REPORT

New International Airport of Cabinda (NAIC Project) - Angola

Environmental and Social Impact Assessment - Chapter 9 - Impact Assessment Methodology

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9.0 IMPACT ASSESSMENT METHODOLOGY

9.1 Introduction

This section presents the methodology for the Environmental and Social Impact Assessment (ESIA) developed considering national and international standards and requirements (Chapter 4). The following figure summarizes the phases of the ESIA report, and the methodology described in this document.

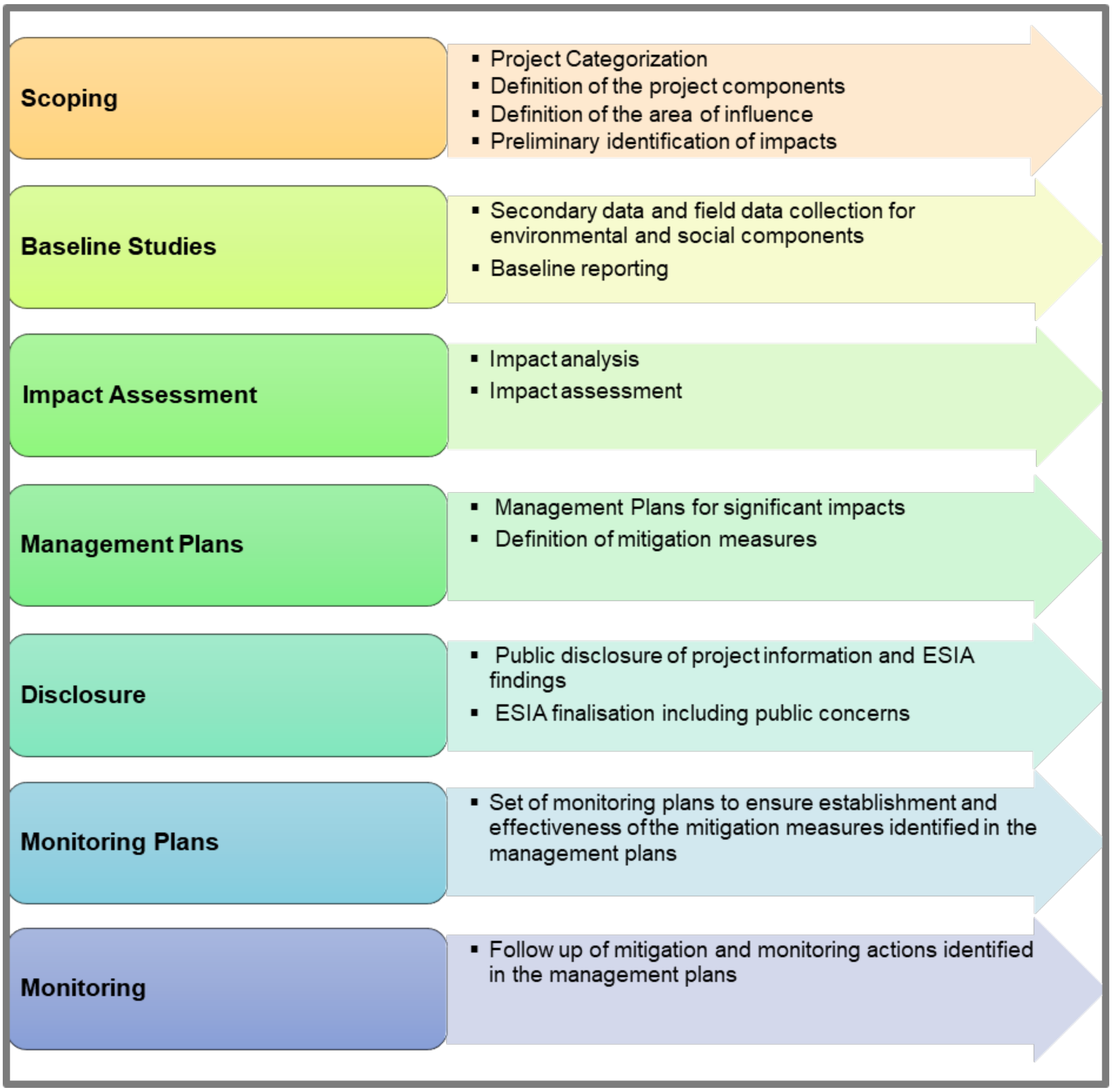

Figure 1: Phases of ESIA process.

The general methodology adopted by WSP for ESIA studies has been designed to be analytical and transparent and to allow for a semi-quantitative analysis of the impacts on the various environmental and social components. This methodology is based under the assumption that projects can generate both negative and positive impacts whose magnitude that can be evaluated considering the different characteristics of the project activities and of the environmental and social context.

This methodology is based on three main analytical phases, as described below:

- **Phase 1: Identification of Project Actions and Impact Factors:**

- **Project actions:** activities directly or indirectly related to the Project that can interfere with the context, generating environmental or social pressures; and
- **Impact factors**: direct or indirect interferences generated by the Project actions on the context and able to influence the state or quality of one or more environmental and social components.

- **Phase 2: Identification of Environmental and Social Components and Sensitivity level allocation:**
  - **Identification of the components potentially subject to interference**: using a specific cross-refence matrix between the impact factors and the Project actions, it is the process identifying the components potentially subject to impacts in each phase of the Project (for example: construction, operation; decommissioning); and
  - **Sensitivity of the component:** sum of the conditions characterizing the current quality and/or the dynamics of a specific environmental and social component and/or of its resources.
- **Phase 3: Impact Assessment:**
  - **Impacts:** changes suffered by the environmental and/or social quality status due to the effects caused by the impact factors on the environmental or social components; and
  - **Mitigation measures:** actions adopted to mitigate negative impacts or to maximize the effects of positive impacts on the environmental and social components.

The three phases are illustrated in Figure 2 and described in the following paragraphs.

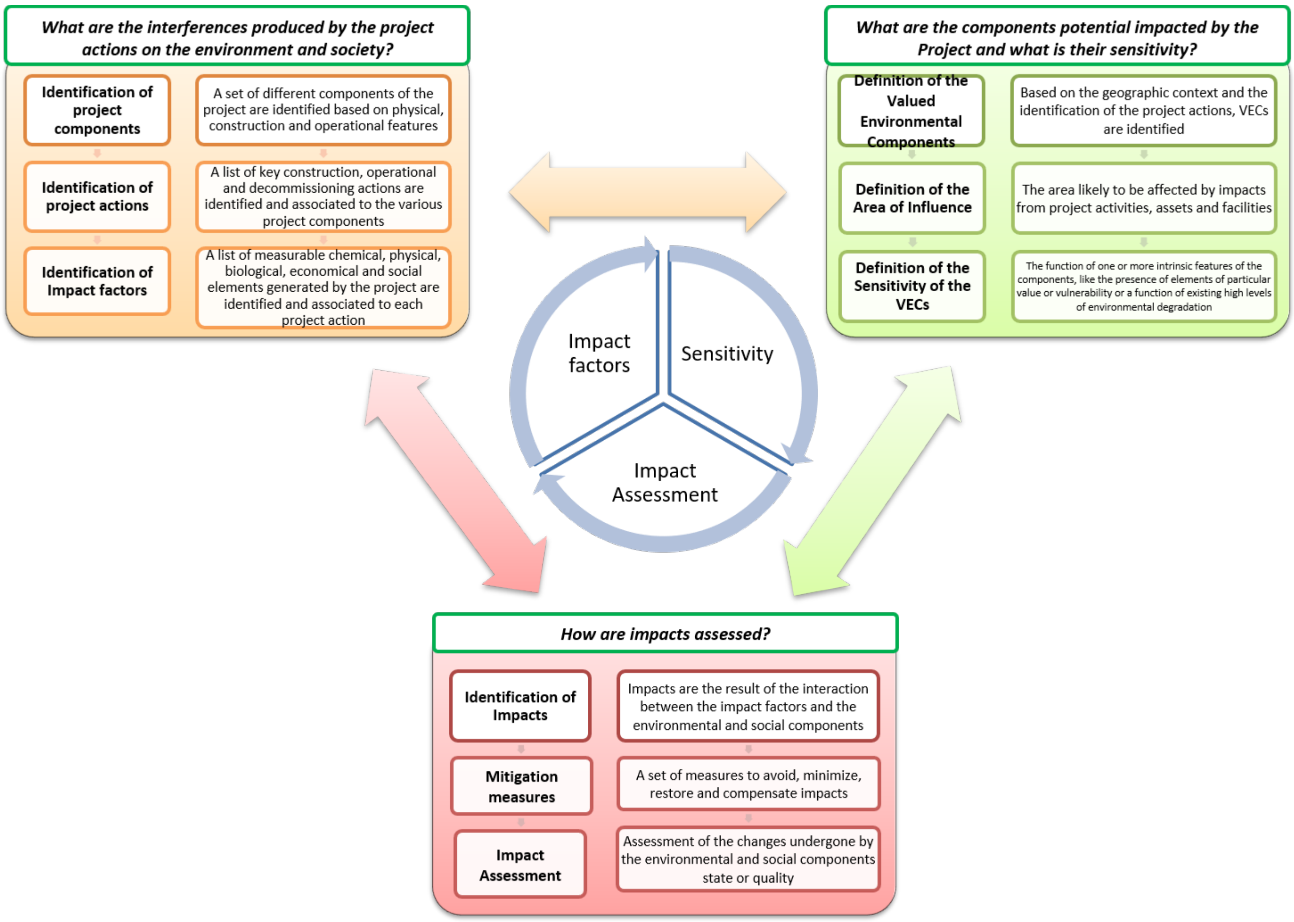

Figure 2: Impact Assessment Methodology - Analytical Phases.

9.2 Phase 1: Identification of Project Actions and Impact Factors

9.2.1 Project Actions Identification

Project actions are activities directly or indirectly related to the Project which can interfere with the natural or social environment as primary generative elements of (environmental or) social pressures, defined in the context of this methodology as impact factors. The actions are identified for the whole Project's lifecycle (construction and operation).

The Project actions have been identified based on the activities foreseen by the Project and described in the Project Description document (Chapter 02). Table 1 lists the Project actions for each phase.

Table 1: Project actions.

Construction Phase
Mobilization of vehicles, workers and equipment, materials transportation
Earthworks (vegetation clearance, land stripping, excavations, landfill, surface levelling/grading)
Construction of the temporary drainage system and the airport stormwater drainage network
Construction of the OEC campsite
Installation of electrical infrastructure and power supply (both for the campsite and the airport)
Construction of the artesian water well
Construction of the water supply network and hydraulic infrastructure
Construction of sewage network, including the underground Wastewater Treatment Station
Construction of all NAIC buildings and support facilities
Road works including: airport access, parking lots construction, installation of aeronautical pavements, and lighting systems
Installation of Building Equipping and Systems
Landscaping
Demobilization activities
Operation Phase
Management of airport activities in the Passenger Terminal (boarding, disembarking and forwarding of passengers and goods)
Management of other airport infrastructure (Police station, Firefighter station, cargo terminal, etc.)
Management of support facilities (WWTP, solid waste collection area, etc.)
Management of goods and passengers movements in the airport premisses, outside buildings (including parking lots)
Management of external green areas
Periodic maintenance of the airport infrastructure and runway
Aircraft take-off and landing

Aircraft maintenance and repair activities
Aircraft refuelling

9.2.2 Impact Factors Identification

Project actions can determine **impact factors** on each component, intended as potential interferences that can influence, both positively or negatively, directly or indirectly, the environmental and/or social quality in the area of influence of the Project. The impact factors identified for the Project are listed:

- Removal/degradation of soil and vegetation;
- Change in the local morphology and topography;
- Change in the local hydrology and surface water quality;
- Change in the local hydrogeology and groundwater quality;
- Emission of greenhouse gases;
- Emission of dust and particulate matter;
- Emission of gaseous pollutants;
- Emission of noise and vibrations;
- Emission of light;
- Existence of new buildings/infrastructures, visual impact;
- Land occupation;
- Production of solid waste;
- Production of wastewater;
- Energy and fuel demand;
- Water demand;
- Influx of population;
- Security management;
- Demand for workforce;
- Demand for raw materials and goods/supply chain;
- Increase of traffic;
- Improvement of road network;
- Interference with roads/infrastructures/services;
- Introduction and spreading of invasive alien species;
- Damage of cultural resources;
- Availability of air transportation services.

Accident or unplanned events (such as accidental spills/releases of oil/fuel from vehicles, fire, etc) are not considered as impact factors because the potential pollution of environmental components deriving from such events cannot be associated with routinary Project activities and are instead due to events that are not predictable and should not occur. Accidents and unplanned events are managed in a specific section of the ESIA study (Chapter 18).

Following the identification of the impact factors generated by the Project, a project actions – impact factors matrix is prepared. For each phase of the Project, the correlation with the actions and impact factors is highlighted in the matrix to identify the list of impact factors generated by each single project action.

Based on the project actions – impact factors matrix, for each project phase, specific tables are generated listing the impact factors from the single phase and the potentially impacted component(s). The tables for the Project are provided in Section 9.5 of this report.

9.3 Phase 2: Identification of Environmental and Social Components Potentially Subject to Impact and Assignment of the Sensitivity Level

Each environmental and social component in the area of influence of the Project has a different sensitivity to the impact factors generated by the Project or can pose a different level of risk to the Project. The sensitivity of an environmental and social component is typically evaluated on the basis of the presence/absence of some features which define both the current degree of quality and the susceptibility to changes of the component. The **sensitivity (S)** of the component is defined using component-specific metrics during the baseline and can assume values between 1 and 5 associated to a definition ranging from Low to High. The S value is assigned considering both the component's characteristics and the possible presence of sensitivity features.

The component's Sensitivity can vary from low (1) to high (5) according to the following definitions:

- Low (1): the component does not present elements of sensitivity;
- Medium-low (2): the component presents few elements of sensitivity that have limited significance;
- Medium (3): the component presents numerous elements of sensitivity that have limited significance;
- Medium-high (4): the component presents few elements of sensitivity that have high significance; and
- High (5): the component presents numerous elements of sensitivity that have high significance.

The Sensitivity for each Project environmental and social component is defined in Table 2. It is noted that the sensitivity is evaluated considering the first round of surveys. Should the additional season survey identify results that may lead to a different conclusion, the sensitivity evaluation will be revised in the updated ESIA.

Table 2: Components Sensitivity.

Components	Sensitivity elements	S value
Physical:		
Air quality	■ Ambient air concentrations of main air quality parameters ($PM_{2.5}$, PM_{10}, SO_2, NO_2 and O_3) in the majority of the samples are considerably above the guideline limits. ■ The presence of heavy metals (cadmium and arsenic) above guideline limits was detected in the particle matter from several samples. ■ The presence of other activities that will generate impacts on air quality in the AoI (Refinery, power plant, port of Caio).	**Medium-high (4)**
Geomorphology and Topography	■ The Project is located on a flat platform, with soft slopes, without any relevant geomorphological features to be impacted.	**Low (1)**
Soil	■ Soil structure stability. In a general way, the soil in the Project area is of ferralsol type, which, in its natural state, is known for being stable and less susceptible to erosion than most other intensely weathered red tropical soils. However, after land clearing, the natural balance between soil formation and erosion rates will be altered, possibly intensifying erosion processes[1] and also increasing the risk of pollution. The psamo-ferralitic soil is the type of ferralsol predominant in the Project area, according to the results of the geotechnical investigation. Psamo-ferralitic soils are sandy textured soils excessively permeable and therefore, susceptible to erosion. ■ Analysis of soil samples in the Project area did not show signs of contamination. ■ The soil in the Project area does not show signs of human interference and is home for a variety of organisms.	**Medium (3)**
Groundwater	■ Very scarce primary and secondary information regarding the hydrogeology at the Project site is available, therefore there is a knowledge limitation to understand possible impacts to this component.	**Medium (3)**

[1] ferralsols.PDF (isric.org).

Components	Sensitivity elements	S value
	■ The geotechnical study performed at the Project site did not reach the aquifer, having drilled two boreholes at the depth of 10m and one at 25m. Therefore, it is understood that the water table is not located close to the surface. ■ According to baseline secondary data, the aquifer is of type unconsolidated. In addition, the soil in the Project area is characterized by excellent porosity and great draining capacity, allowing water to travel through it reasonably quickly. This could represent a risk factor in case of pollution percolation depending on the depth of the soil and the aquifer. ■ Lack of existing utilization of the groundwater as a resource by communities/others in the region (as per socio-economic surveys)	
Hydrology and Surface Water	■ No presence of rivers, water streams, or ponds were identified or reported in the Project site. ■ Watercourses are present in the Project AoI, including the Chiloango River, located approximately 4 km north from the site, the main river in the province of Cabinda. This river is used by surrounding communities as an important source of water, extracted by the population by rudimentary means. In addition, a newly built water extraction system to supply Cabinda city and the province is present in the Chiloango River. ■ The Chiloango River is a perennial river, a quite relevant water body in the region of Cabinda, and important shelter and habitat for several species, together with its tributaries.	**Medium-high (4)**
Noise and Vibrations	■ No presence of sensitive receptors in the footprint area. ■ Presence of some industrial activities with workers that will be exposed to the noise generated by the Project. ■ The AoI includes some sensitive receptors (medical clinic, schools, villages) that will be affected from the Project activities especially during operation. ■ The nature of the Project will expose a larger area to the noise impacts in operation.	**Medium-high (4)**

Components	Sensitivity elements	S value
Solid Waste	■ Solid waste disposal: the Cabinda Landfill is known for having serious management problems[2], with no leachate control system or planned deposition. It is classified as a non-sanitary dumpsite. ■ In the Cabinda Province (in the village of Subantando), located about 20 km from the NAIC, will be built a new sanitary landfill and waste collection and treatment centre, for waste separation and preparation for recycling and recovery (reportedly, the site has been selected but the construction has not started yet). It will serve the Malembo area where the Project is located. Currently, it is not known if this landfill will be used for the Project. ■ No relevant waste recycling and valorisation units are present in Cabinda. Therefore, waste collection operators send waste flows to Luanda or abroad for those purposes. ■ Transboundary impacts on waste management because of the need of transferring certain volume of waste from Cabinda to Angola.	**Medium-high (4)**
Wastewater	■ The Province of Cabinda has no wastewater collection system in place, therefore the wastewater has to be handled individually by each household, industry, commerce, and service. ■ Wastewater management in the Project region seems to face precarious conditions, with no functioning basic sanitation network and most houses do not have septic tanks. ■ Existent Wastewater treatment plants in the Province are not operational.	**Medium-high (4)**
Biological:		
Terrestrial habitats and ecosystems (Flora and fauna)	■ Presence or potential presence of species of conservation concern directly observed or identified as possible present in the Project AoI, during the baseline field survey and desktop analysis. A summary of these species is given in the Chapter 7 of the ESIA, Baseline Conditions Biodiversity, and will be further investigated during the Additional Field Survey.	**Medium-high (4)**

[2] ATERRO SANITÁRIO DE CABINDA UM ATENTADO À SAÚDE PÚBLICA – MBEMBU BUALA PRESS (avozdecabindambembubuala.com).

Components	Sensitivity elements	S value
	■ Presence of suitable habitats to support population of CH-qualifying species and/or species of conservation concern in the Project AoI (within 2 km). High sensitivity is found in *natural habitats* which occupy the 30% of the total AoI and are represented by dense humid forests (26% of the AoI) and dense secondary forest (4% of the AoI). The remaining 70% is covered by *modified habitats* which are potentially suitable areas, highly represented by shrub savanna (52% of the AoI), followed by a mosaic of cropland and forest (6% of the AoI). Low sensitivity occurs within built-up and road areas (respectively 6% and 3% of the AoI), cropland (2% of the AoI) and bare soil (1% of the AoI).	
Marine and freshwater habitats and ecosystems (Flora and fauna)	■ Presence or potential presence of species of conservation concern directly observed or identified as possible present in the Project AoI, during the baseline field survey and desktop analysis. A summary of these species is given in the Chapter 7 of the ESIA, Baseline Conditions Biodiversity, and will be further investigated during the Additional Field Survey. ■ Presence of suitable habitats to support population of CH-qualifying species and/or species of conservation concern in the Project AoI (within 5 km).	**Medium-high (4)**
Protected Areas (PAs)	■ The Project falls entirely within the East Atlantic Flyway, an important migration pathway, and the vast seacoast is rich in different preferred habitats for birds. ■ The Chiloambo proposed PA and suggested IBA (within 20 km from the Project Footprint), is a place dominated from the estuary of Chiloango river, with its lagoons, mangrove forest and Raphia swamps, may present an important hotspot of migratory birds. At 40 km from the Project, we found the Mangrove National Park and at 60 km the Cayo-Loufouleba, both important wetland under the Ramsar Convention. ■ The Mayombe forest region in Cabinda is an Important Bird Areas (IBA). The site has the highest number of species in Angola that are restricted to the Guinea–Congo Forests biome.	**High (5)**
Social:		
Population and demographics	■ The population in the AoI has been increasing in the last years with a high population distribution in the Cabinda Province.	**Medium- High (4)**

Components	Sensitivity elements	S value
	■ In Angola more than 30 per cent of the population is reported to live below the national poverty line. ■ Lack of a national solid social protection system, almost inexistent in rural areas.	
Land use	■ The project's area is grassland with few herbaceous plants and there is no land use by the local communities in the surveyed area, therefore the Project is not expected to generate impacts on this component and the assessment is not performed. The sensitivity of the component is therefore not expressed.	-
Economy and Employment	■ Angola' economy has been growing in 2022 but it is still a scarcely diversified economy mostly specialized onto oil activities and export of oil products. ■ The commune of Malembo is considered one of the oil industrial zones of Angola, agriculture is practiced just by the 22% of locals and it is subsistence-based; ■ Employment indicators in the province is less favorable than in the rest of the country.	**Medium- High (4)**
Education	■ Many children in Cabinda are out of school due to lack of public transport, or financial conditions. ■ Just one school is in proximity with the Project site.	**Medium (3)**
Community Health, safety and security	■ The health sector in Angola is characterised by scarcity and asymmetric distribution of qualified human resources, insufficient health coverage and difficulty in maintaining existing health units and, among other, inadequate funding model. ■ The health system in the commune of Malembo presents difficulties and lacks technical staff for the daily demand, a lack of drugs and support services, such as public transport and ambulances for transfers. ■ Angola is considered to be a part of the countries with an average human development index. Life expectancy has increased and the mortality rate has decreased but it is still considered high.	**Medium- High (4)**

Components	Sensitivity elements	S value
Mobility and Infrastructures	■ In Angola just more than half of the households has access to safe drinking water sources. In Cabinda, the percentage is higher and it accounts for the 73% of households. ■ Only 32% of households in Angola have access to electricity from the public grid. The power supply in the commune of Malembo is considered scarce, the neighbourhoods do not have electrical power from the grid, and the use of lanterns and candles for lighting the houses is very common. ■ More than half of households have unsafe sanitation facilities (53%) and this percentage is almost three times higher in rural areas than in urban areas (86% and 32%, respectively). ■ Just one third of the Cabinda's Road network is paved and most of the people and goods in the province are carried out by private taxi services.	**High (5)**
Cultural Heritage	■ The type of project activities and the lack of significant cultural heritage elements in the survey do not generate any impacts on this component and the assessment is not performed. The sensitivity of the component is therefore not expressed.	**-**
Landscape and visual quality	■ In Cabinda Province, the forest and water features are the landscape units with higher quality and also moderate sensitivity. Considering that the project will be implemented nearby the forest but in the greenfield areas and industrial plots, considered low sensitivity, the landscape quality is assessed to be medium low.	**Medium- low (2)**
Ecosystem services	■ Considering the type of Project activities and the lack of priority ecosystem services in the surveyed area, the Project is not expected to generate impacts on this component and the assessment is not performed. The sensitivity of the component is therefore not expressed.	**-**

9.4 Phase 3: Impact Assessment

9.4.1 Scoring of Impact Factors

The **impact factors** identified during the analysis of the Project (and through the definition of the Project phases and Project actions) are assessed for their relevance, using a scoring system. The parameters considered to assess the impact factor score are the following:

Duration (D): is the duration of the impact factor. It may vary from short to long according to the following definitions:

- Short: if shorter than one month;
- Medium-short: if between one month and six months;
- Medium: if between six months and two years;
- Medium-long: if between two and five years; and
- Long: if over five years.

Frequency (F): is the frequency of the impact factor. It may vary from concentrated to continuous according to the following definitions:

- Sporadic, a single event;
- Moderately frequent, few events evenly or randomly distributed over time;
- Frequent, several events evenly or randomly distributed over time;
- Highly frequent, high number of events evenly or randomly distributed over time; and
- Continuous, event with no interruption over time.

Geographic extent (G): is the geographical area within which the impact factor can exert its effects. It may vary from Project site to transboundary according to the following definitions:

- Project footprint: the impact factor is confined within the facility boundary or exclusively controlled by the Project;
- Local: the impact factor extends to the areas or communities neighbouring the project site;
- Regional: the impact factor extends to an area beyond the surroundings of the project site and to regional physical (airshed – watershed, etc.) or administrative boundaries;
- Beyond regional: the impact factor extends throughout several regions or to the entire country; and
- Global: the impact factor has an international or global reach.

Intensity (I): is a measure of the physical, economic or social extent of the impact factors. It may vary from negligible to very high according to the following definitions:

- Negligible: the impact factors cannot be easily detected or perceived and are unlikely to cause any detectable change in the target environmental or social components;
- Low: the impact factors can be detected or perceived but effects are unlikely to cause tangible changes in the target (environmental or) social components;

- Medium: the impact factors are within legal standards or accepted good industry practices and/or effects are likely to cause tangible changes in the target environmental or social components;
- High: the impact factors are at the limit of legal standards or accepted good industrial practices and/or effects are likely to cause serious impairment in the target environmental or social components; and
- Very high: the impact factors are at risk of exceeding the limits of legal standards or good accepted industrial practices and/or effects are likely to cause very serious to catastrophic damage to the target environmental or social components.

Each of the parameters listed above can have a value between 1 and 5. The severity of the impact is determined through an **impact factor score** which sums the score of each of the 4 parameters, hence it can assume a value between 5 and 20.

9.4.2 Impact Value Calculation

The calculation of the **impact value** is done by multiplying the Impact Factor Score for the value of the sensitivity of the target component, determined during the baseline assessment. The result is then weighted considering the impact reversibility.

The reversibility is the property of an impact to reduce its intensity over time and to eventually disappear entirely. Reversibility may vary from reversible to irreversible according to the following definitions:

- Short term: if the initial condition of the component will be restored in a period between weeks and months after the end of the impact factor and/or the restoration activities;
- Short/mid-term: if the initial condition of the component will be restored in a period between a few months and one year after the end of the impact factor and/or the restoration activities;
- Mid-term: if the initial condition of the component will be restored in a period between one year and five years after the end of the impact factor and/or the restoration activities;
- Long term: if the initial condition of the component will be restored in a period between five and 25 years after the end of the impact factor and/or the restoration activities; and
- Irreversible: if it is not possible to predict restoration to the initial conditions.

The reversibility is measured on a scale between 1 and 5.

The **impact value (IV)** is calculated by multiplying the Impact Factor Score with the component's Sensitivity level and with the Reversibility, according to the following formula: IV= IFS x S x R.

9.4.3 Mitigation Measures

The final assessment is made once the enhancement of mitigation measures is adopted. Mitigation measures are means to prevent, reduce or control adverse environmental effects of a project, and include restitution for any damage to the environment caused by those effects through replacement, restoration, compensation or any other means.

The proposed mitigation measures are the result of an interactive process between the impact assessment and the engineering design. There are some measures which result directly from the application of local regulation, and we call them "embedded", in some cases obvious for the specificity of the project. In addition to these, we propose in the study further measures based on the Good Industry Practices and from the experience of other similar projects which follow the mitigation hierarchy and will help to reach compliance with Lenders' requirements.

9.4.4 Residual Impact Calculation

The next step consists in assessing the effectiveness of the mitigation measures in reducing or eliminating the negative impact (or to maximize the positive one). The mitigation measures should be defined with reference to the mitigation hierarchy listed below in descending order of effectiveness:

- Avoid;
- Minimize;
- Restore; and
- Compensate.

The effectiveness of the mitigation measures defined in the environmental and social management plan is assessed using expert's judgement and the outcomes from previous applications of similar mitigation measures to similar projects. The definitions of the mitigation effectiveness may vary from none to high, as described below:

- None: the measures can reduce the impacts by less than 20% of the expected outcome;
- Low: the measures can reduce the impacts by 20% - 40% of the expected outcome;
- Medium: the measures can reduce the impacts by 40% - 60% of the expected outcome;
- Medium-high: the measures can reduce the impacts by 60% - 80% of the expected outcome; and
- High: the measures can reduce the impacts by more than 80% of the expected outcome.

The mitigation effectiveness is measured on a scale from 1 to 0.2 (1 = minimum effectiveness; 0.2 = maximum effectiveness).

Positive impacts are typically associated with economic and social opportunities and sometimes with environmental aspects a project can solve (e.g., a project located in a brownfield where existing environmental issues can be addressed). Projects are typically promoting activities to enhance the economic, social and environmental opportunities through specific programs, plans and measures including, as examples, professional skills generation, community investment, shared value programs, remediation programs and biodiversity conservation projects.

The assessment of positive impacts is based on the same parameters used to assess the negative ones. The only difference is that the mitigation measures are replaced by enhancement measures, or measures to maximize the potential positive impacts.

The enhancement measures effectiveness defined in the environmental and social management plan is assessed using expert's judgement and the outcomes of previous application of similar enhancement measures to similar Projects. The definitions of the enhancement effectiveness may vary from none to high as shown below:

- None: the measures can enhance the positive impacts by less than 10% of the expected outcome;
- Low: the measures can enhance the positive impacts by 10% - 20% of the expected outcome;
- Medium: the measures can enhance the positive impacts by 20% - 30% of the expected outcome;
- Medium high: the measures can enhance the positive the impacts by 30% - 40% of the expected outcome; and

- High: the measures can enhance the positive impacts by more than 40% of the expected outcome.

The **Residual Impact Value (RIV)** is calculated multiplying the impact value with the impact mitigation effectiveness as per the following formula: RIV = IV x M.

9.4.4.1 Scale of Residual Impacts

The scale of the residual impacts resulting from the methodology described above ranges from 0.8 to 500. The impact value is then scaled to 5 levels by dividing into 5 classes with an equal number of values, the entire distribution of values obtained.

The residual negative impacts are classified into 5 levels according to Table 3:

Table 3: Five levels of residual negative impacts.

Residual impact score	Residual impact definition	
0.8 – 33.0	Negligible	
33.1 – 76.0	Low	
76.1 – 136.0	Medium	
136.1 – 228.0	High	
228.1 – 500.0	Very High	

The residual positive impacts are classified into 5 levels according to Table 4:

Table 4: Five levels of residual positive impacts.

Residual impact score	Residual impact definition	
0.8 – 33.0	Negligible	
33.1 – 76.0	Low	
76.1 - 136.0	Medium	
136.1 - 228.0	High	
228.1 – 500.0	Very High	

9.4.5 Overall Assessment

The methodology described above allows for an analytical assessment of impacts caused by individual impact factors over individual components. The process therefore ends with a table presenting several impacts from different impact factors for each component.

The table defines the assessment of the component’s overall impact. It is a synthesis of the impacts on a component from all the impact factors generated by the Project actions. The impact assessment provides a comprehensive view of the impact value that actually affects the environmental or social component.

The impact assessment is expressed based on the assessor’s experience, assigning higher weight to the values less favourable to the component’s protection, in order to guide the assessment toward a more prudential approach.

Impacts are presented in separate tables for negative and positive impacts to avoid automatic trade-offs and/or mediating between positive and negative aspects, as they are often targeting different sections of the community.

9.5 Project Actions, Impact Factors and Environmental and Social Components Potentially Subject to Impact

For each Project action identified in section 9.2.1, the potential existing connection with each impact factor defined in section 9.2.2 during the Project phases have been identified in the matrices below (Table 5 - construction and Table 6 - operation). The flagged cells indicate the presence of potential correlation, the white cells the absence of correlation.

Consequently, for each Project component (physical, biological and social), the identification of the potential impact factors has been completely connected to the Project actions (those connected to the accidental events have not been considered as they are covered in a specific Section of the ESIA study as already mentioned in section 9.2.2 of this report). Table 6 and Table 8 show the matrices highlighting the correlation between environmental and social components and impact factors, for construction phase and operational phase. The flagged cells indicate the presence of potential correlation, the white cells the absence of correlation.

Because of the lack of some information and the need to complete some baseline campaigns, some components have not been assessed in operation and will be part of a Supplementary study to be completed at a later stage.

The methodology followed for completing the noise and vibration impact assessment is enclosed in the Appendix A, at the end of this report.

Table 5: Project Actions vs Impact Factors (Construction).

	IMPACT FACTORS / PROJECT ACTIONS	Removal/degradation of soil and vegetation	Change in the local morphology and topography	Change in the local hydrology and surface water quality	Change in the local hydrogeology and groundwater quality	Emission of greenhouse gases	Emission of dust and particulate matter	Emission of gaseous pollutants	Emission of noise and vibrations	Emission of light	Existence of new buildings/infrastructures, visual impact	Land occupation	Production of solid waste	Production of wastewater	Energy and fuel demand	Water demand	Influx of population	Security Management	Demand for workforce	Demand for raw materials and goods/supply chain	Increase of road traffic	Improvement of road network	Interference with roads/infrastructures/services	Damage of cultural resources	Introduction and spreading of alien species
Construction phase	Mobilization of vehicles, workers and equipment, materials transportation					✓	✓	✓	✓						✓		✓	✓	✓	✓	✓		✓		✓
	Earthworks (vegetation clearance, land stripping, excavations, landfill, surface levelling/grading)	✓	✓	✓		✓	✓	✓	✓		✓		✓	✓	✓	✓								✓	✓
	Construction of the temporary drainage system and the airport stormwater drainage network		✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓							✓	✓	
	Construction of the OEC campsite			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									
	Installation of electrical infrastructure and power supply (both for the campsite and the airport)			✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓							✓		
	Construction of the artesian water well			✓	✓	✓	✓	✓	✓			✓	✓	✓	✓										
	Construction of the water supply network and hydraulic infrastructure		✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓							✓	✓	
	Construction of sewage network, including the underground Wastewater Treatment Station		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓							✓	✓	
	Construction of NAIC buildings and support facilities			✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓									
	Road works including: airport access, parking lots construction, installation of aeronautical pavements, and lighting systems			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	✓		
	Installation of Building Equipping and Systems			✓			✓		✓	✓			✓	✓	✓										
	Landscaping			✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓									
	Demobilization activities			✓		✓	✓	✓	✓		✓		✓	✓	✓				✓		✓				

Table 6: Project Actions vs Impact Factors (Operation).

IMPACT FACTORS / PROJECT ACTIONS	Change in the local hydrology and surface water quality	Change in the local hydrogeology and groundwater quality	Emission of greenhouse gases	Emission of dust and particulate matter	Emission of gaseous pollutants	Emission of noise and vibrations	Emission of light	Existence of new buildings/infrastructures, visual impact	Production of solid waste	Production of wastewater	Energy and fuel demad	Water demand	Influx of population	Security management	Demand for workforce	Demand for raw materials and goods/supply chain	Increase of road traffic	Interference with roads/infrastructures/services	Introduction and spreading of invasive alien species	Availability of air transportation services
Management of airport activities in the Passenger Terminal (boarding, disembarking and forwarding of passengers and goods)							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Management of other airport infrastructure (Police station, Firefighter station, cargo terminal, etc.)							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Management of support facilities (WWTP, solid waste collection area, etc.)	✓	✓					✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
Management of goods and passengers movements in the airport premisses, outside buildings (including parking lots)			✓		✓	✓	✓				✓		✓		✓	✓	✓	✓		
Management of external green areas						✓	✓				✓	✓	✓			✓		✓		
Periodic maintenance of the airport infrastructure and runway	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓			✓		✓		
Aircraft take-off and landing			✓	✓	✓	✓	✓				✓							✓		
Aircraft maintenance and repair activities	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓				
Aircraft refueling	✓	✓									✓		✓		✓	✓		✓		

Table 7: Project Components vs Identification of Impact factors (Construction)

	ENVIRONMENTAL AND SOCIAL COMPONENTS / IMPACT FACTORS	Removal/degradation of soil and vegetation	Change in the local morphology and topography	Change in the local hydrology and surface water quality	Change in the local hydrogeology and groundwater quality	Emission of greenhouse gases	Emission of dust and particulate matter	Emission of gaseous pollutants	Emission of noise and vibrations	Emission of light	Existence of new buildings/infrastructures, visual impact	Land occupation	Production of solid waste	Production of wastewater	Energy and fuel demand	Water demand	Influx of population	Security management	Demand for workforce	Demand for raw materials and goods/supply chain	Increase of road traffic	Improvement of road network	Interference with roads/infrastructures/services	Damage of cultural resources	Introduction and spreading of invasive alien species
Physical Environment	Air Quality					✓	✓	✓							✓										
	Geomorphology and topography		✓																	✓					
	Soil	✓	✓				✓				✓		✓	✓						✓					
	Hydrology and Surface Water			✓										✓		✓									
	Hydrogeology and Groundwater				✓											✓									
	Noise and Vibrations								✓																
	Solid Waste												✓												
	Wastewater													✓											
Biodiversity Environment	Terrestrial habitats and ecosystems (Flora and fauna)	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓				✓	✓			✓
	Marine and Freshwater habitats and ecosystems (Flora and fauna)			✓		✓	✓	✓	✓				✓	✓			✓				✓	✓			✓
Social Environment	Population and demographics																✓								
	Land use and tenure																								
	Economy and employment																		✓	✓					
	Education								✓												✓		✓		
	Community health, safety and security						✓	✓	✓								✓	✓			✓				
	Mobility and infrastructures												✓	✓	✓	✓					✓	✓	✓		
	Ecosystem services	✓		✓													✓								
	Cultural heritage	✓															✓							✓	
	Landscape and visual quality	✓	✓							✓	✓														

Table 8: Project Component vs Identification of Impact factors (Operation)

	ENVIRONMENTAL AND SOCIAL COMPONENTS / IMPACT FACTORS	Change in the local hydrology and surface water quality	Change in the local hydrogeology and groundwater quality	Emission of greenhouse gases	Emission of dust and particulate matter	Emission of gaseous pollutants	Emission of noise and vibrations	Emission of light	Existence of new buildings/infrastructures, visual impact	Production of solid waste	Production of wastewater	Energy and fuel demand	Water demand	Influx of population	Security management	Demand for workforce	Demand for raw materials and goods/supply chain	Increase of road traffic	Interference with roads/infrastructures/services	Introduction and spreading of invasive alien species	Availability of air transportation services
Physical Environment	Air Quality			✓	✓	✓				✓		✓									
Physical Environment	Geomorphology and topography																				
Physical Environment	Soil	✓			✓	✓				✓											
Physical Environment	Hydrogeology and Groundwater		✓										✓								
Physical Environment	Hydrology and Surface Water	✓									✓		✓								
Physical Environment	Noise and Vibrations																				
Physical Environment	Solid Waste									✓											
Physical Environment	Wastewater										✓										
Biological Environment	Terrestrial habitats and ecosystems (Flora and fauna)																				
Biological Environment	Freshwater habitats and ecosystems (Flora and fauna)																				
Biological Environment	Protected Areas																				
Social Environment	Population and demographics													✓							
Social Environment	Land use and tenure																				
Social Environment	Economy and employment															✓	✓				✓
Social Environment	Education																				
Social Environment	Community health, safety and security				✓	✓	✓							✓	✓			✓			
Social Environment	Mobility and infrastructures									✓	✓	✓	✓					✓	✓		✓
Social Environment	Ecosystem services		✓											✓							
Social Environment	Cultural Heritage																				
Social Environment	Landscape and visual quality							✓	✓												

APPENDIX A

Noise & Vibrations Methodology

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1.0 INTRODUCTION

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20Hz (deep bass) to 20,000Hz (high treble) and over the audible range of 0dB (the threshold of perception) to 140dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

Table 9: Terminology relating to noise

Terminology	Description
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20μPa (20x10^{-6} Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by 20 $\log_{10}$ (s_1 / s_2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise

Terminology	Description
	environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m.
Façade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast/Slow Time Weighting	Averaging times used in sound level meters.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.

The table below lists the data and the construction assumptions on which this assessment is based on.

Table 10: Construction plant assumptions

Stage	Plant	Quantity at peak times	% on-time	L_w, dB
Runway side - Earthworks	Grader, 205kW, 25T	5	30	114
	Articulated dump truck 25T	1	20	109
	Tractor	10	10	111
	Dumper 32kW 3T	35	10	105
	Tracked crusher crushing concrete/rubble, 172kW, 47T	2	40	110
	Wheeled backhoe loader, 62kW, 8t	4	40	96
	Tracked excavator, 170kW, 30T	8	30	103
	Vibratory roller, 50kW, 7000kg	7	30	106
	Diesel generator	5	70	87
	Telescopic handler, 60kW, 10T	2	40	99
	Compressor 3.5m^3/min	1	50	102
Airside – Pavements and Drainage	Grader, 205kW, 25T	5	30	114
	Articulated dump truck 25T	1	20	109
	Tractor	2	10	111
	Concrete mixer truck	3	30	108

Stage	Plant	Quantity at peak times	% on-time	L_w, dB
	Fuel tanker, 11T	3	20	99
	Dumper 32kW 3T	35	20	105
	Wheeled backhoe loader, 62kW, 8t	4	40	96
	Tracked excavator, 170kW, 30T	8	30	103
	Core drill (electric)	1	30	113
	Vibratory roller, 50kW, 7000kg	7	30	106
	Concrete pump, 59 kW, 2.8t / 180mm dia / 59 bar	1	25	103
	Compressor and small petrol driven poker vibrators	5	70	87
	Telescopic handler, 60kW, 10T	2	40	99
	Compressor 3.5m^3/min	1	50	102
Groundside – Road construction	Grader, 205kW, 25T	5	30	114
	Articulated dump truck 25T	1	20	109
	Tractor	2	10	111
	Concrete mixer truck	3	30	108
	Fuel tanker 11T	3	20	99
	Dumper 32kW 3T	35	20	105
	Wheeled backhoe loader, 62kW, 8t	4	40	96
	Tracked excavator, 170kW, 30T	8	30	103
	Vibratory roller, 50kW, 7000kg	7	30	106
	Concrete pump, 59 kW, 2.8t / 180mm dia / 59 bar	1	25	103
	Compressor and small petrol driven poker vibrators	5	70	87
	Telescopic handler, 60kW, 10T	2	40	99
	Compressor 3.5m^3/min	1	50	102
Groundside - Landscaping	Grader, 205kW, 25T	5	30	114
	Articulated dump truck 25T	1	20	109
	Tractor	10	10	111
	Dumper 32kW 3T	35	20	105
	Tracked crusher crushing concrete/rubble, 172kW, 47T	2	40	110
	Wheeled backhoe loader, 62kW, 8t	4	40	96
	Tracked excavator, 170kW, 30T	8	30	103
	Vibratory roller, 50kW, 7000kg	7	30	106
	Compressor and small petrol driven poker vibrators	5	70	87

Stage	Plant	Quantity at peak times	% on-time	L_w, dB
	Telescopic handler, 60kW, 10T	2	40	99
	Compressor 3.5m^3/min	1	50	102

2.0 ASSESSMENT METHODOLOGY

2.1 On site construction

Construction activities inevitably lead to some degree of noise disturbance at locations near the construction activities. It is however a temporary source of noise. Noise levels at any one location will vary as different combinations of plant and machinery are used and throughout construction activities as the specific locations of these activities change.

Noise predictions have been undertaken in accordance with BS5228 (i.e., IFC guidance, *BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise BS5228-1*) to determine the likely noise impact during construction at the nearest noise sensitive receptors to the project site. BS5228:2009+A1:2014 has been applied, as it has an approved methodology for predicting noise levels from construction sites, and assessing its effects on those exposed to it. BS 5228:2009+A1 represents Good International Industry Practice (GIIP) as it the industry approved code of practice in the United Kingdom and is therefore considered to be appropriate for use in the prediction of noise from construction activities regardless of project location.

A set of assumptions have been made on the likely construction stages and the type, location and number of plant items operating in each of them. These assumptions have been informed by details provided within Chapter 02 – Project Description, regarding construction stages and anticipated plant items to be used on site.

The following stages which are anticipated to represent worst-case activities have been adopted for the assessment:

- Stage A – Runway side – Earth works
- Stage A – Runway side – Pavements and drainage
- Stage B – Ground side – Road construction
- Stage B – Ground Side – Landscaping

The above stages are considered to represent the closest activities to sensitive receptors involving the most intensive operations.

To represent a worst case, noise predictions have been undertaken placing all applicable construction plant at the closest possible working area to the closest noise sensitive receptor.

Noise predictions have been undertaken for the closest sensitive receptor to the site (OMITC Academy, technical school for adults, including student dormitory) which is located at a distance of over 400m to the northwest of the Project Site. All other sensitive receptors are located at substantially greater distance (greater than 2km) and are therefore not included in the assessment. The sensitivity of receptors has been considered as ‘Medium - High’.

2.1.1 Assessment criteria

Criteria have been adopted from BS 5228-1 for the construction noise assessment.

Given that baseline noise measurements have not been undertaken in proximity to OMITC Academy, the most stringent BS 5228-1 ABC category (Category A) has been adopted as a worst case. It should be noted however, that less stringent criteria may be appropriate depending on existing ambient noise levels experienced at OMITC Academy.

Table 11: Construction noise assumptions calculation

Period	BS 5228-1 ABC Category	Construction noise threshold, dB L_{Aeq}
Daytime (07:00 – 19:00)	A	65
Evening (19:00 – 23:00)	A	55
Night-time (23:00 – 07:00)	A	45

2.2 Construction traffic noise

Construction traffic using the existing road network has the potential to result in associated road traffic noise level increases which may be experienced at sensitive receptors located adjacent to roads used by construction traffic.

Information on existing road traffic flows and predicted construction traffic movements on the road network local to the Project Site is not currently available. An assessment has therefore been undertaken on a qualitative basis considering available baseline information and the likelihood of construction traffic resulting in traffic noise increases.

2.2.1 Assessment criteria

In line with guidance provided within the International Finance Corporation (IFC) Environmental Health and Safety (EHS) Guidelines, General EHS Guidelines, road traffic noise level increases below 3dB are considered to be of negligible intensity (not significant).

3.0 ASSESSMENT

3.1 On site construction

Noise level predictions have been undertaken to determine worst case on-site construction noise levels at the closest sensitive receptor to the site (OMITC Academy – see figure below).

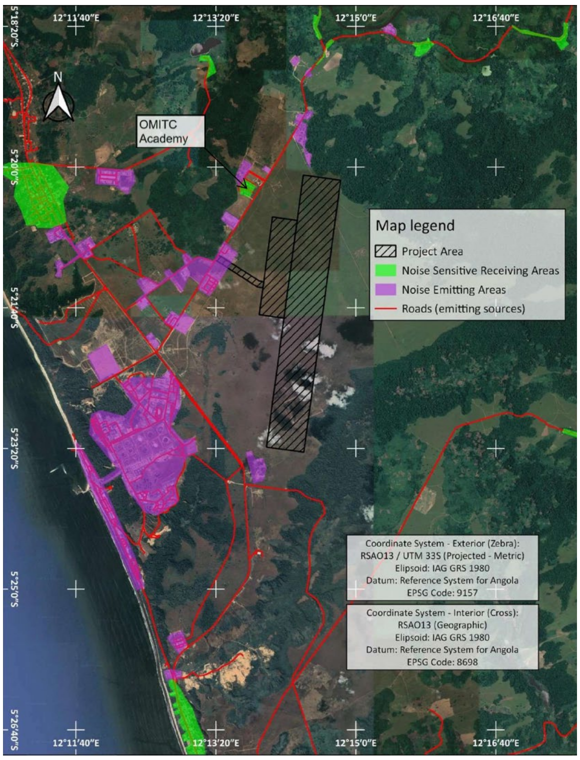

Figure 3: Environmental noise sensitive area and residual noise emitting sources

Predictions are in terms of the Equivalent Continuous Sound Level, $L_{Aeq,T}$ over the core working day and have been undertaken for worst case construction stages based on assumed typical plant types, numbers and utilisation which are presented in The table below lists the data and the construction assumptions on which this assessment is based on.

Table 10. These assumptions have been generated based on available information on construction activities and anticipated plant, presented within *Chapter 2 - Project description*.
As a worst case, predictions have been undertaken assuming 50 percent acoustically soft ground. In reality, it is expected that the intervening ground between construction noise sources and the closest sensitive receptor will be predominantly acoustically soft, thus leading to lower noise levels than those predicted. Other assumptions which have been made with respect to construction noise predictions are:

- No intervening screening has been included;
- Source and receptors have both been assumed to be 1.5m high;
- Meteorological conditions have been assumed to be "neutral".

All plant have been placed at the closest project site boundary to the receptor (400m between noise sources and receptor). In practice however, the plant items identified for each stage will move around site, operating at different distances. As a consequence, noise levels are likely to be lower than those predicted for the majority of the construction phase. Given the worst-case nature of assumed construction plant location, the assessment assumes that the closest construction stage will dominate noise levels at the closest receptor. Scenarios considering cumulative noise levels from overlap of stages have therefore not been included in the assessment. Core daytime construction working hours adopted for the purpose of the construction noise assessment are assumed to be 08:00 to 20:00 hours on weekdays and 09:00 to 13:00 on Saturdays and Sundays, no working on Bank or Public Holidays. The table below presents the range of predicted unmitigated construction noise levels at OMITC Academy.

Table 12: Predicted construction noise levels: LAeq, dB (free-field)

Stage A – Earthworks	Stage A Pavements & drainage	Stage B – Road construction	Stage B - Landscaping
56	57	56	57

It can be seen that the most stringent criterion (BS5228 – 1 ABC Category A) can be easily achieved during the day. It is assumed that either no activities or very limited activities will be undertaken during evenings, nights, weekends and bank holidays and that criteria applicable to these periods are therefore not expected to be exceeded. Given that the adopted assessment criteria are not expected to be exceeded, the Impact Value for construction noise generated by on-site activities is predicted to be negligible.

3.2 Construction traffic noise

Information on anticipated number of construction traffic movements on the existing road network local to the project site is currently unknown. It is however expected that construction traffic will use the EN220, thereafter turning north towards the Project site access road. Construction traffic is therefore not expected to pass noise sensitive receptors after leaving the E220.

From baseline noise measurement data collected at a distance of approximately 10m from the nearside kerb of the E220 (See Chapter 6 Baseline, measurement location R7) it appears that the E220 is a well trafficked road generating relatively high baseline road traffic noise levels in the region of 70 and 65 dB for the L_{day} and L_{night} respectively. Given the likely high existing movements on the E220 relative to the number of construction traffic movements, it is expected that the Impact Value will be medium at worst, prior to the implementation of mitigation.

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