 m^3; this is equipment from the existing power plant • Raw service water: 150 m^3 • Demineralised water: 100 m^3; this is equipment from the existing power plant • One maintenance water (cooling system): 10 m^3 • One additional maintenance water tank (cooling system) for the extension: 10 m^3 • Water for cleaning the boilers: 5 m^3 • One additional water tank for cleaning the boilers for the extension: 5 m^3 Effluents: • Water contaminated by hydrocarbons from the

Description	Characteristics of the main components
	deoiler: 50 m³ • One additional oily water buffer tank for the extension: 50 m³ • Sludge: 80 m³ storage tank Oils • New lubricant: 35 m³ • Used lubricant: 25 m³ • Maintenance lubricant service tank: 16 m³
Water supply and treatment	Buried pipe, managed by the SDE(*) Water treatment system (demineralisation)
Combined cycle	3 boilers (one per engine of the 53 MW plant), 1 steam turbine, 1 boiler for one of the engines of the extension (used for HFO heating) 1 condenser.
SENELEC electricity station	Main transformer (existing): 11 kV / 90kV(*)
Other equipment	Loading / unloading area Unloading area Centrifuge (initial treatment of the heavy fuel oil) Firefighting system Administrative buildings Maintenance workshop Warehouse One additional warehouse for the extension Canteen Laboratory Liquid effluent treatment system Cooling: closed circuit cooled by air

Source: *Wartsila, 2014 and 2016*

The ContourGlobal - Cap des Biches power plant, whose water requirements are mainly linked to the diesel engine cooling system, to the Flexicycle "water / steam" circuit and to its cooling system, as well as to drinking water consumption, will be supplied with water from a buried pipe with an output of 125 m³/day for the 53 MW plant. An additional 20m³/day will be required for the 33MW extension. This pipe already exists and will not require any modification linked to the Project.

The layout of these various buildings within the area covered by the project is shown on the general layout map given in *Annex 5*.

In addition, a temporary area will be laid out during the construction phase in order to store the various materials and equipment necessary, as well as for the concrete plant. This area will be fenced around its entire perimeter and located within the area covered by the power plant.

Characteristics of the stacks

For the initial Project, there will be three stacks with identical characteristics, located alongside each other (one stack per combustion engine). Two additional stacks will be added for the Extension.

The characteristics of the stack as well as the emission parameters of the associated atmospheric emissions (temperature and speed) are show in *Table 3.3*. These characteristics have been defined with a concern to optimise correct dispersal into the atmosphere. The characteristics are reflected in the modelling of atmospheric emissions presented in *Chapter 8.5.*

Table 3.3 Main characteristics of the stacks

Project of reference	Number of stacks	Height of the stack	Internal Stack diameter	Emission temperature	Emission velocity
	[number]	[m]	[m]	[°C]	[m/s]
Initial 53MW power plant	3	40	1.6	180	21.6
Extension 33MW (engine with boiler)	1	40	1.6	253	25
Extension 33MW (engine without boiler)	1	40	1.6	358	30

3.2.2 *Taking account of environmental issues and design optimisation*

The design of the ContourGlobal - Cap des Biches power plant has taken environmental topics into account, with the aim of achieving equilibrium between environmental performance, energy performance and the investment cost of the Project.

For the 53 MW power plant the integration of a combined cycle, associated with engines of recent design and with a high energy performance rate (around 47%) will thus optimise atmospheric emissions.

Moreover, the Wartsila combustion engines will be designed to be able to operate on natural gas (replacing the heavy fuel oil), as soon as this type of fuel is available in Senegal, thus permitting optimisation of costs and atmospheric emissions.

Concerning noise levels, the engines have been designed by Wartsila to have low noise emissions. The following improvements have also been included right from the design of the power plant in order to reduce noise levels:

- Silencer on the exhaust output,
- Absorbent panels on the walls of the building, and
- Air inlet and output fitted with noise captors.

3.2.3 *Fire protection system*

The fire protection system at the site will comply with national requirements and international standards. It will comprise the following elements:

- Fire alarms and visual signals in noisy areas;
- Smoke detectors ;
- 700 m^3 extinction water storage tank ;
- Fire hydrants with an output of 1 500 L/min located all around the heavy fuel oil storage area;
- Sprinklers in the machine room;
- Various water outlets located across the site; and
- Portable extinguishers suitable for the type of fuel (CO_2, powder…).

The nearest fire station is located in Rufisque, less than 3km away; this proximity to the plant means that firefighters could be quickly on the scene. Relations between the Project and this fire station will be the object of a detailed analysis in order to draw up the intervention plan for the new ContourGlobal - Cap des Biches power plant.

The fire system for the initial power plant was designed with some over-capacity, which is considered adequate to cover the extension of the project as well.

3.3 *DESCRIPTION OF THE EQUIPMENT*

3.3.1 *Laboratory, workshops and storage areas*

The storage buildings and maintenance workshop are located between the energy production area and the SENELEC transformer station. They comprise the following:

- Domestic installations: separate male / female changing rooms, showers and toilets;
- Laboratory ;
- Storage areas for the machine tools and spare parts;,
- Work areas fitted with a welding unit and machines such as a lathe, mill, drill, press;
- Electrical equipment maintenance workshop ; and
- Test room for fuel injectors.

3.3.2 *Administrative building*

The administrative building located between the tanks area and the transformer station comprises office areas, a kitchen and a canteen, as well as toilet facilities.

3.3.3 *Access road*

The access road to the existing power plant is asphalted. In view of the location of the new installations, in immediate proximity to the existing power plant, this access road will be reused for the new plant. No major road works will therefore be necessary for implementation of the Project.

3.3.4 *Unloading and settling area*

Fuel Supply

ContourGlobal ensured fuel supply through a contract with the African Refining Company (*Société Africaine de Raffinage* - SAR) via an HFO pipeline. The technical details of this new pipeline are not yet completely finalized. However, it is noted that:

- It will be a short length pipeline, from the existing SAR pipeline passing along the eastern limit of the industrial area of Cap des Biches, to reach ContourGlobal's power plant.

- This pipeline will not go through residential areas or areas used by the local community; its construction will not induce resettlement.

- The pipeline will be maintained to ensure its integrity.

- As part of its emergency response plan, ContourGlobal will develop procedures to respond to any incident involving the pipeline (hydrocarbon leak, fire, etc.).

Fuel oil storage after delivery

Once unloaded, the heavy fuel oil will be stored in the 3 000 m^3 tank, before being treated by centrifuge and then stored in one of the two 1 450 m^3 tanks and the new 2 000m^3 storage tank as well. This mechanical treatment will fluidify the fuel by extracting some of the residue (sludge) present and thus make engine operation more reliable.

3.3.5 *Electric installations*

The new facility will reuse some of the electrical equipment from the existing plant to export the electricity produced and also to import electricity to the site in case of stoppage. The existing electrical equipment that will be reused for the full 86 MW plant are the 11/90 kV transformer and the high voltage station for connection to the SENELEC network (see *Section 3.1.3*).

In addition, new electrical equipment to be installed in the new installation is as follows:

- Connections with the existing electrical system (11/90 kV transformer),

- A low voltage station (0.4 kV) for the plant auxiliary equipment, including a 500kW cold re-start up unit;
- An electrification system for the new installations (buildings, unloading area and storage area, etc.) and lighting;
- A fire detection system ; and
- A gas detection system.

3.3.6 *Compressed air*

Compressed air will be generated, distributed and stored at a pressure of 30 bars in order to be used on start-up of the diesel engines. Pressurised equipment will be designed, manufactured and tested according to the Directive on pressurised equipment.

The system comprises:

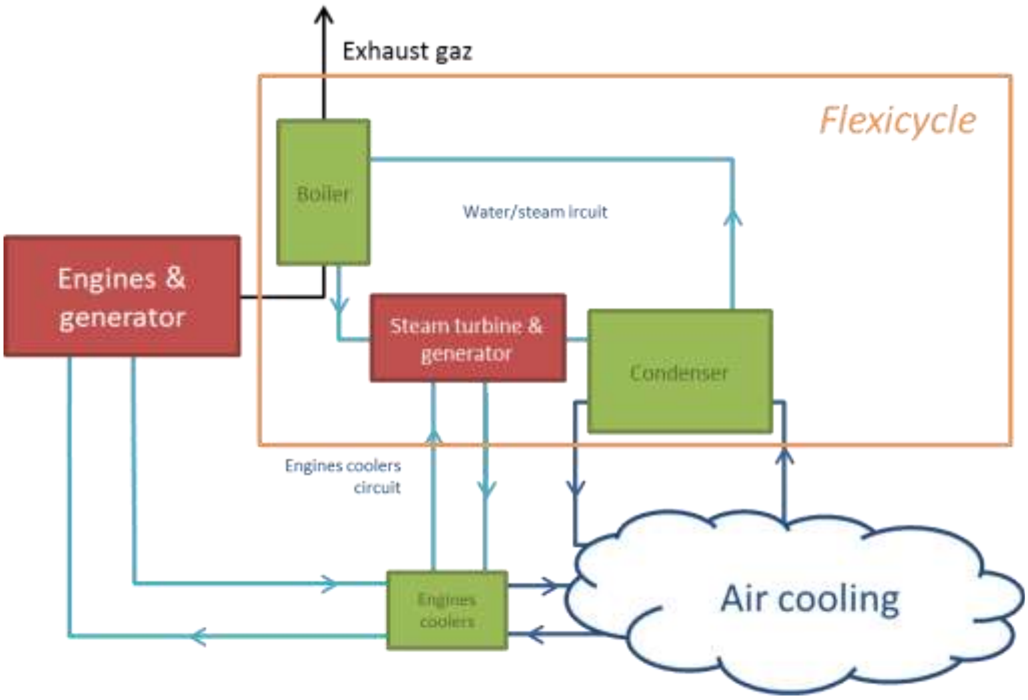
- A double air compressor,
- A compressed air storage tank,
- A pneumatic start-up system for the engines, air treatment equipment and systems, and
- Piping and valves.

3.3.7 *Cooling system*

The new power plant will be equipped with two cooling systems: an air cooling system (radiators) for the Wartsila combustion engines and an air cooling system for the Flexicycle condenser. The extension engines will also be fitted with radiators for cooling.

The principles of the cooling system to be used in the new power plant is summarized in *Figure 3.6* below.

Figure 3.6 ***Block diagram of the combined cycle cooling system - planned power plant***



Source: *ERM, 2014*

Engine cooling

The system at the full power plant (86MW) will comprise:

- One cooling radiator per engine,
- One tank of fresh water for maintenance (10 m³) for the initial Project and one tank of water for maintenance (10 m³) for the extension, and
- Piping and valves.

Condenser

The Flexicycle condenser will ensure that water from the combined cycle transits from steam (output from the turbine) to liquid , before passing again through the boiler (and again being turned to steam). This change of state in the condenser will take place by indirect contact (through a fine metallic wall) of the steam with colder ambient air. Air inlet temperature will be 27ºC and output temperature will be 38ºC.

3.3.8 Site boundary with ONAS

A wall of packed dirt was built at the north-eastern site boundary (see *Figure 3.7* and *Figure 5.25*) to prevent surface water runoff from ONAS waste water treatment plant and the slaughterhouse to contaminate the Project area with biodegradable waste and sewage. This wall prevented other spill events.

Figure 3.7 Boundary with ONAS Wastewater Treatment Plant: Wall of Pack Dirt

Source: ERM, 2016

3.3.9 *Communication and surveillance system*

The power plant will be equipped with a cutting edge communication and surveillance system comprising:

- A system for the control and surveillance of the entire power plant ; this system will be centralised in the control room and will comprise on the one hand an autonomous control system for the power plant and on the other a system for the surveillance and acquisition of data.
- Supervision systems using security cameras and internal and external communication systems.

3.3.10 *Compliance of existing facilities regarding the Senegalese regulation*

The equipment to be installed as part of the Project will comply with the Senegalese regulation. Existing facilities to be reused will be improved with an aim of complying with the regulation, as highlighted in the compliance audit study undertaken in 2012 (cf. *Chapter 3.1.5*). An analysis of the needs of modification is presented in the *Table 3.4* below (based on the 2012 audit).

Table 3.4 Compliance requirements of the existing equipment

Theme	Non-compliance	Corrective actions proposed in 2012	Planned corrective actions
Wastewater management	No buffer tank for storing wastewater before discharge into the natural environment	Creating a buffer tank	Buffer tank planned (cf. *Chapter* 3.6.5)
	Non-transmission of the results of water quality analysis to the DEEC	Transmitting the results to the DEEC	Results will be transmitted as presented in the ESMP (cf. *Chapter 10.7*)
Surface and subsurface contamination	No monitoring of the potential surface and subsurface contamination within the fuel storage area	Assessment of the potential contamination. Setting up of a subsurface monitoring plan, in case of accidental leakage	A Piezometer will be installed in order to monitor groundwater and to detect any potential contamination
Firefighting capabilities	Firefighting equipment not fully efficient	Improvement of firefighting capabilities	Firefighting systems and equipment will be improved
	Internal Operation Plan (IOP) to be updated	Update of the IOP	A new IOP will be undertaken

3.4 PROJECT TIMETABLE

The Project's provisional timetable, developed by ContourGlobal - Cap des Biches in collaboration with SENELEC, is ambitious. For the 53 MW plant, it planned for construction works to start at the beginning of 2015 and commissioning in May 2016. Production will start immediately after the test period. For the extension, construction is expected to start in March-April 2016, and commissioning in September 2016 (over 6 months of construction).

3.5 CONSTRUCTION PHASE

3.5.1 Equipment

Origin of raw materials

Most of the raw materials (steel, cement) and other materials (anti-noise panels…) will be brought from Dakar by truck. Technical equipment such as the engines, boilers, auxiliary transformers and the steam turbine will be delivered via the port of Dakar by suppliers, mainly Wartsila, from Europe.

Hazardous materials

The main hazardous materials required during the construction phase will be the following:

- Inflammable paints, solvents and dilutants ;
- Pressurised gases ;

- Fuels containing oil derivatives ;
- Chemicals used to clean pipes ; and
- Other materials according to the waste products classification contained in current regulations.

The list of hazardous materials used at the site and the relevant Material Safety Datasheets (MSDS) will be available to employees at all times. The use of hazardous materials will be restricted to authorised staff who have received the necessary training and protective equipment.

Hazardous materials will be stored in the areas designated for this purpose and will be handled in compliance with the MSDS.

3.5.2 *Transport*

Deliveries of raw materials and equipment, as well as staff movements from and to the site will cause the traffic referred to in *Table 3.5* below. In all, 1 to 30 vehicles per day will run at the site during peak activity times.

Table 3.5 Traffic expected at the site during the construction phase (maximum)

Deliveries	Approximate numbers of vehicles expected
Materials required to make concrete – cement, gravel, sand	2 deliveries per day on average for 6 months - 4 deliveries per day during peak activity times.
Steel and pipes	Up to 3 deliveries per day for 2 months (these should begin 3 to 4 months later than the concrete production activities)
Technical equipment	6 deliveries for the engines 3 deliveries for the boilers 1 delivery for the turbine 1 delivery for the transformers About 150 deliveries for tank construction and assembly materials
Various	1 to 10 deliveries per week
Staff transport	5 to 15 buses per day (workers) Up to 2 to 40 cars per day (managers, management staff and sub-contractors)

Source: ContourGlobal - Cap des Biches, 2014 and 2016

Deliveries of equipment and materials will not take place during the night and will be planned as far as possible outside the times of day when traffic is at its highest level (between 7:30am and 9am and between 4pm and 6pm).

3.5.3 *Human and logistics resources*

Construction work will be carried out by a main sub-contractor in charge of project management. He will supervise several other sub-contractors performing the various other work.

Staff numbers and working days are described below:

- On average, 84 workers will be on site every day, including about 20 expatriates.

- During peak activity times, up to 200-250 workers will be on site.

- The standard working day will start at 7am and end at about 6pm, to avoid staff journeys coinciding with school times (from 8am in the morning through until 12.30pm-1.30pm and even 4pm some days).

- The standard working day will last between 8 and 10 hours. The working day may occasionally exceed the times described above, when certain tasks have to be carried out without interruption (e.g.: pouring concrete…).

- A typical working week will last 6 days, from Monday to Saturday (with the exception of certain weeks during which some tasks cannot be interrupted).

The recruitment of local workers will be preferred insofar as the skills required are available within the Municipality of Rufisque Ouest. This local preference will be implemented by means of the application of a specific, adapted staff hiring policy.

The transport of staff and materials will mainly use Route Nationale 1 and Autoroute 1 (Highway 1) from Rufisque and Dakar as far as the installation site in Cap des Biches.

No employee accommodation is planned at the site. The construction site will be closed at night, for safety reasons. Employees living in neighbouring communities will continue to live at home and will travel to the site every day. Sub-contractors will organisers shuttle buses for their employees. This will reduce traffic on local roads as well as associated road travel risks.

The specialist employees who work at the site for short periods, as well as site management and managerial staff will be housed in Dakar; they will travel by car to the site every day.

Health and Safety of work force

The construction phase will be managed by Wartsila on behalf of ContourGlobal - Cap des Biches. A health / safety / environment management plan has been specifically developed for this Project.

3.5.4 *Water supply and consumption*

During the construction phase water will be used for the following:

- domestic and sanitation use ;
- concrete unit ; and

- sprinkling on the ground to avoid dust clouds from the construction work and when vehicles travel past.

The water will come from the existing SDE (Sénégalaise des Eaux) pipe in the existing power plant.

For the 53MW plant, the amount of water required for the production of the 2500 m^3 of concrete required for the power plant is estimated in more than 900 m^3. The same amount can be assumed as a conservative figure for the 33MW Extension.

Amounts required for domestic purposes and the prevention of dust clouds have been estimated as follows, based on data from similar projects:

- over 1000 m^3 water for sanitation purposes; and
- over 100 m^3 water for washing equipment and preventing dust clouds.

In all, over 6 100 m^3 water should be consumed during the construction phase.

3.5.5 *Management of emissions, effluent and waste products*

Atmospheric emissions

During the construction phase, atmospheric emissions will be mainly linked to the dust generated by the various activities such as clearance of the site, concrete mixing and the passage of vehicles on non-asphalted roads.

Vehicle engines and site machinery will also generate discharge into the atmosphere. Fuel consumption by the diesel engines of vehicles used cannot be quantified as yet and will evolve over the course of the construction phase. The atmospheric emissions of diesel engines will, however, be proportional to the emissions factors produced by the OGP (Oil and Gas Producers Association, formerly the Exploration and Production Forum) and presented in *Table 3.6*.

Table 3.6 ***Emission factors of a diesel engine***

Pollutant	Emission factors (tons emitted / tons burned)
CO_2	3.2
CO	0.019
NOx	0.07
N_2O	0.00022
SO_2	0.008
CH_4	0.00014
COV	0.0019

Source: *Methods for estimating atmospheric emissions, E&P Forum, 1994*

More details on the project's atmospheric emissions during the construction phase are provided in *Section 8.5* (modelling of atmospheric emissions).

Noise

Noise emissions linked to the construction activities will issue mainly from site preparation works (land clearance, soil preparation and excavation), structural works and equipment installation.

Table 3.7 below shows noise levels for typical site equipment according to British standards (BS, *British Standard*) "*Noise and vibration control on construction and open sites, BS 5228* (1)".

Table 3.7 Acoustic performance of equipment – construction phase

Equipment	Level of acoustic pressure at 10m [dB(A)]
Site preparation	
Chain excavator	79
Bulldozer	81
Wheel loader	68
Roller	76
Steam roller (*road planer*)	82
Asphalt surfacer	84
Dump truck	87
Civil engineering and installation works	
Concrete mixer truck	80
Concrete pump	77
Tower crane	77
Mobile crane	82
Fork lift truck	67
Motorised compressor	75
Generator	74
Worksite truck	87

Source: ERM based on standard BS 5228 *Code of good practice for basic information and procedures to control noise and vibration.*

More details on the estimated levels of noise generated during the project construction phase are provided in *Chapter 8.7* (Noise modelling).

Aqueous effluent

During construction, the various flows of aqueous discharge will be as follows:

- Waste sanitation water
- Water used for washing equipment (truck, concrete mixing unit)

(1) British standard BS 5228: *Code of Practice for Noise and Vibration Control on Construction and Open Sites, Part 1: Noise. BSi, 2009*).

- Rain water.

Discharge of used sanitation water from the temporary buildings (toilets, etc.) and from permanent installations (showers, canteen, toilets…) will be collected and stored in a temporary septic tank during the construction phase. This will then be replaced by a permanent septic tank to be used when the plant is in operation. It is estimated that over 230 m^3 of waste sanitation water will be generated every month during work at the site and gradual start-up of the engines. The septic tank will be emptied by an approved service provider.

Rain water will be separated from any possibly contaminated water by means of a drainage system that will be connected to the discharge canal used by the SENELEC power plants (adjacent to the installation). Discharges of water will comply with current regulations (notably standard NS 05061[(1)]). Rain water may potentially contain MES (matter in suspension) due to site activities or hydrocarbons should any accidental spillage occur.

Waste products

The main waste materials generated during the construction phase will be as follows:

- Excavated soils and materials excavated corresponding to the foundations of the main buildings
- Domestic waste
- Packaging of construction materials and raw materials (cement bags, wooden chests, etc.)
- Materials resulting from structural works (excess concrete, …)
- Greasy waste, batteries, empty drums and other specific waste materials.

Concerning the excavated soils, volumes should be relatively small in view of the level topography and absence of any basements in the buildings (relatively small foundations). Some of the excavated soil can be used for levelling the land. The sub-contractor with responsibility for civil engineering will be contractually responsible for dealing with the soils and will contact the local authorities for details of places where the deposit of excavated materials is authorised.

Waste materials will be sorted according to their origin and treatment methods, this will avoid contact between incompatible waste materials and will permit inspections for the detection of leaks and spillages. The waste materials storage area will be waterproofed and covered to avoid the waste materials coming into contact with rain water. In addition, the area used for the storage of hazardous materials will be fenced and signs will be displayed to prevent access by authorised people and thus minimise any risk of accident.

[1] NS 05-061.- Waste water – discharge standards.- 2001.-22p

According to feedback from similar projects, volumes of special / dangerous materials produced during the construction phase should be low, and most of the waste materials produced can be easily reprocessed via existing facilities. Moreover, over 200 m^3 of ordinary waste materials, (i.e. ten truck loads) will be generated every month.

In all cases, the collection of waste materials generated during the power plant construction phase will be managed by an approved service provider and will comply with current regulations. Special / hazardous waste materials will be evacuated to specialised facilities.

3.6 OPERATIONAL PHASE

3.6.1 Human and logistics resources

The plant will operate 24h/24 for most of the year, with employees working in shifts, 3 x 8h. ContourGlobal - Cap des Biches will employ 35 to 45 workers on a permanent basis. For the extension it is expected that 10 to 12 additional employees will be present on site. Unqualified or semi-qualified staff (cooks, security officers, cleaners…) will represent about 10% of all staff. Staff will be hired by ContourGlobal - Cap des Biches as far as possible from amongst inhabitants of the municipality of Rufisque Ouest.

Employees will be housed at their own expense in the surroundings and in the nearest towns. Employees will travel to the site every day, using their own resources.

Health and Safety of work force

ContourGlobal - Cap des Biches will develop for its own employees, a specific health and safety policy based on the H&S policy of Contour Global that is presented in *Annex 7*.

3.6.2 Traffic

Traffic caused by site operations will be mainly generated by staff and visitor travel to the site in light vehicles (between 20 and 30 per day, depending on the time of year) and the delivery of fuel oil by truck (see below).

3.6.3 Fuel oil supply and consumption

Supply

The option adopted for HFO supply is the installation of a pipeline from the existing SAR's pipeline. The unloading area will remain operational and will be used for LFO supply (used during the starting phases of the power plant). LFO supply will be very limited, and will be realized by trucks travelling from the refinery that is located a few kilometres away.

Unloading area

The unloading area is designed to allow for arrival of the truck at the discharge pump, unloading and exit to take place along a loop, without the need for the truck to carry out any particular movements. This limits the risks of accident.

The unloading area is fitted with safety equipment such as fire hydrants, level gauges, and a shelter over the various equipment and the truck and channels to direct rain water and any leaks towards a hydrocarbons separator.

Specifications relating to heavy fuel oil

The heavy fuel oil used will comply with current regulations. (Decree repealing and replacing decree n°2011-650 of 26th May 2011 setting out the specifications applicable to refined hydrocarbons). *Table 3.8* presents the properties of the fuel oil according to the design of the thermal power plant and the values specified by current regulations.

Table 3.8 Main properties of the fuel oil before treatment (same for 53 MW power plant and 33MW extension)

Parameter	Limit	Value accepted by the engines	Value specified by current regulations*	Reference method
Density at 15°C	max.	950 to 1010 kg/m³	991 kg/m³	ISO 3675 or 12185
Viscosity at 50°C	max.	380 Cst	380 Cst	ISO 3104
Flash point	min.	60 °C	65°C	ISO 2719
Pour point	max.	30 °C	30°C	ISO 3016
Water	max.	0.5 % vol.	0.5 %	ISO 3733 or ASTM D6304-C
Sulphur	max.	4.5 % mass.	2%	ISO 8754 or 14596
Hydrogen sulphide	max.	2 mg/kg	-	IP 570
Acidity index	max.	2.5 mg KOH/g	-	ASTM D664
Ash	max.	0.15 % mass	0.140%	ISO 6245 or LP 1001
Vanadium	max.	450 mg/kg	350	ISO 14597 or IP 501, IP 470
Carbon residue	max.	20 % mass	18%	ISO 10370
Sodium	max.	100 mg/kg	100 mg/kg	IP 501 or IP 470 ISO 8218
Asphaltenes	max.	14 % mass	8%	ASTM D3279 T-60115
Total existing sediments of old fuel oil	max.	0.10 % mass	0.14 %	ISO 10307-2
Calcium	max.	30 mg/kg	30 mg/kg	IP 501 or 470 ISO 8220
Zinc	max.	15 mg/kg	15 mg/kg	IP 501 or 470 ISO 8221
Phosphorus	max.	15 mg/kg	-	IP 501 or 470

Parameter	Limit	Value accepted by the engines	Value specified by current regulations*	Reference method
Aluminium and silicium	max.	60 mg/kg	60 mg/kg	ISO 10478 or IP 501, IP 470

* Decree repealing and replacing decree n°2011-650 of 26th May 2011 setting out the specifications applicable to refined hydrocarbons
Source: ERM, 2014 and 2016 based on Wartsila, 2014 and 2016 and the decree repealing and replacing decree n°2011-650.

The final composition of the fuel oil to be used has not yet been defined at this point in the project. Nevertheless the fuel oil used will have a maximum sulphur concentration of 2% in compliance with the new current Senegalese regulations and with international recommendations. It is interesting to point out that according to feedback on the current quality of heavy fuel oil in Senegal, sulphur concentration in fuel oil can generally vary between 1% and 1.33%. However, using a prudent and conservative approach, sulphur concentration considered in this impact study is 2%.

Compliance with these quality standards will guarantee that atmospheric emissions from the power plant comply correctly with the builder's data, as taken into account in the analysis of impacts on air quality (see *Section 8.5*).

The heavy fuel oil will be treated by centrifuge before being stored in the day storage tanks. This mechanical treatment will fluidify the fuel by extracting some of the residue (sludge) present.

Use of light fuel oil (domestic fuel oil)

Similarly, light fuel oil will be used as start-up fuel. Delivery will be made in 30 ton trucks from local refineries (about 6km away). The trucks will only use main roads and will not go through the town of Rufisque. The site will receive a delivery approximately once a month. Unloading will take place under the same conditions as those described above for heavy fuel oil.

The domestic fuel oil will be stored in an existing 120 m^3 above-ground tank and then sent to a new 100 m^3 day tank designed to operate for about 8 hours at full engine power. A new 80m^3 LFO day tank will be constructed for the Extension.

The tanks for heavy and light fuel oil will be located in the same park. The tanks' park will be fitted with a retention that will be designed to contain 110% of the capacity of the largest tank, i.e. a capacity of 3 300 m^3.

Fuel consumption

Daily consumption of heavy fuel oil is estimated at about 260 tons/day for the 53MW plant and 160 tons/day for the 33MW extension.

Light fuel oil will only be used during the engine start-up phase after a stoppage. Consumption of light fuel oil will be very limited.

Fuel oil storage capacity

Total storage capacity for heavy fuel oil at the site will be 8 165 m^3, which corresponds to consumption over 20 days. The tanks will be full when the plant is started up and will then be continuously refilled by daily deliveries.

The total storage capacity for light fuel oil at the site will be 300 m^3.

Natural gas

As explained in *Section 3.2.1*, the new Wartsila engines can be easily converted to operate on natural gas, when this type of fuel is available in sufficient quantity and quality in Senegal. This will optimise costs and reduce atmospheric emissions.

This future alternative is outside the framework of this impact study. Conversion of the engines to natural gas will be the object of prior consultation with the Senegalese authorities, in compliance with applicable regulatory requirements.

3.6.4 Water supply and consumption

Water consumption

During the operational phase of the full 86 MW plant, water use will be as follows:

- Flexicycle steam turbine
- Fire protection system
- Domestic and sanitation usage (toilets, showers, cooking…)
- Cleaning of floors and equipment
- Cooling systems (maintenance water).

The steam turbine will represent about 60% of daily consumption. The remaining 40% will be divided between the other headings (including domestic consumption). Industrial requirements (mainly the turbine) are estimated at 3 m^3/hour on average (72 m^3/day). It should be noted that the cooling system planned for the new power plant greatly reduces the consumption and discharge of cooling water, in comparison with the cooling system used by the former power plant (pumping and direct discharge of sea water). For the extension approximately 20 m^3/day of water will be required.

Other requirements should, for their part, be close to 50 m^3/day.

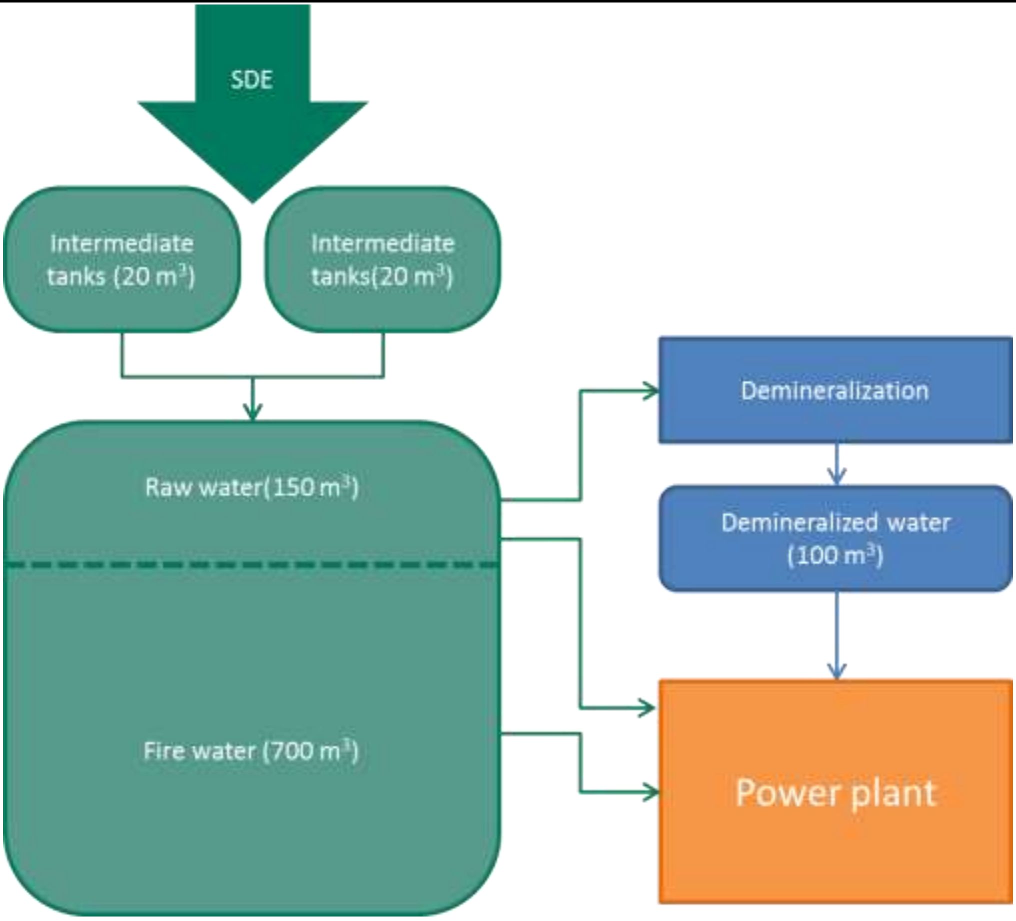
In total, daily consumption of the power plant in operation should not exceed 140 m^3.

Storage and supply

Raw water from the pipe in the SDE network, will be temporarily stored in two 20 m^3 buffer tanks intended to mitigate potential variations in pressure and output from the SDE network.

About 850 m^3 of raw water will be stored at the site, mainly for the fire protection system (700 m^3). A 100 m^3 tank will also be used for the storage of demineralised water, prior to use in the electricity production process. Distribution of water to the various different buildings and equipment will take place by means of buried pipes. A diagram of this organisation is provided in *Figure 3.8*.

Figure 3.8 ***Principles of water supply and storage***



Source: *ERM, 2014*

Demineralization process will use existing equipment, which will be improved and bring up to the Senegalese standards; the process will include the following equipment:

- mechanical sand filters containing silicone dioxides;
- activated carbon filters; and

- reverse osmosis equipment with ion exchange membranes

The demineralization system will consume hypochlorite (ClO), hydrochloric acid (HCl) and sodium hydroxide (NaOH).

3.6.5 *Management of emissions, effluent and waste materials*

Atmospheric emissions

Atmospheric emissions will be mainly those resulting from the combustion of fuel oil:

- particles (including the inhalable fractions PM10 and PM2.5 are taken into account in this ESIA under the generic term of PM)
- sulphur dioxide (SO_2)
- nitrogen oxides (expressed in NOx and NO_2) and
- carbon monoxide (CO).

Section 8.5 "Impact on air quality" provides a quantification of these emissions, as well as a study of their dispersal in the atmosphere after discharge.

Noise

Once started up the power plant will operate continuously, with the exception of production stoppages for maintenance reasons. The main sources of noise are:

- generating sets (18V46 engines, generators) ;
- transfer pumps
- the hydrocarbon separator
- the fuel oil discharge pump
- radiator ventilators
- the machine room
- air outputs and ventilation systems
- water condensers
- transformers

Section 8.7 "Impact on ambient noise" provides more detail on sources of noise linked to the project and a quantification of noise emissions, notably through the modelling of noise levels carried out based on technical documents relating to the design of the power plant obtained from ContourGlobal - Cap des Biches and Wartsila.

Aqueous effluent

After start-up, the various types of aqueous discharge will be as follows:

- Used sanitation water ;

- Rain water ; and
- Industrial water, mainly from purging the cooling system, the steam turbine and the hydrocarbons separator.

Used sanitation water will be collected in a septic tank. In view of the number of employees (about 45 people), monthly volumes of used sanitation water have been estimated at 30 m^3; the septic tank will therefore have to be emptied about twice a month and its contents will be eliminated by an approved service provider.

Rain water not likely to be contaminated will be collected by the drainage system. The drainage system is designed on the basis of rainfall intensity (50-100 mm/15 min), coherent with local rainfall data. The new drainage system will be connected to the existing drainage system and rain water collected will be discharged via the SENELEC discharge canal (western edge of existing installations).

Used water likely to be contaminated, i.e. industrial water and potentially contaminated rain water (e.g. rain water from the storage area), will be collected, directed and treated by the effluent treatment station by dissolved air floatation in two stages. During the first stage, the deoiler will separate the emulsified oil and the heaviest solid matter in suspension in the water. The oil will be transferred to a tank for recuperated oil, to be eliminated.

The separated part of the water will be pumped in a floatation device and treated in the physicochemical section in several stages:

- A floculation stage ;
- Addition of sodium hydroxide (NaOH); and
- Injection of coagulant.

The addition of hydroxides keeps the water within the right pH bracket and ensures an optimised coagulation process. The hydroxide also reacts with the coagulation iron. The iron hydroxides agglomerate the neutralised solids in suspension and the soluble hydrocarbons. Small flakes are then formed and, because their density is over 1kg/dm^3, they form sediment naturally.

The sludge that forms will then be transferred to the sludge reservoir (80 m^3) before being eliminated by an approved provider. The daily output of sludge will be about 0.77 m^3 (*Wartsila, 2014*).

Discharge of treated water (station output) will take place through the SENELEC discharge canal located at the edge of the land. According to the characteristics and size of the treatment unit provided by the builder (Wartsila), treated water will comply with the specific World Bank Group's specific environmental, health and safety directives, 2008. The water will be sampled on a regular basis for analysis purposes at the station output in order to check on compliance of the water discharged into the natural environment with Senegalese limit values (standard NS 05061[1]) and with World Bank Group values. In case of non-compliance, waste water will be treated again, passing again through the station's treatment process. *Table 3.9* below presents the values for discharged, treated water guaranteed by Wartsila. The block diagram for liquid effluent treatment is presented in *Figure 3.9*.

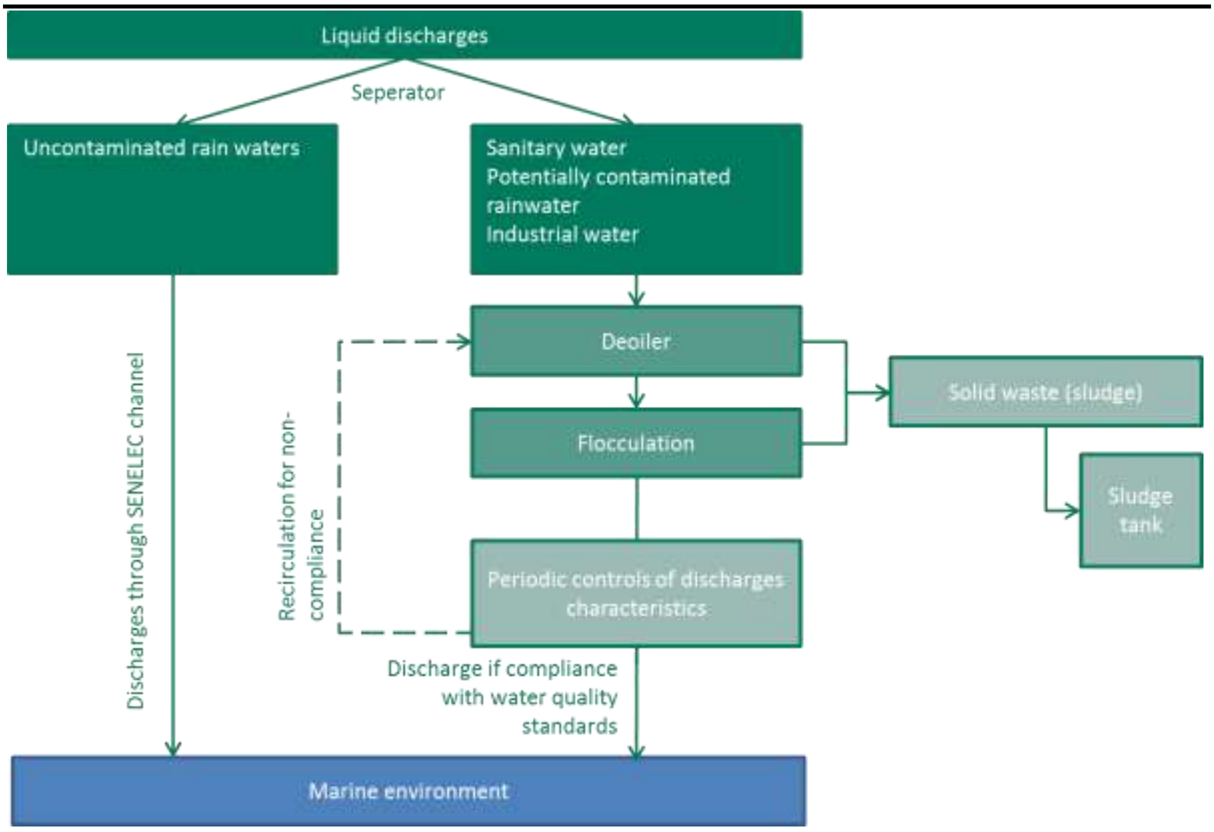
Table 3.9 Discharged treated water values guaranteed by the builder

Parameter	Limit	Value accepted
pH	max.	6-9
Matter in suspension (MES)	max.	50 mg/l
Oils and greases	max.	10 mg/l
Total residual chlorine	max.	0.2 mg/l
Total chromium	max.	0.5 mg/l
Copper	max.	0.5 mg/l
Iron	max.	1.0 mg/l
Zinc	max.	1.0 mg/l
Lead	max.	0.5 mg/l
Cadmium	max.	0.1 mg/l
Mercury	max.	0.005 mg/l
Arsenic	max.	0.5 mg/l

Source: *Wartsila, 2014 and 2016*

[1] NS 05-061.- Waste water : discharge standards.- 2001.-22p

Figure 3.9 Block diagram of liquid effluent treatment



Source: *ERM, 2014*

In total, the power plant will generate an average of 158 l/h of oily water for the 53 MW power plant and 25 l/h for the Extension, i.e. about 4.5 m^3 per day, which will be processed through the treatment unit.

Liquid discharges from the demineralization unit will be punctual and only associated with the regeneration of resins.

They will include small amounts of acids and base (see *Section 3.6.4*) and the minerals trapped in the resin. The water used in the demineralization unit will come from the drinking water network, and will therefore be slightly charged in minerals. Acidic and basic discharges will neutralize each other and the pH of the final discharge will be almost neutral (and slightly acid). In all cases, the discharges will be treated within the liquid waste treatment plant (see above), whose process includes the addition of sodium hydroxide to stabilize the pH. Discharges from the demineralization unit will not represent a significant environmental issue.

Waste products

The main waste products expected after start-up of the site are as follows:

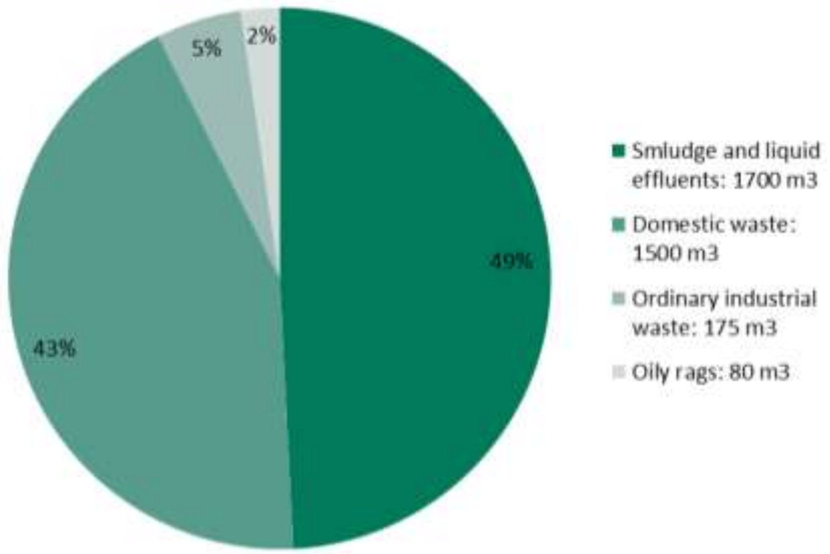
- Domestic waste
- Ordinary industrial waste

- Oily rags
- Sludge and oily effluent

Volumes of domestic waste have not been evaluated precisely, but it is estimated that over 4 m^3 will be generated daily (i.e. over 1 500 m^3 per year).

With regard to the other waste products, the annual amount of waste produced (excluding domestic waste) is estimated at less than 2 000m^3.

Figure 3.10 ***Estimate of the proportion of waste types produced during the operational phase***



Source: *ERM, 2014*

Over 140 m^3 of sludge and other oily effluent will be generated every month, thus requiring between 8 and 10 trucks for collection and transport to a reprocessing centre. This collection, as well as the final processing of sludge, will be done by an approved company.

There are several processing companies in Senegal that specialise in the processing of the type of waste products that will be generated by the Project. This are particularly service providers already involved in the processing of waste products from other thermal power plants, in particular SEPRES and ECOMAR.

ContourGlobal - Cap des Biches will evaluate recycling, reuse or disposal options for the waste products generated, depending on the waste product processing installations present in the site's environs. In step with its environmental policy, ContourGlobal - Cap des Biches will ensure that all waste flows are managed under the terms of a contract with a service provider who holds the necessary certifications.

4 ANALYSIS OF THE REGULATORY AND INSTITUTIONAL FRAMEWORK OF THE STUDY

4.1 INSTITUTIONAL FRAMEWORK APPLICABLE TO THE PROJECT

4.1.1 The Constitution

The country's institutional and regulatory framework is based on the Senegal Constitution established in 1959, the latest revision of which dates back to 2001 (the Constitution of 22nd January 2001, currently in force, is the fourth Senegalese Constitution following those of 1959, 1960 and 1963).

The Constitution of Senegal, defines the organisation and regulations of the following areas:

- Public and personal freedoms, economic and social rights, and collective rights
- The President of the Republic
- International treaties
- The Government
- The State and sovereignty
- The opposition
- The National Assembly
- The Economic, Social and Environmental Council
- Relations between executive power and legislative power
- Judicial power
- The High Court of Justice
- Local authorities
- Revision
- Transitory provisions.

In the First Heading, "of State and Sovereignty" of the Constitution of 22nd January 2001, Article 8 guarantees all Senegalese citizens the right to a healthy environment.

Moreover, Heading VII-1 of the Constitution of 22nd January 2001 is devoted to the Economic, Social and Environmental Council. It establishes that *"the Economic, Social and Environmental Council can be consulted by the President of the Republic, the National Assembly and the Government on any issue of an economic, social or environmental nature. Any programming plan or any draft law of an economic, social or environmental nature is submitted to it for an opinion"*. Also, *"it may also, on its own initiative, give an opinion on all matters of an economic, social or environmental nature involving the Nation's various sectors of activity"* (see *Section 4.2.1.*

The project objectives are fully in line with the guidelines of the State of Senegal, outlined in various policy documents and strategies for economic, social, environmental, institutional development of the country. The project is specifically in line for with the strategies, following economic and social policies and programs.

4.1.2 *Political framework applicable to the Project*

Senegal Emerging Plan (Plan Sénégal Émergent, PSE)

Senegal has decided to adopt a new development model to accelerate its progression towards emergence. This strategy, known as Senegal Emerging Plan (*Plan Sénégal Emergent, PSE*), is the referential of the economic and social policy in the medium and long term. The PSE aims at the economic emergence in 2035. The ambition of the State of Senegal to foster economic growth with high impact on human development is based on the implementation of a major investment program in sector with growth potential, able to stimulate a dynamic of strong and sustained growth. The energy sector plays an important role in the PSE, persistent disruptions in the supply of electricity could compromise the performance of the national economy, in addition to the negative impact on well-being.

According to the 2014-2018 Priority Action Plan (*Plan d'Actions Prioritaires*), the energy sector plays an important role in the PSE, and accounts for 13% of foreseen public financing (304 billion FCFA).

National Strategy for Economic and Social Development 2013-2017 (Stratégie Nationale de Développement Economique et Sociale, SNDES)

The SNDES constitutes the reference framework for the development of policies, sectorial development plans and investment programs in Senegal. This strategy aims to ensure conditions for sustained and sustainable growth, significantly reduce poverty and achieve the Millenium Objectives for Development (*Objectifs du Millénaire pour le développement, OMD*).

The Strategic Document for Poverty Reduction (Document Stratégique de Réduction de la Pauvreté, DRSP).

The strategy of the DRSP is articulated around three axes: (i) Creation of economic opportunities and wealth for the promotion of productive employment and structural transformation of the economy; (ii) Acceleration of access to basic social services, social protection and sustainable development; (iii) Strengthening basic principles of good governance and promotion of human rights. In the energy sector, the fixed document a target of 66% (30% in rural areas) for household access rate to electricity service in 2015.

As asserted by the International Monetary Fund (IMF) after a visit to Senegal in September 2015 (Press release N° 15/418), the economic forecasts for Senegal are positive, with a foreseen above 5% growth rate in 2015 and above 6% in 2016, highlighting the first promising outcomes of the PSE[1].

[1] http://www.imf.org/external/french/np/sec/pr/2015/pr15418f.htm

4.1.3 *Strategic framework for environmental planification*

The environmental sector policy

Environmental policy aims at sustainable economic and social development that is compatible with rational management/use of natural resources and the environment. The environmental policy seeks above all to develop the reflex of taking the environment into account in all activities generating goods and services.

The environmental sector policy is implemented by the Ministry for the Environment and Nature Protection, and has resulted in several national action plans, as listed below.

The national action plan for the environment (PNAE)

The PNAE is made up of study materials, concerted and decentralised reflections as well as proposals made by the various categories of stakeholders concerned by the questions of natural resources and environmental management. Activities carried out within the context of preparation of the PNAE have resulted in:

- An analysis of structuring economic activities and the evaluation of their effects on the environment
- In-depth study of a series of topics based around major environmental stakes and issues
- The drafting of Regional Action Plans for the Environment (PRAE) and their synthesis on an eco-geographic basis
- The synthesis of sectorial intervention strategies with a view to better knowledge of the various fields of expressions of natural resources and environmental management policies.

The national action programme for the combat against desertification (PAN/LCD)

Adopted in 1998, the PAN/LCD is, at national level, an instrument for implementation of the UN Convention to Combat Desertification (CCD, see *Section 4.2.8*) adopted in Paris on 17th June 1994, further to a wish expressed at the Conference on Environment and Development in Rio de Janeiro in 1992. It is a component of the PNAE the aim of which is to integrate the environmental dimension into the economic and social development process.

The strategy and action plan for conservation of biodiversity

The strategy and action plan for the conservation of biodiversity were adopted in 1998, within the context of implementation of the International Convention on the Conservation of Biodiversity (*Section 4.2.8)*. Senegal has drawn up a strategy and an action plan for the conservation of biodiversity, whose objective is to re-establish the essential equilibriums that will ensure sustainable development for the country.

The national strategy for adaptation to climate change (SMMO)

Establishment of the national strategy for adaptation to climate change (SNMO) is part of the programme of activities that Senegal has developed since the 1992 Rio conference 1992 (*Section 4.2.8*). Indeed, in view of the commitments made in the UN Framework Convention on Climate Change (UNFCCC), the country has taken major initiatives with the aim of adapting to climate change. The SNMO thus acts as a reference framework to which all stakeholders and institutions must refer to ensure that their actions fit ever more into integrated adaptation strategies. The framework for action in the strategy for adaptation to climate change is defined in the national plan for adaptation to climate change (PANA) drawn up in 2006.

Among the strategic plans relating to environmental policy in Senegal, mention may be made of the following documents:

- Poverty reduction strategy, with a major section on education
- The national strategy for social cover and risk management (SNPS/GR), in which the "management of catastrophes and major risks" is part of the fourth section of strategies
- The national programme for the prevention and reduction of major risks and management of natural catastrophes; this programme is steered by the Civil Protection Division (DPC), and acts as an operational framework for interventions in the field of the management of risks and catastrophes
- The national integrated strategy for the protection and combat against coastal erosion, which corresponds to an integrated vision of the protection of the Senegalese coastline
- The master plan for liquid waste treatment for the Dakar region; this plan sets out the major guidelines in terms of waste treatment in the Dakar region, through until 2025, and defines the responsibilities of the National Waste Treatment Office (ONAS)
- The national plan for territorial planning which aims, in the medium and long terms, at optimal exploitation of resources and potential resources, decentralisation and the search for a better balance between the regions, in order to make achievements irreversible.

4.1.4 *Policies and programs in the energy sector*

The project also incorporates the objectives of the energy sector development policies and programs. The following programs are concerned.

The Development Policy for the Energy Sector (LPDSE)

In February 2008, the Government of Senegal adopted a Letter of Development Policy for the Energy Sector le (LPDSE), which aimed, amongst other things, to reach by 2012 average electrification rates of 75% at national level, 50% in rural communities and 95% in urban communities, as well as a rate of commercial energy independence of at least 20% by 2020 (compared with 4% in 2004) thanks to the contribution of biofuels, hydroelectricity and renewable energies.

Despite efforts made, it has not been possible to achieve these objectives completely (see *Section 2.1.1*).

Based on lessons learned, the Government in place after the presidential election on 25th March 2012 decided to implement a new energy policy, the fundamental orientations of which were defined by the President of the Republic during the Council of Minister held in DIOURBEL on 26th July 2012. This policy aims to see the emergence of the energy sector, characterised by perfect availability of energy at the lowest cost possible, with universal access to modern energy services whilst complying with social and environmental acceptability principles.

Heading II.2 details the positions and limitations of the Electricity sub-sector, and more particularly of SENELEC and rural electrification. The energy policy vision and strategic objectives are presented in the second section of the LPDSE.

Article 56 sets out Senegal's ambition for 2017: 50% electrification in rural communities, 95% in urban communities and 70% at national level.

This new energy policy (*Nouvelle Politique Energétique du Sénégal*) takes into considerations the positions and limitations of the electricity sub-sector, and more particularly of SENELEC and rural electrification. It fixed the following objectives (non-exhaustive list):

- national electrification rate of 70% by 2017 (50% in rural areas and 95% in urban areas);
- operationalisation of the legal, regulatory and institutional framework;
- commercial energy independence of at least 15% by 2025 (biofuels excluded);
- 20% of electricity from renewable energies; and
- 40% energy saving by 2020.

Decision A/DEC.24/01/06 of 12/01/2006, on application of the objectives of the Economic Community of West African States (ECWAS)

Senegal subscribes to the general objective of the ECWAS of ensuring access by at least half (50%) of the rural and peri-urban population to modern energy services by 2015, in order to achieve the UN Millennium Development Objectives (MDOs). Specifically, 100% of peri-urban and urban populations and 36% of ECWAS countries should have access to an individual electricity service by 2015.

Strategic document on Poverty Reduction

The Strategic Document on Poverty Reduction (DRSP) thus sets at 66% (30% in rural communities) household access rate to the electricity service in 2015.

4.2 *REGULATORY FRAMEWORK APPLICABLE TO THE PROJECT*

Several national and international texts with the environmental, economic and social components are applicable to the project.

4.2.1 *National environmental and social legislation*

Environment code

The regulatory framework relating to the environment is defined by Law 2001-01 of 15th January 2001 covering the Environment Code, as well as by Decree 2001-282 of 12th April 2001 on application of the Environment Code. The Environment Code (2001) is implemented by the Environment Ministry and the Office for the Environment and Classified Installations is responsible for all questions relating to evaluation of the environmental impact when permits are granted (see *Section 4.2.3*).

Heading I (General provision) includes three chapters on the definitions, fundamental principles and instruments for environmental protection.

Heading II on "the Prevention and Combat of pollution and nuisance" (which comprises six chapters) concerns classified installations and the protection of the environment, human establishments, waste management, harmful and hazardous chemicals, impact study and the establishment of emergency plans. Classified installations are divided into two different classes: the first Class is subject to the authorisation regime and the second to declaration.

Heading III (Protection and valuing of receptor environments) comprises four chapters:
- Water pollution
- Air pollution and unpleasant odours
- The pollution and degradation of soils and sub-soils
- Noise pollution.

4.2.2 *Legislation relating to classified installations for environmental protection*

Legislative framework

According to the Environment Code, plants, factories, stores, warehouses depots, worksites and industrial, artisanal or commercial installations are subject to the regime on the declaration and authorisation of Classified Installation for Protection of the Environment (ICPE).

Chapter I of Heading II (Prevention and combat of pollution and nuisance) of the Environment Code deals with classified installations for environmental protection. The installations are classified in two categories (Article 9-11):

- Class I installations are defined as presenting the risk of "serious hazards or disturbance" with regard to "health, safety, public salubrity, agriculture, nature and the environment in general". They are subject to the authorisation regime. A study evaluating impacts on the environment is used to integrate environmental considerations into the economic and financial analysis of the project; this category requires an in-depth environmental evaluation.
- Class 2 installations are not considered to present any major threat of nuisance and are consequently subject to less strict controls. These installations are subject to the declaration regime; this category is the object of a summary environmental analysis.

A power plant such as the one that will be installed in the Project is a Class 1 installation in terms of the Senegalese nomenclature of ICPE. The first class includes installations whose operation can only be authorised on condition that measures are taken to prevent hazards or disruption linked to the environment, whilst the second class includes installations that are subject to more general instructions due to the apparent absence of any serious inconveniences.

Main classified facilities included in the Project and authorization scheme

According to the Senegalese ICPE nomenclature, the Project falls under the following headings:

- A1401 "Production and distribution of electricity [Process by steam and turbine generator]" – authorisation regime requiring the performance of an in-depth study on environmental impact, whatever the production capacity.
- A1402 "Production and distribution of electricity by combustion – thermal power plants, generators, etc." - authorisation regime requiring the performance of an in-depth study on environmental impact when the installed thermal power is over 2 MW.
- S702 "Storage of combustible liquids – Category D" - authorisation regime requiring the performance of an in-depth study on environmental impact when storage capacity is greater than 5000 m^3.

The Project is therefore subject to prior authorisation with prior performance of an in-depth environmental impact study. Authorisation to commence operations must be granted to Project managers by the Ecology and Nature Protection Ministry prior to construction or start-up of the installation.

Other relevant ICPE requirements

According to article L 13 of the environment code, an ICPE must be 500m distant from "*dwellings, buildings habitually occupied by third parties, establishments open to the public and areas intended for use by housing, a water course, a lake, a communication link, a water catchment.*"

According to chapter 1 of law N° 2001 - 01 dated 15th January 2001 covering the Environment Code and relating to the general provisions for ICPE, the Minister with responsibility for civil protection plays a consultative role for the Environment Minister. According to article R4 of this code, authorisations for the opening and operation or start-up of ICPE, as well as the classification of each of them, are determined by order of the Environment Minister, based on opinions from the Mines and Civil Protection Ministers.

Finally, in the "transfer or transformation of the rights to operate or extension or significant modification of those rights" (« *transfert ou mutation des droits d'exploitation ou extension ou modification notable* ») of a classified facility, it is required that the Minister for the Environment is informed before the realization of planned changes in order to decide how to proceed (Article R33 of Decree 2001-282 of 12 April 2001 on the implementation Code of the Environment).

This policy statement also applies when changing operator of a classified installation. The new operator has one month to inform the Minister for the Environment. It then issues a certificate of transfer of the operation rights of the relevant ICPE.

4.2.3 Impact study

Chapter V of Heading II of the Environment Code, as modified, concerns impact studies. It sets out generally that an impact study must be performed for "any development project or activity likely to affect the environment". The promoter is responsible for having the impact study carried out, which he must then communicate to the competent authorities.

The main texts regulating the performance process for impact studies in Senegal are as follows:

- Decree n° 2001-282, of 12th April 2001 which completes the environment code, defines the procedure for the evaluation and examination of the Impact study, its content and public consultation.
- Ministerial order n°9468, of 28th November 2001 setting out regulations for public participation in environmental impact studies
- Ministerial order n°9469, of 28th November 2001 setting out the organisation and functioning of the technical committee
- Ministerial order n°9470, of 28th November 2001 setting out the conditions for issue of Approval for the exercise of activities relating to environmental impact studies

- Ministerial order n°9471, of 28th November 2001 setting out the content of terms of references for Impact Studies
- Ministerial order n°9472, of 28th November 2001 setting out the content of the impact study report.

Decree n° 2001-282 of 12th April 2001 indicates in detail several of the Code's provisions. The Decree requires, notably, additional obligations for Class 1 and 2 installations. Heading II of the Decree sets out the obligation for an environmental impact study (EIE) for Class 1 and 2 installations, either with an in-depth environmental evaluation for ICPEs of Class 1, or through an initial environmental analysis for Class 2 installations. Decree n° 2001-282 also indicates that public consultations must be carried out prior to any administrative authorisation.

In both cases, it is necessary to carry out the EIS with regard to the following issues:

- Effects on the health and well-being of populations, environmental milieus, ecosystems (including flora and fauna)
- Effects on agriculture, fishing and habitats
- Effects on the climate and the atmosphere
- Effects on the use of natural resources (regenerative and mineral)
- Effects of the recycling and disposal of residues and waste
- The effects on the relocation of populations, archaeological sites, the landscape and monuments and social impacts and prior, post and transborder effects.

The impact study must be validated by a technical committee that supports the Ecology and Nature Protection Ministry, as specified in Order n° 9469 of 28th November 2001. This order defines the committee's members and responsibilities. The committee secretariat is assured by the Office for the Environment and Classified Installations.

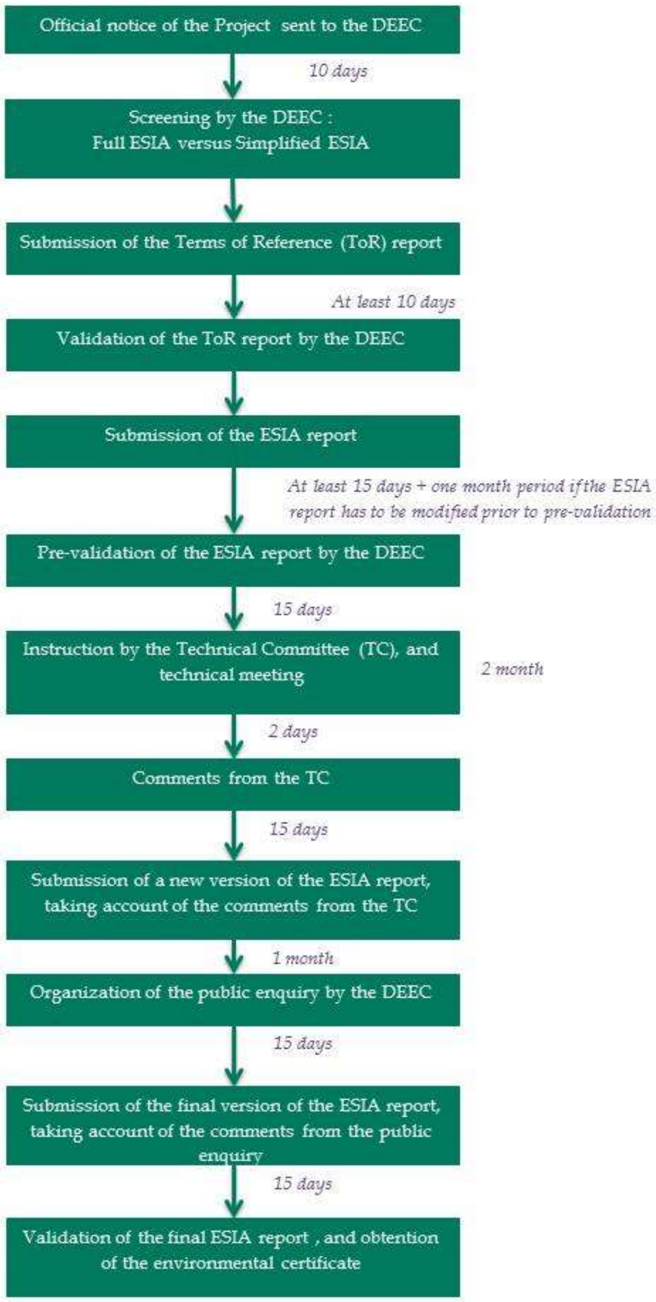
On the basis of the final study (containing all the comments received during public consultations), the technical committee has to present a decision to the Ministry with regard to the promoter's request. The Ministry must then make its decision known (positive or negative).

The two ministerial orders n° 9471 and 9472 dated 28th November 2001 define the content of the terms of reference for impact studies, as well as the content of the environment impact study report.

Process for performing and validating the ESIA

The procedure for requesting authorisation is summarised in *Figure 4.1*.

Figure 4.1 Procedure for requesting authorisation



Source: *ERM, 2014, based on current legislation in Senegal*

This ESIA update concerns the extension of the Cap des Biches power plant. As stated in Article L 13 of the Environment Code and in Article R 37 of Decree 2001/282, the authorisation demand must be renewed in case of a transfer, an extension or a major change of the installations that were granted the authorisation. Article R 33 of Decree 2001/282 further specifies that for the transfer or transformation of the rights to operate or extension or significant modification of those rights of a classified facility, it is required that the Minister in charge of the environment (MEDD) and DEEC is informed before the realization of planned changes in order to decide how to proceed.

4.2.4 *Legislation in terms of public consultation*

Order n° 9468 sets out the conditions for public consultation within the context of the environmental impact study. The aim of the public hearing is "to present a summary of the EIS report and to collect opinions, observations and amendments from local stakeholders". The order on regulation of public participation in the environmental impact study underlines the following requirements:

- Announcement of the initiative by means of notices displayed at the town hall or local authority offices and/or communicated through the press
- Documents deposited at the town hall or local authority concerned
- Holding of an information meeting
- Collection of written and oral comments
- Negotiations, where necessary
- Drafting of the report.

Public hearings must be chaired by the Technical Ministry whose activities are being analysed. The Office for the Environment and Classified Installations deals with the secretariat. The project promoter submits the results of the public hearing to the technical committee.

The updated ESIA will include stakeholder engagement and stakeholder consultation (*see Section 7 – Stakeholder consultation*).

4.2.5 *Other environmental regulations*

Heading III of the law covering the Environment Code concerns the Protection and Valuing of Receptor Milieus and deals with water pollution, air pollution and unpleasant odours, soil and sub-soil pollution and noise pollution. The provisions of the law are supplemented by those of Headings III to VI (water pollution, water policy, air pollution and noise pollution) of the Decree of application and by specific standards.

Water management

The Environment Code defines water as "*a public asset »* (Article L58 of the Law) and defines water pollution as *"any spillage, run-off or direct or indirect deposits of liquids or materials, and more generally any event likely to alter the quality of surface water, groundwater or sea water"* (Article R46 of the Decree).

The framework law governing the regulation of water management is Law 81-13 of 4th March 1981 covering the Water Code. It sets out the various provisions used to combat water pollution whilst reconciling requirements linked notably to the drinking water supply and public health, agriculture, the biological life of the receptor milieu and of fish life, health protection and water conservation.

The most essential principle is that water is in the public domain, which makes this resource an asset shared by all. It is on this basis that good resource planning rests, along with its correct management and fair distribution between the various usages and each according to his requirements within the strict framework of respect for the general interest.

Management of waste water

Law 2009-24 of 8th July 2009 covering the Water Treatment Code establishes a legal framework for the organisation of the public water and collective water treatment service. The parameters of application of the Water Treatment Code are described in Decree 2001-245 of 17th February 2011.

The first heading sets out the perimeter for treatment of liquids, waste water, excreta and rain water and the provisions relating to the elaboration, adoption and approval of waste water and rain water treatment master plans for municipalities and local hydraulic and treatment plans for rural communities, as well as their necessary interconnection with the planning master plan.

It also sets out provisions relating to direct or indirect spillages, run-off, deposit, disposal, burying and immersion of liquid waste or domestic, hospital and industrial origin, subject to the provisions of this law across the whole extent of the territorial, fluvial and coastal territory of Senegal.

Finally, the regime for the various effluents is defined, whether of domestic, rain water, industrial or hospital origin.

The second heading relates to specific provisions. It defines the General Conditions for the discharge of purified water into the natural environment, the re-use of purified water of domestic and industrial origin, the specific regime reserved for sludge, the protection of public treatment equipment against damage and the conditions for installing an autonomous treatment facility.

Water pollution

The Project's operational phase will lead to the generation of aqueous effluent such as waste sanitation water, rain water and industrial water. Management of this effluent is governed by Senegalese standard NS 05-061 of July 2001, laid down by interministerial order as the reference for the discharge of waste water into the receptor milieus defined within the territorial limits of Senegal.

Standard NS 05-061 is supplemented by several Appendices:

- Appendix 1 – Mechanisms for the sampling and measurement of standardised outputs: requirements in terms of the design of output mechanisms and the establishment of measurement points

- Appendix 2 – Limit values for the parameters of treated effluent, likely to be discharged into a receptor milieu; this Appendix presents, amongst other things, the limit values applicable to the Cap-des-Biches power plant
- Appendix 3 – Spreading
- Appendix 4 – Conditions for sample taking and conservation, definition of applicable standards in terms of analysis and testing.

Finally, Senegalese standard NS 05-061 of July 2001 establishes the limit values for the discharge of residual water and leaching, described in *Table 4.1*, below.

Table 4.1 Limit values for the discharge of residual water and leaching in Senegal

Component	Limits (mg/l)
Total matter in suspension (MEST)	50 mg/l
BOD5* (on non-unloaded effluent)	80 mg/l if the maximum authorised daily flow does not exceed 30 kg/d; and 40 mg/l above that amount (30kg/d)
COD** (on non-unloaded effluent)	200 mg/l if the maximum authorised daily flow does not exceed 100 kg/d; and 100 mg/l above that amount (100kg/d).
Nitrogen (total nitrogen including organic nitrogen, ammoniacal nitrogen and oxidised nitrogen)	30 mg/l as average monthly concentration when the maximum daily flow is equal to or over 50 kg/day.
Phosphorous (total phosphorous)	10 mg/l as average monthly concentration when the maximum authorised daily flow is equal to or over 15 kg/day.

Source: *Senegalese standard NS 05-061*
Note: BOD 5 = Biological Oxygen Demand / Note**: COD = Chemical Oxygen Demand*

Air pollution

Article L76 of the Environment Code stipulates that the law and application regulations apply to air pollutions or odours that "*are unpleasant for populations, compromise public health or safety, are harmful to agricultural production, the conservation of buildings and monuments or to the character of natural sites and ecosystems.*"

Moreover, Heading V of the Decree 2001-282 covering application of the environment defines the general provisions on air pollution, with the main objective of regulating the emissions of gassy effluent in order to avoid any kind of pollution. Mainly, Decree 2001-282 describes the following provisions:

- It regulates pollutions caused by gas emissions
- It requires for all sources prior treatment of gassy pollutants prior to any discharge. Supervision and control are provided by certified officials from the Environment Ministry or by any other officer with jurisdiction in this field
- It sets out and specifies the terms of collecting the annual tax that has to be paid by industries that discharge gassy effluent. The tax is set by order. The money collected is paid into the Treasury and part of the money is used to

carry out concrete actions that contribute to the combat against atmospheric pollutions and for the protection of environmental resources.

The combustion of the heavy fuel oil used for energy production will lead to atmospheric emissions that are regulated by Senegalese standard NS 05-062 of December 2004, established by interministerial order as a reference for the discharge of atmospheric emissions. The main instructions of this standard are as follows:

- declaration of emissions to the authorities on the basis of measurements taken at discharge points or a quantitative report on substances used
- discharge conditions: layout of installations so as to enable good diffusion and facilitate the measurement of pollutants
- supervision of discharge: the frequency of discharge measurements and the parameters to be analysed are set forth in the authorisation order
- Appendix 2 – emission limit values for special installations (including stationary combustion engines)
- Appendix 4 – method used for calculating the height of the stack
- Appendix 5 – conditions for sampling and measuring air pollution: definition of applicable standards for analyses and testing.

The limit values defined in the standard and applicable to the Cap-des-Biches power plant are presented in *Table 4.2* below; these values concern stack discharge and are not dependent on atmospheric dispersal. The pollutant concentration limit values in ambient air are also presented in *Table 4.3*; this standard concerns atmospheric emissions in the environment outside a power plant after discharge and dispersal into the air.

Table 4.2 Atmospheric emission limit values for stationery combustion engines running on heavy fuel oil

Parameter	Limit value
CO	650 mg/Nm^3
NO_X	2000 mg/Nm^3
SO_2	2 000 mg/Nm^3
Dust	100 mg/Nm^3

Source: *Standard NS 05-062 – Atmospheric pollution, discharge standards*

Table 4.3 Limit values for concentrations in ambient air

Parameter	Limit value
CO	30 mg/Nm^3 (Average over 24h, must not be exceeded more than once a year)
NO_2	200 µg/Nm^3 (Hourly average) 40 µg/Nm^3 (Annual average)
SO_2	50 µg/Nm^3 (Annual average) 125 µg/Nm^3 (Daily average)
Dust	80 µg/Nm^3 (Annual average) 260 µg/Nm^3 (Average over 24 h, must not be exceeded more than once a year)

Source: *Standard NS 05-062 – Atmospheric pollution, discharge standards*

Waste management

The construction and operational phases will lead to the production of several types of waste. These will be mainly domestic waste products and bulky refuse for the former, and hazardous waste and sludge from the effluent treatment plant for the second.

According to Article L 30 of the Environment, "*waste materials must be disposed of or recycled in a rational, ecological way in order to suppress or reduce their harmful effects on human health, natural resources, fauna and flora or the quality of the environment.*" According to Article L 31 "*Anyone who produces or holds waste products must deal himself with disposal or recycling or ensure that it is disposed of or recycled by companies approved by the Environment Ministry. If not, he must pass these waste products on to the local authority or to any company approved by the State for waste management. This company, or the local authority itself, can sign contracts with waste producers or holders with a view to its disposal or recycling. Recycling must always take place in accordance with current standards in Senegal*". Moreover, this same code bans fly tipping and sets out the obligation of having waste products disposed of or recycled by a company with Ministerial approval. Similarly, the burying of waste materials cannot take place without first obtaining authorisation to do so from the Environment Minister who sets out the technical instructions and specific rules that must be observed.

Other regulatory texts relevant to waste management are as follows:

- Law n° 83-71 of 5th July covering the Hygiene Code which regulates hygiene. In particular, Law n° 83-71 regulates public or collective individual hygiene and the sanitation of the environment. The law defines, amongst other things, the hygiene rules applicable to dwellings, industrial installations, public highways and the packaging of waste materials.
- Law n° 96-06 of 22nd March 1996 covering the Local Authorities Code and law n° 96-07 of 22nd March 1996 covering the Transfer of environmental jurisdiction to local authorities, gives them full jurisdiction in terms of waste management

- Decree 74-338, relating to household waste: decree 74-338 o 10th April 1974 regulates the evacuation and deposit of waste products. This text focuses on the definition of waste, its collection and dumping. The decree does not address the question of transfer centres.

In terms of industrial waste, this is of several types, but regulatory provisions specify that it must be managed in situ by its producer by virtue of the polluter-payer principle. If suitable equipment is not available at the production site, regulations also provide for the possibility of using the services of approved organisations in order to carry out the required treatment.

Waste oil is also regulated, notably for organisation of its collection, storage, re-use and energy valorisation (interministerial order covering the management of waste oil dated 5th October 2007).

Specific instructions are defined for biomedical waste. The Hygiene Code states that this waste must be collected separately from household waste. Moreover, decree n°2008-1007 of 18th August 2008 deals specifically with this type of waste. Biomedical waste must be sorted right from production and then packed so as to avoid any kind of contamination. This waste must be disposed of by a facility approved by the Ministry.

Noise emissions

The main issues linked to noise emissions will take place during the operational phase. Noise emissions generated by installations such as radiator ventilators, water condensers or transformers, must be maintained at levels defined by Senegalese law.

According to article L84 of the Environment Code "*noise emissions likely to harm human health, create excessive disturbance to neighbours or have a negative effect on the environment are forbidden*".
Limit values with regard to human health (corresponding therefore to values measured at the closest dwellings) are defined in the regulatory section of the Environment Code:

- 55 dB(A) to 60 dB(A) by day
- 40 dB(A) by night

Currently no frequency of noise measurement is required.

Land law

In terms of land law, regulations are defined by the framework established in Law N°64-46 of 17th June 1964 relating to the national domain and Law N°76-66 of 2nd July 1976 covering the State domain code, which divided land into public and private domain areas. Law 64-46 reinforces the State's right to be guardian of all land and grants the State authority to intervene in governmental development projects in order to guarantee rational land usage and defend priorities in accordance with the nation's economic policies. It also permits the creation of four categories of land areas: the rural area, the classified area, the urban area and the pioneer area.

Moreover Decree N° 64-574 of 30th July 1964 covering application of article 3 of law 64-46 dated 17th June 1964, relates to the national domain and authorises, temporarily, registration of the name of occupants who have enhanced an area permanently. This legislation governs State public and private ownership and other public bodies.

Decree N°77-563 of 3rd July 1977 covering application of Law N°76-67 of 2nd July 1976 relating to expropriation for public usefulness and other land operations of public usefulness, defines the general provisions for obtaining certification and of certificates of land ownership rights.

Finally, the Decree of 26th July 1932 covering organisation of the land property regime in French West Africa defines the general provisions of private ownership.

The following regulatory texts are also potentially applicable to the Project:

- The Civil and Commercial Obligations Code
- Decree 91-748 of 29th February 1991, relating to reinstallation
- Decree n° 72-1288 of 27th October 1972 relating to the conditions for allocation and disaffection of land in the national domain that forms part of rural communities.

Law n° 2008-43 of 20th of August 2008 on the Urban Planning Code

This code defines building standards and urban plans, the distribution and organization of land in zones; the route of communicaton channels; spaces reserved in public servives, land-use condition etc. The Urban Planning Code sets forecasts and planning rules that are implemented by development and urban master plans (*schémas directeurs d'aménagement et d'urbanisme*), urban planning master plan (*plans directeurs d'urbanisme*), detailed urban planning (*plans d'urbanisme de détails*), subdivision plans (*plans de lotissement*).

The Code is supplemented by Decree No. 2009-1450 of 30 December 2009 on the regulatory part of the Town Planning Code.

Land clearance

The Forestry Code (Law n°98-03 of 8th January 1998, and its application decree, Decree n°98-164 of 20th February 1998) stipulates that any land clearance must obligatorily be authorised by the local authorities. Authorisation is granted only based on a file containing notably a report from the Water and Forestry Service, a milieu impact study and an evaluation of the cost of restoration of the area.

Protected species

Regulations on the protection of plant species are defined in the Forestry Code for flora (Law 98/03 of 8th January 1998 and Decree 98/164 of 20th February 1998).

Law 86-04 covers the Hunting and Fauna Protection Code and its decree of application (Decree n°86-844) regulating hunting activities and the protection of fauna. The provisions of Decree n°86-844 are divided into 3 headings, including Heading II on fauna protection, which includes provisions relating to the protection of certain species, national parks, dispensations to the hunting law, health protection and the protection of people and property.

In the case of a residual impact on protected or partially protected species, a request for a dispensation file must be made to the competent authorities.

4.2.6 Legislation relating to the electricity sector

The electricity sector in Senegal was previously governed by Law l n° 65-59 of 19th July 1965 relating to the production or catchment, transport and distribution of water and electricity and by Decree n° 84-1128 of 4th October 1984 covering regulations on the production, transport and distribution of electricity.

Under the terms of Decree n° 84-1128, it is the Société Nationale d'Electricité (SENELEC), in which the State own all the capital, which has the monopoly over transport and distribution.

The orientation Law n°98-29 of 14th April 1998 relating to the electricity sector creates a new institutional and regulatory framework intended to attract the necessary private investment for developing the electricity sector. It points out that the exercise of any activity in this sector is subject to first obtaining a licence or concession issued by the Minister with responsibility for Electricity.

Moreover, the conditions and terms for the issue and withdrawal of electricity production, distribution and sale concessions are set forth in Decree n°98-334.

Decree n°98-335, relating to the principles and procedures for defining and revising tariffs repeats and develops the tariff principles set forth in Law n° 98-29 relating to the electricity sector and sets out a procedure for revising tariff conditions.

The main institutional stakeholders (see *Section 4.3*) in the field of electricity regulation are:

- The Energy and Hydraulic Resources Ministry (ME) ;

- The Commission for the Regulation of the Electricity Sector (CRSE), established by Decree 98-333 covering the organisation and functioning of the Electricity Regulation Commission.

4.2.7 *Labour legislation*

Labour Code (Law 97-17 of 1st December 1997)

In its health provisions, Law No. 97-17 of December 1st, 1997 regarding the Labour Code sets working conditions: duration of labour (that must not exceed 40 hours per week), working at night, women and children work contracts, and weekly time off work that is mandatory. The text also deals with the Health and Safety at the workplace and identifies the measures that any activity must implement to ensure good health and safety condition that will guarantee healthy and safe working conditions. New Decrees were added to the system in place:

- Decree No. 2006-1249 of 15 November 2006 laying down minimum safety and health requirements for temporary or mobile construction sites;
- Decree No. 2006-1250 of 15 November 2006 on the movement of vehicles and machines inside the boundaries of a company's site;
- Decree No. 2006-1251 of 15 November 2006 on work equipment;
- Decree No. 2006-1252 of 15 November 2006 laying down minimum requirements for the prevention of certain environmental physical factors;
- Decree No. 2006-1253 of 15 November 2006 establishing a medical labour inspection and setting its role;
- Decree No. 2006-1254 of 15 November 2006 on the manual handling of heavy loads;
- Decree No. 2006-1256 of 15 November 2006 laying down the obligations of occupational safety for employers;
- Decree No. 2006-1257 of 15 November 2006 laying down minimum requirements for protection against chemical risks;
- Decree No. 2006-1258 of 15 November 2006 on the missions and rules of organization and operation of occupational medicine services;
- Decree No. 2006-1260 of 15 November 2006 on ventilation and sanitation conditions at the workplace;
- Decree No. 2006-1261 of 15 November 2006 laying down the general hygiene and safety in all types of institutions.

Heading XI of the Labour Code relates to health and safety in companies. It defines the following principles:

- The employer must ensure that workplaces, machines, equipment, substances and working methods do not present any kind of risk to worker health and safety. Prevention must be ensured by technical measures (design of machines, …) or organisational means (vocational medicine, …) (Article L 171).
- If these measures are not sufficient to guarantee workers' health and safety, individual protection measures must be implemented (Article L 172).

- The use of processes, substances, machines or equipment causing workers to be exposed to risks in the workplace must be communicated in writing to the Employment Inspector and Social Security (Article L 174).
- Workplaces must be subject to regular checks, notably with the aim or checking on compliance with safety standards and exposure limits (Article L 175).
- Workers' health must be regularly checked with a medical examination at the time of recruitment, followed by periodic medical examinations (Article L 176).
- Workers must be informed of any professional risks existing at their place of work and must be provided with adequate instructions to protect themselves against these risks (Article L 177).
- A periodic report on workers' state of health must be issued by the employer and a Health and Safety Committee (CHS) must be set up (Article L 178 and L 185).

Decree N°94-244 of 7th March 1994

This decree set out the terms for the organisation and functioning of health and safety at work committees. It defines the following principles:

- A health and safety committee must be organised by the employer and set up by employees in order to implement a health and safety at work programme (Article 1).
- The Committee carries out an inventory of all hazardous products, as well as an analysis and evaluation of real or potential risks (Article 11).
- A health, hygiene and safety register must be kept, in which will be entered minutes of the meetings, accident and professional illness statistics, the means of intervention and evacuation (Article 12).
- The establishment of an annual programme in terms of health and safety (Article 13).

The employer will also comply with articles that refer to legal obligations with regard to Work Inspection and Social Security, as defined in the Labour Code.

Hygiene Code (Law 83-71 of 5th July 1983)

The thermal power plant Project is subject to the Hygiene Code and notably section 6 relating to hygiene rules in industrial installations. The main instruction applicable to ContourGlobal Cap-des-Biches are as follows:

- Industrial premises and their surroundings must not be insalubrious
- Combustion fires, incinerators and incineration plants must not emit any dust, odour or nuisance fumes that may pollute the atmosphere
- Staff at factories and other industrial companies must undergo periodic medical examinations, in accordance with current regulations.

Chemicals

Operation of the power plant will require the use of chemicals, notably for the production of demineralised water. The use of chemicals is governed by decree n° 2006-1257 of 15th November 2006 which sets out minimum instructions for protection against chemical risks and defines conditions for the usage of chemicals in companies and the means of protecting workers against harm. The main instructions are as follows:

- Use labelled substances that come with a safety leaflet
- Limit the number of employee exposed to the chemical risk, notably by isolating workplaces where chemical products are used
- Based on safety leaflets, evaluate the chemical risks of substances and implement appropriate measures
- Implement collective and individual protection measures that are adapted to the risk involved
- Guarantee worker training and information, notably by means of notices on chemical risk prevention at every work station concerned, instructions displayed at premises, training in safety and emergency measures, etc. The employer must ensure that the various documents made available to exposed workers are correctly understood.

Workplace atmosphere

Decree n° 2006-1252 of 15th November 2006 setting out minimum prevention instructions for certain physical atmosphere factors defines the minimum instructions intended to protect workers against any kind of harm that could result from insufficient lighting, excessive or insufficient heat or a high noise level.

Lighting levels must be suitable for the work to be performed. The employer must also ensure that employees are not made uncomfortable by the heat radiating from light sources. Lighting apparatus and electricity carriers must also be firmly attached to avoid any electrical risk for employees. Safety lighting is required in work areas, to permit the evacuation of staff should the main lighting system fail.

Average equipment levels required are defined in the Appendix to the decree. Values applicable to the Cap-des-Biches power plant are summarised in *Table 4.4* below.

Table 4.4 Average lighting according to area of the site

Site area	Average lighting
Traffic and storage areas	
Traffic areas	100 lux 150 lux if vehicles are moving
Stairs, unloading bays	150 lux
Storage warehouses	100 lux
Premises used by workers	
Changing rooms, toilets	100 lux
Canteen, refectory	200 lux
Sick bay	500 lux
Offices and administrative premises	
Archives	200 lux
Filing and reception areas	300 lux
Reading, writing areas, computer rooms, conference rooms	500 lux

In terms of heat, the temperature must be compatible with worker health and be controlled by thermometers installed across all work premises. As far as possible, the use of processes that do not exude heat is required or, failing which, processes that mitigate heat diffusion by insulating the equipment concerned or capturing and evacuating the heat. In case of excessive temperature, ventilation and air conditioning systems will be installed.

Similarly, noise levels must be limited to avoid affecting worker health. It is mainly required therefore to:

- Prefer the least noisy processes
- Reduce noise at source
- Insulate noisy equipment
- Distance employees from noisy areas.

The maximum noise level to which an employee can be exposed is 85 dB(A). If it is not possible to limit the noise level to this value, personal protective equipment must be used.

4.2.8 International conventions and treaties

Senegal has ratified several international conventions and treaties in the environmental and social fields, and has committed to develop and implement sustainable development policies and strategies in relation to these international treaties. A list of the main international conventions is provided in *Table 4.5* below.

Table 4.5 International conventions and treaties

Convention title	Date of signature	Date of ratification	General aim
Protection of the ozone layer and climate change			
Vienna Convention for the protection of the ozone layer	22/03/1985	19/03/1993	To protect human health against the harmful effects of modifications to the ozone layer
Montreal Protocol (and its associated amendments) relating to substances that deplete the ozone layer and its amendments	29/05/1990	06/05/1993	To protect the ozone layer by taking measures to regulate world emissions of substances that deplete it
Kyoto Protocol to the UN framework convention on climate change	11/12/1997	20/07/2001	To reduce greenhouse gas emissions
Rational waste management			
Basel Convention on the control of transboundary movements of hazardous wastes and their disposal (Basel, 1989)	22/03/1989	10/11/1992	To ensure application of provisions governing movements
Protocol on liability and compensation for damage resulting from transboundary movements and the disposal of hazardous wastes (Basel, 1999)	22/03/1989	10/11/1992	To establish a complete system for liability and rapid adequate compensation in case of damage resulting from a transboundary movement and the disposal of hazardous waste, including the unlawful trafficking of this waste.
African Convention on the ban on the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (Bamako, 1991)	30/01/1991	16/02/1994	To regulate transboundary movements of toxic waste. To unite African countries against the import into the continent of hazardous waste.

Convention title	Date of signature	Date of ratification	General aim
Management of chemicals			
The Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade	11/09/1998	20/07/2001	To protect human health and the environment against potential risks from international trade in chemicals, to facilitate the exchange of information on pesticides and prevent illegal trade.
Stockholm Convention de on Persistent Organic Pollutants	23/05/2001	08/10/2003	To protect human health and the environment against persistent organic pollutants.
Management of natural resources and fauna			
UN framework convention to combat against desertification (Paris, 1994)	14/10/1994	26/06/1995	To combat the deterioration of soils
African Convention on the conservation of nature and natural resources (Alger, 1968)	15/09/1968	03/02/1972	To protect nature and natural resources in Africa
Rio Convention on biological diversity (Rio de Janeiro), 1992	13/06/1992	17/09/1994	To conserve the diversity of species and genetic diversity within the same species and the diversity of ecosystems
Bonn Convention on Migratory Species (CMS) (Bonn, 1979)		01/03/1988	To conserve migratory species at world level. Wild animals are the object of particular mesological, ecologic, genetic, scientific, recreational, cultural, educational, social and economic importance.
Convention on the international trade in endangered species (CITES)	05/08/1977	03/11/0977	Convention on the international trade in endangered species of wild fauna and flora (CITES) is an international agreement between states. Its aim is to ensure that the international trade in specimens of wild animals does not threaten the survival of the species to which they belong.

Convention title	Date of signature	Date of ratification	General aim
Ramsar Convention	-	11/11/1977	The convention of wetlands, known as the Ramsar Convention, is an inter-governmental treaty which acts as a reference framework for national action and international cooperation for the conservation and rational usage of wetlands and their resources. Five Ramsar sites are registered in Senegalese territory.
Convention for the creation of the UN World Organisation for Food and Agriculture	16/10/1945	16/10/1945	The creation of the Organisation has the aim of combatting poverty and hunger in the world and working to raise the level of nutrition and production yields, to distribute foodstuffs more efficiently and to improve living conditions in general; to promote mainly agriculture and sustainable rural development.
International Plant Protection Convention, revised at the 29th session of the FAO Conference, November 1997	07/11/1997	02/10/2005	To ensure efficient joint action to prevent the dissemination and introduction of organisms that are harmful to plants and plant products and to promote measures to control them and to provide a framework for international cooperation, harmonisation and technical exchanges in collaboration with regional and national protection organisations.
Cultural heritage			
Convention for Safeguarding of Intangible Cultural Heritage, adopted in Paris (UNESCO)	17/10/2003	03/08/2005	This recent convention insists on the need to preserve the cultural heritage of certain peoples.
Labour regulations			
International Labour Organisation Conventions (ILO)	-	-	Senegal is a member of the international labour organisation and a signatory to several international conventions associated with that organisation. Note, for example, the ILO Convention on child labour, ratified by Senegal on 26th December 1999.

4.2.9 *Requirements in terms of environmental and social compliance: IFC performance standards*

In April 2006, the International Finance Corporation (IFC) published a series of eight Performance Standards (PS) which have become an international benchmark for the social and environmental evaluation process in which IFC and other international fund providers are involved. These standards have recently been revised and the new version came into force in January 2012. *Table 4.6* recapitulates these performance standards.

Table 4.6 ***IFC performance standards***

N°	Title	Field of application
1	Assessment and management of environmental and social risks and impacts	Defines the provisions for instituting an adapted environmental and social management policy, including requirements in terms of the Environmental and Social Impact Study.
2	Labour and working conditions	Defines the provisions for establishing and applying fair staff recruitment and management policies
3	Resource efficiency and pollution prevention	Defines an approach for the rational use of resources and prevention and the combat against pollution at project level, in compliance with technologies and practices used at international level.
4	Community health, safety and security	Defines the provisions to ensure that the Project's negative impacts on the host community are properly managed and controlled.
5	Land acquisition and involuntary resettlement	Defines the provisions for management of land ownership and the relocation of communities within the context of project development.
6	Biodiversity conservation and sustainable management of living natural resources	Defines the provisions for ensuring that the Project's impacts on nature, ecosystems, habitats and biodiversity are properly managed.
7	Indigenous people	Defines provisions to ensure that the rights of native minorities are respected and that native populations benefit from the Project
8	Cultural heritage	Defines the provisions for managing the project's impacts on the tangible and intangible heritage.

Source: *IFC, 2012*

The IFC's first performance standard establishes the importance of managing social and environmental performance throughout a project's lifecycle. It encourages the implementation of a permanent efficient social and environmental management system and real community participation thanks to a good policy of communication and consultation with local populations. It also encourages the integrated evaluation of impacts, risks and opportunities associated with the project right from its initial development phases, thus providing a hierarchy and coherence for the continuous mitigation and management of risks.

On the basis of the information that was collected during the framework report and visit to the site, it would appear that the IFC[1] performance standards applicable to the power plant project are as follows:

---

(1) http://www.ifc.org/wps/wcm/connect/38fb14804a58c83480548f8969adcc27/PS_French_2012_Full-Document.pdf?MOD=AJPERES
(2) The study was carried out on line with the new IFC performance criteria published in January 2012

- Performance Standard n°1: Assessment and management of social and environmental and social risks and impacts
- Performance Standard n°2: Labour and working conditions
- Performance Standard n°3: Resource efficiency and pollution prevention
- Performance Standard n°4: Community health, safety and security
- Performance Standard n°6: Biodiversity conservation and sustainable management of living natural resources

As specified in *Chapter 3* on description of the Project, the land on which the Cap-des-Biches power plant will be installed is part of the land allocated to SENELEC. Performance Standard n°5 (Acquisition of land and involuntary relocation) is not therefore directly applicable to the Project. This issue of land acquisition and local socio-economic consequences will however be addressed in this ESIA.

The project of extending the power plant will consist on the installation of two additional motors within the Project footprint area. This means that PS N°5 (Acquisition of land and involuntary relocation) will not be directly applicable to the project.

IFC directive on the Environment, Health and Safety

The World Bank Group has also published a series of Directives for the management of the environment, health and safety (EHS Directives). These directives are technical reference documents which present examples of international good practice of general scope or concern a specific branch of activity. They present environmental, health and safety guidelines.

Within the context of Project development, the main directives to take into account (that can be consulted on the IFC website) are:

- The general EHS Directive (2007), which presents the environmental, health and safety guidelines applicable in all areas
- The EHS Directive for thermal power plants (2008), which presents good practice to be applied in terms of the various types of power plants and according to the issues identified (particularly emission values to be complied with)
- The IFC EHS Directive on atmospheric emissions and ambient air quality published in 2007, which refer to WHO recommendations for air quality (1).

These Directives present, amongst other things, international recommendations and standards with regard to the main emissions,

(3) The IFC performance criteria 7 on native populations does not apply because no native population (as defined in the CP 7) was identified in the project area.
[1] WHO's guidelines on air quality are available on http://www.who.int/fr/

particularly noise emissions (see *Inset 4.1*), atmospheric emissions (see *Table 4.7*) and ambient air quality standards (see *Table 4.8*).

Inset 4.1 IFC standards on noise emissions

The IFC general EHS directives (2007) that implement the "Ambient Noise Directives" established by the World Health Organisation (WHO) in 1999, set forth absolute noise levels for day and night time, with two possible levels of sensitivity.
- industrial and commercial area
- residential, institutional and educational area.

In residential areas, ambient noise levels considered are 55 dB(A) by day and 45 dB(A) by night. These values are commonly used as design standards for industrial installations.

Measurements must be taken in the receptor areas located outside the limit of the project's property. In areas where ambient noise already exceed (prior to implementation of the project) 55 dB(A) by day and/or 45 dB(A) by night, the IFC requires that the Project's noise emissions should not increase the ambient noise level by 3 dB(A) or more in a residential area (during the noisiest time over a 24 hour period).

Table 4.7 IFC limit values for atmospheric emissions

Limit in standards		NO_x [mg/Nm³]	SO_x [mg/Nm³]	Dust [mg/Nm³]	CO [mg/Nm³]
IFC directives	BND(a)	1850	1170(c)	50	n/a
	BD(b)	400	0.2% S	30	n/a

a) Non-deteriorated basin
b) Deteriorated basin
c) Or use of 2% or less of S fuel

Table 4.8 *IFC air quality standards*

Pollutant	Average period	IFC standards [µg/m³]
SO_2	Calendar year	-
	24 h	125 (Intermediate target 1)
		50 (Intermediate target 2)
		20 (Guideline)
NO_2	Calendar year	40
	1 h	200
PM10	Calendar year	70 (Intermediate target 1)
		50 (Intermediate target 2)
		30 (Intermediate target 3)
		20 (Guideline)
	24 h	150 (Intermediate target 1)
		100 (Intermediate target 2)
		75 (Intermediate target 3)
		50 (Guideline)
CO	24 h	-

4.3 INSTITUTIONAL FRAMEWORK

This Chapter presents the various institutional units involved in validation and supervision of the Project. A recap of these various entities is presented in *Table 4.9*.

4.3.1 *At central level*

Economic, Social and Environment Council

The Economic, Social and Environmental council is made up of 80 councillors and 40 associate members, all of diverse and varied profiles. This diversity of members ensure the wealth of the Institution. Representatives include people from:

- Economic life and social dialogue
- Social and territorial cohesion and associations
- Nature and environmental protection.

The Economic, Social and Environmental council is Senegal's second constitutional Assembly. It acts for the public authorities as a consultative assembly that can be referred to by the President of the Republic, the National Assembly or the Prime Minister in the name of the Government, with requests for opinions or studies.

Made up of the Nation's lifeblood, the Economic, Social and Environmental council is a place for collaboration and participation by socioprofessional categories in the economic, social and environmental policy of the nation. It looks economic, social and environmental developments and suggests the necessary adaptations. It promotes a policy of dialogue and cooperation with local authorities and similar foreign organisations.

It can deal with the examination of economic, social and financial issues, undertake the necessary studies and enquiries and, in conclusion, issue opinions and suggestions for reform that it believes will encourage the nation's economic, social and environmental development.

It is referred to, for an opinion, by the President of the Republic:

- Compulsory for planned laws on programmes and plans of an economic, social or environmental nature, and
- Optionally for draft laws on programming to define multi-annual orientations for public finances, draft laws, orders or decrees and proposals for laws that fall within its area of jurisdiction.

The Environment and Sustainable Development Ministry

The Environment and Sustainable Development Ministry (MEDD) has the task of drawing up and applying environmental policy, the management of which involves several other participants, notably local authorities. In its task it is supported by several technical offices, notably:

- The Environment and Classified Installations Office (DEEC) ;
- The Environmental Planning and Supervision Office (DPVE) ;
- The Office for Water, Forests, Hunting and Soil Conservation (DEFCCS)
- The National Parks Office (DPN)
- The Ecological Monitoring Centre (CSE) ;

In the performance and tracking of ESIA procedures, the MEDD is supported by the Environment and Classified Installations Office (DEEC) and the Technical Committee.

The Environment and Classified Installations Office (DEEC)

In the field of environmental impact studies, this office, through the pollution and nuisance prevention and control division and the office for environmental impact studies, has the task of ensuring application of the provisions relating to environmental and social impacts studies.

It prepares, for the Environment Minister, opinions and decisions relating to environmental and social impacts studies.

The DEEC has an environmental impact studies division which includes specialists competent to ensure scientific and technical supervision as was as checks on compliance and legality.

The Environment and Classified Installations Office is represented at regional level by the Regional Environment and Classified Installations Offices (DREEC).

The technical committee for the validation of environmental impact studies

This was instituted by ministerial order n°00949 of 28th November 2001 and supports the MEDD in the validation of impact studies. Its secretariat is performed by the Environment and Classified Installations Office. The environmental impact study procedure focuses particularly on the holding of a public hearing with a view to validation by the people of the impact study. At this level, note the emergence of a civil society association called Association sénégalaise pour l'évaluation environnementale (ASEE) *(the Senegalese Association for Environmental Evaluation)*, created in 1994.

The Civil Protection Office (DPC)

The Civil Protection Office is responsible for ensuring the protection of people as well as the conservation of public and private installations, resources and property.

The DPC has the following tasks:

- In the field of prevention:
  - To draw up draft law on civil protection
  - To organise, with Regional and Auxiliary Civil Protection Commissions, and with interministerial technical committees, preventive visits to establishments that are open to the public, classified installations, high rise buildings and any other establishment that could present a hazard
  - To follow-up on reports issued after prevention visits
  - To issue opinions, in the form of safety studies, on construction project files for establishments open to the public, classified installations and high rise buildings. These opinions are issued prior to the granting of an authorisation to build
  - Train, inform and create public awareness of risk prevention.

- In the field of disaster management: to issue an opinion on Specific Intervention Plans (P.P.I.) and Internal Operations Plans (P.O.I.).

Thus, the Civil Protection Office draws up specific plans for the management of certain risks: rehabilitation and installation of fire hydrants, installation of lightning rods, etc.

It is thus clear that the DPC has both the resources and the competence necessary for performance of its mandate.

The Labour and Social Security General Office

This office is responsible for implementing the national policy on safety at work and for preparing the texts, orders and application decrees for the labour code. In this respect, it has the task of checking on performance by third parties, notably companies, of the professional risk prevention measures contained in current regulations.

It also works on the reinforcement of capacities in order to take better charge of this issue. In the exercise of its tasks it is supported by the Social Security Office, which also has human resources with competencies in this field.

The Ministry for Mines, Energy and Hydraulic Resources (ME)

The Ministry for Mines, Energy and Hydraulic Resources is responsible for setting out the sector policy and for defining applicable standards. It is solely authorised to grant the licences and concessions that give operators the right to produce, distribute or sell electricity on national territory. On proposal by the Electricity Sector Regulation Commission, the Minister also decides on the tariff conditions applicable to each concession.

The Electricity Sector Regulation Commission (CRSE)

The CRSE is responsible for the regulation of activities in production, transport, distribution and sale of electricity in Senegal. It is the CRSE that considers all requests for licences or concessions, and gives its opinion, with justification, to the Energy Minister for a decision and allocation.

Energy Office, under supervision of the Energy Ministry

The institutional framework of the energy sector was renewed in September 2013, with the establishment of a ministerial department dedicated solely to the sector and a redefinition of the roles of those involved. The Energy Office takes over from the Energy Ministry in terms of energy supply policy in Senegal and as such oversees companies in the para-public sector whose activity is in the import, export or sale of hydrocarbons.

The Energy Office's tasks include:

- The preparation and performance monitoring of development plans and energy based programmes
- Establishment of energy statistics and reports
- Ensuring the tracking of supplies to the domestic market of oil products
- Keeping track of companies and other autonomous administrations working in the energy sector (SENELEC, ASER, CNH, etc.…).

The energy authorities in Senegal (excluding the Ministry and the Energy Office presented above) are as follows:

- The Energy Sector Regulation Commission (CRSE), created by Law n°98-29 of 14th April 1998, it is responsible for the regulation of electricity

production, transport, distribution and sale in Senegal, and in particular for setting tariffs.
- SENELEC a limited company with majority public capital which has the monopoly over the distribution and sale of electricity within its perimeter of concession
- The Senegalese Agency for Rural Electrification (ASER) which promotes rural electrification
- The Agency for Energy Savings and Control (AEME), whose task is to promote the rational use of energy in every sector of activity
- The National Agency for Renewable Energies (ANER), which promotes the use of renewable energies in every sector of activity.

The following agencies also work in the energy sector, overseen by the Energy Ministry:
- The National Hydrocarbons Committee (CNH)
- The African refinery Company (SAR)
- The Senegalese Oils Company (PETROSEN).

Institutions concerned by the project

The main institutions potentially concerned by the Project are the following:

- The National Hygiene Office
- The National Hygiene Service
- The Water Resources Management and Planning Office (DGPRE)
- The Planning and Architecture Office
- The Land Planning Office
- The Local Authorities Office
- The Senegal National Office for Sanitation (ONAS)
- The Municipal Development Agency (ADM)
- Research Centres and Institutes

4.3.2 *At regional and local levels*

The Law 96-06 of 22nd March 1996 covering the local authorities' code defines the region, municipality and rural community in compliance with national unity and territorial integrity. It was modified in 2013 by a major reform of the territorial organisation of the State of Senegal, with a new decentralisation law. Law n° 2013-10 of 28th December 2013 covering the General Local Authorities Code – Act III of decentralisation sets out the framework.

Act 3 of decentralisation has the aim of achieving universal communalisation of local authorities whose economic powers will be increased, to improve local governance, to improve the land and local planning policy, to give local representatives a new status, to increase deconcentration and to define new types of relations between deconcentration and decentralisation, etc.

The current decentralisation context offers local authorities responsibilities in terms of the transfer of competencies, notably with regard to the management of natural resources. More specifically, they hold the prerogative for this management in the field of non-classified land, where they are the main players and even the beneficiaries, even if they very often do not have any proven competency in these areas.

Regional committees

Regional committees for the environmental and social monitoring of development projects (CRSE) have been set up in the regions by Governor order. CRSE meetings are called and chaired by Governors; the DREEC deal with the secretariat. These committees are made up of the technical services involved in the environmental and social management of projects. Amongst the competencies attributed to them, committees can:

- Support the environmental and social evaluation of local development projects;
- Carry out a review of any studies that have been undertaken;
- Track the application of mitigation/accompaniment measures;
- Track the implementation of any project management and monitoring plans;
- Contribute to strengthening the capacities of those involved.

Local authorities

Environmental protection also involves other administrative structure: at local authority level Law n° 96-07 of 22nd March 1996, which supplements the Local Authority Code, transferred competencies in nine areas, including the environment and the natural resource management.

Decree n° 96-1134 of 27th December specified the terms of application of the transfer of environmental and natural resource competencies. Thus local authorities (Region, Municipality and Rural Community) ensure the protection and management of natural resources and the environment.

NGOs and community associations

- Implementation of the active programmes drawn up after consultation with populations and civil society is based in great part on the mobilisation and involvement of non-government stakeholders, amongst which can be distinguished individuals, associations/groupings (civil society) and national NGOs. These proximity structures can play an important role in monitoring the implementation of development projects.

4.3.3 *Summary*

Table 4.9 ***Main institutions / administrative entities involved in the environmental management related to the Project***

Entities	Sub-entities	Fields of involvement / mandates
National administration		
Economic, Social and Environmental Council		Senegal's second constitutional assembly. Public and consultative powers.
Ministries		
Environment and Sustainable Development Ministry	Environment and Classified Installations Office (DEEC) Represented at regional level by the Regional Offices for the Environment and Classified Installations (DREEC)	Ensures the project's compliance with environmental policy and the texts of environmental laws and standards
	Technical Committee for the validation of environmental impact studies	Validation of impact study reports
Ministry of Mines, Energy and Hydraulic Resources	Energy Office	Energy supply policy and the supervision of para public sector companies
	Electricity Sector Regulation Commission (CRSE)	Regulation of production, transport, distribution and selling activities
	SENELEC	distribution and sale of electricity
	The Senegalese Agency for Rural Electrification (ASER)	promotion of rural electrification
	Agency for Energy Saving and Control (AEME)	Promotes the rational use of energy
	The National Agency for Renewable Energies (ANER)	Promotion of the use of renewable energies
Ministry of Trade, Industry and the Informal Sector	Industry Office	Management of industrial establishments
Ministry of Health and Social Action	Health Office	Professional illnesses
	Medical Prevention Office	Other illnesses and the Propagation of STD / Aids
Interior and Public Safety Ministry	Civil Protection Office	Probability of catastrophe and technological risks
Ministry of Land Planning and Local Authorities		
	Local Authorities Office	Interface between State and authorities for local development
Public Service, Labour and Institutional Relations Ministry	Employment Office	Job creating project
	Inspection of Work	Declaration of worksite opening. Professional illnesses according to the provisions of a recent decree
Regional administration		
Dakar region	Management of the regional environment	
Management of the regional environment	Management of the regional environment	
Local authorities		

Entities	Sub-entities	Fields of involvement / mandates
Town of Rufisque	Management of the local environment and living conditions	
Rural Community of West Rufisque	Management of the local environment and living conditions	
Delegates / elders in the neighbouring district of Darou Salam Azur	Management of the local environment and living conditions	
Associations and Non-Governmental Organisation		
Women's groups	Public consultation	
Fishermen's groups	Public consultation	
The Environment Commission APROPRE	Public consultation	
Gatherers/users of shells	Public consultation	

4.4 ADMINISTRATIVE PROCEDURES REQUIRED

This ESIA report is part of a wider administrative context; ContourGlobal - Cap des Biches must obtain the following authorisations and permits to enable the Project to succeed:

- Environmental permit (after validation of the ESIA);
- ICPE classification of facilities (subject to a request for authorization to operate for a classified installation);
- Building permit issued by the Urbanisation and Land Planning Ministry
- Project approval order under the Investments Code, by the Finance Ministry;
- Letter from the Finance Ministry relating to the authorisation to repatriate capital and the convertibility of CFA francs/euros or dollars;
- Letter from the Finance Ministry relating to agreement to the depreciation model for assets at the power plant ;
- Exemption from land tax on land on which buildings are constructed for the power plant ;
- Importer – exporter card ;
- Residence permits and visas from the Labour Ministry for expatriates ;
- Authorisation for foreign investment in Senegal granted by the Finance Ministry ;
- Private electricity producer licence and licence for the sale of energy issued by the Energy Ministry ;
- Agreement from the Finance Ministry on the terms for invoicing value added tax (VAT) by the company.

5 ANALYSIS OF THE SITE BASELINE AND ITS ENVIRONMENT

5.1 INTRODUCTION

5.1.1 *Aim and plan of this chapter*

This chapter presents a description of the environmental baseline:

- A summary of basic environmental conditions using documentary research, the results of inspections carried out in the field and public consultations;
- An identification of the main environmental sensitivities that may be affected by the project.

It includes a description:

- Of the physical environment ;
- Of the biological environment, of protected areas and habitats;
- Of the human environment (general review of socioeconomic conditions and the social context).

This description is completed by an analysis of ecosystemic services in the Project's area. Services rendered by ecosystems represent interactions between the natural environment and the human environment, and their study is based on an analysis of the main sensitivities identified.

5.1.2 *Sources of information*

The topics developed in this analysis of the baseline are based firstly on national, regional and local information. The analysis of environmental and social issues also takes account of the local context in the area in which the power plant is located, by means of a description of the baseline of the Project area. To this end, a desktop study covering the various topics at national and regional level (based on available bibliographic data) and a detailed field study of the installation site have been carried out, in order to have available reliable, up to date information as to the environmental and social components inherent to the Project.

A field study was undertaken from 24th to 27th June 2014 and resulted in a qualitative and quantitative analysis of the biological environment and of ecosystems, as well as initial public consultations. A second mission, undertaken from 6th to 10th October 2014 finalised the public consultations process with interviews with the various stakeholders, in order to describe the administrative, demographic and economic context. A visit was also made to places playing an important role in the social life of the communities concerned (religious buildings, holy places, schools, …) in order to collect secondary data. A visit to the construction site was performed in February 2016.

5.2 *STUDY AREA*

Definition of the study area is based on the various components linked to future activities, on their presumed interactions with the environment and surrounding populations, and on the local context and topics studied, with the aim of marking out the apparent potential zone of influence of the project in order to describe the various environmental and social components that may be influenced by implementation of the project.

Feedback from operation of the power plant in its initial configuration enabled the definition of two types of zones of influence: terrestrial and marine. The potential marine and terrestrial zones of influence are detailed below.

In addition to the Project's zone of influence, a remote study area was also taken into consideration for certain topics:

- Physical environment ➔ the study zone is defined according to the specific characteristics of each parameter studied. Thus, hydrography, climate and geology are presented in large scale, covering the normal variations of each parameter, according to the data available from as close as possible to the Project area.
- Human environment ➔ scale of the sub-prefecture or even the prefecture, depending on the topics addressed. Public consultations also follow this method. Interviews were also organised with representatives of the central administration in order to integrate certain more general topics (see Chapter 5.9 on the public consultations).

The potential marine and terrestrial zones of influence are shown in *Figure 5.1*.

Marine zone of influence

The Project's potential influence on the marine environment is mainly linked to the discharge of water into the coastal area. As detailed in the ToR report (*Annex 1*), a coastal area of 1km on either side of the Project area, up to a distance of 1km out to sea, has been taken into account. This marine environment study area is considered to cover the Project's zone of influence.

Terrestrial zone of influence

The Project's potential terrestrial zone of influence is mainly linked to the discharge of gases. Detailed in the ToR report (*Annex 1*), an area of a radius of 2km around the power plant has been taken into account.

Figure 5.1 Project's potential zones of influence (preliminary evaluation)

5.3 PHYSICAL ENVIRONMENT

The study of the physical environment of the areas in which the Project will be installed was carried out based on local bibliographic data, supplemented by more global information from generic data. In parallel, a field mission was carried out for:

- Geographic reconnaissance with identification of the project site's GPS coordinates;
- Reconnaissance of the Project's zones of influence

5.3.1 *Geomorphology*

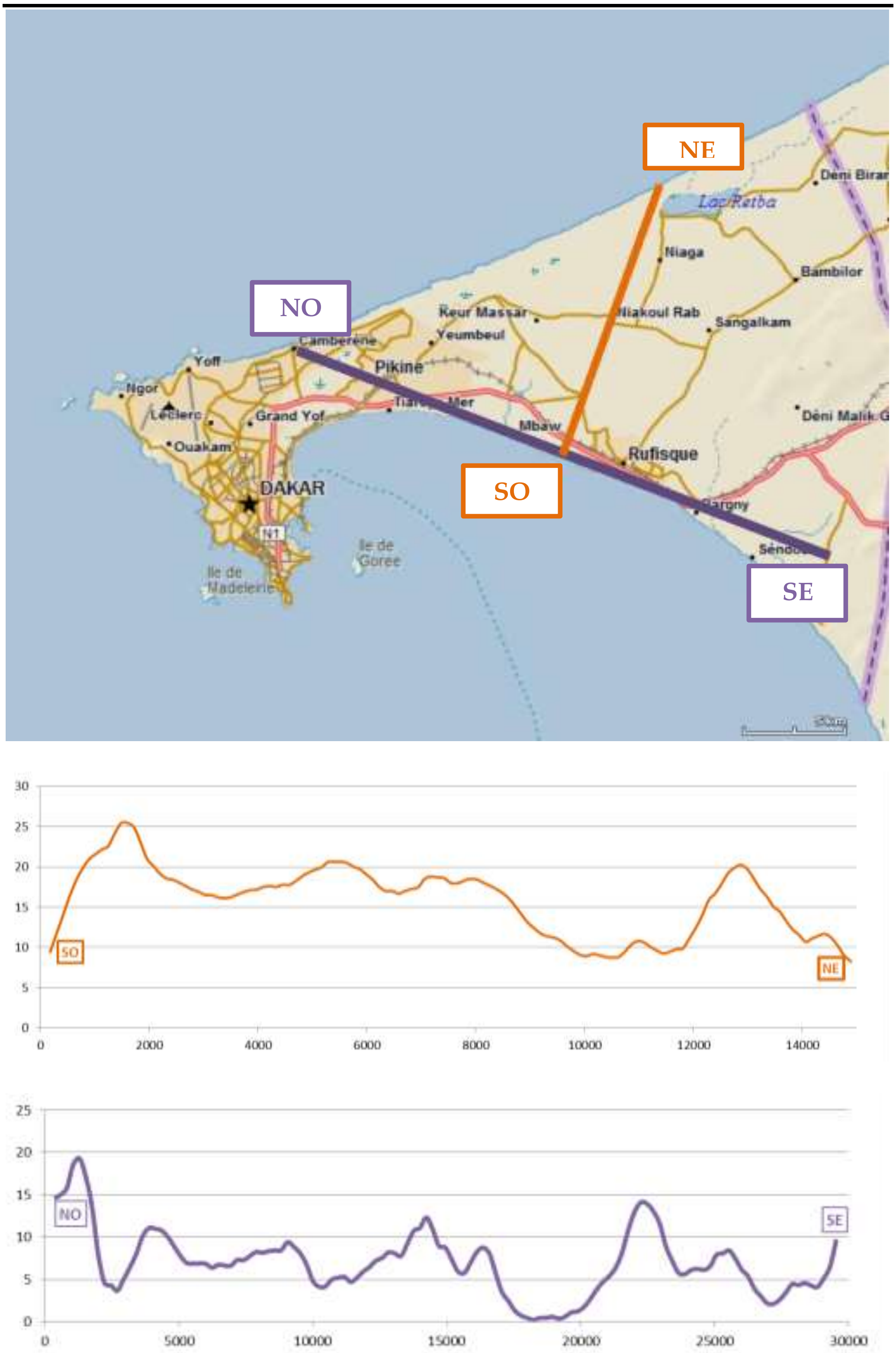
The Project will be installed on 2.99ha of flat land of homogenous geomorphology. Altitude at the installation site is 6 m and the same altitude is found across all parcels. The site is edged to the east by the Rufisque waste water treatment plant, whose waste water storage lagoons are surrounded with berms about 5m high.

Figure 5.2 Berms around the waste water storage lagoons at the Rufisque WWTP

At regional level (15km radius), relief in the coastal area remains homogenous, with altitudes of between 0 and 20m (average of about 7m). This increases slightly inland, with an altitude of between 6 and 25m (average of around 16m).

Figure 5.3 shows the altitude profiles over a 15km radius, in south-west / north-east and north-west / south-east directions.

Figure 5.3 *Morphology of the Project area – regional scale*



Source: *ERM based on altitude data from SRTM 90m (Shuttle Radar Topography Mission)*

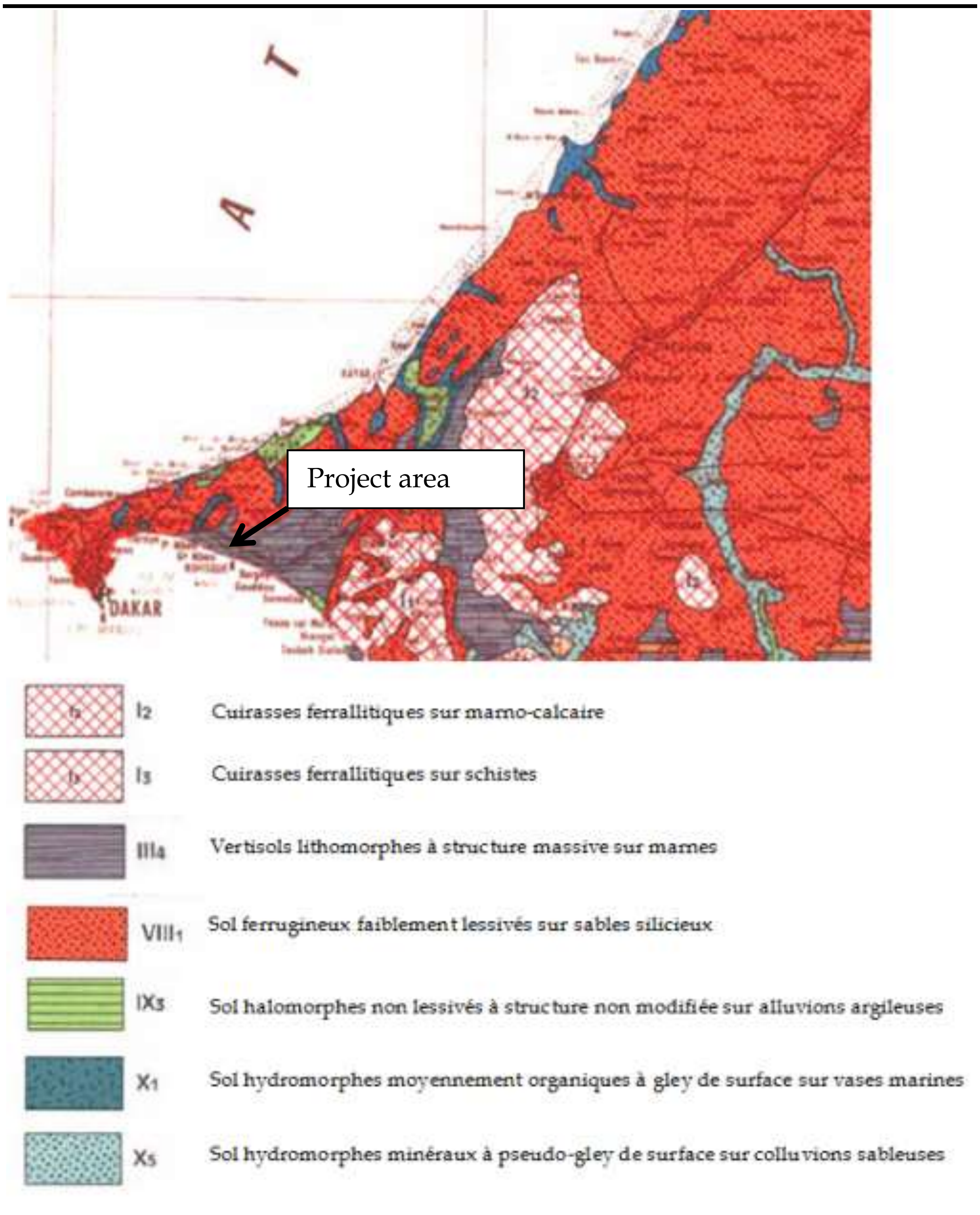
5.3.2 *Pedology*

An extract taken from the pedological map of Senegal (*Figure 5.4*) situates the project area in marlstone formations.

This bibliographic data is confirmed by a geotechnical report dated 16th July 2014 carried out by *Senelabo.btp* and describing the results of sampling taken from the parcel on which the power plant extension will be located. These samples characterised the soils at the site, as follows:

- At depths of 0 to 4m on average (max. 7.5m): clay formations containing high plasticity clays;
- At depths of 3.5 to 6m : sandy formation containing clay sands with shell concretions;
- At depths of 6 to 30m : limestone-marl formation.

Figure 5.4 ***Extract from the pedological map of Senegal***



Source: *Pedological map of Senegal, scale 1/1.000.000 – ORSTOM*

5.3.3 *Geology*

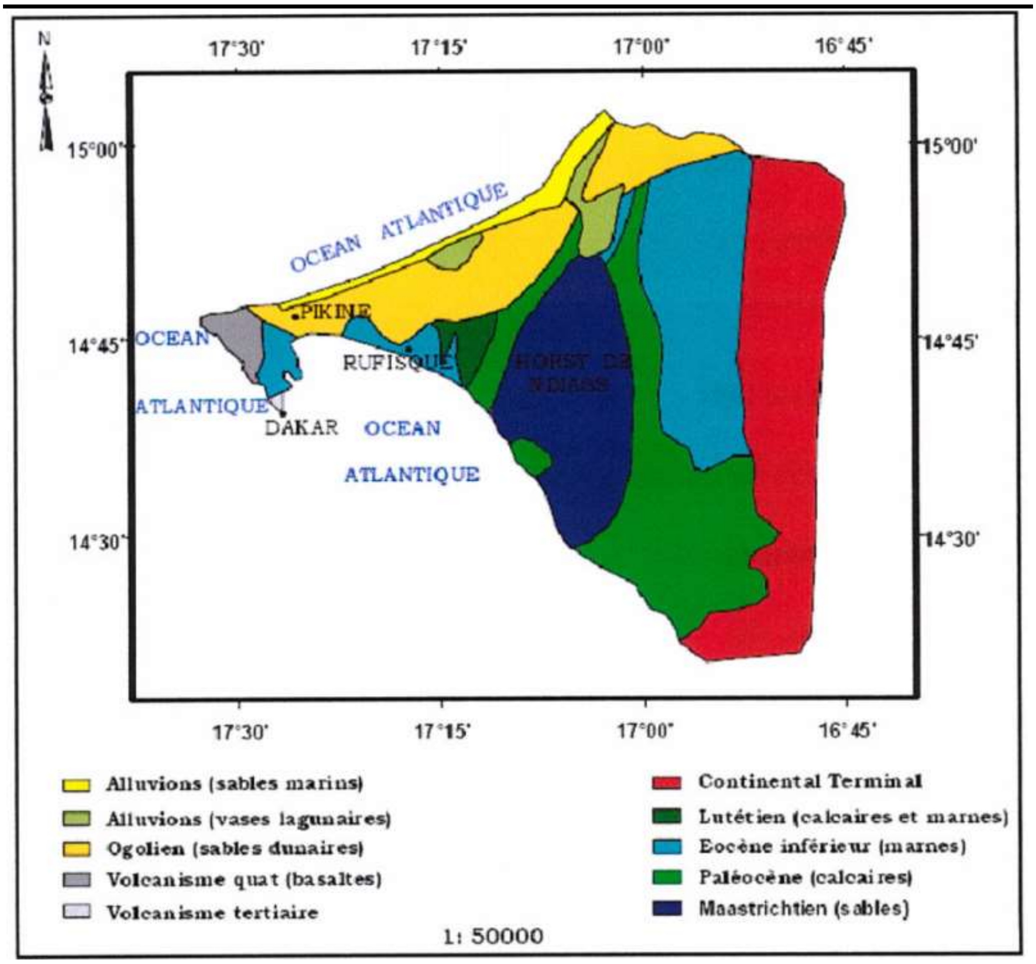
The Project site lies on a basalt substratum from the earliest quaternary. The site's geology is characterised by the presence of:

- Volcanic products (deposit of pyroclastic products and flows of doleritic basanite dating from the lower Pleistocene and the middle Pleistocene which touch the north-west of the peninsula (Figure 5.5), forming coastal cliffs.

- Infra-basalt sands, corresponding to the oldest known quaternary deposits. They comprise a group of sands and clays with sea shells as well as clay and dune sands, with a maximum known thickness of 74 m.

- Geology of the Dakar region is shown in Figure 5.5.

Figure 5.5 Geological outline of the Dakar region



Source: *P. Edouard, 1980*

5.3.4 *Hydrogeology*

According to the geotechnical report drawn up for the Project area (*Senelabo.btp, 2014*), piezometric levels are between 2m and 6m.

These variations can be explained by the proximity of the coast, which could lead to fluctuations in terms of the aquifer depending on the height of tides.

5.3.5 Hydrology

No water course is located in the area in which the Project will be installed. The sandy nature of the soils *Section 5.3.2*) encourages water flow in the soils, which is naturally drained towards the ocean. During the visit to the site, traces of run-off from the Rufisque WWTP adjacent to the site were observed.

To the south-east, at about 1 400m from the Project area, an outlet flows into the ocean. This is a temporary, channelled water course, which is also used to collect waste water from part of the town of Rufisque.

5.3.6 Seismicity

General

The substratum of Senegalese territory is made up of two major geological units: the sedimentary basin which occupies over ¾ of the territory and the Precambrian basement in the south-east of the country.

The Senegalese sedimentary basin dates from the Secondary and the Tertiary. It represents the central section of the north-west African coastal basin which runs from the Réguibat dorsal in the north (in Mauritania) to the Guinean fault in the south.

The most important tectonic accidents and movements are observed in the western section of the basin, in the Cap Vert Peninsula region and its surrounding areas, which have been unstable since the Cretaceous. Excluding this period of "relating instability" with intense tectonic activity in the Cretaceous (Secondary) and volcanism in the Cap Vert peninsula in the Tertiary, no major geological incident or seismic activity has ever been noted in Senegal.

The Senegalese basin is a typical, stable passive margin which opens towards the Atlantic Ocean. The study area is part of this geological context and therefore presents similar seismic conditions.

Seismicity in the Project area

The site is in a 0-1 seismicity area. This means that seismicity in the area is negligible but not zero to weak. The definitions are as follows:

- zone 0 of "negligible but not zero seismicity": there is no particular para-seismic instruction, no earthquake of over VII has been observed historically.

- zone I of "weal seismicity":

- no earthquake of an intensity higher than or equal to VIII has been observed historically, or
- the period for the return of an earthquake of intensity of over VIII exceeds 250 years
- the period for the return of an earthquake of intensity of over VII exceeds 75 years

5.3.7 *Climate*

Regional context

The area in which the Project will be installed is located between parallels 15° and 16° of north latitude. It is therefore part of the semi-arid intertropical area and part of the "Sahelo-Sudanian region" where the transition sub-desert regime is characterised by a three month rainy season (July to September) and a long dry season lasting almost nine months.

This seasonal cycle is caused by the antagonism of the flow of the Alizé trade wind or Harmattan wind (Sahel continental air) and the flow of the monsoon (damp equatorial air originating over the ocean). The area of convergence between these masses of air constitutes the intertropical convergence zone (ITCZ). These air currents are of different origins and directions. They are separated by the intertropical front which represents the northern limit of extension of the damp equatorial air. The position and movement of the ITCZ, mainly linked to surface temperatures, condition the regular alternation of the two seasons (*A. Martin 1970; Serigne FAYE, 1995*).

The Dakar region, which juts out into the Atlantic, is characterised by a coastal type microclimate, strongly influenced by maritime Alizé trade winds and the monsoon.

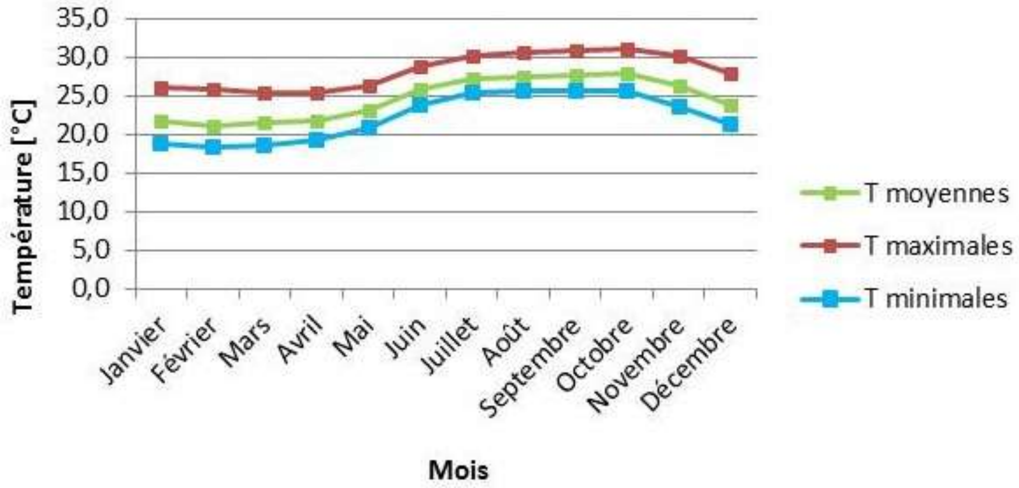
The closest weather station to the Project area is located at Dakar airport, about 20km to the west. This station is used as a reference for the description of the weather conditions presented below, for the period from 1973 to 2013.

Temperatures

The closest weather station to the study area offering regular temperature recordings is the one at Dakar airport, located about 21km from the Project area. The average temperature measured over the last twenty years (1993-2013) is 24.7°C. The Dakar region, where the study area is located, is characterised by a major Atlantic influence, leading to a smaller seasonal difference than in the rest of the country.

The climate is marked by a hot period, lasting from May to November, and a cool period, from December to April. The months July to October are the hottest on average (27.5ºC-27.9ºC) and the months of February and March are the coolest, on average (21.2 °C -21.5 °C). *Figure 5.6* and *Table 5.1* below present the average monthly temperatures recorded at Dakar airport.

Figure 5.6 ***Evolution in average monthly temperatures in Dakar, period: 1993 to 2013 (°C)***



Source: *ERM, 2014 based on data from Dakar airport (January 1993 to December 2013)*

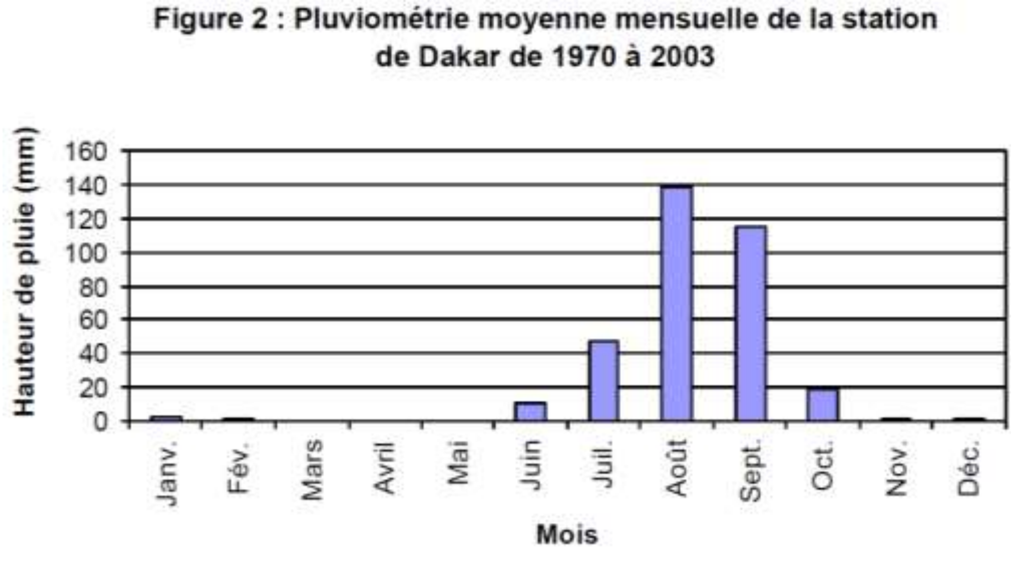
Table 5.1 ***Average monthly temperatures in Dakar, period: 1993 to 2013 (°C)***

Month	Average	Maximum average	Minimum average
January	21.8	26.0	18.9
February	21.2	25.8	18.3
March	21.5	25.4	18.6
April	21.7	25.3	19.2
May	23.2	26.4	20.8
June	25.8	29.0	23.7
July	27.3	30.2	25.5
August	27.5	30.6	25.7
September	27.7	30.9	25.6
October	27.9	31.2	25.7
November	26.3	30.2	23.7
December	23.9	28.0	21.3

Rainfall and cloud

Annual rainfall in the Dakar region is between 300 and 400mm (1970 to 2003 – see *Figure 5.7*). The frequencies of average daily rainfall shows that almost all rainfall is between 0.1 and 50mm. The heart of the rainy season is in the months of August and September, with maximum rainfall that can reach respectively 138mm and 115mm. The dry season runs between October and June.

Figure 5.7 Average monthly rainfall in Dakar, period: 1970 to 2003 (mm)



Source: *UNEP/UNESCO Décembre 2004 « Aquifère superficiel et pollution urbaine en Afrique. Rapport Final du Sénégal »*

Winds system

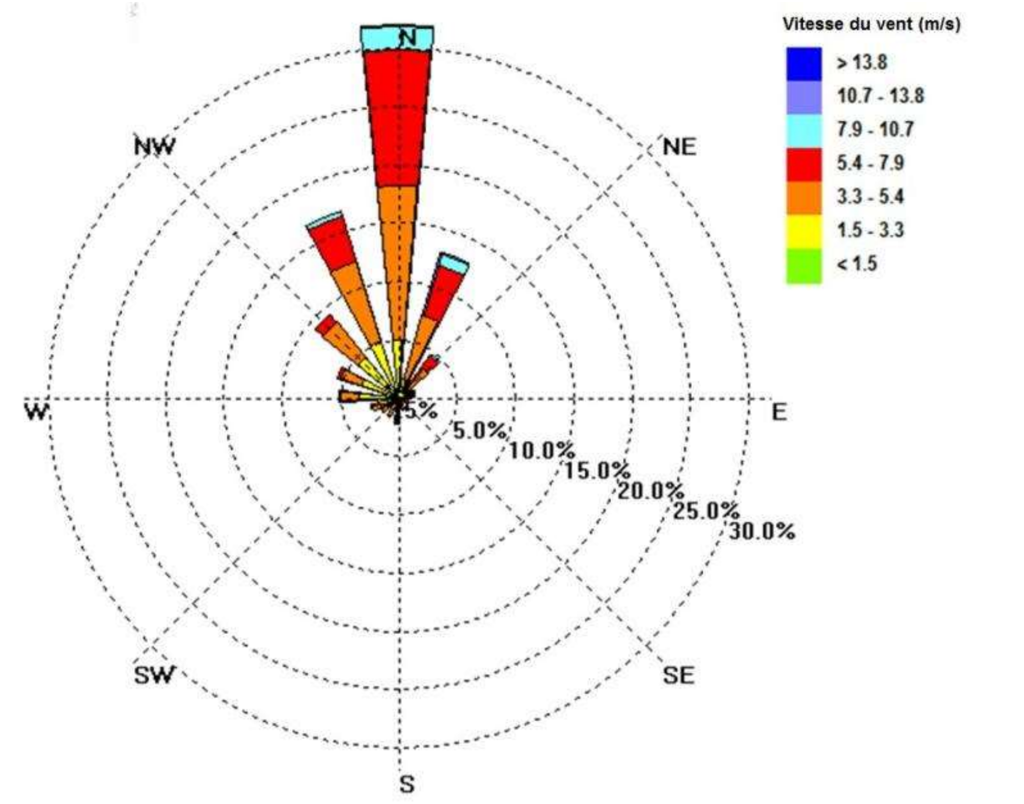
The winds system is characterised by a seasonal variation in prevailing wind directions:

- A season from October to May, with north and north-eastern winds, and
- A second season from June to September, where southern to western sector wind dominate very clearly in terms of frequency.

The wind direction compass in *Figure 5.8* shows that the winds system in the Project area presents a prevailing N and NW wind direction. Mild winds (<0.5 m / s) represent 0.49% of the average wind speed value of 4 m/s. The maximum speed recorded over the period under consideration (1993-2013) is 62 m/s, recorded in October 2007. Also, the maximum wind speed recorded over last year (2013) is 9 m/s.

This wind direction compass shows that, for most of the year, atmospheric emissions from the Project will be blown southwards towards the sea, which should help to minimise concentrations at ground level in the Project area and beyond.

Figure 5.8 Wind direction at the Dakar airport weather station in 2012



Source: ERM, 2014 based on data from Dakar airport *(1993-2013).*

Modelling of atmospheric dispersal conditions

Modelling of atmospheric dispersal conditions was undertaken for this ESIA in order to study closely the impact of atmospheric emissions from the Project. This modelling was based on an extrapolation of one-off measurements of weather conditions in the study area. The data was extrapolated using CALMET software in order to take account of annual climatic variations at the Project area, and therefore is a reliable description of actual atmospheric dispersal conditions in the area where the future power plant will be installed. This is input data which was then used to model the dispersal of gaseous discharge (presented in *Section 8.5* of this study).

CALMET software can be used to generate data in three dimensions for the main meteorological variables. The wind direction compass is created using orography (1), land use and a geographic and altitudinal extrapolation of meteorological data, according to an hourly base and weather data for 2013.

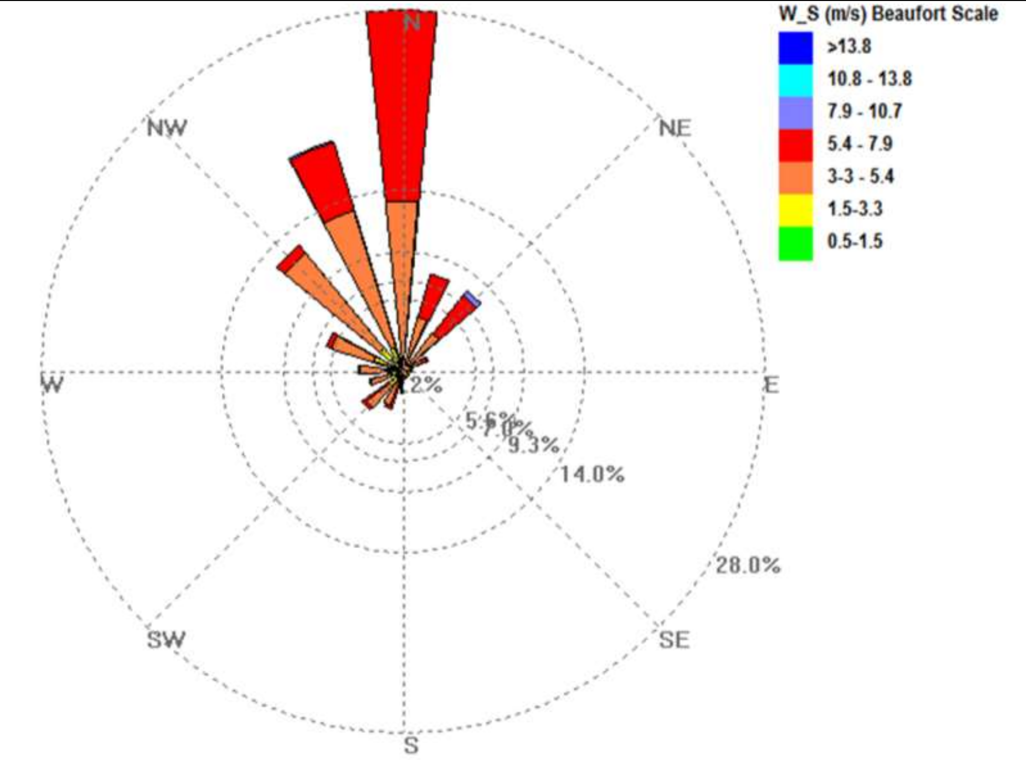
Climatic data is obtained from radiosondes (2) representative of the project area, and is similar to that measured at Dakar airport and presented above. It was transmitted by *Lakes Environmental™*, an international supplier of environmental data (topographic and meteorological).

(1) Data describing the topography of an area.

(2) Meteorological device carried by a sensor-balloon and measuring the characteristics of the atmosphere from ground level up to an altitude that can exceed 35 000 metres.

The wind direction compass below (*Figure 5.9*) was created using these simulations. It is characterised by prevailing north-north-west sector winds which represent over 55% of the winds. The prevailing winds are of moderate speeds (between 3.5 and 5.4 m/s). The strongest winds (up to 7.9 m/s) are more common from the north sector.

Figure 5.9 ***Compass of wind directions in the Project area (modelling)***



Source: *Lakes Environment, 2013*

5.3.8 *Air quality*

Air Quality Standards (AQS)

Current air quality conditions have been assessed on the base of the comparison of monitored concentrations against in force National and International Air Quality Standards (AQS).

At the Senegalese national level, the Law *NS – 05-062- December* 2004 *Pollution atmosphérique – Norme de rejets* sets in force Air Quality Standards (AQS).

International AQS are set by the *IFC Environmental, Health, and Safety Guidelines for Air Emissions and Ambient Air Quality* published on 2007, which refers to the WHO Air Quality Guidelines[1].

[1] WHO Air Quality Guidelines are available at http://www.who.int/en

Table 5.2 presents both national and international air quality standards, for the pollutants of interest for this study.

The international standards presented in *Table 5.2* include guideline values and interim targets levels. The latter, in excess of the guideline values, have been set by WHO to promote a steady progress towards meeting the Air Quality guideline value in developing countries where ambient air quality often exceed the guideline values[1]. WHO in its *Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide – Global Update 2005* also states that interim targets are proposed as incremental steps in a progressive reduction of air pollution and are intended for use in areas where pollution is high.

Therefore, considering that the Project is located in the near proximity of large existing power generating facilities, likely to have a negative adverse impact on local air quality, the IFC interim targets 1 has been considered in the assessment.

Table 5.2 ***Senegalese and IFC/WHO Air Quality Standards***

Pollutant	**Averaging period**	**Senegale AQS [µg/m³]**	**IFC/WHO AQS (a) [µg/m³]**
SO_2	Calendar year	50	-
	24 h	125 (b)	125 (Interim target 1)
			50 (Interim target 2)
			20 (Guideline)
NO_2	Calendar year	40	40
	1 h	200	200
PM10	Calendar year	80	70 (Interim target 1)
			50 (Interim target 2)
			30 (Interim target 3)
			20 (Guideline)
	24 h	260	150 (Interim target 1)
			100 (Interim target 2)
			75 (Interim target 3)
			50 (Guideline)
CO	24 h	30000 (c)	-

(a) IFC Guideline value
(b) It corresponds to the IFC interim target -1 set on SO_2 24h concentration.
(c) Not to be exceeded more than once per calendar year

Air Quality Field Survey Overview

Contour Global has been undertaking an air quality monitoring survey in the airshed of the Project, since November 2014. To date, the monitoring survey is

[1] "WHO air quality guidelines global update 2005", Report on a working group meeting, Bonn, Germany, 18-20 October 2005.

ongoing and the data reported in this Section covers the time period up to December 2015.

The air quality monitoring survey focuses on the following atmospheric pollutants:

- NO_x, NO_2 and SO_2, concentrations were measured at 6 monitoring sites since November 2014 by means of Gradko diffusion tubes; and
- PM10 and PM2.5, measured at 3 monitoring sites since September 2015 by means of E-Samplers manufactured by Met One Instruments.

It is noted that observed baseline data were not fully available while developing the ESIA for the initial Project. The latter included only measured concentrations of NO_x, NO_2 and SO_2 over a two-month period (27/11/2014 to 23/01/2015), and no measured data for PM as PM monitoring activities started after the submission of the ESIA for the initial Project.

The following *Table 5.3* provides an overview of the air quality monitoring survey.

Table 5.3 Overview of Air Quality Monitoring Survey

Pollutants Monitored	Monitoring Method	Monitoring Equipment	Monitoring Location	Monitoring Period	Monitored concentration
NO_x , NO_2 SO_2	Passive Sampling	*Diffusion tubes* (1)	Six (6) monitoring sites: SQA1 to SQA6 in *Figure 5.10*	Period 27/11/2014-28/12/2015 (2)	Monthly concentration
PM_{10}, PM_{25}	Active Sampling	Active Samplers: *E-Samplers* (3)	Three (3) monitoring sites: SQA2, SQA5, and SQA6 in *Figure 5.10*	Period 09/09/2015-31/12/2015	5 minutes concentration

(1) *Provided by Gradko Environmental Laboratory*

(2) *Monitoring activities were interrupted in late May and resumed early July*

(3) *Manufactured by Met One Instruments. It is noted that in January 2016 E-Samplers were replaced by BAM-1020 monitors, also manufactured by Met One Instruments, which are designated USEPA Equivalent Methods for PM10 and PM2.5.*

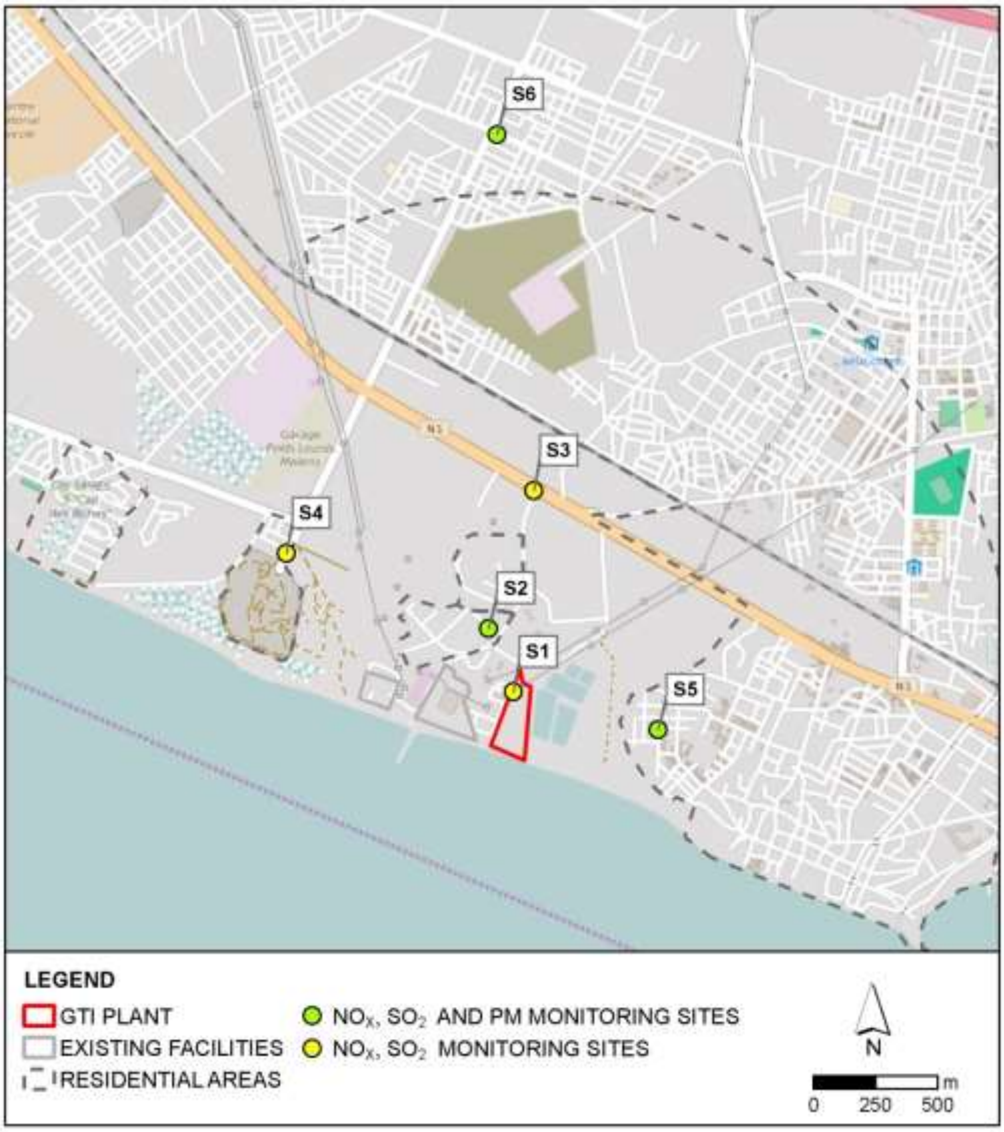
Air Quality Monitoring Sites

Figure 5.10 shows the location of the six monitoring sites. These locations have been defined after a technical meeting with DEEC held on November, 27th, 2014.

Five monitoring sites (S2, S3, S4, S5 and S6) are located in the nearby residential areas (sensitive receptors). Site S6 is the furthest monitoring location upwind of the Project, and is considered as a "reference" point characterising the baseline ambient air quality within the wider Project airshed.

Site 1 (S1) is located at the Power Plant fence line with the existing operating Senelec CIII plant, running on HFO (also near the operating Aggreko and APR containerised power generation units, also running on HFO). It is thus located in an industrial area (it is not considered as a sensitive receptor). This point is used as a reference point to assess the effects of the existing SENELEC, Aggreko and APR facilities in the industrial area of Cap des Biches. Note that the Aggreko and APR containerised units are not expected to be operational once ContourGlobal's power plant comes online.

Figure 5.10 Air Quality Monitoring Sites



Note that in the figure above, S1 is not to be considered as a sensitive receptor; hence it is presented in this note in grey italic font. S1 is located in an industrial area, away from sensitive receptors, within the footprint of the ContourGlobal Cap des Biches site. It was used as a reference to characterise site-specific ambient air quality.

NO_2 and SO_2 Monitoring Results

The following *Table* 5.4 and *Table* 5.5 present the monitoring results collected for NO_2 and SO_2 respectively; results refer to the monitoring period

27/11/2014- 28/12/2015. It should be noted that monitoring activities were interrupted in late May and resumed early July.

The monitoring activities conducted for NO_2 and SO_2 concentrations measured monthly concentrations of pollutants over the above mentioned period of about 12 months, with a high percentage of valid data ranging from a minimum of 83% to a maximum of 100%.

The Tables below report the average of the monthly concentration values collected over the whole monitoring period in comparison with WHO and Senegalese AQS set on annual concentrations. The monitoring period covers about 12 months, and as such the presented averages can be reliably assumed representative of the annual average concentration at the selected monitoring sites.

Table 5.4 NO_2 Monitoring Results

Site	NO_2 Ambient measured Concentrations [27/11/2014- 28/12/2015](3) [µg/m³]	Senegalese and IFC standards set on NO_2 annual average concentration [µg/m³]	% of AQS at current baseline
S1	*54.11*	*40*	***135%***
S2	16.96	40	42%
S3	23.11(1)	40	58%
S4	15.19(1)	40	38%
S5	13.93 (1)	40	35%
S6	18.44(2)	40	46%

(1) *Average of results obtained for 10 monthly sampling periods as data were missing for two sampling periods*
(2) *Average of results obtained for 11 monthly sampling periods as data were missing for one sampling periods*
(3) *Data are not available for the month of June*

Table 5.5 SO_2 Monitoring Results

Site	SO_2 Ambient measured Concentrations [27/11/2014- 28/12/2015][3] [µg/m³]	Senegalese and IFC standards for SO_2 annual average concentration [µg/m³]	% of AQS at current baseline
S1	*105.64*[1]	*50*	***211%***
S2	7.41	50	15%
S3	12.05[2]	50	24%
S4	3.82[1]	50	8%
S5	19.50	50	39%
S6	4.17	50	8%

(1) *Average of results obtained for 11 monthly sampling periods as data were missing for one sampling periods*
(2) *Average of results obtained for 10 monthly sampling periods as data were missing for two sampling periods*
(3) *Data are not available for the month of June*

Monitoring results shows that NO_2 and SO_2 baseline concentrations are well below inforce AQS at sensitive receptors (sites from S2 to S6). Therefore the local airshed at sensitive receptors is classified as undegraded.

Monitored concentration of SO_2 and NO_2 at the monitoring site S1 exceeds the regulatory limits. This exceedance is recorded in an industrial area which does not represent a sensitive receptor. Moreover the high concentrations recorded at the monitoring site S1 are highly influenced by the operation of the Senelec Plant CIII and of the Aggreko units. These facilities are not expected to be in operation when the Project will become operative.

PM10 and PM2.5 Monitoring Results

PM monitoring results presented in this section were not included in the ESIA for the initial Project, as PM monitoring activities started after the submission of the ESIA for the initial Project.
The following *Table 5.6* and *Table 5.7* present the monitoring results collected for PM10 and PM2.5 respectively; results refer to the monitoring period 09/09/2015- 31/12/2015. The monitoring activities conducted for PM10 and PM2.5 concentrations measured 5-minute concentrations subsequently converted to hourly average concentrations for processing. It is noted that the monitoring produced a high percentage of valid data ranging from a minimum of 86% to a maximum of 96.5%.

- The highest 24-h concentration measured during the monitoring period in comparison with WHO and Senegalese AQS set on 24-hour concentrations; and
- The average of the daily concentration values collected over the whole monitoring period in comparison with WHO and Senegalese AQS set on annual concentrations. Monitoring results refer to a time period of

approximately 4 months (from the 9th of September 2015 until the end of December 2015) during the dry season which is characterized by higher atmospheric concentrations of PM, due to the absence of wet deposition. Hence, data available to date are representative of the highest PM concentrations expected throughout the year. In light the above, the average of PM monitoring results over the 4 months monitoring period is not directly comparable against the air quality standards set on annual concentrations. The latter are reported simply as a reference in the following *Table 5.6* and *Table 5.7*. The classification of the local airshed with regards to PM will be assessed once PM monitoring data are collected for a 12-month period.

In addition, monitored results are summarized in *Figure 5.11* and *Figure 5.12*, plotting 24-hour average concentrations by day for each site, and for PM_{10} and $PM_{2.5}$ respectively. Each *Figure* also shows the wind speed during the monitoring obtained from the Dakar airport along with WHO and Senegalese AQS set on 24- hour concentrations.

Table 5.6 PM10 Monitoring Results

Site	Averaging period	Ambient measured Concentrations(1) [µg/m³]	WHO AQS (Interim Target 1) [µg/m³]	% WHO AQS	Senegalese AQS [µg/m³]	% Senegalese AQS
S2	24 hour	658.3	150	439%	260	253%
	Annual Average	*106.2*(2)	70	152%	80	133%
S5	24 hour	691.6	150	461%	260	266%
	Annual Average	*114.1*(2)	70	163%	80	143%
S6	24 hour	784.6	150	523%	260	302%
	Annual Average	*160.8*(2)	70	230%	80	201%

(1) Percentage of valid hourly data 86% for S2, 95.6% for S5 and 89.5% for S6

(2) Average of daily concentrations collected over the period 09/09/2015-31/12/2015; provided values represent 4-month average concentrations during the dry season.

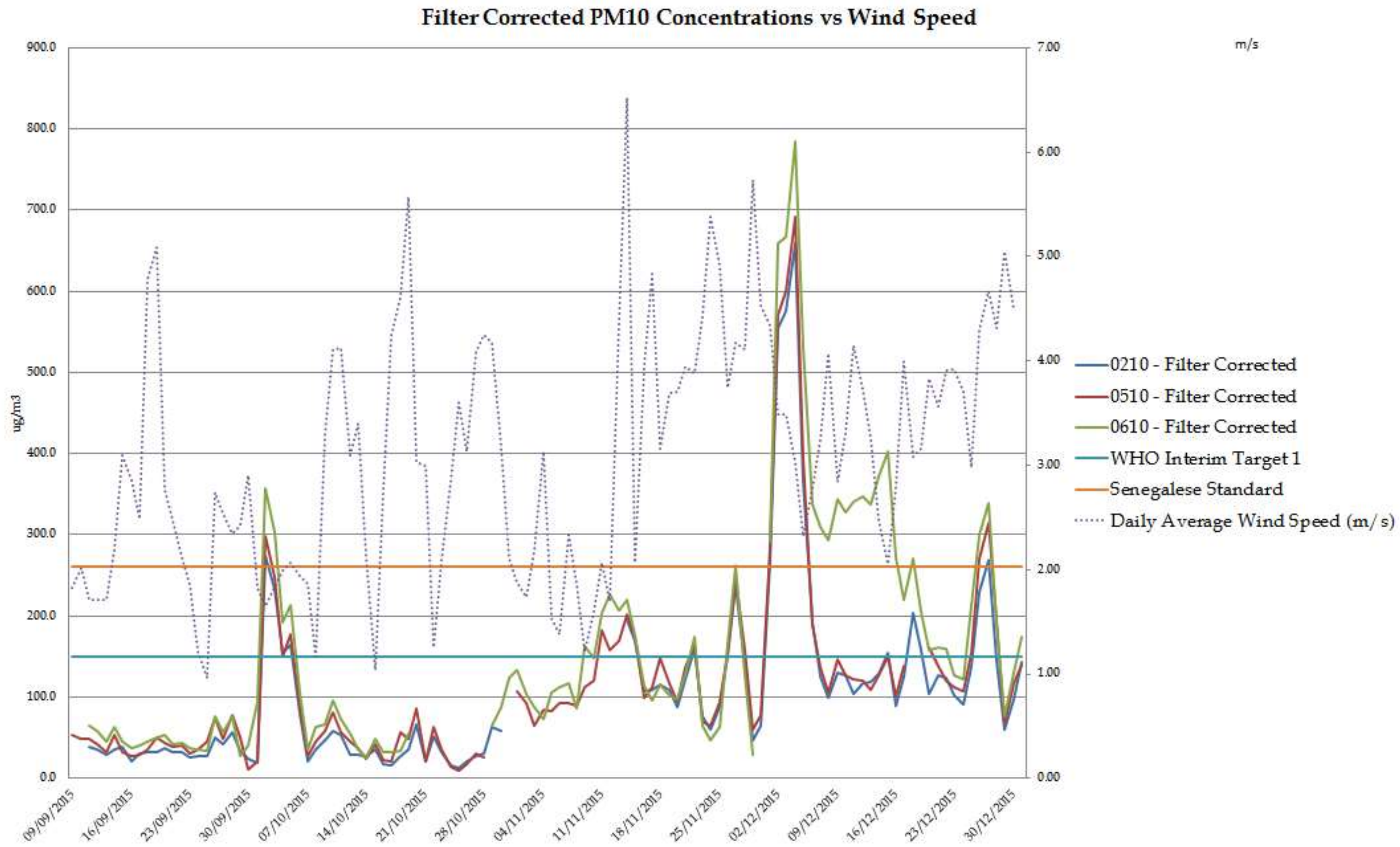
Table 5.7 PM2.5 Monitoring Results

Site	Averaging period	Ambient measured Concentrations(1) [µg/m³]	WHO AQS (Interim Target 1) [µg/m³]	% WHO AQS
S2	24 hour	172.0	75	229%
	Annual Average	*35.8(2)*	35	102%
S5	24 hour	222.2	75	296%
	Annual Average	*40.2(2)*	35	115%
S6	24 hour	222.3	75	296%
	Annual Average	*41.0(2)*	35	117%

(1) Percentage of valid hourly data 92.1% for S2, 96.5% for S5 and 95.6% for S6

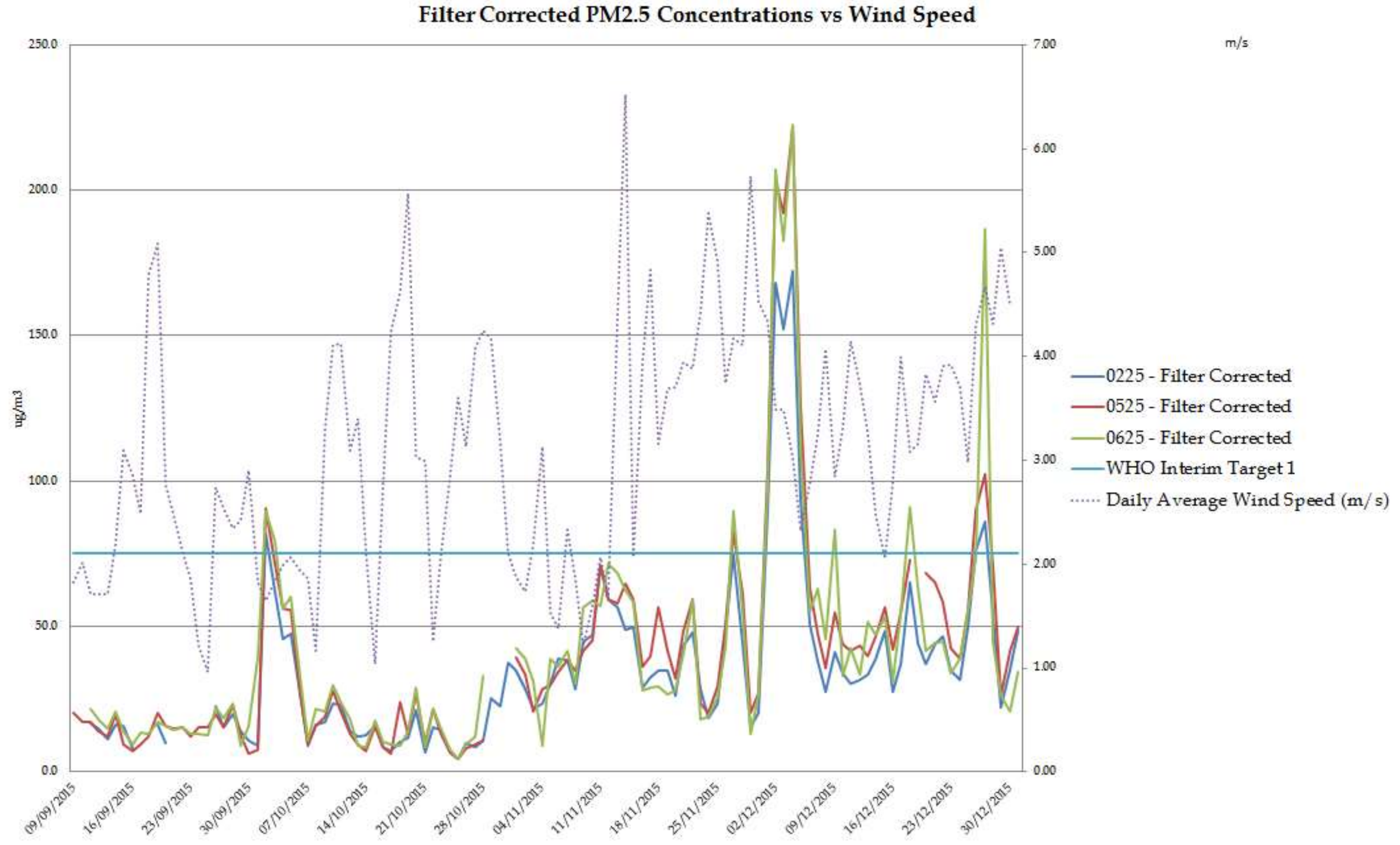
(2) Average of daily concentrations collected over the period 09/09/2015-31/12/2015; provided values represent 4-month average concentrations during the dry season.

Figure 5.11 Profile of PM10 24-h Concentrations over the Period 09/09/2015-31/12/2015



0210 indicates PM10 concentrations monitored at the site S2
0510 indicates PM10 concentrations monitored at the site S5
0610 indicates PM10 concentrations monitored at the site S6
Velocity indicates the Wins Speed velocity expressed in [m/s]

Figure 5.12 Profile of PM10 24-h Concentrations over the Period 09/09/2015-31/12/2015



0225 indicates PM25 concentrations monitored at the site S2
0525 indicates PM25 concentrations monitored at the site S5
0625 indicates PM25 concentrations monitored at the site S6
Velocity indicates the Wins Speed velocity expressed in [m/s]

The average PM10 and PM2.5 concentration measured at each monitoring site over the 4 –month monitoring period does not comply with Senegalese and WHO AQSs, set on annual average concentrations (data in *Table 5.6* and *Table 5.7)*. However, it is noted that the comparison against the limit set on annual average concentration is conservative. This is because the 4-month average concentration was measured during the dry season; as such it is expected to be higher than the annual average concentration which takes into account both dry and wet months.

The highest PM10 and PM2.5 24-hour concentration measured at each monitoring site exceeds the Senegalese and WHO AQSs set on 24-hour concentrations (data in *Table 5.6* and *Table 5.7)*. However while looking at the daily profile of 24-hour average concentrations at the three sites - (*Figure 5.11* and *Figure 5.12*) - the following conclusions can be drawn:

- Monitored PM10 concentrations are below the WHO AQS for about 73% of the monitoring period on average over the three sites;
- Monitored PM10 concentrations are below the Senegalese AQS for about 88% of the monitoring period on average over the three sites;
- Monitored PM2.5 concentrations are below the WHO AQS for about 91% of the monitoring period on average over the three sites.

In general it is clear that for the most part, the measured PM_{10} and $PM_{2.5}$ concentrations correlate well with high wind conditions. These results indicate that the air quality in the area is a regional issue as opposed to any particular site being influenced by a nearby source of emissions.

The correlation with wind speed also indicates a regional phenomenon with the strong north northeast winds of Harmattan during the winter months contributing to the higher concentrations.

To further investigate this issue, three sets of particulate filters from the E-Sampler monitors were sent to MVA Scientific for compositional analysis of the collected particulate matter. Each filter set consisted of the PM10 and PM2.5 filters from a given monitoring site during a selected time period. The results of this analysis are summarized in Table 5.8. Also Figure 5.13, Figure 5.14, Figure 5.15 represents the wind roses from the Dakar Airport corresponding to each set's time period.

The analysis shows that by far the highest percentage composition of particulate matter on each filter was classified as Soil Minerals, representative of naturally occurring dust or sand. This class accounted for greater than 75 percent by weight of the total material. The category called Aciniform Soot represents combustion products, such as particles from heavy fuel oil combustion. Generally this class accounted for less than 15 to 20 percent by weight of the sample. The category NaCl represents the amount of particulate matter potentially attributable to the coastal climate and sea salts. The Iron-rich category is basically a sub-category of Soil Minerals, although separated to represent possible particle composition due to rust and corrosion as well as naturally occurring.

Table 5.8 Summary of Filter Composition Results

						Approximate Weight %				
Site	**Filter No.**	**Filter Type**	**Start Date**	**End Date**	**Accumulated Weight (µg)**	**Aciniform Soot**	**Soil Minerals**	**NaCl**	**Iron-rich**	**"Other"**
SQA5	SEN-8	$PM_{2.5}$	9/23/2015	10/9/2015	1330	15-20%	75-85%	ND	3-8%	None Detected
	SEN-10	PM_{10}	9/23/2015	10/9/2015	4130	10-15%	80-90%	<1%	3-8%	Fungal Material, Diatom Fragments
SQA2	SEN-35	$PM_{2.5}$	11/20/2015	12/4/2015	2300	5-10%	85-95%	<1%	3-8%	Fungal Material
	SEN-40	PM_{10}	11/13/2015	12/4/2015	11233	5-10%	80-90%	3-8%	3-8%	Fungal Material, Diatom Fragments
SQA6	SEN-56	$PM_{2.5}$	12/4/2015	1/8/2016	9300	10-15%	75-85%	2-5%	3-8%	Fungal Material, Char
	SEN-54	PM_{10}	12/4/2015	1/8/2016	18600	10-15%	80-90%	3-8%	3-8%	Char, Fungal Material, Diatom Fragments, Trichomes

Notes:
< = Results less than the laboratory reporting limit.

Abbreviations:
µg = Micrograms
NaCl = Sodium Chloride
ND = Non detect

In reviewing the wind roses, the filters associated with Site 2 and Site 6 collected samples with winds blowing almost exclusively from the north and north-northeast at relatively high wind speeds during the respective time periods. The Site 2 filter set had the lowest percentage of soot composition. The Site 6 filter set had slightly higher soot composition, but still was dominated by soil minerals. The Site 5 filter set experienced the most variable and low speed winds during the sample period and yielded slightly higher soot composition.

Overall, it appears that naturally occurring soil dust and sand, likely originating from the north northeast of Dakar during high wind periods, account for the vast majority of the particulate air quality concerns in the area.

As mentioned, PM monitoring activities will be continued until a one-year dataset is available, in order to make an assessment about the quality of the airshed with regards to PM.

Figure 5.13 Windrose for site 2 time period

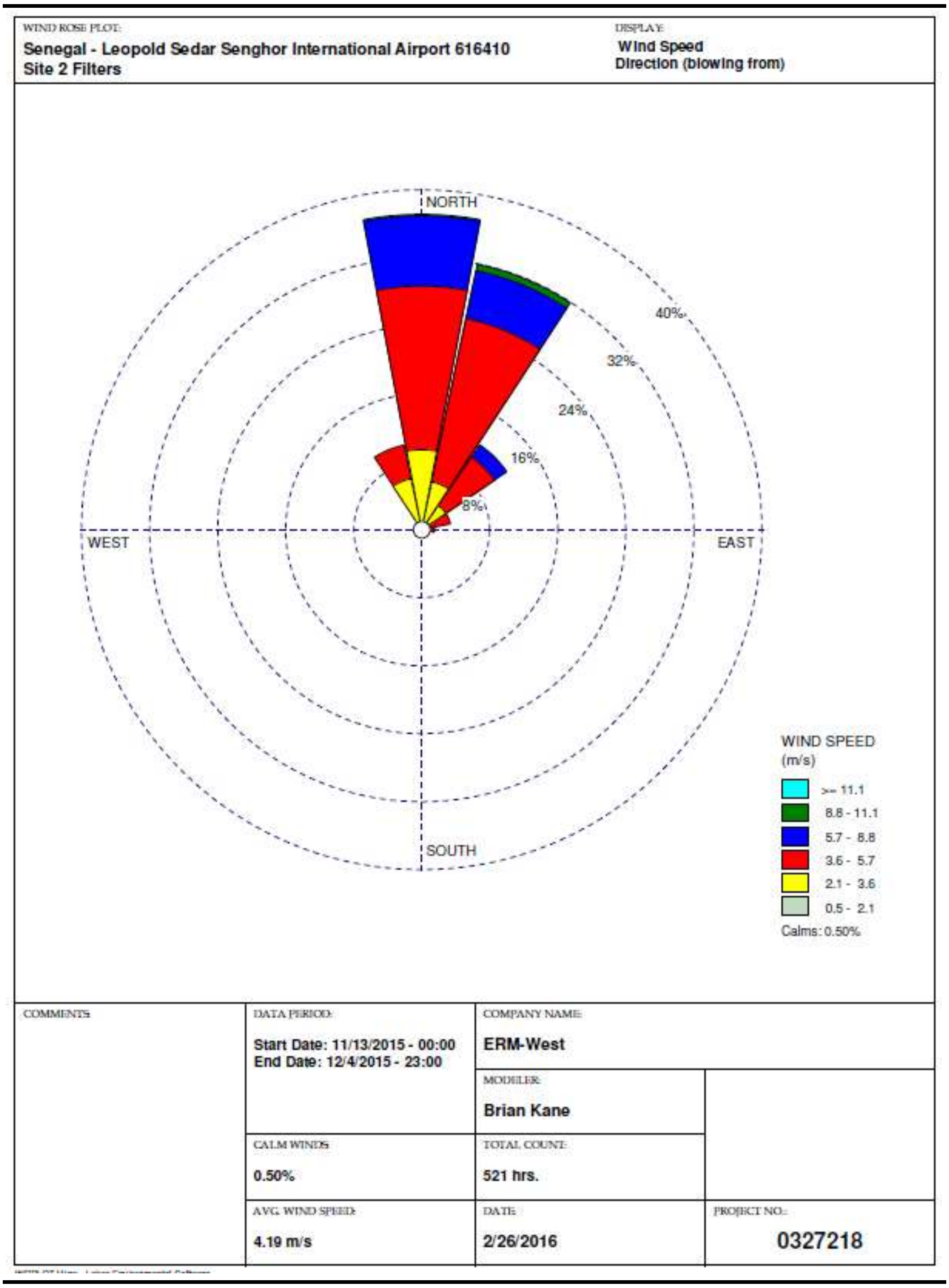


Figure 5.14 Windrose for site 5 time period

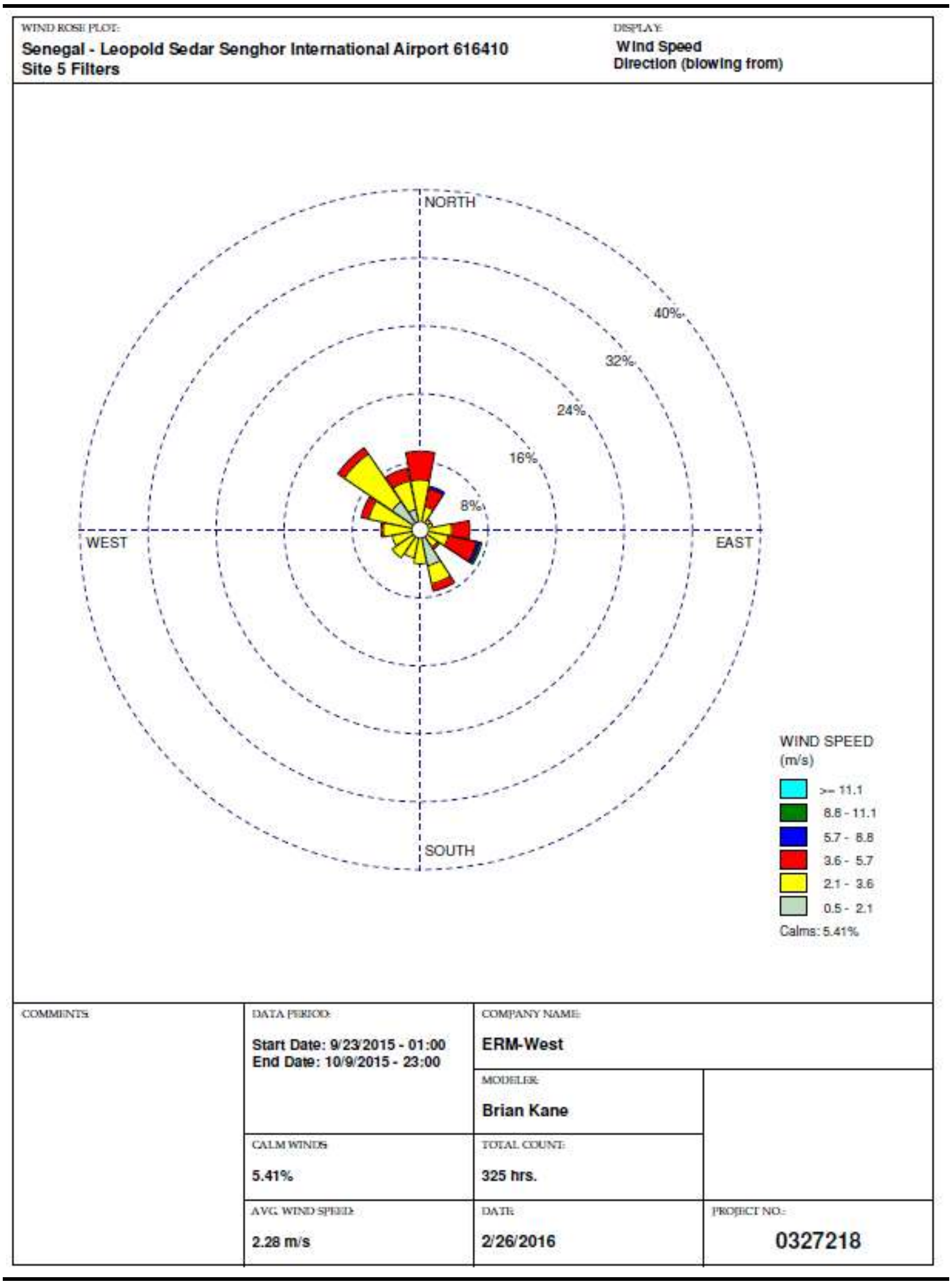
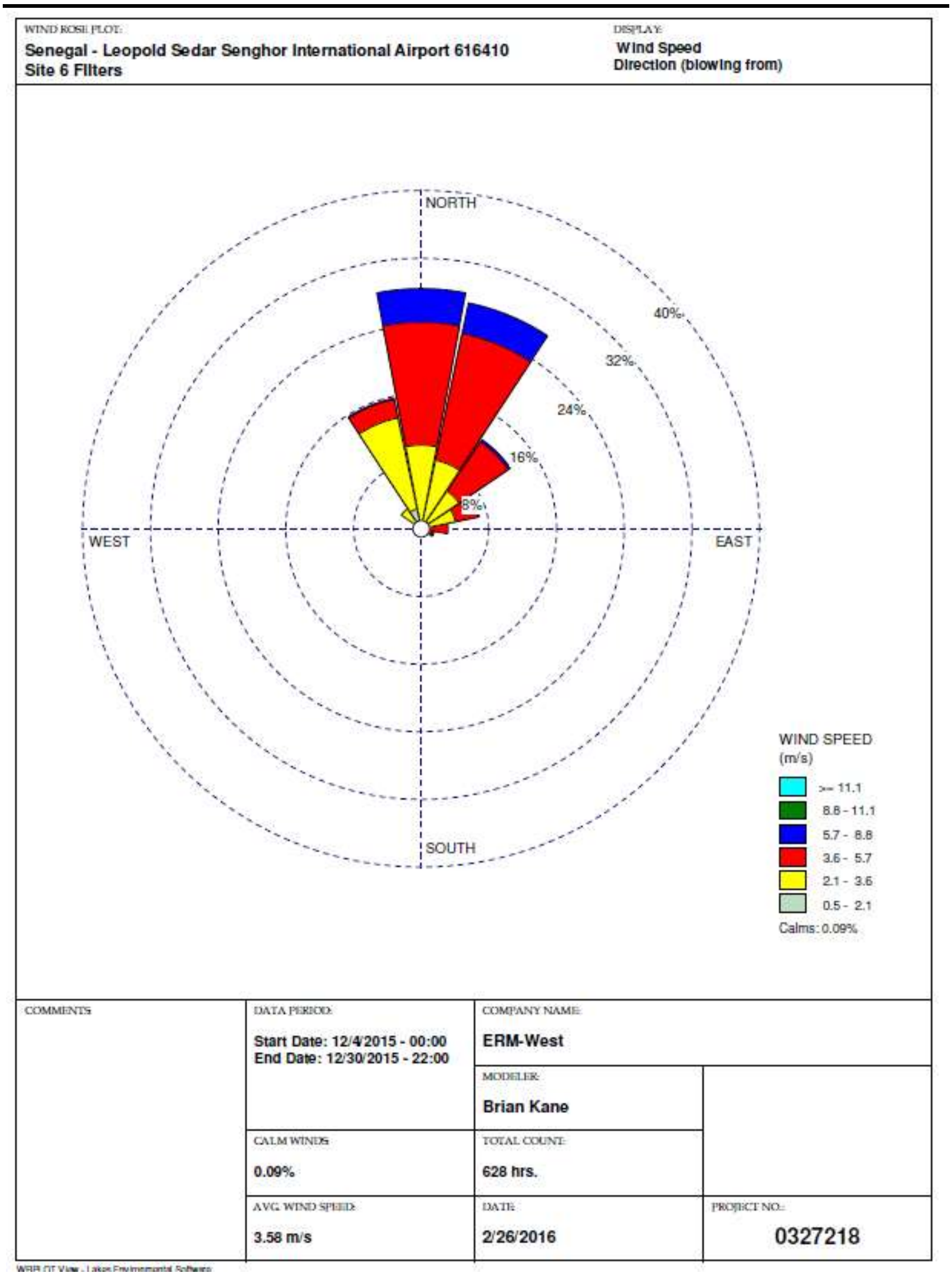


Figure 5.15 Windrose for site 6 time period



5.3.9 *Noise level*

This section includes a description of existing acoustic conditions in the project area. This will enable an evaluation of the acoustic contribution made by the Project to the current situation, taking account of existing SENELEC installations.

In June, noise measurements in the field were carried out by LAME (Laboratoire Africain de Métrologie et d'Essais). Measurements were taken every 6 hours for 24 hours, at the limits of the ContourGlobal - Cap des Biches project site (for a period of 2 minutes at each control point) and at the three receptors (for a 15 minutes period).

Figure 5.16 shows the location of measurement points and *Table 5.9* presents the ambient noise levels measured ($LAeq_{,T}$, LMin, LMax).

Figure 5.16 ***Noise measurement campaign***

Source: *LAME, June 2014*

Table 5.9 ***Ambient noise levels measured (baseline, without Project)***

Location	Time	Duration	LMin	LMax	$LAeq_{,T}$
BM5	10:00	2-min	66.3	67.2	66.9
	16:00	2-min	60.6	63.6	61.9
	22:00	2-min	62.9	63.3	63.1
	04:00	2-min	59.0	59.1	59.1
BM8	10:00	2-min	64.6	65.7	65.1
	16:00	2-min	65.6	66.2	65.9

Location	Time	Duration	LMin	LMax	$LAeq_{,T}$
	22:00	2-min	68.2	69.5	68.6
	04:00	2-min	61.2	61.6	61.5
New plant, lagoon side	10:00	2-min	62.5	65.4	64.1
	16:00	2-min	54.9	55.5	55.2
	22:00	2-min	64.0	65.5	64.9
	04:00	2-min	48.3	57.4	49.6
SENELEC sub-station	10:00	2-min	63.8	64.0	64.3
	16:00	2-min	63.9	64.6	64.3
	22:00	2-min	65.0	66.0	65.3
	04:00	2-min	62.0	65.0	63.3
SENELEC TAG2	10:00	2-min	83.4	84.7	83.8
	16:00	2-min	86.8	87.4	87.0
	22:00	2-min	87.2	87.5	87.3
	04:00	2-min	71.2	75.7	73.4
Waste water treatment plant	10:00	2-min	56.4	57.8	57.2
	16:00	2-min	55.5	56.0	55.7
	22:00	2-min	58.8	60.3	59.7
	04:00	2-min	48.9	59.7	50.8
Diokoul (residential area)	10:00	15-min	50.5	56.3	52.5
	16:00	15-min	50.7	52.6	51.8
	22:00	15-min	52.7	57.5	55.5
	04:00	15-min	47.7	49.8	48.7
SENELEC 1 housing (for SENELEC employees)	10:00	15-min	58.9	60.6	59.5
	16:00	15-min	61.0	62.2	61.4
	22:00	15-min	60.0	61.3	60.7
	04:00	15-min	60.0	60.9	60.3
SENELEC 2 housing (for SENELEC employees)	10:00	15-min	55.8	58.7	56.7
	16:00	15-min	55.5	57.3	56.0
	22:00	15-min	57.8	58.9	58.1
	04:00	15-min	52.6	53.7	53.4

Source: LAME, June 2014

5.4 *TERRESTRIAL BIOLOGICAL ENVIRONMENT*

5.4.1 *Methodology*

In order to collect the maximum amount of information, a bibliographic review was undertaken to describe the general characteristics of the study area. Bibliographic research was carried out by consulting several works on similar subjects (publications, reports, posters, etc.). This part of the work revealed certain aspects relating to vegetation, flora and fauna, as well as current Senegalese legislation.

In addition to the initial bibliographic study, in June 2014 a collection of flora data was carried out in the area in which the Project is to be installed. Samples of several species, not identified in the field, were taken back to the laboratory for identification.

An inventory of fauna was made in advance; all animal species seen during field reconnaissance work were listed. This reconnaissance of animal species was associated with a description of the types of habitats in which these fauna resources were found.

5.4.2 *Study area*

The area for the study of the biological environment covered the area in which the Project is to be installed (2.99ha). An evaluation of natural habitats was also undertaken in the Project study area (2km radius – see *Chapter 5.2*). This evaluation was based on the interpretation of satellite photos, followed by confirmation/validation in the field.

5.4.3 *Natural habitats*

A natural habitat is an area that is homogenous in terms of its ecological conditions and vegetation (grasses, bushes and trees), sheltering animal species that spend all or part of their lifecycle in this area. In the Project area, natural habitats are not very diverse due to the artificialization of the environment and the small surface area concerned.

In the Project area and the near study area (2km), land use is dominated by urbanised areas (Darou Salam Azur district to the east and SENELEC plant and housing to the west). The dominant natural habitat is a deteriorated to highly deteriorated bush covered savannah, in some places being urbanised. The presence within this habitat of some relicts (woody) should be noted, such as *Faidherbia albida.*

In the installation parcel, natural habitats can be classed in three categories:

- Area of market gardening in the centre of the parcel;
- Re-wooded area at the eastern and western edges of the parcel; and
- Damp area, to the south-east of the parcel, due to run-off from the storage lagoons at the Rufisque waste water treatment plant.

These three types of habitats are the result of anthropic activities.

Within the extended study area (2km), bush-covered savannah areas represent 96 ha (i.e. less than 12% of the terrestrial surface area included in the study area), of which over 60% are highly deteriorated and are currently being urbanised. Details of land use are presented in *Section 5.8*.

5.4.4 *Flora*

Methodological approach

The small surface area of the parcel (2.99 ha), the predominant presence of the grass stratum, the relative homogeneity of the bush stratum and the major anthropization of the natural habitat resulted in an inventory being made using the itinerant sampling method (*Chevalier, 1948* and *Aubreville, 1959*). This methodology consists of travelling through the environment in every direction, noting all the plant species found.

A list was drawn up after systematic listing of all the species observed. The various books consulted for identification of the nomenclature are listed at the end of this report. These various approaches or methodologies enabled the establishment of a list of the flora in the project area and its surroundings.

Results

Woody vegetation at the site comprises xerophyte species represented by *Faidherbia albida* (protected species), *Accacia nilotica* (*Fabaceae*), *Calotropis procera* (*Euphorbias*), as well as species planted by land users (see *Section 5.7.4*) such as *Eucalyptus alba*, *Acacia nilotica*, *Casuarina equisetifolia*, *Azzadirachta indica* or *Tamarix indica*. This reforested area is located to the west of the parcel, along the length of the fence and in several areas located inside the site. The aim of reforestation was to reduce the action of hydric and wind erosion.

The grass layer is formed by several short cycle grass species. Close to the shore, halophile formations are represented solely by grasses that are highly rESIAtant to salt, such as *Salsola sp* and *Salicornia sp*.

The agricultural area occupies the central section of the site, where subsistence farming is carried out comprising market gardening plantations and fruit trees. A few forest trees have also been planted in this section. According to the expert's report on the evaluation of the assets of the Diop family's orchard, the following species are found most frequently on the parcel: jujube, lemon, annona, eucalyptus and prosopis.

The south-east section of the site is characterised by a slight depression that receives run-off water from the Rufisque waste water treatment plant adjacent to the site. Vegetation consisting of high grasses such as *Phragmites australis (Figure 5.17)* and *Bauhinia rufescens* and *Faidherbia albida*, populate the area.

Figure 5.17 ***Phragmites australis***

There are cactus plants along the length of the maritime shore. They are generally used to help to reinforce stabilisation of coastal dunes and thereby combat aggression from big waves during high tides.

Figure 5.18 ***Coastal strip of cactus plants***

Table 5.10 ***List of species inventoried in the site perimeter (excluding cultivated species)***

Species name	Average density (plants/ha)	Vulnerability (IUCN status)
Acacia nilotica	50	NL
Gossypium sp (cotton)	67	NL
Eucalyptus alba	22	NL
Caesalpinia sp	2	NL

Species name	Average density (plants/ha)	Vulnerability (IUCN status)
Solanum sp	1	NL
Leptadania hastate	17	NL
Azzadirachta indica	17	NL
Salsola sp	-	NL
Salicornia sp	-	NL
Phragmites australis	-	LC
Tamarindus indica	83	NL
Faidherbia albida	1	NL
Lantana camara	1	NL
Calotropis procera	83	NL
Casuarina equisetifolia	8	NL
Parkinsonia acuelata	1	NL
Bauhinia rufescens	7	NL
Opuntia tuna	-	NL

LC: least concern
NL: species not listed

5.4.5 *Fauna*

Methodological approach

The itinerant sampling method was used. This methodology consists of travelling through the project site and zone of influence, noting all the animal species found and presence indices observed.

Results

The power plant is located in a highly anthropised peri-urban area. Natural habitats have been replaced by urbanised areas, or else are in a poor state of conservation (*Section 5.4.3*).

Bird life observed at the site is not very diversified. The presence of the black-winged stilt was observed (*Himantopus himantopus*), along with the spur-winged lapwing (*Vanellus spinosus*) and the western reef heron (*Egretta gularis*).

Figure 5.19 Spur-winged lapwing (Vanellus spinosus)

During a visit to the site in 2013, the presence of a black kite (*Milvus migrans*) was observed (nesting on the recovery boiler – this equipment will not be reused as part of the Project). No nesting activity was observed, however, in June 2014, neither in the Project site or in the existing facilities.

Rainbow agamas (*Agama agama*) are observed on the parcel where existing installations are located. Traces of lizards were also found linking the islands of vegetation present on the installation site to the parcel where the WWTP is located.

No mammal or any trace likely to indicate the presence of mammals on the site was found during the visit.

Due to the poor state of conservation of natural habitats at the site notably, very little diversity of fauna species is likely to be present at the site.

5.4.6 Threatened and/or protected species

Flora

None of the species found during the inventory undertaken on the area to be covered by the power plant is classified as either endemic or threatened in the Sahelo-Sudanian region(1) area or in West Africa. However, the presence of two *Faidherbia albida* (*Table 5.10*) specimens was observed, which are considered to be threatened at national level. This plant species is also partially protected under article R-63 of the Forestry Code. This partial protection means that prior authorisation has to be obtained before clearing the ground, in application of article R-61 of the same code. An itinerant inventory carried out within the study area, and more particularly to the east

(1) This is the eco-geographic area contained between isohyets 350 and 600 mm.

of the site, identified numerous *Faidherbia albida* plants in areas not concerned by the Project.

None of the species listed is considered to be vulnerable (see *Table 5.10*).

Fauna

As mentioned in *Section 5.4.5,* a black kite was observed in 2013 to be nesting on existing installations. This species is fully protected by the Hunting Code (1). However, black kites are very common in the zone of influence and the presence of nesting birds was due to stoppage of the combined cycle in March 2011. This nest was not observed during the June 2014 visit. The site and the surroundings of the ContourGlobal - Cap des Biches power plant do not therefore represent an important area for this species, and this presence is not synonymous with any particular sensitivity in terms of the fauna.

5.4.7 *Sensitive and/or protected natural areas*

No sensitive and/or protected natural area is located within the Project study area. The closest protected natural areas are:

- Thiès classified forest, located 28km to the east of the site;
- The Popenguine nature reserve located 25 km to the south.

5.5 *MARINE ENVIRONMENT*

There are few studies available that describe the state of Haan Bay, within which the Project area is located. In 1994, SENELEC ordered a study intended to measure the degree of sedimentation around their seawater drawing structure. Prior to that, the Dakar Thiaroye Centre de Recherches Océanographique (*CRODT, 1994*) carried out a study on algae in the bay.

More recently, the Bureau de Recherches Géologiques et Minières (BRGM) worked with the Environment Ministry to carry out a study on the coastal area, covering water quality, bathymetry and biodiversity across the whole of Senegal (*BRGM, 1992*). For Haan Bay, this work was undertaken with the aim of drawing up an action plan for the environment hoping to respond to the needs of a range of user groups and activities such as industry, fishing, leisure and biodiversity conservation.

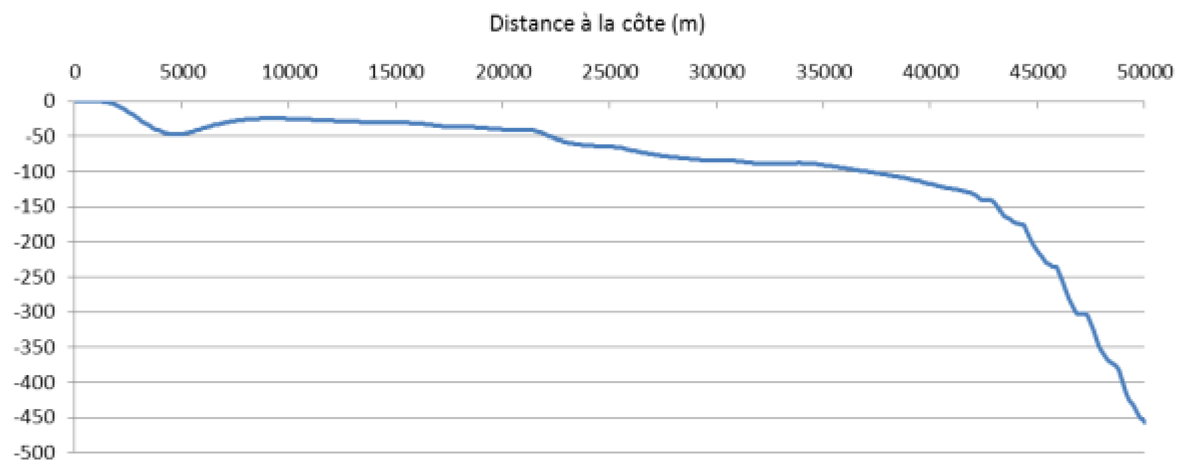
5.5.1 *Hydrology and bathymetry*

The bay is relatively shallow, with depths of around 3 to 5m along the whole coast (*CROT, 2006*). It reaches a depth of about 50m at a distance of 5km from the coast. It is as from this area that the continental ocean plate commences, whose depth varies from 25 to 100m. At between 35 and 45km from the coast the plate plunges down and depths rapidly reach several hundreds of metres.

(1) Law n°86-04 of 24th January 1986 and Decree n°86-844 dated 14th July 1986

Figure 5.20 below presents the bathymetric profile at the installation area, up to a distance of 50km from the coast.

Figure 5.20 Bathymetry at the Project installation area



Source: *ERM based on the altitudinal data of SRTM 90m (Shuttle Radar Topography Mission)*

Hydrological studies carried out by the BRGM (dry season in 1992) indicate a trend in surface water movements southwards, due to prevailing wind conditions (up to 15 cm/s), with underlying counter-currents (around 5 cm/s) in lower water layers, moving towards the north of the bay. These phenomena have a direct influence on the dispersal of discharge into the marine environment.

Seasonal variations are also likely to modify dispersal conditions in the Cap des Biches area:

- From December to April: current parallel to the coast, mainly moving southwards, and mainly influenced by the Alizé trade winds blowing during this period
- From May to November: current parallel to the coast, mainly northwards, and mainly influenced by the monsoon wind.

5.5.2 *Temperatures and salinity*

Surface water temperatures are recorded daily by SENELEC. These temperatures, presented in *Table 5.11*, vary from 18°C in January to 33°C in August.

Table 5.11 Average monthly temperature of the surface of the ocean, Cap des Biches (1996)

Month	°C	Month	°C
January	18	July	30
February	20	August	33
March	22	September	30
April	24	October	27
May	26	November	22
June	28	December	19

Salinity of the water, in the project area, shows a minimum value of 35.44%, and maximum values of 35.61 ‰ (*CRODT, 2006*).

5.5.3 *Water quality*

The results of the Haan Bay study carried out by BRGM indicate a high level of organic pollution. High concentrations of organic matter and clearly linked to the quantities of untreated domestic waste water that are discharged into the bay. This is coherent with a report from the World Bank on the state of the environment in Senegal, which claims that most residual urban water is discharged, untreated, into the ocean (*World Bank, 1994*). Other sources of pollution are industry and ballast cleaning by large ships, particularly in Dakar's main port.

Available data on dissolved oxygen show relatively average values, of around 65%, which decrease with depth (*CRODT, 2006*).

Turbidity decreases from the coast outwards to sea and from the surface downwards. Values recorded in the project's zone of influence are relatively low, from 6 to 7 ppm (*CRODT, 2006*).

5.5.4 *Waves and tides*

The small coast, at Rufisque, is influenced by two types of waves:

- Waves from the north-west (320° to 20°), which move in a rotational movement around the Cap Vert peninsula and can reach an annual maximum height of 4.25m. These waves are characterised by an annual average amplitude of 1.7m and an annual average period of 7.1s. Waves from the north-west depend strongly on Alizé trade winds from the north and occur mainly between October and January.

- Waves from the south-west (180° to 200°) which are created in the South Atlantic. They occur between around the month of July and reach their maximum between August and September (equivalent to the rainy season), before gradually disappearing in about October. Waves from the south-west are characterised by an annual average amplitude of 1.4m and an annual average period of 7.0s.

These waves mainly lead to two types of coastal currents, which are currents that are perpendicular to the coast and currents along the coast, in a north-south direction. In a general way, whatever the direction simulated, waves tend, as they propagate, to be directed perpendicularly to the isobaths. Thus, in the surroundings of the study area, the wave direction is generally between 200 and 230°N (*DEEC/AGETIP/EFFAGE*).

With regard to tides, the Senegalese coasts are characterised by a semi-diurnal tide, with a micro tidal system. Difference between high and low water is relatively small, with annual averages of between 0.5m (low water) and 1.6m (high water). In the Dakar region, average difference is 1.2m for high water and 0.60m for low water.

Tidal currents are very low in the project area; their speed is less than 0.3 knots, i.e. less than 0.15 m/s (*Niang Diop, 1995*).

The elevation rate of sea level is 1.4mm per year (*Elouard et al., 1977*; *Emery and Aubrey, 1991*). Seasonal differences in sea level varied between 9 and 25cm, i.e. an average of 20 cm. These seasonal variations in sea level can be attributed to upwellings (*Verstraete, 1985*).

5.5.5 ***Biodiversity***

The Senegalese coastal waters are in the transition area between the marine ecosystems in the Gulf of Guinea and the Canary Islands. The area enjoys the seasonal upwelling of deep water (November to April) bringing water rich in nutritional elements to the surface and stimulating the production of plankton.

Fish stocks are reputed to be abundant off Haan Bay, both for pelagic and demersal species such as mullet, herring, African carp and prawns (*World Bank, 1994).* The bay is also a major spawning ground (*Itaf Gningue, 1997*). Fishing is a relatively important economic activity for local inhabitants.

BRGM studies (1992) identified two dominant phytoplankton groups, including 71 species of diatoms and 40 species of dinophyta. The algae studies carried out by CRODT in 1985, concentrating on the Haan Bay zone, identified three dominant species, including:

- *Ulva* genus species: 50% of samples
- *Cladophora* genus species: 35% of samples
- *Hypnea* genus species*:* 15% of samples

5.5.6 Coastal ***area***

The sandy coastline is relatively damaged in the Cap des Biches area and a phenomenon of green tide occurs at certain times of the year in the Cap des Biches area (*Figure 5.21*). This phenomenon would not appear to be linked to the presence of power plants, the activities of which do not cause any significant emissions of substances that could lead to algae proliferation (mainly phosphate and nitrate).

In certain sectors of the town of Rufisque, the beach suffers from the effects of coastal erosion. In places, a protective wall has been built to protect dwellings. To the south-east of the Project area, a think sandy strip, 10 to 30m wide, remains. According to some studies, data on coastal erosion phenomena is estimated at between 1.2 and 1.3 m/an (*Diallo, 1982, Sall, 1982, Niang-Diop, 1995*).

Figure 5.21 Green tide phenomenon

5.6 LANDSCAPE

The study area landscape is an urban landscape with a strong industrial dominant, easily identifiable by the many chimneys, storage tanks and electricity cables visible from the dwellings to the south-east (Darou Salam Azur district). This landscape is shown in *Figure 5.22*.

In parallel, the coastal landscape, represented by long, narrow sandy beaches, shows a high anthropic component, symbolised by the many dwellings on the coast as well as shell gathering activities. This landscape is shown in *Figure 5.23*.

Figure 5.22 Industrial landscape seen from Rufisque cemetery

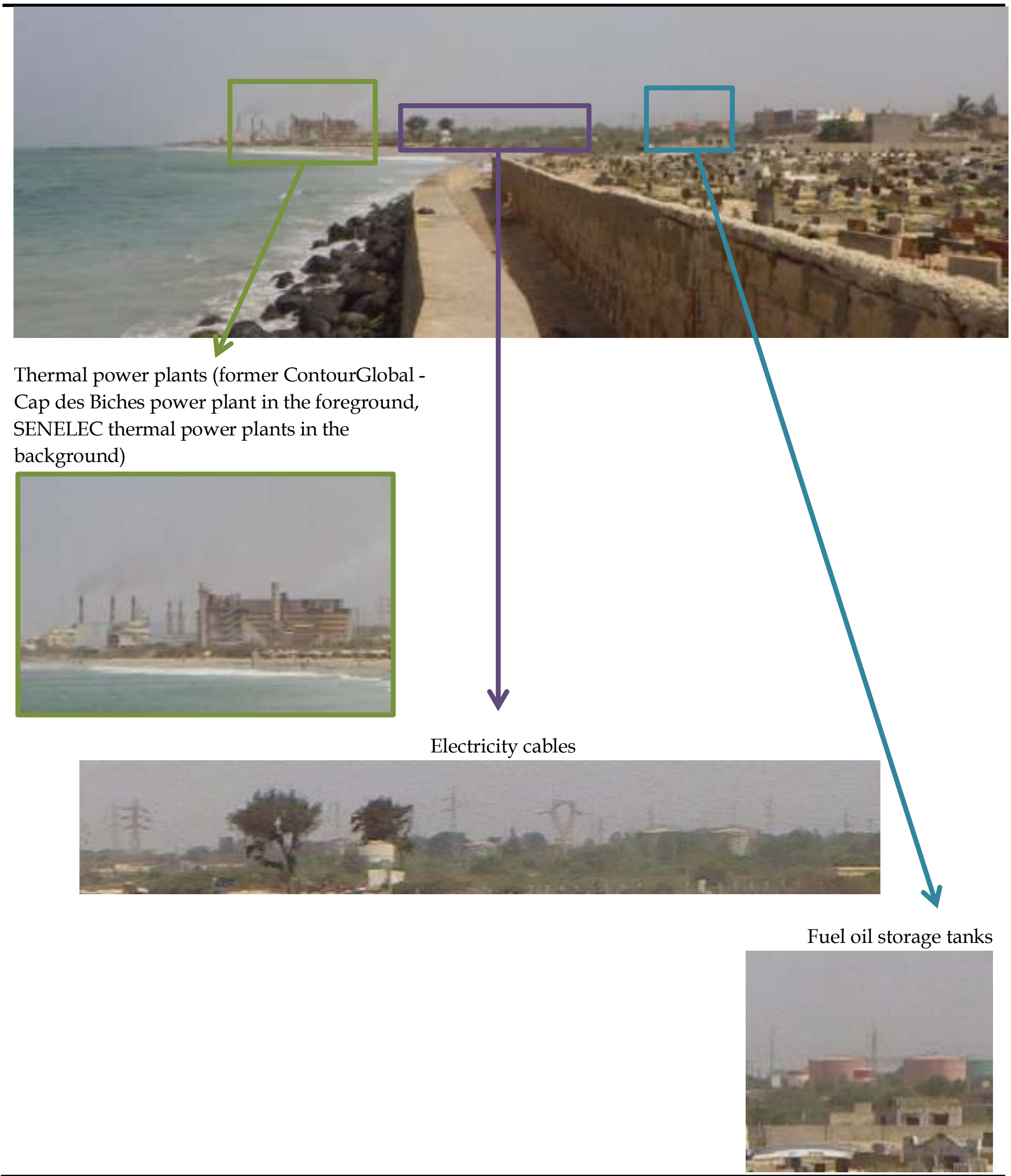


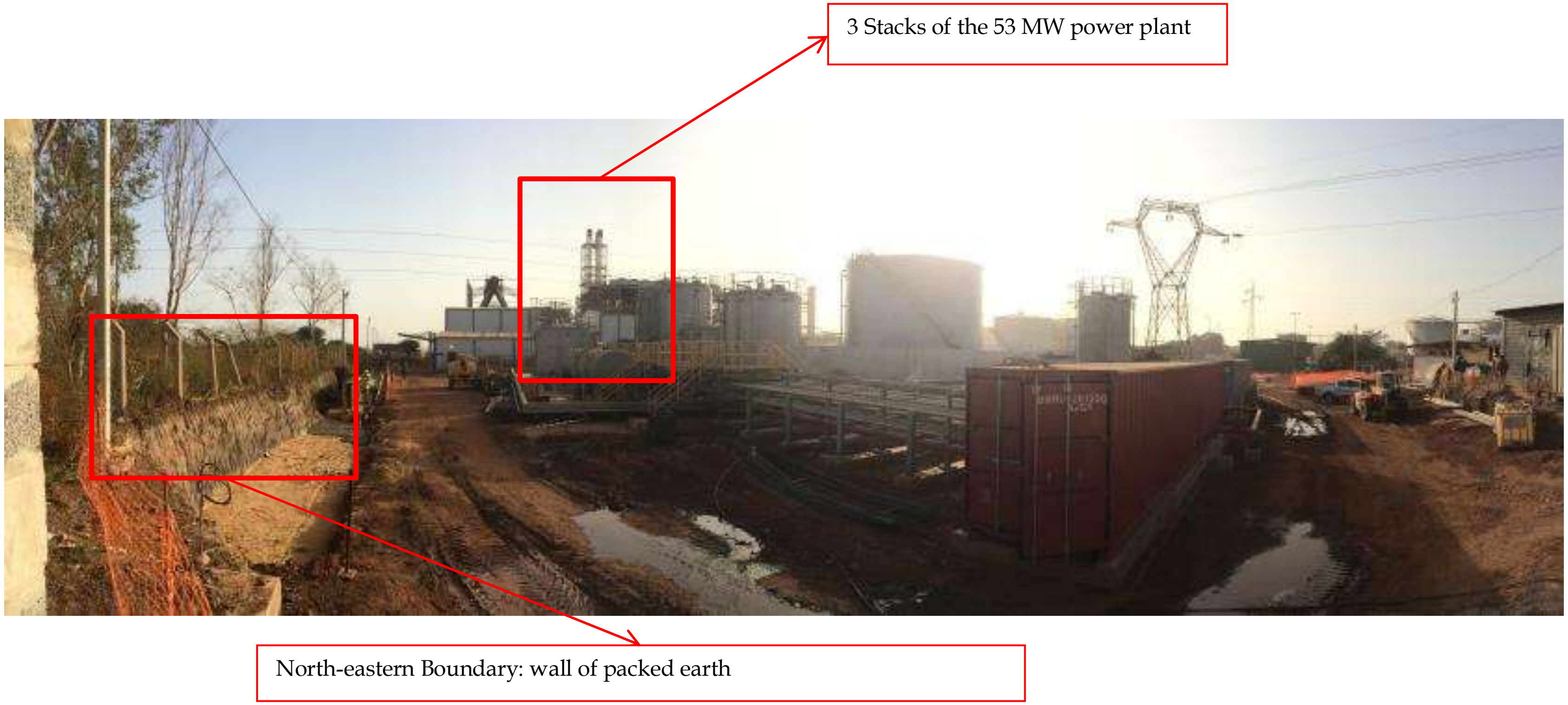
Figure 5.23 ***Coastal landscape seen from the surroundings of the power plant (photograph taken from the edge of the Project site, looking south-eastwards).***

Blue: traces of shell gathering activities
Orange: West of Rufisque - Darou Salam Azur district

A photo survey was performed on site during a visit in February 2016. Photos were taken close to the site boundaries to assess the visual impact of the components being built. Below, key views at some of the locations were represented.

Figure 5.24 ***Location of photo survey sample points***

Figure 5.25 ***Panoramic view at Point 1 at North-Eastern boundary***

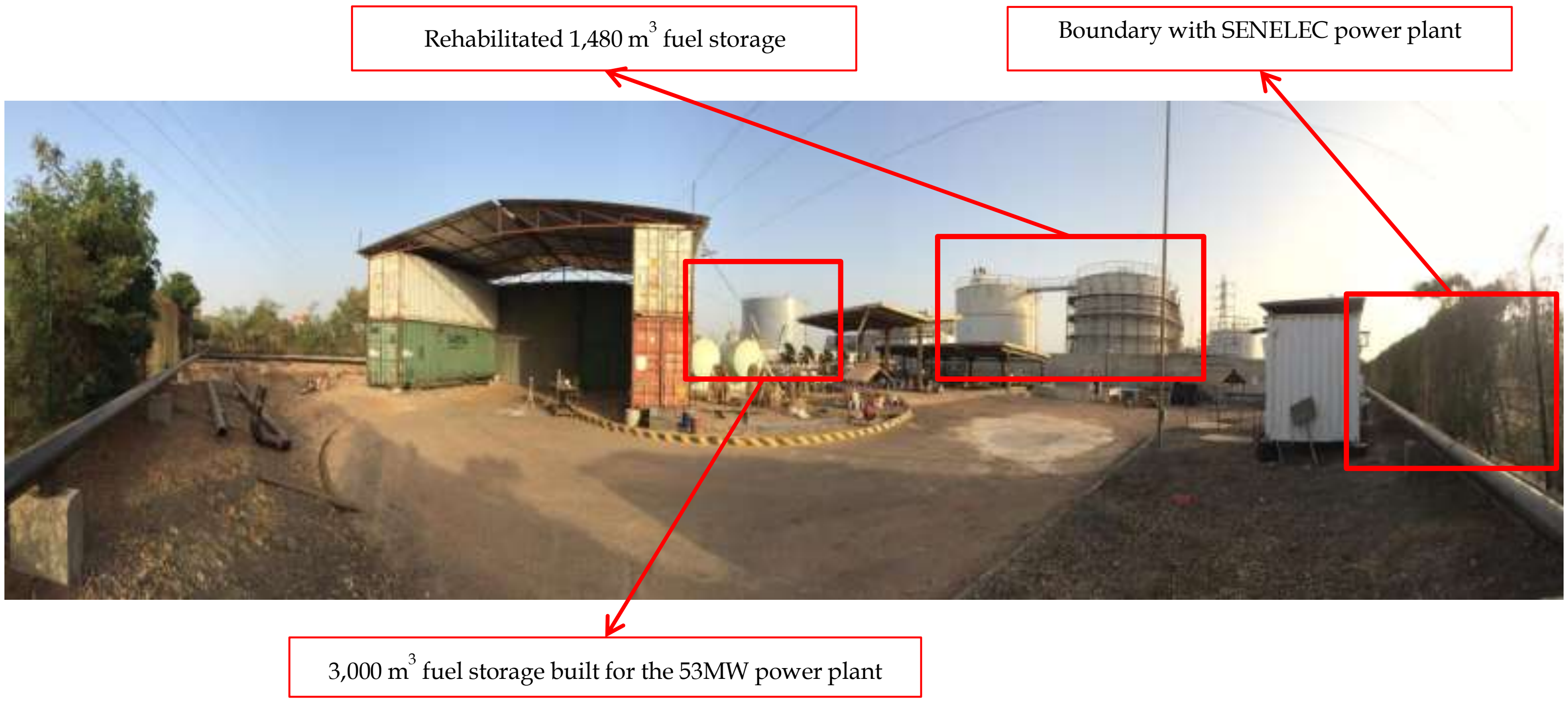


Note: photo taken in south-west direction

Figure 5.26 Panoramic view at Point 3 at South-Western boundary

Note: photo taken in north eastern direction

Figure 5.27 Panoramic view at Point 7 at North-Western boundary



Note: photo taken in south eastern direction

5.7 HUMAN AND SOCIOECONOMIC ENVIRONMENT

5.7.1 *Introduction*

This chapter reviews the project's socioeconomic environment, the baseline of which is drawn up at national, regional and local levels. It presents the economic and social conditions in the baseline, using secondary data obtained from the various planning and analysis departments, as well as databases and documents obtained from the technical partners of the State of Senegal, who are active in the economic and social development of the country and the region. These sources are supplemented by information obtained from observations in the field and consultations with the various stakeholders.

Within the context of the socioeconomic component of the ESIA, two levels of influence have been considered with regard to the study area:

- A zone of influence extended to include the whole of the Town of Rufisque and the district (formerly a municipality district - *commune d'arrondissement*) of Rufisque Ouest, an area affected by the project's indirect socioeconomic impacts.
- A restricted study area, covering the Darou Salam Azur district, a perimeter where the Project's impacts and effects will be potentially directly felt by the population.

A detailed description of public consultations undertaken for the Project is included in *Chapter 5.9*.

5.7.2 *Administrative organisation of the study area*

Administrative organisation

Located in the Sahelian region, in the westernmost part of Africa, Senegal is a member country of the West African Econoic and Monetary Union (WAEMU) It covers a surface area of 196 722 km². Senegal has 14 regions, 45 departments, 113 municipalities, 46 municipality districts, 133 districts and 340 rural communities since the 2008 territorial reform. The number of villages in Senegal is estimated at 14 958 according to the National Program on Local Development (*Programme National de Développement Local*, PNDL, 2016)[1]

The project area is within the jurisdiction of the municipality of West Rufisque, which is limited to the east by the Kheury Souf districts, to the north by the Guendel, Ndar Gounaw and SantaYalla quarters, to the west by the department of Pikine (Municipality of Mbao) and to the south by the Atlantic Ocean. The Town of Rufisque is sub-divided into three municipality districts: East Rufisque (4.7 km²), North Rufisque (3 km²) and West Rufisque (9.9 km²).

[1] http://www.pndl.org/Repertoire-des-villages-du-Senegal.html

The capital of the department of the same name, the Town of Rufisque covers an estimated surface area of 42 km^2. Outside the industrial area located in the territory of West Rufisque, the town centre (historic centre of Rufisque) concentrates most of the town's administrative and commercial activities.

Local governance and organisational dynamic

The current context of local government in Senegal is characterised by the implementation of Act III of the decentralisation law (Law n°2013-10 dated 28th December 2013 and containing the General Local Authorities Code with Act III of decentralisation). This new general Code repeals and replaces laws n°96-06 containing the Local Authorities Code, n°96-07 containing the transfer of jurisdiction to region, municipalities and rural communities and n°96-09 dated 22nd March 1996 setting out the administrative and financial organisation of a municipality district and its relations with the town.

The different administrative levels in the study area are:

- The town of Rufisque, represented by the mayor of the town
- The municipality of West Rufisque, represented by the mayor of the municipality
- The Darou Salam Azur district, represented by the district delegate and grassroots organisations.

The two levels of local authorities which are the Town of Rufisque and the Municipality of West Rufisque are run by councils elected by universal suffrage and each have their own responsibilities to assume within a given area. They are, however, subject to a legality check by State representatives: the Prefect and Sub-Prefect (administrative authorities), respectively for the Departments and/or the Town and Municipality.

In principle, there is no hierarchy between local authorities, however the mayor of the town associates the mayor of the municipality with the examination of general conditions for the building and operation of infrastructure and equipment projects planned within the limits of the municipality. The Mayor of the Municipality must also inform the Town Mayor of any investments made under the jurisdiction of the municipality.

The Town is instituted to pool the competencies of several municipalities with territorial homogeneity. Amongst others, the main competencies transferred to the Town are the following:

- Management of waste and the combat against insalubrity
- Hospital management and maintenance
- Participation in universal health cover
- The surveillance and conservation of historic sites and monuments

- The establishment of the Town Planning Plan (PDU), the Planning and Land Use Guidelines (SDAU), planning maps with details of agreed land use areas, urban renovation areas and urban consolidation
- Drafting and implementation of the town development plan (PDV)
- Implementation of the contract with the State for the creation of development projects.

The Municipality groups inhabitants from within the perimeter of one locality made up of districts and/or villages. Districts and villages form the basic administrative units (administered by district Delegates or village chiefs).

The municipality council is responsible for the following, which are likely to concern the Project to a greater or lesser extent:

- The general land use plan
- Projects for the development, allotment and equipment of areas used for housing, as well as the authorisation to install dwellings or camps
- Use and decommissioning of land in the national domain
- The creation, modification or suppression of fairs and markets
- The classification, re-classification, opening, straightening, aligning, extension, widening and suppression of public roads and squares
- The regime and terms of access and use of water sources of all kinds
- Environmental protection
- The creation and management of municipal woods and protected areas
- The drafting of municipal action plans for the environment
- The management of waste and the combat against insalubrity

The district delegate acts as State representative in the various districts and works in collaboration with district public figures and populations. Elders are considered to be the spokesmen for populations in relation with district delegates and administrative and religious authorities.

Associations are highly developed in the Municipality of West Rufisque. These includes Economic Interest Groupings (GIE) and Women's Groups (GPF) active in the fields of commerce and fish processing.

These groupings also organise "Tontines" (joint savings associations), in order to carry out income generating activities to improve the living standards of the women taking part.

The Darou Salam Azur district also has commissions in charge of the management of local development (commission responsible for the management of disputes, environment commission, elders' commission, social commission etc.).

The Environment Commission (APROPRE) was set up in the Darou Salam Azur district in 2009, at the same time as the social affairs and Elders' commissions. This commission deals with issues of salubrity and sanitation in the district and on the beach. Since 2011 it has had the status of association and enjoys legal recognition. It has dealt with reforestation with sheoaks, the layout of a sports course, the layout of a gymnastic area and clean-up operations in the surroundings districts and on the beach.

The following table presents the main associations and organisations working in the Darou Salam Azur district.

Table 5.12 Organisations active in the Darou Salam Azur district

Name of Organisation	Date of creation	Number of members				Field of activity
		M	W	Y	Total	
GPF ADAMA SEYDI	2010	0	60	20	80	Sewing and dying, shop
GPF KHADY DIENG LO	2006	0	70	0	70	Micro finance
GPF ABY GUEYE	2012	0	50	0	50	Micro finance
ASC BRA GUEYE MBAYE	2013	80	50	20	150	Health, youth and leisure, environment
COMMISSION DES SAGES	2009	05	0	0	05	Prevention and settlement of conflicts in the district
COMMISSION ENVIRONNEMENT	2009	06	01	0	07	Salubrity in the district and on the beach Reforestation
COMMISSION SOCIALE	2009	05	0	0	05	Creation of awareness of medial prevention. Awareness of other events linked to life in the district.

Source: *data from consultations, 2014*

5.7.3 *Demographic context*

National context

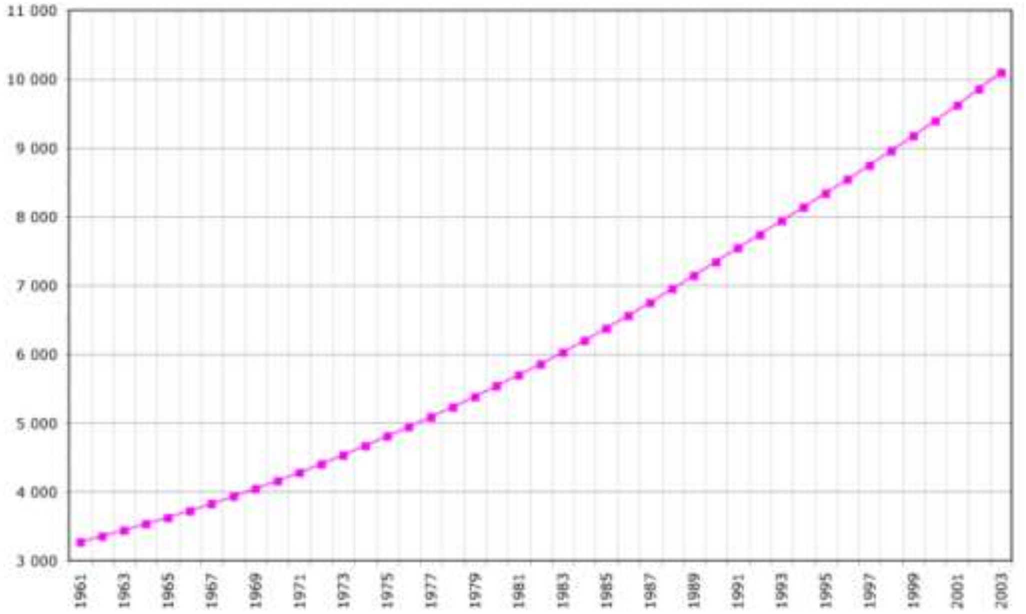
Estimated at 14 million in 2014, the national rate of increase is 2.4% and corresponds practically to a doubling of the population every twenty-five years. The Senegalese population is young and unequally distributed across national territory, with a concentration in the west, in regions close to the coast, which are Dakar, Thiès, Kaolack, Saint-Louis and Ziguinchor.

Finally, the average density of the Senegalese population was estimated at 65.3 inhabitants/km² in 2011 (*ANSD, 2012*).

Due to the exodus from the countryside, the region of Dakar is undergoing rapid demographic growth, which is considerably larger than in the rest of the country. The share held by the City of Dakar in Senegal's demographics and economy is therefore tending to increase. Compared to the sub-region, Senegal is already highly urbanised. The urban population represents almost 50% of the total population, compared with around 33% on average in sub-Saharan Africa.

According to the National Agency for Statistics and Demographics (*Agence Nationale de la Statistique et de la Démographie*), in 2016 the population is estimated at 14,799,859 and density is around 75 inhabitants/km². [1]

Figure 5.28 ***Evolution of demographics in Senegal (1961 – 2003)***



Sources: *FAOSTAT, 2005*

Local context

The population of Rufisque has seen major development over recent years, with a growth rate of between 2.2 and 4.3%. With 15 000 inhabitants in 1930 and 74 351 in 1976 (*Dubresson, 1978*), the results of the 2002 census, published by the D.P.S in January 2006, estimate the population of the town of Rufisque at 154 975 inhabitants, and predict 173 000 inhabitants in 2010 and 192 000 in 2015.

Based on the census, 66% of the population is aged under 25 and women make up about 52% of the population.

Table 5.13 ***Distribution of concessions, homes and gender in the Rufisque municipality districts***

Locality	Number			
	Concessions	Homes	Men	Women
West Rufisque MD	2229	3680	17259	17305
Centre Rufisque MD (North)	4591	6995	28294	28575
East Rufisque MD	4228	5857	27079	26770

[1] http://www.ansd.sn/

TOTAL	11048	16532	72632	72650

Source: *2002 census*

The main ethnic groups in Rufisque are the Lébous, who are the native people and in the majority, the Wolofs, Halpularen, Sérères, Diola, Mandingue and Manjack.

According to the National Agency for Statistics and Demographics (*Agence Nationale de la Statistique et de la Démographie, 2016*), the population of West Rufisque is estimated at 58,890 people (28,803 men and 30,087 women).[1]

5.7.4 Town planning, housing and land ownership context

Town planning and habitat

The area located directly around the Project is highly industrialised and does not contain any dwellings. The industry is mainly factories, former industrial installations and lagoons used by the waste water treatment plant which is located directly to the east of the site.

The Darou Salam Azur district, which is the nearest inhabited zone, is located at around 400m to the east of the Project area and developed as from 2004. It is limited to the east by 'Cité Gabon' and Diokoul, to the west by the ONAS waste water treatment station (Office National d'Assainissement du Sénégal), to the north by the Cité Bata estate and to the south by the sea. This district has developed rapidly over the past 10 years. However it contains very little infrastructure or basic socioeconomic equipment.

The district's population is estimated at 4 000 inhabitants living in 600 concessions. The Darou Salam Azur is residential and the type of habitat is marked by the predominance of modern, solid constructions organised around streets and a regular gridding (very few spontaneous settlements).

Land ownership and process for acquiring land

In Senegal land can be divided into three categories:

- The "State Domain" comprises public and private property in the property assets and rights that belong to the State. It is governed by law n° 76-66 of 2nd July 1976 containing the State Domain Code (CDE). Compensation is provided for in case of easement of public usefulness (article 7 CDE). The State may grant various types of occupation on its domain (authorisation to occupy on a temporary, revocable basis, ordinary lease, concession to rights to the surface area). The maritime domain forms an integral part of the State Domain.

[1] http://sigstat.ansd.sn/sigstatv2/repertoire_localites_senegal

- The “National Domain” comprises land that is not classified in the State Domain, not registered or whose ownership has not been entered into the mortgage conservation registry. The national domain is governed by law n° 64-46 of 17th June 1964 and its various implementation texts. The land in the national domain is divided into four categories: pioneer areas, urban areas, classified areas (protected spaces) and territorial areas which are areas intended for agriculture and stock rearing and grazing

- The “Individuals’ Domain” or “Private Domain” which comprises registered land owned by private individuals. It is governed by the Civil Code and the decree of 26th July 1932 which reorganised the property regime in French West Africa.

Property rights at the Project site

As mentioned earlier, the Project will be built on a parcel of about 3ha, which is adjacent to the site of the existing power plant. This parcel is currently used for agricultural purposes.

An expert has been designated to supervise the inventory and compliance of the procedure to value the assets present on the parcel in question. A report was published in June 2014 (*Evaluation of the orchard property belonging to the family of Isma Diop, deceased, located at Cap des Biches*) which summarised the position and the results of the inventory.

Figure 5.29 Views of the agricultural area concerned by the Project

Sources: *ERM, June 2014*

According to the expert’s report, the land concerned by the Project’s development comprises two parcels:

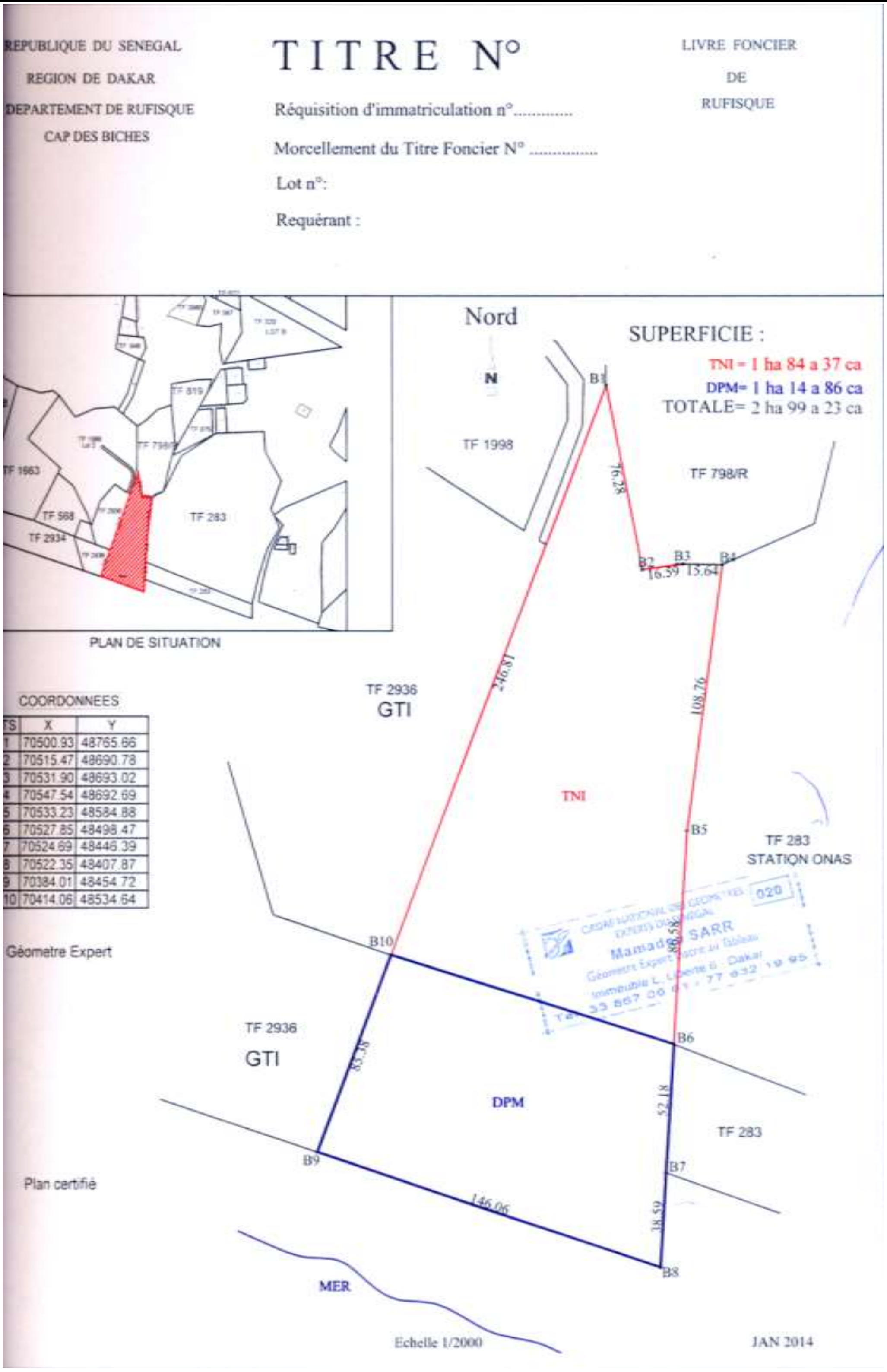
- A parcel belonging to the National Domain, of a surface area of about 1.84ha and considered to be TNI (Unregistered land), the allocation of which depends on the municipality of Rufisque; this land has been allocated to SENELEC, which will transfer it to ContourGlobal - Cap des Biches on a long lease, before the start of the works phase.

- A parcel of about 1.15ha belonging to the Maritime Public Domain (State Domain), the allocation of which takes place via the Ministry of Finance (Domains Administration). Procedures for the granting of this land to SENELEC are on-going with the Ministry of the Economy and Finance.

SENELEC and ContourGlobal - Cap des Biches have agreed that SENELEC will become the owner of the land that forms part of the national domain (transformation of the TNI into a land deed, TF) and that the parcel that is part of the Maritime Public Domain will be made available to it by the Domains Administration. SENELEC will then sign a lease with ContourGlobal - Cap des Biches for occupation of the area.

Correspondence between SENELEC and the various administrations with responsibility for allocation of land (Town of Rufisque, Town Planning and Housing Ministry, Ministry of the Economy and Finances, …) is contained in the expert's study carried out in June 2014.

Figure 5.30 Land registry map of the parcel concerned by the Project



Sources: *Report on the evaluation of disbursements, June 2014*

The extension of the plant does not induce any changes in terms of rights, since it only includes the adding of two motors within the Project site.

Compensation for unofficial occupiers

In parallel to the allocation of the land to SENELEC, a phase to compensate the land occupier was carried out, in which the family concerned participated, along with ContourGlobal - Cap des Biches, SENELEC and the Rufisque local authorities. This phase was supervised by the independent expert with responsibility for the disbursement evaluation procedure.

The land is occupied by one family (Mr Diop and his two children) and has been used for agricultural purposes for several years. Mr Diop has a market garden (okras, cucumbers and peppers), fruit trees and forest trees.

A commission comprising representatives of SENELEC, ContourGlobal -Cap des Biches, the expert and the farmer working on the parcel in question was set up in order to manage the issue of compensation and reach an agreement between the various parties.

Following the detailed inventory of assets present on the parcel, carried out in May 2014, the value of disbursements was assessed at 57 244 165 CFA F. This amount has been paid to the beneficiaries' designated representative.

5.7.5 Economic context

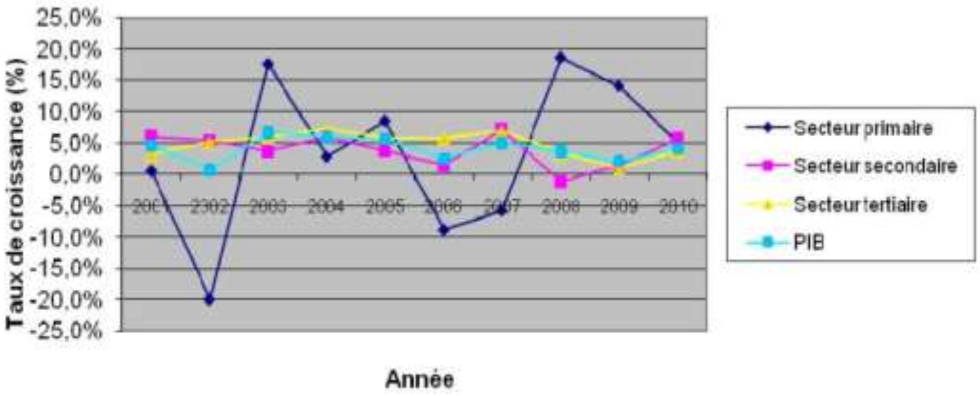
Economy

Senegal has seen sustained economic growth since the mid-nineties, with an increase in GDP volume close to 5% per year on average. This growth has permitted significant improvement in GDP per inhabitant.

The Senegalese economy is dominated by three sectors identified as strategic by the World Bank. These are the agricultural sector (particularly the arachide sub-sector), fishing and the services sector. Climatic imponderables, particularly repeated droughts due to the Sahelian position of Senegal, have had a major negative impact on the agricultural sub-sector, whose role in and contribution to GDP has dropped. The Senegalese economy also remains highly dependant on external transfers.

The Senegalese economy remains characterised by major fragilities. Firstly, economic growth would appear to have had a limited effect on the reduction of inequalities. Senegal remains characterised by a high degree of inequality, and by strong duality between the urban and rural worlds, with rural areas characterised by a very high incidence of poverty. The Sahelian nature of the country also strongly restricts the potential for agricultural development. The primary sector thus represents only 20% of Senegalese GDP, whilst occupying the majority of the active population (2001 figures, *Bertholet,* 2004).

Figure 5.31 ***Actual growth rate in Senegalese GDP per sector of activity (2001-2010)***



Sources: *ANSD* [(1)]*, 2011*

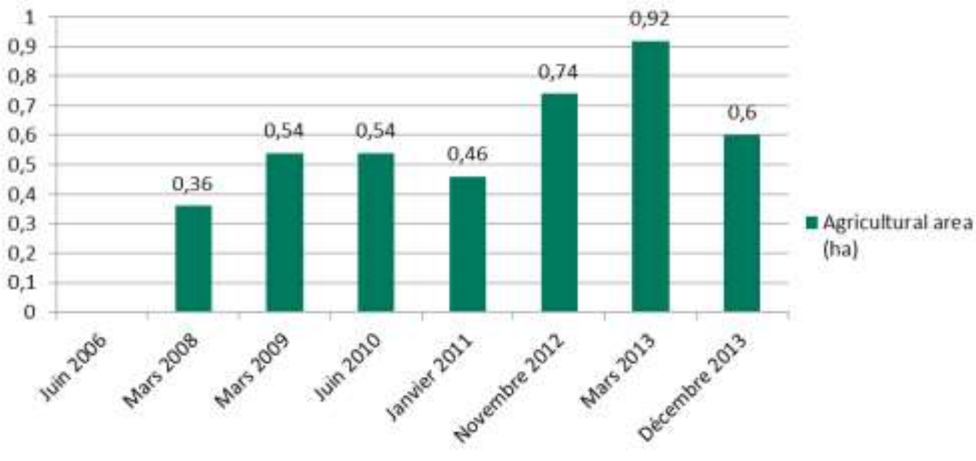
In the Project area, economic activities are mainly artisanal fishing, the tertiary sector and informal trade in particular. The few pockets where urban agriculture was still being carried out have practically disappeared over these past few years, specifically due to the pressure on land in the Rufisque area.

In the area where the Project is located, agricultural activities concerned mainly market gardening on a surface area of less than 1ha (see *Inset 5.1*).

Inset 5.1 ***Market gardening activities in the installation area***

The northern section of the TNI is used for agricultural purposes (market gardening) over a variable surface area. A retrospective analysis of recent satellite images (June 2006 to December 2013) enabled evaluation of the surface area concerned by the market gardening activities at between about 0.3 and 0.9ha, depending on the years. No agricultural activity was visible before March 2008.

This development is shown in the figure below.



Most inhabitants work either in Rufisque town centre or in Dakar.

(1) National Agency for Statistics and Demographics

The extraction of sand and shells is also an activity that generates income for vulnerable populations, particularly on the beaches to the south-east of the Project area.

According to the World Bank, the Senegalese economy is expected to continue its acceleration in 2016. This is due to a number of factors such as positive agricultural production (favourable weather conditions are expected), the end of the Ebola outbreak, low oil prices, reduced production costs, and electricity subsidies. Real GDP is expected to reach 5.3% for the 2016-17 period, with the economy being driven mainly by the services sector (e.g., telecommunications, financial services). However, the slow implementation of reforms to curb unproductive public consumption, delays in raising expenditure efficiency, sluggish policy implementation in the energy and agriculture sector, and the limited absorption capacity regarding the precautionary reserve of investment projects might slow down growth in 2016 and beyond. The risk of possible elections in 2017 could also test the Government's resolve to maintain fiscal discipline in the medium term.[1]

Industrial context

Many industries are present in the West Rufisque municipality. In addition to the power plant at Cap de Biches operated by SENELEC, the Socosim cement works and the Valda cosmetics / pharmaceuticals plant, lots of SMB are located in this area (Rufsac paper bag manufacturers, Cikatrans leather processing plant, Avisen poultry products, Shydrapa – cattle feed, Ghanisen – fish meal).

Employment

Table 5.14 below shows the distribution of the Senegalese population of working age, according to their occupation, for 2008. An analysis of this data shows that within this population, 45.1% of people are considered to be active and 54.9% to be inactive. Amongst the active population are 39.1% people in work and 6.0% unemployed. Pupils-students and housewives represent respectively 20.6% and 21.5% of the inactive population. The percentage of active population in work is around 56.0% for men compared with 23.1% for women, wherever they live. However, it is in the urban environment that most unemployed are found, around 7.7% compared with 4.7% in the rural environment.

A correlation is observed between the level of education and employment status. People who have studied in higher education represent 58% of the active population. People who did not go beyond primary education are more affected by professional inactivity, with this situation being less clear-cut in the rural environment (21.9%) than in the urban environment (28.7%). Disparities in the level of occupation are also observed between men and

[1] http://www.worldbank.org/en/country/senegal/overview

women, whether in the rural or urban environment, and whatever the level of education.

The data presented for an urban context is representative of the local situation in the Rufisque area.

Table 5.14 Distribution of the Senegalese population by occupation according to place of residence and gender (%)

Occupation	Urban			Rural			Together		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Worker	50.1	22.0	35.8	60.2	23.9	41.5	55.8	23.1	39.1
Unemployed	0.2	5.3	7.7	6.1	3.3	4.7	7.8	4.2	6.0
Active sub-total	**60.3**	**27.3**	**43.6**	**66.4**	**27.3**	**46.2**	**63.8**	**27.3**	**45.1**
Pupils / students	29.4	25.2	27.3	8.3	13.2	15.7	23.1	18.2	20.6
Housewives	0.0	38.8	19.6	0.0	44.3	22.8	0.0	42.0	21.5
Other	0.3	8.7	9.5	8.3	15.3	15.3	3.2	12.8	12.8
Inactive sub-total	**39.7**	**72.7**	**56.4**	**33.6**	**72.7**	**53.8**	**36.2**	**72.7**	**54.9**
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: *ANSD: 2008*

According to the first national survey on employment in Senegal (*1ère enquête nationale sur l'emploi au Sénégal*) carried out by the ANSD and which results were published in November 2015, unemployment rate it estimated at 13,4% in 2015 for the above 15 years old population, and is higher for women (16,7%) and in urban areas (17,2%). Underemployment rate is estimated at 27,7%.[1]

Fishing

The municipality of West Rufisque is edged by a relatively big coastal strip which is the reason for the existence of traditional fishing districts. The sea is one of the municipality's main natural resources. Many of the inhabitants of the town of Rufisque and of the municipality of West Rufisque live from activities linked to fishing and fish processing (salting, smoking and drying, etc.).

There is a large fish quay in Rufisque located in the Municipality of East Rufisque and run by all the Town's stakeholders in fishing, organised in the economic interest grouping (EIG) ''Interprofessionnel Teung – Guedj de la pêche de Rufisque''. This EIG is responsible for managing the town's fish quay. Its management board is made up of fishermen, fishmongers and women working in fish processing.

At local level, the fishing areas are not located directly in the Project's study area, but much further out to sea.

[1] http://www.ansd.sn/index.php?option=com_ansd&view=theme&id=15

According to a study dating from 2013 and carried out by the Institute of Environmental Sciences – ISE – in partnership with the USAID Com /Fish project, fishing activities in the Rufisque zone is tending to decrease, with fishermen heading more towards the areas Mbour, Joal, Gambia and Casamance. This observation was confirmed during the consultations.

The consultations confirmed that artisanal processing activities (drying in particular) take place on the beach, close to the power plant.

5.7.6 Social context

Schooling and access to education

In Senegal, according to UNICEF, school attendance rates are relatively low in nursery education (11% for boys and 12% for girls) and in secondary education (20% for boys and 16% for girls). In primary education, on the other hand, the rate is relatively high (75% on average).

There are four public primary schools in the municipality of West Rufisque, as well as a middle school (CEM) and two professional training centres. Near to the Project area there are also three private primary schools, a Koranic school (Darra) and a Franco-Arab school. *Table 5.15* below details the school establishments present in the study area.

In the field of education, the Municipality of West Rufisque has the following competencies:

- The building and equipment of elementary and nursery school, basic community schools and Franco-Arab schools.
- Participation in the management and administration of nursery and elementary schools, daaras (Koranic schools, basic community schools and Franco-Arab schools.
- The recruitment of educational and training staff for community nursery schools and basic education centres for illiterate young people and adults, as well as recruitment and responsibility for temporary staff in elementary and nursery schools, Franco-Arab schools and basic community schools
- Support for daaras.
- Educational support.
- The allocation and distribution of grants and school financial assistance.
- Drafting and implementation of the municipal plan to combat illiteracy.

Table 5.15 School establishments located in proximity to the site

Name	Date of Creation	Type of construction	Number of teachers	Number of pupils			Level of equipment
				Total	Boys	Girls	
Public primary school	2001	Modern	06	380	193	185	-Electricity -Water -4 latrines

Name	Date of Creation	Type of construction	Number of teachers	Number of pupils			Level of equipment
				Total	Boys	Girls	
Maguette Ndoye private primary and secondary school	2005	Modern	14 women	420	210	150	-Electricity -Water -10 latrines
Koranic Daara El Hadji Ibrahima ciss	1974	Modern	2	30	30	0	None
Franco-Arab Daara	1999	Modern	2	100	40	60	-Electricity -Water -Computer

Source: *Data obtained from the consultation phase with stakeholders, 2014*

Sanitary context

There are three health stations in the Municipality of West Rufisque, for a population of over 50 000. The Maîmouna private clinic is also accessible but mainly frequented by wealthy families.
The Town of Rufisque has a hospital, several health stations and two health centres.

A study dating from 2005 states that 1.7% of children in the district suffered from severe malnutrition and 16.8% from moderate malnutrition.

In a more general context, malaria is the disease that most affects the communities located in the study area. According to the National Programme to Combat Malaria in Senegal, at national level it is the leading cause of morbidity and general mortality, particularly in children under 5 years old. Over 50% of the demand for health services year round in the country, is linked to malaria. According to health services questioned during consultations, other pathologies observed in the study area are linked to pulmonary problems and issues of hygiene and salubrity. These are diarrhoea and gastro-intestinal diseases.

The Regional Services for Statistics and Demography in Senegal indicate a prevalence rate of HIV/AIDS in Senegal of 0.7% (*EDS, 2005*).

The recent report on the socio-economic situation of Senegal in 2012 (*Situation Economique et Sociale du Sénégal en 2012*), published by the ANSD in May 2015[1] highlights the recent outcomes of the Senegalese health system and health policies in particular with regards to health infrastructures, prevention actions, fight against diseases (VIH, malaria tuberculosis, diarrhoea, etc.) and mortality rates. Overall, the Senegalese health situation has significantly improved for the last two decades.

[1] http://www.ansd.sn/ressources/publications/Sante-SES-2012.pdf

Cultural and religious context

Islam is the main religion practised in the area (over 95% of inhabitants). Three mosques were observed in the Darou Salam Azur district. There are no other religious buildings for other religions located in the district.

In the north-west of the Project area, about 900m from the Project installation area, is located the Christian religious complex "Cité de la Paix", which includes several religious buildings (charity home, church) in an area of about 10ha.

No cemetery or other holy site or sizeable cultural site where any specific practices, rites or statuses are carried out, was identified at the site where the future power plant is to be installed.

The closest cemetery is located on the coast in West Rufisque, at over 700m from the Project installation area.

Vulnerable groups

Vulnerability is linked to the resilience of an individual or group, i.e. his ability to deal with change whilst preserving his means of subsistence and social well-being. Resilience is often associated with the extent to which individuals have access to appropriate resources, such as equipment, social networks or any other means of potential subsistence to which they are tributary.

In the Project study area, the major categories of people who are considered to be vulnerable are:

- Women
- Old people
- Young people
- Marginal groups and ethnic minorities
- People who are disabled or suffering from chronic diseases.

Women are considered to be vulnerable because certain traditional practices tend to define their social status as being inferior to that of men, such as:

- The traditional structure of property inheritance
- Agricultural practices used: they work mainly on unpaid agricultural tasks whilst the men control commercial crop growing and agricultural income. Women use their production mainly for their own home requirements
- Decision-making at community level, in which they often play a limited role
- Social development in terms of literacy, level of education or general health conditions, to which women also have a low access rate.

Old people are generally considered to be vulnerable. They often depend on the younger generations to cover their elementary needs (housing, water, food). Old people normally prefer to keep their lifestyle and adapt less easily to change. Since they are not part of the active labour force, they are not generally in a position to benefit from the advantages usually associated with construction projects.

Young people (a group qualitatively defined according to their degree of independence in terms of their means of subsistence and their lifestyle) are considered to be vulnerable in view of the fact that they generally depend on their families and generally have difficulty getting started with an active life.

People with disabilities are generally considered to be vulnerable individuals in society and have less chance of benefitting from the Project's advantages. People living with HIV/AIDS and tuberculosis can also be considered to have disabilities since their ability to remain in good health and maintain their means of subsistence are often compromised by their illness.

According to the data in the Enquête de Suivi de la Pauvreté au Sénégal (ESPS II, 2010-2011), 46.7% of the Senegalese population lives below the poverty line (households that do not earn enough to cover the monthly expenditure required per person to buy the minimum food ration).

According to poverty indicators in households and individuals in the administrative circumscriptions in the Dakar region, in 2005 and 2006 Dakar was the region with the least poverty in Senegal (between 13.4% and 17%). In the Dakar region, the Pikine department had the lowest poverty rate (37.9 and 45.8%), followed by the department of Rufisque (between 33.2% and 40.6%).

According to the results of the study on the vulnerability of coastal communities and adaptation to climate change (*Institute of Environmental Sciences – ISE – in partnership with the USAID Com/Fish project, 2013*), the Rufisque/Bargny coastal community is extremely vulnerable on a socioeconomic level. Fishermen there earn on average less than 100 000 CFA francs per month. As for women working in fish processing, their monthly income is evaluated at less than 50 000 CFA francs on average.

5.7.7 *Infrastructures and services*

Road network

The transport sector plays a very important role in the Senegalese economy. According to a World Bank report on road transport (*Bertholet, 2004*), the road sector occupies an absolutely dominant position within the whole of the Senegalese transport sector for internal transport. Thus, road transport represents about 99% of internal passenger travel and 95% of goods transport.

AGEROUTE Senegal is an agency linked to the Ministry with responsibility for infrastructures which also deals, in general, with the implementation of all building, rehabilitation and road maintenance works, work on bridges and other structures as well as the management of the classified road network. This agency also works on the building, rehabilitation and maintenance of all the rest of the national network.

The Project area is located about 800m to the south of the N1 linking Dakar to the east of the country. This road is a major communication link for the region and is used to carry goods and people inland and into the sub-region. An asphalted road leads directly to the power plant from the N1.

In 2013, Senegal inaugurated its first highway (*Autoroute 1*), which connects Dakar to Diamniadio along 34 km, in order to decongest the traffic inwards and outwards of the capital, and in particular along the N1. Further sections are planned to be constructed. An interchange exists with Rufisque Ouest.

Infrastructures and limitations encountered

Based on the information collected during the public consultations, the main limitations found in terms of infrastructures for the town of Rufisque are linked to:

- The evacuation and treatment of waste water
- Drainage of rain water
- The collection, transport and elimination of household waste
- The extension of spontaneous settlement areas (see Inset 5.2)
- Risks, nuisance and unpleasant odours from open channels.

Waste water treatment poses a problem in the Project area. The existence of open air rain water channels which cohabit with a network of waste water evacuation poses hygiene problems, particularly in the Guendel I, Léona, Cité Filaos, Thiokho and Diokoul districts.

In addition to the infrastructures presented in the chapter above (hospitals, schools, religious buildings, …), the Municipality of West Rufisque also has a bus station and a municipal abattoir.

Access to drinking water in the Project area and the town of Rufisque is guaranteed by the Société des Eaux (SDE).

There are some hotel complexes located in the Municipality of West Rufisque: the Kumba Lamba Complex, l'Auberge des Quatre Vents, l'auberge l'Oustal de l'Agenais and L'Oasis Camping du Désert.

Inset 5.2 Extension of spontaneous dwellings areas

The extension of areas of spontaneous dwellings is a phenomenon found across a majority of Senegalese land.
However, in the area close to the Project, urban expansion is limited by the following factors:
- to the north-west, the only houses are those of SENELEC employees; there is no plan to extend this company accommodation
- to the south-east (Darou Salam Azur district), the extension of settlements westwards is limited by the fences of the waste water treatment station (see map below).

Blue: area in which the new installations will be located
Orange: fenced limits of the WWTS

5.8 LAND USE

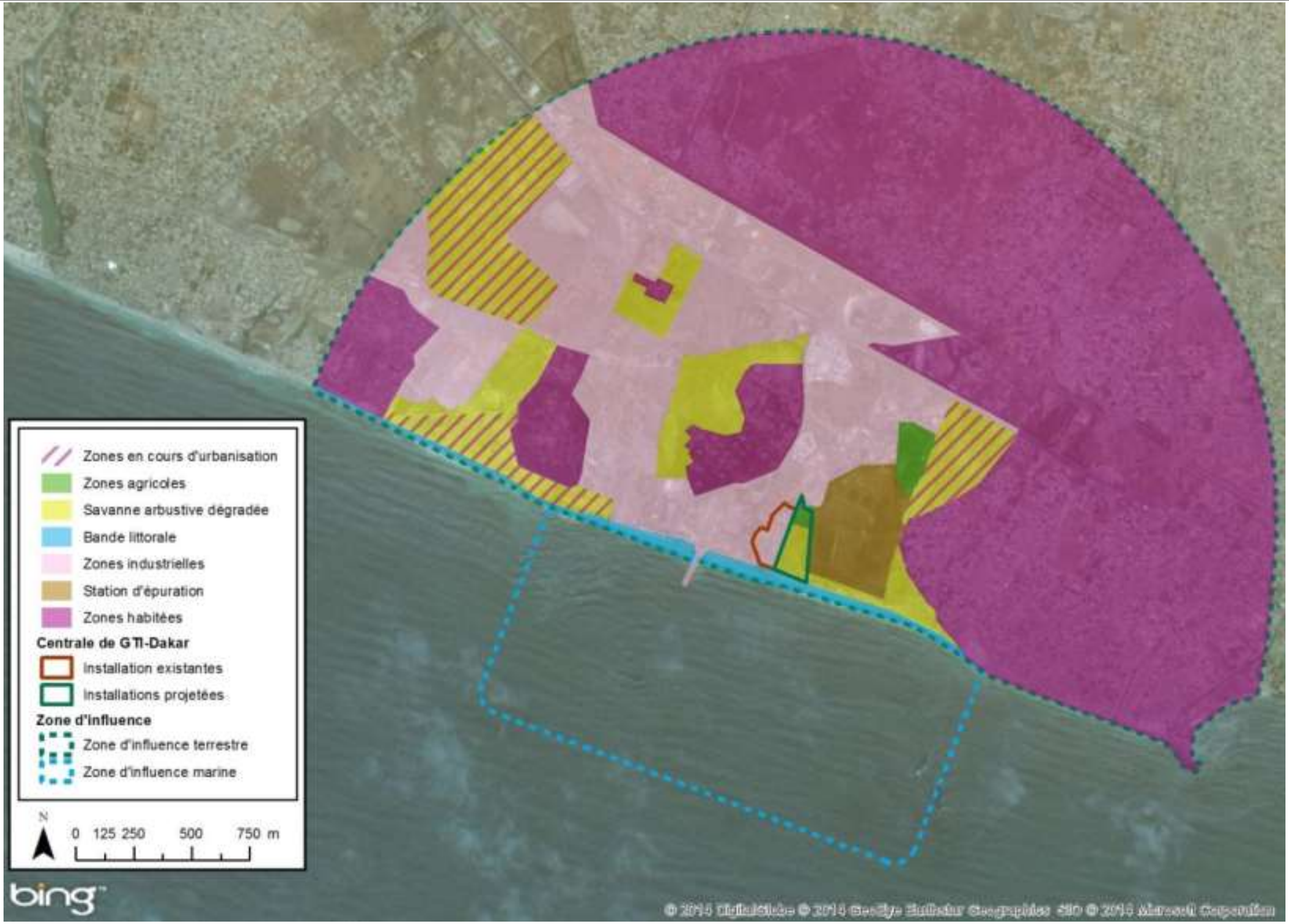
Figure 5.32 below presents a summary of land use, based on the information provided in previous sections. The surface areas and proportions of each type of usage are presented in *Table 5.16*.

Table 5.16 Land use in the study area (2 km) – Surface areas

Land use	Surface area	
	Ha	%
Agricultural areas	5	0.6%

Coastal strip	10	1.2%
Industrial areas	190	23.5%
Inhabited areas (including the SENELEC estate)	491	60.6%
Damaged bushy savannah	38	4.7%
Damaged bushy savannah currently subject to urbanisation	58	7.2%
Waste water treatment plant	18	2.2%
TOTAL	810	100.0%

Figure 5.32 Land use in the study area (2 km)



5.9 ECOSYSTEMS SERVICES

5.9.1 *Introduction*

This chapter presents the services rendered by ecosystems in the Project area. Services rendered by ecosystems are interactions between the natural environment and the human environment. Because of this, the chapter uses information from the initial state and the results of the various analyses presented in previous sections.

Inset 0.1 Definition and type of ecosystem services

Services rendered by ecosystems are the benefits that people draw from ecosystems. The Millennium Ecosystem Assessment[1] classified them into four main categories.

Supply services refers to the production, by ecosystems, of goods or products such as foodstuffs, wood, medicines, fibres and fresh water.

Regulation services refers to the natural processes that regulate an ecosystem such as climate, disease control, erosion, hydric flows and protection against natural hazards.

Cultural services refer to the provision, through ecosystems, of intangible benefits, such as recreational leisure activities, spiritual values or aesthetic pleasure.

Support services refers to natural processes such as the formation of soil, the nutritional cycle and primary production which act as support for other services rendered by ecosystems.

5.9.2 *Method*

The study of ecosystem services follows a preliminary identification exercise, the results of which are used to define the scope of the study and as a first stage in the ranking of services rendered by ecosystems within the study area. It is followed by an analysis of the baseline of services likely to be affected within the area, notably the importance of these services for beneficiaries and the availability of sustainable, accessible modifications. Results of the baseline analysis are then used to provide a definitive list of priority ecosystem services.

The study of ecosystem services is interconnected with several subjects contained in other chapters of the ESIA, notably those listed below:

- Geology and soils
- Water quality
- Biodiversity
- Cultural heritage
- Landscape
- Land use and means of subsistence
- Health of population

[1] Millennium Ecosystem Assessment, available from: www.maweb.org/en/index.aspx

5.9.3 *Study area*

The study area for services rendered by ecosystems takes the following factors into account:

- The area of potential influence of the proposed installation in terms of the availability and functionality of services rendered by ecosystems
- The probable distance that people are willing to travel on a regular basis to use natural resources
- The actual distribution of resources
- Current and potential usage of resources by the populations concerned

This analysis was carried out in the biological environment study area, that is the Projection installation area (5.5ha) and the zone of direct influence of the works, i.e. within a radius of 500m around the site.

5.9.4 *Preliminary identification*

Table 0.12 presents the results of a preliminary identification exercise. This was used to define a preliminary list of services rendered by ecosystems in the study area.

The World Resources Institute lists the five main direct factors on changes to ecosystems:

- local usages of land and plant cover ;
- exploitation and consumption of resources ;
- pollution ;
- introduction of invasive species ; and
- climate change.

In addition, indirect factors in changes to ecosystems can include demographic, economic, sociopolitical and religious or even scientific and technological factors, giving rise to changes in the consumption of resources.

Table 0.12 Preliminary identification of services study

Service category	Service	Resource
Supply	Foodstuffs: crop growing and fruit trees	Market gardening, jujube, lemon, annona, eucalyptus and prosopis.
Supply	Foodstuffs : fish and fishing activities : (fishing and processing)	Fish and shellfish
Supply	Extraction of sand and shells	Sand and shells
Cultural	Value of the existence of biodiversity	Species recognised as having a medium to high conservation value At national level (protected and partially protected species)

Service category	Service	Resource
Cultural	Aesthetic value	Landscape
Regulation	Erosion control	Cactus plants: *Tamarix indica*, *Eucalyptus alba*, *Accacia nilotica*, *Casuarina equisetifolia* and halophile formations *Salsola sp* and *Salicornia sp*.

6 DESCRIPTION AND ANALYSES OF PROJECT ALTERNATIVES

6.1 INTRODUCTION

The analysis of Project alternatives was carried out with account taken of the project's most essential components, that is

- The possibilities for total rehabilitation of the existing power plant.
- The location of the initial Project (53MW) and the Extension (33MW).
- Technological choices for electricity production.

Before the analysis of the alternatives of each component, the "no project" option was the analysis of a separate analysis.

6.2 "NO PROJECT" OPTION

As stated in *Chapter 3* containing the project description, the current Senegalese energy context requires an increase in electricity production in order to secure the country's supply, thus guaranteeing the population better access to energy and encouraging economic development.

Social

From an economic and social point of view, the "no project" option is part of Senegal's current energy situation, characterised by the frequent cutting off of supply. On the other hand, the installation of the ContourGlobal - Cap des Biches thermal power plant will result, in the short term, in an increase in the region's electricity production capacity. Similarly, the Project may represent opportunities for local jobs and economic development.

Environmental

From an environmental point of view, the "no Project" option does not, by definition, represent any quantifiable change to current physical and biological characteristics. The non-increase in electricity production capacity could, however, lead to increased pressure on natural resources (particularly forestry) by populations with only limited access to this energy source (or even with no access at all) across the whole of the Senegalese territory with an electricity network.

The aim of this study is, in any case, to show that no notable modification will be made to the environmental features of the study zone.

6.3 *POSSIBILITIES OF TOTAL REHABILITATION OF THE EXISTING POWER PLANT*

As stated in *Section 3.1.3*, the existing power plant was shut down completely in July 2013, with any re-start being subject to total rehabilitation of existing installations.

The existing power plant was one of Senegal's most expensive power plants, due to the fact that it operated on diesel (which is more expensive than heavy fuel oil). The cost of rehabilitation would have amplified this price gap still further, resulting in a generalised increase in the cost of electricity.

This option was discussed between ContourGlobal - Cap des Biches and SENELEC, and was dismissed by mutual agreement, in view of the budgetary consequences associated with rehabilitation.

The only possible option was therefore to create a new power plant, operating more economically (heavy fuel oil), re-using as much current auxiliary equipment as possible (storage tanks, electricity transformer, etc.).

6.4 *LOCATION OF THE POWER PLANT*

The decision to create a new power plant re-using some of the existing equipment played a large part in the choice of the installation site.

The other criteria justifying this location are as follows:

- Land located within an area that is already highly industrialised, where non-industrial human activities are very limited.
- Presence of other thermal power plants already connected to the Senegalese electricity transport network. Since electricity transport lines are already scaled for the former power plant (of equivalent power) no modification of the electricity network is required.
- Proximity to the SAR refinery, thus simplifying fuel supplies. These supplies could be made simpler still if SAR creates a heavy fuel oil supply pipe (see Chapter 3).

The extension will not have any additional footprint as the new engines will be installed within the previously authorised project area.

6.5 *TECHNOLOGICAL CHOICES*

Technological choices made by ContourGlobal - Cap des Biches in the definition of the industrial process for the power plant's configuration, including the extension, concerned the following topics:

- Choice of fuel
- Choice of supply
- Choice of process.

Since the choice of fuel is linked to supply facilities, these two issues are considered together.

Choice of fuel and supply

Several fuels could have been used for this power plant project: heavy fuel oil, diesel (light fuel oil), coal and gas.

From and environmental and health point of view, coal was the least good solution due to atmospheric emissions (mainly SO_2) which are potentially not acceptable under Senegalese standards and international good practice. The power plant would therefore have had to be fitted with expensive equipment to treat atmospheric emissions. Conversely, natural gas was the best solution in terms of emissions, although the risk associated with its usage is potentially high.

From an economic point of view, heavy fuel oil and coal were the most profitable solution in the absolute, permitting energy production at the lowest cost possible. However a coal fired power plant requires additional investments, both in terms of equipment (to limit the classic negative effects of coal fired power plants) and in terms of controlling supply (the lack of coal resources in Senegal would involve massive imports of coal from the international market). Moreover, choosing coal would have required the installation of an unloading and storage area, thus significantly increasing the total surface area of the power plant.

The use of diesel was too expensive, and this option was quickly dismissed during initial discussions with SENELEC on the possibilities of rehabilitating the existing power plant.

The main benefits and disadvantages are detailed in the table below. It would thus appear that as things stand in terms of the possibilities open to ContourGlobal - Cap des Biches, the choice of a power plant running on heavy fuel oil is the best technological choice. For the same reason, and to use the same fuel supply, the extension was also chosen to run on HFO.

Note that the engines that will be installed will be convertible to natural gas, in case this energy source were to become available in Senegal.

Table 6.1 Benefits/disadvantages of the main fuels

Fuels	Environment /health	Economy / cost-effectiveness	Supply
Heavy fuel oil	2	1	2
Diesel	2	3	2
Coal	3	1	2
Natural gas	1	1	3

Scale from "1 – the most advantageous solution" to "3 – the most unfavourable solution"

Choice of process

The choice of process was mainly conditioned by the choice of fuel. The use of combustion engines was motivated by the use of heavy fuel oil. It was also the easiest and quickest technological choice to be implemented, optimising the Project's timetable.

The decision to install a Flexicycle too, associated with the combustion engines, was discussed with SENELEC. This choice, although it entails a substantial additional investment when the power plant is built, will result in savings of 6 to 7% in the cost of fuel, by recuperating heat generated by burning in the combustion engines. The additional amount of water consumed is very small compared to the increase in energy yield. This is therefore an improvement in both environmental and economic terms, reducing in the end the cost of kWh production by 3.7 CFA francs (taking account of the amortisation of the initial investment linked to the Flexicycle throughout the duration of the Project). This information is included in the table below.

Table 6.2 ***Economic comparison of the process with and without combined cycle***

Characteristics	Without Flexicycle	Flexicycle
Installed power (MW)	49.5	53
Total cost of the Project (millions of Euros)	72.4	87.2
Cost of fuel (Euro/MWh)	120.9	112.8
Total cost of energy produced (CFAF/kWh)	103.2	99.5

Source: *ContourGlobal - Cap des Biches, 2014*

HFO supply by pipeline

HFO supply by pipeline requires the building of new equipment from SAR facility to the Project site, but presents the advantage to limit the risk on traffic safety and to ensure a more stable HFO supply. Based on these considerations, supply by pipeline is considered as the best option. The technical details of this new pipeline are not yet completely finalized. However, it is noted that:

- It will be a short length pipeline (about 500 m), from SAR existing pipeline and arriving to the Project site by going through Cap des Biches industrial area.

- The pipeline will not go through residential areas; the building will not induce any resettlement.

- The pipeline will be maintained to ensure its integrity.

- As part of its emergency response plan, ContourGlobal will develop procedures to respond to any incident involving the pipeline (hydrocarbon leak, fire, etc.).

6.6 *JUSTIFICATION FOR THE CHOICE OF THE PREFERRED VARIANT*

The following criteria have been considered in the *Table 6.3*, in order to identify the preferred alternative for the Project:

- Feasibility:
  - 1 when options are impossible to implement in the current state
  - 2 for difficult solutions to implement
  - 3 for solutions easy to implement

- Environmental aspects:
  - 1 for solutions that can lead to major environmental issues
  - 2 for solutions that can induce medium environmental issues
  - 3 for solutions with low environmental implications

- Economics:
  - 1 for solutions with significant economic implications
  - 2 for solutions with average economic implications
  - 3 for solutions with low economic implications

Table 6.3 Alternatives analysis summary

Criteria	Option « without project »	Refurbishment	New power plant (86MW)			
			LFO	HFO	Coal	Natural gas
Feasibility	2 The project without option induce the dismantling of facilities that would be the responsibility of SENELEC	2 Complicated technical feasibility, due to the significant decay of the old plant.	3 Technically feasible solution	3 Technically feasible solution	2 Solution requiring major port infrastructure, as well as high capacity storage	1 Natural gas is currently not available for the Project.
Environmental	2 Stopping production induce the perpetuation of containerized groups whose the impact on air quality is important	2 The existing plant induced significant withdrawals and discharges into the marine environment.	2 No release of SO_2.	1 Release of SO_2	1 Ash management	3 Best environmental alternative

Criteria	Option « without project »	Refurbishment	New power plant (86MW)			
			LFO	HFO	Coal	Natural gas
Economic	1 The dismantling costs would not be offset by the profits from the power production and would be SENELEC's responsibility. The total cost may be even more important because power production using containerized groups is more expensive compared to other technologies.	1 The rehabilitation will be very expensive, and not compatible with the electricity feed-in tariff in Senegal.	1 LFO cost not compatible with the electricity feed-in tariff in Senegal	3 HFO cost compatible with the electricity feed-in tariff in Senegal	3 Coal cost compatible with the electricity feed-in tariff in Senegal	3 Gas cost compatible with the electricity feed-in tariff in Senegal
TOTAL	**5**	**5**	**6**	**7**	**6**	**7**

Thus, the creation of a new plant including the extension (86MW in total) appears to be the best available option for the Project. In addition, two types of fuel get a better rating than the others: HFO and natural gas. Natural gas is the best environmental and economic compromise, but is however not available in the state for use in the Project.

In view of these various elements, the decision to establish a thermal power running with HFO, convertible to natural gas (when this fuel will be available to the plant) and associated with a combined cycle represents the best compromise in terms of social, environmental and economic (cost-effectiveness and cost of energy production) criteria.

7 STAKEHOLDER CONSULTATION

7.1 GENERAL METHODOLOGY AND TIMETABLE

As required by Senegalese regulations and by World Bank Group's sustainable development and social policies, performance of this ESIA has been based on consultations with stakeholders affected by the Project. As shown in *Inset 7.1* below, listing requirements in terms of consultation as set forth by World Bank Group policies, the extent of this involvement must be proportional to the magnitude of impacts on communities affected.

Inset 7.1 Main requirements in the consultation process

The process used in consultation and information activities throughout the ESIA is recapitulated below:

1. Identify a sufficiently large sample of stakeholders in order to meet consultation objectives and record them in a stakeholder database. This sample is chosen such that it guaranteed representative involvement by the various types of stakeholders.

2. Prepare information carriers for the consultations, including notably data relating to the Project and contacts in the form of group meetings or interviews to meet specific, set objectives.

3. Prepare and carry out stakeholder consultation sessions, ensuring that the protocol is respected and that the consultation format (group meetings/interviews) is adapted to each specific group of stakeholders.

4. Record the consultation process, ensuring that stakeholder concerns appear in reports produced to then be the object of research or studies and showing how they have been taken into account in the Project decision and design.

5. Ensure that all information to be communicated is passed on sufficiently well in advance for it to be taken into account prior to the consultation and that it is accessible and relevant and can be understood (for example, non-technical summaries, relevant language and illustrations, etc.).

Within the context of the project to build the power plant and its extension, stakeholder participation and consultation took the form of information meetings and discussions with national and regional technical services, local elected representatives and members of local associations, as well as with communities neighbouring the ContourGlobal - Cap des Biches power plant development project, located in the municipality of West Rufisque.

The consultation was carried out at three different levels: local level, which involved mainly the municipalities potentially concerned by the Project, whilst consultations at regional and national level were used to consult with the regional offices and national institutions concerned.

For the initial Project (53MW), a consultation campaign took place between 25th and 27th June 2014, and another was held in October 2014.

For the Extension (33MW), consultations took place between the 16th and 25th of February 2016.

The following stakeholders were consulted over the course of the two campaigns:

- National Senegalese authorities and institutions:
  - Environment and Classified Installations Office (DEEC);
  - The Environmental Impact Evaluations Office (DEIE) at the DEEC;
  - The Classified Installations Division (DIC) at the DEEC ;
  - SENELEC;
  - Urban Planning Office (*Direction de l'Urbanisme*);
  - Civil Protection Office (Direction de la Protection Civile);
  - Air Quality Management Center (Centre de Gestion de la Qualité de l'Air) ; and
  - Coastline Management Office (*Direction Gestion du Littoral*).

- Regional Senegalese authorities:
  - Rufisque Prefecture
  - Departmental Office for Rural Development in Rufisque.

- Service in the Municipality of Rufisque
  - Rufisque fire service.

- Local communities – Municipality of Rufisque-Ouest:
  - Rufisque town hall and mayor;
  - Members of technical services; and
  - Darou-Salam Azure district, Rufisque.

- Local communities – Villages in West Rufisque:
  - Consultation with fishermen ;
  - Consultation with village elders and chiefs ;
  - Directors of private and public schools ;
  - Consultation with women's groups ;
  - Consultation with users (swimmers, sportspeople, etc.) ; and
  - Consultation with shell gatherers/users.

The list of the consulted persons is detailed in *Annex 8.*

Figure 7.1 Photographs illustrating the public consultations held for the ESIA

Top left: Consultation with elected representatives in the Municipality of West Rufisque. Top right: Focus group with fishermen. Middle left: Focus group with the Association for Environmental Protection and Prevention. Bottom left: mayor of Rufisque Ouest. Bottom right: Focus group with shell gatherers/users.

7.2 MAIN STAKEHOLDERS IN THE PROJECT

Figure 7.2 presents the main stakeholders in proximity to the Project and other institutional or financial stakeholders with jurisdiction.

Figure 7.2 Main stakeholders in the Project

Local communities in the surroundings

Municipality of Rufisque-Ouest
- Mayor and members of technical services
- Women's groups
- Youth associations
- Fishermen

Economic players/activities located in the surroundings
- SENELEC - Cap des Biches thermal power plant
- Other industries
- Farmers

Senegalese National Authorities
- General government of Senegal
- Environment Ministry
- Energy Ministry
- Environment and Classified Installations Office (DEEC)
- Urban Planning Office (*Direction de l'Urbanisme*);
- Civil Protection Office (*Direction de la Protection Civile*);
- Air Quality Management Center (*Centre de Gestion de la Qualité de l'Air*) ; and
- Coastline Management Office (*Direction Gestion du Littoral*).

Regional authorities
- Sub-prefecture
- Regional Water and Forestry Inspection (IREF)
- Regional Environment and Classififed Installations Office (DREEC)
- Regional Civil Protection Office
- Regional Agriculture Office

International funds
- Overseas Private Investment Corporation (OPIC)
- International Finance Corporation (IFC)
- Other multilateral or bilateral funds
- Potential private financial institutions

The Municipality of Rufisque-Ouest is the closest community to the Project (about 400m distance). Its inhabitants therefore represent the most important group of stakeholders, both in terms of interest in and influence on the Project. Meetings were therefore mainly concentrated on these communities.

7.3 *Scope of Public Consultation*

All the groups of people and authorities referred to in the table above were consulted separately. The various interviews took place as follows:

- presentation of the plan to build and extend the Cap des Biches thermal power plant and the challenges involved
- aims of the ESIA and ESIA update and the need to imply the public and local interested parties actively in the evaluation process
- collection of the questions, opinions and concerns raised by the people questioned

- answers by consultants ERM in response to questions raised.

Consultations with local communities for the initial 53MW plant took place in the form of interviews with inhabitants and use of the “focus group” method, i.e. grouping the population by professional activity, centre of interest or age bracket. Consultations with the authorities for the 33MW extension took place as individual visits.

The outcomes of the consultations of both consultation campaigns (in 2014 for the initial Project and in 2016 for the extension) will be taken into account both for the construction phase (including the Extension) and for the operation phase of the initial Project (53MW) first and then for the full power plant (86MW).

7.4 *CONSULTATION WITH SENEGALESE AUTHORITIES FOR THE 53 MW POWER PLANT*

7.4.1 *Consultation with the Classified Installations Division (DIC) at the Environment and Classified Installations Office (DEEC)*

Reminder by the Head of the DIC that the ICPE is distinct from that of the impact study (but complementary to it) and that the two can be launched in parallel.

It was thus recommended that ContourGlobal - Cap des Biches should submit an ICPE transmission file as soon as possible, in parallel to the ESIA, and including the following:

- Presentation of the Project
- Map of the location
- List of pressurised equipment.

Finally, the possibility of organising a visit to the power plant was addressed.

7.4.2 *Consultation with the Environmental Impact Evaluation Office (DEIE) at the Classified Installations Division of the Environment and Classified Installations Office (DEEC)*

After presentation of the planned Project and the current context of ContourGlobal - Cap des Biches installation, the Head of the DEIE agreed that the request for an audit set forth in the letter responding to the Project notice (letter n° 001607 MEDD/DEEC/DEIE/rd dated 19th June 2014) was not justified.

He also stated the need to undertake an in-depth impact study.

In order to optimise the timetable, it was agreed that ContourGlobal - Cap des Biches/ERM/2iEC would draw up a proposed report. After publication of this report by the DEEC, a new Project notice, accompanied by Terms of Reference, can be submitted.

7.4.3 *Consultation with Rufisque Prefecture*

Courtesy visit with information on the project. The Prefect offered his support for the Project, and hoped that the ESIA would be carried out with account taken of possible nuisance caused to populations, in order to avoid/suppress them.

7.4.4 *Consultation with the Rufisque Rural Development Office*

Courtesy visit intended to inform the Departmental Office of ContourGlobal - Cap des Biches's Project and the acquisition/compensation process with regard to the land where the new installations will be located.

The Head of the departmental office saluted this initiative.

7.4.5 *Consultation with the Mayor of Rufisque*

Information session held at Rufisque Town Hall with the DAGE and the Deputy Director of Town Planning. The Town of Rufisque, which is already involved in the procedure for acquisition of the land on which the extension project will be built, also made a commitment to facilitate implementation of the project. ContourGlobal - Cap des Biches was thus advised to proceed rapidly with payment of disbursements, in order to finalise acquisition of the land. ContourGlobal - Cap des Biches pointed out that the farmer had been authorised to continue farming until the start of the works.

The DAGE reminded the meeting that Contour Global – Cap des Biches was the third largest tax payer in the town of Rufisque (over 500 000 00 CFA francs per year).

Finally, the technical services in charge of planning committed to supervise the development of future urbanised areas in the Cap des Biches area closely, in order to ensure compliance with the exclusion area, which will be defined based on the conclusions of the hazard level study.

In terms of recommendations, the involvement and information of elected representatives in implementation of the Project was suggested.

7.4.6 *Consultation in the Darou-Salam Azur district*

Visit to provide information on the Project and the on-going ESIA procedure.

The District Head welcomed the project and wished to see some of the district's young people employed during certain phases of the Project (at least during the worksite phase). It was pointed out that priority will be given to local people wherever profiles correspond to the skills sought.

The District Head also said that the existing SENELEC power plants are already noisy and he hoped that the building of new installations would not constitute a new source of noise pollution for the inhabitants of Darou- Salam Azur.

It is important to note that the Darou Salam Azur district did much to facilitate the integration and work of the staff responsible for carrying out these consultations. This first characterisation enabled identification of the environmental and social issues linked to implementation of the project.

7.4.7 Consultation with the Rufisque fire service

The Rufisque fire service possesses equipment that is considered sufficient to combat any fires or accidents that may occur at Cap des Biches.

However, it will be necessary to organise regular training sessions at the power plant, to ensure:

- That ContourGlobal - Cap des Biches staff are trained in emergency procedures (in order to optimise intervention by emergency teams), and
- That the firemen are familiar with the terrain and with risk installations (in order to optimise the efficiency of their intervention).

7.4.8 Consultation with local populations and stakeholders

With regard to the project's impact, interviews were held with various stakeholders (district delegates, the directors of public and private, Arabic and French schools and focus groups were held with women's groups, fishermen, swimmers, sportspeople, and Environment Commission APROPRE and gatherers/users of shells.

Within the project impact zone, delegates and elders showed their willingness to work with the project.

In relation to the concerns expressed by villagers and local stakeholders met during the two consultation phases (June and October), preliminary suggestions and recommendations were expressed:

- Use of appropriate technology that takes account of the health and well-being of populations.

- Use of another form of fuel drainage, taking account of the marine ecosystem and of users working around this resource: fishermen, various users, etc.

- When new installations are created at the power plant, it would be a good idea to take account of the health of pupils in particular and of populations in general, using techniques that reduce emissions.

- Encourage as far as possible the recruitment of young people from the district and more particularly during the construction phase (which potentially corresponds to skills present at the site).

7.5 CONSULTATIONS WITH SENEGALESE AUTHORITIES FOR THE 33 MW EXTENSION

7.5.1 DEEC

A meeting was organized with DEEC on the 16th of February 2016. ERM and Contour Global – Cap des Biches presented the Extension project and preliminary results of the impact assessment procedure.

DEEC confirmed they will answer to the letter transmitting the ESIA Terms of References on 23/02/2016. DEEC requested to update the water consumption figures within the present ESIA. Preliminary air quality modelling results were discussed. The results of the air quality monitoring were also presented (included in Section 5.3.8 of this report).

7.5.2 *Municipality of Rufisque Ouest*

The mayor of Rufisque Ouest showed support for the Extension and the Project in general. He showed concern for air quality results presented during the preliminary ESIA and for social community project in the area.

The mayor also expressed his wish to see local young people from the municipality employed on certain phases of the Project (construction phase especially).

7.5.3 *Urban Planning Office (Direction de l'Urbanisme)*

The Urban Planning Office wishes to receive some documentation as soon as available (ESIA, 3D and layouts etc.). The involvement of this office will be in partnership with the municipality of Rufisque Ouest.

7.5.4 *Civil Protection Office (Direction Protection Civile)*

The Civil Protection Office showed no particular concern for the expansion. For the approval of the Emergency Plan (*Plan d'Operation Interne* – POI) of the initial Project of 53MW, the office expressed the need to receive the plan in advance in order for the sizing and design of firefighting facilities. The office also reminded that the POI has to be reviewed first by Rufisque Fire brigade.

7.5.5 *Air Quality Management Center (Centre de Gestion de la Qualité de l'Air)*

The center expressed the request to be updated on the Air quality measure campaign results (See section 5.3.8). An effort on collaboration between the center and the Contour Global Cap des Biches must be achieved in order to share important results. The following website should be used as a reference for published information on the air quality in Dakar and its surroundings. http://www.air-dakar.org/

7.5.6 *Coastline Management Office (Direction Gestion du Littoral)*

The issue of maritime protection in front of the power plant site was raised. The ESIA and the management plan will assess the need for specific study in due time.

7.6 MAIN CONCLUSIONS OF THE PUBLIC CONSULTATION PROCEDURE

In a general way the Project was well received by the various people met during the consultations. Involvement, right from the very start of the process, of elected representatives and the local population, was well appreciated by all stakeholders met.

All the stakeholders consulted agree on the relevance of the initial Project (and similarly for the which, they believe, is a priority for the country in terms of improvement to energy production capacities and they also agreed on the fact that there will be lots of positive impacts on the town of Rufisque.

Local elected representatives recognised the fact that the shutdown of the current ContourGlobal - Cap des Biches power plant had had negative impacts on Rufisque (loss of municipal income and loss of jobs), and they made a commitment to work with the project.

At local level (Sub-Prefecture, Municipality and residents) the main concerns and expectations with regard to the studies to be carried out concerned the health impacts linked to operation of the power plant (particularly atmospheric emissions and noise pollution and impacts on the marine environment). In terms of access to jobs, expectations in terms of local employment (particularly amongst young people) were expressed.

To this end the Municipality has an Environment Commission, a "Coastline" Commission and a Social Commission which could be approached by ContourGlobal - Cap des Biches, if necessary.

Table 7.1 below presents the concerns expressed by the stakeholders as well as the suggestions and recommendations made during the consultations. Note that these remarks do not specifically concern the Project, but all industrial activities (and mainly electricity production) in the Cap des Biches area.

Table 7.1 Points raised by villagers and local stakeholders in proximity to the thermal power plant

Topics raised	Observations made	Inclusion of observations made as part of the study
Classified	The Classified Installations Office drew attention to the	The need to start a procedure of

Topics raised	Observations made	Inclusion of observations made as part of the study
installations	fact that the ICPE procedure is separate from that of the environmental and social impact study (but complementary to it). Both procedures can be undertaken in parallel. ContourGlobal - Cap des Biches was therefore recommended to submit an ICPE transmission file as soon as possible. The Head of the DEIE agreed that the request for an audit expressed in the letter in response to the Project notice (letter n° 001607 MEDD/DEEC/DEIE/rd dated 19th June 2014) was not justified. He also stated the need to carry out an in-depth impact study. ContourGlobal - Cap des Biches/ERM/2iEC has drafted a proposed report, which will be published by the DEEC after a new Project notice accompanied by Terms of Reference. The results of the air monitoring and preliminary results including the extension were discussed during the meeting in February 2016.	authorization ICPE was added to the ESMP, as required by recommendations. . Air monitoring results were included in the updated ESIA for the extension
Impacts on populations	The Prefect of Rufisque gave a favourable opinion with regard to the project. However, he insisted on the fact that particular attention must be given to avoiding and/or attenuating potential nuisances for populations. Local elected representatives expressed the wish that the Project wold help to improve living conditions for populations, by offering family grants underprivileged and poor populations. The Head of Darou-Salam Azur district expressed his wish to see local young people from the district employed on certain phases of the Project (worksite phase). Villagers and local stakeholders expressed the wish to see the Project encouraging access to recruitment for young people from the district. The mayor of Rufisque Ouest also emphasized the need to local employment as much as possible.	These recommendations have been considered through the definition of the ESIA methodology, particularly by always considering the inhabited areas as sensitive receptors. Attention was given to the most sensitive receptors (schools and health center). The results of technical studies (particularly air and noise) and the absence of significant impact also confirms that the Project design has been optimized in order to minimize the nuisances to the populations. Finally, concerning the other complaints issued, they will addressed as part of the social responsibility policy that will be developed by ContourGlobal - Cap des Biches. As far as possible, non-qualified jobs will be held as a priority by candidates from the neighbouring urban community of Rufisque Ouest.
Impact on noise	The Head of Darou-Salam Azur district pointed out that existing SENELEC power plants are already noisy, and he hoped that the building of new installations would not constitute an additional source of noise	A specific noise modelling study was undertaken. Mitigation measures related to noise emissions were defined at Project design, in order to minimize

Topics raised	Observations made	Inclusion of observations made as part of the study
	pollution for the inhabitants of Darou- Salam Azur. Villagers and local stakeholders said that noise pollution is heard in the district, sometimes very loudly, due to existing installations that are currently in operation.	these emissions.
Impact on Environment	Local elected representatives expressed their wish to see fishermen involved in and informed about the project. They also suggested that analyses of discharge should be carried out on a regular basis. Villagers and local stakeholders noted marine pollution from fuel oil being discharged into the sea, leaving the beach dirty.	The fishermen were consulted specifically (« focus group ». Also, liquid discharge analyses are planned as part of the ESMP. In addition, interactions between the future thermal plant and the marine environment were improved compared to previous configuration : - End of seawater sampling - Decrease of liquid discharges - Improvement of monitoring of the quality of liquid discharges •
Acquisition and Expropriation	The Departmental Office for the Rural Development of Rufisque saluted the particular attention paid by ContourGlobal - Cap des Biches to anticipate the acquisition/compensation process with regard to the land on which the new installations will be located. The Rufisque Town Hall advised ContourGlobal - Cap des Biches to proceed rapidly with the payment of disbursements, in order to finalise acquisition of the land.	The payment of disbursements was undertaken in conformity with Rufisque authorities advices.
Land use	The technical services in charge of planning committed to supervise the development of future urbanised area close to the Cap des Biches area strictly, in order to ensure compliance with the exclusion zone that will be defined based on the consultations of the hazard level study.	The hazard study allowed to define an exclusion zone on the basis of potential hazards associated with the plant operations. ContourGlobal-Cap des Biches will be in relation with the technical services, as part of the supervision of urbanism in the proximity of the plant.
Risk	The firemen from Rufisque requested that personnel from ContourGlobal-Cap des Biches be trained for risks associated with the operation of the plant, and that regular exercises should be performed. The Rufisque fire service required the organization of regular training sessions at the power plant.	Trainings and practices will be undertaken. Note that these were already in place as part of the operations of the former plant. In addition, a POI will be undertaken, in collaboration with the firemen and Civil Protection services.
Impact on air quality	Villagers and local stakeholders referred to atmospheric pollution from smoke dispersal. The Air Quality Management Center (*Centre de Gestion de la Qualité de l'Air*) expressed the request to obtain the results of the air monitoring campaign.	Project impact on the air quality was studied through modelling. Modelling results do not show any significant impact from the Project on air quality. Air monitoring results were included in the updated ESIA for the extension
Other impacts, not	The presence of the WWTP alongside dwellings which emits bad odours, and the high voltage cables above	This observation is not related to the Project, and thus was not taken into

Topics raised	Observations made	Inclusion of observations made as part of the study
directly linked to the Project development	dwellings.	account in this study.

8 IDENTIFICATION AND EVALUATION OF POTENTIAL IMPACTS LINKED TO THE PROJECT

8.1 INTRODUCTION

Potential impacts will be linked to the various phases of the Project:

- Construction phase of the Project and the buildings and installations associated with it;

- Operation of the combined cycle thermal power plant, comprising five 16.5MW diesel engines, three engines of the initial project (53MW) will be associated with a heat recovery boiler operating a 3.5MW steam turbine and one of the engines of the extension will be equipped with a boiler for fuel heating. In total the power plant will have a capacity of 86MW); and

- Dismantling of the power plant, shut down and restoration of the site.

The main stages used to define the Project's impact and developed in chapter are summarised below:

- identification of activities relating to the Project and likely to cause environmental or social impacts

- identification of the sensitivity of environmental and social receptors likely to be affected by the Project

- detailed description of the potential environmental or social impacts identified, including identification of the proposed measures to control and mitigate impacts (control and mitigation measures are incorporated into the evaluation)

- Definition of the extent of potential residual environmental or social impacts resulting from implementation of the proposed mitigation measures.

8.2 IDENTIFICATION OF POTENTIAL IMPACTS LINKED TO THE PROJECT

An initial identification of potential impacts linked to the Project was carried out based on the description of the Project presented in *Chapter 3,* and based on the environmental issues identified within the context of analysis of the baseline of the site (see *Chapter 4*). *Table 8.1* below presents a recap of the issues identified.

Table 8.1 Scoping Matrix of main environmental and social issues identified

Topic	Comments	Environmental or social issues
Air quality	Baseline air quality data have been collected for one year for NO_2 and SO_2. PM monitoring is ongoing, to date data have been collected over 4 months, covering the most critical period of the year (dry season). The project contribution in terms of atmospheric emissions and consequent impacts induced at receptors is not expected to be critical.	Medium [1]
Noise	Particularly high noise level at night measured during analysis of the baseline conditions (readings higher than Senegalese standards).	Low to medium
Groundwater	Aquifer not very deep but of mediocre quality. Relatively impermeable limestone-marl soils.	Low to medium
Surface water	No water course in the Project's zone of influence.	Nil
Soil erosion	Flat area.	Very low
Biodiversity (terrestrial habitats, fauna and flora)	Peri-urban, industrialised, highly anthropised environment. One partially protected plant species. One protected but not vulnerable animal species.	Low
Landscape	Flat, relatively monotonous landscape. Industrial area.	Low
Land use	Limited presence of agricultural activities in the installation area (1 unit). Acquisition of the parcel concerned and compensation already paid to beneficiaries by SENELEC.	Low to medium
Local agriculture and means of subsistence	Extended study area highly urbanised and industrial. Some parcels occupied by market gardening but decreasing rapidly due to urbanisation and industrialisation of the area. Activities linked to artisanal fishing (drying) and the collection of shells on the beach adjacent to the installation parcel – no direct impact by the project. Small informal shops.	Low to medium
Local economic & social context	Industrial area at the edge of an urban area (town of Rufisque) with a very high unemployment rate.	Low

[1] The assessment of the quality of the airshed will be finalized when 12 months of monitoring data (including PM) are available for review and analysis. The Project Contribution is expected to be low (as demonstrated through modelling in Section 8.5) for long term SO_2, NO_2 and PM.

Table 8.2 is a matrix for identifying impacts for the Project's ESIA. This matrix presents relationships between potential sources of environmental and social impacts caused by the Project, and the environmental and social elements likely to be affected by the Project, on the basis of information collected within the context of study of the baseline and the framework mission. Areas where component sources coincide are dealt with in more detail in the following section.

Table 8.2 Matrix for identifying the potential impacts of the ContourGlobal - Cap des Biches thermal power plant (86MW)

Factors within the milieu →		Environmental factors (physical and biologic)						Social factors				
Sources of impact ↓		Air quality	Noise	Water quality and resource	Soils	Biodiversity (terrestrial habitats, fauna and flora)	Landscape	Land use	Local agriculture and means of subsistence	Local economic and social context	Health and safety of communities and workers	Waste production
Construction	Change in land use			QE-1	QS-1	BFF-1		OF-1	A-1			
	Site machinery	QA-1	B-1								SS-1	D-1
	Building	QA-1	B-1	QE-2		BFF-2						
	Storage of chemicals			QE-3	QS-2						SS-2	
	Labour force			QE-2						ES-1		
Operation	Presence of the power plant						P-1					
	Supplies (water, heavy fuel oil, etc.)	QA-2		QE-4							SS-3	D-2
	Electricity production	QA-3	B-2	QE-5		BFF-2						
	Labour force			QE-2						ES-2		
	Storage of chemicals			QE-3	QS-2						SS-2	
	Run-off from the site			QE-5								

Key to understanding the identification matrix:

QA-1	Exhaust emissions and dust from site machinery – Dust emissions
QA-2	Exhaust emissions and dust from deliveries by truck
QA-3	Atmospheric emissions
B-1	Noise emissions from the worksite
B-2	Noise from the power plant in operation
QE-1	Complete clearance of soils which could lead to changes to run-off
QE-2	Increase in water consumption
QE-3	Pollution of surface water and groundwater due to the storage of chemicals
QE-4	Power plant's water requirements
QE-5	Liquid discharge from the operational phase
QS-1	Complete clearance of soils which could lead to changes in erosion
QS-2	Risk of soil contamination
BFF-1	Destruction of the habitats, flora and fauna found within the perimeter of the Project
BFF-2	Disturbance of fauna
P-1	Effect on the landscape of the power plant's buildings
OF-1	Modification of land use
A-1	Loss of agricultural land
ES-1	Effect on local employment
ES-2	Effect on local employment
SS-1	Workers' working conditions and risks for populations caused by the worksite
SS-2	Health impact linked to the storage and use of chemicals
SS-3	Safety of populations related to the increase in road traffic
D-1	Production of waste during the construction phase
D-2	Production of waste during the operational phase

8.3 METHOD USED TO EVALUATE IMPACTS

A preliminary identification of potential impacts linked to the Project was carried out based on the description of the Project provided by the client, referred to in the previous section.

A detailed evaluation of impacts was then carried out, looking one by one at the potential impacts identified during the framing phase in the field.

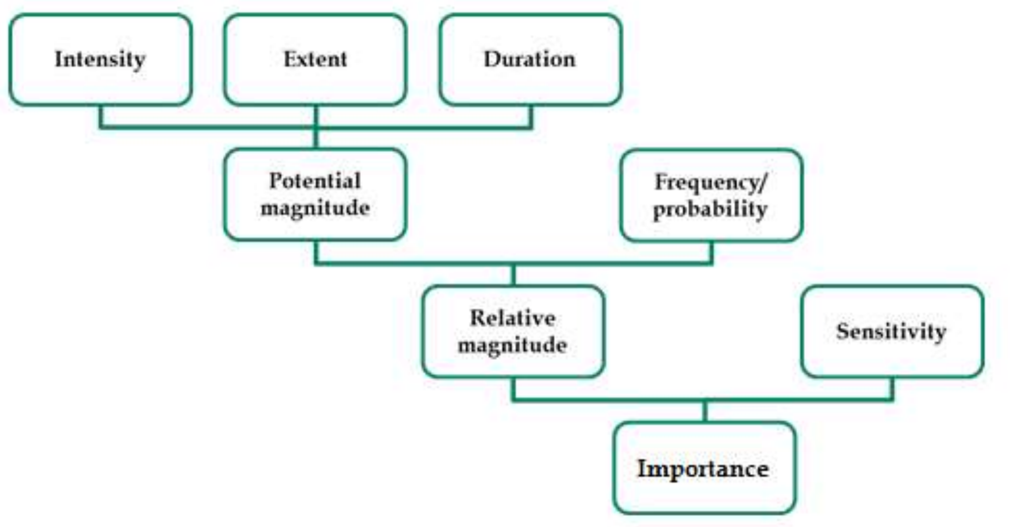
Potential impacts may be direct, indirect or caused, according to the Project's various phases of creation and operation. These terms are defined in *Table 8.3*.

Table 8.3 Definition of types of impacts

Type of impact	Definition
Direct	Impact that results from direct interaction between the project and a receptor / resource
Indirect	Impact that comes from direct interactions between the project and its environment following subsequent interactions within the environment.
Caused	Impact resulting from other activities (which are not part of the project) and which occur as a consequence of the project.

The importance of the Project's potential impacts is defined by evaluating the magnitude of an impact and comparing it to the characteristics of the milieu and its sensitivity to the expected changes. This approach is presented in *Figure 8.1*.

Figure 8.1 Method used to analyse impacts



Potential magnitude

The potential magnitude of an impact is a function of the extent, duration and intensity of the impact

- Extent:
  - local (limited to the site and its immediate surroundings)
  - regional (impacts that affect resources at regional level) or
  - national/international (impacts that affect resources of national importance or resources at national / international level).

- Duration of the potential impact:
  - Temporary (potential impacts lasting between a few hours and a few days)
  - Short term (potential impacts lasting between a few days and a few weeks)
  - Medium term (potential impacts lasting between a few weeks and a few months) or
  - long term (potential impacts lasting for a few years at least).

- Intensity:
  - Negligible (no perceptible change)
  - Low (perceptible change but no significant change to the environment or to human activities)
  - Moderate (perceptible change but the environment or human activities will not suffer from it in the long term)
  - High (the environment or human activity is affected in the medium or long term).
  - It should be noted that intensity is not necessarily a given fact and may depend on the receptor. In this case it is defined specifically in terms of the receptor using detailed criteria.

Relative magnitude

The potential magnitude weighted by frequency or probability factors is the impact's relative magnitude (see *Table 8.5*).

These frequency factors are:

- Frequency, which is the number of times that the impact takes place. It is evaluated on a semi-quantitative scale and relates to events occurring during so-called normal functioning periods. The impact may be:
- rare (rarely or never observed in similar activities)
- occasional (sometimes observed in similar activities) or
- high (regular in similar activities).

OR

- Probability which is the characteristic that relates solely to unexpected events (for example a traffic accident, accidental discharge of toxic gases, etc.). The probability that an unplanned event occurs is evaluated on a qualitative scale (or semi-quantitative when the appropriate data is available) described in Table 8.4 below, and thus provides the degrees of occurrence of an action with a finite probability but which is likely to occur.

Both frequency and probability can be determined based on historic data, modelling, sectorial data and contributions from stakeholders, and based on the consultant's experience.

Table 8.4 Definition of frequency / probability

Frequency / Probability	Definition
Rare / Improbable	The event is not foreseeable but could occur at a given moment.
Occasional / Probable	The event is likely to occur at a given moment in normal operating condition.
High	The event will occur in normal operating condition (i.e. it is almost unavoidable).

Table 8.5 Criteria for evaluating relative magnitude

		Frequency / Probability		
		Rare	Occasional	High
Potential magnitude	Insignificant	Insignificant	Insignificant	Insignificant
	Low	Insignificant	Low	Low
	Medium	Low	Medium	Medium
	High	Medium	Medium	High

Sensitivity

Sensitivity is defined as the degree of aptitude of a milieu to react to external events. A whole range of factors is taken into account in the definition of sensitivity which may be of a physical, biological, cultural or human nature. In the end, sensitivity is held to be low, medium or high depending on the intrinsic characteristics of receptors and the consultant's expertise.

Magnitude of the impact

Once the characteristics of the relative magnitude of impacts and sensitivity of receptors have been defined individually, they are paired in order to define the importance of each impact (see *Table 8.6*). In the end it is a case of describing the degree of change that the impact is likely to make to a factor within the milieu (receptor, resources).

Table 8.6 Criteria for evaluating the importance of the impact

		Sensitivity		
		Low	Medium	High
Relative magnitude	Insignificant	Negligible	Negligible	Negligible
	Low	Negligible	Minor	Medium
	Medium	Minor	Medium	High
	High	Medium	High	High

Positive impacts

In cases where positive impacts are found, the analysis carried out is based mainly on the consultant's assessment. The scale thus assessed is compared to the receptor's ability to benefit from the positive effects anticipated, in order to evaluate the supposed importance of the positive impact studied.

8.4 CREATION OF MITIGATION MEASURES AND RESIDUAL IMPACT

One of the aims of an ESIA consists of suggesting mitigation measures in order to limit any potential negative impacts affecting all physical, biological and socioeconomic resources as well as receptors. The mitigation measure must be adapted and in proportion to the impact identified and must generally follow a hierarchy of measures – avoid, reduce, re-establish or compensate – in terms of the potential negative impacts identified.

The aim of mitigation measures is to prevent or reduce the importance of negative impacts whilst optimising the feasibility and potential benefits of the Project. Impact mitigation objectives are often established on the basis of legal standards or by referring to best practice. In the absence of any existing benchmarks, objectives specific to the project are established. The approach used to define the mitigation measures is based on the hierarchy of decisions and measures described in *Figure 8.2.*

Figure 8.2 Hierarchy of mitigation measures

Avoid at source – Reduce at source
Avoiding or reducing at source consists mainly of "developing" a project to ensure that a characteristic which is the origin of an impact is suppressed (e.g. a flow of waste materials is eliminated) or modified (e.g. reducing the volume of waste materials). It is often called minimisation.
Abate at source
This is a case of adding something to the basic design in order to reduce the impact – pollution control falls into this category. Often called "at chain end".
Reduce at receptor
If an impact cannot be reduced on site, measures can then be taken off site (e.g. efficient communication with authorities to help to control the level of interference in local communities).
Repair or re-establish
Some impacts result in unavoidable damage to a resource: e.g. land clearance. Repairing means mainly applying restoration or re-establishment measures, such as restoration of plant life on a seismic line.
Compensate in kind
If the other mitigation methods are impossible to apply or if they do not have full effect, compensation may then prove appropriate, to a certain extent, in case of loss, damage or general intrusion.

Residual impact

An impact remaining after application of mitigation measure(s) is called the residual impact.

8.5 IMPACTS ON AIR QUALITY

8.5.1 Overview

The Project has the potential to adversely impact ambient air quality in its surroundings both during its construction and operation phases.

The assessment of impacts on local air quality arising from the Project construction and operation phases was conducted in accordance with the methodology presented in *Section 8.3*. The assessment of construction impacts was based on qualitative criteria, whereas the assessment of operational impacts was supported by an atmospheric dispersion study and was based on quantitative criteria.

The choice of a qualitative evaluation for the project's construction phase is based on the temporary and variable nature of atmospheric emissions produced during this phase. Importance of potential impacts on air quality have been estimated based on the type of emissions and the dispersal capacity of emissions into the atmosphere.

During the Project operation phase, atmospheric emissions will be continuously released into the atmosphere by the Project facilities, and impacts on local air quality are more likely to occur. As a consequence, the assessment of operational impacts was supported by an atmospheric dispersion modelling study performed with the USEPA-approved modelling system CALMET-CALPUFF[1]. The modelling study quantified the contribution of the Project emissions to atmospheric concentrations of pollutants in the Project area. Quantitative criteria have been developed to correlate the outcome of the modelling study to the impacts intensity (defined in Section below in this section). These criteria are reported in the following part of this Section.

Intensity criteria for Operational Impacts on Air Quality

The definition of the intensity criteria was based on international guidance released by the IFC and World Bank[(2)] and takes into account the following elements:

- The Process Contribution (PC): this is the impact on air quality from the process emissions only;
- Applicable Air Quality Standards (AQS), presented in the Air Quality Baseline *Section 5.3.8* and reported below in *Table 8.7*;
- the Predicted Environmental Concentration (PEC): this is the PC cumulated with the existing baseline; and
- Consideration of the exiting baseline conditions, and evaluation of whether the local airshed is degraded or undegraded.

Table 8.7 summarises the impact intensity criteria used in this assessment.

---

[1] http://www.epa.gov/scram001/dispersion_prefrec.htm#calpuff

(2) Environmental, Health, and Safety Guidelines for Air Emissions and Ambient Air Quality, IFC / World Bank, 2007.

Table 8.7 Evaluation criteria for the Intensity of impacts on local air quality

Intensity of impacts	Non-deteriorated atmosphere (Baseline < AQS)	Deteriorated atmosphere (Baseline > AQS)
Negligible	PC < 25% of AQS	PC < 10% of AQS
Low	PC > *25% of AQS, <50% of AQS*(1) and *PEC<100% of AQS*	PC > 10% AQS, <15% of AQS
Moderate	PC > 25% AQS, <50% of AQS and *PEC >100% of AQS;* or PC > *50% of AQS, <100% of AQS*(1) and *PEC <100% of AQS*	PC >15% of AQS, <25% of AQS
High	PC > 50% of AQS, <100% of AQS and *PEC >100% of AQS;* or PC > *100% of AQS*(1)	PC >25% of AQS

(1) *In italics, criteria based solely on the PC, used to evaluate the intensity of impacts over the short term (e.g. hourly, daily concentrations)*

AQS= Air Quality Standards

Table 8.8 Senegalese and IFC/WHO Air Quality Standards

Pollutant	Averaging period	Senegale AQS [µg/m³]	IFC/WHO AQS (a) [µg/m³]
SO_2	Calendar year	50	-
	24 h	125 (b)	125 (Interim target 1)
			50 (Interim target 2)
			20 (Guideline)
NO_2	Calendar year	40	40
	1 h	200	200
PM10	Calendar year	80	70 (Interim target 1)
			50 (Interim target 2)
			30 (Interim target 3)
			20 (Guideline)
	24 h	260	150 (Interim target 1)
			100 (Interim target 2)
			75 (Interim target 3)
			50 (Guideline)
CO	24 h	30000 (c)	-

(a) IFC Guideline value
(b) It corresponds to the IFC interim target -1 set on SO_2 24h concentration.
(c) Not to be exceeded more than once per calendar year

8.5.2 *Recap of Baseline Conditions*

CountourGlobal Cap de Biches is undertaking an air quality monitoring survey since November 2014 in the area surrounding the Project. The survey is aimed at characterising the existing baseline conditions in terms of NOx, SO_2, PM10 and PM2.5 concentrations. Monitoring activities are currently ongoing, and results collected up to December 2015 are presented in Section 5.3.8 of this ESIA.

With regard to the classification of the quality of the local airshed, the IFC General EHS Guidelines state that: *"An airshed should be considered as having poor air quality [degraded] if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly".*

Based on the available results and on the above criteria, this study aimed at classifying the local airshed for each of the monitored pollutant.

NOx and SO_2 monitored concentrations detected over a time frame of 12-months at sensitive receptors, showed that the airshed is undegraded for these pollutants. As a consequence, the assessment of operational impacts related to NOx and SO_2 emissions followed the criteria presented in *Table 8.7* for undegraded airsheds.

PM10 data collected to date refer to a period of 4 months, during the dry season; the latter is characterized by higher atmospheric concentrations of PM, due to the absence of wet deposition. Hence, data available to date are representative of the highest PM concentrations expected throughout the year and show some exceedances of regulatory limits. In light the above considerations, the classification of the local airshed with regards to PM will be undertaken once PM monitoring data are collected for a 12-month period.

8.5.3 *Potential impacts during the construction phase*

Impact sources

The main sources of emissions during the construction phase are:

- Motorised equipment and energy generators used to supply electricity during construction activities
- Heavy machinery and vehicles: front loaders, trucks, compactors and pick-ups will be used for construction activities such as site preparation and the transport of materials and workers.

These emissions sources imply two types of atmospheric emissions:
- Release of exhaust emissions from vehicles and engine driven machinery;
- Release of dust from earthworks.

Impacts associated with these atmospheric emissions are presented in the following part of this Section.

Exhaust Emissions

The use of motorised vehicles and equipment (e.g. trucks, generators), will produce gas emissions from to the combustion of fuel oil and hydrocarbons. These emissions may cause an increase in pollutant concentrations in the atmosphere, such as carbon monoxide (CO), nitrogen oxides (NOx) and sulphur dioxide (SO2), from exhaust fumes.

The engines of vehicles and motorised equipment and energy generators will also generate atmospheric emissions.

The quantities of pollutants discharged into the air by site machinery and generators are expected to be relatively small. In addition, emissions will be dispersed into the atmosphere at a distance from areas where people live and work. In light of the nature of emissions sources, impacts should not be observed at a distance greater than 0.5-1 km from the construction site. Significant increase in the atmospheric concentration of pollutants is unlikely.

In conclusion, impacts associated to exhaust emissions during the Project construction phase are expected to have a local extent, a temporary duration, Low intensity and occasional Frequency/Probability.

Assuming a medium sensitivity of receptors, the importance of this impact is assessed as **negligible** (see *Table 8.9)*.

Emissions of particles and dust

During the construction phase, dust emissions will be mainly caused by excavation activities (e.g. site clearance, scraping and levelling) and by dust resuspension due to the wind action on exposed surfaces and vehicles transit on unpaved roads.

In particular, the following activities are most likely to produce dust emissions:

- excavation and levelling of the land prior to building the new installations;
- evacuation of materials excavated from the worksite ;
- site clearance ;
- excavations ; and
- concrete production operations.

Minor emissions of particles and dust may also come from the indirect transport of particles, due to adherence of dust to the wheels and chassis of vehicles entering the site and involved in the evacuating excavation materials. This phenomenon depends on several factors, as follows:

- the number of vehicles accessing the site;
- the cleanliness of traffic routes at the site;

- the installation of wheel and chassis washing units; and
- weather conditions.

Particles and dust may also be emitted in case of dust clouds or accidental spillage from the vehicles during the transport of backfill earth or the evacuation of excavated earth.

Emissions of particles and dust during the construction phase are by nature highly variable. The potential impacts associated to dust emissions during the construction phase depends to a great extent on the type of soil, the type of activities, the prevalence of hot, dry weather during the work, the speed of prevailing winds and the ability of the wind to carry particles and dust towards potential sensitive receptors.

The closest residential receptors likely to be affected by emissions of fine particles and dust emitted by activities taking place during the construction phase are the first dwellings located at about 400m from the project area. Sensitivity of receptors is assumed to be medium for the purpose of this assessment.

The transport of fine particles and dust varies according to the weather conditions observed in the study area. With regard to the project area, annual rainfall is estimated at between 500 mm and 600 mm. It is lower from October to June (dry season). During the dry season, evaporation is stronger, thus the probability of particle emissions by activities carried out during the construction phase will be higher during these months, compared to wetter periods (in the months of August and September). With regard to winds, the project area is characterised by prevailing north and north-north-west winds (direction opposite to the sensitive receptors) which represent over 55% of annual winds. The prevailing winds are of moderate speed (between 3.5 and 5.4 m/s). The strongest winds (up to 7.9 m/s) are more commonly from the north.

In view of the information presented above, impact intensity is considered to be moderate on potential receptors and frequency/probability of occurrence to be occasional. Duration of impacts is expected to be short and the extent local. Assuming a medium sensitivity of receptors, the above leads to **minor** impacts importance as summarised in *Table 8.9*.

Evaluation of the Importance of Project's impact

Table 8.9 Evaluation of Importance of potential impacts on air quality – Construction phase

Impact criteria	Frequency /Probability	Magnitude	Sensitivity	Impact importance
Pollutant emissions				
• Intensity: low • Extent: local • Duration: Temporary	Occasional	Insignificant	Medium	Negligible
Emissions of particles and dust				
• Intensity: Moderate • Extent : Local • Duration: Short term	Occasional	Low	Medium	Minor

Measures to mitigate and control impacts on air quality during the construction phase

In order to minimise the emissions of pollutants by worksite machinery during the construction phase, the following measures must be applied on site:

- As default good practice, site machinery and generators will be regularly maintained and inspected by the contractor with responsibility for the works, and
- Atmospheric emissions discharged by all transport vehicles used during the construction phase (equipment, excavated earth or backfill, staff, etc.) will be reduced by minimising the number of journeys as far as possible.

Concerning the nuisance caused by particles and dust at the site and in its surroundings, the following good practices should be followed:

- Suitable management and maintenance of raw materials' storage areas to minimise clouds of particles
- Tarpaulin coverings on trucks during the transport of crumbly building materials or excavated earth or backfill
- Speed restrictions for vehicles travelling on non-asphalted roads
- Washing of vehicle wheels as they leave the site
- Covering of storages of materials likely to be carried by the wind (notably contaminated or hazardous materials)
- In case of activities on surfaces covered with fine materials, access roads and the site must be sprayed during construction activities to reduce dust production
- Check on correct functioning of vehicles and machines, and compliance of their emissions with current regulations
- Ensure that vehicles and machines are turned off when they are not being used.

With the above mitigation measures enforced, residual impacts arising from both exhaust and dust emissions during the Project construction phase, are expected to be of **negligible** importance.

8.5.4 *Potential impacts during the operational phase*

Overview of Atmospheric Dispersion Modelling Study

The main atmospheric emissions released by the Project during operation are linked to the activity of the five (5) 18V46 combustion engines running on HFO. In particular:

- Three (3) engines of the Initial Project (53MW) - labelled as 18V46 FC1, 18V46 FC2 and 18V46 FC3 hereinafter - are connected to an alternator and associated with a "Flexicycle" type combined cycle (more details provided in *Section 3.2*). The stacks from these 3 engines are clustered together;
- Two (2) engines of the Extension (33 MW) are not associated with a Flexicycle.
  - One of these two engines- labelled ad 18V46 1B - is associated with the boiler of the steam generation system; steam is generated by recovering waste heat from the engine exhaust gas for fuel heating;
  - The remaining engine – labelled as 18V46 2- is not associated with any facilities.

The five 18V46 combustion engines will burn heavy fuel oil (HFO) with a maximum sulphur content of 2%, leading to emissions of nitrogen oxides (NOx), particles (such as PM), carbon monoxide (CO) and sulphur dioxide (SO_2).

These emissions have the potential to result in *Direct* impacts on air quality for each of these pollutants.

Detailed air dispersion modelling was performed to assess the intensity and extent of the potential impacts associated with the above presented emission sources and emissions. The air dispersion modelling estimated ground concentrations of pollutants produced by the Power plant operation under normal operative conditions.

The modelling was carried out with the US EPA approved CALMET-CALPUFF modelling system(1) and evaluated ground concentrations of pollutants produced by the operations over a 30 km x 30 km domain, centred on the Power Plant location, *Figure 8.3* shows the modelling domain of the study. The modelling assumed a realistic representation of local meteorological condition considering a time frame of 1 year (2013). In particular, the US EPA CALMET- CALPUFF modelling system used for the study, takes into account a 3 dimensional meteorological field varying in time and space

(1) Peer Review of the Calmet/Calpuff Modeling System, Allwine, Dabberdt, Simmons, 1998.

A brief description of the modelling system, along with its set up and main assumptions is provided in *Annex 12 Information on air quality modelling.* The emission inventory is presented in *Table 8.10* and *Table 8.11*; in particular, *Table 8.10* presents the coordinates and characteristics of the Project's emission sources and *Table 8.11* shows the rate and composition of emissions considered as input data into the modelling study. It is noted that all the emission parameters provided in this Section are based on Wartsila engine specifications.

The engines will operate 24 hours per day, thus the model simulated a continuous release of atmospheric pollutants at the rates presented in *Table 8.11* during the whole simulation year (year 2013, 8760 hours). This approach enabled to identify the ground level concentration of pollutants occurring in the worst weather conditions predicted for the simulated year (2013).

Figure 8.3 CALPUFF Simulation Domain

Table 8.10 Characteristics of emission sources

Emission source	X	Y	Height of stack	Diameter of stack	Temperature of combustion gases	Speed of combustion gases
	UTM 28N [m]		[m]	[m]	[°C]	[m/s]
18V46 FC1(a)	252658	1628461	40	1.6	180	21.7
18V46 FC2(a)	252658	1628461	40	1.6	180	21.7
18V46 FC3(a)	252658	1628461	40	1.6	180	21.7
18V46 1B	252623	1628444	40	1.6	253	25.0
18V46 2	252621	1628444	40	1.6	358	30.0

(a) *The three stacks are located next to each other and modelled as a single stack based on the standard modelling procedure for stack emissions (U.S. EPA EPA-454/R-92-019 Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised). This is reflected in the input data and the equivalent stack diameter model used in the model is based on 3 x 1.6 m in diameter.*

(b) *Engine stacks operate 24 hours a day.*

Table 8.11 Emission rate and composition

Source demission	Concentration in dry fumes, at 15% of O_2 (b) [mg/Nm³]				Emission rate [g/s]			
	NO_x	CO	PM (c)	SO_2	NO_x	CO	PM	SO_2
18V46 FC1(a)	1850	77	65	1205	62.5	2.6	2.2	40.75
18V46 FC2(a)	1850	77	65	1205	62.5	2.6	2.2	40.75
18V46 FC3(a)	1850	77	65	1205	62.5	2.6	2.2	40.75
18V46 1B	1850	77	65	1170	62.5	2.60	2.20	39.55
18V46 2	1850	77	65	1170	62.5	2.60	2.20	39.55

(a) *The three stacks are located next to each other and modelled as a single stack based on the standard modelling procedure for stack emissions (U.S. EPA EPA-454/R-92-019 Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised). Thus, the model considers that the sum of emissions produced by the 3 stacks is emitted by a single equivalent stack.*

(b) *Limit values to air emission based on the specifications of Wartsila 18 V46 diesel engines*

(c) *Considering the typical HFO composition available in country, the PM emissions for ContourGlobal is 65 mg/Nm3. Because of the low exhaust gas temperature, PM emissions are over the 50 mg/Nm³ limit. Without the Flexicycle, the exhaust gas temperature would be above 300°C and PM emissions would comply with the 50 mg/Nm³ limit. Indeed the amount and composition of PM is fuel and sampling temperature dependent.*

Modelling Results

The modelling study simulated the PC (Process Contribution) arising from the Project operation phase.

Table 8.12 sets out the maxima concentration values obtained in the simulation domain for the Project Operation in its base design for NO_2, CO, SO_2 and PM10 along with Senegalese AQS and IFC Interim target 1. For short term concentrations (e.g. hourly and daily concentrations) the numerical results presented correspond to the worst hour/day predicted by the model over the temporal domain (one year time frame: 2013).

Table 8.12 Maximum concentrations of atmospheric pollutants modelled

Pollutant	Average duration	Senegalese standards [µg/m³]	IFC standards (b) [µg/m³]	PC– concentrations modelled [µg/m³]
NO_2	annual	40	40	21.96
	1 h	200	200	892.30(c)
SO_2	annual	50	-	18.83
	24 h	125	125	428.15(d)
PM	annual	80	70	1.03
	24 h	260	150	23.48
CO	24 h	30000 (a)	-	27.74

(a)Must not be exceeded more than once a year
(b)Intermediate objective-1
(c) Correspond to the worst hour predicted by the model over the temporal domain (one year time frame: 8760 hours) and spatial simulation domain; no atmospheric removal processes (such as dry and wet deposition) are also taken into account by the model;
(d) Correspond to the worst day predicted by the model over the temporal domain (one year time frame: 8760 hours) and spatial simulation domain no atmospheric removal processes (such as dry and wet deposition) are also taken into account by the model;

Note: PC= process contribution

Table 8.12 shows that the Project is generally compliant with the Air Quality Standards guidelines, except for a few hours for NO_2 short term concentrations.

In particular, the predicted concentration of PM and CO complies with regulatory limits both for short term and long term concentrations. Predicted concentrations of SO_2 and NO_2 in the long term are also compliant with regulatory standards whereas the maximum short term concentrations estimated for NO_2 and SO_2, exceed Senegalese air quality standards as well as IFC standards.

To refine the assessment, predicted concentrations have been analysed at seven sensitive receptors located in the near proximity of the project site (presented in *Figure 8.9). Table 8.13* shows the maximum predicted concentration at the air quality sensitive receptors identified for NO_2 and SO_2 concentrations.

It should be noted that the values reported for NO_2 and SO_2 for short term concentrations refer to the worst hour/day simulated over the entire period modelled, which is one year (or 8760 hours/365 days).

Figure 8.4 Air Quality Sensitive Receptors

Table 8.13 Maximum concentration modelled at air quality calculation receptors

Averaging period	PC - Modelled concentrations [µg/m³] NO₂ Calendar year	1 h	N. Exceedances (a)	SO₂ Calendar year	24 h	N. Exceedances (b)
Senegalese AQS [µg/m3]	40	200		50	125	
Receptors *ID Name*						
1 Ecole privé préscolaire et Elémentaire	3.10	326.78(c)	13	3.98	55.48	0
2 Ecole primaire "Cité Gabon"	2.85	541.65(c)	37	3.66	65.86	0
3 Ecole préscolaire	2.89	313.18(c)	9	3.72	62.62	0
4 Ecole coranique	2.63	388.46(c)	16	3.37	68.77	0
5 Ecole coranique	2.88	279.10(c)	8	3.70	74.09	0
6 Ecole coranique	4.19	539.15(c)	63	5.39	88.96	0
7 Poste de santé	3.21	268.74(c)	5	4.13	54.02	0

(a) Number of hours exceeding the limit set on hourly concentrations at the receptor location.
(b) Number of days exceeding the limit set on 24h concentrations at the receptor location.
(c) *Correspond to the worst hour predicted by the model over the temporal domain (one year time frame: 2013- 8760 hours) at the receptors location; no atmospheric removal processes (such as dry and wet deposition) are also taken into account by the model;*

Note: PC = process contribution

As showed in *Table 8.13*, annual average concentrations predicted at receptors are well below the regulatory limit; while looking at predicted short term concentrations, SO_2 24-h concentrations at receptors never exceeds the regulatory limits, whereas the latter are exceeded at all receptors for NO_2 hourly concentrations. However, the number of hourly exceedances at receptors of the limit set on NO_2 hourly concentrations is extremely limited, and accounts at most for the 0.8 % of the year.

Moreover, it should be noted that predicted concentrations, in the short-term, are subject to high variability during the year, being dependent on specific local meteorological conditions. Consequently, exceedances of short term air quality guideline values are often linked to adverse meteorological conditions that may not occur often over the course of a year (e.g. calm winds, stable atmospheric conditions). To account for rare conditions that may result in short-term exceedances, many regulatory regimes (e.g. US EPA and EU) allow for a certain number of exceedances per year for short-term standards.

Following these international precedents, a certain number of hourly/daily exceedances predicted in the modelling would be excluded from consideration. In particular the *European Directive 2008/50/EC on Ambient Air Quality* sets the same numerical concentration limits provided by the Senegalese law, but allows for the following exceedances per calendar year:

- NO_2 1-hour concentration, limit of 200 µg/m³ not to be exceeded more than 18 times a calendar year;

In light of the above it is clearly apparent that while comparing NO_2 hourly concentrations predicted at receptors (*Table 8.13*) against EU AQS, exceedances of the limit are observed only at two receptors (n. 2 and n.6); at all other receptors the number of hourly exceedances of the limit per year is below 18.

Concentration maps have also been produced and presented in the report for NO_2 and SO_2 short term and long term concentrations. The concentration maps enabled to spatially localise the concentration maxima and to identify the area where exceedances of the Senegalese AQS. These areas are highlighted in yellow line in the concentration maps so that their extent can be assessed. Moreover inhabited areas located in the near proximity of the Project facilities are also highlighted in the concentration maps, in order to allow a visual interpretation of the maxima concentrations predicted over these areas.

The following concentration maps have been produced:

- Figure 8.5 NO_2 Annual Concentration;
- Figure 8.6 NO_2 Maximum Hourly Concentrations;
- Figure 8.7 SO_2 Maximum Daily Concentrations;
- Figure 8.8 SO_2 Annual Concentration.

Figure 8.5 NO_2 Annual Concentration

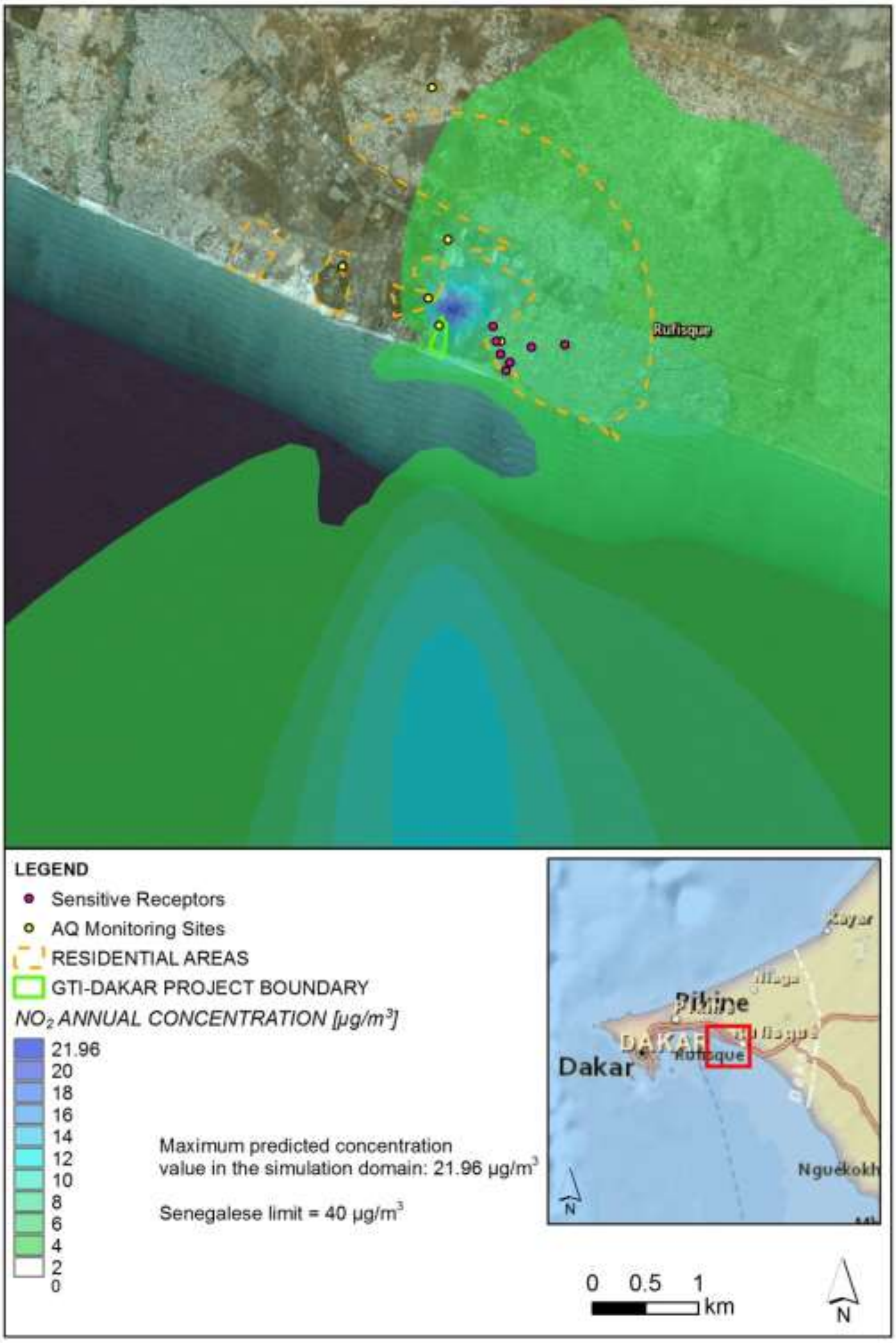


Figure 8.6 NO_2 Maximum Hourly Concentrations

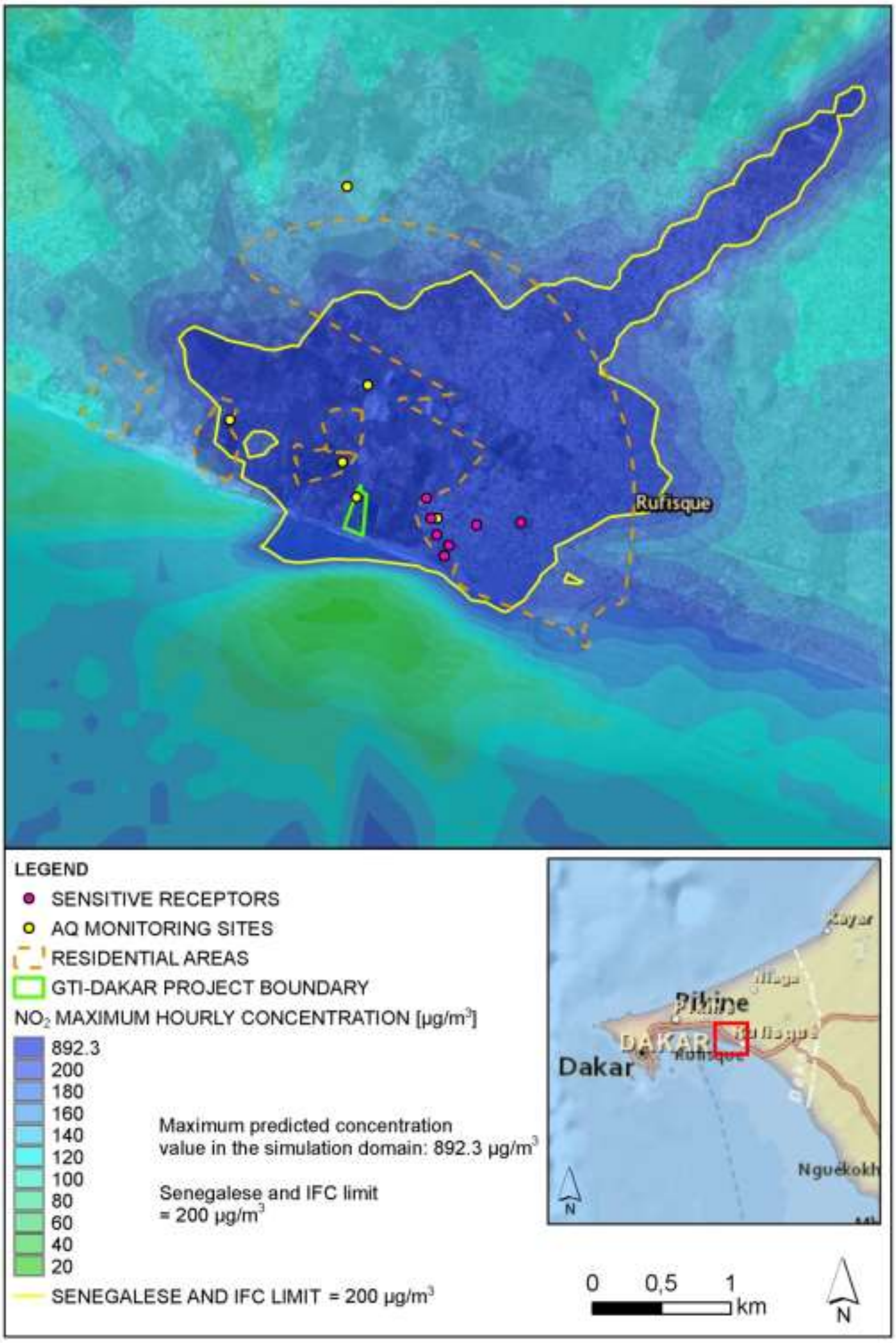


Figure 8.7 SO_2 Maximum Daily Concentrations

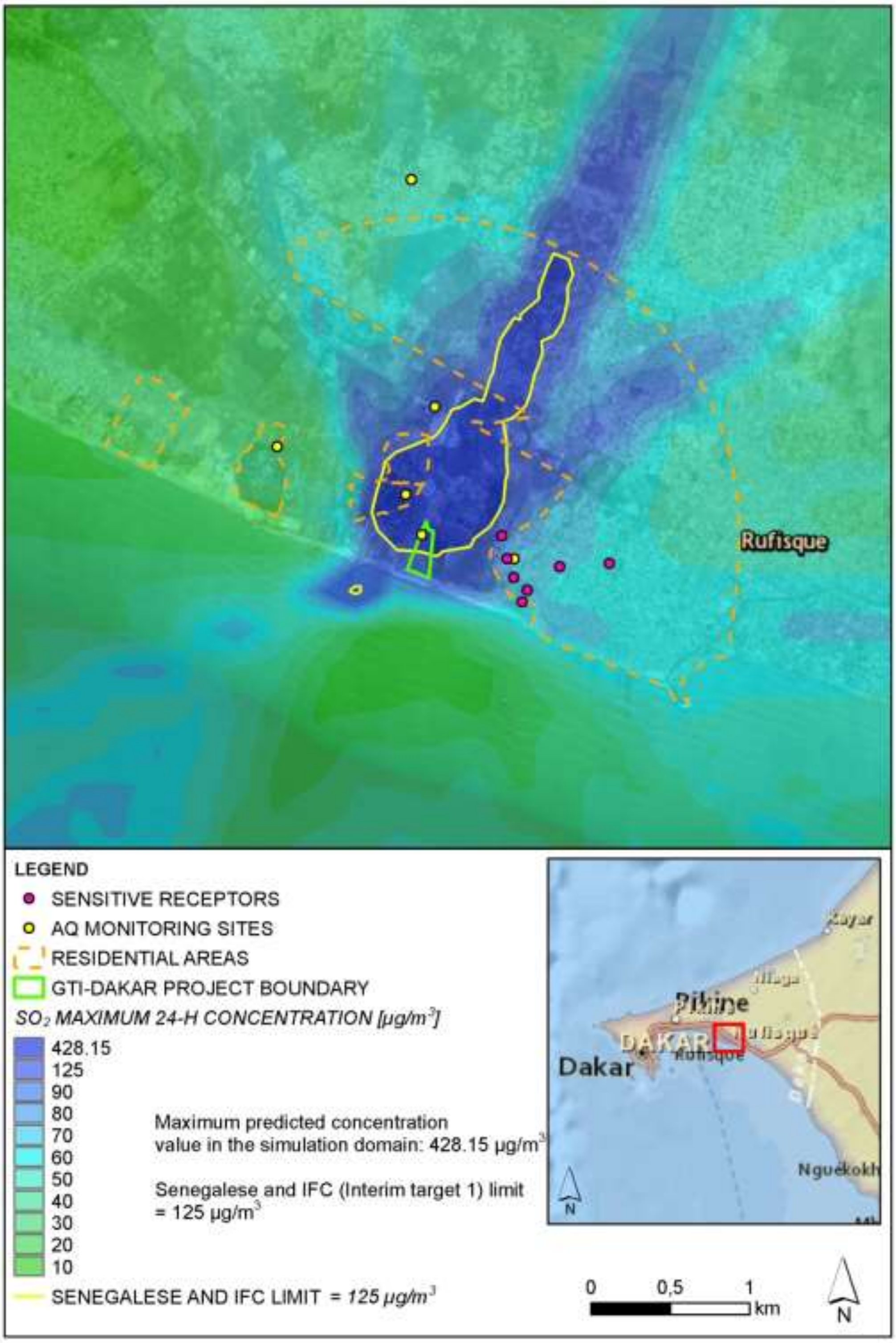
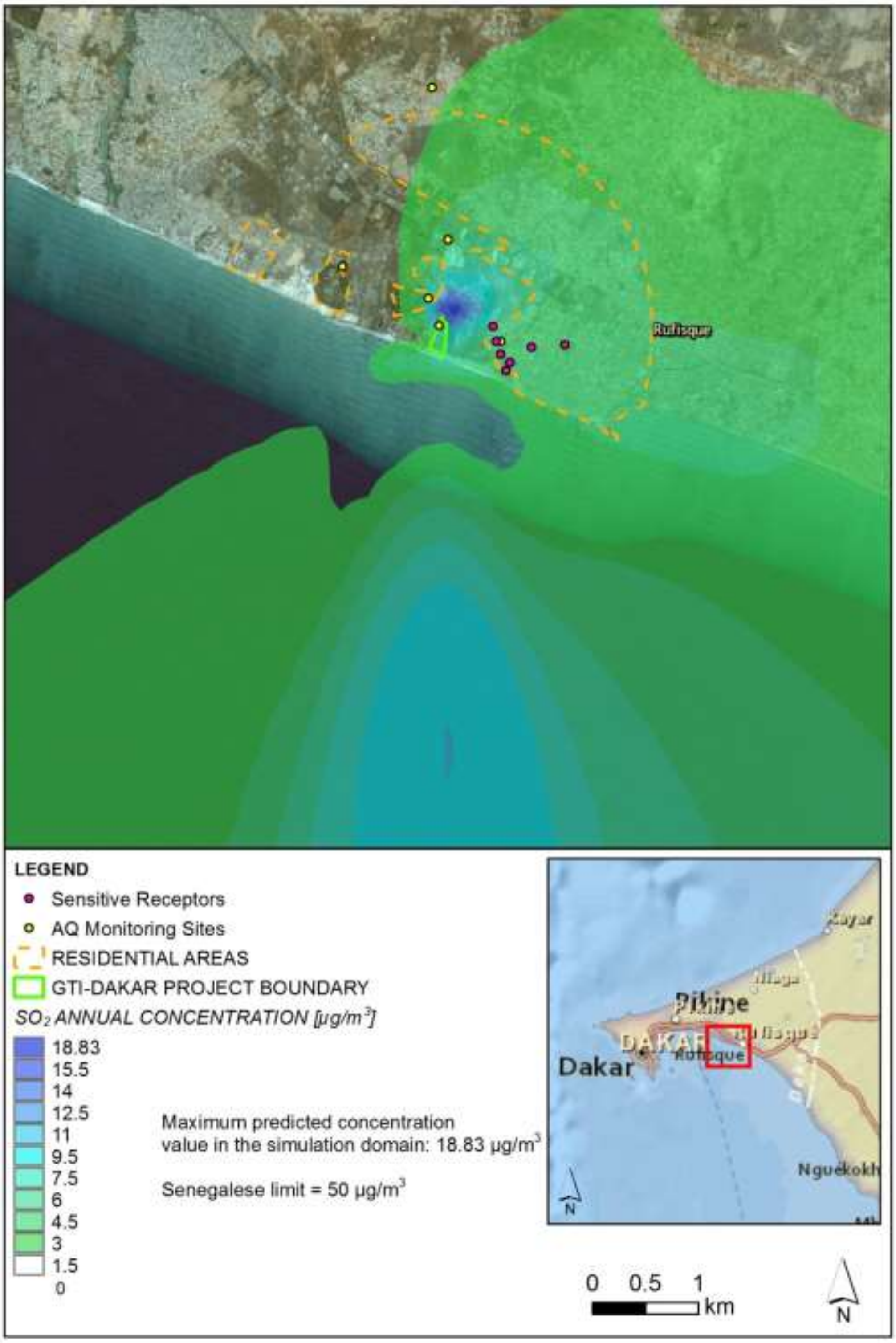


Figure 8.8 *SO_2 Annual Concentration*



The maps of NO_2 and SO_2 annual concentrations show that the concentration maxima are localised in the surroundings of the Project; moreover induced concentrations mainly fall into the water, due to the action of predominant winds.

The exceedance area identified for SO_2 daily concentrations is located north of the project site with limited interference with inhabited areas. The exceedance area for NO_2 hourly concentration is located around the project site and reaches a radius of approximately 3000-4000 m, extending over the closest inhabited areas. NO_2 results have been further investigated by means of time series analysis of maximum hourly concentrations.

Time series have been extracted at the location where the maximum concentration is predicted (over the whole simulation domain) and at the receptor n. 6 ("Ecole Coranique"), at which the highest number of hourly exceedances of the limit was predicted. These time series are presented below in *Figure 8.9* and *Figure 8.10.*

Figure 8.9 ***Time series of hourly concentrations of NO_2 at the location where maximum concentration is observed***

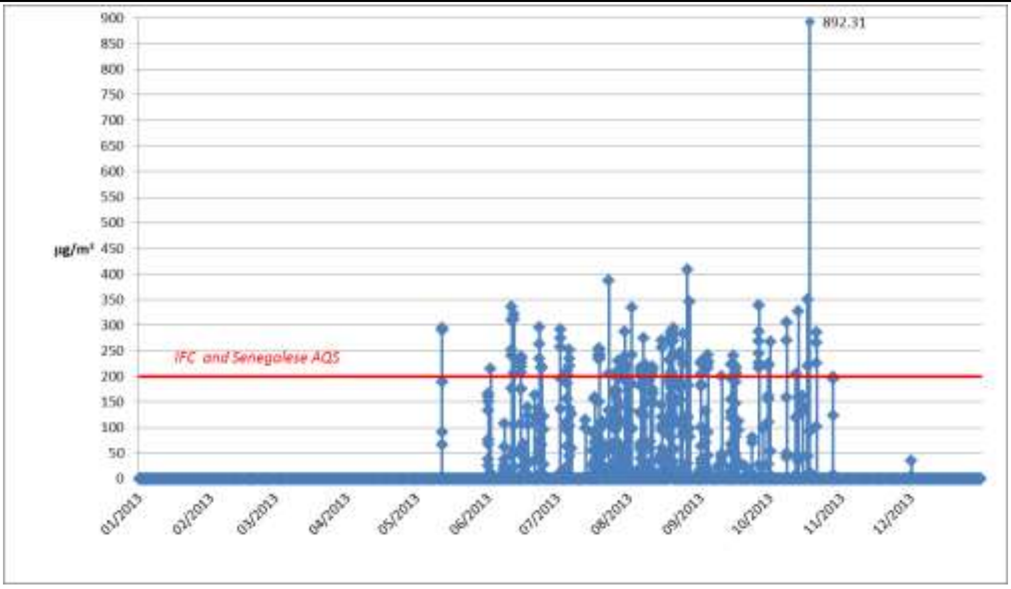
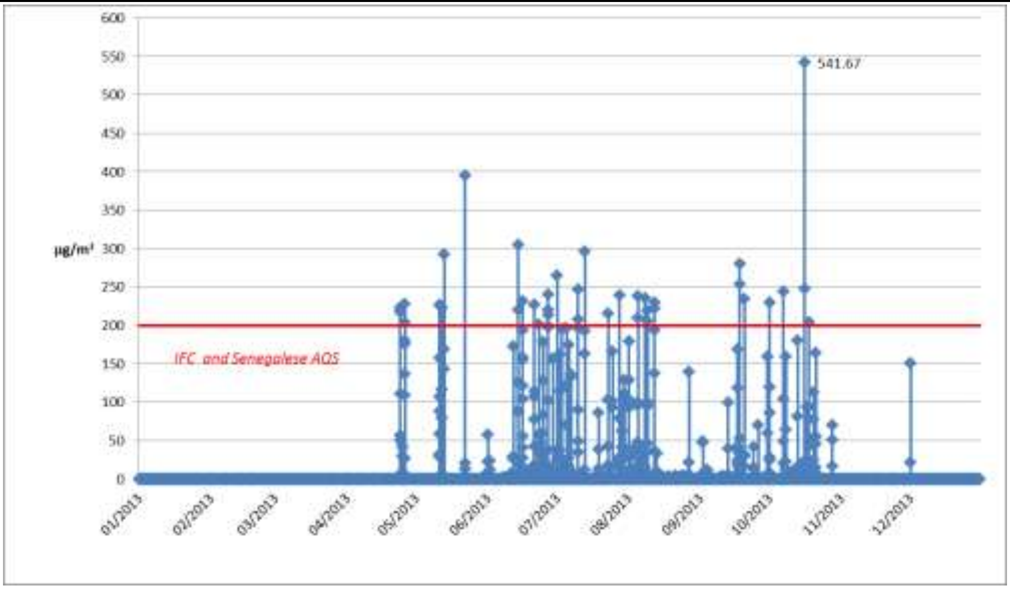


Figure 8.10 ***Time series of hourly concentrations of NO_2 at the "Ecole Coranique" (Receptor n°6)***



The time series in *Figure 8.9* shows 114 exceedances of the limit set by the IFC and Senegalese law on hourly NO_2 concentrations, at the location where the maximum occurs. Thus at this location the limit is exceeded only for the 1.3% of the year. Moreover, 96.28% of hourly concentration values are below 25% of the applicable AQS.

At the sensitive receptor n.6, the time series show 63 exceedances. Thus at this receptor the limit is exceeded only for the 0.72% of the year. Moreover, 97.71% of the year hourly concentration values are below 25% of the applicable AQS .

With regard to concentration levels of NO_2 and SO_2 predicted during the rainy season (June to October), it is noted that the modelling does not take into account wet deposition. The latter abates the concentrations of pollutants in the atmosphere. Hence, the model overestimated pollutants concentrations during the rainy season.

In conclusion, predicted results showed some exceedances of the limits set on short term concentrations of NO_2 and SO_2. Exceedances of the SO_2 24-h concentration limit do not affect sensitive receptors, whereas episodic exceedances of the NO_2 1-h concentration limit are predicted at receptors. These exceedances never accounts for more than 1.3% of the year. Appropriate mitigation measures will be discussed and agreed later on with the competent authorities and stakeholders, based on the outcomes of the ongoing Air Quality Monitoring activities.

Cumulative Impacts (PEC)

Predicted Environmental Concentrations (PEC) result from the sum of the existing baseline and the Process Contribution (PC). Therefore, PEC enables to assess cumulative impacts, which takes into account the existing conditions and the proposed future development.

Existing baseline conditions for SO_2 and NO_2 are available for a period of approximately one year, at 6 monitoring sites (S1 to S6 presented in presented in *Figure 5.10)*.The PC for NO_2 and SO_2 was extracted at the 6 air quality monitoring sites from the performed air quality modelling study. *Table 8.14* and *Table 8.15* present NO_2 and SO_2 baseline data, PC and PEC at the six air quality monitoring sites. It is noted that among the 6 monitoring sites, the monitoring site S1 is not to be considered as a sensitive receptor, since it is located in an industrial area, within the fence line of the ContourGlobal Cap des Biches site.

Existing baseline conditions for PM10 are available for a period of roughly 4 months (09/09/2015 - 31/12/2015) during the dry season, at 3 monitoring sites (presented in presented in *Figure 5.10)*. The dry season is characterized by higher atmospheric concentrations of PM, due to the absence of wet deposition. Hence, data available to date are representative of the highest PM concentrations expected throughout the year. In light of what reported above, available PM monitoring values are not suitable for the calculation of annual

PEC. However, in order to provide a preliminary and conservative assessment of PEC, 4-month average concentrations have been summed to the PC modelled for PM10 annual average concentrations. *Table 8.16* below presents PM10 baseline data, PC and PEC at the 3 PM quality monitoring sites. It is noted that PEC will be reassessed after PM data are collected for a 12-month period.

The performed air quality measurements recorded the contribute of the Aggreko units which are not expected to be in operation once the GTI Cap des Biches power station will become operative. Therefore the cumulative concentrations calculated are conservatively overestimated.

Table 8.14 Project Operation NO_2 – Baseline data PC and PEC at Monitoring Sites

Site	NO_2 Ambient measured Concentrations [27/11/2014-28/12/2015](5) [μg/m³]	NO_2 Modelled annual concentrations: PC [μg/m³]	NO_2 Cumulative concentrations PEC [μg/m³]	Senegalese and IFC standards set on NO_2 annual average concentration [μg/m³]	% of AQS for PC	% of AQS for cumulative concentrations PEC
S1	*54.11*	*16.99*	*71.10*	*40*	*42%*	*178%*
S2	16.96	8.32	25.28	40	21%	63%
S3	23.11(1)	4.64	27.75	40	12%	69%
S4	15.19(2)	0.41	15.60	40	1%	39%
S5	13.93 (3)	4.33	18.26	40	11%	46%
S6	18.44(4)	1.47	19.91	40	46%	50%

(4) *Data for the 1st and the 4th sampling period were missing*
(5) *Data for the 2nd and 9th sampling periods is missing*
(6) *Data for the 5th and 12th sampling periods is missing*
(7) *Data for the 6th sampling period is missing*
(8) *Data are not available for the month of June*

Table 8.15 Project Operation: SO_2 – Baseline data PC and PEC at Monitoring Sites

Site	SO_2 Ambient measured Concentrations [27/11/2014-28/12/2015](4) [μg/m³]	SO_2 Modelled annual concentrations: PC [μg/m³]	SO_2 Cumulative concentrations PEC [μg/m³]	Senegalese and IFC standards set on SO_2 annual average concentration [μg/m³]	% of AQS for PC	% of AQS for cumulative concentrations PEC
S1	*105.64(1)*	*14.51*	*120.15*	*50*	*29%*	*240%*
S2	7.41	7.12	14.53	50	14%	29%
S3	12.05(2)	3.97	16.02	50	8%	32%
S4	3.82(3)	0.35	4.17	50	1%	8%
S5	19.50	3.71	23.21	50	7%	46%
S6	4.17	1.26	5.43	50	3%	11%

Site	SO_2 Ambient measured Concentrations [27/11/2014-28/12/2015](4) [µg/m³]	SO_2 Modelled annual concentrations: PC [µg/m³]	SO_2 Cumulative concentrations PEC [µg/m³]	Senegalese and IFC standards set on SO_2 annual average concentration [µg/m³]	% of AQS for PC	% of AQS for cumulative concentrations PEC

(4) *Data for the 4th sampling period is missing*
(5) *Data for the 1st and the 4th sampling period is missing*
(6) *Data for the 9th sampling period is missing*
(7) *Data are not available for the month of June*

Table 8.16 Project Operation: PM10– Baseline data PC and PEC at Monitoring Sites

Site	PM10 Ambient measured Concentrations [09/09/2015 - 31/12/2015] [µg/m³]	PM10 Modelled annual concentrations: PC [µg/m³]	PM10 Cumulative concentrations PEC [µg/m³]	Senegalese standard set on PM10 annual average concentration [µg/m³]	% of AQS for PC	% of AQS for cumulative concentrations PEC
S2	*106.2(1)*	0.40	102.6	80	0.50%	128%
S5	*114.1(1)*	0.22	114.32	80	0.28%	143%
S6	*160.8(1)*	0.02	160.82	80	0.03%	201%

1) *Average of daily concentrations collected over the period 09/09/2015-31/12/2015 (dry season).*

PEC for NO_2 and SO_2 at the 5 at sensitive receptors (monitoring sites from S2 to S6) is always below their respective AQS; PEC at the fence line (S1) exceeds the limit both for NO_2 and SO_2. This exceedance is recorded at the Power Plant boundary, thus in an industrial area which does not represents a sensitive receptor and is mainly influenced by the existing baseline concentrations

As previously stated the high NO_2 concentration recorded at the monitoring site S1 is highly influenced by the operation of the Senelec Plant CIII and of the Aggreko units. These facilities are not expected to be in operation when the Project will become operative.

With regard to PEC for PM10, *Table 8.16* shows that they do not comply with National AQS. However, monitoring results collected to date refer only to 4 months during the dry season, characterised by the highest dust concentrations encountered throughout the year. Moreover while comparing the PC at the three monitoring sites against observed concentrations, it appears that the Project contribution is negligible in comparison with both existing baseline level and in force AQS.

Hence, in accordance with the adopted impact assessment methodology, the intensity of impacts associated to PM10 concentrations is based solely on the PC and is therefore **negligible**.

Emissions linked to road traffic

Traffic linked to site operations will be mainly generated by journeys made in light vehicles by staff, representing between 20 and 30 vehicles every day, and by traffic linked to the delivery of fuel oil by truck (daily average of about 10 trucks). The characteristics of emissions from engines are identical to those presented in *Chapter 3.5.5*.

Emissions from light vehicles and trucks will be occasional and transitory due to the low intensity of traffic. Moreover exhaust emissions from vehicles, will be likely to disperse in the atmosphere in the distances between the emission sources and the populated areas (schools, health station, dwellings, etc.) that are located at a distance of at least 500 m from the road. Hence, traffic emissions are unlikely to cause any significant impacts at the closest sensitive receptors.

In conclusion, air quality impacts at receptors associated to the Project related road traffic are expect to be rare, of local extent, temporary duration and negligible intensity.

Evaluation of the importance of the Project's impact

The assessment of Impacts importance for the project operation phase is based on the outcome of the modelling study as follows:

- impacts intensity is based on predicted concentrations at sensitive receptors following the criteria presented in *Table 8.7*;
- impacts extent is assessed on the base of the spatial distribution of predicted concentrations, showed in the concentration maps (
- the assessment of the frequency/probability for short term concentrations is supported by time series analysis.

With regard to the concentration induced by the Project operation in the short term (1h- 24h concentrations) the modelling study highlighted that impacts at receptors will be very limited in time and will not be significant for a very large part of the year. The model predicted some exceedances of the AQS set on short term concentrations; however these excesses are episodic and should not concern more than a few hours per year.

Induced concentrations in the long term are generally negligible, and below existing baseline levels.

The following *Table 8.17* provides a summary of the assessment of air quality impacts related to the project operation, based solely on project contribution.

Table 8.17 *Evaluation of Importance of potential impacts on air quality (due to project contribution) – Operational phase*

Evaluation criteria	Frequency /Probability	Magnitude	Sensitivity	Importance of the impact
NO_2 short term				
• Intensity: high • Extent: local • Duration: short term	Occasional/ Probable	High	Medium	Medium
NO_2 long term				
• Intensity: negligible • Extent: local • Duration: long term	Rare / Improbable	Insignificant	Medium	Negligible
SO_2 short term				
• Intensity: medium • Extent: local • Duration: short term	Rare / Improbable	Moderate	Medium	Minor
SO_2 long term				
• Intensity: negligible • Extent: local • Duration: long term	Rare / Improbable	Insignificant	Medium	Negligible
PM10 short term				
• Intensity: negligible • Extent: local • Duration: short term	Rare / Improbable	Insignificant	Medium	Negligible
PM10 Long Term				
• Intensity: negligible • Extent: local • Duration: long term	Rare / Improbable	Insignificant	Medium	Negligible
CO short term				
• Intensity: negligible • Extent: local • Duration: short term	Rare / Improbable	Insignificant	Medium	Negligible
Emissions linked to road traffic				
• Intensity: negligible • Extent: local • Duration: long term	Rare / Improbable	Insignificant	Medium	Negligible

Measures to mitigate impacts on air quality during the operational phase

Impact by NO_x: The potential impacts of atmospheric emissions linked to operation of the power plant are mainly due to NOx emissions, however exceedances of applicable standards are occasional and below 1.3% of the year. It is worth noting that some of these exceedances might be attributed to the conservative assumptions of the model.

In light of the above ContourGlobal is committed to ensuring the compliance with AQS at receptors during the operation phase, by continuing the ongoing monitoring of NO_2 and SO_2 concentrations as part of the ESMP. ContourGlobal is committed to applying mitigation measures when needed (according to monitoring results). Appropriate mitigation measures will be discussed and agreed later on with the competent authorities/stakeholders.

It shall be noted that the Project was defined with the Senegalese Energy Company SENELEC in order to enhance the power production capacities of the country and its realisation is crucial in this perspective.

SO_2 emission limits: With regard to SO_2, ContourGlobal - Cap des Biches will ensure that this potential impact remains limited as much as possible, by ensuring that Sulphur Content in the fuel delivered does not exceed 2% A quality control on the heavy fuel oil used will thus be implemented and data relating to supplies (amount delivered and analysis results) will be recorded.

Impacts related to PM emissions: project contributions in terms of PM10 are negligible, however in light of the high background level concentrations of PM CG is evaluating the impacts of fuel quality on the project emissions, in order to minimize contributions further. ContourGlobal is exploring economically feasible technical options.

Air quality monitoring: ContourGlobal – Cap des Biches is currently continuing the air quality field survey presented in Section 5.3.8 of this report. Hence, ContourGlobal – Cap des Biches is undertaking air quality measurements of NOx, SO_2, PM10 and PM2.5 at the monitoring sites presented in *Figure 5.10.*

This air quality monitoring will continue during construction and operational phases in order to keep track of air quality levels at receptors.

Finally with regard to emissions linked to road traffic, delivery vehicles will be the object of regular maintenance and will be inspected by the company responsible for supplies.

8.6 GREENHOUSE GAS EMISSIONS

8.6.1 Sources of emission

Construction phase

During the construction phase the main source of greenhouse gas emissions to take into account is transport of the goods and staff presented in *Table 8.18* below. For goods we considered that they are carried by road from the port of Dakar (about 25 km). For staff, we considered that most of them live in the surroundings of the site, a maximum of 25km distant.

Table 8.18 Traffic expected at the site during the construction phase

Delivery	Approximate numbers of vehicles expected
Materials for producing concrete – cement, gravel, sand	2 deliveries per day on average for 10 months – 6 to 10 deliveries per day during peak activity periods
Steel and pipes	Up to 4 deliveries per day for 8 months

Delivery	Approximate numbers of vehicles expected
Technical equipment	5 deliveries for the engines 5 deliveries for the boilers 1 delivery for the turbine 2 deliveries for the transformers 5 deliveries for construction and tank assembly materials
Various	1 to 2 deliveries per week
Staff transport	16 to 20 buses per day (workers) Up to 30 to 50 cars per day (managers, management team and sub-contractors)

Operational phase

During the operational phase, the main sources of emissions will be:

- Heavy fuel oil combustion by the power plant with a nominal power of 86MW which will produce 690 GWh (contractual commitment).
- Traffic linked to site operations, mainly generated by journeys in light vehicles (between 30 and 60 per day) and visitors (relatively limited).
- A pipeline will be installed for the direct supply of heavy fuel oil, hence GHG emissions related to the road transport of HFO are not anticipated.

8.6.2 *Evaluation of greenhouse gas emissions*

The perimeter and hypotheses used for this study are as follows:

- Only the main emitters listed above have been taken into account
- Dismantling and restoration of the site have not been evaluated
- Nominal production has been used for the evaluation
- The consumption of domestic fuel oil is negligible because it is mainly used on start-up of the power plant
- Greenhouse gas emissions from sea transport have not been evaluated
- Emission factors used are those taken from the ADEME[1] carbon report

Results

Table 8.19 below recapitulates the greenhouse gas emissions from the main emitters listed previously.

[1] http://www.energies-davenir.com/bibliotheque-ea/production_energie_reseau_alimentation/bilan_carbone_guide_facteurs_emissions_V5.pdf

Table 8.19 Main greenhouse gas emissions

		Construction (t Ceq)	Operation (t Ceq/ year)
Transport	Materials	20(1)	-
	Staff	131	15
Materials, raw materials		-	700000(2)
Total		**151**	**700015**

Notes:
1. Transport of materials: steel, concrete, equipment etc.

2. Fuel oil consumed mainly by the power plant's engines.

These emissions are negligible in view of total annual emissions in Senegal, which amounted to 20.3 million tons of carbon equivalent (t Ceq) in 2007 (source: UN[1]); they represent a contribution of around 3.45% to the country's annual emissions.

8.7 IMPACTS OF NOISE EMISSIONS ON AMBIENT NOISE LEVELS

8.7.1 *Overview*

The Project has the potential to adversely impact ambient noise in its surroundings, both during its construction and operation phases.

The assessment of impacts on local noise levels arising from the Project construction and operation phases was conducted in accordance with the methodology presented in Section 8.3. The noise assessment is focused on the compliance with Senegalese and IFC standards at sensitive receptors identified in the proximity of the Project site.

A qualitative assessment has been performed to predict the noise levels for the area surrounding the Project plant during the construction phase, whereas the assessment of operational impacts was supported by quantitative modelling.

Intensity criteria for construction impacts on noise

Construction noise is not addressed directly by national or IFC guidelines. Considering that the duration of the construction period is a 6 months period for the extension (following a 12 months period for the initial Project), the IFC threshold levels of 55 dB(A) for daytime was used in this assessment.

The intensity of construction noise is evaluated by establishing a threshold noise level at which significant impacts start to occur. It is common practice to

[1] http://unstats.un.org/unsd/environment/air_co2_emissions.htm

consider impacts as negligible if the predicted construction noise levels do not exceed the applicable noise limit.

Table 8.20 presents the evaluation criteria for impact intensity relating to the contributed noise level from the construction phase.

Table 8.20 Evaluation criteria for the intensity of noise impacts during construction phase

Criteria	Intensity of Impact							
	Daytime				Night-time			
	Negligible	Low	Moderate	High	Negligible	Low	Moderate	High
Noise Level – Laeq (dBA)	<55	<60	>60-65	>65	<45	45-50	50-55	>55

Intensity criteria for operational impacts on noise

Noise criteria for residential receptors have been adopted based on noise limits that apply to new industrial facilities in Senegal (55 to 60 dB(A) during daytime, 40 dB(A) during the night-time, see *Section 4.2.5*). It is noted that these are comparable with the noise standards in IFC guidelines during the daytime (55 dB(A)), whilst at night the Senegalese regulations are 5 dB(A) more stringent than the thresholds in IFC guidance (45 dB(A)).

Table 8.21 presents the evaluation criteria for impact intensity relating to the contributed noise level from the project operational phase. The criteria are based on receptors being residential and have been selected to be compatible with a *Moderate* intensity of impact being specified when noise levels are just above Senegalese and IFC noise standards for daytime, and respectively with a *Low* and *Moderate* intensity of impact for night-time.

Table 8.21 Evaluation criteria for the intensity of impacts on noise during operational phase

Criteria	Intensity of Impact							
	Daytime				Night-time			
	Negligible	Low	Moderate	High	Negligible	Low	Moderate	High
Noise Level – $Laeq_{1hr}$ (dBA)	<50	50-55	55-60	>60	<40	40-45	45-50	>50

8.7.2 *Recap of baseline conditions*

A noise monitoring survey was carried out in June 2014. The measurements were performed at ContourGlobal - Cap des Biches project site boundary and at three sensitive receptors, both during day and night time. Monitored noise pressure levels are reported in *Section 5.3.9*, *Table 5.9* of this ESIA.

Based on the results of the noise survey, local acoustic climate is already affected by significant noise sources, mainly related to the operation of SENELEC facilities. In particular, noise levels monitored at the nearest inhabited buildings range:

- between 51.8 dB(A) and 61.4 dB(A) during day time, exceeding Senegalese noise limit (55 dB(A) to 60 dB(A)) and IFC limit (55 dB(A)) at Habitation SENELEC 1 and Habitation SENELEC 2;
- between 48.7 dB(A) and 60.7 dB(A) during night time, well above the Senegalese noise limit (40 dB(A)) and IFC limit (45 dB(A)) at all receptors.

8.7.3 Potential impacts during the construction phase

Sources of impact

Noise associated with construction activities will only occur between 7 a.m. and 7 p.m. and depend on the particular activities being undertaken as well as the number and type of equipment in operation. Predictions are based on a reasonably likely worst case based on the information which is currently available.

The construction activities have been grouped in two main sub-phases, representing the most intense phases of work:

- Site preparation sub-phase, which includes significant noise-producing activities such as vegetation clearance, topsoil removal, earthworks. These activities will require heavy construction vehicles and equipment (excavators, dozers, rollers, dump trucks).
- Civil works and installation sub-phase, which includes significant noise-producing activities such as installation of concrete and asphalt batch plants, installation of foundation structures and paved areas within the plant facilities, assembly of plant items. These activities will require equipment such as concrete trucks, cranes, generators, compressors.

Considering that construction activities will extend throughout the project site, for the assessment it is assumed a typical maximum activity with all equipment operating simultaneously and at full load, and no screening from existing walls or structures between the site and the receptor.

The equipment simulated and their acoustic performances are shown in *Table 8.22* and *Table 8.23*.

Table 8.22 Site preparation equipment list

Equipment	Sound Pressure Level at 10 m [dB(A)] (a)
Tracked excavator	79
Dozer	81
Wheeled loader	68
Roller	76
Road planer	82
Asphalt paver	84
Dump truck	87
Note: *(a) Noise data from "BS:5228, British Standards: Code of practice for noise and vibration on construction and open sites"*	

Table 8.23 Civil works and installation equipment list

Equipment	Sound Pressure Level at 10 m [dB(A)] (a)
Concrete mixer truck	80
Concrete pump	77
Tower crane	77
Mobile crane	82
Fork-lift	67
Moto-driven compressor	75
Generator	74
Dump truck	87
Note: *(a) Noise data from "BS:5228, British Standards: Code of practice for noise and vibration on construction and open sites"*	

Predicted noise levels

A qualitative assessment for construction phase has been performed to predict the noise levels for the area surrounding the Project plant.

The predicted noise levels generated during Project construction at fixed distances from emission sources are reported in *Table 8.24*. The assessment is based on the emission scenarios reported in previous *Table 8.22* and *Table 8.23* and on the appropriate attenuation formula for noise propagation due to distance, as set out in the BS:5228 British Standard. It should be noted that the predicted construction noise levels are indicative and are subject to variables including location, buildings, specifications of construction plant (including power output, silencers, etc.) and works phasing.

Table 8.24 ***Predicted construction noise levels at fixed distances from Project site (Project Contribution)***

Construction activity	Noise pressure level [dB(A)] at							
	25 m	50 m	100 m	200 m	300 m	500 m	1000 m	2000 m
Site preparation	83	75	68	60	56	50	43	35
Civil works and installation	82	74	67	59	55	49	42	34

During construction activities, the noise levels from Project contribution are about 75 dB(A) at a distance of 50 m from the work sites and decrease to about 35 dB(A) at 2000 m from the work sites.

The Project's noise construction criteria for daytime (55 dB(A), *Section 8.7.1*) is achieved at about 300 meters from the work site where construction activities will take place. Thus, considering the nature of the emissive sources, impacts are unlikely to occur at a distance greater than 300 m from the construction site.

Table 8.25 ***Predicted noise levels at sensitive receptors during construction phase***

ID	Receptor (a)	Distance from Project Site [m]	Ambient noise level LAeq [dB(A)] (b) (c)	Predicted noise level (Project contribution) LAeq [dB(A)] (d)	Cumulative noise level LAeq [dB(A)] (e)	Increase over background noise [dB(A)] (f)	Daytime noise limits [dB(A)]
1	Ecole privée préscolaire et élémentaire	820	51.8	45	52.6	0.8	55-60 (Senegalese) 55 (IFC) 3 (IFC - increase above background)
2	Ecole primaire "Cité Gabon"	480	51.8	51	54.3	2.5	
3	Ecole préscolaire	640	51.8	47	53.2	1.4	
4	Ecole coranique	540	51.8	49	53.8	2.0	
5	Ecole coranique	620	51.8	48	53.3	1.5	
6	Ecole coranique	440	51.8	52	54.7	2.9	
7	Poste de santé	1120	51.8	41	52.2	0.4	
8	Habitacion Senelec 1	340	59.5	54	60.7	1.2	
9	Habitacion Senelec 2	420	56.7	52	58.0	1.3	
10	Diokoul	400	51.8	53	55.2	3.4	

ID	Receptor (a)	Distance from Project Site [m]	Ambient noise level LAeq [dB(A)] (b) (c)	Predicted noise level (Project contribution) LAeq [dB(A)] (d)	Cumulative noise level LAeq [dB(A)] (e)	Increase over background noise [dB(A)] (f)	Daytime noise limits [dB(A)]

Note:
(a) Receptor n. 8 and n.9 are lodgings for SENELEC employees, however conservatively they have been considered as sensitive receptors.
(b) Background noise levels monitored during the field survey of June 2014 performed by LAME. Conservatively, to evaluate the noise increase due to Project contribution, the lowest noise level monitored during day time has been considered to describe the background noise at receptors.
(c) The noise level monitored at site labeled as Diokoul has been considered for the high sensitive receptors identified in the proximity of the Project site .
(d) Predicted noise level due to Project contribution only. The highest value predicted for construction activities (site preparation and civil works) has been considered.
(e) The cumulative noise level are calculated as the logarithmic sum of the monitored background noise level (affected by existing facilities) and the Project contribution.
(f) IFC guideline states that [..noise impacts should not result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site].

Receptor n. 8, that is the nearest sensitive receptor, located at 340 meters from the Project site boundary, may experience a noise level during construction of about 53-54 dB(A), only 1 dB(A) below Senegalese and IFC noise limit. This is mainly due to the proximity of the receptor to the Project boundary. At all the other receptors, the construction activities are unlikely to affect the offsite ambient noise levels; in fact, noise emission levels from construction activity are expected to be well below 55 dB(A).

Cumulative noise levels result in a compliance of the noise limits at all receptors, except for Receptor n. 8, 9 and 10. Here the predicted cumulative noise levels are above 55 dB(A); this is mainly due to the high background noise levels monitored already affected by existing industrial facilities; in fact, the Project contribution is in compliance with noise limits.

Compared to IFC requirements, Receptor n. 10 will be subject to an increase above background higher than 3 dB(A). This exceedance is mainly due to the proximity of the receptor to the Project site and to the noise background level assumed for this point. It has to be noted that the increase at this receptor have been evaluated on the basis of an assumed noise background level, not on real monitored measurement (conservatively, to evaluate the noise increase due to Project contribution, the lowest noise level monitored during day time has been considered to describe the background noise at receptors).

Hence, it is possible that the current background noise level at this point is higher than the assumption; consequently the increase due to Project construction could be lower than the estimate. All the other receptor will be in compliance with IFC standard for increase above background (3 dB(A)).

Evaluation of the importance of the impact

The importance of impacts has been assessed based on key factors, as the potential magnitude (function of the extent, duration and intensity of the impact), the frequency/probability of the impact and the receptor sensitivity, as per criteria reported in *Section 8.7.1*.

The importance of impacts on noise assessed for Project construction at each sensitive receptor is reported in *Table 8.26*.

Considering Project contribution only, the importance of project impacts on local acoustic climate during the construction phase is assessed as *Negligible* at all receptors.

Considering the cumulative noise levels (background noise and Project contribution), *Medium* impacts are expected at Receptors n. 8 to 10, mainly due to the existing acoustic conditions, already affected by noisy facilities operated by SENELEC. The assessment of the only Project contribution (*Table 8.26*) results in *Negligible* impacts.

Table 8.26 Evaluation of importance of noise impacts during construction phase

Impact Criteria	Frequency /Probability	Magnitude		Sensitivity	Importance of the impact		
		Project contribution	Cumulative noise level		Background noise	Project contribution	Cumulative noise level
ID 1 Ecole privée préscolaire et élémentaire							
• Intensity: ○ Project: negligible ○ Cumulative noise: low • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 2 Ecole primaire "Cité Gabon"							
• Intensity: ○ Project: negligible ○ Cumulative noise: low • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 3 Ecole préscolaire							
• Intensity: ○ Project: negligible ○ Cumulative noise: low • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 4 Ecole coranique							
• Intensity: ○ Project: negligible ○ Cumulative noise: low • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Low	Medium	Minor	Negligible	Minor

Impact Criteria	Frequency /Probability	Magnitude		Sensitivity	Importance of the impact		
		Project contribution	Cumulative noise level		Background noise	Project contribution	Cumulative noise level
ID 5 Ecole coranique							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 6 Ecole coranique							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 7 Poste de santé							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 8 Habitacion Senelec 1							
• Intensity: o Project: negligible o Cumulative noise: high • Extent: local • Duration: long term	Occasional/ Probable	Insignificant	Medium	Medium	Medium	Negligible	Medium
ID 9 Habitacion Senelec 2							

<table>
<tr><th rowspan="2">Impact Criteria</th><th rowspan="2">Frequency /Probability</th><th colspan="2">Magnitude</th><th rowspan="2">Sensitivity</th><th colspan="3">Importance of the impact</th></tr>
<tr><th>Project contribution</th><th>Cumulative noise level</th><th>Background noise</th><th>Project contribution</th><th>Cumulative noise level</th></tr>
<tr><td>• Intensity:
○ Project: negligible
○ Cumulative noise: moderate
• Extent: local
• Duration: long term</td><td>Occasional/ Probable</td><td>Insignificant</td><td>Medium</td><td>Medium</td><td>Medium</td><td>Negligible</td><td>Medium</td></tr>
<tr><td colspan="8">ID 10 Diokoul</td></tr>
<tr><td>• Intensity:
○ Project: negligible
○ Cumulative noise: moderate
• Extent: local
• Duration: long term</td><td>Occasional/ Probable</td><td>Insignificant</td><td>Medium</td><td>Medium</td><td>Minor</td><td>Negligible</td><td>Medium</td></tr>
</table>

Measures to mitigate and control impacts on noise during the construction phase

Noise emissions from construction are sufficiently low and receptors sufficiently distant from the Project to avoid being significantly affected, consequently no specific mitigation measure is necessary. Nevertheless, best practice and good operational management of vehicles will be implemented across the Project as standard requirements.

The following recommendations should be adopted where practical, feasible and reasonable throughout the construction phase:

- Selection of equipment/vehicles in accordance to available best practice for noise emissions.
- All plant brought on to the site will comply with the relevant international noise limits applicable to that equipment or will be no noisier than would be expected based on the noise levels quoted in BS 5228-1:2009.
- Hours of construction will be restricted to daytime only. No work will be audible at the site boundary at any other time.
- Equipment/vehicles operating intermittently will be shut down in the intervening periods between use.
- Equipment/vehicles will be properly maintained and operated in accordance with manufacturers' recommendations.
- Compliance with driving and traffic management rules to limit driving speed and traffic of heavy vehicles through noise-sensitive areas.

8.7.4 Potential impacts during the operation phase

Overview of noise modelling system

To assess noise impacts during operation phase, an acoustic model has been developed using the environmental noise modelling program "SoundPLAN", version 7.3, developed by Braunstein + Berndt GmbH. The model implements the methods identified within ISO 9613 Part 2 for noise propagation. SoundPLAN is one of the most recognised noise prediction tool, used extensively in road, railway and industry noise modelling.

The industrial model is comprehensive and allows:

- modelling of sound power sources in third of octave;
- modelling of noise sources as point, line or area sources;
- 2D and 3D directivity of sources;
- 3D topography;
- noise sources ranking;
- use of various noise model standards (ISO, Concawe, Nordic, etc.);
- screening and meteorological effects.

This software applies the "ray tracing" method. Sources are simulated as surfaces, lines or points: each source propagates sound waves. The resulting acoustic field depends on the absorptions and reflections characteristics of all existent obstacles between the source and the receptor.

Every ray carries a part of the acoustic energy of the sound source. The energy decreases along the way, as a result of the absorption of surfaces, geometrical divergence and atmospheric absorption. The absorption of sound energy by air is related to the dispersion of energy caused by the collisions of air molecules among them. Every collision scatters one small part of the energy and causes more impacts. In the area of interest, the acoustic field will be the result of the acoustic energies sum of "n" rays which reach the receiver. The levels in the whole area are indicated by iso-phones with equivalent steps, at a conventional height (e.g., 1.5 meters above ground level).

The mathematical model uses international standards for sound attenuation in the environment . In this study *ISO 9613 Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation* has been applied. This standard has many equations regulating the propagation and it allows to calculate noise levels in the study area with a defined accuracy. The aim of such methodology is to determine the equivalent continuous A-weighted sound pressure level, as described in ISO 1996/1-2-3, under meteorological conditions favourable to sound propagation from sources of known power emission.

As all the receivers are considered to be downwind from the source, the propagation takes place under the worst wind conditions, as specified in ISO 1996/2 (part 5, 4, 3).

The medium level of sound pressure to the receiver in the propagation direction (downwind conditions) is calculated for every source with:

$$L_P = L_W - A$$

where:

- L_p = Sound Pressure Level at receptor [dB(A)];
- L_W = Sound Power Level of source [dB(A)].

The factor A is the attenuation that the sound energy endures during the propagation and it is composed of the following contributors:

$$A = A_{div} + A_{atm} + A_{ground} + A_{refl} + A_{screen} + A_{misc}$$

where:

- A_{div} = attenuation due to geometrical divergence;
- A_{atm} = attenuation due to atmospheric absorption;
- A_{ground} = attenuation due to the ground effect;
- A_{refl} = attenuation due to reflections from obstacles;
- A_{screen} = attenuation due to screen effects;
- A_{misc} = attenuation due to other effects.

As specified in ISO 9613, it's necessary to underline that the use of the previous equations is subject to limitations due to model accuracy. The following *Table 8.27* reports the estimated accuracy for noise pressure levels calculated using the noise attenuations described before.

Table 8.27 Estimated accuracy for broadband noise of L_{AT} (DW) (a) calculated using previous equations. From ISO 9613-2, Table 5

Height, h (b)	Distance, d (c)	
	0 < d < 100 m	100 m < d < 1000 m
0 < h < 5 m	± 3 dB	± 3 dB
5 m < h < 30 m	± 1 dB	± 1 dB

Note:
(a) L_{AT} (DW) is the average A-weighted sound pressure level for downwind propagation
(b) h is the mean height of the source and receiver
(c) d is the distance between the source and receiver
These estimates have been made from situations where there are no effects due to reflection or attenuation due to screening

Computational domain

Conservatively, the noise study has been performed considering a calculation domain of 10 km x 10 km with 5 meters resolution centred on the Project site, in order to include in the study area all the Project facilities and the nearest sensitive receptors.

Noise emission levels have been calculated at a conventional height of 1.5 meters above ground level.

Topography and land cover

A 3-D representation of the terrain's surface has been calculated through the generation of a digital ground model (DGM) in SoundPLAN.
The attenuation due to the ground between the noise sources and the receptors has been included in the noise model; an absorption coefficient value of 0.0 dB has been applied for water surfaces and urban areas, whereas an absorption value of 0.8 dB has been applied for rural areas.

Obstacles between source and receptor

Obstacles between the source and the receptor, such as buildings and fences, result in additional noise reductions depending upon their size, density and location. To reproduce in a more detailed way the plant layout, the following obstacles have been considered:

- fences (3 m high) all along the Project plant boundary;
- storage tanks, manned and unmanned buildings inside the Project plant;
- main buildings and tanks of the facilities operating by SENELEC.

Meteorological Data

The following average environmental conditions, set for the whole calculation domain, have been considered according to a desktop review of available and most reliable meteorological data covering a 10-years period for the Project area (*Source*: Dakar Airport met-station [616410], NCDC Database):

- Air Pressure: 1009 mbar
- Air Temperature: 25°C
- Humidity: 70%.

The atmospheric attenuation coefficient for the previous environmental conditions is based on ISO 9613-2 (*Attenuation of sound during propagation outdoors -- Part 2: General method of calculation*). The noise propagation is carried out under down wind conditions (from source to receptor).

Sources of impact

During operation phase, noise emissions will be generated by plant equipment. A worst case scenario has been simulated based on the assumption that equipment are operating simultaneously and at full load for 24 hours/day, with no modification of the operation load during day and night-time.

The main sources of noise identified for the Project and their acoustic performance are reported in *Table 8.28*. All the noise sources have been simulated as buildings or point sources.

Table 8.28 Project operation equipment list

Unit	Equipment	Number of units	Sound Power Level [dB(A)] (a)	Mitigation Measure
Power generation	Generation module (18V46 engine, generator, auxiliary module)	5	113	Standard panel wall
	Engine exhaust gas stack	5	198	Silencer (35 dB(A)) and boiler
	Air inlet into the engine (primary layout)	6	99	Silencer (35 dB(A))
	Air inlet into the engine (secondary layout)	4	89	Silencer (45 dB(A))
	Output ventilator	10	99	Silencer 1400 mm
	Cooling radiators	30	99	-
Flexicycle system	Steam turbine	1	108	Standard panel wall
	Condenser cooled by air	1	105	-
	Exhaust gas from the gas boiler	4	90	-
	Heat recovery reservoir	1	85	-
	Water pump for washing the boiler	1	78	-
Compressed air system	Air compressor (180 m^3/h)	2	83	-
Oil lubrication system	Oil separation unit (pumps)	2	96	-
	Separation module (oil mist.)	5	74	-

Unit	Equipment	Number of units	Sound Power Level [dB(A)] (a)	Mitigation Measure
Fuel treatment	HFO unloading pump (truck)	3	99	-
	HFO transfer pump	2	96	-
	HFO supply pump	2	91	-
	Oily water transfer pump	2	96	-
	Oily water supply pump	2	91	-
	Sludge transfer pump	2	96	-
Power transmission	Station auxiliary / Transformer	2	90	-

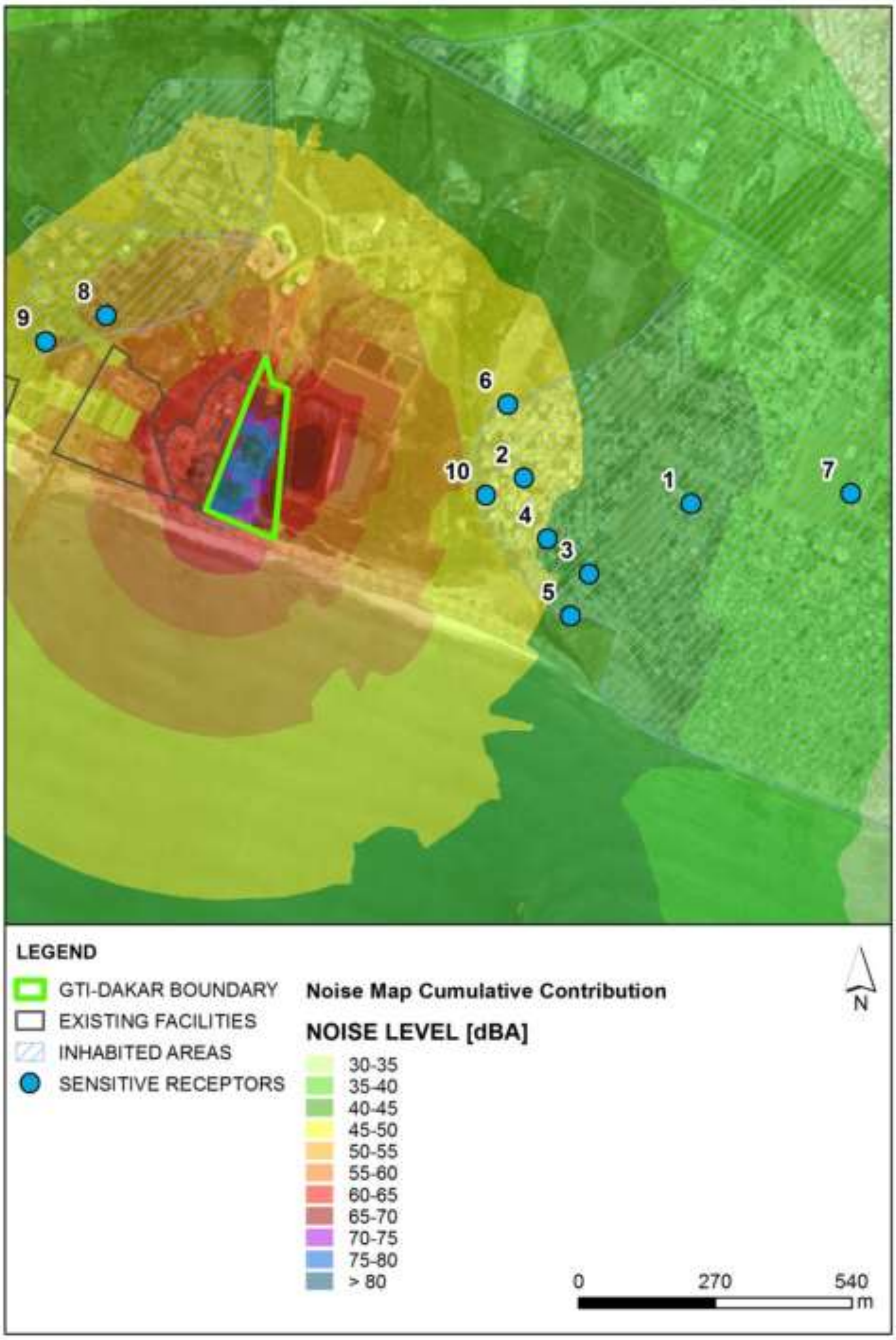
Note:
(a) Noise emission date was supplied by Wartsila for a W18V46 power plant. Where this type of data is not available, hypotheses were made on the basis of typical emission levels for equipment in a similar plant. All occasional sources were simulated at a height of 1.5 m above ground.

Predicted noise levels

The noise contours map for the Project's operational phase (Project contribution only, excluding background noise) is shown in *Figure 8.11* below, with locations of the nearest sensitive receptors.

At the site's boundary, the maximum noise levels planned are between 60 and 65 dB(A) on both east and west sides. Thus, the maximum value of 70 dB (A) indicated by the IFC at industrial site's boundary during operation is respected.

Figure 8.11 Map of noise contours – Operational phase for daytime and night-time



The predicted noise levels generated during operation at the sensitive receptors in the surroundings of the Project site are reported in *Table 8.29* and *Table 8.30*, for daytime and night-time respectively.

Table 8.29 ***Predicted noise levels at sensitive receptors during operation phase for daytime***

ID	Receptor (a)	Ambient noise level LAeq [dB(A)] (b) (c)	Predicted noise level (Project contribution) LAeq [dB(A)] (d)	Cumulative noise level LAeq [dB(A)] (e)	Increase over background noise [dB(A)] (f)	Daytime noise limits [dB(A)]
1	Ecole privée préscolaire et élémentaire	51.8	41.9	52.2	0.4	55-60 (Senegalese) 55 (IFC) 3 (IFC - increase above background)
2	Ecole primaire "Cité Gabon"	51.8	47.8	53.3	1.5	
3	Ecole préscolaire	51.8	44.1	52.5	0.7	
4	Ecole coranique	51.8	45.4	52.7	0.9	
5	Ecole coranique	51.8	45.0	52.6	0.8	
6	Ecole coranique	51.8	48.1	53.3	1.5	
7	Poste de santé	51.8	38.8	52.0	0.2	
8	Habitacion Senelec 1	59.5	48.8	59.9	0.4	
9	Habitacion Senelec 2	56.7	50.8	57.7	1.0	
10	Diokoul	51.8	48.4	53.4	1.6	

Note:
(a) Receptor n. 8 and n.9 are lodgings for SENELEC employees, however conservatively they have been considered as sensitive receptors.
(b) Background noise levels monitored during the field survey of June 2014 performed by LAME. Conservatively, to evaluate the noise increase due to Project contribution, the lowest noise level monitored during day time has been considered to describe the background noise at receptors.
(c) The noise level monitored at site labeled as Diokoul has been considered for the high sensitive receptors identified in the proximity of the Project site .
(d) Predicted noise level due to Project contribution only, equal for daytime and night-time (equipment in continuous operation 24h/day) .
(e) The cumulative noise level are calculated as the logarithmic sum of the monitored background noise level (affected by existing facilities) and the Project contribution.
(f) IFC guideline states that [..noise impacts should not result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site].

Table 8.30 Predicted noise levels at sensitive receptors during operation phase for night-time

ID	Receptor (a)	Ambient noise level LAeq [dB(A)] (b) (c)	Predicted noise level (Project contribution) LAeq [dB(A)] (d)	Cumulative noise level LAeq [dB(A)] (e)	Increase over background noise [dB(A)] (f)	Night-time noise limits [dB(A)]
7	Poste de santé	48.7	38.3	49.1	0.4	40 (Senegalese)
8	Habitacion Senelec 1	60.3	48.8	60.6	0.3	45 (IFC)
9	Habitacion Senelec 2	53.4	50.8	55.3	1.9	3 (IFC - increase above background)
10	Diokoul	48.7	48.4	51.6	2.9	

Note:
(a) At night no activities are expected at schools (Receptors 1 to 6), thus they are not taken into account in the assessment of night-time impacts.
(b) Background noise levels monitored during the field survey of June 2014 performed by LAME.
(c) The noise level monitored at site labeled as Diokoul has been considered for the high sensitive receptors identified in the proximity of the Project site.
(d) Predicted noise level due to Project contribution only, equal for daytime and night-time (equipment in continuous operation 24h/day) .
(e) The cumulative noise level are calculated as the logarithmic sum of the monitored background noise level (affected by existing facilities) and the Project contribution.
(f) IFC guideline states that [..noise impacts should not result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site].

During the daytime (*Table 8.29*), predicted noise levels at receptors are well below 55 dB(A), noise limit stated by Senegalese and IFC for daytime. Project noise contribution is therefore in compliance with the applicable noise standards. Moreover, the noise emissions generated by project operation are well below the ambient noise level measured in June 2014, at all receptors. Thus, considering the cumulative noise levels (Project contribution and background noise), the increase above the background fully respect the IFC criterion of a maximum increase of 3dB.

During the night-time (*Table 8.30*), the predicted noise levels exceed Senegalese and IFC standards at all receptors, except n. 7.

Considering the cumulative noise levels, the increase above the background noise generated by operation of the new Contour Global Cap des Biches facilities ranges between 0.2 to 1.6 during day time and 0.3 to 2.9 during night time. The IFC criteria for increase above background (3 dB(A)) is respected at all receptors, thus it can be stated that the Project will not significantly increase the existing acoustic climate, already affected by SENELEC facilities.

Thus it can be said that the project will not increase the area's existing acoustic climate in any significant way, the area being mainly subject to noise emissions from existing industrial installations and from human activities.

Evaluation of the importance of the impact

The assessment of Impacts importance for the project operation phase is based on the following:

- impacts intensity based on predicted noise levels at sensitive receptors reported in *Table 8.29* and *Table 8.30.* Although project noise emissions do not vary between the day and the night (24 hour operation), the intensity of the impact is different because the noise limit thresholds established vary between daytime and night-time (see *Table 8.21*);
- impacts extent is assessed on the base of the spatial distribution of predicted noise levels, showed in the noise contour map. A local extent has been assumed.
- a high frequency and a long term duration.

Table 8.31 and *Table 8.32* show the importance of impacts assessed at each sensitive receptor during day and night time. In order to better distinguish the noise contributions made by existing installations (included in the monitored background noise), these tables present the importance of impacts also for the project contribution and the current baseline (background noise).

During daytime, the importance of impacts related to contribution of the Project is generally *Negligible* compared to the noise baseline (a Minor importance is assessed only at receptor n.9). In fact, it has to be noted that the noise emissions generated by the Project operation are well below the existing noise level monitored in June 2014 at all monitoring sites.

During the night, impacts of High importance are predicted at Receptors n. 8 to 10. These impacts are mainly caused by the existing acoustic conditions, already affected by noisy facilities operated by SENELEC. It is noted that the importance of impacts attributable solely to the Project is always lower or at most equal to the effect of the existing baseline. Moreover, the increase above the background due to Project contribution is in compliance with the IFC criterion of a maximum increase of 3dB(A) at all receptors. In particular:

- At Receptor n.8, the predicted noise level is 48.8 dB, resulting in a Medium importance for Project contribution. The background noise level is characterised by much higher noise levels (60.3 dB(A), about 12 dB(A) above the Project contribution) that result in a High importance for ambient noise. Thus, the High importance assessed for cumulative noise is only driven by the current background noise levels.
- At Receptor n.9, both ambient and Project contribution result in a High importance of impact. However, the predicted noise level for Project contribution is 3 dB lower than the existing ambient noise, thus it can be stated that the High importance is, also in this case, mainly driven by the current background conditions affected by SENELEC facilities (the increase above the background is below the 3dB IFC criteria).
- At Receptor n.10, the predicted noise level is 48.4 dB, resulting in a Medium importance for Project contribution. The background noise level is characterised by similar noise level (48.4 dB(A)) that result in a Medium importance for ambient noise as well. The High importance

assessed for cumulative noise is due to the synergy of both contributions.

Table 8.31 Evaluation of importance of noise impacts during operation phase (Daytime)

Impact Criteria	Frequency /Probability	Magnitude		Sensitivity	Importance of the impact		
		Project contribution	Cumulative noise		Background noise	Project contribution	Cumulative noise level
ID 1 Ecole privée préscolaire et élémentaire							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 2 Ecole primaire "Cité Gabon"							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 3 Ecole préscolaire							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 4 Ecole coranique							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor

Impact Criteria	Frequency /Probability	Magnitude		Sensitivity	Importance of the impact		
		Project contribution	Cumulative noise		Background noise	Project contribution	Cumulative noise level
ID 5 Ecole coranique							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 6 Ecole coranique							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 7 Poste de santé							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor
ID 8 Habitacion Senelec 1							
• Intensity: o Project: negligible o Cumulative noise: moderate • Extent: local • Duration: long term	High	Insignificant	Medium	Medium	Medium	Negligible	Medium
ID 9 Habitacion Senelec 2							

Impact Criteria	Frequency /Probability	Magnitude		Sensitivity	Importance of the impact		
		Project contribution	Cumulative noise		Background noise	Project contribution	Cumulative noise level
• Intensity: o Project: low o Cumulative noise: moderate • Extent: local • Duration: long term	High	Low	Medium	Medium	Medium	Minor	Medium
ID 10 Diokoul							
• Intensity: o Project: negligible o Cumulative noise: low • Extent: local • Duration: long term	High	Insignificant	Low	Medium	Minor	Negligible	Minor

Table 8.32 Evaluation of importance of noise impacts during operation phase (Night-time)

Impact Criteria	Frequency /Probability	Magnitude		Sensitivity	Importance of the impact		
		Project contribution	Cumulative noise level		Background noise	Project contribution	Cumulative noise level
ID 7 Poste de santé							
• Intensity: o Project: negligible o Cumulative noise: moderate • Extent: local • Duration: long term	High	Insignificant	Medium	Medium	Medium	Negligible	Medium
ID 8 Habitacion Senelec 1							
• Intensity: o Project: moderate o Cumulative noise: high • Extent: local • Duration: long term	High	Medium	High	Medium	High	Medium	High
ID 9 Habitacion Senelec 2							
• Intensity: o Project: high o Cumulative noise: high • Extent: local • Duration: long term	High	High	High	Medium	High	High	High
ID 10 Diokoul							
• Intensity: o Project: moderate o Cumulative noise: high • Extent: local • Duration: long term	High	Medium	High	Medium	Medium	Medium	High

Measures to mitigate and control impacts on noise during the operation phase

The Project has already implemented the needed mitigation measures to reduce the noise emissions from equipment. In particular, the use of silencers on stacks, air inlets and ventilators on ventilation output, and the installation of anti-noise panels for the generators and steam turbine have been planned.

During the operational phase, achievement of project noise guidelines may be further accomplished through the use of best practice and good operation management. The following mitigation measures shall be implemented, where appropriate, throughout the operation:

- Fit diesel engine vehicles and compression equipment with silencers;
- Prefer electric energy production over mechanical solutions, where possible;
- Switch off equipment, when not in use;
- Locate stationary equipment as far away as possible from receptors
- If possible, plan to carry out the various noisy activities at the same time, in view of the fact that the combined noise levels will probably not be very much higher than the level produced if operations were carried out separately; and
- Avoid the movement of heavy vehicles during night time.

8.8 IMPACT ON WATER RESOURCES

8.8.1 *Impacts during the construction phase*

Water consumption

Water requirements during the Project's construction phase concern mainly:

- General domestic use for consumption by the labour force
- Cleaning and dust control
- Site maintenance
- Concrete preparation

The amount of water required for making concrete is estimated at about 900m^3, due to the fact that 2500m^3 of concrete will be necessary to build the 53 MW power plant. The same amount can be assumed as a conservative figure for the 33MW Extension.

About 1000m^3 of water should be used for sanitation purpose and 100m^3 of water for washing equipment and preventing dust rising.

In total, about 6 100m^3 of water should be consumed during the construction phase.

Water will come from the existing SDE (*Sénégalaise des Eaux*) pipe at the existing power plant. It is interesting to point out that no water supply problem was identified as a concern by the stakeholders met during consultations. Sensitivity of the area is considered to be low.

A description and characterisation of the impacts are presented in *Table 8.33*.

Impacts on water and soil quality

Impacts of the construction phase on water quality can be from:

- Run-off loaded with matter in suspension (MES) from the work site, during rainy periods (mainly from the cleared areas on the site and heaps of excavated soil)
- Direct discharge of waste sanitation water
- Accidental leaks or spillages.

A list of the main products that will be used at the site, as well as an assessment of annual quantities, is provided in the hazards study in *Chapter 9*.

Rain water can be the vector for soil and therefore water pollution (by infiltration) as well as pollution of the marine ecosystem. It can, by run-off over the new parcels that have been cleared and/or waterproofed for the project, take with it and "diffuse" pollutants into the natural environment (soils either outside or inside the site and, potentially, the aquifer and the coast). Run-off water can thus become loaded with matter in suspension (MES) and various other components (such as hydrocarbons) that have accumulated during dry weather on the waterproofed surfaces (notably roadways). Indeed, the project will result in the creation of waterproofed surfaces that were previously non-existent (roads, concreted areas, etc.) up to a maximum of 2.99ha.

The main rainy season is in the months of August and September, with maximum rainfall that can reach 493mm and 365mm respectively (see *Chapter 4*). For calculation we will use the monthly August peak of 493mm as potentially falling all at once. This is a very conservative approach, in view of the fact that pollution is mainly collected during the first 30 minutes of a storm (the soil is then clean and risks of washing off are therefore very low).

The maximum amount of rain water running off in 1 day over the perimeter of the project (including the existing parcel and the area in which the new project and the Extension is to be installed) measuring 30 000m^2 (this surface area is considered to be entirely waterproofed and therefore of run-off coefficient 1), and which will not filter down into the soil nor will be used by plants, is therefore as follows: Qp = (30 000*1)*(493/1000) / 30 = 493 m^3. The daily amount found is therefore 493 m^3.

The intensity of impacts by run-off will therefore be low. Good practice in terms of run-off management will be implemented by means of characterisation of the site's surface, draining ditches and sediment traps.

Waste water from the living infrastructures (mainly toilet facilities and canteen) are a source of organic and biological pollution that may be transferred to aquifers by infiltration into the soil. This water will also contain cleaning products and detergents.

Discharge of waste sanitation water from temporary buildings (toilets etc.) and permanent installations (shower, cafeteria, toilets etc.) will be collected and stored in a temporary septic tank during the construction phase. The septic tank will be emptied as often as necessary and its contents eliminated by an approved service provider.

During the construction work the quality of surface water and groundwater may also be affected by accidental spillage of chemicals, fuel or oil from the intermediate storage tanks or vehicles used on the site. Any slight changes will probably be reversible, but larger accidental spillages of fuel or chemicals could result in a medium term reduction in water quality.

No water course is located in the Project's area of influence. The sensitivity of surface water at the site is therefore nil.

Piezometric levels in the project's area are between 2m and 6m. Soils at the project are characterised by the presence of clay and limestone-marl formations. They can therefore be considered to be relatively impermeable. The sensitivity of the groundwater factor is therefore considered to be medium.

A description and characterisation of impacts are presented in *Table 8.33*.

Table 8.33 Evaluation of impacts on resources during the construction phase

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Domestic usage and construction work – quantitative aspects				
Insignificant • Intensity: low • Scope: local • Duration: short term	High	Insignificant	Low	Negligible
Quality of surface water				
Insignificant • Intensity: negligible • Scope: local • Duration: short term	Occasional	Insignificant	Nil	Negligible
Quality of groundwater				
Insignificant • Intensity: low • Scope: local • Duration: short term	Occasional	Insignificant	Medium	Negligible

In conclusion, liquid discharge during the Project's construction phase will have a negligible impact on surface water and groundwater, from both a quantitative and qualitative point of view.

Mitigation measures

Within the context of general good practice in terms of water consumption during the construction phase, Contour Global Cap des Biches will require the contractor with responsibility for the works:

- To optimise water consumption and minimise wastage
- Supervise water consumption in order to identify any over-consumption and provide a basis on which to improve efficiency.

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

- The impact of construction activities can be treated by minimising the surface area of bare earth and re-planting on berms as soon as possible. Temporary heaps of materials must be protected from erosion by using the lowest possible berm angle and integrating sediment traps in the drainage ditches. A drainage plan can be drawn up for this purpose.

- Good site management practice must be observed to ensure that products are properly stored on site (secondary retentions, double-walled tanks, overfill alarms, etc.) and that site machinery is check and maintained correctly and regularly.

- The drainage system will be installed prior to the start of construction operations.

- Regular check and maintenance of the drainage system and the waste water evacuation system (temporary and permanent septic tank). Keeping of a register of spillages and the results of checks carried out.

- The non-contaminated water drainage system will be separate from the contaminated water collection system.

8.8.2 *Potential impacts during the operational phase*

Water consumption

During the operational phase, water usage will be as follows:

- Flexicycle steam turbine ;
- Fire protection system ;
- Domestic and sanitation use ;
- Cleaning of floors and equipment ; and
- Cooling systems (maintenance water).

Cooling water requirements will be limited and the cooling system using air will be designed with a closed loop. About 700m^3 of water will be stored on site with the context of the fire protection system. About 180m^3 of service water for the 53 MW plant and 15 m^3 for the 33MW Extension (raw service water, water for cleaning the boilers and maintenance water) and 100m^3 of demineralised water will be stored on site. The rest of the water used will be supplied directly by a dedicated pipeline connected to the SDE distribution network. Water will be distributed to the various buildings and equipment by means of buried pipes.

The volume required for the power plant's industrial purposes is estimated at about 72m^3/day for the 53MW power plant and about 20m^3/day for the Extension, to which is added about 50m^3/day intended for domestic consumption. In all about 140m^3 should be consumed on a daily basis. Supplies will be through a pipeline connected to the SDE distribution network. This will therefore be a low intensity impact at regional level.

As specified in *Chapter 8.8.1* on the impact on water resources during the construction phase, sensitivity to this issue is considered to be low.

A description and characterisation of impacts are presented in *Table 8.34.*

Note that the new ContourGlobal - Cap des Biches power plant will no longer use sea water for cooling, unlike the former power plant which consumed about 150 m^3/h. This is a significant improvement due to implementation of the Project, which limits the project's discharge into the marine environment.

Liquid discharge

After start-up, the various flows of aqueous discharge will be as follows:

- Waste sanitation water
- Rain water
- Washing water
- Industrial water, mainly from purging of the cooling system and the steam turbine. This water may contain certain chemical elements from conditioning prior to use (softening / demineralisation, etc.) as well as trace of metallic ions from pipe corrosion.

The various treatment stages are presented in *Chapter 3.6.5*.

The effluent treatment unit will guarantee that waste water is evacuated as required by regulations (1). A buffer tank will be created in which to store liquid effluent after treatment and prior to discharge. This tank will be sized to take account of any high rainfall episodes that could occur in the Project area, in order to avoid any overflow of effluent prior to discharge (see *Section 3.6.5*.

It should also be noted that no heated discharge will be made by the power plant in operation. This is a significant improvement compared to the power plant's previous configuration, in which heated water (after cooling in the secondary circuit) was discharged.

Average volumes discharged will be over 4 m^3/day. Discharge will be made into the marine environment via the SENELEC discharge canal located at the western edge of the existing ContourGlobal - Cap des Biches power plant. As explained in *Chapter 3*, this is a discharge canal shared with the SENELEC power plant which discharges into the sea. The existing SENELEC canal is designed to discharge into the ocean at an output rate of 20 000m^3/h, and previously took the cooling water discharged from the former ContourGlobal - Cap des Biches power plant (115m^3 /h – see *Section 3.1.3*). New discharge rates will be lower than those of the former power plant and the capacity of the canal is therefore sufficient to take the new discharge amount planned by ContourGlobal - Cap des Biches.

Solid sludge and residues from treatments will be collected for treatment and/or disposal by an independent waste management company.

The nature of the soils (clay formations) encourages run-off of water into the soils, which is then naturally drained towards the ocean. As mentioned previously, no permanent or temporary water course is located within the Project's area of influence. Consequently continental surface water is not concerned by the discharge of waste water. Nevertheless, any major run-off of contaminated water could reach the coast which is adjacent to the installation

(1) Standard NS 05-061 of July 2001 relating to the discharge of waste water

site. This will be avoided by means of a drainage system and the waterproofing of surfaces.

With regard to groundwater, the impact of discharge will be of low intensity and localised scope. This is an impact potential over the long term (operational lifespan of the power plant), of only occasional frequency (the volume of water discharged will depend, amongst other things, on the amount of rainfall). However, in view of the fact that no means by which to detect any excess is in place, apparently, abnormal functioning could lead to moderate or even high intensity.

A description and characterisation of impacts are presented in *Table 8.34.*

Evaluation of impacts on water resources during the operational phase

Table 8.34 Evaluation of impacts on water resources during the operational phase

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Water requirements –quantitative aspects				
Low • Intensity: low • Scope: regional • Duration: short term	High	Low	Low to medium	Negligible
Quality of surface water				
-	-	-	Not applicable	-
Quality of groundwater – normal functioning				
Low • Intensity: low • Scope: local • Duration: long term	High	Low	Medium	Minor
Quality of groundwater – abnormal functioning				
High • Intensity: high • Scope: local • Duration: short term	Rare	Low to medium	Medium	Medium

In conclusion therefore, water use and liquid discharge linked to operation of the power plant will have a minor impact on water resources in normal functioning mode. In abnormal functioning mode, this impact could however become medium. Mitigation and control measures will limit the Project's impact on water resources, to make them acceptable.

Measures to mitigate and control impacts on water resources during the operational phase

A piezometer was installed at the fuel storage tanks, in order to monitor groundwater quality and to verify the absence of accidental contamination. This measure allows limiting the impact on groundwater during abnormal functioning. The piezometer was installed in February 2016 during the construction of the initial Project.

The additional following measures will minimise the potential impacts of power plant operations on water quality:

- oily water will be treated in a deoiler prior to discharge into the SENELEC canal provided
- installations will be regularly checked and maintained
- an analysis of effluent prior to discharge will be carried out once a month. In case of discharge thought to be abnormal, analyses will be carried out (even if they are not directly part of the regular effluent monitoring round)
- every week samples will be taken of effluent prior to discharge. Samples will be kept between two monthly analyses and will only be analysed in case of abnormal measurement (in order to trace the source of the abnormality)
- results of analysis after treatment will be recorded and measures implemented in case of any measurement that exceeds limits.

As mentioned in *Section 3.3.8*, a wall of packed dirt was built at the North-eastern site boundary (see *Figure 5.25*) to prevent surface water runoff from the ONAS wastewater treatment plant and the slaughterhouse to contaminate the Project area with biodegradable waste and sewage. This wall prevented other spill events.

8.9 IMPACTS ON BIODIVERSITY

8.9.1 Impacts during the construction phase

The construction phase for both the initial power plant (53MW) and the extension (33MW) will start with preparation of the land on which the power plant will be built, and particularly with a phase preparing the 2.99ha of the parcel covered by the perimeter of the future power plant.

In view of the small surface area and the absence of any remarkable habitats on this parcel, the impact will be of low intensity and will be over the long term (no return to normal state). Finally the impact is considered to be local.

The installation area is occupied by three habitats influenced by anthropic activities: market gardening, reforested areas and a shallow wet area supplied by run-off from the Rufisque water treatment station's storage lagoons. Consequently, the sensitivity of habitats concerned by land clearance is considered to be low. This is also the case for the Extension given that the construction works for the initial plant are well underway.

With regard to protected species in Senegal, two isolated specimens of a partially protected plant species (*Faidherbia albida*) and a protected bird (the black kite – *Milvus migrans*) have been observed at the installation site. None of these species is vulnerable or threatened at national or international level.

Moreover, several specimens of *Faidherbia albida* were also identified in other sectors in the study area, such that the specimens located in the Project area do not represent any issue for conservation of the species at local level. The same is true for the black kite, large numbers of which can be found within the study area – the black kite is a species that is notoriously commensal with humans, which proliferates close to public waste dumps where it finds an abundance of food.

Finally no protected or sensitive area is located within the Project area or in its immediate surroundings. The closest protected area is 25km from the site.

In view of these various arguments, low sensitivity of the biodiversity to clearance operations has been taken into account in this ESIA.

A description and characterisation of impacts are presented in *Table 8.35*.

Building operations will result in the development of an industrial site on a peri-urban parcel of at least 3ha, which was previously partially cultivated by a local inhabitant. The parcel is already located within an industrial area, which explains why habitats and biodiversity are very limited there. Impact intensity will therefore be low and of local scope.

A description and characterisation of impacts are presented in *Table 8.35*.

In conclusion, the Project's impact on biodiversity will therefore be negligible.

Table 8.35 Evaluation of impacts on biodiversity during the construction phase

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Change in land use (clearance)				
Low • Intensity: low • Scope: local • Duration: long term	High	Low	Low	Negligible
Construction operations (disturbance)				
Low • Intensity: low • Scope: local • Duration: short term	Occasional	Low	Low	Negligible

8.9.2 *During the operational phase*

In operational phase, the project will not have any impact on biodiversity since the parcel concerned will have already been developed and surrounding areas (where sensitivity is also very low) will not be concerned by the Project.

A description and characterisation of impacts are presented in *Table 8.36*.

Table 8.36 Evaluation of the impacts on biodiversity during the operational phase

Potential scope	Frequency /Probability	Relative scope	Sensitivity	Impact importance
Power plant operation				
Insignificant • Intensity: negligible • Scope: local • Duration: long term	Rare	Insignificant	Low	Negligible

No specific mitigation measure or additional control is required.

8.10 IMPACTS ON THE LANDSCAPE

8.10.1 *Recap of initial conditions*

The study area landscape is highly dominated by industrial activities, marked by the presence of several electricity generation installations.

No significant tourist activity was found in the Project area.

Finally, no landscaped area of interest is present in the surroundings of the Project site and the landscape does not have any sensitive characteristics in terms of heritage buildings or cultural heritage (archaeological sites, monuments or sites of intangible heritage) close to the proposed site or in the more extended study area (up to 10 km).

Sensitivity in terms of landscape impact associated with installation of a new power plant is therefore considered to be low.

8.10.2 *Potential impacts during the construction phase*

Evaluation of landscape impacts during the construction phase

Landscape impacts during the construction phase will be gradual, temporary and limited to the construction period.

In view of the project activities described in *Chapter 3*, those likely to generate potential impacts on perception of the landscape are as follows:

- The installation of temporary offices and signs
- Temporary storage works and installations
- The installation and movement of light and heavy construction machinery (including high cranes)
- Installation of lighting systems, including lighting pylons for activities
- The movement of special loads.

These activities will integrate easily into an area that is already highly dominated by industrial activities, such that the scale of the impact is considered to be small.

In view of the low sensitivity in landscape terms and the temporary and limited nature of this impact during the construction phase, this is therefore an impact of negligible importance.

Measures to mitigate and control impacts on the landscape during the construction phase

The mitigation measures described below form an integral part of good management practices in the construction phase. These measures, which are used to minimise visual and landscape impacts, are as follows:

- Machines and materials will be stored properly during works. High machines, including cranes, will not be left in place for any longer than necessary for the construction work

- Outdoor lighting of the construction work must be as discreet as possible and must not allow light to shine upwards or towards residential areas

- Work safety lighting (during construction and operations) will be directed downwards to limit light emissions in the area during the night-time.

8.10.3 Potential impacts during the operational phase

Evaluation of landscape impacts during the operational phase

The two main sources of visual and landscape impacts are the height and volume of the proposed infrastructures. The main potential impacts resulting from the Project can be summarised as follows:

- Long term visual and landscape impacts from new buildings on the Project's main site, particularly installation of the stacks, which will be about 40m high and will be visible from the edge of the site.
- Installation of reservoirs and of the main steam turbines block and the five engines (about 16 -18 m).

In addition to these potential impacts associated with the buildings are those linked to site lighting and, to a lesser extent, those caused by atmospheric emissions (even though their visibility will be very limited).

The scale of landscape impacts connected to the Project will be low, since they will be part of a landscape that is already highly dominated by industrial infrastructures.

In view of the low sensitivity of the landscape and the intensity of the change made by the Project, which is considered to be low (slight change made to landscape characteristics), the resulting impacts on the landscape during the operational are considered to be of negligible importance.

Measures to mitigate and control impacts on the landscape during the operational phase

The following mitigation measures are recommended throughout the power plant's operational phase in order to reduce visual and landscape impacts:

- Design, orientation and materials will be properly and reasonably developed to fit in with the site's existing characteristics and with the landscape's characteristics
- Appropriate usage of non-reflecting surfaces and coloured surface treatments
- External lighting as discreet as possible and directed downwards to limit light emissions in the area during the night-time.

8.10.4 *Summary of landscape impacts*

Table 8.37 ***Evaluation of impacts: land use and local infrastructures***

Potential magnitude	Frequency /Probability	Relative scope	Sensitivity	Impact importance
Impacts during the construction phase				
Low • Intensity: low • Scope: local • Duration: temporary	High	Low	Low	Negligible
Impacts during the operational phase				
Low • Intensity: medium • Scope: local • Duration: long term	High	Medium	Low	Minor

8.11 IMPACTS ON LAND USE AND LOCAL INFRASTRUCTURES

Land use

Building the power plant on the new parcel will mean expropriation of a farmer who has been using the land concerned for market gardening and fruit trees for several years (see *Section 5.7.4*). However this farmer was not the owner of the land he was using.

As shown in *Chapter 4*, a land acquisition procedure has been implemented by SENELEC, in collaboration with ContourGlobal – Cap des Biches and a Senegalese surveyor who supervised the operations. A report was published in June 2014 (*Evaluation des biens du verger de la famille de feu Isma Diop sis au Cap des Biches*) which summarises the situation, results of the inventory and the value of disbursements. Since then an agreement has been signed with the beneficiaries and the planned compensation amounts have been paid. No conflict arose in the resolution of this issue.

Based on these considerations, potential impact intensity on land use of development of the power plant is low, of local scope and long term. The consensual approach used by SENELEC and ContourGlobal - Cap des Biches during the compensation procedure and the absence of any dwellings in the area concerned by development of the power plant suggest low sensitivity.

The Extension will be installed on the same parcel; therefore it does not require any additional land acquisition process.

A description and characterisation of impacts are presented in *Table 8.38*.

Cultural heritage and traditions

As mentioned in *Chapter 4*, no historic or archaeological site was identified in the Project area during the investigations carried out during the socioeconomic study. No cemetery or place of worship is located close to the future power plant and will not therefore be affected by development of the Project. The intensity of the potential impact linked to development of the power plant on local infrastructures, and cultural and religious heritage can therefore be considered to be low and of only local scope. The absence of receptors either directly or indirectly concerned by the power plant explains the low sensitivity.

Disruption on access roads

The power plant area is currently linked to the N1 highway that runs between Dakar and the rest of the country. This asphalted highway runs along the industrial zone and the SENELEC estate to reach, about 800m further on, the area in which the former power plant was located and finally the unloading quay that gives onto the bay. This road is not a direct access route to urbanised areas and is used very little by local populations.

The Autoroute 1 (A1 - Motor highway #1), now completed, also links Rufisque Ouest to Dakar.

No major modification to access routes needs to be planned for the Project development except a deviation towards the future power plant area from the main road, which will not have any significant impacts on local populations.

Impact intensity is considered to be low and of only local scope because it concerns the industrial zone only.

In view of the absence of any dwellings in the direct surroundings of the Project area, with the exception of the SENELEC housing estate, built to house managerial staff working at the power plant, sensitivity is considered to be medium based on a conservative approach.

A description and characterisation of impacts are presented in *Table 8.38*.

Evaluation of impacts on land use and local infrastructures during the construction phase

Table 8.38 Evaluation of impacts: land use and local infrastructures

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Clearance of the area and changes made to use of the terrain – Land use				
Low • Intensity: low • Scope: local • Duration: long term	High	Low	Low	Negligible
Clearance of the area and changes made to use of the terrain - Cultural heritage and traditions				
Low • Intensity: low • Scope: local • Duration: long term	High	Low	Low	Negligible
Clearance of the area and changes made to use of the terrain - Disruption to access roads				
Medium • Intensity: low • Scope: local • Duration: long term	High	Low	Medium	Minor

In conclusion, the Project's impact on land use and local infrastructures will therefore be negligible to minor. The mitigation and control measures indicated below will reduce these impacts and maintain them at their lowest level.

Measures to mitigate and control impacts on land use

ContourGlobal - Cap des Biches will inform all those concerned of the planned start date for works as early as possible and at least three weeks in advance, to enable former users the possibility of cutting down trees and collecting the wood for heating. This measure will help to lessen the loss of the production area for the people concerned and will be in addition to the financial compensation paid by SENELEC on acquisition of the land.

8.12 IMPACTS ON THE LOCAL SOCIOECONOMIC CONTEXT AND LIVING CONDITIONS

8.12.1 *Construction phase*

Employment

An average of 85 workers will work on construction the power plant including the period for the construction of the extension. The recruitment of local workers will be preferred as much as possible. Workers will be employed for periods from several days (for specific construction works) up to the total duration of construction works excluding commissioning). Staff numbers will therefore vary throughout the construction phase. Some construction work will require intervention by qualified and specialised workers, who may be recruited from further away if the skills required are not available locally.

The extension of construction work will therefore have a positive impact in terms of employment at both local and regional level.

A description and characterisation of impacts are presented in *Table 8.39*.

Local economy and inflation

The local economy is already perfectly well integrated into the industrial and urban context of the study area, such that the changes brought about by the arrival of workers in the area should be only limited.

Construction work at the power plant will have the consequence of creating a dynamic in the local economy of varying degrees, depending on distance from the power plant area and the size of the communities affected. It is expected that workers working on the worksite and neighbouring communities will be in contact with one another during rest periods and various types of commercial exchanges will take place: restaurants and catering, sales of basic equipment, various services. These potential impacts can be considered as positive for the communities concerned.

An inflation phenomenon linked to the presence of workers (who could lead to an increase in demand) is extremely unlikely. The local economy is already highly influenced by the proximity of Dakar, the N1 highway (which already sees a large flow of goods and people) and now the A1.

Concerning the economic activities presented in the study area (shell gathering, fishing, etc.), these will not be affected by installation of the power plant. The Project will not lead to any change to the coast likely to impact shell gathering activities.

Immigration and pressure on existing local infrastructures

In the case of construction of the ContourGlobal - Cap des Biches power plant, the probability of migration to the project area is very low. Indeed, the relatively limited size of the project and the fact that the site is located close to both the town of Rufisque and Dakar will have the effect of diluting the arrival of people looking for work at regional level. The sensitivity of local communities can therefore be considered to be low.

Agriculture

The Project area was used by a farmer for several year for market gardening and the growing of fruit trees, over a surface area of less than 1 ha.

The halting of these agricultural activities will not have any significant impact on the availability of agricultural products in the region in view of the urban context in which the project is located; towns act as places for the convergence of agricultural products, where they are sold on local markets.

Also, in view of the low density of agricultural activities in the study area, the creation of local jobs on the worksite to build the power plant will not have any real significant impact on agricultural production due to a reduction in the workforce on agricultural land and in orchards.

A description and characterisation of impacts are presented in *Table 8.39*.

Vulnerable groups

In the case of the study, no specific impact on a vulnerable group was identified.

Evaluation of impacts on the socioeconomic context and living conditions during the construction phase.

Table 8.39 Evaluation of impacts: socioeconomic context and living conditions during the construction phase

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Socioeconomic context - Employment				
Low positive impact	-	-	Medium	Positive
Socioeconomic context – Local economy				
Low positive impact	-	-	Low	Positive
Socioeconomic context – Immigration and pressure on local infrastructures				
Insignificant to low • Intensity: low to moderate • Scope: local • Duration: short term	Occasional	Low	Medium	Negligible
Socioeconomic context - Agriculture				
Low • Intensity: low • Scope: local • Duration: long term	High	Low	Low	Negligible

The Project's impact on the local socioeconomic context will therefore be positive.

8.12.2 *Potential impacts during the operational phase*

The positive impacts described above, observed during the construction phase, that is employment and a dynamic in the local economy, will also be observed during the operational phase. On the other hand the importance of these impacts on the socioeconomic context during the operational phase will be more limited because the number of workers hired short term and long term will be less than during the construction work phase.

Also, about 90% of the sixty or so permanent jobs at the power plant will be for qualified staff. The number of local jobs and jobs for young people will therefore be relatively limited during the operational phase. Operations will also lead to temporary jobs, the precise number of which is not known at this stage in the Project (estimated at between 10 and 25 employees, depending on requirements).

With regard to impacts linked to opportunist migration phenomena and pressure on local infrastructures during the operational phase, these can be considered to be negligible in view of the small number of people who will work at the site and the adaptation of local communities that should take place during the construction work phase (integration into communities of people working at the site, implementation of structured exchanges with power plant employees). The local economy may even draw a positive impact from operations, either directly with development linked to the new industrial activity in the urban community, or indirectly by presupposing the installation of future activities, attracted by this new industrial dynamic. However, in view of the relatively hypothetical nature of these positive impacts, they have not been included in the evaluation.

In terms of fishing activities, no favourable area is located in immediate proximity to the area where liquid effluent is discharged. Also, the volume of discharge will be limited and concentrations discharged will comply with current regulations (see *Section 2)*. The potential impact on fishing activities will not therefore be significant.

The description and characterisation of the impacts are present in *Table 8.40*.

Table 8.40 ***Evaluation of impacts: socioeconomic context and living conditions during the operational phase***

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Socioeconomic context – Employment				
Low positive impact	-	-	Medium	Positive
Socioeconomic context – Local economy				
Low positive impact	-	-	Medium	Positive

The impact of power plant operations on the socioeconomic context will therefore be positive.

8.12.3 Main social management measures

As far as possible, non-qualified jobs will be held as a priority by candidates from the neighbouring urban community of Rufisque Ouest. To achieve this, ContourGlobal - Cap des Biches and the various contractors working on the project will estimate as best possible the number of jobs requiring few or no qualifications, depending on the various stages in work at the site, in order to draw up a provisional recruitment timetable. This document and the main eligibility criteria will be communicated at local level, particularly within the Municipality of West Rufisque in order to encourage local employment (particularly the employment of young people). This approach should limit a perception of favouritism on the part of certain members of the surrounding communities by making the recruitment process as transparent as possible. However, this approach will not prevent any opportunistic migratory influx, but will mean that this phenomenon is restricted to a minimum.

In order to limit opportunistic immigration, the Promoter will specify clearly that no worker will be hired at the site gate, and will communicate very precisely on the formal recruitment process, in order to discourage as much as possible the local installation of opportunistic immigrants. ContourGlobal - Cap des Biches will also work in coordination with local authorities, notably the Municipality of West Rufisque.

8.13 IMPACTS ON THE HEALTH AND SAFETY OF LOCAL COMMUNITIES AND EMPLOYEES

The following phases of the Project will be likely to have an impact on the health and safety of local communities and employees:

- Use of labour during the construction and operational phases
- Traffic during the construction and operational phases
- Emissions and discharge from the power during the construction and operational phases
- Sanitary impact related to workers (HIV/AIDS)

The environmental, health and safety directive developed by World Bank Group for thermal power plants specifies that risks relating to health and safety at work associated with the development and operation of a power plant fall into the following categories:

- heat ;
- noise ;
- confined spaces;
- risk due to electricity ;
- risk of fire and explosion ;
- chemical risks ; and
- dust.

This directive also specifies that the risks that the construction and operation of a thermal power plant may pose for the health and safety of the population are, in many case, the same as for most infrastructures and major industrial installations, i.e. problems with the development of contagious diseases, safety and, above all, the risks linked to traffic due to development of the Project in the area concerned.

Issues related to major risks associated with the development and operation of the power plant (fire, explosion, etc.) and those linked to the presence of chemicals, will be covered specifically in the hazards study presented in *Chapter 9.*

8.13.1 Potential impacts during the construction phase

Health and safety of the labour force

Construction phase will be directed by the Company Wartsila on behalf of ContourGlobal - Cap des Biches. A Health / Safety / Environment (HSE) management plan has been specifically developed ensuring compliance to international best practices and local Senegalese legislation. This plan is detailed in the *Annex 7.*

HIV-AIDS

As is the case for most development projects located in peri-urban areas, there is a risk that building the thermal power plant will lead to an increase in health problems. Health risks inherent to major development projects are those that result from poor living and hygiene conditions, sexually transmitted diseases and infections transmitted by vector. The most serious transmissible diseases during the construction work phase are, due to the mobility of the labour force, sexually transmissible diseases, such as HIV/AIDS. An influx of workers during the power plant's construction and operational phases is indeed likely to increase the risks of propagation of diseases amongst local populations: major construction projects often lead to the arrival of a large amount of male workers, temporarily distanced from their families. These men who find themselves alone for some time may tend to call on the services of prostitutes. These impacts should remain limited, however, on the one hand because the number of workers from outside the community will be relatively small and on the other because no official worker accommodation will be available at the Project. The concentration of workers in the same small space is in fact often one of the factors that encourage the negative effects described above.

Malaria

In addition the pools of stagnant water observed on construction projects, even though they are temporary, encourage the development of mosquito larvae which are a vector for malaria. The intensity of this potential impact can be considered to be low, however, in view of the limited extent of the future power plant. Its scope is regional, on the other hand, in the short term. The sensitivity of neighbouring communities is considered to be medium.

A description and characterisation of the impacts are presented in *Table 8.41*.

Worker accommodation

At this stage is it planned that most of the workers working at the worksite will come from neighbouring communities (from as far as Dakar) and will not require any accommodation during this period. Some of the workers will come from surrounding towns (Municipality of West Rufisque, town of Rufisque). The installation of temporary camps for worker accommodation is therefore not expected.

ContourGlobal – Cap des Biches Traffic

During the construction phase, traffic around the future power plant's installation area will increase significantly, in view of the fact that employees and equipment will have to be transported by road to the site (mainly from Rufisque and Dakar). In view of population density in certain areas, traffic risks could be increased. As specified in the environmental, health and safety directive developed by World Bank Group, road accidents are one of the main causes of death and injury amongst communities, and this is the case the world over.

ContourGlobal - Cap des Biches believes that around 20 journeys will be made per day for equipment deliveries, in addition to individual and collective vehicles transporting staff working at the worksite. Some of the workers working at the site will be from neighbouring communities, which will reduce journeys along the main road. These are short journeys however (less than 30km) along a major route that is already relatively saturated. The intensity of impact linked to the increase in road traffic is therefore considered to be medium.

Most of the traffic will used the N1 and A1 highway from Dakar eastwards and will turn off towards the site shortly before the town of Rufisque (Municipality of West Rufisque); this is a road where there is already a lot of traffic, which crosses built-up districts and urban areas, and where inhabitants are already used to lots of traffic; sensitivity is therefore considered to be medium.

Emissions and discharge

The construction phase will generate noise and atmospheric emissions and liquid effluent likely to have potential effects on the health of local communities and workers.

As mentioned in *Section 8.5,* the impact on air quality caused by the Project during the construction phase is considered negligible to minor.

Noise emissions during the construction phase have been modelled according to the most unfavourable scenario (worst-case), taking into account the closest receptors. The modelling described in *Section 8.7.3* concludes that there will be a low impact. This is a potential estimate, based on a worst-case scenario, the actual occurrence of which is extremely unlikely.

Liquid effluent discharge during the construction phase will be mainly comprised of waste sanitation water and run-off water potentially loaded with MES. Estimates of this discharge, impact evaluation and associated mitigation measures are detailed in *Section 8.8.1.* Liquid discharge will take place in compliance with Senegalese regulations and impact is therefore considered to be negligible.

In all three cases, since the distance from the main sensitive receptors (schools, health station, dwellings, etc.) is at least 400m, sensitivity in terms of emissions and discharge is considered to be low due to the potential of dispersal and propagation of emissions. However, non-permanent receptors close to the worksite, such as people working in the surroundings during the daytime, must be taken into account. Impact analysis therefore considers medium sensitivity within the context of a prudent, conservative approach. It should also be remembered that no major potential impact on the environment has been identified with regard to emissions and discharge during the operational phase. The impact is of low intensity, of regional scope and short term. Impact is therefore negligible.

Evaluation of impacts on the health and safety of workers and communities during the construction phase

Table 8.41 Evaluation of impacts: health and safety of workers and communities during the construction phase

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Health and safety of the labour force				
Insignificant to low • Intensity: low • Scope: local • Duration: short term	Occasional to rare	Low	Medium	Negligible
Use of labour: contagious diseases				
Insignificant to low • Intensity: low to moderate • Scope: local • Duration: short term	Occasional to rare	Low	Medium	Minor

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Emissions and discharge				
Low • Intensity: negligible • Scope: regional • Duration: short term	High	Insignificant	Medium	Negligible
Resulting traffic				
Medium • Intensity: moderate • Scope: regional • Duration: short term	High	Medium	Medium	Medium

Measures to mitigate and control these various impacts on health and safety linked to construction of the Project are presented at the same time as those relating to operations in *Chapter 8.13.3*.

8.13.2 *Potential impacts during the operational phase*

Use of the labour during the operational phase

Operation of the power plant will take place in compliance with international good practice and Senegalese regulations in terms of the health and safety of workers.

ContourGlobal - Cap des Biches will develop a specific health and safety policy for its own employees. This policy will be stemming from Contour Global health and safety policy as presented in *Annex 7*.

Resulting traffic

As indicated in the World Bank Group's directive, operation of a thermal power plant leads to increased traffic, particularly in the case of power plants running on fuel oil transported by road.

For this Project, fuel supply will be brought by pipeline from the SAR refinery located very close by. Therefore, there is no added traffic for fuel supply by truck. This impact is negligible.

Emissions and discharge

The operational phase will generate noise and atmospheric emissions and liquid effluent likely to have potential effects on the health of local communities and workers.

The modelling of atmospheric emissions presented in *Section 8.5* shows that the impact on air quality during the operational phase is negligible to minor, depending on whether short or long term emissions are taken into account. No impact on the health of communities and workers is therefore predicted.

Noise emissions during the operational phase have been modelled according to the most unfavourable scenario, taking into account the closest dwellings. The modelling described in *Section 8.7.3* concludes that there will be a minor impact notably because the Project's contribution to ambient noise levels is very low, due to the already industrialised nature of the area. The impact on communities' health is therefore negligible.

Aqueous effluent generated after treatment during the power plant's operational phase will comply with limits imposed by Standard NS 05-061 on waste water discharge (see *Section 8.8.2*). Mitigation and control measures implemented will lead to a minor impact on groundwater, which in any case is not used by the population downstream from the Project. The impact on community and worker health is therefore negligible.

In all three cases, the long distance (about 400m) of the Project area from the main sensitive receptors (schools, health station, dwellings, etc.) results in low sensitivity in terms of emissions and discharge.

.

Evaluation of impacts on the health and safety of workers and communities during the operational phase

Table 8.42 Evaluation of impacts: health and safety of workers and communities during the operational phase

Potential magnitude	Frequency/ Probability	Relative magnitude	Sensitivity	Impact importance
Health and safety of labour				
Insignificant to low • Intensity: low • Scope: local • Duration: long term	Occasional to rare	Low	Medium	Negligible
Resulting traffic				
Low • Intensity: negligible • Scope: regional • Duration: long term	High	Low	Low	Negligible
Emissions and discharge				
Medium • Intensity: Moderate • Scope: regional • Duration: long term	High	Low	Low	Minor

The Project's impact on the health and safety of communities during the operational phase is therefore evaluated as medium prior to the implementation of mitigation measures; implementation of the measures described below will reduce this impact to an acceptable level.

8.13.3 *Mitigation measures*

Health and safety of the labour force

GTI Dakar will use a health and safety management system that will identify risks and implement protective measures to preserve the health and safety of workers, in compliance with international good practice and Senegalese regulations.

Prevention of transmissible diseases

In order to reduce the potential impacts linked to an increase in sexually transmitted diseases, the Project will adopt and apply an HIV/AIDS prevention policy aimed at proactively creating awareness within the labour force of HIV/AIDS prevention and other contagious diseases. The Project promoter will establish a "code of conduct" right from the construction phase to ensure that employees behave in ways that will limit the increase in contagious diseases and discourage prostitution. This programme will also include an aspect intended to combat discrimination in the workplace based on HIV status.

During the construction phase, the Project will also minimise risks to the safety of local communities and Project employees by means of the implementation of coordination with local authorities and the local police, and the recruitment of security officers, in order to prevent criminality. A code of conduct will also be established for the attention of police forces and security officers to prevent the use of violence, coercion or intimidation.

In terms of worker accommodation, the promoter will ensure that the international standards presented in the chapter below are complied with. A specific process for recording worker complaints on issues of accommodation and living conditions will also be developed and updated to ensure transparency and accessibility.

Road traffic during the construction and operational phases

The implementation of measures intended to reduce the risks associated with the movements of trucks and other transportation vehicles on the roads leading to the power plant will include amongst other things:

- Compliance with speed limits by installing limitation around the power plant area for trucks carrying equipment during the construction phase and fuel oil during the operational phase.
- The installation of adequate signing in the Project's surroundings.
- Regular maintenance of vehicles to avoid a far as possible any kind of mechanical breakdown

- Awareness of the drivers and populations concerned of the risks associated with the presence of transportation trucks in the surroundings of the power plant area.

Emissions and discharge

The emissions and discharge mitigation and control measures already presented in *Chapters 8.5, 8.6, 8.7* and *8.8* will also be efficient in attenuating potential impacts on the health of communities during the construction and operational phase. No additional mitigation or control measure is required.

8.14 ECOSYSTEM SERVICES

8.14.1 Methodology

The study of ecosystem services was carried out using the global methodology of impact study. The importance of the impact is evaluated according to the value / sensitivity of the receptor and the scale of this impact. In the case of services rendered by ecosystems, the analysis of the baseline produced a list of services rendered by ecosystems.

Value

The value of a service is based on a study of its importance to beneficiaries, the availability of sustainable alternatives and the resilience of species and habitats adjacent to the origin of the service.

To define the value, two aspects of services rendered by ecosystems in the study area are considered:
- The importance of the service for its beneficiaries
- The way in which it can be replaced, or not, by alternatives in other places (or "replaceability").

The importance to beneficiaries of services rendered by ecosystems is evaluated according to the following criteria and according to a scale from minor to essential:
- Intensity of usage: for example daily weekly or seasonal usage of a supply service. Number of villages downstream that rely on erosion or flooding control services.
- Scope of usage: for example at home or village level ; use as a means of subsistence, for trade, or both
- Geographic proximity (as far as possible)[1]
- Degree of dependency: for example the share in total protein consumption represented by fish or bush meat.

[1] By taking account of geographic proximity, the study favours services that profit local communities. National and world beneficiaries are indissociable from the study of services rendered by ecosystems and they are included where relevant. However, when everything is equal elsewhere, a service that benefits local communities will be given greater importance than a service enjoyed only by national or world stakeholders.

The replaceability of services rendered by ecosystems is evaluated according to the following criteria, on a scale from low to high:

- The existence of other geographic locations (other sites where the same service rendered by ecosystems is available and is sufficiently close to be used by the communities affected)
- The sustainability of the other geographical locations, in view of the risk of increase in the use of the resources, notably by taking account of other users as well as the current state of the resource and the threats facing it.

Low replicability indicates that there is no other or very few other geographic locations possible, whereas high replicability means that there are lots of other locations in the area.

Results on the importance and replaceability of services are used to assign a value to services rendered by ecosystems (see *Table 8.43*).

By means of an analysis of data referring to baseline and comments made by stakeholders with regard to services rendered by ecosystems, each service is given a value indicating its importance to beneficiaries and the availability of alternatives (replaceability) to the service.

Table 8.43 Criteria used to define the value of services rendered by ecosystems

		Replaceability / Resilience of the service		
		High (lots of geographic locations possible)	Moderate (a few geographic locations possible)	Low (a few to no other possible geographic location)
Importance to beneficiaries of the service rendered	Minor	Low	Low	Medium
	Moderate	Low	Medium	High
	High	Medium	High	Critical
	Essential	High	Critical	Critical

At the end of the ranking process, a final sustainability filter is applied to services with a high to critical value. By sustainable usage is meant maintenance of the biological, ecological and socioeconomic sustainability of the resource on which a particular service rendered by ecosystems is based.

These conditions are defined as follows:

- Biological sustainability indicates that the populations or resources used (for example fresh water) must not be subject to a continual reduction in terms of number / quantity.
- Ecological sustainability indicates that the density of populations or resources used must not be reduced to the point where the latter no longer fulfil their ecological role.
- Socioeconomic sustainability indicates that the density of populations or resources used must not be reduced to the point where the latter cease to be a significant resource for human users.

If it is found that the use of a service rendered by ecosystems is not sustainable in the study area, the service will not be considered to be a priority service rendered by ecosystems.

Magnitude

In the case of services rendered by ecosystems, the receptor is the service itself, supplied by the adjacent ecosystem. However, because the end beneficiaries are the human users of this service, the study takes into account the magnitude of an impact on a service rendered by ecosystems and the resulting magnitude of the impact on the human beneficiaries of this service.

The magnitude is classified in the following way:

- Negligible: in the normal bracket of natural variations
- Low: the impact leads to a small reduction in the availability or functionality of the service rendered by the ecosystems and/or has implications for only a small number of people compared to the whole of the population within the area of influence. A perceptible difference is observed compared to the baseline conditions.
- Medium: the impact leads to a moderate reduction in the availability or functionality of the service rendered by the ecosystems and/or has implications for substantial numbers of people compared to the whole of the population within the area of influence. Does not threaten the long term viability of the service.
- High: the impact leads to the loss of all or a significant proportion of the availability or functionality of the service rendered by the ecosystems and/or has implications for the majority of people in the area of influence. Long term viability of the service is threatened.

8.14.2 Evaluation of impacts on services rendered by ecosystems

Supplies: Crops and fruit trees

As explained in the description of the baseline of the site (see *Chapter 5.9*), land available for urban agriculture has almost disappeared in the project's area of influence. Some market gardening crops are present in the Project area.

The Project will cover a parcel of 2.99ha where agricultural activities were carried out, notably market gardening and fruit trees. After discussion with SENELEC, ContourGlobal - Cap des Biches listed all the assets on the installation site in mutual agreement with the farmer. Replaceability is considered to be low, due to the relatively low availability of alternative sites for crop growing. Importance is considered to be low in view of the fact that agriculture does not represent an essential means of subsistence for communities and the farmer was financially compensated in compliance with current regulations. The value is judged to be medium.

Values conferred upon supply services are therefore high for "foodstuff" services and medium for "transformation" services.

Value of the existence of biodiversity

This service refers to the value globally placed on the protection of species and habitats considered to be "emblematic" or which have a particular value for conservation. The benefits are often at world or national level because the service excludes any physical or religious value, encompassing only the non-usage value attributed to the continued existence of a species.

No sensitive natural and/protected area is located in the near study area. The only classified forest found in the more distant study area is Pire Gourèye forest, which is over 25km from the Project area.

Importance for the community is considered to be low. Replaceability is high because the species present are neither vulnerable nor threatened. Value is low.

Aesthetic value

As mentioned in the chapter on landscape, there is no landscape of recognised interest in the study area. Pleasure found in the current landscape is considered to be low for the community, its replaceability is moderate and its value low.

Table 8.44 Analysis of services rendered in the area

Service	Description	Importance for the community affected	Replaceability	Value
Supply services				
Foodstuffs: Crops and fruit trees	Little agricultural activity due to the low availability of suitable agricultural land. The Project's installation site will cover a farm of about 3ha (mainly market gardening crops, notably peppers and okra, and fruit trees, mainly lemon and annona).	Low	Low	Medium
Cultural service				
Value of the existence of biodiversity	Only one partially protected plant species and one protected animal species (but which is common in the area) have been found on the installation site.	Low	High	Low
Aesthetic value	Landscape	Low	Moderate	Low

Impacts on supply services

Taking account of the analysis above, a description and characterisation of the impacts are presented in *Table 8.45*.

Table 8.45 Evaluation of impacts: supply services

Potential magnitude	Frequency/Probability	Relative magnitude	Value of the ecosystem	Impact importance
Market gardening activities				
Low • Intensity: Low • Scope: Local • Duration: Long term	High	Low	Medium	Minor

In conclusion, the Project's impact on supply services is evaluated as being minor; this is therefore an acceptable impact, dealt with by the procedure for acquisition of the parcel and compensation paid by SENELEC to beneficiaries for the small surface areas being cultivated (less than 1ha).

Impacts on cultural services

In view of the fact that existence value is neither tangible nor easily quantifiable, the ESIA does not attempt to attribute a value to impacts on this service. On the other hand, the study of biodiversity examines the impacts on habitats and species. The associated impact therefore refers to the impact on biodiversity (*Section 8.9*).

A description and characterisation of the impacts are presented in *Table 8.45*.

Table 8.46 Evaluation of impacts: cultural services

Potential magnitude	Frequency /Probability	Relative magnitude	Value of the ecosystem	Impact importance
Existence value of biodiversity – change in land use				
Low • Intensity: moderate • Scope: local • Duration: long term	High	Low	Low	Negligible

In conclusion, the Project's impact on cultural services is therefore evaluated as negligible; this is therefore an acceptable impact.

Impacts on cultural services

Impacts on the "aesthetic value" service relate to landscape and visual impacts. These impacts have been evaluated as being non-significant to moderate during the various phases of the project, according to the methodology used for specific areas in the Project study area.

A description and characterisation of the impacts are presented in *Table 8.47.*

Table 8.47 ***Evaluation of impacts: cultural services***

Potential magnitude	Frequency /Probability	Relative magnitude	Value of the ecosystem	Impact importance
Aesthetic value provided by natural landscapes				
Specific methodology (developed in *Chapter 8.10*)			Low	Negligible

The Project's impact on cultural services is therefore evaluated as negligible.

8.15 IMPACTS LINKED TO SOLID WASTE

8.15.1 Potential impacts during the construction phase

Construction of the Project will generate the following types of waste:

- Excavated soils and materials excavated corresponding to the foundations of the main buildings
- Domestic waste
- Packaging of construction materials and raw materials (cement bags, wooden chests, etc.)
- Materials resulting from structural works (excess concrete, …)
- Greasy waste, batteries, empty drums and other special waste materials.

Concerning the excavated soils, volumes should be relatively small in view of the level topography and absence of any basements in the buildings (relatively small foundations). Some of the excavated soil can be used for levelling the land. The sub-contractor with responsibility for civil engineering will be contractually responsible for dealing with the soils and will contact the local authorities for details of places where the deposit of excavated materials is authorised.

Waste materials will be sorted according to their origin and treatment methods, in accordance with international waste management standards. Based on feedback and experience with similar projects, volumes of special waste materials produced during the construction phase should be small and most of the waste products can be easily reprocessed through existing facilities. Moreover, about 200 m^3 of ordinary waste (i.e. one truckload) will be generated every month during the construction period whether it is the initial Project or the Extension.

Most of the hazardous waste will be mainly contaminated by oils and can be directly collected and disposed of based on contracts with recycling and industrial waste disposal companies in Senegal.

Waste materials will be sorted according to their origin and treatment methods. The collection of waste generated during the power plant construction phase will be managed by an approved service provider and will be in compliance with current regulations.

Sensitivity of the environment has been considered to be medium because the power plant will be installed on land of a certain economic value (agricultural) and because of the presence of a relatively shallow aquifer. The storage area for waste products will be waterproofed and covered to avoid the waste coming into contact with rain water.

Table 8.48 Evaluation of impacts: production of waste during the construction phase

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Waste production				
Low • Intensity: low • Scope: regional • Duration: short term	High	Low	Medium	Minor

In conclusion, the impact of waste production during the construction phase is considered to be minor. This is therefore an acceptable impact if the mitigation and control measures described below are correctly implemented.

Mitigation and control measures:

To mitigate potential impacts linked to waste production, the following measures will be applied:

- Ensure the application of good maintenance and layout practices on the premises by workers, right from the start of the works.
- Develop and maintain an inventory of stocks in order to reduce the amount of waste generated due to materials out of date, materials that do not meet specifications or which are damaged or in greater quantities than required, and which identifies opportunities for re-using materials and equipment such as containers.
- A Waste Management Plan was developed prior to the start-up of construction work and includes the collection and management of waste produced by the workers recruited to build the power plant. This plan will consider the current saturation of local storage centres (Rufisque, Dakar), in order to select the most suitable destination for disposal.

- Ensure that all staff know about and have received the necessary training for compliance and application of the Waste Management Plan as well as the procedures associated with it.
- All solid waste will be collected, stored, transported and disposed of ecologically and in complete safety by the service provider in charge. This service provider will be approved under the terms of current regulations.
- Service providers in charge of waste management will be selected according to their competence and the quality of their services.
- Performance reviews of service providers will be undertaken.
- Traceability of waste evacuation and processing will be guaranteed by the systematic recording of transport forms detailing the type of waste, the amount and its destination, and indicating the carrier's identity.

8.15.2 Potential impacts during the operational phase

The main waste products expected during start-up of the site are as follows:
- Domestic waste
- Sludge from the effluent treatment plant and the hydrocarbon separator
- Hazardous waste comprising lubricants and waste oils and their containers, used filters, oily rags, solvents used for cleaning, etc.
- Waste from the maintenance workshop.

In view of the expected level of activity, sludge will probably need to be collected once or twice a month. This collection and the final processing of sludge will be dealt with by an approved company.

ContourGlobal - Cap des Biches will evaluate options for recycling, reusing or disposing of waste products generated, including sludge, depending on waste processing installations and service providers present in the site's surroundings. ContourGlobal - Cap des Biches will ensure that every waste flow is managed by an approved service provider.

For all waste treatment it is interesting to remember that ContourGlobal - Cap des Biches benefits from experience acquired with the existing power plant operations. Waste that was produced during operation of the existing power plant was managed by approved companies. For example, sludge and oily waste was collected by an approved company and sent to a cement factory for elimination. ContourGlobal - Cap des Biches will use its knowledge and local experience in the choice of collection and treatment companies for this new power plant.

Table 8.49 Evaluation of impacts: waste production during the operational phase

Potential magnitude	Frequency /Probability	Relative magnitude	Sensitivity	Impact importance
Waste production				
Low to medium • Intensity: low to moderate • Scope: regional • Duration: short term	High	Low to medium	Medium	Medium

In conclusion, the impact of waste production during the operational phase is evaluated as medium. Implementation of the mitigation and control measures described below will reduce this impact to an acceptable level.

Mitigation measures

A waste management plan must be implemented in order to guarantee the storage, collection and evacuation of waste, including liquid, solid, hazardous and non-hazardous waste. The plan will describe waste sorting, its transfer and disposal in appropriate places. This plan will include a procedure to monitor the performance of all sub-contractors involved. Moreover, it will benefit from the waste management plan implemented during the operation of the existing ContourGlobal - Cap des Biches thermal power plant. Notably with regard to limitations, management possibilities and feedback on waste management in the Project area.

The main objectives of this type of plan are to minimise the amount of waste generated, to maximise its reuse and recycling and to dispose of the remaining waste with a minimum impact on the environment. These objectives must be in agreement with legal and regulatory requirements.

Waste management must include:

- Information on the storage and retention of hazardous liquid waste
- The sorting and separation of hazardous and ordinary waste, associated with clear, understandable differentiation (to avoid any kind of confusion)
- The promotion of waste recycling, particularly used oils, containers, equipment, paper, plastics
- A ban on burning waste
- Storage and treatment of waste undertaken in a manner that protects the environment: use of specific installations, authorisation prior to burying waste, accreditation of specialised companies
- The traceability of hazardous waste, detailing the type of waste, quantity and identification of both carrier and destination.

This plan must provide information on waste monitoring and traceability and include details on training. It must also consider the tracking of waste after being taken in hand by accredited companies after leaving the site.

This plan will be completed by performance reviews of service providers in charge of waste management.

8.16 CUMULATIVE IMPACTS OF THE PROJECT WITH OTHER ACTIVITIES BEING DEVELOPED

Context

In the case of the Project developed by ContourGlobal - Cap des Biches, no other project currently being developed was identified during preparation of this study. Also, infrastructures existing in the study area were taken into account in analysis of the baseline, since current conditions in the study area are already under the influence of activities associated with these infrastructures and their impacts.

More particularly, the following issues have been the object of a cumulative analysis of Project impacts with existing infrastructures:

Air quality

The main sources of atmospheric emissions in the area of influence of the Project are the SENELEC Power Plant in Cap des Biches along with the APR and Aggreko containerised power units. These facilities primarily influence baseline levels of SO_2, NOx and secondarily also affect PM baseline concentrations. The latter are mainly influenced by natural sources, and depended on climatic factors (e.g. dry season and high winds) and on the geographical location of the Project.

The AQ baseline measurements undertaken by ContourGlobal in the surroundings of the Project highlighted that the local airshed is undegraded in terms of NO_2 and SO_2 concentrations. It should be noted that the performed air quality measurements recorded the contribution of the Aggreko units which are not expected to be in operation once the Contour Global Cap des Biches power plant will be in operation. Hence baseline levels are expected to lower once the Contour Global Cap des Biches power station will be in operation.

Cumulative impacts resulting from the sum of the existing baseline and the Project contribution to air quality are considered negligible for the Project construction phase; whereas they are most likely to occur and be critical for the Project operation phase and for long term concentrations (e.g. annual averages). Short term concentrations (e.g. hourly/daily concentrations) are subject to a high variability during the year since they are dependent on specific short term meteorology. For this reason, the assessment of cumulative impacts in the short term is highly unpredictable and the assessment presented in this section only refers to long term concentrations. Predicted Environmental Concentrations (PEC) have been calculated as presented in *Section 8.5.4*. (PEC) result from the sum of the existing baseline and the Process Contribution (PC). Therefore, PEC assesses cumulative impacts.

As reported in *Table 8.14 and Table 8.15* PEC of NO_2 and SO_2 at sensitive receptors are compliant with the legislation, whereas PEC of PM10 at receptors *(Table 8.16)* exceeds the regulatory limit. The dry season is characterized by higher atmospheric concentrations of PM, due to the absence of wet deposition. Hence, data available to date are representative of the highest PM concentrations expected throughout the year. The classification of the local airshed with regards to PM will be undertaken once PM monitoring data are collected for a 12-month period.. The Project contribution in terms of PM10 concentrations induced at receptors accounts at most for 0.4% of existing baseline level.

Noise

Measurements taken for the baseline analysis took place when the SENELEC power plants and other nearby industries were in operation (see *Section 5.3.9*). The analysis of impacts on ambient noise (see *Section 8.7*) took these noise measurements into consideration, which were then added to the noise of the modelled future ContourGlobal - Cap des Biches power plant (86MW) in operation.

Marine environment

No data relating to liquid discharge from industrial activities in the Project area is available. However, it is important to note that the marine environment was under the influence of discharge from the former ContourGlobal - Cap des Biches power plant, shut down in July 2013 and which drew up and discharged about $115m^3/h$ of sea water when the combined cycle was operating. For this Project (86 MW), no sea water will be drawn up and liquid discharge will be limited to a very modest flow of about $4m^3/h$. The cumulative impacts of the various infrastructures in the study area on the marine environment will therefore be less than those that existed up until July 2013, when the former ContourGlobal - Cap des Biches power plant was still in operation.

Mitigation measures

The mitigation measures presented in the previous sections will reduce the Project's interactions with the environment, thereby limiting cumulative impacts in the study area.

Moreover, the environmental monitoring that will take place, particularly the monitoring of air quality, will take into account the cumulative impacts of the various infrastructures in the surroundings of the Project area.

8.17 MITIGATION MEASURES AND RESIDUAL IMPACTS

This section recapitulates in table form the potential impacts linked to the Project's various components and the mitigation measures recommended in *Chapter 8*. Residual impacts after implementation of the various measures recommended are also evaluated.

Measures can be general or specific. General measures are intended to mitigate the Project's negative effects overall. Specific measures will aim to mitigate impacts on one environmental component in particular.

All this information is presented in *Table 8.50*.

Table 8.50 Summary of impacts and mitigation measures applicable to the Project

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
Construction – Exhaust emissions from engine driven machinery and vehicles	Air quality – concentration of atmospheric pollutants	Impact of NO_x, SO_2 and particles emissions on the main sensitive receptors (schools, health station, dwellings, etc.)	• Regular maintenance and site machinery and generators by the contractor in charge of the works • Reduction, as far as possible, in the number of journeys in order to limit the amount of atmospheric emissions discharged by all the transport vehicles used during the construction phase (equipment, excavated soils or backfill, staff, etc.)	Negligible
Construction – Exhaust emissions from engine driven machinery and vehicles	Air quality – concentration of atmospheric pollutants	Impact of particle and dust generation on the main sensitive receptors (schools, health station, dwellings, etc.)	• Management and maintenance suitable for raw materials storage areas in order to minimise the flight of particles • Trucks covered with tarpaulins when carrying crumbly construction materials or backfill or excavated soils • Speed limits for vehicles travelling on non-asphalted tracks • Washing of vehicle wheels on leaving the site • Covering of storage areas used for materials likely to be blown away by the wind (notably contaminated or hazardous materials) • In case of activities on surfaces covered with fine materials, access roads and the site must be sprayed during construction activities to reduce dust production. • Check on the correct operation of vehicles and machinery and compliance of their emissions with current regulations • Ensure that vehicles and machines are turned off when not in use.	Negligible
Construction – Noise emissions from site machinery	Ambient noise	Impact on ambient noise in terms of neighbours (particularly the closest dwellings)	• No works during the night.	Negligible
Construction – Water consumption	Water resources	Impact of water consumption on available resources. The fact that there will be no drilling for a water supply (which will come from a dedicated pipeline), strongly reduces the impact on local resources (no competition).	• Optimise water consumption and minimise wastage • Supervise water consumption to identify any over-consumption and provide a basis from which to improve use-effectiveness.	Negligible

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
Construction – Liquid discharge	Water resources	Impact of discharge on the quality of soils and water resources (potential contamination).	• The impact of construction activities can be addressed by minimising the surface area of bare soil and replanting on all berms as soon as possible. Temporary heaps of materials must be protected from erosion by using a reduced slope angle as much as possible and by integrating sediment traps into drainage ditches. This requires the establishment of a drainage plan. • Good site management practices must be observed to ensure that products are correctly stored on site (secondary retentions, double walled sides, overfill alarms, etc.) and that site machinery is regularly and properly checked and maintained. • The drainage system will be installed prior to the start of construction operations. • Regular checking and maintenance of the drainage system and the waste water evacuation system (temporary and permanent septic tank). Maintain a register of spillages and the results of controls carried out. • The non-contaminated water drainage system will be separate from the contaminated water collection system.	Negligible
Construction – Land clearance and other construction activities	Biodiversity	Construction operations will entail the development of a peri-urban parcel of less than 3ha, previously cultivated by a local inhabitant, to turn it into an industrial site. The parcel is already located in an industrial area, which explains why habitats and biodiversity are very limited there. The extension is located on the same parcel that was already cleared for construction activities of the initial Project (53MW).	• Avoid or minimise the clearance of vegetation anywhere other than in the power plant works and construction areas.	Negligible
Construction – Presence of the worksite	Landscape	Visual and landscape impact of the presence of the works (machinery, storage, lighting)	• Machinery and materials will be stored properly during the works. High machines, including cranes, will not be left on site for any longer than necessary for the construction work. • The construction work's outdoor lighting must be as discreet as possible and must not allow the light to shine upwards or towards residential areas	Negligible

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
			• Safety and work lighting (during construction and operations) will be directed downwards to limit light emissions in the area at night-time.	
Construction – Land clearance and other construction activities	Land use and local infrastructures	Impacts linked to the change in land use: construction the power plant (86MW) on the new parcel was linked to the expropriation of a farmer who was using the land but did not own it. A land acquisition procedure has been implemented by SENELEC, in collaboration with ContourGlobal – Cap des Biches and compensation payments have been made. No major modification to access roads is to be planned for development of the Project, except the creation of a deviation towards the future power plant area from the main road, which will not have any significant impact on local populations.	• A procedure to acquire the land has been implemented by SENELEC, in collaboration with ContourGlobal – Cap des Biches and a Senegalese surveyor who supervised operations. A report was published in June 2014 (Evaluation of the assets of the orchard owned by the family of the late Isma Diop located in Cap des Biches) summarising the situation, inventory results and the value of disbursements. Since then an agreement has been signed with the beneficiaries and the agreed compensation amounts have been paid. There was no report of any dispute in the resolution of this issue. •	Negligible
Construction – labour requirements	Socioeconomic context and living conditions	With regard to impacts of the construction phase on employment and the local economy, these will be positive impacts linked to the creation of jobs requiring no qualifications and a dynamic for the economy. The impact on agriculture (in terms of local economic activity generating income) will be negligible, in view of the small surface area concerned (1ha).	• As far as possible, jobs requiring no qualifications will be given in priority to candidates from the neighbouring urban community. To do this, ContourGlobal - Cap des Biches and the various companies working at the site will provide their best estimate of the number of jobs available requiring no or few qualifications, depending on the different stages in work at the site, in order to draw up a provisional timetable for recruitment. This document together with the main eligibility criteria will be communicated at local level. • In order to limit opportunistic immigration, the Promoter will clearly state that no worker will be hired at the site gate and will communicate very precisely on the formal recruitment process, in order to discourage as much as possible the local installation of opportunistic immigrants. ContourGlobal - Cap des Biches will also work in coordination with local authorities, notably the Municipality of West Rufisque.	Positive
Construction – construction	Health and safety of populations	The construction phase could result in a risk to the health and safety of local communities	• Limitation of access to the site, by the erecting of fences and notices and information on risks communicated to local communities	Negligible

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
activities and the ensuing influx of labour		and workers: - Risk in the worksite area - Contagious diseases (including STC) - Safety - Worker accommodation conditions - Resulting traffic Whereas almost all the impacts in the construction phase can be considered to be negligible to minor, the impact linked to road risk is evaluated as medium, before mitigation.	• Prevention policy concerning HIV/AIDS, intended to create awareness proactively amongst workers with regard to the prevention of HIV/AIDS and other contagious diseases. • Compliance with speed limits, with limits set around the power plant area for trucks carrying equipment during the construction phase and fuel during the operational phase. • Installation of adequate signing in the Project's surroundings. Regular maintenance of vehicles to avoid any kind of mechanical breakdown • Create awareness amongst drivers and the populations concerned with regard to the risk associated with the presence of transport trucks in the power plant area surroundings.	
Construction – waste generation	Waste management	Waste generated by the Project during the construction phase could include special waste and hazardous waste which requires specific treatment. The amount generated would appear to mean an impact of medium importance before mitigation.	• Ensure application of good maintenance and layout practices by workers on the premises, right from the start of the works. • Develop and maintain an inventory of stocks in order to reduce the amount of waste generated due to materials being out of date, materials that do not meet specifications, which are damaged or more than required and identifying opportunities for the reuse of material and equipment such as containers. • A Waste Management Plan was developed prior to start-up of the construction works and will include the collection and management of waste produced by the workers recruited to build the power plant. This plan will take the current saturation of local storage centres (Rufisque, Dakar) into considerations in its selection of the most suitable destination for disposal. • Ensure that all the staff is aware of and have received the necessary training for compliance with and application of the Waste Management Plan and its associated procedures. • All solid waste will be collected, stored, transported and disposed of ecologically and in complete safety by the service provider in charge. This service provider will be approved under the terms of current regulations. • Service providers in charge of waste management will be selected	Minor

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
			according to their competence and the quality of their services. • Performance reviews of service providers will be undertaken. • Traceability of the evacuation and processing of waste will be guaranteed by systematic recording of transport forms detailing the type of waste, the quantity and destination, and indicating the carrier's identity.	

Operations – exhaust emissions linked to operations at the power plant	Air quality – concentration of atmospheric pollutants	Impact of CO, NO_2, SO_2 emissions and particles at closest sensitive receptors (schools, health station, dwellings, etc.)
		
		This impact mainly concerns NO_2 hourly concentrations, which are expected to occasional exceed the regulatory limit for a limited amount of hours during the year (at most 0.72% of the year).
			• ContourGlobal - Cap des Biches will ensure that sulphur concentration in the fuel delivered does not exceed 2%.
			• A quality control will take place on the heavy fuel oil used and data relating to supplies (quantity delivered and analysis results) will be recorded.
			• ContourGlobal - Cap des Biches is currently continuing the air quality field survey started in November 2014 for the collection of air quality baseline data. In particular ContourGlobal – Cap des Biches is undertaking the following measurements:
			  • air quality measurements of NOx, SO2, at 6 monitoring sites by means of diffusion tubes; and
			  • PM10 and PM2.5 at three monitoring sites by means of BAM-1020 monitors manufactured by Met One Instruments; BAM-1020 monitors are designated USPEA Equivalent Methods for PM10 and PM2.5 and replaced E Samplers in January 2016.
				Minor (as an average of impacts related to all pollutants and to both short term and long term concentrations

Operations – gas and dust emissions linked to road traffic	Air quality – concentration of atmospheric pollutants	Impact of CO, NO_2, SO_2 emissions and particles from traffic resulting from the operational phase (e.g. the transport of LFO).	• Regular maintenance of transportation vehicles will mitigate exhaust gas emissions as best possible.	Negligible
Operations – noise emissions from equipment at the power plant (engines, stack, dry coolers, etc.)	Ambient noise	Impact on ambient noise in terms of local populations (particularly the nearest dwellings), particularly at night.	• Equip vehicles running on diesel engines and compressor equipment with silencers • Prefer the production of electricity over mechanical solutions, where possible • Turn apparatus off when not in use • Locate mobile equipment as far away from receptors as possible	Minor

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
			• Wherever possible plan to perform noisy activities all at the same time in view of the fact that combined noise levels will probably not be higher than the level produced if operations were carried out separately • Avoid the movement of heavy vehicles during the night.	
Operations – Water consumption	Water resources	Impact of water consumption (linked to the industrial process and domestic requirements) on available resources. Supply from a pipeline rather than a well will make the impact negligible before mitigation measures are implemented.	• Optimise water consumption and minimised wastage • Supervise water consumption to identify any over-consumption and provide a base from which to improve efficiency.	Negligible
Operations – Liquid discharge	Water resources	Impact of the discharge of liquid effluent (industrial, rain and sanitation water) on the quality of the resource (groundwater). The effluent treatment process will limit the impact of discharge. Impact on groundwater quality during abnormal functioning	• Oily water will be treated in a deoiler prior to discharge in the SENELEC canal used for this purpose • Check on the installations will be carried out regularly • An analysis of effluent prior to discharge will be carried out once a month. In case of any discharge believed to be abnormal analyses will be carried out (even if they are not directly part of the regular effluent monitoring process) • Samples will be taken of effluent prior to discharge every week. The samples will be kept between two monthly analyses, and will be analysed only in case of an abnormal measurement (to trace the source of abnormality) • Results of analyses performed on exiting treatment will be recorded and measures taken in case of any excessive result • A piezometer was installed at the fuel oil storage tanks, in order to monitor groundwater quality and verify the absence of accidental contamination.	Minor
Operations – Power plant operation	Biodiversity	During the operational phase the project will not have any impact on biodiversity since the parcel concerned will have already been	• No specific mitigation measure or additional check is required.	Negligible

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
		developed and surrounding areas (where sensitivity is also very low) will not be concerned by the Project.		
Operations – Presence of the power plant	Landscape	Visual and landscape impact due to the presence of the power plant: presence of the stack and the turbines block, as well as lighting.	• Appropriate usage of non-reflecting surfaces and coloured surfaces • External lighting as limited as possible and directed downwards to limit light emissions in the area during the night-time.	Minor
Operations – labour requirements	Socioeconomic context and living conditions	The effects of the construction phase on employment and the local economy will represent positive impacts with the creation of jobs requiring no qualifications and a dynamic for the economy.	• As far as possible, jobs requiring no qualifications will be given in priority to candidates from the neighbouring urban community. To do this, ContourGlobal - Cap des Biches and the various companies working at the site will provide their best estimate of the number of jobs available requiring no or few qualifications, depending on the different stages in work at the site, in order to draw up a provisional timetable for recruitment. This document together with the main eligibility criteria will be communicated at local level. • In order to limit opportunistic immigration, the Promoter will clearly state that no worker will be hired at the site gate and will communicate very precisely on the formal recruitment process, in order to discourage as much as possible the local installation of opportunistic immigrants. ContourGlobal - Cap des Biches will also work in coordination with local authorities, notably the Municipality of West Rufisque.	Positive impact
Operations – construction activities and the associated influx of labour	Health and safety of populations	During the operational phase the only interactions of the Project with communities will concern risks linked to road traffic (trucks bringing fuel oil supplies).	• Contacts with traffic regulation authorities during the project's peak activity times. This collaboration could also mean taking the most suitable the routes and journey time, particularly during the construction phase which will generate the most traffic.	Minor

Activities	Environmental components affected	Impacts	Recommended mitigation and control measures	Importance of residual impact
Operations – waste generation	Waste management	In addition to household waste, Project operations will generate hazardous waste (used oil, etc.) as well as sludge containing hydrocarbons.	• A waste management plan for the operation phase will be implemented in order to guarantee storage, collection and disposal of waste, including liquid, solid, hazardous and non-hazardous waste. The main objectives of this plan are to minimise the amount of waste generated, to maximise its reuse and recycling and to dispose of remaining waste so as to have minimum impact on the environment. Waste management should include: • Information on the storage and retention of hazardous liquid waste • The sorting and separation of hazardous and ordinary waste with clear, understandable differentiation to avoid any confusion) • Promotion of waste recycling, particularly used oils, containers, equipment, paper, plastics • A ban on burning waste • Storage and treatment of waste in a manner that protects the environment: use of specific installations, authorisation prior to burying waste, accreditation of specialised companies. • Traceability of the transport of hazardous waste, detailing the type of waste, the quantity and identification of the carrier and the destination. • This plan should provide information on the tracking and traceability of waste and present aspects relating to training. It should also consider the tracking of waste after being taken in hand by accredited companies after leaving the site.	Medium

9 *HAZARD STUDY*

9.1 INTRODUCTION

9.1.1 *Presentation of the study*

This chapter presents the study of the hazards and accidents in the operation and refurbishment of the heavy fuel oil power plant located in Dakar (including the extension for a total of 86MW), and the methods to be used for prevention and protection from them.

This study has been performed in accordance with the Hazard Studies Guidelines[1] of the Ministry of Environment and Nature Protection of the Republic of Senegal and the Directorate of Environment and Classified Facilities. The standard methodology for hazard studies ("*Etude de dangers*") developed by the Order of September 29, 2005[2] and the Circular of May 10, 2010[3] of the French regulation has also been considered.

9.1.2 *Perimeter of the Project*

The Hazard Study covers all risks related to the equipment, operations and processes of Cap des Biches power plant, this includes:

- Re-used equipment from GTI power plant (2 x 1 450 m^3 HFO tanks, LFO tank, unloading area, firewater tanks, etc.)
- The initial Project of 53 MW, designated in this chapter as "Phase 1" power plant" equipment, including 3 x 18V46 engines, a "Flexicycle" combined cycle, 3 000 m^3 HFO tank and related equipment. This is under construction by Wartsila as of December 2015
- The Extension of 33MW designated as "Phase 2" power plant equipment, including 2 x 18V46 engines, 2 000 m^3 HFO tank and related equipment

The Hazard Study covers also occupational risks during the construction and operation phases to ensure health and safety of workers on site.

---

(1) Hazard study guideline, Republic of Senegal, DECF – Ministry of Environment and the Nature Protection; October 2005 (*Guide d'étude de danger, République du Sénégal, DEEC - Ministère de l'environnement et de la protection de la nature ; version octobre 2005*)

(2) Order of September 29, 2005 related to the assessment and the consideration of the probability of occurrence, kinetic, intensity of the effects, and severity of consequences of potential accidents ; within the Hazard studies of the classified facilities subject to approval (*Arrêté français du 29 septembre 2005 relatif à l'évaluation et à la prise en compte de la probabilité d'occurrence, de la cinétique, de l'intensité des effets et de la gravité des conséquences des accidents potentiels dans les études de dangers des installations classées soumises à autorisation*)

(3) Circular of May 10, 2010 summarising methodological rules that are applicable to Hazard studies, the assessment of the approach to reduce risks at the origin and Plans for prevention of technological risks (PPTR) in classified installations in force with law of July 30, 2003 (*Circulaire française du 10 mai 2010 récapitulant les règles méthodologiques applicables aux études de dangers, à l'appréciation de la démarche de réduction du risque à la source et aux plans de prévention des risques technologiques (PPRT) dans les installations classées en application de la loi du 30 juillet 2003*)

9.2 *METHODOLOGY*

The hazard study has been prepared considering the methodological guidelines published by the DECF[1], and with a view to compliance with the Senegalese law. Its objective is to identify and assess the major risks associated with the project implementation.

The steps of the hazard study are as follows:

- Identification of potential risks

- Preliminary risk assessment, including the identification of potential hazards, a review of accidents and an assessment of the residual risks considering the prevention methods to be used

- Detailed assessment of the residual risks for the selected scenarios

- Risk ranking conclusions.

A major technological risk is an event related to a loss of control of an industrial plant, such as a fire, explosion, or the major emission of toxic substances. It causes a serious hazard that can have immediate or delayed consequences for humans and/or the environment, which can occur inside or outside the facility. This can involve one or more dangerous substances.

The following definition makes a clear distinction between hazard and risk:

- A hazard is a situation that has intrinsic potential to cause damage to people and property. In the industry, the hazard may be related to products, processes and equipment.

- A risk is the probability of hazard occurrence. An accidental event is characterised by the severity of its effects and the likelihood of their occurrence.

The nature of technological risks at a power generation site is very diverse. Risks can generally fall into several categories:

- Fire
- Explosion
- Accidental spill of harmful products
- Escalation of minor incidents to major accidents
- Accidents with an external origin to the site (malevolence, etc.).

(1) Hazard study guideline, Republic of Senegal, DECF – Ministry of Environment and the Nature Protection; October 2005 (*Guide d'étude de danger, République du Sénégal, DEEC - Ministère de l'environnement et de la protection de la nature ; version octobre 2005*)

In addition to technological risks, there are natural hazards (i.e. storm, earthquake) that may have an impact on the site.

The hazard study also enables the assessment of the significant hazards on the site, that is, those that have a high probability of occurrence and/or those that can lead to serious consequences for humans, the environment and facilities.

The hazard study will involve the identification and assessment of key potential major hazards that may occur in the thermal power station. The identification will be methodical and systematic, and will analyse the specific hazards and risks associated with the products to be used, the proposed facilities and the chosen process, as well as to the environment as a potential "target" or as a potential aggressor. The identification will rely on the provision of accident data from several official sources. Following identification, prevention and protection measures to reduce risks will be proposed for inclusion in the final plant design.

The risk ranking assessment is based on the matrix (see *Table 9.1*) of the hazard study guideline prepared by the Directorate of Environment and Classified Facilities.

Table 9.1 Risk classification matrix

LEVEL OF RISK		**Consequences**				
		5	**4**	**3**	**2**	**1**
Probability	**5**	25	20	15	10	5
	4	20	16	12	8	4
	3	15	12	9	6	3
	2	10	8	6	4	2
	1	5	4	3	2	1

Acceptable risk: No action is required.

Significant risk: The facility must propose a reduction plan to be implemented in the short, medium and long terms.

Unacceptably high risk: A detailed study of major accident scenarios will be required. The facility must take immediate reduction measures (implementing prevention and protection methods).

25 Risk level: Probability x Severity

The Probability/Severity levels considered are determined based on *Table 9.2*, and the hazard study guidelines mentioned above.

Table 9.2 Severity and probability scale used in the EDD

Probability Scale		**Severity Scale**	
Score	Meaning	Score	Meaning
1 = Unlikely	Never seen in the industry. Almost impossible in the facility.	1 = Negligible	- Minor impact on staff - No shutdown - Low environmental impacts
2 = Unusual	Previous occurrence in this industrial sector. Possible in the facility.	2 = Minor	- Medical care for staff - Minor damage - Small production loss - Minor impacts on the environment
3 = Occasional	Previous occurrence in the facility. Occasional but can occur in the facility.	3 = Important	- Staff seriously injured (extended work shutdown) - Limited damages - Partial production shutdown - Localised impacts on the environment
4 = Likely	Occurs 2-3 times a year in the facility.	4 = Critical	- Life disabling injury - Significant damage - Production shutdown - Important impacts on the environment
5 = Continual	Occurs more than 3 times a year in the facility.	5 = Catastrophic	- Loss of life - Widespread damages - Long production shutdown

9.3 DESCRIPTION OF ENVIRONMENT AND SITE

9.3.1 *Description of the environment*

The site is located in an industrial area, close to a wastewater treatment plant, with an agricultural area located to the north.

The plant is located at the edge of the Atlantic Ocean, which is considered the most sensitive receptor in terms of potential pollution (wastewater or hydrocarbons discharge).

The nearest human receptors are the SENELEC staff accommodation units, located 300 m west of the site; and the village of Diokoul, which is 400 m to the east of the site.

9.3.2 *Description of installations and processes*

The layout map of the facility is provided in Annex 6.

Considering the objectives of the development of a hazard study, the facilities and processes that are identified as sensitive are:

- For GTI power plant and Cap des Biches Phase 1 power plant:
    - The power generation system, including:
        - Three Wartsila 18V46 engines, with a nominal power of 16.5 MW each
        - The steam turbine for the combined cycle system (3.5MW)
    - The storage in tanks, including:
        - HFO
            - A 3 000 m^3 storage tank fed by the pipeline
            - Two 1450 m^3 storage tanks
            - 50 m^3 buffer tank
            - 100 m^3 service tank
        - LFO
            - 120 m^3 storage tank
            - 100 m^3 service tank
        - Oils
            - 35 m^3 oil tank
            - 20 m^3 waste oil tank
            - 16 m^3 service tank
        - Water
            - Raw water: 180 m^3
            - Deionized water: 100 m^3
            - Fire: 700 m^3
        - Effluents: 80 m^3 (wastewater) and 50 m^3 (oily water)

- For Cap des Biches Phase 2 power plant:
    - The power generation system, including:
        - Three Wartisla 18V46 engines, with a nominal power of 11 MW each
    - The storage in tanks, including
        - HFO
            - A 2 000 m^3 storage tank
            - 35 m^3 buffer tank
            - 80 m^3 day tank
        - LFO
            - 80 m^3 day tank
        - Effluents
            - 50 m^3 oily water buffer tank

9.4 *IDENTIFICATION OF POTENTIAL RISKS*

9.4.1 *Inventory and characteristics of the products used*

The following products will be used on site:

- Heavy fuel oil, as fuel under normal conditions
- Light fuel oil or diesel as back-up

- Various chemical products (i.e. acids, products for water treatment)
- Industrial gases (nitrogen, oxygen, etc.).

Heavy Fuel Oil

A maximum volume of 8165 m^3 (6050 m^3 for GTI and Phase 1, 2115 m^3 for Phase 2) of heavy fuel oil will be stored on site, with characteristics as noted below. Heavy fuel oil is supplied by pipeline from the storage tanks of *Société Dakaroise d'Entreposage*. Company's pipeline operation limit is set at the retention basin of the 3000 m^3 storage tank.

Main physico-chemical characteristics:

- Colour : Brown/black
- Odour : Oily
- Physical state : Viscous liquid
- Flash point : 73° C
- Steam pressure : 0.02 to 0.791 kPa at 120 °C
- Flammability limit : Not applicable
- Density : 965 kg/m^3 at 15°C
- Sulphur content : 1.33 ppm

Incompatibility, stability, reactivity:

The product is stable under normal conditions of storage and use.

Potential impacts on health:

- Inhalation: Harmful by inhalation. Exposure to decomposition products may be a risk to health, with serious effects potentially being delayed.
- Ingestion: No known effects
- Skin contact: Grease should be immediately removed from skin. May eventually cause dryness and irritation.
- Eye contact: May cause eye irritation.

Toxicity and ecotoxicity:

- Acute oral toxicity – DL 50, rat: > 5g/kg
- Acute dermal toxicity – DL 50, rabbit: > 2g/kg
- Ecotoxicity – CE 50 (48 hours), water flea: 2mg/l
- Ecotoxicity – NOEC (72 hours), algae: < 1mg/l
- Acute ecotoxicity – CL 50 (96 hours), fish: 79mg/l

Diesel or domestic heating oil (LFO)

Domestic heating oil will be used during the start-up of engines or in case of emergency. Quantities used will be low, which explains the difference in storage capacity compared to heavy fuel oil. Only 300 m^3 (220 m^3 for Phase 1, 80 m³ for Phase 2) of domestic heating oil will be stored on site. Domestic heating oil will be delivered by tankers when needed.

Main physico-chemical characteristics:

- Colour : Yellow
- Odour : Characteristic
- Physical state : Fluid at 20 °C
- Flash point : > 55° C
- Steam pressure : < 10 hPa at 40 °C
- Flammability limit : Around 0.5 and 5 % in volume of steam in the air
- Density : 820 to 845 kg/m³ at 15 °C
- Sulphur content : 1.3 ppm

Incompatibility, stability, reactivity:

The product is stable under normal conditions of storage and use.

Potential impacts on health:

- Inhalation: Irritating to respiratory system. Prolonged exposure may cause nausea and headaches.
- Ingestion: Burns of mouth, throat, and/or the stomach as well as nausea, faintness or vomiting.
- Contact with skin and eyes: Burns.

Toxicity and ecotoxicity:

- Acute oral toxicity – DL 50, rat : > 675mg/kg
- Acute dermal toxicity – DL 50, rabbit : > 890mg/kg
- Ecotoxicity – CL 0 (48 hours), water flea : 50mg/l
- Ecotoxicity– CL 100 (46 hours), fish: 500mg/l

Chemical products

Many chemical products are present on site. However, they are stored in small quantities. Risks of severe accidents for the population or the environment associated with those are considered negligible when precautions are considered. Risks of work accident linked with these chemical products are analysed in *Section 9.13*. *Table 9.3* shows the average amount of key chemicals products used and stored on site.

Table 9.3 Main chemical products used and stored on-site

Product / Description	Function	Average amount used per year	Average amount present on site
Cleanblade GTC1000 – aqueous solution	Turbine cleaning	1, 500 L	400 L

Product / Description	Function	Average amount used per year	Average amount present on site
Corrshield MD4154 - sodium nitrite solution	Corrosion inhibitor in the water/steam cycle	2, 200 L	1, 000 L
Cortrol OS7780	Oxygen absorber	3, 300 L	1, 400 L
Depositrol BL5310	Cooling water chemical products	2, 000 L	2, 000 L
Hydrochloric acid	Various uses	3, 000 kg	600 kg
Hypersperse MDC220 (Phosphonate)	Scale inhibitor	1, 000 L	900 L
Optiperse HP5494 – phosphate polymer / solution	Boiling feed water treatment	8, 000 L	6, 350 L
Sodium hypochlorite	Various uses	3, 000 kg	3, 000 kg
Spectrus CT1300 – ethanol and dimethylbenzylammonium	Biocide	1, 000 L	
Spectrus NX1100	Bactericidal		1, 000 L
Steamate NA0540E - Morpholin	Corrosion inhibitor	3, 300 L	2, 200 L

9.4.2 *Hazards of the products used*

Fire hazard

Fire is a combustion that comes uncontrolled in time and space. For liquid hydrocarbons, vapours emitted by the heated liquid burn, rather than the liquid itself.

The combustion process is a chemical oxidation reaction of a fuel by an oxidizer. The reaction requires a source of energy. Three conditions must be met simultaneously for combustion, according to the principle of the "fire triangle", as shown below.

1. Presence of fuel: Material able to burn (i.e. coal, petrol, butane)
2. Presence of combustive: Body that, combined with fuel, enables combustion (i.e. oxygen or air)
3. Presence of a source of energy (energy required to start combustion).

The absence of one of the three elements prevents combustion from occurring.

A source of ignition may come from:

- Maintenance or repair activities, including hot spot works (welding, grinding, cutting)
- A spark of electrical origin or the impact of steel objects hitting the same metal
- Negligence of a smoker

- An electrical fault (e.g. overheating of an electric cable in poor conditions; an electrical connection poorly implemented)
- Mechanical heating.

In general, the consequences of a fire are myriad, and include:

- Damages caused to property
- Release of gaseous and potentially toxic combustion products
- Movement of pollutant substances with the extinguishing waters.

Thus, a fire can cause air, surface and ground water or soil pollution.

As part of a hazard study, the most harmful impact to consider during a fire is its thermal radiation. The impacts on humans and equipment caused by thermal radiation are presented in *Table 9.4*.

Table 9.4 Impacts on humans and equipment caused by thermal radiation

Heat fluxes received by the receptor	Impacts
40 kW/m²	Spontaneous ignition of wood within 40 seconds
36 kW/m²	Likely fire spread on hydrocarbon reservoirs, even when they are water-cooled
27 kW/m²	Spontaneous ignition of wood within 5 and 15 minutes
20 kW/m²	RESIAtance of concrete structures for fewer than 5 minutes
12 kW/m²	Unlikely fire spread on hydrocarbon reservoirs, even when they are water-cooled
9.5 kW/m²	- Pain threshold in 6 seconds - Lethal exposure threshold of 30 seconds
8.4 kW/m²	- Beginning of spontaneous combustion of wood and paints - Unlikely spread of fire on uncooled hydrocarbon reservoirs - Intervention by persons protected with fireproof outfits
5 kW/m²	- Broken windows by thermal effect - Pain after 12 seconds - Blisters after 30 seconds - Lethal exposure threshold of 60 seconds - Rapid response for protected persons (firefighters)
3 kW/m²	- Pain after 30 seconds (light outfit) - Lethal exposure threshold of 120 seconds
2 kW/m²	Damages to PVC cables
1.5 kW/m²	Acceptable threshold of continuous radiation to unprotected people, usually dressed
1 kW/m²	Solar radiation in the equatorial area
0.7 kW/m²	- Skin reddening - Burns with extensive exposure

Risk of explosion (overpressure wave)

None of the products present in the facility can cause an explosive cloud, because the fuels used have low volatility limits. In this case, overpressure waves only occur in confined tanks, following vessel bursts, and following a fireball.

An explosion is a rapid transformation of a hardware system, which leads to a large emission of gas, possibly accompanied by the significant emission of heat.

The main event of an explosion is the sudden increase in pressure that causes a blast effect, a pressure wave and in some cases, projections (missiles). This sudden overpressure can have devastating impacts on people and buildings. In addition, the maximum rate of pressure rise is an important feature of the explosion strength.

Table 9.5 describes the effects of pressure waves associated with explosions.

Table 9.5 ***Effects of Pressure Waves Associated with Explosions***

Overpressure (mbar)	Effect
5	5% of exposed windows shatter
20	50% of exposed windows shatter
50	Very slight damages to structures, risk of injuries
80 - 100	Slight damages to metal structures
140	Lower limit of serious damage to structures, first mortality effects
150 – 200	Concrete walls collapse
200	Metal structures shatter
250	Storage tanks break
200 – 400	Large trees flatten
500	Filled wagons turn over, brick walls (20-30 cm thick) burst

Risks related to toxic products

Most chemical products have an effect on the body. Certain substances, declared toxic, have acute and/or chronic adverse effects and may:

- Induce cancer, tumours or neoplastic effects on humans
- Cause genetic modifications and therefore a mutation that remains in the lineage
- Cause malformations in the development of human embryos
- Cause irritation or sensitisation of the skin, eyes or respiratory tract
- Reduce mental or motor skills or alter the behaviour of humans
- Harm human health by producing reversible or irreversible bodily injuries that put lives at risk, or cause death by inhalation, epidermal, ocular, oral or any other means of exposure, independently of the quantity, concentration or dose used over any time period.

Inhalation, skin contact and ingestion are pathways into the body.

The effects on humans of a toxic substance are multiple and of varying severity. They are linked to several factors including the toxicity of the product, the product concentration, the duration of exposure, the sensitivity of the target person, and body penetration method.

Heavy fuel oil, domestic heating fuels and lubricating oils may contain polycyclic aromatic hydrocarbons (PAHs), some of which have been proven to be carcinogenic in animal studies. Prolonged contact with these can also cause skin dryness and nausea.

With respect to the aquatic environment, the considered hydrocarbons have the following characteristics:

- High chemical oxygen demand (COD)
- Low solubility in water
- Slow biodegradability.

Microorganism respiration that leads the biological oxidation process in the case of excessive presence of hydrocarbons slows down biodegradation processes. In forming a layer, this hinders gas exchange with the atmosphere and photosynthetic reactions.

Heavy fuel oil and domestic heating fuel may therefore be toxic to water and aquatic organisms, and this also likely to be the case for the lubricating oil.

Given their physicochemical characteristics and the biological data available, these products can also be harmful to wildlife and terrestrial and aquatic flora.

However, there is no product on site that presents an acute toxicity in humans.

Toxic effects of fire smoke

In the particular case of fire smoke, American, English, Japanese and French statistical summaries indicate that intoxication by smoke, and in particular carbon monoxide and hydrogen cyanide, is the leading cause of fire deaths.

The smoke includes all gaseous products and particles emerging from a burning body or a body at high temperature. Fire smoke conveys a multitude of toxic gases which can lead to poisoning. In the case of a hydrocarbon fire, toxic gases present in smoke are mainly carbon monoxide (CO), carbon dioxide ($CO_{2)}$ and particles of unburnt matter.

Fire smoke conveys incandescent particles called soot, which form a true aerosol of solid particles. These particles enter the respiratory system and cause not only an obstruction of the pulmonary system and increased heat stress, but also a toxic effect due to their caustic nature (attack of body tissues).

Carbon monoxide prevents the binding of oxygen to haemoglobin, which carries oxygen to cells. In addition, CO binds to myoglobin present in the muscles, which explains its disabling effect. The decrease in the binding of oxygen to haemoglobin is around 50% if there is 0.84% of CO in the air. CO is considered to be responsible for one third of deaths from smoke inhalation. *Table 9.6* below shows the physical effects associated with exposure to carbon monoxide.

Table 9.6 Physical effects associated with exposure to carbon monoxide

CO concentration (ppm)	CO content in the air (%)	Physical effect
100	0.01	No symptoms
250	0.025	Possible light headaches after 2-3 hours of exposure
500	0.05	Headaches after 1-2 hours, nausea, dizziness
750	0.075	- Headaches after 0.5 -1 hour - Nausea, unconsciousness after 2 hours of exposure
1000	0.10	- Headaches, dizziness, nausea - Unconsciousness after 1 hour - Without care, death after 3 - 4 hours of exposure
1500	0.15	- Headaches, dizziness, nausea - Unconsciousness after 30 minutes - Without care, death after 2 -3 hours of exposure
2000	0.20	- Unconsciousness after 20 minutes. - Without care, death after 1 - 2 hours of exposure
5000	0.50	- Unconsciousness after 10 minutes. - Without care, death after 30 minutes of exposure
> 10 000	> 1	- Immediate unconsciousness - Death after 2 – 3 minutes of exposure

Carbon dioxide, a compound similar to carbon monoxide, is also found in fire smoke. In addition to its toxicity (narcosis), it leads to an increase in respiratory rate, thus facilitating penetration of other toxic substances in lungs.

The risk of air pollution remains secondary for fuel storage in comparison to the risk of fire or water pollution, in terms of environmental protection.

In case of an accident, individuals exposed to smoke should have adequate respiratory protection.

9.4.3 Risks related to facilities

Product storage and usage methods involve their own hazards.

Storage of Heavy Fuel Oil and diesel in fixed or fragile roof tanks

There are several hazards associated with storing liquid fuel in tanks, including:

Explosion of gaseous phase
This event involves the accumulation of flammable vapours in the gaseous phase of the tank, as well as ignition. This causes a sudden increase in pressure within the tank and the release of a pressure wave during the tank breakdown.

Fireball after a slow pressurisation of the tank
This hazard is more specific because it occurs when a tank is caught in a fire. The risk occurs when the product within the tank evaporates faster than it is evacuated by the breathing vents. This causes an increase of tank pressure, followed by breakdown, resulting in a short and intense thermal flux that is received by the receptors during the combustion of the fireball. The pressure wave resulting from the event is limited.

Tank fire
This is a secondary event resulting from a loss of confinement. A tank fire can occur after a weakening of the structure of the tank. The pressure in the gaseous phase of the tank created by the heating can cause a roof collapse and the ignition of the tank content.

Boil-over
A boil-over is a large scale event caused by the evaporation of the water layer at the bottom of the tank or water mixed with fuel. A pool fire or tank fire can lead to the evaporation of this water, which may result in the spraying of burning hydrocarbons.

The term Thin-Layer Boil-Over (TLBO) is used for lighter hydrocarbons. The amount of oil likely to be involved in the eruptive event is lower in this case.

Retention fire basin
This hazard involves the retention basin of the tanks. A loss of containment in a tank causes a hydrocarbons flow and the formation of a liquid layer. There is a risk of retention basin fire if liquid or liquid steams meet an ignition source.

Combustible products Transportation

Transportation of combustible products by pipelines does not generate other hazards that those linked to the flammability of the product. However, in case of a loss of containment of pipelines outside bunds, a free hydrocarbon pool may form and result in a pool fire if ignited.

Power generation

Engines do not involve any particular risk, other than those related to rotating elements (i.e. projection parts) in case of uncontrolled overspeed for instance. These hazards are limited to the immediate surroundings of the facilities, in the power generation buildings.

Combined cycle

The combined cycle or cogeneration aims to recover the heat of the combustion gases of the engines, for heating the water and transforming it into steam. This steam is then used in a turbine in order to generate power and improve the system performance.

Steam production does not involve any particular hazard, while the turbine has similar hazards to those of the engines. The main hazard of this facility is related to the buffer storages of pressurised steam in tanks. The bursting of a pressure tank would result in the release of a pressure wave. The consequences of this would be limited to the immediate vicinity of these facilities and the associated buildings. This type of risk has not been considered in the detailed risk analysis.

9.4.4 Hazards associated with the external environment

There are various types of hazard related to the environment, including the impact of potential neighbouring industrial facilities, and risks of natural origin (i.e. earthquakes, landslides, storms, floods).

The population density in the plant area is low. The plant is located in an industrial area next to a wastewater treatment plant. An agricultural area is located at the north of the site. The nearest residential area is located approximately 400 m to the east of the site.

Natural Conditions

There is a risk associated with storm and lightning. Thunderstorm activity has no influence on the facilities. However, lightning can be detrimental to facilities due to the use of flammable liquids – a lightning strike can cause a fire in the fuel storage tanks.

The site is located in seismic zone 0-1. This means that the seismicity of the area is negligible but not absent. The definitions are as follows:

- *Zone 0* "negligible but not zero" seismicity: There is no special seismic recommendation. Historically, no quaking above VII has been observed.

- *Zone I* "low seismicity" :
    - Historically, no quaking above or equal to VII has been observed
    - The return period of a quake above VIII is above 250 years
    - The return period of a quake above VII is above 75 years.

There is *a priori* no other extreme weather events that may pose a major risk to the facilities of the station. Flood risks were taken into account as part of the design of the stormwater network.

Malicious Act

Malicious acts may occur in the case of an intrusion on the plant boundaries, but the potential hazard is difficult to quantify. Regular patrolling of the area and the presence of CCTV cameras would reduce this risk.

9.5 ACCIDENT REVIEW

9.5.1 Methodology

The analysis of accidents which have occurred at similar facilities to the power station is essential to the hazard study. Considering a much broader statistical population (the entire world), the study of accidents enables:

- Identification (at least for the most likely accidents) of the type of potential accidents that may occur within a facility
- Assessment of the probability of occurrence of each type of accident
- Assessment of the potential severity of each type of accident
- Identification of appropriate prevention and protection measures, on the basis of the conclusions of published post-accident surveys.

In order to get an overview of the different types of accidents that can occur at power generation and distribution areas, ERM has conducted a brief review of accidents reported internationally over several years. This overview is based on a query of the ARIA database of the Directorate of Pollution and Risks Prevention, dependent on the French Ministry of Environment, which is available on the internet [1]. It essentially includes an inventory of more than 40,000 accidents occurring worldwide between 1900 until today, with detailed industrial accidents analysis sheets, as well as articles and technical recommendations.

9.5.2 Results

Assessment of the hazards encountered

Research using the ARIA database was carried out for power generation and distribution activities and hydrocarbons storage, using the following keywords:

- Fuel; fuel oil; diesel; diesel oil
- Power Station; Combined cycle

(1) http://www.aria.developpement-durable.gouv.fr

Using these search terms, the database lists 55 accidents since 1981. Some involve facilities that are different from those of the present study (e.g. nuclear stations, coal use) and these have not been considered. 46 accidents have occurred in facilities similar to the Dakar power station.

Table 9.7 presents the results of the ARIA database consultation. The hazardous event, the involved product and equipment, the cause, the activity or the operation and the consequences of each listed accident are indicated in the table.

It is important to note that this list is non-exhaustive and that in most cases, for accidents outside of France, only the most significant events are listed in this database. The statistics will thus be only for accidents happening in France in order to avoid overestimation causes and consequences of accidents linked with this type of facilities.

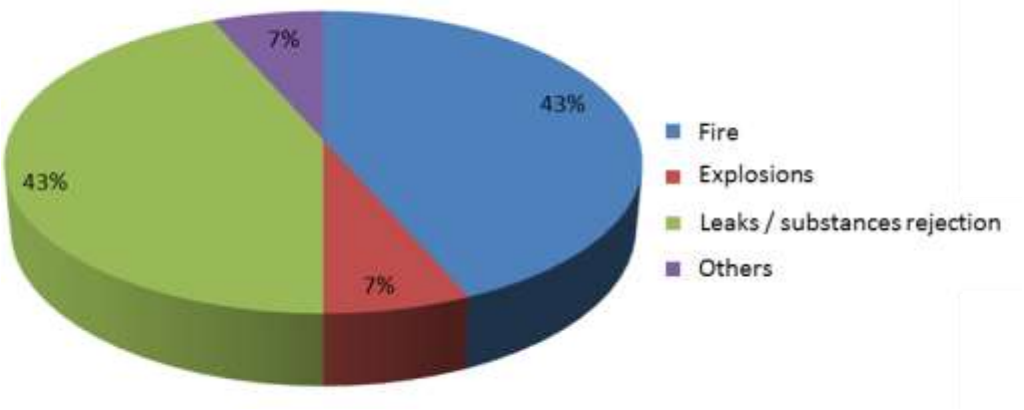
Table 9.7 Results of the consultation of the ARIA database

Ref. BARPI	Date	Location	Hazardous event				Product involved				Equipment involved							Cause					Operation / Activity					Consequences				
			Explosion	Fire	Spill of Liquid / Leak	Other	Fuel / Diesel	Oil	Vapour	None / Other	Boiler	Generator	Diesel Group	Canalisation	Electrical Cabinet	Storage	Other / Unknown	Human error	Equipment failure	Natural factor	External factor (tampering)	Other / unknown	Production	Storage	Unloading / Supply	Maintenance	Other / Unknown	Human	Social	Material	Environmental	None
45591	15/08/2014	France		X				X				X										X	X									X
42812	27/09/2012	France		X						X		X							X				X						X			
42622	19/08/2012	France		X						X		X							X				X						X			
43150	11/07/2012	France			X		X										X		X						X						X	
40969	22/09/2011	France			X		X										X		X								X				X	
38230	20/05/2010	France		X			X				X								X				X									X
39184	09/05/2010	France		X						X					X				X								X					X
37152	19/09/2009	Zambia		X						X							X					X	X					X		X		
37139	28/07/2009	France			X		X									X		X						X							X	
37224	01/06/2009	France			X		X							X					X						X						X	
36192	29/05/2009	France		X				X								X						X				X						X
36176	07/05/2009	France		X			X					X							X				X					X				
35992	27/01/2009	France			X		X									X						X			X							X
35748	17/01/2009	France			X		X									X						X			X						X	
34718	16/06/2008	France			X		X							X				X								X						X
33899	22/11/2007	France		X			X						X						X				X									X
34118	07/11/2007	USA	X						X		X								X				X					X				
32177	03/09/2006	France		X			X							X					X				X					X				
32030	14/07/2006	Lebanon		X	X		X									X					X			X							X	
28097	23/09/2004	China	X							X	X								X							X		X				
28389	17/07/2004	France	X						X		X							X	X				X							X		
27392	21/06/2004	Algeria	X				X									X						X		X				X				
25834	29/10/2003	France			X		X										X					X					X				X	
25653	29/09/2003	Netherlands				X				X	X							X								X		X				

Ref. BARPI	Date	Location	Hazardous event				Product involved				Equipment involved							Cause					Operation / Activity					Consequences				
			Explosion	Fire	Spill of Liquid / Leak	Other	Fuel / Diesel	Oil	Vapour	None / Other	Boiler	Generator	Diesel Group	Canalisation	Electrical Cabinet	Storage	Other / Unknown	Human error	Equipment failure	Natural factor	External factor (tampering)	Other / unknown	Production	Storage	Unloading / Supply	Maintenance	Other /Unknown	Human	Social	Material	Environmental	None
21513	09/12/2001	France	X	X	X			X				X							X				X							X		
20905	08/08/2001	UK	X							X		X										X	X					X				
19283	11/09/2000	France			X		X									X		X						X							X	
18924	10/08/2000	USA	X	X	X		X					X										X	X					X	X			
17544	04/04/2000	USA	X							X		X										X				X		X				
17318	27/12/1999	France			X		X										X			X							X				X	
16836	13/09/1999	Pakistan		X						X		X										X	X						X			
16550	06/08/1999	Saudi Arabia		X						X		X										X	X						X			
15931	25/07/1999	Colombia	X							X		X										X				X		X	X			
15807	09/05/1999	Taiwan	X	X						X		X										X	X						X	X		
15776	09/05/1999	Pakistan	X	X						X							X					X				X			X	X		
14945	17/01/1999	USA	X	X						X							X					X	X						X			
12184	26/12/1997	France			X		X							X					X								X				X	
14085	10/07/1997	France			X		X										X		X				X								X	
11623	28/06/1997	Russia		X						X							X					X	X						X	X		
6641	22/01/1995	Georgia	X							X							X				X		X							X		
3799	18/08/1992	France			X			X								X				X				X							X	
3795	16/08/1992	France		X			X					X							X				X							X		
3901	06/03/1992	France			X					X							X					X					X				X	
6556	10/05/1991	Salvador	X							X							X				X		X							X		
1659	01/01/1990	USA	X							X							X					X	X					X				
1122	14/03/1989	France		X				X				X										X	X								X	
25754	28/11/1984	France	X						X		X											X				X		X				
6052	19/12/1982	Venezuela		X			X									X		X						X				X	X	X		

Figure 9.1 shows the distribution of accidents by type of hazard for those who occurred in France.

Figure 9.1 ***Distribution of Accidents by Type of Hazard***



Consequence Analysis

Table 9.8 shows the consequences per type of accident for each of the 28 events identified in France.

Table 9.8 ***Consequence analysis***

	Fire	Explosions	Leaks	Others
Total number of events	12	3	15	1
• Human consequences	2	2	0	1
• Social consequences	2	0	0	0
• Consequences on the environment	1	0	12	0
• Hazardous materials released	2	1	1	0
• No consequences (other than material)	5	0	2	0

Analysis of this table demonstrates that the vast majority of accidents are caused by fires or oil spills (not burning). However for almost 50% of events, fires do not have human or environmental consequences. The large number of oil leakage events emphasises the importance of controlling ignition sources.

It should be noted that fire is generally caused by generators and transformers, through bursting or surges. However, accidents involving transformers rarely cause significant impacts given the physical separation between transformers on site.

Example scenarios from accidents recorded in the ARIA database are detailed hereinafter.

Example of consequences on the environment (Réf. BARPI n°19283)
A power plant discharged 5 t of heavy fuel oil in a ditch following a handling error. An employee raised the alarm.
Causes: Poor positioning of a manually-operated valve led to a return of heavy fuel oil in one of the two 150 m³ light fuel tanks of the plant. Hydrocarbons boiled over in the retention basin connected with a sump that drains rain to a sludge-oil separator tank with a hay filter. With the sump valve opened, the retention basin did not fulfil its role and the oil spill resulted.
Consequences: the hydrocarbons join at 3 km from the rivers, the pollutants 8km. The operator and private companies specialised installed 6 dams. Oil and waste was recovered for several months. Fuel oil is stored in two trays of 2,900 and 6,500 m³.

Example of human consequences (Réf. BARPI n°42812)
A third party informed about the presence of a fire on two of the four generators of a power plant that supplied an isolated area.
Cause: material disfunctioning
Consequences: Distribution of electricity shut off automatically, impacting upon 750 people. Firefighters extinguished the flames and the plant operator restored power at 5pm. A firefighter and two employees of the plant were hospitalised.

Example of explosion of gaseous phase of a tray followed by a boil-over (Réf. BARPI n°6052)
In a thermal power plant, the overheated gaseous phase (80°C instead of 65°C) in a 40 000 m3 tray filled at 40% of heavy fuel oil (FO – PE = 71°C) explodes.
Cause : ignition by 2 employees during a gauging work
Consequences : the ejected frangible fixed roof falls into the 33 000 m3 basin. After a 6hr fire tray, a boil over occurs. A fire ball rises up to 300 m, a wave of hydrocarbon on fire submerges the merlons (H=6m) and spreads until 400 m on a lower level. It floods the basin of another tray of FO and destroys 60 vehicles located on the only access road, as well as 70 houses and 2/3 of the plant. 160 persons are killed, among which 40 firemen, and 500 other persons are hurt. Total costs of the damages are estimated at 300 MF. The unique access road, narrow and sinuous, goes on a lower level of the basin. It is obstructed with rescue and press vehicles as well as numerous onlookers. The roof fall destroys the aspersion crown of 4'. Forty thousand persons mainly inhabitants from the township are evacuated by the army and relocated in tents.

Example of an explosion at a boiler (Réf. BARPI n°25754)
An explosion occurs on a new boiler in a thermal plant (10 t of steam/h). This auxiliary boiler was aimed to complete the steam supply needed for the heating of the heavy fuel oil of the storages and for the cooling of the burners of unit station 3. This is a home type wave boiler with three smoke revolution generators. Combustion gases are directed to the back of the boiler, then redirected to the front through the lower smoke tubes, before they are redirected to the stack located at the back via the upper tubes. It should be working on a buffer on the network, in parallel to another boiler of a same type (stopped the day of the accident) and with the steam transformers producing bleeder steam from the turbine generators.

Cause : unknown

The accident occurs at the end of the starting tests of the boiler, which was supervised by one technician from the company that built the product and 2 technicians from the boiling room.

Consequences : during the accident, an end of the home tube was separated from the tubular plate, creating a breach on the rear face of the boiler. The water, contained in the boiler, under the action of instantaneous vaporization of the steam contained under pressure (13 bar), escaped through this breach, propelling the boiler ten meters behind. The steam from the boiler went through the handling span, blew into the wall of the mechanical workshop and, by vaporizing partially at atmospheric pressure, occupied a much larger volume, inducing burns to the personnel of the workshop. The explosion resulted in 1 death and 17 injured ; all were located in the mechanical workshop. Although for some calculation codes, boiler characteristics are not acceptable, this one was however compliant with ISO standard and French norm NFE 32.104. Hydrocarbons heavier than water at boiler functioning temperature ware present in the supply water. They deposit in the home tube that would induce vaporization, and thus an elevation of the metal temperature that becomes greater than the maximal guarantee temperature of the concerned metal. There are indeed possibilities of contamination of the steam circuit by fuel oil during its heating: during recovery of steam condensates, it can be admitted in the supply system of the boiler. Real working conditions at the time of the explosion are not known with certainty, the conjunction of the presence of fuel oil in the supply water and limit calculation characteristics made the accident happen.

9.6 *PRELIMINARY RISKS ANALYSIS*

9.6.1 *Measures taken to reduce the risk of injury*

The measures taken to prevent hazards and mitigate their consequences have been defined using the project design, and are also based on pre-identified hazards. In addition to these preventive measures, specific intervention measures will be implemented in case of accident.

A more comprehensive description of the prevention and protection measures will be included in the Internal Operation Plan (IOP), to be performed by the operator before the operational phase of the plant.

Numerous passive safety devices will be installed in the plant, including:

- Vents appropriately sized on the tanks
- Protection against lightning on chimneys and covering the entire area of the plant
- Protection against static charges related to land on each storage tank.

In order to mitigate the risks, in addition to active safety systems the following systems will be installed:

- Liquid Level meters with high and low level alarms on each tank

- A firefighting system with fire and gas detection equipment to minimise the risk of fire and the resulting damage
- Procedures for preventive maintenance and inspection will be implemented.

9.6.2 *Preliminary risk analysis*

Following the preliminary risk analysis, 35 scenarios were initially identified as being high risk, and these have been selected for quantitative analysis and detailing. Analysis includes a map for each scenario, allowing accurate assessment of the severity of each event.

The following scenarios have been studied for each tank:

- Tank fire
- Boil-Over/Thin-Layer Boil-Over
- Fireball following slow pressurisation
- Explosion of gaseous phase
- Retention basin fire (common or individual)

In addition to tank scenarios, the risks of pool fire in case of leakage when unloading trucks and on pipelines was studied in detail.

The 3000 m^3 heavy fuel oil tank is powered by a pipeline managed by the Société Dakaroise d'Entreposage until the level of the retention basin. Only the section of pipeline operated by GTI Dakar is considered in the hazard study.

Table 9.9 presents the list of scenarios studied in the detailed risk analysis of the plant.

Table 9.9 List of the scenarios studied in the detailed risk analysis

Reference Scenario	Effect	Equipment	Location
S01.a	Tank fire	HFO pre-storage	Phase 1 Power Plant
S01.b	Tank fire	HFO storage 1	GTI Power Plant
S01.c	Tank fire	HFO storage 2	GTI Power Plant
S01.d	Tank fire	HFO buffer	Phase 1 Power Plant
S01.e	Tank fire	HFO service	Phase 1 Power Plant
S01.f	Tank fire	LFO storage	GTI Power Plant
S01.g	Tank fire	LFO service	Phase 1 Power Plant
S01.h	Tank fire	HFO Storage	Phase 2 Power Plant
S01.i	Tank fire	HFO buffer	Phase 2 Power Plant
S01.j	Tank fire	HFO service	Phase 2 Power Plant
S01.k	Tank fire	LFO service	Phase 2 Power Plant
S02.a	Boil-over	HFO pre-storage	Phase 1 Power Plant
S02.b	Boil-over	HFO storage 1	GTI Power Plant
S02.c	Boil-over	HFO storage 2	GTI Power Plant
S02.d	Boil-over	HFO buffer	Phase 1 Power Plant
S02.e	Boil-over	HFO service	Phase 1 Power Plant
S02.f	TLBO	LFO storage	GTI Power Plant
S02.g	TLBO	LFO service	Phase 1 Power Plant

Reference Scenario	Effect	Equipment	Location
S02.h	Boil-over	HFO Storage	Phase 2 Power Plant
S02.i	Boil-over	HFO buffer	Phase 2 Power Plant
S02.j	Boil-over	HFO service	Phase 2 Power Plant
S02.k	TLBO	LFO service	Phase 2 Power Plant
S03.a	Fireball following slow pressurisation	HFO pre-storage	Phase 1 Power Plant
S03.b	Fireball following slow pressurisation	HFO storage 1	GTI Power Plant
S03.c	Fireball following slow pressurisation	HFO storage 2	GTI Power Plant
S03.d	Fireball following slow pressurisation	HFO buffer	Phase 1 Power Plant
S03.e	Fireball following slow pressurisation	HFO service	Phase 1 Power Plant
S03.f	Fireball following slow pressurisation	LFO storage	GTI Power Plant
S03.g	Fireball following slow pressurisation	LFO service	Phase 1 Power Plant
S03.h	Fireball following slow pressurisation	HFO Storage	Phase 2 Power Plant
S03.i	Fireball following slow pressurisation	HFO buffer	Phase 2 Power Plant
S03.j	Fireball following slow pressurisation	HFO service	Phase 2 Power Plant
S03.k	Fireball following slow pressurisation	LFO service	Phase 2 Power Plant
S04.a	Explosion of the gaseous phase	HFO pre-storage	Phase 1 Power Plant
S04.b	Explosion of the gaseous phase	HFO storage 1	GTI Power Plant
S04.c	Explosion of the gaseous phase	HFO storage 2	GTI Power Plant
S04.d	Explosion of the gaseous phase	HFO buffer	Phase 1 Power Plant
S04.e	Explosion of the gaseous phase	HFO service	Phase 1 Power Plant
S04.f	Explosion of the gaseous phase	LFO storage	GTI Power Plant
S04.g	Explosion of the gaseous phase	LFO service	Phase 1 Power Plant
S04.h	Explosion of the gaseous phase	HFO Storage	Phase 2 Power Plant
S04.i	Explosion of the gaseous phase	HFO buffer	Phase 2 Power Plant
S04.j	Explosion of the gaseous phase	HFO service	Phase 2 Power Plant
S04.k	Explosion of the gaseous phase	LFO service	Phase 2 Power Plant
S05.a	Retention basin fire	Retention basin of HFO pre-storage	Phase 1 Power Plant
S05.b	Retention basin fire	Retention basin of HFO storage 1	GTI Power Plant
S05.c	Retention basin fire	Retention basin of HFO storage 2	GTI Power Plant

Reference Scenario	Effect	Equipment	Location
S05.d	Retention basin fire	Retention basin of LFO storage	GTI Power Plant
S05.e	Retention basin fire	Retention basin of service tanks	Phase 1 Power Plant
S05.f	Retention basin fire	Retention basin of HFO storage	Phase 2 Power Plant
S05.g	Retention basin fire	Retention basin of service tanks	Phase 2 Power Plant
S06	Pool fire	Unloading area	GTI Power Plant
S07.a	Pool fire	Pipelines	Phase 1 Power Plant
S07.b	Pool fire	Pipelines	Phase 2 Power Plant

9.7 DETAILED RISK ANALYSIS

The hazards associated with the use of fuel oil were modelled to determine their severity, according to the standard forms 'Tank/Retention Basin Fire', 'Boil-Over', 'Thin Layer Boil-Over' and 'Tank Slow Pressurisation' developed by INERIS ([1]) (National Institute for Industrial Environment and Risks), as well as the for 'Tank Internal Explosion' developed by the GTDLI ([2]) (Working Group on Deposits of Flammable Liquids). Only overpressure and thermal effects have been studied.

Considering that the flash point of fuel oil is above 55°C, it was assumed that the amount of steam produced during a rejection would not be sufficient to produce a flammable cloud. For the same reason, it is considered that a leak of heavy fuel oil from a pipeline under pressure would not ignite and produce a flame jet.

Only the effects of a pool fire will be studied in the case of a tank, tanker or pipeline leakage.

Equipment characteristics

Table 9.10 shows the dimensions of the studied tanks.

Table 9.10 Tank characteristics

Tank	Location	Number	Available volume (m^3)	Height (m)	Diameter (m)
HFO pre-storage	Phase 1 Power Plant	1	3, 000	12.6	18
HFO storage	GTI Power Plant	2	1 450	11.4	13.5
HFO buffer	Phase 1 Power Plant	1	50	3.6	4.5
HFO service	Phase 1 Power Plant	1	100	7.2	4.5
LFO storage	GTI Power	1	120	4.7	6
LFO service	Plant Phase 1 Power Plant	1	100	7.2	4.5
HFO storage	Phase 2 Power Plant	1	2,000	12.5	14.3

(1) INERIS is a French public institution whose mission is to contribute to the risk prevention caused by the economic activities to the health and safety of persons and property, and the environment (http: //www.ineris .com /)

(2) The GTDLI is an industry working group set up by the Ministry of Environment in France to develop specific tools for the flammable liquids sector.

Tank	Location	Number	Available volume (m^3)	Height (m)	Diameter (m)
HFO buffer	Phase 2 Power Plant	1	35	5.3	2.9
HFO service	Phase 2 Power Plant	1	80	5.7	4.2
LFO service	Phase 2 Power Plant	1	80	5.7	4.2

Table 9.11 presents the dimensions of the retention basins and the unloading area.

Table 9.11 Dimensions of the retention basins and loading area

Retention basins	Location	Number	Width (m)	Length (m)
HFO pre-storage	Phase 1 Power Plant	1	36	38
HFO storage	GTI Power Plant	2	22	22
LFO storage	GTI Power Plant	1	9	9
Service tank	Phase 1 Power Plant	1	16	32
Loading area	GTI Power Plant	1	8	19
HFO storage *	Phase 2 Power Plant	1	37	24
Service tank	Phase 2 Power Plant	1	25	11

* The HFO storage retention basin in Phase 2 power plant is not rectangular, biggest two distances are given in the table above

Hazards Modelling

The effect distances were calculated based on thresholds relating to human life as shown in the Senegalese methodological guidelines for hazard studies. Threshold values are provided in *Table 9.12*.

Table 9.12 Threshold values for human life

Threshold	Heat level		Overpressure level (mbar)
	Radiation (kW/m^2)	Thermal dose ($(kW/m^2)^{4/3}.s$)	
Irreversible effects threshold SEL	3	600	50
Lethal effects threshold SEL	5	1000	140
Threshold of very significant lethal effects SELS	10	2600	350

The table shows two thermal levels, dependent on the exposure period and/or the duration of the hazardous event:

- Radiation for more than two minutes of exposure period, for example a pool fire
- Thermal dose for an exposure period of less than two minutes, for example a fireball or a tank boil-over.

Modelling results

Effect distances calculated with GTDLI and INERIS models are provided for the following:

- 1.5 m of target height
- From the centre of the tank for storage tank scenarios
- From the edge of the retention basins for retention basin and unloading area fires
- From the discharge point for pipelines.

Table 9.13 presents the modelling results and the initial probability and severity of the risks (without taking account the eventual risk measures in place). The hazard contours for each scenario are provided in *Annex 10* .

Annex 11 shows the cause-consequence trees for each scenario studied.

Table 9.13 Modelling results of the hazardous events

Reference Scenario	Hazardous event	Location	Equipment	Distance to thresholds (m)			Initial Probability	Initial Severity
				SEI	SEL	SELS		
S01.a	Tank fire	Phase 1	HFO pre-storage	35	0	0	2	3
S01.b	Tank fire	GTI	HFO storage 1	30	20	0	2	3
S01.c	Tank fire	GTI	HFO storage 2	30	20	0	2	3
S01.d	Tank fire	Phase 1	HFO buffer	15	15	10	2	3
S01.e	Tank fire	Phase 1	HFO service	15	15	0	2	3
S01.f	Tank fire	Phase 1	LFO storage	20	15	0	2	3
S01.g	Tank fire	Phase 1	LFO service	15	15	0	2	3
S01.h	Tank fire	Phase 2	HFO storage	25	0	0	2	3
S01.i	Tank fire	Phase 2	HFO buffer	15	10	5	2	3
S01.j	Tank fire	Phase 2	HFO service	15	15	10	2	3
S01.k	Tank fire	Phase 2	LFO service	15	15	10	2	3
S02.a	Boil-over	Phase 1	HFO pre-storage	155	115	0	2	4
S02.b	Boil-over	GTI	HFO storage 1	100	70	0	2	4
S02.c	Boil-over	GTI	HFO storage 2	100	70	0	2	4
S02.d	Boil-over	Phase 1	HFO buffer	0	0	0	2	4
S02.e	Boil-over	Phase 1	HFO service	0	0	0	2	4
S02.f	TLBO	Phase 1	LFO storage	15	10	0	2	4
S02.g	TLBO	Phase 1	LFO service	10	10	0	2	4
S02.h	Boil-over	Phase 2	HFO storage	120	85	0	2	4
S02.i	Boil-over	Phase 2	HFO buffer	0	0	0	2	4
S02.j	Boil-over	Phase 2	HFO service	0	0	0	2	4
S02.k	TLBO	Phase 2	LFO service	15	15	0	2	4
S03.a	Fireball following slow pressurisation	Phase 1	HFO pre-storage	90	75	40	2	4
S03.b	Fireball following slow pressurisation	GTI	HFO storage 1	70	55	30	2	4
S03.c	Fireball following slow pressurisation	GTI	HFO storage 2	70	55	30	2	4

Reference Scenario	Hazardous event	Location	Equipment	Distance to thresholds (m)			Initial Probability	Initial Severity
				SEI	SEL	SELS		
S03.d	Fireball following slow pressurisation	Phase 1	HFO buffer	25	20	5	2	4
S03.e	Fireball following slow pressurisation	Phase 1	HFO service	25	20	10	2	4
S03.f	Fireball following slow pressurisation	Phase 1	LFO storage	35	25	10	2	4
S03.g	Fireball following slow pressurisation	Phase 1	LFO service	25	20	10	2	4
S03.h	Fireball following slow pressurisation	Phase 2	HFO storage	75	60	35	2	4
S03.i	Fireball following slow pressurisation	Phase 2	HFO buffer	15	10	5	2	4
S03.j	Fireball following slow pressurisation	Phase 2	HFO service	25	20	5	2	4
S03.k	Fireball following slow pressurisation	Phase 2	LFO service	25	20	5	2	4
S04.a	Explosion of gaseous phase	Phase 1	HFO pre-storage	80	40	25	2	5
S04.b	Explosion of gaseous phase	GTI	HFO storage 1	65	30	20	2	5
S04.c	Explosion of gaseous phase	GTI	HFO storage 2	65	30	20	2	5
S04.d	Explosion of gaseous phase	Phase 1	HFO buffer	25	10	10	2	5
S04.e	Explosion of gaseous phase	Phase 1	HFO service	35	15	10	2	5
S04.f	Explosion of gaseous phase	Phase 1	LFO storage	45	20	10	2	5
S04.g	Explosion of gaseous phase	Phase 1	LFO service	35	15	10	2	5
S04.h	Explosion of gaseous phase	Phase 2	HFO storage	70	35	20	2	5
S04.i	Explosion of gaseous phase	Phase 2	HFO buffer	25	10	5	2	5
S04.j	Explosion of gaseous phase	Phase 2	HFO service	30	15	10	2	5
S04.k	Explosion of gaseous phase	Phase 2	LFO service	30	15	10	2	5
S05.a	Retention basin fire	Phase 1	Retention basin of HFO pre-storage	50	40	20	2	3
S05.b	Retention basin fire	GTI	Retention basin of HFO storage 1	40	30	20	2	3
S05.c	Retention basin fire	GTI	Retention basin of HFO storage 2	40	30	20	2	3
S05.d	Retention basin fire	GTI	Retention basin of LFO storage	25	20	15	2	3
S05.e	Retention basin fire	Phase 1	Retention basin of service tanks	45	35	20	2	3
S05.f	Retention basin fire	Phase 2	Retention basin of HFO storage	45	35	30	2	3
S05.g	Retention basin fire	Phase 2	Retention basin of service tanks	40	30	25	2	3
S06	Pool fire	GTI	Unloading area	35	30	20	4	2
S07.a	Pool fire	Phase 1	Pipelines	30	25	20	3	2
S07.b	Pool Fire	Phase 2	Pipelines	30	25	20	3	2

9.7.1 *Detailed analysis of scenario 1 – Tank fire*

Description

A tank fire can occur following a lightning strike on the relevant tank. This causes the collapse of the tank roof and the ignition of its content. Fire can also occur, for example, during maintenance work on the roof.

In the initial stages of a fire, the tank walls are cooled by the liquid that is still cold. As the fire advances, this liquid is consumed, reducing levels in the tank and increasing the contact surface between the flames and bare metal walls. If the walls are not cooled from the outside, the steel will lose its structural properties and weaken after a few minutes of direct contact, causing the rupture of the tank and the spill of its contents into the retention basin.

Severity and Probability

The distances to the thermal radiations of interest have been calculated with the tool developed by the GTDLI and are presented in *Table 9.13*.

No hazardous effects are expected outside the boundaries of the site. Since the distances to hazardous thermal radiations remain in the surroundings of the tanks, the impact on staff will be minor. The severity of tank fire scenarios is primarily related to structural damage to the relevant tank. Severity is considered as Level 3 - *Important*.

The probability level is determined to be 1 - *Unlikely*, considering that the site has lightning protection systems and that for tank maintenance work, certain procedures have been developed (draining the tank before work, insulating the tank in case heat sources are used, permit to work etc.).

The level of tank fire risk is therefore considered to be *Acceptable*.

9.7.2 *Detailed analysis of Scenario 2 – Boil-over*

Description

A Boil-Over is a large-scale event involving a tank or bund fire and causing the evaporation of the water layer at the bottom of the tank or mixed with the fuel. It can be caused by:

- Tank fire resulting in a temperature rise inside the tank
- Retention basin fire containing the tank and evaporation of a water bottom after a long-term thermal exchange through radiation and conduction between the fire and the tank
- The combination of these two effects

Three conditions must be met in order for a boil-over to occur:

- The presence of water (in the bottom of the tank) to be transformed into steam

- The formation of a heat wave that enters into contact with the water bottom located under the hydrocarbons layer

- A sufficiently viscous hydrocarbon so as to prevent the steam from easily passing through from the bottom.

A boil-over can also occur on a tank containing a less viscous liquid. The event is called Thin Layer Boil-Over (TLBO) because the amount of hydrocarbons involved is lower than in a conventional boil-over. Effect distances will be less important.

Severity and Probability

The distances to thermal radiations of interest have been calculated with the method developed by INERIS within the OMEGA 13 document and are presented in *Table 9.13*.

Since this event occurs following a tank fire or bund fire and its kinetic is relatively slow (tank subject to a constant thermal radiation for a few hours), it may occur only if the fire has not been detected and extinguished and if the tank in question were not cooled down by fire water. Its probability is therefore 1 - *Unlikely*.

For the same reasons, site personnel and external population would have been evacuated from dangerous areas before a boil-over occurred. However, such an accident could cause severe damage to facilities and result in an operating loss of the plant. Severity is therefore 4 - *Critical*.

The risk level is therefore *Important*. In order to limit the probability of occurrence of such an event, it is advisable to act on the presence of water in the bottom of the tank, by proper tank design and regular draining of accumulated water.

9.7.3 Detailed analysis of Scenario 3 – Pressurisation and fireball

Description

Tank pressurisation occurs when a tank is exposed to a fire. The risk in this scenario is that the product contained evaporates faster than it is emitted from the vents, which causes an increase in the tank pressure and its eventual breakdown. The result is the transformation of a large amount of liquid product into a fireball when this breakdown occurs. The consequences of this are a short and intense thermal flux received by the receptors during the combustion of the fireball. The pressure wave resulting from the event remains limited.

Severity and Probability

Effect distances were calculated according to the model developed by the UFIP and are presented in *Table 9.13*. Hazardous thermal radiations due to fireball could exceed site boundaries, however, it is considered very unlikely that there would be irreversible/lethal effects to people external to the facility.

The tank pressurisation occurs if the tank is exposed to thermal radiations, if the vents are not able to reduce the pressure fast enough and if the fire cannot be controlled by internal or external methods. Therefore the likelihood of occurrence is 1 - *Unlikely*.

Due to the very low kinetic of this scenario (tank subject to a constant flow of heat for several hours), the site personnel and potential external population would have been evacuated from hazardous areas before the fireball occurred. However, such an accident could result in asset damage and operating loss of the plant. Severity is therefore *4 - Critical*.

The risk level is *Important*. It should be noted that this hazard only occurs if the tank is exposed to thermal radiations. Any action undertaken to limit the fire, and in particular, its duration (e.g. drainage of the retention basin, fire suppression) will reduce the probability of pressurisation. Furthermore, cooling the tank during the fire will limit the temperature and the pressure rise in the tank.

It can be noticed that this scenario cannot occur if the vents of the tanks are designed for this scenario (API2000 standard or equivalent).

9.7.4 *Detailed analysis of scenario 4 – Gaseous phase explosion*

Description

Tank gaseous phase explosion can be caused by maintenance work on the tank (hot point work or spark generation) or by a lightning, leading to the ignition of the gas inside the tank.

Tanks bursting can be divided into several successive or simultaneous phases:

- Chemical reaction of internal combustion
- Tank breakdown including wall destruction
- Projectiles emission
- Pressure wave propagation in the environment
- Internal (conduction with the wall) and external (radiation, convection) heat exchanges.

If the storage tank contains air, the vapour pressure can be sufficient for the air/steam mixture, or at least a percentage of the gaseous phase, to be within flammability limits.

Once this scenario occurs, a number of potential sources of ignition enable the mixture to be set alight, including:

- Electrostatic spark, mechanical or electrical (the temperature of the vapour mixture is above the flash point)

- Hot source (above the auto-ignition temperature of the vapour mixture) such as tank wall heated in a fire, hot point works.

The internal explosion can result in an overpressure wave and the production of missiles. For the modelling the following can be considered:

- The pressure inside the tank increases in an uniform manner throughout the space

- Pressure effects generated in the external environment after containment breakdown are no longer influenced by the combustion.

Consequently, we can consider that the explosion parameters are exclusively determined by the bursting pressure of the tank walls and the characteristics of the compressed vapours.

Bursting
The occurrence of an explosion in an enclosure containing hydrocarbon vapours causes severe internal overpressure. No vertical fixed roof storage tank can contain and control such a variation. The internal pressure of the tank then increases and causes tank breakdown.

It must be ensured that tanks are constructed according to the standards of CODRES (French construction code for vertical cylindrical steel tanks) or equivalent. In this way, they are frangible, that is to say that the junction shell/roof is weaker than the shell/bottom junction. Therefore, as a result of an accidental internal overpressure, the tank breaks at the shell/roof assembly and not at the shell/bottom. Such a rupture decreases the consequences of a sharp and sudden increase in the internal pressure.

A static calculation shows that the energy absorbed by the destruction of the wall represents a minor percentage (about 1%) of the chemical energy initially present, considering that the mixture is at its stoichiometric proportions with air. The tank roof will then tear and the roof will be expelled like a missile, absorbing 60% of the residual energy.

Aerial shockwave propagation

As discussed in the previous paragraph, an important part of the chemical energy initially present is absorbed. Only a percentage of this energy is available for the propagation of the pressure wave in the environment. There is therefore a volume (equal to the volume of the tank) of flue gas under pressure (equal to the static burst pressure of the reservoir), creating an overpressure wave which propagates in the air.

<u>Heat exchanges</u>
Heat exchanges, both internal and external, are also responsible for the loss of original chemical energy. These are difficult to estimate (it can be assumed about 5% of the initial energy).

If the tank contains liquid at the time the gaseous explosion occurs, the content will be discharged into the retention basin and burn as a retention basin fire.

Severity and probability

Overpressure effect distances were calculated according to the model developed by the GTDLI and are presented in *Table 9.13*.

The explosion causes are related to exceptional events (maintenance, lightning etc.). The probability is therefore 1 - *Unlikely*.

If an explosion does occur, the effects would be severe for staff on site but also for surrounding tanks and equipment. This could result in fatalities, significant asset damage and operating loss. The severity level is therefore 5 - *Catastrophic*.

As a result, the risk level is *Important*. The probability of occurrence of this event is mitigated by reducing the probability of ignition (using grounding equipment, lightning protection, procedures and maintenance works etc.) and by reducing the likelihood of the concentration to reach the hydrocarbon LEL (ventilation of the gaseous phase).

9.7.5 Detailed analysis of Scenario 5 – Retention basin fire

Description

For the retention basin fire, consideration is given to the loss of containment of a tank (pipelines leakage, tapping breakdown, tank breakdown) by external aggression or corrosion, or the overflow that a spreading liquid pool will generate. In the case of the HFO pre-storage tank, a supply pipeline leak may also generate a hydrocarbons pool in the retention basin.

Ignition of the surface vapours causes the ignition of the liquid pool, which can cause a retention basin fire. This event can also result from a leak in a portion of the transfer pipeline located in the retention basin.

In order to reduce the risk of spillages, the retention basin shall be designed to have sufficient capacity to contain the maximum tank storage volume. Otherwise, the fire can spread outside the area and cause damage to other plant equipment. It should also be ensured that tank dikes are resistant enough to absorb the shockwave caused by a complete tank breakdown.

There are seven retention basins on site:

GTI Power Plant:
- Retention basins of the two HFO storage tanks (32m x 15.7m)
- Retention basin of the LFO storage tank (9m x 9m)

Phase 1 Power Plant
- Retention basin of the HFO pre-storage tank (36m x 38m)
- Retention basin of the eight service tanks (14.7m x 32m)

Phase 2 Power Plant
- Retention basin of the HFO storage tank (non-rectangular)
- Retention basin of the 4 service tanks (10.5m x 24.5m)

Severity and probability

Distances to the thermal radiations of interest have been calculated using the tool developed by the GTDLI and are presented in *Table 9.13*.

All retention basin fires have effects with various levels of importance outside the area. However, the hydrocarbons pool remains contained on the retention basin. It is therefore very unlikely that staff members will be injured by this event. The severity level is mainly related to structural damages and operating losses, and is considered as 3 - *Important*.

A leak may occur on a tank, tapping or portion of pipeline, but the probability of ignition of HFO remains very low. Frequency level is estimated as 1 - *Improbable*.

The risk level is *Acceptable*.

9.7.6 Detailed analysis of Scenario 6 – Unloading area fire

Description

A loss of containment can occur when unloading a tanker. Three types of losses of containment are considered:

- A tanker leak
- Leak in the unloading arms and related equipment
- Leak on lines towards the storage tanks.

Hydrocarbons spreading will remain limited to the size of the unloading area (8 m x 19 m).

Severity and Probability

Distances to the thermal radiations of interest have been calculated using the tool developed by the GTDLI and are presented in *Table 9.13*.

A leak during tanker unloading is considered common, but generally the procedures in place limit the amount of hydrocarbons released and the probability of ignition of the fluid. The frequency level of this scenario is considered as 3 - *Occasional*.

In case of fire at the loading area, staff and/or tanker drivers may not have time to evacuate the area. Some may suffer burns that require care. The severity of this scenario is 2 - *Minor*.

The risk level is therefore *Important*. However, it should be noted that the probability of ignition of the hydrocarbons discharged is relatively low. In addition, risk is further reduced due to the implementation of preventive measures (i.e. absence of hot spots near the loading area and equipment earthing).

9.7.7 Detailed analysis of Scenario 7 – Pool fire

Description

For pool scenarios, the loss of containment by external aggression or corrosion of hydrocarbons-transfer pipelines is considered. Ignition of the surface vapours can lead to a pool fire. As a consequence of the fire, the size of the pool will quickly reach a balance between the supply and the combustion. The following assumptions were considered:

- Maximum flow Q in pipelines: 20 m^3/h – around 4.5 kg/s
- Surface flow q of heavy fuel oil combustion: 0.0225 $kg/m^2/s$

The diameter D of the pool is calculated so that the combustion rate Q equals the maximum feed flow of the pool. This balance is translated into the following relationship:

$$\frac{\pi . D^2}{4} = \frac{Q}{q}$$

Then

$$D = \sqrt{\frac{4. Q}{\pi . q}}$$

The diameter of the pool fire in balance is 16 m. Effect distances of a 16 m diameter circular pool fire were reported throughout the pipelines outside the retention basins.

Severity and probability

Distances to the thermal radiations of interest have been calculated using the tool developed by the GTDLI and are presented in *Table 9.13*.

A hydrocarbon leak in this type of pipeline and the ignition of the pool is very unlikely on such a site. The probability level is therefore considered as 2 – *Unusual* – this event is not common but still possible in the facility.

The severity level depends on the capacity to control the leak. In this case, the severity of this scenario is estimated to be 2 - *Minor* because this type of leakage is easily detectable and mitigated by stopping the pumps.

The risk level is therefore considered *Acceptable*.

9.7.8 Summary of technological risks

Table 9.14 summarises the risks in terms of likelihood and severity. The risk quantification takes into account the preventive and protective measures identified for each scenario. The kinetic of the scenario (hazard occurrence rate) is also provided.

Table 9.14 Summary of the risk assessment

Reference Scenario	Hazard	Location	Equipment	Kinetic	Distance to thresholds (m)			Final Probability	Final Severity
					SEI	SEL	SELS		
S01.a	Tank fire	Phase 1	HFO pre-storage	Fast	35	0	0	1	3
S01.b	Tank fire	GTI	HFO storage 1	Fast	30	20	0	1	3
S01.c	Tank fire	GTI	HFO storage 2	Fast	30	20	0	1	3
S01.d	Tank fire	Phase 1	HFO buffer	Fast	15	15	10	1	3
S01.e	Tank fire	Phase 1	HFO service	Fast	15	15	0	1	3
S01.f	Tank fire	Phase 1	LFO storage	Fast	20	15	0	1	3
S01.g	Tank fire	Phase 1	LFO service	Fast	15	15	0	1	3
S01.h	Tank fire	Phase 2	HFO Storage	Fast	25	0	0	1	3
S01.i	Tank fire	Phase 2	HFO Buffer	Fast	15	10	5	1	3
S01.j	Tank fire	Phase 2	HFO Service	Fast	15	15	10	1	3
S01.k	Tank fire	Phase 2	LFO Service	Fast	15	15	10	1	3
S02.a	Boil-over	Phase 1	HFO pre-storage	Slow	155	115	0	1	4
S02.b	Boil-over	GTI	HFO storage 1	Slow	100	70	0	1	4
S02.c	Boil-over	GTI	HFO storage 2	Slow	100	70	0	1	4

Reference Scenario	Hazard	Location	Equipment	Kinetic	Distance to thresholds (m)			Final Probability	Final Severity
					SEI	SEL	SELS		
S02.d	Boil-over	Phase 1	HFO buffer	Slow	0	0	0	1	4
S02.e	Boil-over	Phase 1	HFO service	Slow	0	0	0	1	4
S02.f	TLBO	Phase 1	LFO storage	Slow	15	10	0	1	4
S02.g	TLBO	Phase 1	LFO service	Slow	10	10	0	1	4
S02.h	Boil-over	Phase 2	HFO Storage	Slow	120	85	0	1	4
S02.i	Boil-over	Phase 2	HFO Buffer	Slow	0	0	0	1	4
S02.j	Boil-over	Phase 2	HFO Service	Slow	0	0	0	1	4
S02.k	TLBO	Phase 2	LFO Service	Slow	15	15	0	1	4
S03.a	Fireball following slow pressurisation	Phase 1	HFO pre-storage	Slow	90	75	40	1	4
S03.b	Fireball following slow pressurisation	GTI	HFO storage 1	Slow	70	55	30	1	4
S03.c	Fireball following slow pressurisation	GTI	HFO storage 2	Slow	70	55	30	1	4
S03.d	Fireball following slow pressurisation	Phase 1	HFO buffer	Slow	25	20	5	1	4
S03.e	Fireball following slow pressurisation	Phase 1	HFO service	Slow	25	20	10	1	4
S03.f	Fireball following slow pressurisation	Phase 1	LFO storage	Slow	35	25	10	1	4
S03.g	Fireball following slow pressurisation	Phase 1	LFO service	Slow	25	20	10	1	4
S03.h	Fireball following slow pressurisation	Phase 2	HFO Storage	Slow	75	60	35	1	4
S03.i	Fireball following slow pressurisation	Phase 2	HFO Buffer	Slow	15	10	5	1	4
S03.j	Fireball following slow pressurisation	Phase 2	HFO Service	Slow	25	20	5	1	4
S03.k	Fireball following slow pressurisation	Phase 2	LFO Service	Slow	25	20	5	1	4
S04.a	Explosion of gaseous phase	Phase 1	HFO pre-storage	Very fast	80	40	25	1	5
S04.b	Explosion of gaseous phase	GTI	HFO storage 1	Very fast	65	30	20	1	5
S04.c	Explosion of gaseous phase	GTI	HFO storage 2	Very fast	65	30	20	1	5
S04.d	Explosion of gaseous phase	Phase 1	HFO buffer	Very fast	25	10	10	1	5
S04.e	Explosion of gaseous phase	Phase 1	HFO service	Very fast	35	15	10	1	5
S04.f	Explosion of gaseous phase	Phase 1	LFO storage	Very fast	45	20	10	1	5
S04.g	Explosion of gaseous phase	Phase 1	LFO service	Very fast	35	15	10	1	5
S04.h	Explosion of gaseous phase	Phase 2	HFO Storage	Very fast	70	35	20	1	5
S04.i	Explosion of gaseous phase	Phase 2	HFO Buffer	Very fast	25	10	5	1	5
S04.j	Explosion of gaseous phase	Phase 2	HFO Service	Very fast	30	15	10	1	5
S04.k	Explosion of gaseous phase	Phase 2	LFO Service	Very fast	30	15	10	1	5

Reference Scenario	Hazard	Location	Equipment	Kinetic	Distance to thresholds (m)			Final Probability	Final Severity
					SEI	SEL	SELS		
S05.a	Retention basin fire	Phase 1	HFO pre-storage	Fast	50	40	20	1	3
S05.b	Retention basin fire	GTI	HFO storage 1	Fast	40	30	20	1	3
S05.c	Retention basin fire	GTI	HFO storage 2	Fast	40	30	20	1	3
S05.d	Retention basin fire	GTI	LFO storage	Fast	25	20	15	1	3
S05.e	Retention basin fire	Phase 1	Service tanks	Fast	45	35	20	1	3
S05.f	Retention basin fire	Phase 2	HFO Storage	Fast	45	35	30	1	3
S05.g	Retention basin fire	Phase 2	Service Tanks	Fast	40	30	25	1	3
S06	Pool fire	GTI	Unloading area	Fast	35	30	20	3	2
S07.a	Pool fire	Phase 1	Pipelines	Fast	30	25	20	2	2
S07.b	Pool fire	Phase 2	Pipelines	Fast	30	35	20	2	2

Table 9.15 shows the risk classification within the matrix presented in Section above.

Table 9.15 Risk Classification in the DEEC Matrix

RISK LEVEL		Consequences				
		5	**4**	**3**	**2**	**1**
Probability	**5**					
	4					
	3				S06	
	2				S07	
	1	S04	S02 & S03	S01 & S05		

9.8 DOMINO EFFECTS ANALYSIS

The domino effects of a scenario can cause, by their proximity, other hazardous events and an increase in the severity of the initial event.

When the hazard is an explosion or a long-term thermal radiation, there is a risk of domino effects.

Domino effect threshold values are provided in *Table 9.16*.

Table 9.16 Thresholds of domino effects

Threshold	Thermal level (kW/m²)	Overpressure level (mbar)
Threshold of the domino effects	8	200

Modelling results of the domino effect thresholds are provided in *Table 9.17*.

Table 9.17 Distance to domino effect thresholds and potential domino effects

Scenario Reference	Hazard	Location	Equipment	Distance to thresholds of the domino effect (m)	Potential domino effect
S01.a	Tank fire	Phase 1	HFO pre-storage	N/A	-
S01.b	Tank fire	GTI	HFO storage 1	N/A	-
S01.c	Tank fire	GTI	HFO storage 2	N/A	-
S01.d	Tank fire	Phase 1	HFO buffer	10	S02.e, S02.g, S03.e, S03.g
S01.e	Tank fire	Phase 1	HFO service	N/A	-
S01.f	Tank fire	GTI	LFO storage	N/A	-
S01.g	Tank fire	Phase 1	LFO service	N/A	-
S01.h	Tank fire	Phase 2	HFO Storage	N/A	
S01.i	Tank fire	Phase 2	HFO buffer	5	S02.j, S02.k, S03.j, S03.k
S01.j	Tank fire	Phase 2	HFO service	10	S02.i, S02.k, S03.i, S03.k
S01.k	Tank fire	Phase 2	LFO service	10	S02.i, S02.j, S03.i, S03.j
S04.a	Explosion of gaseous phase	Phase 1	HFO pre-storage	25	Service tanks rupture
S04.b	Explosion of gaseous phase	GTI	HFO storage 1	20	HFO storage 2 tanks and LFO storage tanks rupture
S04.c	Explosion of gaseous phase	GTI	HFO storage 2	20	HFO Storage 1 tank rupture
S04.d	Explosion of gaseous phase	Phase 1	HFO buffer	10	Service tank rupture
S04.e	Explosion of gaseous phase	Phase 1	HFO service	10	Service tanks rupture
S04.f	Explosion of gaseous phase	GTI	LFO storage	10	HFO Storage 1 tank rupture
S04.g	Explosion of gaseous phase	Phase 1	LFO service	10	Service tanks rupture
S04.h	Explosion of gaseous phase	Phase 2	HFO Storage	25	Service tanks rupture
S04.i	Explosion of gaseous phase	Phase 2	HFO buffer	10	Service tanks rupture
S04.j	Explosion of gaseous phase	Phase 2	HFO service	10	Service tanks rupture
S04.k	Explosion of gaseous phase	Phase 2	LFO service	10	Service tanks rupture
S05.a	Retention basin fire	Phase 1	Retention basin of HFO pre-storage	20	S02.a, S02.d, S02.e, S03.a, S03.d, S03.e
S05.b	Retention basin fire	GTI	Retention basin of HFO storage 1	20	S02.c, S02.f, S03.c, S03.f
S05.c	Retention basin fire	GTI	Retention basin of HFO storage 2	20	S02.b, S03.b
S05.d	Retention basin fire	GTI	Retention basin of LFO storage	15	S02.b, S03.b

Scenario Reference	Hazard	Location	Equipment	Distance to thresholds of the domino effect (m)	Potential domino effect
S05.e	Retention basin fire	Phase 1	Retention basin of service tanks	20	S02.d, S02.e, S02.g, S03.d, S03.e, S03.g
S05.f	Retention basin fire	Phase 2	Retention basin of HFO storage	25	S02.h, S02.i, S02.j, S02.k, S03.h, S03.i, S03.j, S03.k
S05.g	Retention basin fire	Phase 2	Retention basin of service tanks	30	S02.h, S02.i, S02.j, S02.k, S03.h, S03.i, S03.j, S03.k
S06	Pool fire	GTI	Unloading area	20	-
S07.a	Pool fire	Phase 1	Pipelines	20	S02.a, S02.c, S02.d, S02.e, S02.g, S03.a, S03.c, S03.d, S03.e, S03.g
S07.b	Pool fire	Phase 2	Pipelines	20	S02.a, S02.c, S02.d, S02.e, S02.g, S02.h, S02.i, S02.j, S02.k, S03.a, S03.c, S03.d, S03.e, S03.g, S03.h, S03.i, S03.j, S03.k

N/A : Thermal radiation or overpressure required for potential escalation not reached
- : No sensitive equipment within the domino effect area

In order to reduce the escalation potential, safety distances between areas of hydrocarbon storage and areas of electricity generation will be implemented as well as protective measures (sprinklers, fire walls, etc.).

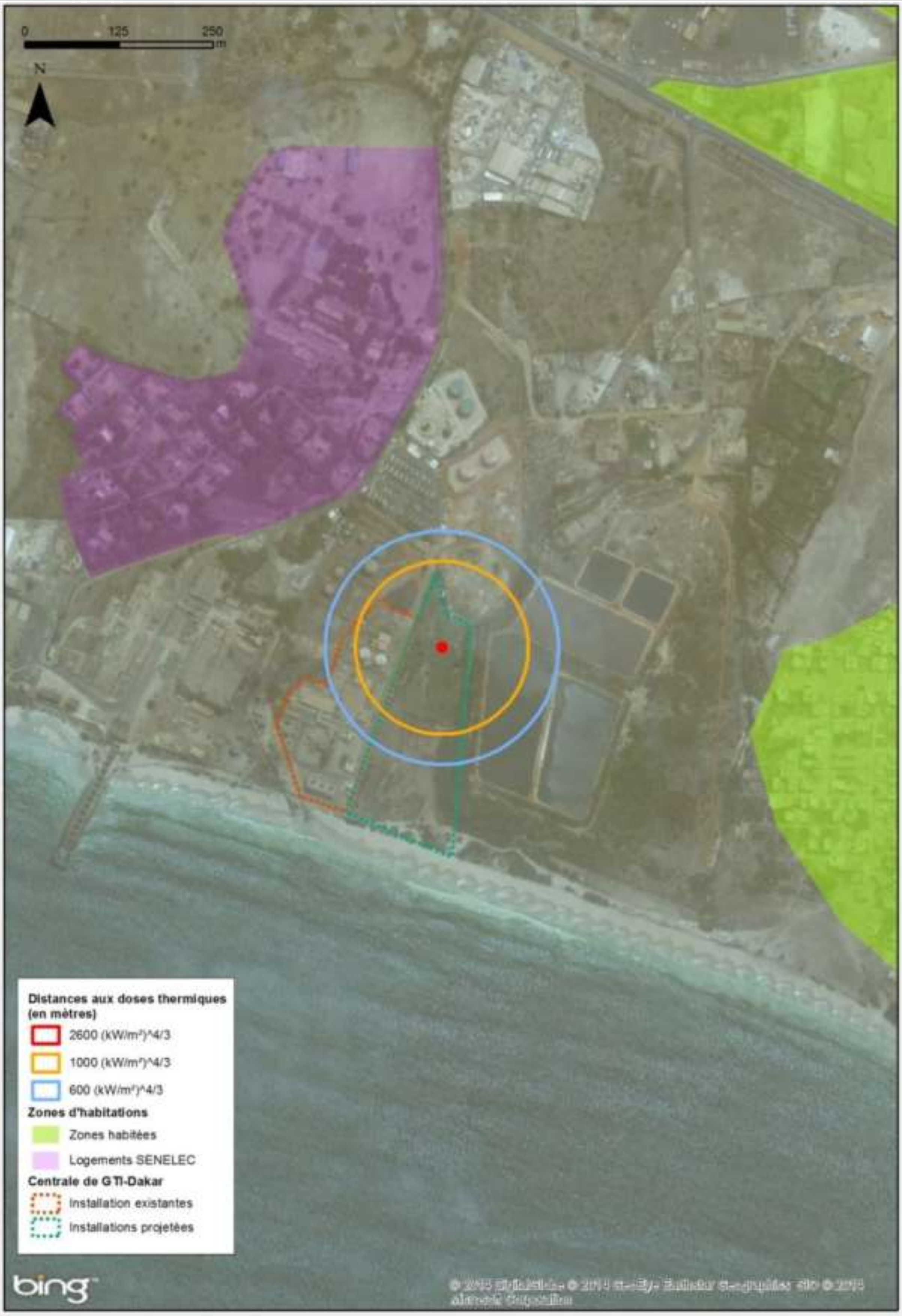
Regarding scenarios S07.a and S07.b, the leak can occur anywhere on the piping and the consequences (if ignition) would be localised, all potential domino effects indicated in the table above would not occur at the same time.

Worst case scenario

Considering the location of the equipment taken into account in the domino effect analysis, the worst case scenario is the worsening of the consequences of a retention basin (S06.a) or tank fire (S01.a) on the 3000 m^3 HFO tank, by domino effect. If fire is not controlled, a boil-over (Scenario S02.a) may occur in this tank. This scenario has the major effect distance of 115 m for the first lethal effects and 155 m for irreversible effects.

Figure 9.2 below presents the effect distances.

Figure 9.2 Hazard contour of boil over scenario



According to *Figure 9.2*, hazard contour of the upper bound scenario does not reach the closest inhabited areas from the site. SENELEC residences (North West from the facility) are located at 82m from the hazard contour relating to « 600 kW/m² » and the residential area of Diokoul (East from the facility) is located at 270 m from this hazard contour. These distances represent additional safety buffer zones in case of the main hazardous scenario identified would occur. In this case no inhabited areas would be affected.

9.9 TAKING INTO ACCOUNT NEIGHBOURING HAZARDS

This assessment identified and took into account the following neighbouring hazards around the project area:

- SENELEC power plants CIII and CIV, as well as associated hydrocarbons storage facilities; and
- *Société Dakaroise d'Entreposage's* facilities, solely dedicated to hydrocarbons storage.

These neighbouring hazards shall be taken into account in the emergency planning (POI).

9.9.1 SENELEC

The 'étude de dangers' of SENELEC power plants CIII and CIV (Quartz Afrique, 2009) identifies 12 major scenarios:

- Scenario 1.1.b): BOIL-OVER of Heavy Fuel storage tank (2002) following an uncontrolled tank fire;
- Scenario 1.2: Vapour phase explosion on fixed-roof storage tank (1001) due to internal overpressure;
- Scenario 1.5: Pool fire at the C3 road tankers temporary unloading area C3 following a major diesel oil release;
- Scenario 2.2.a): Vapour phase explosion on 90 m3 diesel oil fixed-roof storage tank due to internal overpressure;
- Scenario 4.1: Explosion inside combustion zone on boiler 302 or 303 as a result of unburnt combustible (heavy fuel) presence
- Scenario 4.3: BLEVE on boiler 302 or 303 water drum due to sudden water vaporisation;
- Scenario 5.2: Electric transformer explosion following a short-circuit;
- Scenario 7.1.a): Retention area fire following loss of containment on diesel oil storage tank 1002;
- Scenario 7.1.b): BOIL-OVER on heavy fuel storage tank (1003 or 1004) following an uncontrolled tank fire;
- Scenario 7.2: Vapour phase explosion on fixed-roof storage tank (1002) due to internal overpressure; and
- Scenario 7.5: Pool fire at the C3 road tankers temporary unloading area C3 following a major diesel oil release.

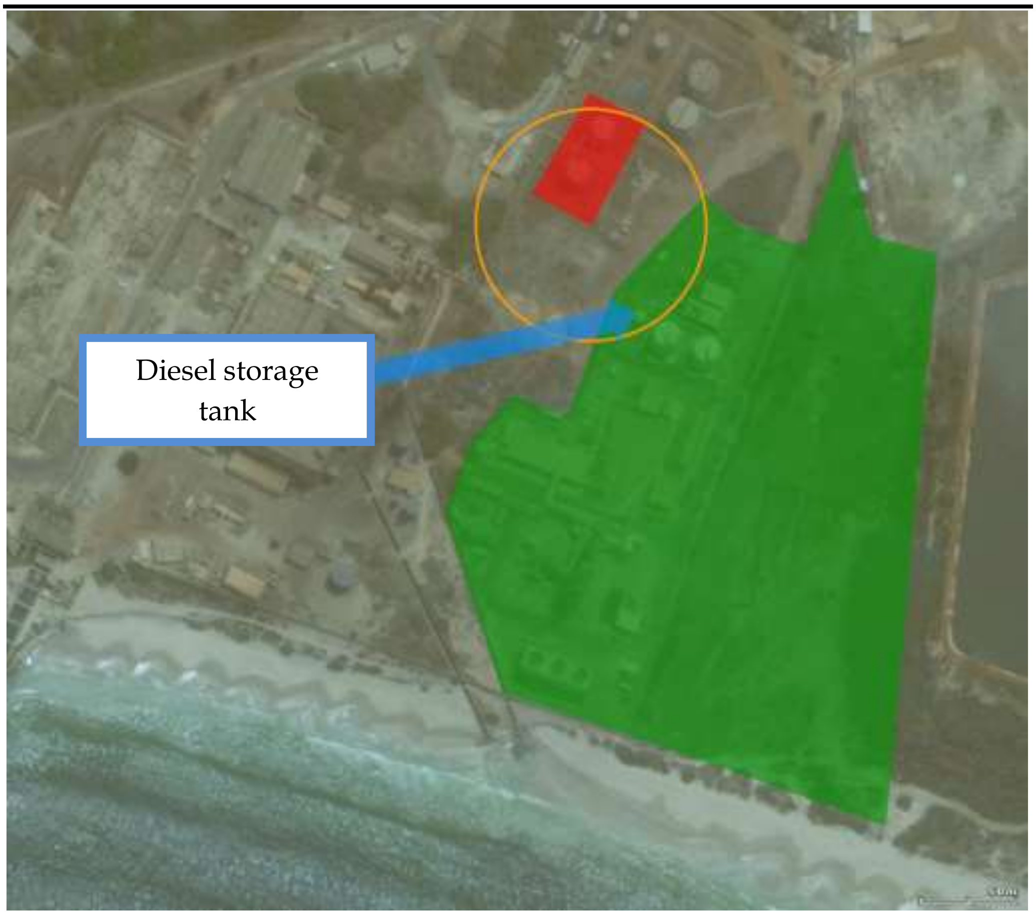
According to the 'étude de dangers', and using reference values of 10 kW/m^2 and 140 mbar as thresholds for domino effect for thermal and overpressure impacts, risk of escalation due these scenarios is contained within SENELEC site enclosure, except for scenario 1.1.a (Retention area fire following a loss of containment on diesel oil storage tank 1001) whose impact distance was assessed as 59 m for escalation (cf. *Figure 9.3*).

In case of SENELEC tank 1001 retention area fire, diesel oil storage tank would be impacted with thermal flux high enough to result in escalation. To avoid this escalation scenario, exposed tank walls shall be cooled using fire nozzles for the whole duration of the SENELEC fire.

However, if no preventive measure is set up in case of a SENELEC fire, there is a risk of tank damage resulting in containment loss, fire and/or explosion. Risks associated with these accidents have been assessed in this 'étude de dangers' (scenarios S02.f, S03.f and S05.d).

Risks associated with SENELEC facilities do not therefore modify the hazard study conclusions.

Figure 9.3 ***Domino effect impact zone associated with SENELEC diesel oil storage tank 1001 retention area fire***



Legend: red = Tank 1001 retention area / orange = 59m radius impact zone / green = ContourGlobal facilities (old and new)

9.9.2 *Société Dakaroise d'Entreposage - SDE*

The 'étude de dangers' of SDE (*TSE3P, 2013*) identifies 6 major scenarios:

- Scenario A: Fire / explosion of hydrocarbons tank (Fuel 380) ;
- Scenario B: Retention area fire ;
- Scenario C: Loss of containment on a tank ;
- Scenario D: Explosion of an hydrocarbons road tanker at site entrance ;
- Scenario E: Hydrocarbons piping rupture and ignition ; and
- Scenario F: Pool fire.

Among these scenarios, the following ones may have the potential to impact ContourGlobal facilities:

- Scenario A: 30 m from tank centre
- Scenario B: 47 m from the edge of retention area
- Scenario D: 14 m from site entrance

Impact distances of these scenarios, as indicated in SDE 'étude de dangers', do not reach ContourGlobal facilities.

Figure 9.4 Domino effects linked to SDE facilities

Legend: red = retention area and site entrance area / orange = 30m radius impact circle / blue = 47 m radius impact circle / yellow = 14 m radius impact circle / green = ContourGlobal site (old and new facilities)

9.10 RISK CONTROL MEASURES

According to the classification matrix included in the guidelines of the DECF, some accidents have an important risk level. The associated hazards are:

- Scenario 2 « Boil-over » and especially for HFO pre-storage tank and HFO storage tank.
- Scenario 3 « Slow pressurisation and fireball in tanks »
- Scenario 4 « Explosion of the gaseous phase of the tanks »
- Scenario 6 « Fire in the unloading area »

The risk levels of the remaining scenarios are considered as *Acceptable* based on the guideline of the DECF:

For scenarios with high risk, it is recommended to check that risk control measures are sufficient and reasonable for the associated risk to be considered as acceptable in the context of current knowledge.

Table 9.18 outlines the risk control measures identified on the site, their functions and the scenarios to which they apply.

Table 9.18 Risk control measures

Risk control measures	Function	Scenario
Regular purge of the water of the tanks	Remove aqueous phase of the storage tanks in order to avoid Boil-Over	S02
High Level Independent alarms on the tanks	Prevent tank flood in the retention basin	S02 S03
Hydrocarbon detectors in the retention basins	Detect leaks and enable the operator to control leaks	S02 S03 S05
Internal and external firefighting methods (i.e. water network, foam, fire/smoke/heat detectors)	Fire control and prevention of domino effects	S02 S03 S06
Vents appropriately sized on the tanks	Prevent pressure rise within the tanks	S03
Ventilation of gaseous phase of the tanks	Prevent the gaseous phase to reach the LEL of the hydrocarbon stocked	S04
Review procedures during tank maintenance or works	Prevent ignition of gaseous phase of the tank	S04
Emergency stop button on each loading station, control of equipment prior to its use	Control leaks related to tankers unloading	S06
Classified areas, approved equipment, lightning protection, equipment grounding	Prevention of ignition sources	All

Risk control measures	Function	Scenario
Works and maintenance procedures (approved companies, staff training, work authorisation)	Control accidents related to works and maintenance activities	All
Procedures related to people and vehicles circulation (closed areas around tanks, speed limit within the site, signage, operator round, closure)	Control accidents related to traffic and as a result of a malevolent act	All
Tank and equipment construction in accordance to the 'state of the art', and maintenance procedures in place	Reduce losses of containment related to corrosion and structural or construction defaults	All

Conclusions of the risk control measures

The risk measures identified enable control of risks related to major scenarios.

Purges and regular checks of the water bottom facilitate a very low probability of Boil-Over occurring. Moreover, a suitable firefighting system will prevent escalation hazards such as Boil-Over and Fireball from occurring.

The fireball following slow pressurisation scenario can only result if the vents on the tanks are not designed to cope with such an event. Therefore, it is advised that vents be sized on the tanks, and checks and maintenance operations be regularly made to reduce the likelihood of a fireball event occurring.

The explosion of the gaseous phase of a tank is very unlikely during normal operations. Good control of ignition sources and works is required to limit the likelihood of this event occurring. During maintenance operations inside the tanks, review procedures of the tank (degassing) must be respected to prevent ignition of residual gases.

At the loading area, the consequences of a leak can be easily controlled by an operator (i.e. emergency stop button). Major leaks related to a traffic accident are very unlikely due to traffic procedures (i.e. speed limits, signage) applied to the site. The control of ignition sources also reduces the fire risk at the unloading.

9.11 BASIC PRINCIPLES OF THE INTERNAL EMERGENCY PLAN

9.11.1 *Emergency Procedures*

Specific measures aimed at mitigating the consequences of an accident will be defined in the IOP that will be implemented as part of the operation of the plant. These measures are related with the physical devices aimed to reduce the consequences (i.e. fire protection system), as well as the procedures to be implemented.

These procedures will include, among others:

- Warning signal to the population (i.e. factories staff, staff of the fields close to the station)

- Warning system of the external intervention methods.

Regular exercises will be carried out with the emergency services and communities to assess the real intervention capabilities and potential implementation problems of the procedures.

9.11.2 Training

Staff training on the various hazards of the plant and emergency procedures should be conducted to adequately respond to every hazardous situation. These trainings will need to be repeated as much as necessary, in order to guarantee an optimal reactivity in case of an incident.

9.11.3 Consequence reduction features

Devices are installed at sites of sensitive equipment in the plant in order to mitigate the consequences of a potential leak. These include:

- Waterproofed retention basin around storage tanks
- Paved retention area at the loading space
- Paved retention areas at the transformers with an oil recovery basin.

9.11.4 Fire detection and protection system

The fire detection and protection system of the site will comply with national requirements and international standards (NFPA10, NFPA11, NFPA14, NFPA16, NFPA20, NFPA24, NFPA30 and NFPA850: 2010 "Recommended Practice for Fire Protection for Electric Generating Plants").

For an immediate response to local fires, the site is equipped with numerous 6 kg and 12 kg powder extinguishers, located in strategic locations, and 5 kg CO_2 fire extinguishers for electrical fires.

The new fire pumps (Phase 1) with 300 m^3/h capacity are adapted for the firewater needs as specified in Section 6.2 of NFPA 850:2010 standard. Firewater capacity should be at least 600 m^3 to provide protection for at least 120 min at a flow rate of 300 m^3/h. The existing firewater tank has a capacity of 750 m^3 and is in line with this requirement. The firefighting system of Phase 2 will be connected to the firefighting system of Phase 1. Firewater demand calculations shall be carried out for Phase 2 to ensure sufficient firewater is available for Phase 2 power plant according to international standards.

Engine halls are equipped with heat sensors (hot point) and smoke detectors (optical beams). Each hall is also provided with one mobile foam unit (100 L, 3% mixing ratio, 200 L/min water flow) and portable dry powder fire extinguishers. The engines are also protected by a sprinkler network and deluge provided with AFFF type of foam

Detection and fire protection systems are also present at:

- The control room (smoke detector, portable CO_2 extinguishers)
- The electrical room (smoke detector, portable and mobile dry powder and CO_2 extinguishers
- The compressed-air generating plant (heat detector, portable CO_2 extinguisher, water intake)
- The workshop and warehouse (heat and smoke detectors, sprinkler, dry-chemical portable extinguisher)
- Plant transformers (flood and sprinkler, deluge water spray, dry powder portable extinguishers)
- The steam turbine (heat detectors, mobile foam and dry-chemical portable extinguishers)
- Fuel oil treatment unit (smoke detector, dry-chemical portable and mobile extinguishers, water intake)
- The fire pump (dry-chemical portable extinguisher, sprinkling network, water intake)
- The heat recovery unit (heat detection, dry-chemical portable extinguishers, water intake)
- Tanks (sprinkling network to cool in case of thermal radiation exposure, foam mobile extinguishers, water intake)
- Fuel Treatment House (sprinkler system, dry powder fire extinguishers)
- Warehouse (sprinkler system, portable dry powder fire extinguishers)

The alarm system of the plant meets the following principle:

- The control room where the alarm system is located is continuously occupied by personnel
- The plant is divided in different alarm areas in order to facilitate the location of a potential fire

- The visual and audible alarms are located in such a way that they can be heard or seen from any areas inside or outside
- When the ambient noise level is above 105 dB, visual alarms shall be installed.

In addition to these fire protection systems, improvements have been made at the design phase to reduce the risk to the minimum. Indeed, fire doors, specific ventilation system, or an integration of the main electrical equipment in metal boxes have been implemented.

The following principles have been implemented for the fire alarm system:

- The fire alarm centre is located in the control room which is continuously occupied by a member of the staff

- The Power Plant is divided in fire alarm zones in order to ease locating an eventual fire

- Each room is provided with a suitable amount and type of detectors, including manual alarm call point

- Alarm bells, sirens and flashing lights are located so that they can be heard or seen everywhere inside and where needed outside the buildings.

- When the average ambient sound level is greater than 105 dB, visual flashing alarms are implemented.

The implementation of the fire protection system will also reduce the risk of accidents, by avoiding any spread to other plant equipment. It is therefore also a risk prevention system.

9.11.5 External intervention methods

The station is close to a major road and several cities, including Dakar, which enables an optimal response time.

The response period of the different Civil Protection services as well as the methods to be used should be discussed with the Civil Protection Directorate during consultation of the technical services. A specific analysis will be done as part of the ORP in order to include new facilities of the station refurbishment and modification. Training exercises should be carried out regularly with external intervention groups.

9.12 *HAZARD STUDY CONCLUSIONS*

This hazard study has been prepared in accordance with Senegalese regulations, building on the methods described in French regulations and international standards.

The present study considered hazard related to:

- Hydrocarbons storage
- Unloading hydrocarbons by road tankers
- Hydrocarbons-transfer pipelines between various tanks and site units.

Table 9.19 summarises all of the studied scenarios and provides for each scenario its principal causes and consequences, its initial probability, severity and risk ranking, the preventive and protective risk measures in place and its final probability, severity and risk ranking.

Potential hazards of the facilities have been modelled and assessed in terms of their severity and probability of occurrence. The scenarios have been classified according to the criteria of the Senegalese guideline (see *Table 9.1* and *Table 9.2*). None of the scenarios have an intolerable risk level. Scenarios with an important risk level have risk measures (see *Section 9.10*) in order to obtain a risk as low as possible in the current "state of the art".

Finally, to further minimise these risks or limit their consequences, particularly within the site, an Internal Organisation Plan (*POI, Plan d'Organisation Interne*) or Emergency Plan will be developed following the principles outlined in *Section 9.11* and including emergency procedures in case of incident occurrence on neighbouring industrial sites.

As such, considering the control risk measures proposed and the absence of inhabited areas within the risk areas associated with each potential accident identified, the hazard related to the project are considered acceptable.

Table 9.19 Table recapitulating the scenarios considered in the Hazards Study

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S01.a	Tank fire	HFO pre-storage Phase 1	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.b	Tank fire	HFO storage 1 GTI	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.c	Tank fire	HFO storage 2 GTI	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.d	Tank fire	HFO buffer Phase 1	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.e	Tank fire	HFO service Phase 1	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.f	Tank fire	LFO storage GTI	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.g	Tank fire	LFO service Phase 1	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.h	Tank fire	HFO Storage Phase 2	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S01.i	Tank fire	HFO Buffer Phase 2	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.j	Tank fire	HFO Service Phase 2	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S01.k	Tank fire	LFO Service Phase 2	Lightning Maintenance	Material	Quick	2	3	Important	Lightning protection and maintenance procedures	Fire water network/foam	1	3	Acceptable
S02.a	Boil-over / BOCM	HFO pre-storage Phase 1	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S02.b	Boil-over / BOCM	HFO storage 1 GTI	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S02.c	Boil-over / BOCM	HFO storage 2 GTI	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S02.d	Boil-over / BOCM	HFO buffer Phase 1	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S02.e	Boil-over / BOCM	HFO service Phase 1	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S02.f	Boil-over / BOCM	LFO storage GTI	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S02.g	Boil-over / BOCM	LFO service Phase 1	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S02.h	Boil-over / BOCM	HFO Storage Phase 2	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S02.i	Boil-over / BOCM	HFO Buffer Phase 2	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S02.j	Boil-over / BOCM	HFO Service Phase 2	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S02.k	Boil-over / BOCM	LFO Service Phase 2	Fire + water in the tank bottom	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Fire alarms, smoke detectors, fire water network/foam, purges hydrocarbon detectors in secondary containment	Fire water network/foam	1	4	Important
S03.a	Fireball due to slow pressurisa tion	HFO pre-storage Phase 1	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S03.b	Fireball due to slow pressurisation	HFO storage 1 GTI	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.c	Fireball due to slow pressurisation	HFO storage 2 GTI	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.d	Fireball due to slow pressurisation	HFO buffer Phase 1	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.e	Fireball due to slow pressurisation	HFO service Phase 1	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.f	Fireball due to slow pressurisation	LFO storage GTI	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S03.g	Fireball due to slow pressurisa tion	LFO service Phase 1	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.h	Fireball due to slow pressurisa tion	HFO Storage Phase 2	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.i	Fireball due to slow pressurisa tion	HFO Buffer Phase 2	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.j	Fireball due to slow pressurisa tion	HFO Service Phase 2	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important
S03.k	Fireball due to slow pressurisa tion	LFO Service Phase 2	Uncontrolled fire next to a tank	Material (human consequences unlikely due to slow kinetic)	Slow	2	4	Important	Vents on tanks, fire alarm, smoke detector, hydrocarbon detectors in secondary containment	Fire water network / foam	1	4	Important

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S04.a	Vapour explosion	HFO pre-storage Phase 1	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.b	Vapour explosion	HFO storage 1 GTI	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.c	Vapour explosion	HFO storage 2 GTI	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.d	Vapour explosion	HFO buffer Phase 1	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.e	Vapour explosion	HFO service Phase 1	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.f	Vapour explosion	LFO storage GTI	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.g	Vapour explosion	LFO service Phase 1	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S04.h	Vapour explosion	HFO Storage Phase 2	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.i	Vapour explosion	HFO Buffer Phase 2	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.j	Vapour explosion	HFO Service Phase 2	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S04.k	Vapour explosion	LFO Service Phase 2	Lightning Maintenance Hot spot	Human and material	Very quick	1	5	Important	Lightning protection Maintenance procedures		1	5	Important
S05.a	Retention fire	HFO pre-storage retention	Tank loss of containment: external aggression or corrosion Tank overfill Loss of containment on the supply line	Material	Quick	2	3	Important	Maintenance and equipment inspection procedures High level alarms on tanks	Fire water network / foam	1	3	Acceptable

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S05.b	Retention fire	HFO storage 1 retention	Tank loss of containment: external aggression or corrosion Tank overfill Loss of containment on the supply line	Material	Quick	2	3	Important	Maintenance and equipment inspection procedures High level alarms on tanks Hydrocarbon detectors in secondary containment	Fire water network / foam	1	3	Acceptable
S05.c	Retention fire	HFO storage 2 retention	Tank loss of containment: external aggression or corrosion Tank overfill Loss of containment on the supply line	Material	Quick	2	3	Important	Maintenance and equipment inspection procedures High level alarms on tanks Hydrocarbon detectors in secondary containment	Fire water network / foam	1	3	Acceptable
S05.d	Retention fire	LFO storage retention	Tank loss of containment: external aggression or corrosion Tank overfill Loss of containment on the supply line	Material	Quick	2	3	Important	Maintenance and equipment inspection procedures High level alarms on tanks Hydrocarbon detectors in secondary containment	Fire water network / foam	1	3	Acceptable

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S05.e	Retention fire	Service tanks retention	Tank loss of containment: external aggression or corrosion Tank overfill Loss of containment on the supply line	Material	Quick	2	3	Important	Maintenance and equipment inspection procedures High level alarms on tanks	Fire water network / foam	1	3	Acceptable
S05.f	Retention fire	HFO Storage	Tank loss of containment: external aggression or corrosion Tank overfill Loss of containment on the supply line	Material	Quick	2	3	Important	Maintenance and equipment inspection procedures High level alarms on tanks	Fire water network / foam	1	3	Acceptable
S05.g	Retention fire	Service tanks retention	Tank loss of containment: external aggression or corrosion Tank overfill Loss of containment on the supply line	Material	Quick	2	3	Important	Maintenance and equipment inspection procedures High level alarms on tanks	Fire water network / foam	1	3	Acceptable

Scenario reference	Effect	Equipment	Causes	Main consequences	Kinetic	Probability	Severity	Level of risk	Preventive measures	Protective measures	Residual probability	Residual severity	Residual risk
S06	Pool fire	Unloading platform	Leak (corrosion or external aggression) at: - the road tanker - unloading arms or related equipment - Lines in direction of the storage tanks	Human	Quick	4	2	Important	No hot spot near the unloading area Earthing of equipment Maintenance and equipment inspection procedures Experienced Staff	Fire water network/foam, emergency cut-off button to limit the quantity of hydrocarbon discharged	3	2	Important
S07.a	Free pool fire	Piping	Corrosion or external aggression	Human	Quick	3	2	Important	Maintenance and equipment inspection procedures Fire alarm Smoke detector	Fire water network/foam	2	2	Acceptable
S07.b	Free pool fire	Piping	Corrosion or external aggression	Human	Quick	3	2	Important	Maintenance and equipment inspection procedures Fire alarm Smoke detector	Fire water network/foam	2	2	Acceptable

9.13 *OCCUPATIONAL RISKS – HEALTH AND SAFETY OF WORKERS*

9.13.1 *Objectives*

The evaluation of professional risks is mandatory, as defined by *article 6 of decree 2006-1256* relating to employer obligations in terms of Health and Safety at Work, which stipulates that the employer must take the necessary measures to promote the health and safety of workers. It is the basis for any procedure to improve safety and working conditions.

The evaluation of professional risks is used to plan preventive action.

Professional risks are the source of professional illnesses and accidents at work.

A professional illness is defined as a symptom or sickness that is the consequence of longer or shorter exposure to a risk and which may cause lesions or even the death of the worker.

An accident at work is a sudden event and may cause physical injury or even the death of the worker.

The start point for professional risk prevention is an evaluation of these risks. This evaluation consists of identifying risks and then ranking them and planning the appropriate preventive action for each of the risks identified. This ranking is a function of the frequency of occurrence and the seriousness of damage caused.

It should be noted that the evaluation suggested in this chapter was made prior to the start-up of the power plant's construction and operational activities. It is therefore an analysis of the professional risks potentially caused by an installation of the same type as the ContourGlobal - Cap des Biches power station. This conceptual analysis does not therefore replace the evaluation of work station risks that will be carried out in parallel to the construction and operational phases, as soon as the work stations and work organisation have been defined in detail.

9.13.2 *Methodology*

The approach was follows:

- Inventory of work units (stations, jobs or work station)
- Identify risks by work unit: draw up an inventory of the properties intrinsic to the equipment, substances, working method, etc. that could cause damage to employee health
- List risks: note risks according to their level of seriousness and frequency in order to rank them and prioritise preventive action.
- Suggest preventive action: this action must decrease the risk (with influence on the seriousness and frequency of the risks identified).

Work units inventory

Division into work units is based on an analysis of the various activities of the companies that will be working (including ContourGlobal - Cap des Biches). Activities have been grouped in some cases, where they present similar types of risks.

Type of professional risks evaluated

The following list covers the types of risks potentially incurred by workers on a project such as the ContourGlobal - Cap des Biches project:

- Risks linked to the use of excavation machinery
- Risks linked to the use of manual tools
- Risks linked to manual handling
- Risks linked to repetitive movements
- Risks linked to noise
- Risks linked to work in excessive heat conditions
- Traffic risks
- Risks linked to the use of handling machinery
- Risks linked to objects falling
- Risks linked to the use of machines
- Risks linked to mechanical handling
- Risks linked to manual handling
- Risks linked to repetitive movements
- Risks linked to falls: from heights, on the level
- Electrical risks
- Chemical risks
- Risks linked to screen work
- Risks linked to solitary work
- Risks linked to work in a confined space
- Risks linked to hot environments
- Risks of fire and explosion.

Risk identification and evaluation

Risk identification is based on feedback (accidents and professional illnesses occurring within the sector of activities concerned), regulations (labour code and appendix texts) and on visits to similar sites.

A grading system has been used to evaluate the various risks identified. Criteria taken into account in this evaluation are:

- The frequency of occurrence of the accident / incident or professional illness
- The seriousness of the accident / incident or professional illness.

With regard to professional illnesses, the duration of an activity that may lead to a risk is taken into account to evaluate the seriousness.

Frequency and severity levels taken into account in the study are present in *Table 9.20*.

Table 9.20 ***Scale of frequency and seriousness***

Scale of Frequency		Scale of seriousness	
Score	Meaning	Score	Meaning
F1	Once every 10 years or less	G1	Reversible lesions, with no sick leave or sick leave of less than 2 days
F2	Once a year	G2	Reversible lesions with sick leave
F3	Once a month	G3	Irreversible lesions, permanent incapacity
F4	Once a week or more often	G4	Death

Risk is evaluated by the association of Frequency (F) with Seriousness (G). This enables the establishment of a "criticality matrix" and thus visualisation of low, moderate and high risks. Actions are then ranked from 1 to 3, based on this classification.

	F1	**F2**	**F3**	**F4**
G4	41	42	43	44
G3	31	32	33	34
G2	21	22	23	24
G1	11	12	13	14

Key to colours:

- A low risk will be given green. In this case, preventive action to take is given as level 3
- Yellow means a moderate risk. In this case priority of action to take is given a 2.
- A high risk is shown in red. This requires level 1 priority action.

	High risk with Priority 1 action
	Moderate risk with Priority 2 action
	Low risk with Priority 3 action

Note that all professional risks that could lead to the death of a worker are considered as high, even when the frequency of the risk is very low. This prudent and conservative approach highlights any residual risk of this type, in order to focus prevention efforts for workers.

Definition of prevention and protection measures

Prevention and protection measures to be implemented are defined for all risks identified. These measures are intended on the one hand to reduce risk frequency (by attenuating risk factors) and on the other to reduce seriousness (for example by implementing worker protection measures). With regard to risks of level 4 seriousness (death) it should be noted that protection measures rarely reduce the consequences associated with the activity. Therefore only prevention measures (aimed at reducing frequency of occurrence) reduce the criticality of such a risk.

The residual risk after implementation of protection measures will therefore be of the same type as the initial risk, but its criticality level will have been mitigated.

9.13.3 *Inventory of project activities*

The various activities in the construction and operation of the thermal power plant project, and the risks to which staff may be exposed are identified in *Table 9.21*.

Table 9.21 ***Inventory of Project activities and of associated potential professional risks***

Phases	Activities	Work station or staff exposed	Professional risks
Construction phase	Excavation work (manual or mechanical)	Staff doing the work, machinery operator or staff present on the site	- Risks linked to the use of excavation machinery - Risks linked to the use of manual tools - Risks linked to manual handling - Risks linked to repetitive movements - Risks linked to same-level falls - Risks linked to noise - Risks linked to work in excessive heat conditions
	Moving material on site by truck and crane	Operators or staff present on the site	- Traffic risk - Risks linked to the use of handling machinery - Risks linked to objects falling - Risks linked to work in excessive heat conditions
	Unloading material and equipment	Staff doing the work	- Risks linked to the use of machines - Risks linked to mechanical handling - Risks linked to manual handling and repetitive movements - Risks linked to objects falling - Risks linked to work in excessive heat conditions
	Welding work	Staff doing the work	- Risk linked to chemicals - Risks linked to repetitive movements

Phases	Activities	Work station or staff exposed	Professional risks
	Installation of equipment (mechanical or manual)	Staff doing the work	- Risks linked to the use of machines - Risks linked to mechanical handling -
	Backfill and profiling (manual or mechanical)	Staff doing the work, machinery operator or staff present on the site	- Risks linked to mechanical handling - Risks linked to manual handling and repetitive movements - Risks linked to the use of machines - Risk linked to chemicals -
Operational phase	Functioning of installations	Staff working on operation of the power plant (control room)	- Risks linked to same-level falls - Risks linked to screen work - Electrical risk - Chemical risk
	Maintenance of installations	Staff maintaining installations	- Risks linked to noise - Electrical risk - Risks linked to falls : from height and at same level - Risks linked to solitary work - Risks linked to work in confined spaces - Risks linked to hot environments
	Surveillance of installations	Staff working on maintenance of installations	- Risks linked to noise - Electrical risk - Risks linked to falls : from height and at same level - Risks linked to solitary work - Risks linked to hot environments
	Unloading	Staff unloading trucks	- Chemicals risks - Risks of fire and explosion - Risks linked to the use of machines
	Administrative work	Administrative staff	- Risks linked to same-level falls - Risks linked to screen work
	Other connected activities (cleaning, deliveries, maintenance etc.)	Sub-contractor staff	- Risks linked to same-level falls - Risks linked to mechanical handling - Risks linked to manual handling and repetitive movements -

9.13.4 *Analysis of occupational risks*

The various risks to which staff may be exposed are defined in *Table 9.22* below together with prevention measures.

Table 9.22 Analysis of initial professional risks and presentation of residual risks

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
Construction phase	Excavation work	Staff doing the work, machinery operators or staff present on the site	Risks linked to the use of excavation machinery	Machinery / pedestrian collision: injury, death	4	3	43	Implement a traffic plan and signs on the worksite. Machinery maintenance. Train machinery operators in driving rules. Clear traffic movement routes. Assist the operator during excavation work.	4	1	41
			Risks linked to the use of manual tools	Cuts, fractures	3	4	34	Train staff in the handling of these tools. Provide staff with gloves.	2	2	22
			Risks linked to manual handling	Repetitive strain injury (RSI) Muscular pain	2	3	23	Limit daily load. Train staff in postures to use for manual handling. Implement mechanical assistance. Introduce regular rest times.	1	2	12
			Risks linked to repetitive movements	RSI Muscular pain	2	3	23	Introduce rest times. Implement mechanical assistance	2	2	22
			Risks linked to same-level falls	Injury, Fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22
			Risks linked to noise	Temporary or permanent hearing loss	3	2	32	Provide workers with ear plugs and helmets with ear muffs and ensure that they are used	1	2	12
			Risks linked to work in excessive heat conditions	Heat stroke, dehydration	2	4	24	Avoid work during the hottest hours of the day. Supply workers regularly with bottles of water. Introduce regular breaks	1	2	12
	Movements of materials and equipment on	Operators or staff present on the site	Traffic risk	Vehicle / pedestrian collision:	4	2	42	Train drivers in driving rules	4	1	41

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
	site by truck and crane			injury, death							
			Risks linked to the use of handling machinery	Vehicle / pedestrian collision: injury, death	4	2	42	Implement a traffic plan and signs on the worksite. Machinery maintenance. Train machinery operators in driving rules. Clear traffic movement routes. Assist the operator during movements	4	1	41
			Risks linked to falling objects	Injury, fractures, death	4	2	42	Wear PPE (hard hat, protective eyewear, safety shoes) Check on installations and machinery likely to be the source of falling objects Limit storage heights Install protections to hold back falling objects	3	1	31
			Risks linked to work in excessive heat conditions	Heat stroke	2	4	24	Avoid work during the hottest hours of the day. Supply workers regularly with bottles of water. Introduce regular breaks	1	2	12
	Unloading materials	Staff unloading materials or present on the site	Risks linked to the use of machines	Injury, fractures, death	4	2	42	Emergency stop devices clearly identifiable on machines. Identify controls clearly to avoid any accidental start up. Safety devices on the machine in good working order. Check compliance of equipment by an approved organisation. Give instructions for work to be done on machines when stopped. Make employees aware of safety rules. Wear PPE	3	1	31
			Risks linked to mechanical	Death, injury, fractures	4	3	43	Use handling means adapted to the loads being carried. Follow the instructions given by the	4	1	41

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial serious ness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousnes s 1 to 4	Residual frequency 1 to 4	Residual risk level
			handling					equipment supplier. Check regularly on the condition of handling equipment. Employees must be trained in the use of this equipment.			
			Risks linked to manual handling and repetitive movements	RSI Muscular pain	2	3	23	Limit daily load. Train staff in postures to use for manual handling. Implement mechanical assistance. Introduce regular rest times.	1	2	12
			Risks linked to falling objects	Injury, fractures, death	4	2	42	Wear PPE (hard hat, protective eyewear, safety shoes) Check on installations and machinery likely to be the source of falling objects Limit storage heights Install protections to hold back falling objects	3	1	31
			Risks linked to working in excessive heat conditions	Heat stroke, dehydration	2	4	24	Avoid work during the hottest hours of the day. Supply workers regularly with bottles of water. Introduce regular breaks	1	2	12
	Welding work	Staff doing the work	Chemical risks	Death, burns, respiratory illnesses, irritation of the eyes or skin in case of repeated and prolonged contact with the product. Burns,	4	3	43	Provide PPE and ensure that it is worn Limit as much as possible the number of employees potentially exposed.	3	2	32

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
				Allergies							
			Risks linked to repetitive movements	RSI Muscular pain	2	3	23	Limit daily load. Train staff in postures to use for manual handling. Implement mechanical assistance. Introduce regular rest times.	1	2	12
	Installation of equipment (mechanical or manual)	Staff doing the work or operating machinery	Risks linked to the use of machines	Injury, fractures, death	4	2	42	Emergency stop devices clearly identifiable on machines. Identify controls clearly to avoid any accidental start up. Safety devices on the machine in good working order. Check compliance of equipment by an approved organisation. Give instructions for work to be done on machines when stopped. Make employees aware of safety rules. Wear PPE	3	1	31
			Risks linked to mechanical handling	Death, injury, fractures	4	3	43	Use handling means adapted to the loads being carried. Follow the instructions given by the equipment supplier. Check regularly on the condition of handling equipment. Employees must be trained in the use of this equipment. Wear PPE	4	1	41
			Risks liked to manual handling and repetitive movements	RSI Muscular pain	2	3	23	Limit daily load. Train staff in postures to use for manual handling. Implement mechanical assistance. Introduce regular rest times	1	2	12
			Risks linked to falls: from	Injury, Fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
			height and at same level								
			Risks linked to noise	Temporary or permanent hearing loss	3	2	32	Provide workers with ear plugs and helmets with ear muffs and ensure that they are used	1	2	12
			Electric risk	Death, burns	4	2	42	All interventions must be carried out by staff who have received authorisation. Have installations set up and checked regularly (electrical, pressurised devices) by qualified staff. Train staff in measures to take in case of fire.	3	1	31
	Backfill and profiling (manual or mechanical)	Staff doing the work, machinery operator or staff present on the site	Risks linked to mechanical handling	Death, injury, fractures	4	3	43	Use handling means adapted to the loads being carried. Follow the instructions given by the equipment supplier. Check regularly on the condition of handling equipment. Employees must be trained in the use of this equipment. Wear PPE	4	1	41
			Risks linked to manual handling and repetitive movements	RSI, muscular pain	2	3	23	Limit daily load. Train staff in postures to use for manual handling. Implement mechanical assistance. Introduce regular rest times	1	2	12
			Risks linked to the use of machines	Death, injury, fractures,	4	2	42	Emergency stop devices clearly identifiable on machines. Identify controls clearly to avoid any accidental start up. Safety devices on the machine in good working order. Check compliance of equipment by	3	1	31

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
								an approved organisation. Give instructions for work to be done on machines when stopped. Make employees aware of safety rules. Wear PPE			
			Chemical risks	Death, burns, respiratory illnesses, irritation of the eyes or skin in case of repeated and prolonged contact with the product. Burns, Allergies	4	3	43	Provide PPE and ensure that it is worn Limit as much as possible the number of employees potentially exposed.	3	2	32
Operational phase	Operation of installations	Staff working on power plant operation (control room)	Risks linked to same-level falls	Injury, fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22
			Risks linked to screen work	RSI muscular pain	3	2	32	Lay out the work station so as to adopt good posture (position of the computer, screen adjustments, seat position, etc.)	2	1	22
			Electric risk	Death, burns	4	2	42	All interventions must be carried out by staff who have received authorisation. Have installations set up and checked regularly (electrical, pressurised devices) by qualified staff. Train staff in measures to take in case of fire.	3	1	31

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
			Chemical risk	Death, burns	3	2	32	PPE (gloves, mask, protection glasses) All interventions must be carried out by staff who have received authorisation. Have installations set up and checked regularly (electrical, pressurised devices) by qualified staff. Train staff in measures to take in case of fire.	1	2	12
	Installation maintenance	Staff maintaining installations	Risks linked to noise	Temporary or permanent hearing loss	3	2	32	Provide workers with ear plugs and helmets with ear muffs and ensure that they are used	1	2	12
			Electric risk	Death, Burns	4	2	42	All interventions must be carried out by staff who have received authorisation. Have installations set up and checked regularly (electrical, pressurised devices) by qualified staff. Train staff in measures to take in case of fire.	3	1	31
			Risks linked to falls: from height or at same level	Injury, fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22
			Risks linked to solitary work	Injury, fractures	2	3	23	Reduce the number and length of interventions Depending on the work station and its specific characteristics, draw up instructions, train and inform staff.	2	2	22
			Risks linked to work in confined spaces	Death, injury	4	2	42	Create staff awareness Define operational methods before intervention Work in pairs.	1	2	12

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
								Ventilate confined spaces during interventions			
			Risks linked to hot environments	Heat stroke, dehydration	2	4	24	Plan for breaks in a cool place. Provide work clothes suitable for the temperature	1	2	12
	Surveillance of installations	Staff in charge of the surveillance of installations including security officers	Risks linked to noise	Temporary or permanent hearing loss	3	2	32	Provide workers with ear plugs and helmets with ear muffs and ensure that they are used	1	2	12
			Electric risk	Death, burns	4	2	42	All interventions must be carried out by staff who have received authorisation. Have installations set up and checked regularly (electrical, pressurised devices) by qualified staff. Train staff in measures to take in case of fire.	3	1	31
			Risks linked to falls: from height or at same level	Injury, fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22
			Risks linked to solitary work	Injury, fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22
			Risks linked to hot environments	Heat stroke, dehydration	2	4	24	Plan for breaks in a cool place. Provide work clothes suitable for the temperature	1	2	12
	Unloading	Staff unloading trucks	Chemical risks	Death, burns, respiratory illnesses, irritation of the eyes or skin in case of repeated	4	3	43	Provide PPE and ensure that it is worn Limit as much as possible the number of employees potentially exposed. …) Remove and ban the use of any source of flame close to the unloading area.	3	2	32

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
				and prolonged contact with the product. Burns, Allergies				Set up firefighting equipment.			
			Risks of fire and explosion	Death, injury, burns	4	3	43	Maintain installations periodically. Display pictograms with safety instructions. Remove and ban the use of any source of flame close to the installations, Set up firefighting equipment. Wear PPE	4	1	41
			Risks linked to the use of machines	Injury, fractures, death	4	2	42	Emergency stop devices clearly identifiable on machines. Identify controls clearly to avoid any accidental start up. Safety devices on the machine in good working order. Check compliance of equipment by an approved organisation. Give instructions for work to be done on machines when stopped. Make employees aware of safety rules. Wear PPE	3	1	31
	Administrative work	Administrative staff	Risks linked to same-level falls	Injury, fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22
			Risks linked to screen work	RSI Muscular pain Fatigue	3	2	32	Lay out the work station so as to adopt good posture (position of the computer, screen adjustments, seat position, etc.)	2	1	21

Project phase	Activities	Station or staff exposed	Risks identified	Potential damage (lesion, health affected)	Initial seriousness 1 to 4	Initial frequency 1 to 4	Initial risk level	Prevention measures	Residual seriousness 1 to 4	Residual frequency 1 to 4	Residual risk level
	Other connected activities (cleaning, deliveries, upkeep excluding maintenance, etc.)	Sub-contractor staff	Risk linked to same-level falls	Injury, Fractures	2	3	23	Mark out and place signs in slippery areas	2	2	22
			Risks linked to mechanical handling	Death, injury, fractures	4	3	43	Use handling means adapted to the loads being carried. Follow the instructions given by the equipment supplier. Check regularly on the condition of handling equipment. Employees must be trained in the use of this equipment. Wear PPE	4	1	41
			Risks linked to manual handling and repetitive movements	RSI Muscular pain	2	3	23	Limit daily load. Train staff in postures to use for manual handling. Implement mechanical assistance. Introduce regular rest times	1	2	12

Prevention and protection measures will therefore reduce professional risks significantly. However, as pointed out in *Section 9.13.2*, the severity of some risks that can lead to death cannot be significantly reduced; in these cases the prevention measures suggested will reduce to a minimum the frequency of occurrence.

9.13.5 Summary of mitigation measures

Some risks such as those linked to vehicle and machinery movements on the worksite, to extreme noise from machinery during the construction phase and to contact with products and fires during the operational phases may reach high levels and must therefore obligatorily be associated with the suggested prevention and protection measures.

Thus, in order to control the various risks and promote worker health and safety, ContourGlobal - Cap des Biches will ensure that safety measures are implemented and complied with.

Construction phase

ContourGlobal - Cap des Biches will require from the contractor responsible for engineering and construction:

- A risk analysis at work stations associated with construction activities, based on those identified in this report
- A worker risk prevention plan

The risk analysis and prevention plan will be periodically reviewed and updated, notably at every new construction phase (excavation, civil engineering, assembly, testing).

They will be duly communicated to all sub-contractors working on the Project construction phase. Staff from ContourGlobal - Cap des Biches, the contractor and his sub-contractors will received training.

Operational phase

For the operational phase an evaluation of risks for worker health and safety will also be carried out and periodically updated.

It will take into account:

- The various accident events linked to Project operations and described in *Section 9.4*
- An accident risk analysis at work stations, on the basis of those identified in this report

A plan to prevent risks to worker health and safety will be drawn up for the operational phase, and periodically updated. This plan will notably include an internal organisation plan (IOP) applicable to the process hazards already identified in this hazards study, as well as operational health and safety factors.

Making work stations safe

ContourGlobal - Cap des Biches will carry out analysis of work station risks, which will be updated regularly, notably in case of any change in the organisation of work stations or processes. This analysis will act as a reference for making work stations safe in terms of the prevention of risks to worker health and safety.

Evacuation procedure in case of fire

Right from the construction phase, ContourGlobal - Cap des Biches will ensure that alert and evacuation procedures in case of fire or emergency has been implemented. Workers will be trained to follow this procedure. An alert and evacuation procedure will also be defined for the operational phase. This procedure will be periodically updated, notably in case of any significant change in site or process organisation.

9.14 EXCLUSION ZONE AND SAFETY DISTANCE

The hazards study was able to define safety distances according to the risk identification and consequence assessment. Irreversible effects could thus be felt at a distance of up to 155m from the storage areas in case of boil-over [1]. The maximum distance for irreversible effects is 82m from the SENELEC accommodation and 270m from the inhabited area of Diokoul (see *Figure 9.2*). In view of these safety distances, risks to local people caused by the Project will be very limited (*Section 9.8*).

In addition, since boil-over is the worst case scenario (*Section 9.8*), and is a slow phenomenon, workers and neighbouring population could be evacuated before the boil-over occurred. Moreover, this is an event considered to be unlikely.

The general location of the site also allows for rapid intervention by emergency crews in case of an accident. The power plant is located 650m from the Highway N1 and 3km from the Rufisque fire station.

The least improbable scenario (considered to be occasional) is n° 6 which corresponds to a fire on a free pool of fuel oil after spreading over the unloading platform. In this case, the maximum area of irreversible effects would extend up to 35m from the engine fuel oil supply pipe. The area of irreversible effects is therefore entirely contained within the perimeter of the power plant.

(1) Large scale phenomenon involving fire in the tank or retention vat, or leading to vaporisation of a water base, free water or in emulsion in the mass.

Thus, in every case, the maximum area for irreversible effects is 82m from the closest dwellings, which are the homes of SENELEC employees, and 270m from the Diokoul district, which is the closest public area.

It should be noted that urban expansion will be very limited in the Project area, thus avoiding any new dwellings being located within the safety distance. In fact, the location of SENELEC infrastructures to the west (power plant) and north-west (housing) will prevent any new installation of populations. Similarly, the presence of the Rufisque water treatment plant to the east will maintain the maximum area of effects at its current size. The WTP is fenced around its perimeter and a guard ensures surveillance of the installations (see *Section 5.7*).

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN

10.1 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

This Environmental and Social Management Plan (ESMP) was prepared on the basis of the results of the ESIA on the ContourGlobal - Cap des Biches project.

Its aim is to meet the requirements of law N° 2001-01 of 15th January 2001 covering the Environment Code in Senegal. It has also been developed with the aim of complying with international good practices applicable to impact studies, meeting the requirements of IFC environmental Performance Standards.

The aim of the ESMP is to provide a framework for the environmental and social management of the Project, translating the mitigation measures specified in the ESIA into a plan for implementation of the Project. Thus the ESMP:

- Lists mitigation measures to be implemented by the Project for every phase in its implementation, with the aim of complying with Senegalese regulations and international standards and good practices
- Provides a framework for monitoring or even auditing project compliance with these standards and good practices.

The ESMP is supplemented by:

- A surveillance and monitoring plan
- A capacity reinforcement plan
- An implementation plan.

10.2 GENERAL PRINCIPLES OF ENVIRONMENTAL SURVEILLANCE AND MONITORING

Internal environmental monitoring (the aim of the ESMP) carried out within the context of the Project will ensure efficient implementation of the measures. This monitoring will be carried out using monitoring indicators defined by means of verification of associated sources of control.

Internal monitoring will be carried out by an HSE manager who is a member of ContourGlobal - Cap des Biches staff or is working for one of ContourGlobal - Cap des Biches's service providers (insofar as ContourGlobal - Cap des Biches delegates surveillance responsibility contractually). In all cases, the HSE manager will perform regular inspections and checks on the installations during the construction and operational phases. His role will be to remind operators of good practices and management measures to be applied for every activity in the Project; any deviation observed will be recorded in a written report.

An annual environmental report will set out the various monitoring indicators defined in the ESMP and any deviations from them that have been observed.

The environmental report drawn up by the HSE manager will be a basis for environmental surveillance carried out by the Senegalese authorities. The authorities will also carry out checks on site, of variable frequency depending on the issue (see *Section 10.4*).

10.3 APPLICABLE STANDARDS AND PROCEDURES

The environmental and social standards and procedures applicable to the Project are those described in *Chapter 6* of the ESIA report. The impacts reduction plan below sets out which management measures will have to be undertaken in order to ensure that the Project complies with Senegalese environmental standards.

10.4 IMPACT REDUCTION PLAN AND MONITORING AND SURVEILLANCE PLAN

The impact reduction plan is a compilation of the mitigation measures identified in *Chapter 8, Evaluation of Impacts and Mitigation Measures* of the ESIA report.

For each measure, objectively verifiable monitoring indicators (OVI), means of verification (MV), the person in charge of implementing the measure and the budget involved are suggested.

The responsibilities and costs of the internal surveillance that will be implemented by ContourGlobal - Cap des Biches are also specified (see *Section 10.2*).

The budget given for each management measures is an estimate, calculated on the basis of an average cost of 65 000 CFA francs/man-day. It also takes into account the material costs of implementing measures, wherever possible. For mitigation measures that are integrated into Project design, the budget required for their implementation is included in investment expenditure (CAPEX) and operational expenditure (OPEX). The amounts of OPEX and CAPEX intended for implementation of the ESMP have not been included in this analysis, such that the detailed budget is a low estimate of the expenditure that will actually be incurred for the Project.

Note that some measures for managing environmental issues were already included in the Wartsila technical instructions book, which will supervise the construction phase.

Table 10.1 Impact reduction plan – construction phase

Activity/ Source	Potential impact	Impact receptors	Mitigation measures	OVI	MV	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Costs	Frequency manager	Costs
Impacts on air quality												
Site machinery, transport vehicles	Impact on air quality from combustion engine emissions	Local people Workers	Regular maintenance and inspection by the contractor in charge of the works	100% of vehicles that have been the object of annual maintenance over the past 12 months.	Maintenance report.	Throughout the construction phase	Contractor	Included in the budget of the company in charge	Service provider's HSE manager 1/ month	130 000 CFA F (2h/month i.e. 4 days over 6 months)	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	250 000 CFA F / 2 months
			Reduction of atmospheric emissions from vehicles by limiting the number of journeys as much as possible	Vehicle fuel consumption	Monthly report from the worksite HSE manager	Throughout the construction phase	Contractor	Same	Service provider's HSE manager 1/ month	520 000 CFA F (1 day/month) i.e. 16 days over 6 months)		
Storage and transport of excavated earth	Impact on air quality due to dust emissions	Local people Workers	Covers over dust generating storage areas to minimise dust flight	Visual observation	Monthly report from the HSE manager	Throughout the construction phase	Contractor	Same	Service provider's HSE manager Daily	260 000 CFA F (0.5 day / month i.e. 8 days over 6 months)		
			Cover loads that generate dust.	Visual observation	Monthly report from the HSE manager	Throughout the construction phase	Contractor	Same	Service provider's HSE manager 1/ month	130 000 CFA F (2h/month i.e. 4 days over 6 months)		
			Spray site access tracks if they are not asphalted.	Visual observation	Monthly report from the HSE manager	Throughout the construction phase	Contractor	Same	Service provider's HSE manager Daily	260 000 CFA F 0.5 day / month i.e. 8 days over 6 months		
Transport	Impact on air quality due to dust emission	Local people Workers	Speed limits of 30km/h on non-asphalted site access tracks.	Visual observation	Monthly report from the HSE manager	Throughout the construction phase	Contractor	Same	Service provider's HSE manager 1/ month	325 000 CFA F (2 days then 0.5 day / month i.e. 10 days over 6 months)		
Transport	Impact on air quality due to dust emission	Local people Workers	Wheels rinsed on vehicles leaving the site.	Visual observation	Monthly report from the HSE manager	Throughout the construction phase	Contractor	Same	Service provider's HSE manager 1/ month	260 000 CFA F (0.5 day / month i.e. 8 days over 6 months)		
Impacts on ambient noise levels												
Machinery, vehicles and all sources of noise	Ambient noise	Local people	Avoid night work as much as possible.	Number of nights worked less than 20% of the total number of days worked	Worksite register	Throughout the construction phase	ContourGlobal - Cap des Biches	No specific implementation cost	E&S manager, ContourGlobal - Cap des Biches	-	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	- *(included in the cost of bimonthly visits presented in terms of monitoring of air quality)*

Activity/ Source	Potential impact	Impact receptors	Mitigation measures	OVI	MV	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Costs	Frequency manager	Costs
Impacts on water resources												
Water requirements	Quantitative impact on water resource	Water resource	Optimise water consumption and minimise wastage Check absence of leaking equipment Supervise water consumption to identify any over-consumption and provide a basis from which to improve efficiency.	Volume of water consumed per day	Monthly report from the HSE manager Analysis of water volumes will identify any over-consumption which must be justified.	Throughout the construction phase	Contractor	Included in the budget of the contractor in charge	Service provider's HSE manager 1/ month	520 000 CFA F 1 day/month i.e. 16 days over 6 months	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	- *(included in the cost of bimonthly visits presented in terms of monitoring of air quality)*
Accidental spillages or leaks from the chemical product or fuel oil storage tanks or from the worksite machinery used at the site.	Impacts on water quality	Groundwater	Retentions on storage tanks for hydrocarbons or hazardous products and on unloading areas. Unloading and storage management procedure which minimises risks of leakage. Provision of cleaning equipment in case of spillage. In case of accidental spillage, a "spillage" incident will be opened; this incident will be closed when the area has been cleaned up.	Visual observation during bimonthly audits or ad hoc statements Number of incidents involving leakages or spillage	Monthly report from the HSE manager End of worksite report (in the case of monitoring "spillage" incidents).	Throughout the construction phase	Contractor	Same	Service provider's HSE manager 1/ month An audit of the way in which products are stored must be carried out once a month.	260 000 CFA F 0.5 day / month i.e. 8 days over 6 months		
Discharge of sanitation effluent	Impacts on water quality	Surface water and groundwater	Check and regular maintenance of the waste water evacuation system (temporary and permanent septic tanks)	Volumes of effluent emptied	Monthly reports from the HSE manager	Throughout the construction phase	Contractor	Idem	Service provider's HSE manager	260 000 CFA F 0.5 day / month i.e.8 days over 6 months		
Discharge of rain water	Impacts on water quality	Surface water and groundwater	Check and regular maintenance of the drainage system. The drainage system for non-contaminated water will be separate from the contaminated water collection system.	Visual check on management means after every major rainfall episode.	Monthly reports from the HSE manager	Throughout the construction phase	Contractor	No implementation cost Usual worksite practices	Service provider's HSE manager 1/ month	260 000 CFA F 0.5 day / month i.e.8 days over 6 months		
Impacts on biodiversity												
Construction work	Impacts on biodiversity Modification of natural habitats on site	Natural habitats, Fauna, Flora	Avoid or minimise clearance of vegetation anywhere other than in the power plant's construction area.	Visual observation	Daily reports from the HSE manager	Throughout the construction phase	Contractor	No implementation cost	Site HSE manager	260 000 CFA F 0.5 day / month i.e.8 days over 6 months	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	- *(included in the cost of bimonthly visits presented in terms of monitoring of air quality)*

Activity/ Source	Potential impact	Impact receptors	Mitigation measures	OVI	MV	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Costs	Frequency manager	Costs
Landscape and visual impacts												
Worksite installation, machinery, presence of the worksite	Landscape and visual impacts	Local people	Machines and materials will be stored in an orderly manner during the works. High machinery, including cranes, will not be left on site for any longer than is necessary for the construction work.	Visual observation	Daily reports from the HSE manager	Throughout the construction phase	Contractor	Included in the budget of the contractor in charge	Service provider's HSE manager	See measures relating to impacts on air quality: dust particles.	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	- *(included in the cost of bimonthly visits presented in terms of monitoring of air quality)*
Lighting required for the worksite	Landscape and visual impacts	Local people	External safety lighting directed downwards.	Visual observation	Daily reports from the HSE manager	Throughout the construction phase	Contractor	Same	Service provider's HSE manager	-		
Social impacts												
Preparation of land, change in land use	Impacts on land use of the parcel concerned by the works	Local people and employees	The Project Promoter will ensure that the land acquisition procedure implemented by SENELEC and validated by the Municipality of West Rufisque and the Domains Administration has been properly complied with.	Compensation reports of the beneficiaries (available at SENELEC)	Management committee meeting reports	Prior to start-up of the construction works	ContourGlobal – Cap des Biches	Costs already covered by SENELEC	Site manager	Already performed	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	- *(included in the cost of bimonthly visits presented in terms of monitoring of air quality)*
Employment of local labour	Local employment (positive impact).	Local people and employees	Ensure that the recruitment policy is well defined and advertised and that job offers and published at local level. This local procedure for jobs will be established in agreement with the authorities.	Monitoring of the number of local employees of the Project	Recruitment plan / policy. Recruitment policy. Before the start of the works and checks during the construction work.	Prior to start-up of the construction works	ContourGlobal - Cap des Biches	No specific implementation cost	Promoter's human relations manager	No specific monitoring cost	Technical committee and/or DEEC "Pollution and Disturbance" Division	
Employment of local labour	Local employment (positive impact).	Local people and employees	As far as possible jobs requiring no qualifications will be given in priority to candidates from the neighbouring urban community. ContourGlobal - Cap des Biches and the various contractors working on the project will estimate the number of jobs requiring few or no qualifications according to the different stages in the worksite, in order to draw up a provisions timetable for recruitment.	Monitoring of the number of local people hired.	Before the start of the works and intermittent checks during the construction work	Prior to start-up of the construction works	ContourGlobal - Cap des Biches	No specific implementation cost	Promoter's human relations manager	260 000 CFA F 0.5 day / month i.e. 8 days over 6 months		
Employment of labour	Propagation of contagious diseases, notably HIV/AIDS	Local people and employees	HIV/AIDS and contagious diseases prevention policy, with training sessions of the workers The Project promoter will establish a "code of conduct" right from the construction phase to ensure that employees behave in such a way as to limit the increase in contagious diseases and discourage prostitution.	Frequency of implementation of the awareness programme	Awareness programme communicated at the site and amongst surrounding communities	Prior to and during construction works	ContourGlobal - Cap des Biches	10 000 000 CFA F	Site manager responsible for HSE	520 000 CFA F 1 day / month i.e. 16 days over 6 month		

Activity/ Source	Potential impact	Impact receptors	Mitigation measures	OVI	MV	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Costs	Frequency manager	Costs
Impacts on health and safety												
Transport	Road safety risk	Local people and employees	Prepare a traffic plan comprising notably the establishment of speed limits for trucks around the power plant area. Installation of adequate signs in the Project's surroundings. Plan a timetable for traffic caused by the Project to avoid, if possible, peak traffic times in Rufisque.	Number of deviations observed	Daily reports from the HSE manager	Right from start-up of the construction works	ContourGlobal - Cap des Biches	Included in the budget of the contractor in charge	Site manager	See measures on air quality impacts: dust particles	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	- *(included in the cost of bimonthly visits presented in terms of monitoring of air quality)*
			Awareness of drivers and populations exposed to the road risk in the plant's surroundings.	100% of drivers who have attended training	Monthly reports from the HSE manager	Prior to and during construction works	GTI - Dakar	5 000 000 F CFA	Site manager	130 000 CFA F 2h /month i.e. 4 days over 6 months		
Impacts linked to waste management												
Waste management	Risk of pollution if badly managed	Local people and employees	Waste Management Plan (WMP) was developed prior to the start-up of construction work.	WMP approved prior to the start of works	WMP	Before start-up of the works and implemented throughout the construction phase	Contractor or service provider responsible for waste	Already performed	Site HSE manager	32 5000 CFA F 1 day over 6 months	Technical committee and/or DEEC "Pollution and Disturbance" Division Every 2 months	- *(included in the cost of bimonthly visits presented in terms of monitoring of air quality)*
		Local people and employees	Collection, storage, transport and disposal of waste by a specialist service provider, in compliance with Senegalese regulations. Traceability of removal and treatment of waste will be guaranteed by systematic recording of transport forms detailing the type of waste and the quantity and indicating the carrier's identity. Develop and maintain an inventory of stocks to reduce the amount of waste caused by materials out of date, materials that do not meet specifications, materials that are damaged or are in excess of requirements.	Report on waste produced and quantities removed for treatment by service providers.	Approval of the service provider. Waste dispatch form: Volume Type Destination	Right from start-up of the construction works. Throughout the construction phase.	Contractor in collaboration with GTI Dakar	Included in the contractor's budget	Site manager + HSE manager	780 000 CFA F i.e. 2 days/ month for 6 months		

Table 10.1 Impact reduction plan – operational phase

Activity source	Potential Impact	Impact receptors	Mitigation measures	OVI	MVI	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Annual costs	Frequency manager	Annual costs
Administrative procedures and applicable regulations												
Operation of the plant	Non-compliance with applicable Senegalese regulations	N/A	ContourGlobal –Cap des Biches will follow the administrative procedures required within the frame of this project (cf. Section 4.4 of this report), in particular those related to the ICPE regulations.	Absence of regulatory non-compliance	Obtained authorizations	Before the operational phase	ContourGlobal – Cap des Biches	Included	HSE Manager	-	Technical Committee	250 000 CFA per year
Impact on air quality												
Engines running on heavy fuel oil	Gas emissions (NO_x, SO_2, CO) and impacts on air quality	Local people Employees	Sulphur concentration in the fuel oil delivered will not exceed 2%.	100% of fuel oil will have a concentration <2%	Monitoring and recording of fuel oil quality used by means of delivery slips validating the quality requested.	Prior to start-up of the initial Project power plant (53MW), on signature of the supply contract. On every delivery during the operational period.	ContourGlobal - Cap des Biches Fuel supplier	1 200 000 CFA F	Site operational team. Monitoring terms included in the fuel supplier contract.	780 000 CFA F 1 day / month	Energy Office, DEEC, within the context of the annual report review	No direct cost involved
		Local people Employees	Delivery vehicles will be the object of regular inspections and maintenance. The number of journeys made by transport vehicles will be optimised.	Percentage of vehicles that have been the object of maintenance over the past 12 months. Objective of 100%	Vehicle inspection certificates	Operational phase.	Fuel delivery service provider	Included in the contractor's budget	Service provider's manager (regular maintenance of vehicles). Site operational team 1/month	200 000 CFA F 2h/month i.e. 3 days per year	DEEC Once / year	Travel cost paid: 200 000 CFA F

Activity source	Potential Impact	Impact receptors	Mitigation measures	OVI	MVI	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Annual costs	Frequency manager	Annual costs
		Local people Employees	Air quality monitoring to of baseline conditions and monitoring of ambient air quality over the long term. See *Table 10.7* related to the monitoring plan	Results of measurements	Monitoring report	Monthly report	Service provider specialising in air quality measurements	150 000 CFA F / month of labour 600 000 CFA F / month of analyses i.e. 9 000 000 CFA F / year	Site HSE manager 1/ month	1 560 000 CFA F i.e. 2 days/month	DEEC Twice / year	
		Local people Employees	Monitoring of atmospheric emissions at output from the stack : 1/ month	Results of measurements	Monitoring report	Every 6 month	Service provider specialising in air quality measurements	250 000 CFA F / month of labour i.e. 3 000 000 CFA F / year	Site HSE manager 1/ month	1 560 000 CFA F i.e. 2 days/ month	Energy Office DEEC, with the context of the annual report review	No direct cost involved
Impacts of noise emissions on ambient noise levels												
Power plant design	Ambient noise	Local people Employees	Use of silencers on exhaust stacks, air inlets and ventilation output ventilators. The installation of anti-noise panels for generators and the steam turbine has been planned. See *Table 10.7* related to the monitoring plan.	Results of measurements	Environmental monitoring report (section on noise)	During design of the power plant and then prior to start-up. Throughout the duration of power plant operations.	ContourGlobal - Cap des Biches Measurement already taken into account during the power plant design phase Specialised service provider	Annual cost of 1 000 000 CFA F (of which cost of analyses 130 000 CFA F i.e. 2 days / year)	Site HSE manager	195 000 CFA F i.e. 2h/month	Energy Office DEEC, with the context of the annual report review	No direct cost involved
Vehicles and machinery	Ambient noise	Local people Employees	Equip diesel engine vehicles and compression equipment with silencers Locate mobile equipment as far away from receptors as possible. As far as possible, plan to perform the various noisy activities all at the same time, in view of the fact that combined noise levels will probably not be much higher than the level produced if the operations had been carried out separately.	Sale	Environmental monitoring report (section on noise)	During design of the power plant and then prior to start-up. Throughout the duration of power plant operations.	ContourGlobal - Cap des Biches Measurement already taken into account during the power plant design phase Specialised service provider	Annual cost: 1 000 000 CFA F (of which cost of analyses 130 000 CFA F i.e. 2 days / year	Site HSE manager	195 000 CFA F i.e. 2h/month	Energy Office DEEC, within the context of the annual report review	No direct cost involved
Impacts on water resources												
Water consumption	Impacts on water resources	Populations (pressure on the resource)	Optimisation of water consumption and minimisation of wastage Monitoring of water consumption to identify any over-consumption	Volume of water consumed.	Check and analysis of the HSE manager's reports on water consumption to detect any abnormality. Evolution of consumption over time. Number of unexplained consumption peaks.	Right from start-up of the power plant and throughout operations	Site HSE manager	390 000 CFA F/year i.e. 4h/month	Site HSE manager twice / week twice / month once / day	390 000 CFA F i.e. 4 h / month	DEEC once / year	Travel cost paid: 300 000 CFA F

Activity source	Potential Impact	Impact receptors	Mitigation measures	OVI	MVI	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Annual costs	Frequency manager	Annual costs
Accidental spillage	Impacts on water quality	Groundwater	Regular check on installations to prevent any leakage or accidental spillage Installation of a piezometer at the fuel oil storage tanks in order to monitor groundwater quality (see *Table 10.7* related to the monitoring plan).	Number of problems observed Results of groundwater monitoring campaigns	Installation control sheets Environmental monitoring report (section related to groundwater quality monitoring)	One piezometer was installed before the operational phase of the initial Project power plant (53MW), in parallel of the construction phase. Control measures will be undertaken from commissioning of the plant and during all operation duration.	Maintenance manager	Control of the installations: 130 000 CFA F i.e. 2 days/month i.e. 1 560 000 / year Installation of a piezometer: performed in February 2016	Site HSE manager	195 000 CFA F i.e. 2h/ month 3 000 000F CFA / month (analyses)	DEEC once / year	
Effluent management	Impacts on water quality	Groundwater	Treat oily water in a deoiler before discharging it into the SENELEC canal provided	Daily water volume discharged	Environmental monitoring report (section relating to liquid effluent)	Same	ContourGlobal - Cap des Biches	Included in the functioning budget	Site HSE manager	2 340 000 CFA F i.e. 1h/day	DEEC once / year	
Effluent management	Impacts on water quality	Groundwater	Analyse effluent once a month	Results of analyses (hydrocarbons and pH)	Environmental monitoring report (section relating to liquid effluent)	Same	ContourGlobal - Cap des Biches	Included in the functioning budget	Site manager Monthly analyses	200 000 CFA F/ month	DEEC once / year	
Effluent management	Impacts on water quality	Groundwater	Storage of waste sanitation water in septic tank and emptying by an approved service provider	Volumes emptied	Service provider's tank emptying data sheets	Same	Specialised service provider	Included in the functioning budget	Site HSE manager	780 000 CFA F i.e. 1 day / month	DEEC, within the context of the annual report review	No direct cost involved
Landscape and visual impacts												
Functioning of the power plant	Landscape and visual impacts linked to the presence of the infrastructures and the effects of the lights at night	Local people	The design, orientation and materials will be suitably and reasonably developed to fit in with the characteristics of the existing site and with the characteristics of the landscape. Appropriate usage of non-reflecting surfaces and coloured surfaces External lighting as discreet as possible and directed downwards to prevent lateral lighting	Not applicable.	Adequate design and implementation	Same	Site HSE manager	Included in the functioning budget	Site HSE manager	130 000 CFA F i.e. 1 h / month	DEEC Once / year	150 000 CFA F
Social impacts												
Employment of local labour	Local employment (positive impact)	Local people and employees	Ensure that the recruitment policy is well defined and advertised and that job offers and published at local level. This local procedure for jobs will be established in agreement with the authorities.	Number of local workers	Recruitment plan / policy. Recruitment policy.	Throughout the operational phase	ContourGlobal – Cap des Biches	No specific implementation cost	Promoter's human relations manager	No specific monitoring cost	-	-

Activity source	Potential Impact	Impact receptors	Mitigation measures	OVI	MVI	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Annual costs	Frequency manager	Annual costs
Employment of local labour	Local employment (positive impact)	Local people and employees	As far as possible jobs requiring no qualifications will be given in priority to candidates from the neighbouring urban community. ContourGlobal - Cap des Biches and the various contractors working on the project will estimate the number of jobs requiring few or no qualifications according to the different stages in the worksite, in order to draw up a provisions timetable for recruitment.	Number of people hired locally.	Same	Same	ContourGlobal - Cap des Biches	No specific implementation cost	Promoter's human relations manager / HSE manager	520 000 CFA F 0.5 day / month i.e. 8 days per year		
Employment of labour	Propagation of contagious diseases, notably HIV/AIDS	Local people and employees	HIV/AIDS and contagious diseases prevention policy, with training sessions of the workers. The Project promoter will establish a "code of conduct" right from the construction phase to ensure that employees behave in such a way as to limit the increase in contagious diseases and discourage prostitution.	Frequency of implementation of the awareness programme	Awareness programme distributed around the worksite and amongst surrounding communities	Same	ContourGlobal – Cap des Biches	10 000 000 CFA F	Site manager /HSE manager	1 040 000 CFA F 1 day / month i.e. 16 days		
Impacts on health and safety												
Transport	Road safety risk	Local people and employees	Prepare a traffic plan comprising notably the establishment of speed limits for trucks around the power plant area. Installation of adequate signs in the Project's surroundings. Plan a timetable for traffic caused by the Project to avoid, if possible, peak traffic times in Rufisque.	Number of deviations observed	Daily reports from the HSE manager	Same	ContourGlobal – Cap des Biches	Included in the functioning budget	Site manager	See measures on air quality impacts: dust particles	DEEC, within the context of the annual report review	No direct cost involved
			Awareness of drivers and populations exposed to the road risk in the plant's surroundings.	100% of drivers who have attended training	Monthly reports from the HSE manager	Same	ContourGlobal – Cap des Biches	5 000 000 CFA F	Site manager	260 000 CFA F 2h /month i.e. 4 days per year		

Activity source	Potential Impact	Impact receptors	Mitigation measures	OVI	MVI	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Annual costs	Frequency manager	Annual costs
Impacts liked to waste management												
Waste management	Risk of pollution if badly managed	Local people and employees	Waste Management Plan (WMP) to be developed prior to the start-up of operations.	WMP approved prior to the operational phase	WMP	Before commissioning of the plant (using and adapting the WMP implemented throughout the operations).	Contractor or service provider in charge of waste	5 000 000 CFA F	Site HSE manager	65 000 CFA F 1 day per year	DEEC Once at the start of the operational phase	150 000 CFA F
		Local people and employees	Collection, storage, transport and disposal of waste by a specialist service provider, in compliance with Senegalese regulations. Traceability of removal and treatment of waste will be guaranteed by systematic recording of transport forms detailing the type of waste and the quantity and indicating the carrier's identity. Develop and maintain an inventory of stocks to reduce the amount of waste caused by materials out of date, materials that do not meet specifications, materials that are damaged or are in excess of requirements.	Report on waste produced and quantities removed for treatment by service providers.	Approval of the service provider. Waste dispatch form: Volume Type Destination	Same	Contractor in collaboration with ContourGlobal – Cap des Biches	Included in the contractor's budget	Site manager + HSE manager	1 560 000 CFA F i.e. 2 days/month		

Activity source	Potential Impact	Impact receptors	Mitigation measures	OVI	MVI	Timetable for implementation	Implementation		Internal monitoring		External monitoring	
							Manager	Costs	Frequency manager	Annual costs	Frequency manager	Annual costs
Power plant operation	Risks linked to installations	ContourGlobal - Cap des Biches staff, sub-contractors, surrounding populations	Establishment of an Internal Operation Plan (IOP) by ContourGlobal - Cap des Biches before the power plant's operational phase Staff training in IOP procedures Performance of exercises to train in procedures	IOP Number of staff trained Number of internal exercise for training in procedures Number of external exercises organised with firefighters and the Civil Protection Office	Validation of the IOP List of staff trained Reports on internal and external exercises Participation by the Civil Protection Office in the exercises (in collaboration with Rufisque firefighters)	Drafted prior to start-up of the power plant (implemented during the whole of the construction phase) Regular staff training sessions (at least once a year during the operational phase) Bi-monthly internal exercises Annual external exercises	ContourGlobal - Cap des Biches	• Creation : 13 000 000 CFA F • Inclusion of protection mechanisms into the design: included in CAPEX • Maintenance of protection mechanisms : included in OPEX • Staff training and performance of exercises: 400 000 CFA F /year	Site HSE manager	6 days a year i.e. 390 000 CFA F	Civil Protection Office Once /year	250 000 CFA F

10.5 ENVIRONMENTAL MANAGEMENT SYSTEM: MAIN THEMED PROCEDURES

In addition to the mitigation plan presented above, the following themed environmental management procedures are to be planned:

- Water resource management
- Waste management
- Transport management
- Environmental emergency response plan in case of spillage
- Periodic for audit and review of the ESMP.

The essential principles of these procedures are defined in the following sections.

These procedures must be integrated into the power plant's environmental management system. They will be designed to be adaptable to the various Project phases, in order to remain relevant to the specific issues arising in each phase.

Other procedures relating to the safety of installations and associated industrial risks will also be implemented through the Power Plant's IIP (Internal Intervention Plan) and IOP (Internal Operation Plan). Specific procedures relating to worker health and safety will also be planned; the study of occupational risks presented in *Chapters 8 and 9* of the ESIA report will act as a basis for this procedure.

10.5.1 Water resources management procedure

The aim of this procedure is to integrate into the ESMP the water resource conservation demands that are part of Senegalese national policy and inherent to development of the Project. It concerns:

- Water consumption by the power plant
- The protection of soils, groundwater and seawater, notably by the prevention of discharge of pollutant products into the environment and the prevention of pollutant migration from the power plant into groundwater and onto the coast.

The water resources conservation procedures will include provisions aimed at limiting the risks of soil contamination notably in areas of temporary accumulation of rain water on the surface.

The water resources conservation procedure will include the following elements in particular:

- An inventory of water consumption stations planned for each phase in the Project
- A description of water consumption monitoring and reduction measures to be implemented for each phase in the Project

- Details of planned water storages
- Details of liquid effluent treatment and discharge mechanisms, for effluent from each phase in the Project (notably: origin, design of networks and collection ditches, design and performance of treatment units and surveillance of the quality of treated water prior to discharge).

The environmental management manager at the power plant will ensure that water resource management reports are drawn up regularly, including results from the periodic monitoring of resource quality and availability, the results of environmental audits concerned with water resource management and the corrective measures implemented where necessary.

Table 10.2 Principles applicable to the water resource management procedure

Aspect	Management principle
Reduction of water consumption	• Collection and recycling of rain water and non-contaminated water used to wash equipment and surfaces, with the aim of reducing dust. • Monitoring of water consumption and identification of abnormally high consumption episodes, to detect any possible leakages and define corrective action.
Implementation of management measures for hazardous products, effluent and waste products in order to prevent any infiltration of pollutants into groundwater / the coast	• Systematically implement a substitution principle: replace any hazardous products with its less hazardous equivalent. • Storage and handling of products: use of retentions with recuperation of drips and spillages for the storage and unloading of hazardous products as well as for washing and maintenance activities. • No buried tank will be installed for the storage of hydrocarbons or other hazardous products. • Storages of hazardous products will be designed and built so as to allow adequate confinement and protection with regard to any leakages, in order to prevent any impact on the environment. Each tank will be located on a retention fitted with a leakage detection system. • Storages and networks of hazardous products, i.e. tanks, pipelines and connecting pipes will be regularly inspected by qualified staff and an inspection report will be drawn up. • Staff will be trained in good practice in terms of the storage and handling of products and in maintenance, to prevent any risks linked to hazardous products.

10.5.2 *Waste management procedure*

This sub-section describes the principles applicable to the development of a management procedure for waste at the power plant. These principles are defined on the basis of the requirements of Senegalese regulations applicable to waste and current good practice relating to waste management.

The optimisation of waste management is a continuous process and ContourGlobal - Cap des Biches will periodically review this procedure with a view to continual improvement. This revision should not be restricted to the evaluation of waste treatment and disposal facilities, but should also focus on the use of technical solutions with a view to the reduction of waste at source.

Table 10.3 Principles applicable to the waste management procedure

Aspect	Management principle
Purchasing department – selection of materials and products that generate the least possible waste	• In its supplies policy, ContourGlobal - Cap des Biches will take waste generation potential into account in order to selection options that generate the least waste, wherever possible.
Inventory management	• Inventory management system will be kept up to date with a view to identifying product consumption, ensuring the traceability of waste and identifying any wastage and over-consumption. • An inventory will be kept of all waste generated and eliminated (type and volumes). • ContourGlobal - Cap des Biches will develop objectives for reductions in the amounts of waste generated, year on year, based on a periodic review of inventories.
Staff training	• Waste will be handled and stored according to its type and risk classification, in compliance with health and safety rules. • An area for central accumulation of waste (ACAW) will be used to store waste. Compatible waste materials will be stored together. • Areas of the ACAW used to store hazardous waste will be covered and the ground will be waterproofed. Liquid and hazardous waste storage units will be fitted with retention systems. • The ACAW will be fenced and only authorised staff will be allowed access to the site. • The ACAW will be maintained in good order, clean and with waste products separated by type and risk classification, in order to minimise risks of pollution, fire and explosion, and the proliferation of vermin.
Final disposal of waste	• Recyclable waste will be regularly collected for recycling by local recycling companies. Contracts for the collection of waste by these companies will be confirmed after verification of acceptability of their practices from an environmental, health and safety management point of view. • All hazardous and non-combustible waste will be processed appropriately in the country or exported abroad for processing and final discharge. Any export of waste for elimination outside the borders of Senegal will meet the demands of the Basel Convention on the control of transborder movements of waste and other hazardous materials. • Potentially infectious waste will be place in dedicated, labelled recipients, for evacuation to a specialized centre for incineration in a dedicated incinerator. • No waste will be burned in the open air.
Transport of waste off site	• When waste materials are sent off site, suitable transport vehicles will be used (if needed by means of use of a service provider) in order to comply with the rules on ensuring that loads are safe, properly labelled and traceable. • The transport vehicles used will be fitted with means with which to take action in case of any accidental spillage.

Aspect	Management principle
Cumulative impact	• Monitoring of what happens to waste in order to anticipate any saturation of the facility. • The waste management plan will describe possible alternatives to the local facility, in anticipation of any saturation.

This plan was already developed for the construction phase of the initial Project (53MW).

10.5.3 Transport management procedure

This section describes the principles to follow for the development of a Transport Management Procedure (TMP), notably associated with the following phases of the Project:

- Construction:
  - transport of construction equipment and machinery
  - transport of products and materials purchased or extracted locally, in the periphery of the Project area, to the construction site

- Operation:
  - transport to the Project area of technical supplies: chemicals, spare parts, equipment/tools for work on installations
  - fuel
  - maintenance equipment
  - workers transport

Table 10.4 Transport management principles

Aspect	Management principle
Condition of public roads used by vehicles for the Project	• A review will be carried out of regulations applicable to the transport of staff and goods on public roads, in order to provide a basis for regulatory conformity of transport activities, notably in terms of maximum axle loads authorised depending on the type of road taken. • Public road preservation measures specific to the Project will be implemented, notably: o Compliance with regulatory limits on vehicle axle loads o Compliance with Project speed limits on road and tracks o Transport of site machinery using flatbed trucks o Creating driver awareness of road driving that respects the state of roads and highways. • It may be necessary to improve certain sections of road or track, in agreement with local highway authorities.

Aspect	Management principle
Atmospheric emissions linked to car and truck traffic	• Vehicles used for the Project's construction phase must comply with the emission limit specifications identified by regulations and by international best practice. • The vehicles will be duly maintained by ContourGlobal - Cap des Biches and its sub-contractors, in order to ensure correct functioning of their engines and their exhaust fume filtering systems. • Measures to reduce fuel consumption and atmospheric emissions will be studied.
Site machinery traffic	• Safety measures will be implemented to ensure road user safety, notably: o The signalling of heavy vehicles using public roads (use of flashing lights and signs) o Escort of wide loads by escort vehicles, (leader cars and cars bringing up the rear) o Limitation of the weight and volume of loads to ensure good road stability o Coordination with local authorities to agree on routes to be taken, times and road safety measures to be implemented and intervention and coordination measures to be implemented in case of incident. • Where possible, ContourGlobal - Cap des Biches and its sub-contractors will ensure that vehicle loads are optimised, if necessary by means of loads shared between different Project operators in order to limit the number of vehicles to be mobilised.
Waste transport	• Any transport of waste, whether hazardous or not, will be undertaken in compliance with the waste management procedure, taking into account applicable regulations and international good practice relating to the packaging, packing, labelling and transportation of waste.
Parking on public roads	• Vehicles, particularly HGVs, which are stopped on public roads or in populated areas, must ensure that they are safely parked and do not obstruct the public highway.
Training	• Driving training will be provided to ContourGlobal - Cap des Biches and sub-contractor staff, to ensure that the drivers of vehicles and machinery working on the Project apply good road driving rules, in order to guarantee the safety of staff and third parties. • ContourGlobal - Cap des Biches and its sub-contractors will ensure that only staff who have taken road safety training and have reached the levels of competence required are authorised to drive the Project's vehicles and machinery. • In addition, all drivers must receive (at least): o Training that is specific to their type of vehicle o Defensive driving training o Driver training in driving rules to ensure the safety of off-site road users (for example pedestrians, farmers using the road to move their farm machinery, herdsmen moving their animals across the road).

Aspect	Management principle
Measures in case of accident	• In case of a traffic accident involving one of the Project's vehicles, the ContourGlobal - Cap des Biches manager in charge of activity supervision will inform emergency services as quickly as possible. These emergency services will be on the one hand the ContourGlobal - Cap des Biches emergency crew (working immediately, off the public highway) and on the other hand (on the public highway) public emergency services. Details of the incident or accident will be recorded in an accident report.

10.5.4 *Environmental emergency response plan in case of spillage*

Accidental events may result in various environmental impacts, such as, for example, uncontrolled spillages of hydrocarbons, chemicals or other hazardous waste, notably in case of:

- A leak or crack of the fuel oil supply pipe, a tank, vat or container
- A leak from a collection network
- An accident situation in the processing installations, during the operational phase, leading to the spillage of hydrocarbons, sludge or potentially contaminated water into the environment
- A traffic accident involving damage to a diesel tank or a fuel oil tank.

An emergency response plan in case of spillage will be implemented by ContourGlobal - Cap des Biches organising a systematic, quick and efficient response to any kind of emergency, accident situation or spillage of water contaminated by hydrocarbons, or of any other hazardous chemical product, in order to reduce/remedy potential damage to the environment and property. This plan must plan for immediate confinement of any spillage and rapid cleaning of any deteriorated area.

This procedure will define the roles and responsibilities of ContourGlobal - Cap des Biches staff and sub-contractors in the response process in case of accidental spillage. The location of intervention equipment and the contact details of trained staff must be clearly displayed.

The emergency response plan in case of spillage will include training and awareness, and will notably specify requirements terms of continuous staff training and the performance of periodic training exercises. It will also include provisions for the correct periodic verification and maintenance of intervention resources.

This procedure will be periodically audited and revised in order to ensure it remains relevant and operational throughout the Project's lifespan.

10.5.5 *Periodic audit and update of the ESMP*

Audit and review levels

The ESMP will be periodically audited and updated to ensure sustainability and continuous improvement throughout the Project, from detailed design phase to operational phase.

At corporate level, the ESMP will be reviewed within the context of ContourGlobal - Cap des Biches Project audits, focussing on risk identification, the ESMP, specific HSE standards and objectives and the reporting process for environmental indicators related to the Project. To ensure audit integrity it is preferable for audits to be carried out by staff members who do not work directly on the Project, or by specialised sub-contractors.

At operational level, a periodic audit programme will be drawn up and implemented aiming to check that the environmental management procedures specified in the ESMP are included in operational procedures, effectively implemented and that their results in terms of improving the environmental efficiency of activities are monitored over time. These audits will be scheduled and accompanied by the Project's environmental management team.

Within this context ContourGlobal - Cap des Biches will establish an audit schedule for the environmental management procedures used by sub-contractors involved with the Project, and their environmental performance. To this end all sub-contractors must draw up an internal verification programme, permitting continuous improvement of the ESMP at their level, between each audit.

Integration and use of results

The integration of audit and monitoring results will permit periodic evaluation of the relevance and adequate nature of the Project's ESMP. Any change to or adaptation of the ESMP will be the object of written tracking and an update of the checked version of the ESMP. Changes to the ESMP will be communicated to the Project team and their results will be evaluated during the next audits, in a continuous improvement cycle.

10.6 CLOSURE AND RESTORATION OF THE SITE AFTER OPERATIONS

The contract signed between ContourGlobal - Cap des Biches and SENELEC provides for operation of the power plant for 20 years. This duration could be extended depending on local electricity generation requirements and according to the national production strategy defined by SENELEC. The power plant will be subject to a Closure and Restoration Management Plan (CRMP). In compliance with the CRMP, ContourGlobal - Cap des Biches will implement the measures required to restore all sites at the end of the Project, and to ensure that environmental and social impacts associated with closure of the site are kept under control, in accordance with regulations and good practice.

In this respect, ContourGlobal - Cap des Biches will implement measures throughout operation of the power plant to ensure the absence of any deterioration of the site. If such an event, impacting the condition of the site, were to take place during the operational period, ContourGlobal - Cap des Biches would record it and the necessary investigations and remediation would be undertaken. In order to prevent any contamination of the soil and groundwater, various measures in terms of the storage and use of chemicals, lubricants and hydrocarbons, will be implemented.

10.6.1 Integration of issues linked to closure – design phase

The power plant has been designed for continuous operation whilst guaranteeing a relevant safety level. All the design studies for the power plant have included the good practices currently recognised in the industry. With the aim of minimising impacts linked to site closure, design of the power plant has taken into account and included the following aspects (this list is not exhaustive:

- Choice and use of materials
- Ease of replacement and dismantling
- Location of equipment
- Limitation of pollution accumulation, in waste water networks, for example
- Installation of secondary containment around tanks and storage areas
- Ease of operation
- Ease of cleaning

Pipelines carrying hydrocarbons will be either over ground or buried and fitted with a double skin or easy access, in accordance with international good practice, in order to allow any leak to be detected.

10.6.2 Integration of issues linked to closure – operational phase

ContourGlobal - Cap des Biches will adopt a series of measures during the operational phase in order to minimise site restoration requirements after operations are finished. The following measures in particular will be adopted:

- Confinement and appropriate management of chemicals, lubricants and hydrocarbons in order to minimise the risk of accidental leakage
- Development and maintenance of a drainage system in order to avoid, in the product spreading, in case of leakage, and contaminating surface water (including seawater) and groundwater
- Storage of anti-spillage kits in the storage areas and employees trained to use them.

- Management of sub-contractors during deliveries of chemicals, fuel oil and lubricants as well as during waste product collection
- Regular review of measures implemented for the storage, control and cleaning of chemicals, hydrocarbons and lubricants
- Adequate staff training.

10.6.3 *Site closure and restoration*

The CRMP will be established in agreement with SENELEC and the competent authorities, after a closure audit carried out according to national regulations or international good practice. This plan will be reviewed regularly throughout the project's various phases and updated in case of modification of operating conditions (change in fuel oil delivery methodology). Implementation of the measures described in the preceding paragraph will minimise any contamination of the environment. The management plan will detail the following:

- replacement or cleaning of pipelines and equipment if necessary and evacuation of any hazardous materials that they might contain
- plans of buried cables, pipelines and equipment
- site protection and surveillance programme, including soil sample analyses if necessary.

Content of the CRMP will be organised as follows:

- summary of scenarios envisaged in terms of site closure and restoration
- summary of applicable environmental recommendations (Senegalese and international)
- description of standards and criteria applicable to the site, after dismantling
- initial description of planned dismantling measures for the various site installations
- surveillance of the site after closure and requirements in terms of maintenance
- planned timetable for the dismantling of installations
- responsibilities it terms of dismantling and maintenance
- supervision of costs.

The CRMP will include the following appendices:

- cleaning, restoration and remediation methods
- erosion control
- treatment facilities for waste generated by site dismantling.

A report on cessation of activity will also be drafted after operations are ended, reporting on the condition of the site. This report will be communicated to the Environment Minister and to the ICPE supervisory Minister.

Before commencing dismantling operations, an evaluation of risks linked to these operations will be undertaken. This evaluation will address activities, risks and control measures, as well as the following points:

- consumables, chemicals, oils, lubricants …
- exposure to noise and control
- staff management
- handling and storage
- burns, cuts
- cleaning
- demolition
- site dismantling and cleaning
- evaluation of the presence of hazardous materials
- accidents and near-accidents
- loading and unloading
- elimination of waste and materials
- contaminated soils and materials
- health and safety.

Dismantling of the power plant will be carried out in compliance with good practice in force at the time of these operations. Operations to dismantle the power plant and its associated installations may lead to a risk of exposure to dust and hazardous and inflammable products. Infrastructures likely to present the greatest risks during their dismantling are as follows:

- fuel oil unloading area
- heavy fuel oil storage and service tanks
- oil storage tanks
- fire water tank
- pumping station
- sludge treatment area
- sludge tanks
- machines and engines room
- pipelines
- stacks

Exposure to the various hazards identified must be prevented by the implementation of suitable good practice, such as:

- staff training in the removal of potentially hazardous waste from tanks, equipment or contaminated soil
- staff training in the treatment and removal of potentially hazardous equipment (for example electrical or insulation equipment containing mercury)
- use of personal protection equipment (PPE) adapted and selected after risk evaluation such as, for example, gloves, eyewear and insulating respiratory apparatus

- implementation of a work permit system for work by hotspot or operations performed close to or on electrical equipment.

During the dismantling phase, all collections or removal of materials and waste will be recorded to ensure the traceability of these movements.

10.7 ENVIRONMENTAL SURVEILLANCE AND MONITORING PLAN

10.7.1 *Environmental surveillance*

The environmental report drawn up by the ContourGlobal - Cap des Biches HSE manager will act as the basis for environmental surveillance by the DEEC (particularly the "Pollution and Disturbance" division and the air quality management centre) and the DREEC, through the Environmental Monitoring Committee.

These Offices will also check on the installations, by means of regular visits to the worksite area (construction phase) and the power plant (operational phase) in order to ensure that the measures set forth in the ESMP are being properly complied with, and that annual reports are a good reflection of the actual situation at the site. Other regional offices, in particular the DEFCCS (Office for Water, Forests, Hunting and the Conservation of Soils), the Office for Civil Protection will also be involved in surveillance of the power plant.

With the context of environmental surveillance, it is planned that the actions presented in *Table 10.5* will be carried out. The exact terms may be adapted however, depending on specific issues inherent to the various different Project phases (see *Section 10.4*).

Table 10.5 Environmental surveillance methods

	Construction phase	Operational phase
Report review	1 report at the end of the overall construction phase for the Project (86MW).	1 annual environmental monitoring report
Site visit	Up to one monthly visit involving the various Offices concerned with surveillance by turn (depending on the issues of the moment).	• Unannounced inspections. • About 1 visit per year to supplement/fine-tune the information presented in the annual report.

Requirements for institutional reinforcement of the Senegalese authorities in order to be able to carry out the surveillance action are identified in *Section 10.8.2* on the plan to reinforce capacities.

10.7.2 *Environmental monitoring*

The environmental and social management plan presented in *Section 10.4* comprises:

- Corrective measures intended to suppress or reduce potential impacts
- Monitoring measures aimed at ensuring the efficiency of corrective measures.

This environmental monitoring concerns the issues for which the Project's potential impacts, prior to mitigation, were relatively large. It aims to evaluate the efficiency of certain environmental measures and possibly to identify impacts whose scope is different to that anticipated.

An environmental monitoring plan will thus be implemented to enable regular monitoring of the Project's potential impacts, notably of ambient air quality, noise levels, quality of water discharged, groundwater and soils. The results of these specific measures will be integrated into the environmental annual report that will be reviewed by the Senegalese authorities. This plan is summarised in *Table 10.6* below.

Table 10.6 Environmental monitoring plan

Aspect	Type of monitoring / location	Method / indicators to follow	Periodicity	Implementation date
Air quality	Monitoring of the power plant's atmospheric emissions.	• Air quality monitoring of SO_2 and NO_2 by means of passive samplers, diffusion tubes, deployed at 6 monitoring sites. These sites are located at sensitive receptors which could potentially be affected the emissions of the Project itself. • Air Quality Monitoring of PM10 and PM2.5 by means of BAM-1020 monitors at 3 monitoring sites where of SO_2 and NO_2 is also monitored.	• SO_2 and NO_2 sampling is performed on a monthly basis. Diffusion tubes are retrieved and replaced after the tube has been exposed for 4 weeks. • PM10 and PM2.5 measurements are collected on a continuous basis.	Campaign to consolidate data from the baseline, prior to the operational phase (during with the power plant's construction phase). Monitoring campaign during operations in "normal" mode as from start-up of the power plant.
Quality of water discharged	Sampling of effluent and laboratory analysis	• An analysis of effluent prior to discharge will be performed once a month. In case of discharge thought to be abnormal, the water will be recycled to the treatment plant and specific analyses will be performed. • Results of analyses performed after treatment will be recorded and measures will be taken in case of any excessive readings.	Sampling, and monthly analyses.	As from start-up of the of the initial Project power plant (53MW).

Groundwater quality	Monthly sampling via the piezometer. Monthly analysis of the quality of groundwater.	• An analysis of the quality of groundwater will be conducted once a month in order to detect potential contamination related to abnormal functioning of the facility. • The analysis results will be recorded and measures will be put in place only if exceedances are shown. • In the event of detection of a groundwater pollution, the Senegalese authorities will be informed.	Monthly sampling and analysis	As from start-up of the of the initial Project power plant (53MW). The piezometer was set up in February 2016
Water consumption	Monitoring of water consumption to identify any over-consumption.	• Check and analysis of the HSE manger's reports on water consumption, in order to detect any abnormality.	Monthly check.	As from start-up of the of the initial Project power plant (53MW).
Acoustic environment	Noise levels monitoring in the environment.	Noise measurements: • At the site boundary • At the closest sensitive receptors (see points used in the baseline).	Every 6 months Additional measurements will be achieved in case of a complaint from a neighbour	As from start-up of the of the initial Project power plant (53MW).

Environmental monitoring will be carried out either by a specialised external company or internally by ContourGlobal - Cap des Biches technicians (measurement of air quality at stack output, for example). Roles and responsibilities will be specified at the same time as the monitoring and surveillance methods.

10.7.3 *Air quality measurements: proposal for monitoring areas*

Contour Global has been undertaking an air quality monitoring survey in the airshed of the Project, since November 2014.

The air quality monitoring survey focuses on the following atmospheric pollutants:

- NO_x, NO_2 and SO_2, monitored at 6 monitoring sites since November 2014 by means of Gradko diffusion tubes; and
- PM10 and PM2.5, monitored at 3 monitoring sites since September 2015 by means of E-Samplers manufactured by Met One Instruments. It is noted that in January 2016 E-Samplers have been replaced by BAM-1020 monitors also manufactured by Met One Instruments, which are designated USEPA Equivalent Methods for PM10 and PM2.5.

An extensive overview of the air quality survey timing and logistic is presented in *Section 5.3.8*.

10.8 *ENVIRONMENTAL AWARENESS AND INSTITUTIONAL CAPACITIES REINFORCEMENT PLAN*

10.8.1 *ContourGlobal - Cap des Biches staff awareness*

Staff training on issues relating to environmental management, industrial hygiene and work station safety is an important element on which the Project's ability to meet the relevant HSE standards depends.

Training is required at ContourGlobal - Cap des Biches in order to maintain a high level of knowledge of HSE procedures and standards, commensurate with the environmental management objectives and plan.

Recommended training modules could cover:

- The understanding of environmental sensitivities and risks associated with the Project

- The understanding of mitigation measures in the design and creation of the Project

- The understanding of adequate procedures for the use and handling of chemicals and of waste management procedures

- Awareness of individual responsibilities and the team's responsibility when the environmental management plan is implemented, and training in application of its procedures

- Knowledge of, and training in, emergency procedures.

Other subjects could be defined depending on staff competencies at various work stations and their hierarchical levels.

In parallel to this internal training policy for ContourGlobal - Cap des Biches staff and sub-contractors, there will also be some communication actions with village communities around the site. These awareness actions, which are measures to accompany the Project's residual impacts, were presented in *Section 10.4*. The main topics that will be addressed may concern the following elements:

- HIV/AIDS prevention
- Road safety prevention
- Awareness in case of incident (in relation with the power plant's IPP and IOP).

10.8.2 *Possible reinforcement of the capacities of authorities responsible for environmental surveillance*

As indicated in *Sections 10.4* and *10.7.1*, several Senegalese administrative entities (particularly the DEEC and the DREEC) will be involved in the Project's environmental surveillance.

Similar environmental surveillance is already being undertaken by the DEEC at the Kounoune power plant and at other power plants in the country.

In the Project's case, it should be noted that DEEC staff, particularly from the "Pollution and Disturbance" Division (which will coordinate the majority of action linked to environmental surveillance) and from the Air Quality Management Centre (CGQA), are relatively used to monitoring thermal electricity generation plants, in view of the existence of several installations of this type (particularly in the Cap des Biches area).

However, a need to reinforce the capacities of the DEEC ("Pollution and Disturbance" Division and CGQA) in terms of atmospheric discharge and noise surveillance has been identified. If it takes place, this reinforcement must take into account complementarity between national and regional levels, by also involving the DREEC. ContourGlobal - Cap des Biches and DEEC can work together in order to specify the details of these requirements and make them official (training sessions and supply of equipment) and to define implementation responsibilities.

In this respect ContourGlobal - Cap des Biches could contribute to the acquisition of measurement equipment (sonometer, hydrocarbon analysis kit, etc.) up to an amount of 15 000 000 CFA francs.

Alongside this support, support linked to actual implementation of external monitoring could be provided. This support could involve:

- Review of reports: help with the interpretation of environmental monitoring results with intervention by a specialised service provider during the first two years of plant operation, to give enough time for the Senegalese authorities to increase their skills.
- Visit to the site:
  - Help with the performance of control measurements with intervention by a specialised service provider (cost already included in external monitoring – see *Chapter 10.4*)
  - Provision of logistic requirements for these visits (cost already included in external monitoring – see *Chapter 10.4*)

Costs associated with support for the authorities within the context of external monitoring are estimated at:

- Intervention by a specialised service provider (help with report review): 10 days' work per year, i.e. 5 000 000 CFA F per year, for a period of 2 years.

    - Intervention by a specialised service provider (help with the performance of measurements on site): 4 000 000 CFA F / year an (cost already included in external monitoring – see *Chapter 10.4*).
- Provision of logistic requirements (cost already included in external monitoring – see *Chapter 10.4*).

These elements must be taken into account if a protocol of cooperation is defined with a view to institutional support for the Senegalese authorities in charge of the project, if this protocol is defined between the Promoter and the DEEC.

10.9 ESMP IMPLEMENTATION PLAN

10.9.1 Responsibilities

Aim

This section describes the organisation of environmental and social management for application of the ESMP during the various phase of the Project.

Project Promoter

As Project promoter and owner, ContourGlobal - Cap des Biches will take general responsibility for correct application of the ESMP. ContourGlobal - Cap des Biches will mandate an environmental and social manager, with a sufficient level of authority and resources to supervise correct application of the ESMP.

The ContourGlobal - Cap des Biches HSE manager will be notably responsible for:

- Implementing and monitoring the Project's environmental and social management measures
- Coordinating sub-contractors of second and third levels with regard to ESMP requirements
- Reacting to the results of site inspections
- Supervising the reception, registration and processing of any complaint brought by external parties.

Alongside these internal monitoring activities the HSE manager will draw up an annual environmental report presenting the various monitoring indicators defined in the ESMP as well as any deviations observed. This environmental report will act as a basis for the environmental surveillance that will be carried out by the Senegalese authorities during installation inspections.

Contractors and sub-contractors working on the Project

During the construction phase, ContourGlobal - Cap des Biches will hire contractors to provide services of a technical nature and to carry out construction work at the power plant. They will be responsible for the implementation of all the mitigation measures specified in the ESMP.

They will also be responsible for continuous management of potential environmental and social impacts associated with their activities within the context of their mandate from ContourGlobal - Cap des Biches, whether these activities are carried out by them or by their sub-contractors.

10.9.2 Implementation deadlines

Some measures described in the ESMP will be implemented right from the start of the construction phase, whilst others will only be implemented once the operational phase has begun. Implementation details are given in the impacts reduction plan in *Section 10.4.*

10.9.3 Budget

The budget for each management measure presented in *Section 10.4* includes the costs of implementing the measure and those of internal monitoring. Costs associated with environmental surveillance (external monitoring) are also estimated, for information. These estimates are still to be fine-tuned, they are based on the costs of equipment and salaries at the time of writing this ESIA.

Some of these mitigation measures have been implemented during the project conception phase. For those measures, the associated costs are included in the investment costs (CAPEX) and in the operational costs (OPEX). Costs relating to the ESMP implementation within CAPEX and OPEX budgets have not been integrated in this study. Consequently, the estimated budget detailed in this ESIA underestimates the real cost of the measures that will be implemented at the site for the Project.

Estimated budget for the implementation of mitigation measures that have not been taken into account during the conception phase is presented in the *Table 10.7.* Estimated costs for external monitoring correspond both to logistic support with travel by authorities and to the sub-contracting of certain monitoring activities to specialised experts as well as technical support (acquisition of equipment and training).

Table 10.7 Budget for ESMP implementation

Project phase		Measure implementation	Internal follow up	External follow up
Construction		15 000 000 F CFA	5 460 000 F CFA	250 000 F every two months i.e. 750 000 F CFA (duration 6 months)
Operation	*Annual cost*	16 610 000 F CFA	12 360 000 F CFA	10 050 000 F CFA / year for the two first years, including support for annual reports drafting
				then 5 050 000 F CFA the following years, including support from a specialized subcontractor

11 GENERAL CONCLUSION

This report presents the conclusions of the updated Environmental and Social Impact Assessment study undertaken for the ContourGlobal - Cap des Biches's Project to revamp and modify a thermal power plant (53MW) located at Cap des Biches and for its extension (33MW) for a total capacity of 86MW.The power production process of the new facility will implement a recent technology, different from the one initially implemented between 2000 and 2013. This new technology will allow limiting the project interactions with environment in particular with the marine environment. In addition, some existing equipment will be refurbished and reused in the new facility.

Data sources that were used for this study include:

- secondary sources, notably technical documents linked to the project and drawn up by ContourGlobal - Cap des Biches, studies undertaken for other projects in the region, statistics issued by Senegalese ministries, publications of international organizations or research centers ;

- examination of the legislation, of international policies and standards connected to the Project implementation;

- two visits in the Project area to validate and complete available data related to environmental and social aspects of the Project ; and

- outputs of public in-depth information and consultation process. During this process, stakeholders had the opportunities to ask questions and to share their concerns related to the Project and to the ESIA implementation.

Based on the data collected and the Project characteristics, potential impacts associated with the power plant construction and operation have been identified, and in particular for air quality, ambient noise, wastewater discharge and waste disposal. To limit these impacts, mitigations measures to eliminate or reduce them have been defined. These measures have been integrated in an Environmental and Social Management Plan (ESMP). This plan will be implemented and followed up during the construction and operation phases of the Project. Regular monitoring of the results of the ESMP implementation will be undertaken and these results will be compared to the Senegalese legislation and international standards requirements. The monitoring plan will be implemented by both ContourGlobal - Cap des Biches and Senegalese authorities within the framework of their environmental surveillance activities.

Based on the conclusions of this ESIA study, international experts in charge of the ESIA implementation consider that the ContourGlobal - Cap des Biches Project, as described in the ESIA report, follow the best international practices and is acceptable with regards to the environmental and social Senegalese legislation requirements.

BIBLIOGRAPHY

Agence Nationale de la Statistique et de la Demographie, Indicateurs clés, 2012

AUBREVILLE A.A la recherche de la forêt de Cote d'Ivoire. Bois Forêt tropicale, 1958

BERHAUT J. Flore du Sénégal. Clairafrique Dakar, 1967

BERHAUT, J. Flore Illustrée du Sénégal. Gouvernement du Sénégal, (1971-1979)

BERTHOLET, F. Le secteur des transports routiers au Sénégal, Rapport de la Banque Mondiale, 2004

BORROW, N. et DEMEY, R. Guide des oiseaux d'Afrique. Delachaux et Nestelé SA, Paris.511, 2008

BRGM, Réévaluation de la ressource en eau du littoral nord. Synthèse des données. Modification hydrodynamique et simulations prévisionnelles. Services sol et sous-sol, 1992

Carte pédologique du Sénégal au 1/1.000.000 – ORSTOM, 1965 ; Carte dressée par R. Maignien d'après les travaux de MM. P. Audry, P. Bonfils, C. Charreau, J. Dubois, R. Fauck, J. Faure, M. Gavaud, J. Maymard, S. Peirera-Barreto, J. F. Turenne, J. F. Vizier

CHEVALIER A. Biogéographie de la Forêt dense ombrophile de la cote d'ivoire. Rev. Bot. Appl. Agr. Trop., Tome 28, numéros 305-306 : pp 101-115, 1948

CRODT, Les pêcheries de la Zone Economique Exclusive sénégalaise : situation des ressources et recommandations en matière de gestion, 1994

DEME-GNINGUE I., ROY C., TOURÉ D.Variabilité spatio-temporelle de la température, des nitrates et de la chlorophylle devant les côtes du Senegal - Centre de recherches océanographiques de Dakar-Thiaroye, 1990

Ecosystems and Human Well-Being, SynthESIA, Millenium Ecosystem Assessment, 2005

DIALLO S., Evolution géomorphologique du littoral sur la Petite Côte à Rufisque, 1982

DUBRESSON A., Note sur les activités industrielles au Sénégal, 1978

EDOUARD P., Croquis géologique de la région de Dakar au 1/50.000, 1980

ELOUARD. P. ; FAURE. H. & HEBRARD. L., Variations du niveau de la mer au cours des 15.000 dernières années autour de la presqu'île du Cap Vert, Dakar, Sénégal, 1977

EMERY K.O. & AUBREY D.G., Sea levels, Land Levels and Tide Gauges, 1991

FAYE, A. Contribution à l'étude géologique et hydrogéologique du horst de Ndiass et de ses environs, 1995

FAYE, S. Modélisation hydrodynamique des nappes du littoral Nord entre Cayar et St Louis. Impact des futurs prélèvements envisagés dans le cadre de l'approvisionnement en eau de Dakar et de ses environs, 1995

Institut des sciences de l'environnement -ISE- en partenariat avec le projet Com/Fish USAID, 2013

Laboratoire Africain de Métrologie et d'Essais, Rapport sur les mesures de bruit aux limites de site du Projet, Juin 2014

LEBRUN, J. P. & STORK, A. Enumération des plantes à fleurs d'Afrique tropicale, CJB de la Ville de Genève, (1991-1997)

MABBERLEY, D.J. The Plant-Book. Cambridge University Press, 1997

MARTIN, A. Les Nappes aquifères de la Presqu'île du Cap Vert. Leur utilisation pour l'alimentation en eau de Dakar, 1970

NDIAYE P. Atlas de l'Afrique – Sénégal, 1er Edition, 2007

NIANG DIOP I., Erosion côtière sur la petite côte du Sénégal à partir de l'exemple de Rufisque, 1995

République du Sénégal. Code de la Chasse et de la Protection de la Faune(1986). Loi n° 86-04 du 24 janvier 1986. 63 p

République du Sénégal. Enquête Démographique et de Santé à Indicateurs Multiples Sénégal (EDS-MICS) 2010-2011. Février 2012

République du Sénégal. Résultats définitifs du troisième recensement général de la population et de l'habitat – (2002), rapport national de présentation. Juin 2008

République du Sénégal. Repères statistiques. juillet 2012

République du Sénégal. Note d'analyse des comptes nationaux définitifs 2008, semi-définitifs 2009 et provisoires 2010

République du Sénégal. Situation économique et sociale du Sénégal. décembre 2011

SALL M., Dynamique et morphogénèse actuelles au Sénégal Occidental, 1982

SARR M., Rapport d'expertise N°030M/06/14 – Evaluation des biens du verger de la famille de feu Isma Diop sis au Cap des Biches, juin 2014

SENELEC, Bilan des activités de SENELEC 2011-2013, mars 2013

SENELEC, rapport annuel 2010

SERLE. W. et Morel. G., Les oiseaux de l'ouest africain. Delachaux et Nestelé SA, Lausanne (Suisse)-Paris.331 p, 2001

SFI. Politique et Critères de Performance en matière de Durabilité Sociale et Environnementale, 2006

VANDEN BERGHEN, C. Flore Illustrée du Sénégal. Gouvernement du Sénégal, 1988 – 1991

USDA Foreign Agricultural Service - Senegal, Agricultural Situation, Country, Report 2007

U.S. EPA EPA-454/R-92-019 Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Révisée

Verstraete J.M. Contre-courants équatoriaux et variations saisonnières du contenu thermique et du niveau moyen dans l'Atlantique tropical Est, 1985

Wartsila, Technical specification of ContourGlobal - Cap des Biches Project, Exhibit A, 14 mai 2014

WILLIS, J. C. A dictionary of the flowering plants and ferns. Cambridge University Press, 1985

Other external information:

- IUCN Red list
- CITES (Appendix)

ANNEX 1 ESIA TERMS OF REFERENCE

ANNEX 2 DEEC COMMENTS ABOUT TERMS OF REFERENCES

ANNEX 3 ALLOCATION OF THE PROJECT'S LAND

ANNEX 4 OPERATING PERMIT

ANNEX 5 PROJECT LAY OUT AND SECTION MAPS

ANNEX 6 COMPLIANCE AUDIT REPORT, 2012

ANNEX 7 CONTOURGLOBAL HSE POLICY

ANNEX 8 LIST OF CONSULTED PERSONS

Name of persons met	Organization	Fonction
M. Papa Toby Gaye	SENELEC	Coordinateur du Projet
M. Moussa Diop	SENELEC	Chef de la division environnement et qualité
M. Ibrahima Gueye	SENELEC	Division environnement et qualité
Mme Guene	DEEC	Directrice adjointe de la DEEC
M. Sada Kane	DEEC	Chef de la Division des Installations Classées (DIC)
M. Momar Sow	DEEC	Chef de la Division Des Evaluations D'impact Sur L'environnement (DEIE)
M. Sall	Préfecture de Rufisque	Préfet
M. Ibrahima Ndiaye Sall	Mairie de Rufisque	Directeur Administratif et Financier
M. El Malick Fall	Mairie de Rufisque	Directeur adjoint à l'Aménagement Urbain
M. Balla Kante	Service départemental du développement rural de Rufisque	Chef de Service
M. Bruno Lamba	Service départemental du développement rural de Rufisque	Agent
M. Pathé Samb	Sapeurs-pompiers de Rufisque	Adjudant-chef
M. Ousseynou Dia	Municipalité de Rufisque	Chef du quartier de Darou- Salam Azur
M. Alassane Sow	Ecole primaire publique de Dioukoul	Directeur
M. Momar Ndoye	Ecole primaire et secondaire privée Maguette Ndoye, Dioukoul	Directeur
M. Mohamet Ciss	Daara coranique El Hadji Ibrahima ciss	Directeur
Mme Aita Ndoye Gueye	Daara franco-arabe	Directrice
M. Momar Ndiaye	Commission Environnement du quartier de Dioukoul	Membre de la commission

ANNEX 9 CONSULTANTS WHO PARTICIPATED TO THE ESIA

ANNEX 10 HAZARD CONTOURS OF EACH SCENARIO

ANNEX 11 CAUSE-CONSEQUENCE TREES FOR EACH SCENARIO STUDIED

ANNEX 12 INFORMATION ON AIR QUALITY MODELLING