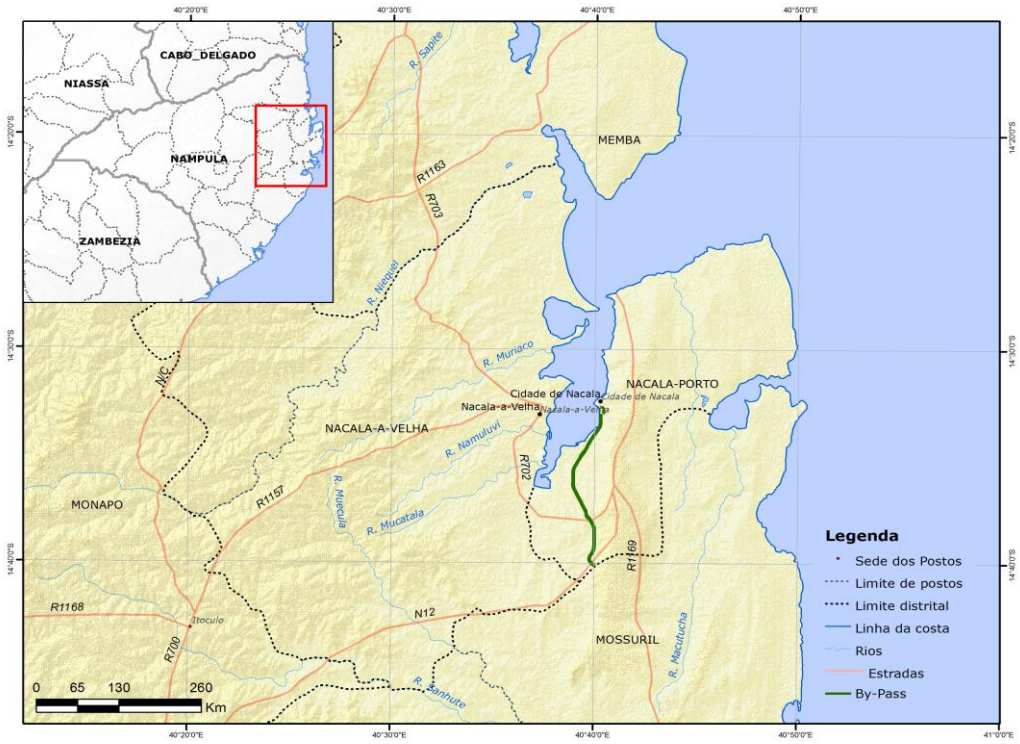
Appendix-10 Simplified Environmental Report (SER)

CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT STUDIES (EIA) AND ACTION PLANS FOR RESSETTLEMENT (PAR) FOR THE NACALA CORRIDOR PROJECTS – ACCESS ROAD TO THE PORT OF NACALA – LOTE A

Contrato N^{o} 41/DG/360/2016



SIMPLIFIED ENVIRONMENTAL ASSESSMENT FOR THE ACCESS ROAD TO THE PORT OF NACALA

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Acronyms and Abbreviations

HHs	Households
EIA	Environmental Impact Assessment
AID	Direct Influence Area
AII	Indirect Influence Area
ANE	National ´Roads Administration
ANE - DM	ANE – Monitoring Department
AQUA	National Agency for the Control of Environmental Quality
BOD_5	Biochemical Oxygen Demand
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
DDT	Diclorodifeniltricloroetano
DINAB	National Directorate of Environment
DO	Dissolved Oxygen
DPTADER	Provincial Directorate of Land, Environment and Rural Development
DUAT	Right to Use and Benefit from the Land
SEA	Simplified Environmental Assessment
EIA	Environmental Impact Assessment
ENMC	National Strategy for Climate Change
EPDA	Environmental Impact Pre-assessment Study and Definition of Scope
EPI	Personal Protective Equipment
ER	Resident Engineer
FA	Environmental Inspector
GHG	Greenhouse Gases
HC	Hydrocarbons
IFC	International Finance Corporation
INE	National Institute of Statistics
JICA	Japan International Cooperation Agency
LAeq	Equivalent continuous sound level
MITADER	Ministry of Land, Environment and Rural Development
NO_2	Nitrogen Dioxide
NT	Total Nitrogen
O_3	Ozone Layer
OA	Environmental Officer
WHO	World Health Organization
PAIA	Environmental Impact Assessment Procedure

PAP	Person Affected by the Project
PAR	Resettlement Action Plan
PCB	Polychlorinated Biphenyls
PEDEC	Project for Corridor Economic Development Strategies
PEU	Urban Structure Plan
EMP	Environmental Management Plan
PGCB	Biodiversity Counterbalance Management Plan
PM10	Particles with a diameter less than 10 micrometers
PM2.5	Particles with a diameter less than 2.5 micrometers
PPP	Public Participation Process
PR	Resettlement Plan
PTS	Total Suspended Particles
REIA	Environmental Impact Assessment Report
RLSFE	Physical and Socioeconomic Survey Report
RPAIA	Regulation on the Environmental Impact Assessment Procedure
SDT	Total dissolved solids
SO_2	Sulfur dioxide
Tss	Total suspended solids
TBT	Tributyl tin
ToR	Terms of Reference
TMDA	Annual Average Daily Traffic
TMH	Average Hourly Traffic
TP	Total phosphorus
USD	United States Dollar
uvle	Units of Equivalent Light Vehicles
VPP	Peak Velocity of Particles
WWF	World Wide Fund for Nature

1 Introduction

This document is a report about the Simplified Environmental Assessment (SEA) for the Project for Access Road to the Port of Nacala.

This Project is part of the Priority Infrastructure Projects covered by the Project for Nacala Corridor Economic Development Strategies (PEDEC-Nacala) currently being implemented by the Government of Mozambique with the support of Japan International Cooperation Agency (JICA).

According to the Regulation for Environmental Impact Assessment Process – RPAIA (Decree no. 54/2015, of 31 December 2010), the Environmental Impact Assessment (EIA) process of the Project for Access Road to the Port of Nacala began with the submission of documentation on 11/05/2015 to the Nampula Provincial Directorate of Land, Environment and Rural Development (DPTADER) for commencement of the process. Subsequently, the pre-assessment provided for in the regulation was carried out, resulting in the allocation of Category B to the Project, as indicated in the letter dated 01/06/2015 (Annex 1).

As set forth in the RPAIA, category B projects shall be subject to a simplified environmental assessment, preceded by a previous stage of preparation of terms of reference, which examines the project actions that are most likely to cause significant impacts to the environment and identifies the scope of the SEA and methodologies that will be followed in its elaboration. The terms of reference of this assessment have been approved by the DPTADER in letter dated 9 December 2016 (Annex 2).

This final version of the SEA was conducted taking into account the inputs collected from interested and affected stakeholders throughout the public consultation carried out under regulations provided for.

2 Definition and description of the Project

2.1 Definition and Justification of the Project

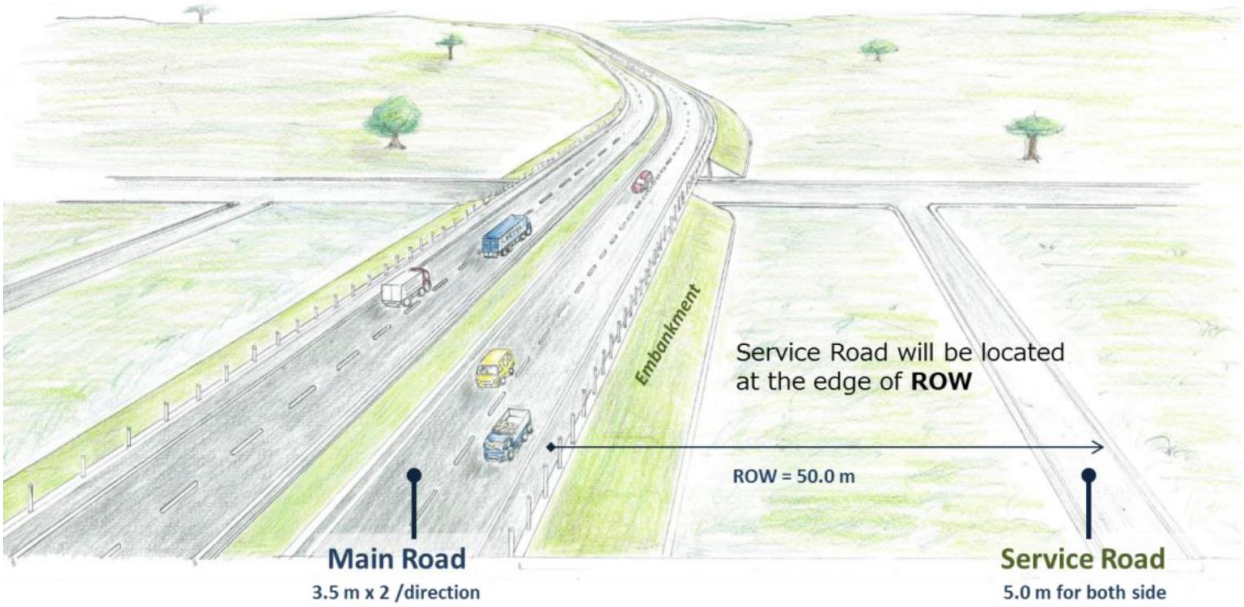
The construction of the Access Road to the Port of Nacala aims to reduce traffic which currently affects the urban area as well as the traffic jam at the port entrance.

Thus, the role of the new road is to provide direct access to the port of Nacala to heavy goods vehicles, industrial park and multi-modal terminal.

The road layout lies mainly in the area under specific jurisdiction where housing is not allowed, which leads to reduced presence of communities in this area.

Once completed, the road connecting to the port of Nacala will have 4 traffic lanes (2 in each direction), service road and sidewalks. However, given the demand for scheduled traffic and the cost and time of construction involved it is expected that in the initial stage the road works temporarily with only 2 traffic lanes (1 in each

direction). The impact assessment has been made based on the premise that there will be 4 lanes.



Source: JICA, Oriental Consultants Global Co., Ltd., Eight-Japan Engineering Consultants Inc., Kokusai Kogyo Co., Ltd.- Preparatory Survey for Nacala Corridor Road Network Upgrading Project in the Republic of Mozambique, Draft Final Report, June 2016

Figure 1 : Preview of the access road to the port of Nacala when completed

2.2 Location and Framework with existing Land Use Plans

The access road to the port of Nacala will be developed along a length of about 14.54 km[1] between the road N12 and the port of Nacala, as represented in the following figure.

[1] The extension of the road design indicated in the Process Preparation which was submitted in May 2015 (13.5 km) was based on the engineering studies available at that time. However, the feasibility study led to an update of this extension to 15.2 km mentioned in submitted ToRs. However, further investigation found that the approximately 0.65 km road located in the city of Nacala that is not linked to the subject road does not belong to ANE and hence was considered to be out of the scope of the project based on a discussion made between ANE and JICA Study Team in December, 2016.

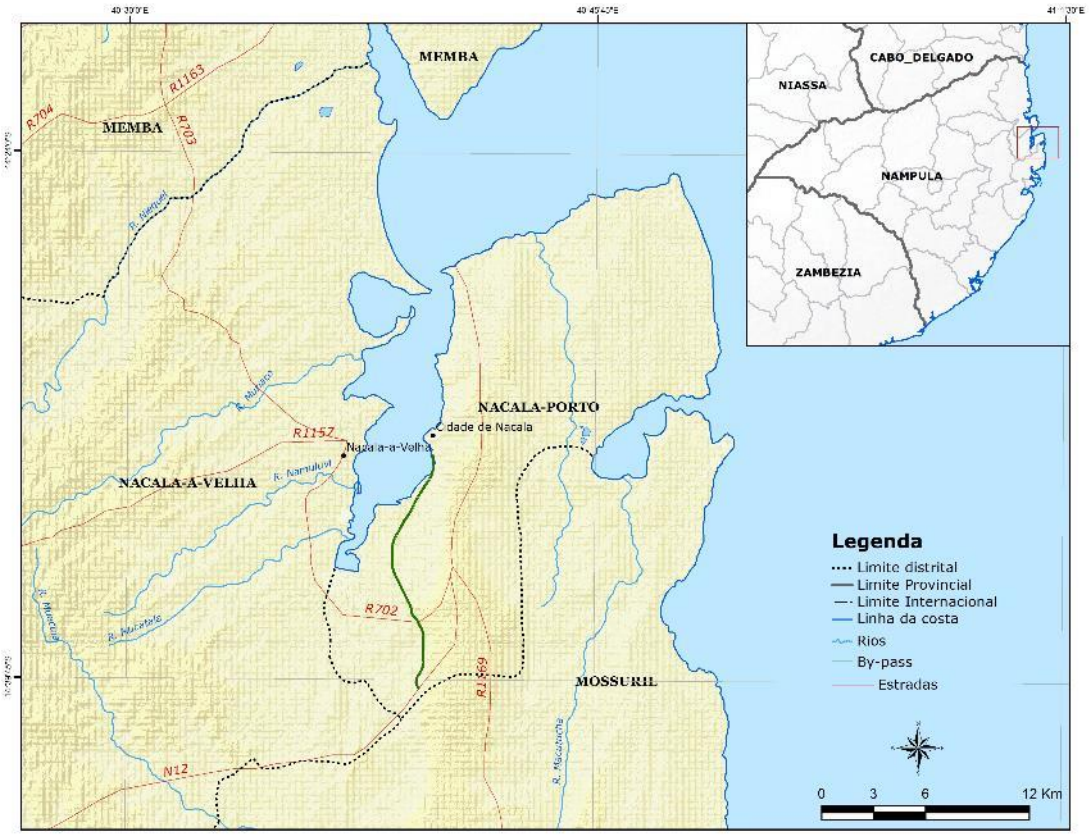


Figure 2 : Geographical and administrative framework of the Project

The coordinates of the beginning and end of the road design giving access to the port of Nacala are the following:

- Beginning (next to the port of Nacala): 14°33'1.01"S; 40°40'16.66"E
- End (Intersection with N12): 14°40'6.48"S; 40°40'0.53"E.

Administratively, the project is located in Nampula province and exclusively crosses territories within Nacala municipality – Port, Administrative Posts of Mutiva and Muanona.

The road layout results from a study of alternatives carried out in the feasibility study (draft) report dated June 2016 and which resulted, among other methodological steps, a process of consultation and coordination with the municipality.

This consultation process led to the submission by the municipality of suggestions for the road layout in order to avoid interference of the road with concessions and some homes in Matola neighborhood. Such suggestions were accommodated in the definition and comparative analysis of alternatives that culminated with the indication, in the above mentioned feasibility study, of the preferred alternative.

In addition to these suggestions the municipality did not express any objection with regard to the framework of the project in terms of the municipal structure plan.

As previously stated the Project for the Access Road to the Port of Nacala is one of the priority infrastructure projects covered by PEDEC-Nacala currently being carried out by the Government of Mozambique with the support of JICA.

2.3 Project Description

2.3.1 Route design

The following figure is a more detailed representation of the route layout and the area affected by the project. In addition, an important element of this road infrastructure that should be noted is the 840-metre bridge over the Bay area, right at the beginning of the road layout along the expansion area of the port of Nacala. Other structures included in the project are the viaduct for crossing a line of water from km 4+200, the viaduct for the grade-separated junction with the road R702 and the junction with the road N12.

Figure 3 : Route design (1/4)

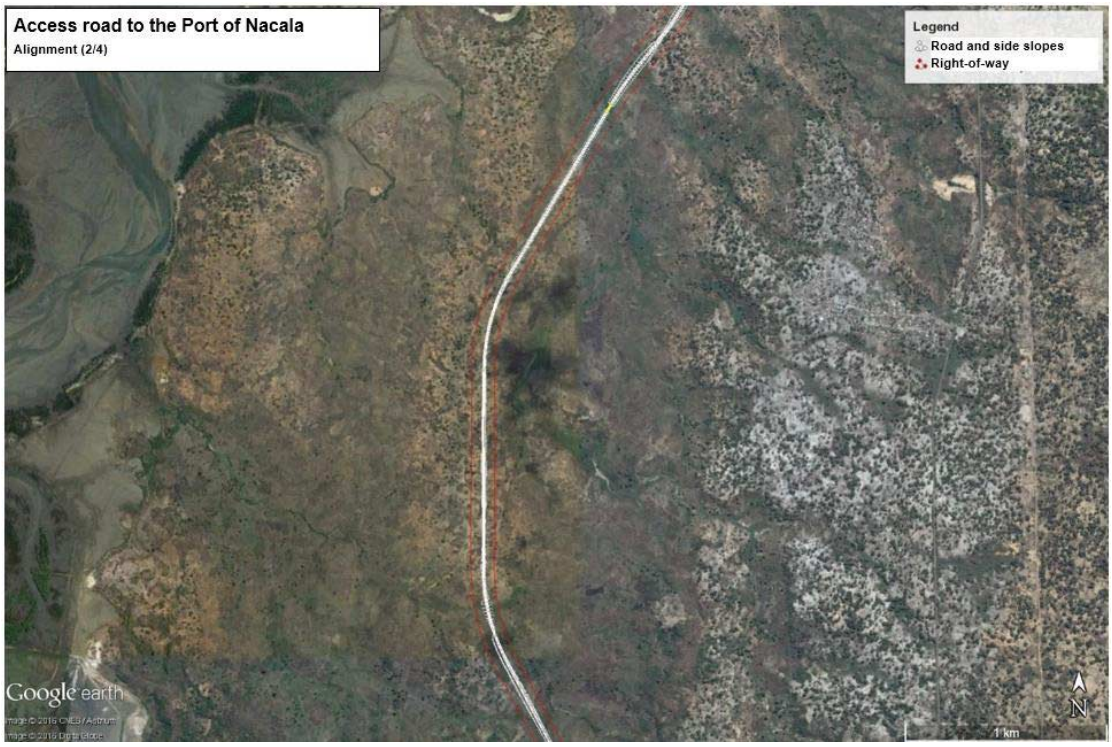


Figure 4 : Route design (2/4)

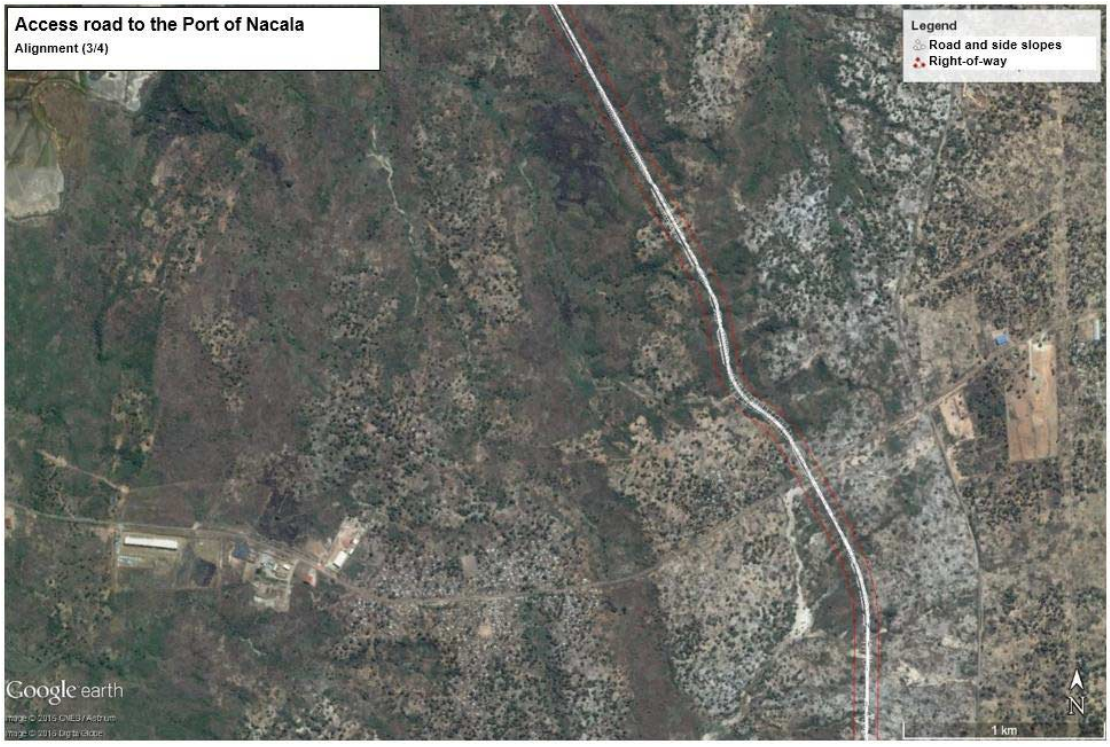


Figure 5 : Route design (3/4)

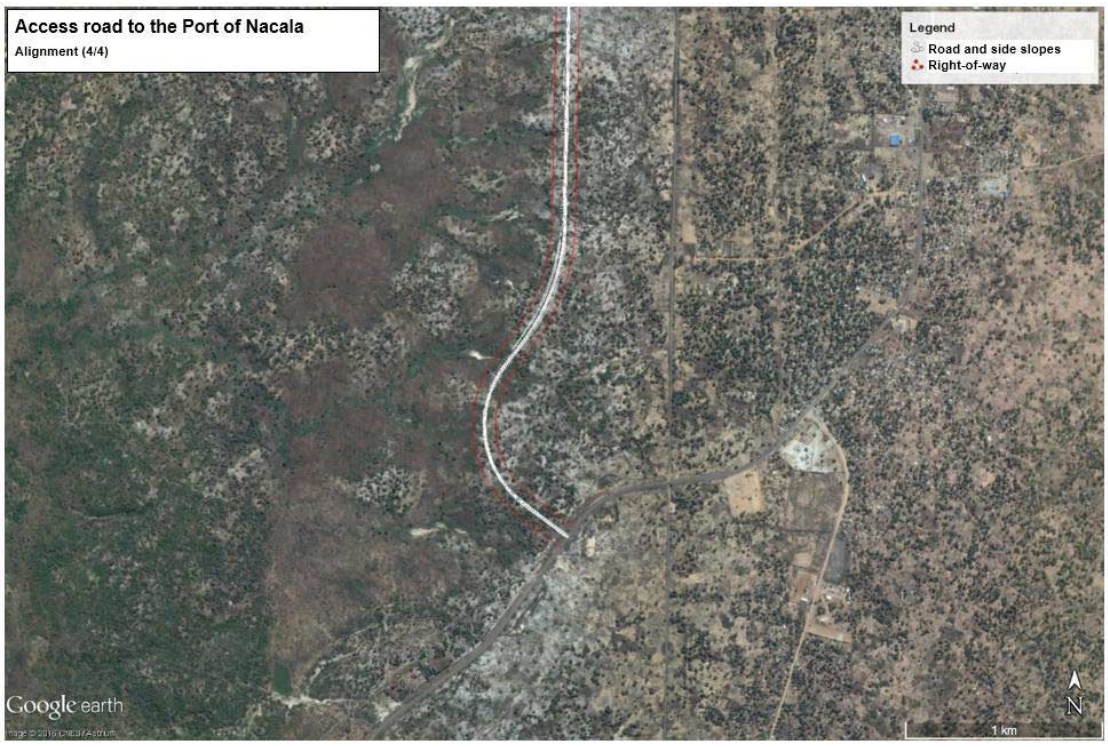
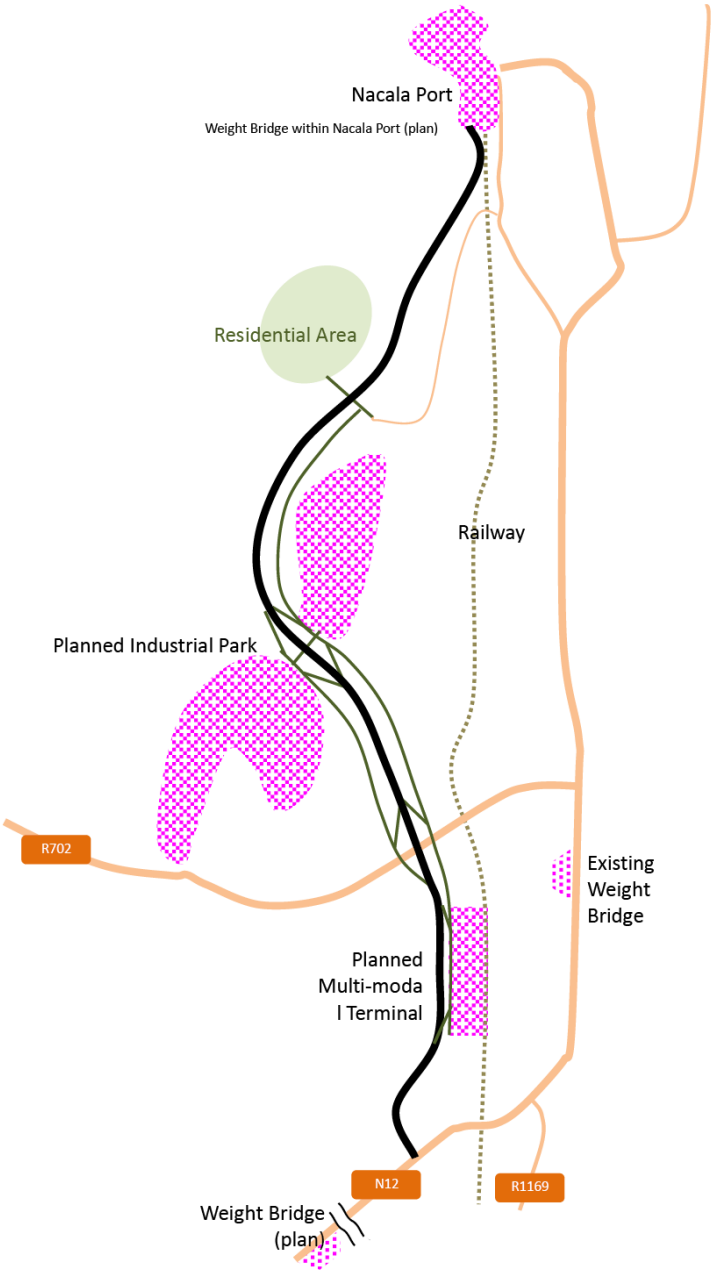


Figure 6 : Route design (4/4)

Since the presence of communities and economic activities are only expected in some of the affected areas, the service road expected along the main road (and which will be within the preservation area) will be limited to the sections marked in green in the following figure.



Source: JICA, Oriental Consultants Global Co., Ltd., Eight-Japan Engineering Consultants Inc., Kokusai Kogyo Co., Ltd.- Preparatory Survey for Nacala Corridor Road Network Upgrading Project in the Republic of Mozambique, Draft Final Report, June 2016

Figure 7 : Road Plan for the Access Road to the Port of Nacala

The north end of the service road will be in an area where there are salt waters and a coastal community, where it will be necessary to ensure crossing of the main road through a grade-separated junction. The service will be equally important for the connection of the planned industrial park and the road R702.

It is expected that the southern section between the roads N12 and R702 is used not only for heavy traffic but also for vehicles moving between Nampula and Nacala-à-Velha. The fact that this is an area with a less favorable terrain leads the service road

to be provided for only to a limited extent, guaranteeing the connection between the multi-modal terminal and the road R702.

2.3.2 Construction

Construction methods

In carrying out earth movement and paving, current constructive methods shall be used.

However, some sections of the future road will require special construction methods, especially with regard to the bridge which will be right at the beginning of the road. For the construction of this bridge, the feasibility study provides for a temporary pontoon bridge and a bulkhead gate consisting of steel-stake waterproof curtain, aiming to mitigate the negative impacts on the Bay through minimizing the contamination of water and reduction of soils and sediments excavations. The use of floating barge is not expected given that during low tide this area is mostly uncovered.

The steps for the construction of this bridge are:

1. Construction of a temporary pontoon bridge (during low tide);
2. Construction of a bulkhead gate (steel-stake waterproof curtain deeply placed);
3. Excavation (using pumping to remove water);
4. Laying foundations and substructures (pillars based on stakes);
5. Laying of superstructure;
6. Removal the bulkhead gate;
7. Removal of the temporary pontoon bridge.

The foundations of this bridge will be on the stakes, distributed throughput the planned 29 pillars. The stakes will be molded in-situ by rotation drilling through reverse circulation method. This method involves the injection of compressed air inside the auger drilling, leading to the reduction of the drilling fluid, facilitating the extraction of this fluid which is then received in a series of tanks where separation of water (which will be returned to the sea) and the solids (which will be conducted to controlled deposition) is made.

The superstructure of the bridge will be in pre-stressed concrete, with no particular environmental aspects to emphasize.

Earthworks and roads to be used for the construction

The feasibility study recommended that the road construction is done in a manner that balances as much as possible excavations and embankments respectively. However, given the characteristics of many of the materials to be excavated that make it almost impossible to have embankments with desired quality, it is estimated

that the road construction could involve the use of up to about 110 000 m3 of inert materials for embankments, to be obtained from borrow pits and quarries. The feasibility study has already discussed several possible sources for these materials to be taken into account in the development of road design, also taking into account the recommendations to be made in this respect under SEA.

Earth movement works will start at the intersections with the existing roads, particularly along the port at the beginning of the road, in the R702 and N12 at the end of the road. With continuing earth movement works it will be possible to use the platforms designed either to the main road or for the service roads for the movement of vehicles and machinery, which will reduce the use of existing roads.

Drainage

The road will have two main types of drainage:

Cross drainage, consisting of hydraulic passages for the restoration of water lines intercepted by the road network. These take a form of bridges, tubular concrete culverts, and box culverts.

Longitudinal drainage, consisting of hydraulic works intended for reception and drainage of surface and internal waters, from the roadway and the surroundings. These works consist basically of roadway and edge drains, slopes, gutters, water traps.

In the context of the feasibility study, a relatively detailed study on drainage conditions of the road has already been carried out in order to ensure proper routing of the waters so as to prevent erosion.

Surface

The surface will be asphalt concrete, without sound absorption characteristics. The pavement of the service road may take less demanding specifications, such as DBST – Double Bituminous Surface Treatment.

Construction site

To date the number and location of necessary construction sites have not been defined yet, which consist of support areas for works execution aimed at storing and processing materials, maintaining equipment and, in some cases, operation of construction management structures and personal accommodation.

In any case, its location will abide by, on the one hand, functionality criteria, related to proximity and access to work fronts and, on the other hand, environmental social protection criteria, so as to ensure minimization of impacts and disorders always associated with the presence of this type of facility. In principle, construction sites

shall be located within the range of the road protection or on lands not subject to the Right to Use and Benefit from the Land.

Materials, water, energy and waste

The construction of the project will involve the use of current construction materials, similar to those most used in works of this kind, and in accordance with the specifications laid down. Inert materials and cement can be procured locally, while others such as steel and more diverse equipment shall, in principle, be imported.

A project of this type may involve relevant consumption of water during the construction phase (for concrete production, wetting the embankment and dust suppression, for example) but not during the operation. The source of water to be used will vary depending on the location of the work fronts and construction site and shall obey rules that aim to ensure balance between works needs and local community use.

Most of the electrical energy required for construction work will mainly be obtained from the generators belonging to the works. The operation of these generators will contribute together with the operation of vehicles and equipment for the global consumption of fossil fuels for the works.

It should be noted that means for storing fuel (diesel, mainly) in the construction site should be in place, in which case it is necessary to take appropriate measures to prevent spills and contamination of soil and water.

Construction works will bring about various types of waste, common to most of this type of works. This includes oils (lubricants and hydraulic oils) with hazardous nature which will be produced in larger quantities.

The construction site will be equipped in a way that allows storing such wastes in a safe and environmentally acceptable manner. Its later treatment or final destination shall follow legal requirements and solutions available in Mozambique.

Workforce

At this stage it is not feasible to present a reliable estimate of the workforce that will be used in the construction of the project.

In any case dozens of direct jobs are expected to be created (a very high percentage of jobs is expected to be filled by locals) for a considerable period of time whose duration will depend on how the various work fronts will be designated over time.

Whenever possible and based on the needs local workforce will be hired, taking into account, however, the skills and experience of available staff. The process of hiring technicians will always be in collaboration with local authorities.

Apart from direct jobs, the construction will also bring about indirect jobs (equipment, goods and service providers, etc.), which in some cases may provide non-negligible income to local communities.

2.3.3 Operation - traffic estimates

It is estimated that in 2025 and in a setting with one direction lane, about 16 400 light vehicles (uvle)[2] will drive on used (total in both directions) in the section which is further in the north of the road under study, while in 2035 and in a setting with 4 lanes (2 in each direction) the number will be up to 30 900 uvle.

In order to assess the project impact, especially for modeling noise levels, it was necessary to process the data from a study of traffic drawn up within scope the road feasibility study.

Thus, it should be noted that traffic numbers presented in the study correspond to Annual Average Daily Traffic (TMDA) for each of the following classes of vehicles (as defined by ANE): light vehicles; light goods vehicles commonly referred to as the "pick-up"; light passenger vehicles; heavy passenger vehicles; heavy goods vehicles with 2-axis and double wheels on the rear axle; heavy goods vehicles with 3-4 axles and double wheels on the rear axle; heavy goods vehicles with more than 4 axles.

In the counting of traffic during the study motorcycles and agricultural tractors were also taken into account.

The traffic data for the input in modeling noise levels, taking into account the method for calculating NMPB-96, are the TMH (average hourly traffic) encompassing all classes of vehicles and the percentage of heavy vehicles for each of the reference periods evaluated (day period - 7h-22h and night time - 22h-7h).

In this context, various classes of vehicles were added in the following way: light vehicles < 3.5 t (light vehicles; light goods vehicles commonly referred to as "pick-up"; light passenger vehicles and motorcycles); heavy vehicles >= 3.5 t (heavy passenger vehicles; heavy goods vehicles with 2-axis and double wheels on the rear axle; heavy goods vehicles with 3-4 axles and double wheels on the rear axle; heavy goods vehicles with more than 4 axles).

The distribution of traffic volume between the two reference periods (day period - 7h-22h and night period - 22h-7h) was carried out taking into account day extrapolation factors established by ANE:

1. 24 hours (5:00 to 5:00) - 1.00

[2] Units of equivalent light vehicles (uvle) - a means of accounting for the vehicles in traffic studies, taking into account the characteristics of occupation of space and ease of movement of the different categories of vehicles. This study assumes that 1 light vehicle = 1 uvle, 1 bus = 2 uvle, 1 truck = 2.5 uvle.

2. 17 hours (5:00 to 22:00) - 1.10
3. 12 hours (6:00 to 18:00) - 1.37

Given that the day period consists of 15 hours (7:00 to 22:00), 1.2 factor was used by extrapolation in order to convert TMDA for the period of 15 hours (day period) and the difference determined traffic for the night period.

The counting carried out in the 2015 traffic study is taken into account for the "current situation". The counting was carried out for a week for each of the classes of vehicles, and it took into account the averages of TMD obtained for each of the 7 days of the week. The following table shows the values of TMH for the current situation.

Table 1: Traffic values (TMH) for the current situation

Road	TMH		Percentage of heavy vehicles (%)
	Day period (7h-22h)	Night period (22h-7h)	
N12 to the north of the intersection with R702	342	114	22
N12 to the south of the intersection with R702	275	92	22
R702 to the west of N12	205	68	24

For the scenarios regarding the future situation traffic estimates made in the traffic study shall be considered.

Table 2 shows traffic volume estimates (TMH) for the different sections illustrated in Figure 8: Sections taken into consideration for the study.

Table 3 shows traffic volume estimates (TMH) for N12 and R702 with and without project, taking into account the different scenarios considered.

The TMH values presented were obtained considering the same criteria explained above in relation to current situation traffic, in particular with regard to the aggregation of different classes of vehicle and extrapolation to obtain traffic volume for the period of 15h hours corresponding to day period.

In the traffic study carried out in the scope of the feasibility study, estimates for motorcycles were not carried out. The same proportion of motorcycles in the current situation was taken into account, instead. Traffic volumes presented in Tables 2 and 3 include motorcycles.

The following Figure shows the implementation of project and roads N2 and R702 as well as the various sections.

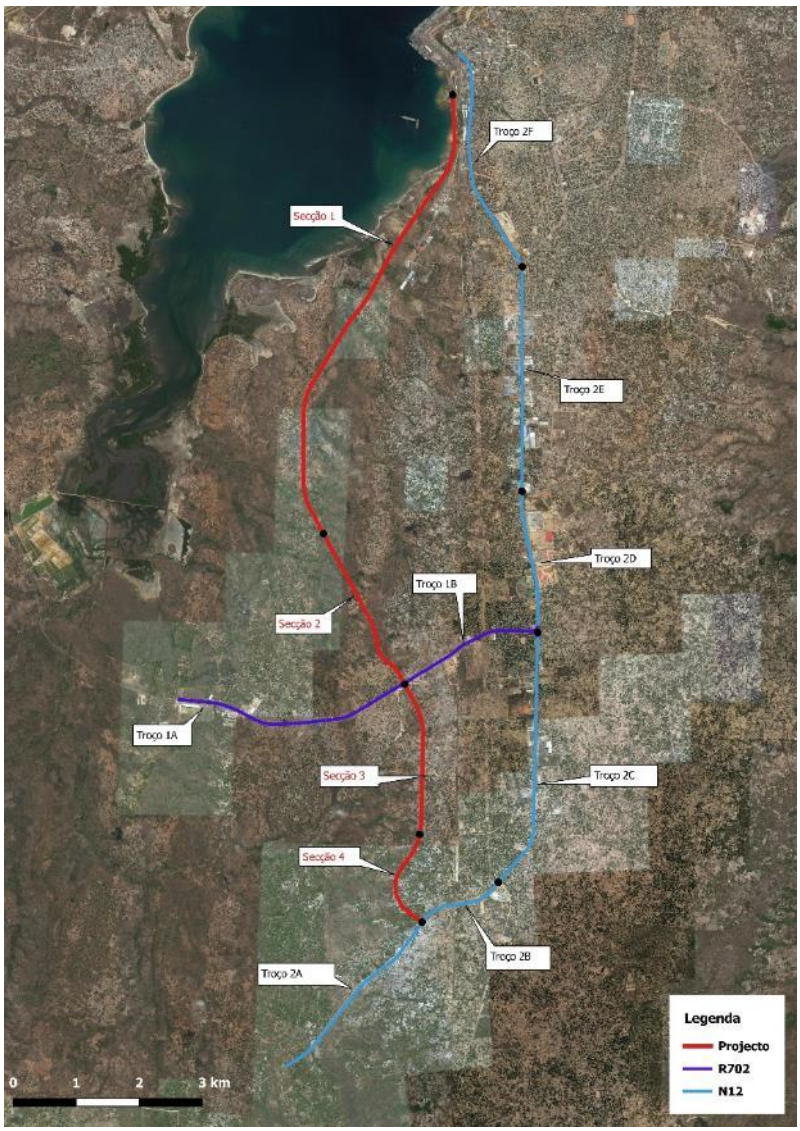


Figure 8: Sections taken into consideration for the study

Table 2: Traffic values (TMH) estimated for the access road to the port of Nacala

Project Sections	Period	TMH 2017	Percentage of heavy vehicles (%)	TMH 2025	Percentage of heavy vehicles (%)	TMH 2035	Percentage of heavy vehicles (%)
Section 1	Day time (7h-22h)	287	37	698	30	1110	37
	Night (22h-7h)	96	37	233	30	370	37
Section 2	Day time (7h-22h)	287	37	700	28	1079	32

Project Sections	Period	TMH 2017	Percentage of heavy vehicles (%)	TMH 2025	Percentage of heavy vehicles (%)	TMH 2035	Percentage of heavy vehicles (%)
	Night (22h-7h)	96	37	233	28	360	32
Section 3	Day time (7h-22h)	160	31	392	23	685	22
	Night (22h-7h)	53	31	131	23	228	22
Section 4	Day time (7h-22h)	160	31	392	23	70	24
	Night (22h-7h)	53	31	131	23	235	24

Table 3: Traffic values (TMH) estimated for N2 and R702

Project Sections	Period	TMH 2025	Percentage of heavy vehicles (%)	TMH 2025	Percentage of heavy vehicles (%)	TMH 2035	Percentage of heavy vehicles (%)
Section 1A	Day time (7h-22h)	541	30	475	20	914	21
	Night (22h-7h)	180	30	158	20	305	21
Section 1B	Day time (7h-22h)	541	30	259	18	487	13
	Night (22h-7h)	180	30	86	18	162	13
Section 2A	Day time (7h-22h)	632	15	635	15	1189	14
	Night (22h-7h)	211	15	212	15	396	14
Section 2B	Day time (7h-22h)	632	15	338	18	723	11
	Night (22h-7h)	211	15	113	18	241	11
Section 2C	Day time (7h-22h)	687	19	296	10	578	7
	Night (22h-7h)	229	19	99	10	193	7

Project Sections	Period	TMH 2025	Percentage of heavy vehicles (%)	TMH 2025	Percentage of heavy vehicles (%)	TMH 2035	Percentage of heavy vehicles (%)
Section 2D	Day time (7h-22h)	1132	22	536	15	1027	10
	Night (22h-7h)	377	22	179	15	342	10
Section 2E	Day time (7h-22h)	1052	25	372	11	657	12
	Night (22h-7h)	351	25	124	11	219	12
Section 2F	Day time (7h-22h)	745	33	65	37	173	32
	Night (22h-7h)	248	33	22	37	58	32

Movement speeds considered are those indicated in the traffic study:

1. 100 km/hour for the access road to the port of Nacala (project speed), and 90 km/h for heavy goods vehicles;
2. 80 km/h for N12 and R702, and 70km/h for heavy vehicle

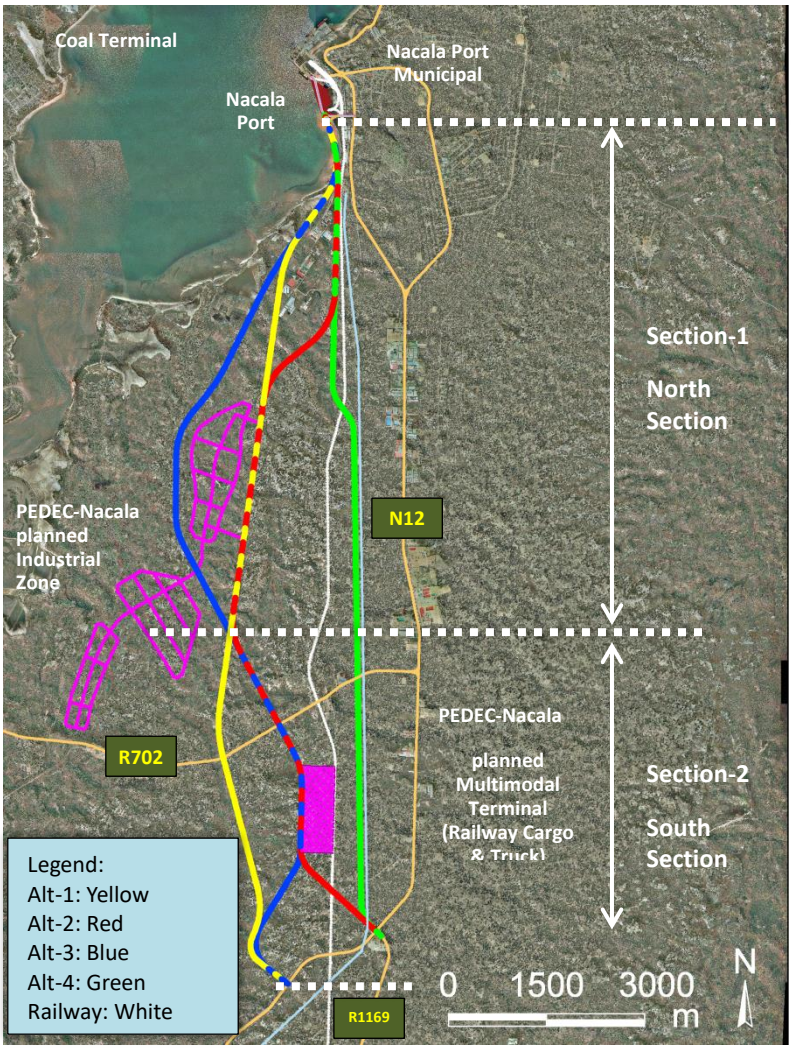
2.4 Analysis of Alternatives

As previously mentioned, the road design is a result of a study of alternatives carried out in the feasibility study which involved, among other methodological steps, a process of consultation and coordination with the municipality.

This consultation process led to the submission by the municipality of suggestions for the road layout in order to avoid interference of the road with concessions and some homes in Matola neighborhood. Such suggestions were accommodated in the definition and comparative analysis of alternatives that culminated with the indication, in the above mentioned feasibility study, of the preferred alternative.

The following figure represents the different alternatives analyzed in the study. The alternative routes/alignments were technically set and divided into two sections as shown in the figure. As a result, Alternative 3 (marked in blue) was selected as the route for the project.

The study of alternatives sought to minimize interference by the access road to the port of Nacala with existing built environment and also with planned environment for building (marked in pink color in the following figure).



Source: JICA, Oriental Consultants Global Co., Ltd., Eight-Japan Engineering Consultants Inc., Kokusai Kogyo Co., Ltd.- Preparatory Survey for Nacala Corridor Road Network Upgrading Project in the Republic of Mozambique, Draft Final Report, June 2016

Figure 9 : Studied alternatives

An outline of different alternatives is shown in the following figure.

Table 4: Outline of alternatives

	Description of the section	Alternative 1 (yellow)	Alternative 2 (red)	Alternative 3 (blue)	Alternative 4 (green)
Section 1 (Northern section)	· It starts at the Port of Nacala and ends on the road R702; · Presence of areas at risk of erosion; · It is necessary to align with areas planned for industrial development	· Road design along the coast; · Connection to the port via a bridge over the bay	· Connection to the port via a bridge over the bay; · It crosses the source of the existing industrial area; · It crosses pipelines	· Connection to the port via a bridge over the bay; · It crosses planned industrial areas; · It crosses lower land, with less risk of erosion	· Separate design form alternative 2 after the bridge; · It crosses the railway line and then the land between this line and N12
Section 2 (Southern section)	· It starts on the road R702 and ends on road N12; · It is necessary to align with multi-modal terminal (piggy-back)	· It crosses areas with settlements (houses) · No connection to multi-modal terminal	· Separation of alternative 3 crosses the railway line · Connection at the intersection between N12 and R1169 (where there is a police station, in a residential area)	· Consistent with the planned multimodal terminal	· No connection to multi-modal terminal · Connection at the intersection between N12 and R1169 (where there is a police station, in a residential area)

Source: JICA, Oriental Consultants Global Co., Ltd., Eight-Japan Engineering Consultants Inc., Kokusai Kogyo Co., Ltd.- Preparatory Survey for Nacala Corridor Road Network Upgrading Project in the Republic of Mozambique, Draft Final Report, June 2016

The results of evaluation for Section 1 and 2 are presented in Table 5 and 6, respectively followed by an explanation as to why they were selected.

Table 5: Characteristics and Evaluation of Alternatives (Section-1)

No.	Evaluation Items	Alternatives			
		Alt-1 (Yellow)	Alt-2 (Red)	Alt-3 (Blue)	Alt-4 (Green)
1)	Consistency to integrated development plan	Well integrated same as original idea [Good]	Integrated, but passing through existing industrial area [Fair]	Well integrated with planned industrial area [Good]	No integration [Bad]
2)	Benefit to Traffic Congestion Relief	Functioned [Good]	Functioned [Good]	Functioned [Good]	Functioned, but required railway crossing [Bad]
3)	Benefits to Urban Development and Residents	No relations [Fair]	No relations [Fair]	No relations [Fair]	Adverse impact for residential area [Bad]
4)	Road Safety	Straight alignment [Good]	Many crossing points [Bad]	Mild slope [Good]	Many crossing points with railway flyover [Bad]
5)	Affordability	Similar among alt-1 to 3 [Fair]	Same as alt-1 [Fair]	Same as alt-1 [Fair]	Additional railway bridge [Bad]
6)	Environmental Impacts	Careful embankment volume design required [Fair]	Erosion area [Bad]	Better than alt-1 [Fair]	Erosion area [Bad]
7)	Property Acquisitions	Required concession area of factories [Bad]	Required factories' property [Fair]	Minimum [Good]	Required resettlements [Bad]
8)	Community including Property Access	Required crossing point for a village [Fair]	Required many crossing points for factories, villages [Bad]	Required crossing point for a village [Fair]	Required many crossing points for factories, villages [Bad]
	[Good]	3	1	4	0
	[Fair]	4	4	4	0
	[Bad]	1	3	0	8

As shown in the above table, alternative-3, namely as the "Plan for passing lowland area with moderate vertical alignment", was selected for the route for Section 1 as it earned the highest number of "Good" evaluations.

Because Section 1 passes around limited space of the hinterland of Nacala port and through the planed industrial development within erosion area, the evaluation criteria of "1) consistency to integrated development" and "6) environmental impacts" were considered by the feasibility study team as more important than the others. In addition, the study team also considered social aspects as essential. Alternative-2 and -4 were evaluated as "Bad" for "7) poverty acquisitions" and "8) community" due to relatively inappropriate social impacts.

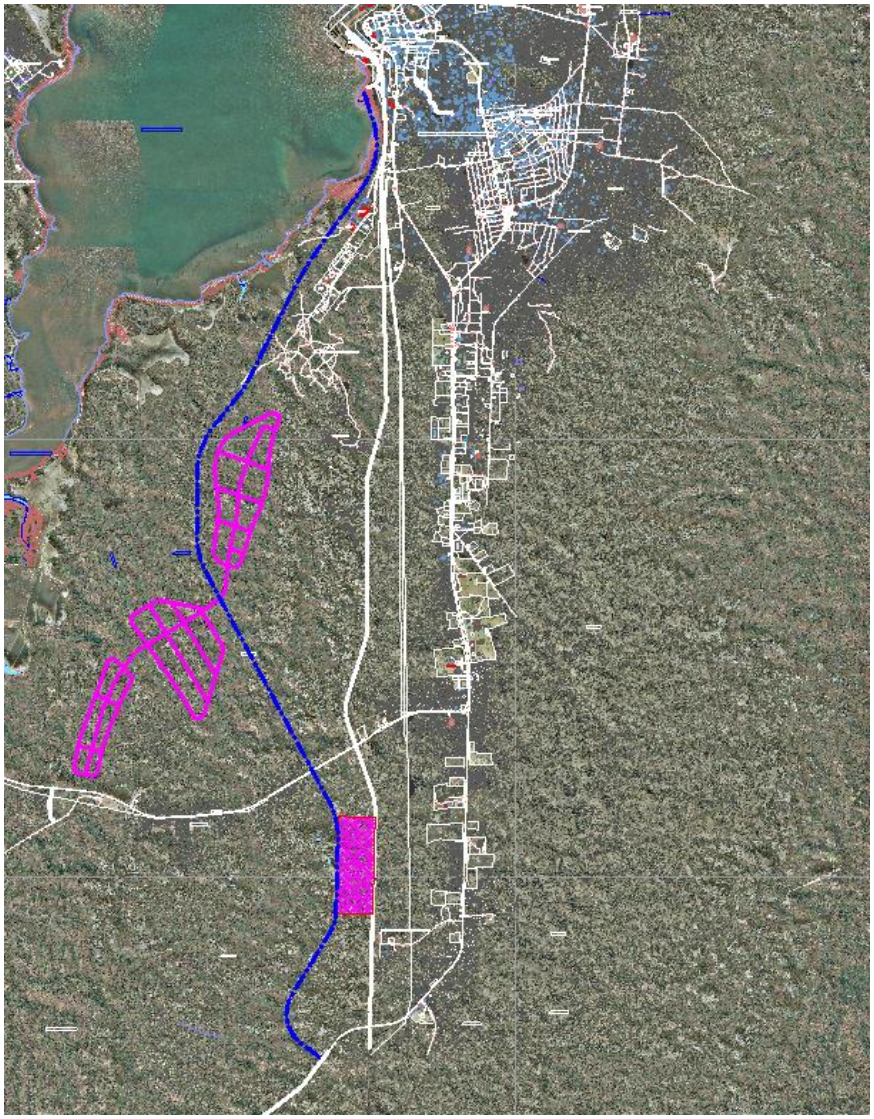
Table 6: Characteristics and Evaluation of Alternatives (Section-2)

No.	Evaluation Items	Alternatives			
		Alt-1 (Yellow)	Alt-2 (Red)	Alt-3 (Blue)	Alt-4 (Green)
1)	Consistency to integrated development plan	No integration [Bad]	Integrated, but passing through existing housing area [Fair]	Well integrated with planned multi-modal terminal [Good]	No integration [Bad]
2)	Benefit to Traffic Congestion Relief	Functioned [Good]	Functioned, but less diversion [Fair]	Functioned [Good]	Functioned, but less diversion [Fair]
3)	Benefits to Urban Development and Residents	Adverse impact for village development [Fair]	Adverse impact for residential area [Fair]	Better impact to industrial area development [Fair]	Adverse impact for residential area [Fair]
4)	Road Safety	Straight alignment and mild slope, near village [Fair]	Pass through residential area, and railway crossing (steep road) [Bad]	Mild slope [Fair]	Pass through residential area [Bad]
5)	Affordability	Less embankment volume [Fair]	Required railway bridge construction [Bad]	Depend on embankment volume [Fair]	Short length [Good]
6)	Environmental Impacts	Careful treatment of erosion and drainages [Fair]	Same as alt-1 [Fair]	Same as alt-1 [Fair]	Better than alt-1 to 3 [Good]
7)	Property Acquisitions	Less required acquisition [Good]	Required resettlements [Bad]	Less required acquisition [Good]	Required resettlements [Bad]
8)	Community including Property Access	Required crossing point for a village [Fair]	Required many crossing points for residential area [Bad]	No required [Good]	Required many crossing points for residential area [Bad]

No.	Evaluation Items	Alternatives			
		Alt-1 (Yellow)	Alt-2 (Red)	Alt-3 (Blue)	Alt-4 (Green)
	[Good]	2	0	4	2
	[Fair]	5	4	4	2
	[Bad]	1	4	0	4

With regards to Section-2, alternative-3 obtained the highest number of "Good" evaluations and hence was selected. This section, where the future residential development is limited because it passes through the building development prohibited zone and the multi-modal terminal is planned, provides high weighting of importance to the evaluation items of "1) consistency to integrated development". Moreover, it requires the amount of traffic diversion of port related vehicles so "2) traffic congestion relief" was given high priority. In addition to the above, the impacts on the environment and social considerations were also considered to be important and less impact to the current community and residents were required.

In summary, Alternative-3 (blue color line) was selected for both Section 1 and 2 as shown in the figure below.



Source: JICA, Oriental Consultants Global Co., Ltd., Eight-Japan Engineering Consultants Inc., Kokusai Kogyo Co., Ltd.- Preparatory Survey for Nacala Corridor Road Network Upgrading Project in the Republic of Mozambique, Draft Final Report, June 2016

Figure 10 : Selected Route/Alignment of Nacala Port Access Road

2.5 Scheduling and budget

The project is still at the stage of feasibility study and there is no schedule for the construction phase. In any case it is expected that construction work can take place within a total length of 48 months (4 years), assuming there will be several work fronts simultaneously. The detailed planning of construction work will be drawn up in subsequent stages of development of engineering studies.

The project budget provided for to date is USD 45 million, amount to be expressed in the detailing of engineering studies.

3 Legal Framework

3.1 Road Sector

The Decree no. 14/99 dated 27th April establishes that the System of Road Administration regulates the legal, institutional and financial framework for road administration and it has the following objectives:

- Ensure development, balance, unity and complementarity of the national road network;
- Promote integration, participation and training of public and private players in road planning, development, financing and management;
- Establish an institutional framework that will lead to increased efficiency in dealing with issues related to roads;
- Establish legal framework to ensure continued funding and regular road maintenance and management.

The National Strategy and Policy for Roads (Resolution no. 50/98 of 28th July) states that, although roads have overall positive impact on the environment, the development of road activities must take into consideration the mitigation of damages that construction and use of roads can cause. Thus, the resolution indicates that the Government will continue to abide by the standards of environmental protection during the construction of roads, which should be included in the specifications of tender documents for construction works.

The Environmental Guidelines for the Road Sector[3] define the procedures and requirements for environmental studies for projects in this sector, according to the following aspects:

- Support the entity responsible for the road sector (ANE) in the implementation of planned activities for a road project, classifying environmental responsibilities for different players;
- Serve as an operational tool for the institutions involved in the environmental impact of road projects;
- Introduce environmental principles and methodologies for the planning process of road construction and/or rehabilitation in order to ensure that these are carefully prepared in accordance with environmental legislation in force;
- Support the process of environmental impact assessment and adoption of assessment procedures appropriate for the development phase in Mozambique.

The Regulation about the Use of Roads and respective protected areas (Decree no. 109/2014 of 31 December 2010), defines permissions, restrictions and prohibitions on the use of roads and the respective partial protection areas (as defined in the

[3] ANE Internal Regulations

legislation about land). Article 8 states that the practice of agricultural activities and grazing animals it is prohibited.

3.2 Environmental Impact Assessment

In 1997 the Environment Law (Law no. 20/97 of 1st October) was approved, which aims to establish the legal basis for using and managing the environment, so as to ensure sustainable development of the country. This law is applicable to all activities, public or private, which may, directly or indirectly, affect the environment.

In accordance with the Environment Law, Environmental Impact Assessment (EIA) is a tool that assists the Government of Mozambique in the decision making process with regard to issuing environmental licenses for development projects. The issuance of an environmental license must precede other legal licenses required.

The Ministry of Land, Environment and Rural Development (MITADER), through the National Directorate of Environment (DINAB), is the authority responsible for EIA and licensing of environmental activities. The National Agency for the Control of Environmental Quality (AQUA) is responsible for environmental auditing and control and environmental inspection.

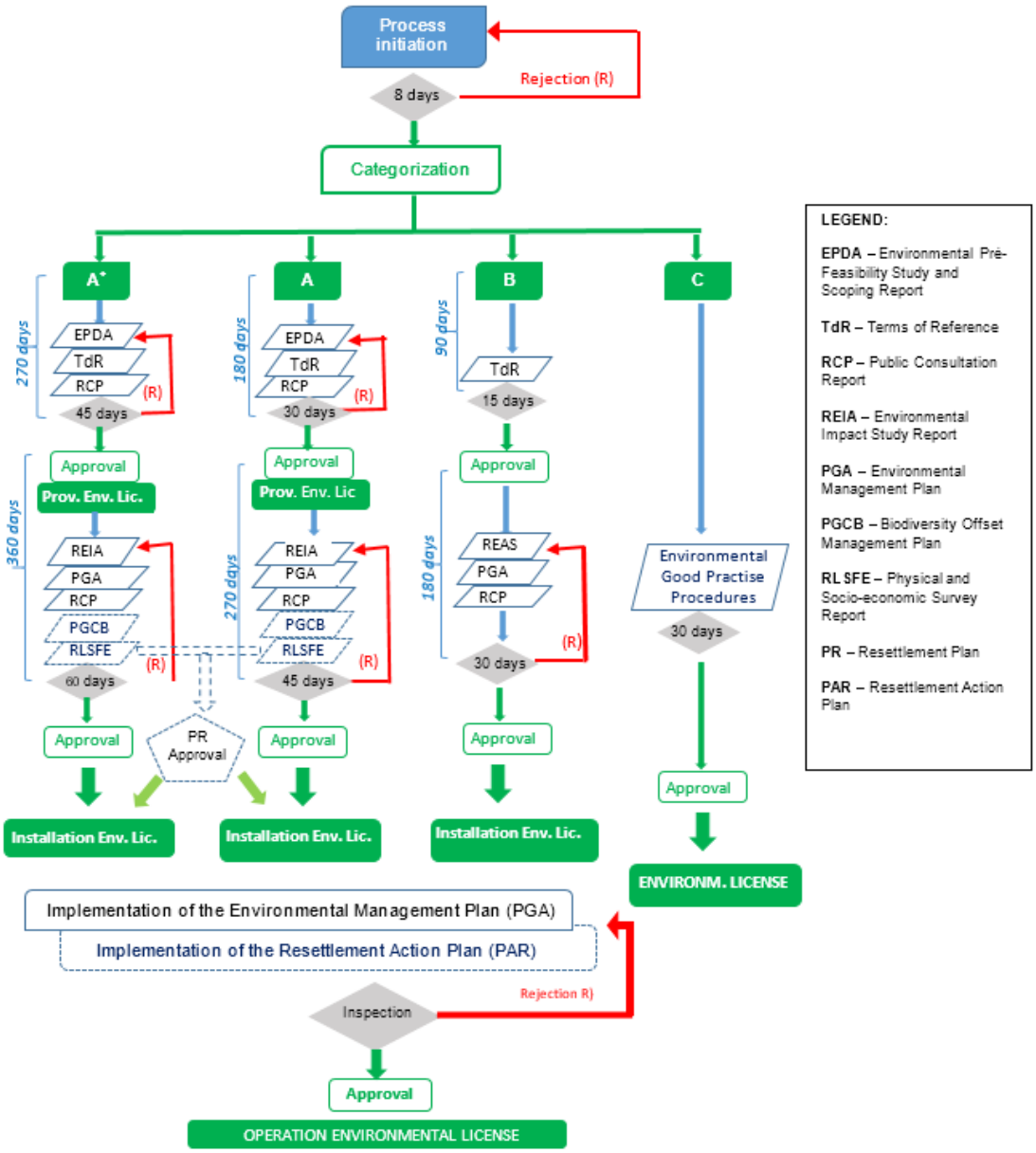
The **Regulation on the Environmental Impact Assessment Process** (Decree no. 53/2015, of 31st December, repealing Decrees no. 45/2004 and 42/2008) sets the standards on the environmental assessment process, namely the process of categorizing activities, the level and content of environmental studies required for different categories, public participation process, review process, stages of environmental licensing (provisional, construction and operation licenses), responsibilities, inspections, fees and penalties.

The Environmental Impact Assessment Process is a tool aiming to contribute to the environmental and social sustainability of activities. It begins with Pre-Assessment of activity by the Environmental Impact Assessment Authority (at national or provincial level). It is based on the information about the proposed activity and about the proposed area for the activity. This information is provided by the proponent in the preparation process to be submitted to the Provincial Directorate of Land, Environment and Rural Development (DPTADER) with jurisdiction in the proposed area for the activity. Following the Pre-Assessment the proposed activity is categorized or rejected. The following Table shows the categories taken into account in the EIA process.

Table 7: List of de Categorization based on the decree 54/2015

Category A+	Actions which, due to their complexity, location, and/or irreversibility and magnitude of impacts, should not only be subject to high level social and environmental vigilance but also experts should be involved in the EIA process.
Category A	Actions which affect significantly living beings and environmentally sensitive areas, and their impacts are of long term, intensity, magnitude and significance.
Category B	Actions which do not affect significantly living beings or environmentally sensitive areas, compared to activities pertaining to Category A.
Category C	Actions causing negative insignificant and minimum impacts or those likely to be neglected.

The following figure summarizes the process, indicating the studies required by category of activity, the deadlines for submission of documents to the Environmental Assessment Authority and the deadlines for communicating its decision. It should be noted that in cases where there is a need for preparation of resettlement plan, its approval shall precede the approval of the Construction License.



Environmental Impact Assessment Process in Mozambique, according to the Decree 54/2015

Figure 11 : Environmental Impact Assessment Process, in accordance with the Decree no. 54/2015

The EIA process is a tool to support the decision on environmental and social feasibility of activities. In any of the process phases prior to issuing a construction license, the Environmental Assessment Authority could question the environmental and social feasibility and request changes to or reject the project.

As mentioned in the introductory chapter, the Project for the Access Road to the Port of Nacala was assigned category B and it is in this context that this SIA is presented, as a result of the ToR approved by DPTADER of Nampula in December, 2016.

During construction and operation phases, through environmental audits (regulated by Decree no. 32/2003) or environmental inspections (regulated by Decree no. 11/2006), the Environmental Authority may supervise the implementation of the Environmental Management Plan and approve or suspend the operation, in case of non-compliance and violations.

3.3 Additional Environmental and Social Legal Requirements

The Table below presents other legal requirements about environmental and social subject matters which must be taken into consideration in the project in question, highlighting specific aspects which are directly applicable.

Table 8: legal requirements about environmental and social matters

LAND	
Land Law (Law no. 19/97 of 1st October) and *Regulation of the Land Law* (Decree No. 66/98, as amended by Decree No 1/2003)	It establishes as main principle that the land is owned by the State and cannot be sold, mortgaged or seized, in accordance with the Mozambican Constitution. It defines, at public level, total and partial protection areas, and for this project the following areas are classified as partial protection areas (Art 5 and 6): • Seashore strip and islands, bays and estuaries outlines, measured from high tides up to 100 meters to the interior of the territory; • Primary roads and 30 metres of the surrounding land strip; • Highways and four-lane roads and 50 metres of the surrounding land strip; • Facilities and superficial aeral conductors (..) of electricity, of telecommunications (..) along the coast and 50 metres of the surrounding land strip. In case of restriction need of the right of use and benefit from the land for the installation of public interest infrastructure, the public or private entity shall compensate the right holder, in amount that represents the effective harm for not using the land (Art 17)
LAND USE PLANNING	
*Land Use Planning Law (*Law no. 19/2007, *18th* July*)*	It aims to ensure the organization of national land and sustainable use of their natural resources, compliance with legal conditions, respect for cultural rights, provision of favourable conditions for socio-economic development of the country, promotion of population's quality of life, and protection and conservation of the environment. "expropriation in the public interest, need or utility shall be subject to the payment of a fair compensation in accordance with the Law, to be calculated so as to compensate for, among others: (a) the loss of tangible and intangible property; b) disruption of social cohesion; c) loss of production of goods." (Art 20).
Regulation of Land use Planning (Decree no. 23/2008, of 1st June)	Expropriation for the purpose of land use planning falls within public interest category when the ultimate objective is to protect a common interest of the community, and may be declared (..) for the acquisition of areas for the implementation of economic or social infrastructures with great positive social impact (Art 68)

	Expropriation is always preceded by a public statement of public interest, need or utility of the area to be expropriated (to be issued by the Government), in which ground for expropriation are indicated. (Art 69) The expropriation in the public interest, need or utility always requires the payment of a fair compensation to be made prior the transfer of ownership or possession of the property to be expropriated. The compensation should cover not only the actual and current value of expropriated property, on the date of payment, but also the damage arising and the profits casing from losing the property. (Art 70)
Guidelines about the Expropriation Process for the Purpose of Land Use Planning (Ministerial Order no.181/2010*)*	It defines compensation payment methods: in cash (in a single installment) or in kind (in the case of buildings or housing an equivalent property shall be constructed) It defines the calculation formula of compensation for the property (based on typology, importance, quality, location and depreciation) and for plants/trees (based on age, growth period, annual average production, sale price) and annual crops (on the basis of production per hectare)
FORESTS AND WILDLIFE	
Forests and Wildlife Law (Law no. 10/99, dated 7th July) and *Regulation of the Forests and Wildlife Law* (Decree no. 12/2002, of 6th June, amended by Decree no. 11/2003).	It establishes the legal framework applicable to all existing values and natural resources in the Mozambican territory and in the waters under its jurisdiction. Felling trees requires authorization request (Art 105) Burning forests is not allowed (Art 106) Annex II shows a list of protected animals, whose hunting is not allowed (includes gulls, gaivinas, herons, sea turtle, among others)
Regulation for the Control of Invasive Exotic Species (Decree no. 25/2008, of 1st July)	It sets he legal standards that prevent the introduction of invasive exoctic species that threaten ecosystems, habitats or species from its territory. It is prohibited to conduct restricted activities involving invasive exotic species, without prior authorization (Art 8)
MARINE AND COASTAL ENVIRONMENT	
Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment Stat (Decree no. 45/2006)	It sets measures for the prevention of pollution and protection of the marine and coastal environment. • The construction of infrastructures in the partial protection area along the bays (100 m strip above the line of high tide) "shall be carried out in such a way as to allow, in every 100 metres, free access to the beach for every citizen, and, in particular, to the local comnidades" (No.2, Art. 67); in fragile ecosystems, particularly in the dunes and mangroves, the construction of infrastructure (..) is only allowed upon obtaining necessary special license5 and compliance with the environmental legislation in force.The use of motorized vehicles in the coastal strip, for the construction of allowed infrastructure, requires an authorisation from the competent authority. Vehicles should be used according to proper indications for carrying out the work, while respecting local environment (Article 54)

[5] Included in the environmental license for the implementation of the project

Recreative and Sports Fishing Regulation (Decree no.. 51/99, of 31st August)	It lists a set of species protected from fishing, including dugong, walesand dolphins, whose fishing is forbidden.
WATER RESOURCES	
Water Law (Law no. 16/91 of 3rd August)	• It sets the principles for the management of inland water resources and water resources from protection areas, the user- pays and polluter-pays principle • It is prohibited to carry out directly or indirectly evictions or accumulate solid waste or any substances that contaminates or risks contamination of waters (Article 53)
Regulation for Water Licenses and Concessions (Decree no. 43/2007, of 30 October)	• It establishes principles and procedures for awarding licenses and concessions for the use of inland waters. It requests for private use of water or dumping of effluent will undergo the decision of the Regional Administration of Waters (Art 22 and 24).
QUALITY OF THE ENVIRONMENT	
Environmental Law (Law no. 20/97, *1st* October)	It establishes the environment legal framework. • It limits "production, deposit in the soil and subsoil and release into the water or into the atmosphere of any toxic substances and pollutants, as well as the practice of activities that accelerate soil erosion, desertification, deforestation or any other form of degradation of the environment" to the limits legally established (Article 9). • It provides for the establishment of environmental standards through regulation (Article 10), which came to pass through Decree no. 04/18 of 2nd June).
Regulation on Environmental Quality Standards and Emission of Effluents (Decree no. 18/2004, 15th September, as amended by Decree no. 67/2010, of 31st December)	• It sets the standards for air quality and emission of pollutants for stationary and mobile sources (SO_2, NO_2, CO, O_3, total suspended solids, carcinogenic inorganic and organic pollutants, and odorant substances – see in Annex 1 of this report the standards relevant for this project) and the basic parameters that must characterize the quality of the air. [6] [7] • It defines the emission standards for industrial and domestic liquid efluents • It sets water quality standards for the receptor (sea/ocean)[8]
Regulation on the Management of Hazardous Waste (Decree no.83/2014, of 31st December 2010)	It establishes the legal framework for the management of hazardous waste. The solid hazardous waste should be segregated in accordance with the classes defined in the regulation. Each producer or handling entity should have the minimum technical conditions in place for securing waste (Art. 13). The collection of solid hazardous waste is the sole responsibility of producing entities (Art.15). The solid hazardous waste may only be moved outside the premises of the entities by transport operators certified for that purpose (Art. 16)

[6] The Regulation does not establish quality standards for particulate inhalable materials with diameter equal or less than 10 µm (PM10) and with diameter equal or less than 2,5 µm (PM2,5).

[7] The Regulation refers the noise emission standards to the ministerial order to be published, which has not taken place yet

[8] The Mozambican legislation does not set environmental objectives for minimum quality of surface water nor quality criteria of surface fresh water aimed at producing drinking water.

Regulation on the Management of Municipal Waste (Decree no.94/2014, of 31st December 2010)	It sets the legal framework for the management of municipal solid waste and industrial and hospital waste, to be treated as municipal, applicable to all natural and legal persons, public and private. Waste producers and transporters (Art 11) are responsible for: a) minimizing the production of municipal solid waste; b) building the capacity of employees involved in handling waste on health, safety and environment matters; c) ensuring segregation and securing waste into different categories according to the provisions of Article 14 of this Regulation; (d) ensuring treatment of municipal solid waste before its final disposal; (e) ensuring the protection of all employees involved in the management of municipal solid waste from accidents and diseases resulting from their exposure to the risk of contamination; (f) ensuring that transportation of waste is carried out in appropriate manner, ensuring that there is no dispersion of solid urban waste along the road to the place of treatment or final destination; g) ensuring that the elimination of waste, inside and outside the production place, has no negative impact on the environment or public health and safety; an h) maintaining an annual registration of the sources, quantities and types of waste handled, transported, processed, recycled or disposed.
CULTURAL HERITAGE	
Cultural Heritage Law (Law no. 10/88)	• It was formulated to legally protect tangible and intangible cultural heritage of Mozambique, and the cultural heritage is defined as "group of tangible and intangible property created or incorporated by the Mozambican people throughout history, aiming to define the cultural identity of Mozambique". Cultural tangible property include: monuments, groups of buildings with historic, artistic or scientific importance, places or locations (with archaeological, historical, aesthetic, ethnological or anthropological interest) and natural elements (physical and biological properties with particular interest from the aesthetics or scientific point of view). • "Any person who find places, buildings, objects or documents likely to be classified as cultural heritage should communicate it to the administrative authority" (Art 13)
Regulation for the Protection of Archaeological Heritage (Decree no. 27/94 of 20th July)	It aims to protect different categories of movable and immovable property, which due to its archaeological value, is regarded as cultural heritage in Mozambique. • "The author of any fortuitous discovery of archeological elements must communicate with a deadline of 48 hours to the local authority, responsible for notifying entities responsible for culture, as soon as possible, so they can take appropriate measures for the protection of those elements." (Art 10)

3.4 Institutional framework

As mentioned above the environmental licensing process is conducted by the Authority for Environmental Impact Assessment form both national and/or provincial. EIA processes of activities classified in categories A+ or A are conducted at national level by the National Directorate of Environment (DINAB) under MITADER, while EIA

processes of activities form categories B or C are the responsibility of the provincial authorities (DPTADER).

It is worth noting that the environmental licensing does not inhibit the need of obtaining other permits and licenses, presented in the table above. In the following table licenses and permits on environmental and social issues relevant to this project are listed.

Table 9: Institutional framework on environmental and social issues relevant to the present project

Licenses/authorisations	Institution
Compensation process for affected families who lost farms and/or fruit trees	Provincial Directorate of Land, Environment and Rural Development (DPTADER)
Authorization for felling trees	
Authorization for using motor vehicles on the coastline for the construction of authorized infrastructures	
Authorization for registering land	
License for private use of water (boreholes or surface water) and/or effluent discharge	Regional Water Admiinistration – Central and Northern Region
Authorization for disposing of waste in the municipal waste site	Municipal Council of Nacala
Authorization for using borrow pits	Provincial Directorate of Mineral Resources and Energy

3.5 International conventions

Mozambique is a signatory to various international conventions, with emphasis on the following:

1. Convention on Wetlands of International Importance especially as Habitat for Aquatic Birds (Ramsar Convention)
2. UNESCO Convention on the Protection of World Cultural and Natural Heritage
3. Convention on Migratory Species of Wild Animals, 1979, as amended (the Bonn Convention)
4. African Convention on the Conservation of Nature and Natural Resources.
5. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
6. UNESCO Convention on the Protection of Cultural and Natural Heritage of the World Heritage. Ratifies the Convention.

7. Convention on Prohibition of the Importation into Africa and the Control of Transboundary Movement and Management of Hazardous Waste in Africa (Bamako Convention)
8. United Nations Convention on Biological Diversity (CBD)
9. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
10. United Nations Convention on Climate Change, June 1992.
11. Convention on Biological Diversity
12. United Nations Convention of 7 June 1984 on Combating Desertification in Countries affected by drought and/or desertification, particularly in Africa
13. Cartagena Protocol on Bio-safety
14. Stockholm Convention on Persistent Organic Pollutants
15. Convention on the Rights of the Child

3.6 International Guidelines

In the case of a project funded by JICA, there is a need to take into consideration the Guidelines for Environmental and Social Considerations of this institution (Guidelines for Environmental and Social Considerations, 2010).

These guidelines require the disclosure of environmental and social considerations of projects and the consultation of interested and affected parties.

The projects should be categorized according to the extent of environmental and social impacts expected and set the type of environmental assessment required.

The assessment of impacts should cover a variety of topics, including the natural environment (air, water, soil, waste, accidents, use of water, climate change, ecosystems, fauna and flora), as well as social impacts (migration of populations and involuntary resettlement, local economy, employment, livelihoods, land use and local resources, social institutions, infrastructure and social services, vulnerable groups, equity in development processes, gender, rights of the child, cultural heritage, conflicts of interest, infectious diseases, working conditions, occupational safety).

In addition to compliance with environmental and social requirements set forth by the national legislation, projects must take into account the international best practices, in particular policies of the World Bank, namely, the Environmental Assessment (OP 4.01) and Involuntary Resettlement (OP 4.12).

4 Terms of Reference of the EAS

As mentioned previously, in accordance with the RPAIA, the EIA for the access road to the Port of Nacala began with the submission on 11/05/2015, to the Provincial Directorate of Land, Environment and Rural Development (DPTADER) of Nampula, of documentation for the preparation of the process. Subsequently, pre-assessment provided for in regulation was carried out, resulting in the allocation of Category B to the Project, as indicated in the DPTADER letter dated 01/06/2015.

As a result, and as set out in RPAIA, prior to the formulation of this SIA preparation of terms of reference (ToR) took place, in which project actions with the greatest potential to cause significant impacts to the environment were discussed and the scope and methodologies of the SIA identified.

In these ToRs the potential environmental and social impacts arising from the construction and operation were preliminarily identified and evaluated. These impacts have been examined during the preparation of the SIA, based on the matrix applied by JICA in projects it funds.

The following codification was used for this preliminary assessment:

- A+/-: significant expected positive / negative impact;
- B+/-: less significant expected positive / negative Impact;
- C+/-: significance of the unknown positive / negative impact (need for more detailed analysis, with clarification of the impact in the course of work);
- D: impact unexpected

The impacts evaluated preliminarily during the preparation of ToRs were, thus, as follows:

Table 10: Impacts evaluated preliminarily in the ToRs for the SIA

Category	No.	Impact	Preliminary Impact Assessment		Comments
			PC/C	Operation	
Pollution Control	1	Air Pollution	B-	B±	**During Construction:** Deterioration of air quality due to the emission of dust, SOx, NOx etc. to the atmosphere as a result of the movement of land and mobilization of vehicles and machinery in the work is expected. **During Operation:** Negative impact on air quality in surrounding the project due to the increase in the volume of traffic and consequently of their atmospheric emissions is expected. On the other hand an improvement in air quality in the surrounding of the national road due to the diversion of traffic to the new road is expected.
	2	Water contamination	B-	C	**During the construction** : Increase in the turbidity of the water at sea and in water lines of the surrounding the labor and oil drilling sites is expected. In the construction

Category	No.	Impact	Preliminary Impact Assessment		Comments
			PC/C	Operation	
					site wastewater will be generated including sanitary facilities and workshops that can pollute the water. **During Operation:** It is expected that the impact of water run-off from the highway is insignificant, except in the case of an accident with carriage of dangerous substance (see below -accident).
	3	Waste	B-	D	**During the construction** : Woody material (wood and forest) and lands of the excavations and perforations will result from deforestation of the area for the new road. On the other hand, in the construction site solid wastes will be generated, as well as hazardous waste, in the workshops. **During Operation:** The expected impacts are negligible.
	4	Soil Pollution	C	D	**During the construction** : The impact resulting from the deposition of woody material and land is negligible. However, the deposit of materials resulting from drilling in the Bay of Nacala, which may contain contaminated sediments, may cause soil pollution. Soil pollution caused by leaks of dangerous substances in workshops or work zones of machinery from the work is also possible, although in principle these impacts are immediate and not very significant. **During Operation:** These impacts are not expected at this stage.
	5	Noise/vibration	B-	B±	**During the construction** : Increase of noise and vibration in the surrounding of the site (including any quarries and gravel sites) and on the roads of access to the work in which there is movement of vehicles and equipment is expected. **During Operation:** Negative impact on the surrounding of the project due to the increase in the volume of traffic and consequent increase in noise and vibration is expected. On the other hand it is expected a reduction of noise and vibration in the surrounding of the national highway, as a result of diversion of traffic to the new road.
	6	Erosion and subsidence of land	C	C	**During the construction and operation**: The movements of earth and the changes in the drainage network can cause some occasional increases soil erosion but may also help to remedy some existing situations. Activities (e.g. pumping of large quantities of groundwater) which may result in the reduction of land and as such impacts of this kind are not expected to conduct

Category	No.	Impact	Preliminary Impact Assessment		Comments
			PC/C	Operation	
	7	Odors	B-	D	**During the construction and operation:** Only the realization of some works in the coastal zone in the intertidal as well as situations of low tide may generate odors. However it will be a very immediate situation whose impact is expected to be insignificant.
	8	Deposition of sediments	B-	D	**During the construction** : There is possibility of deposition of sands or sludge generated during the execution of the foundations of the bridge, however in principle it is expected that the resulting impact is negligible. **During Operation:** No impact is expected at this stage.
Biotic Environment	9	Conservation areas	D	D	**During the construction and operation:** There are no conservation areas in the area of implementation of the project, or in close proximity.
	10	Ecosystems	C	C	**During the construction and operation:** The project implementation area will occupy areas which may be of some interest in terms of biodiversity, as coastal areas, wetlands and small patches of natural vegetation in terrestrial environment. During biologist field work the importance of these sites, the extent, magnitude and significance of the impact will be assessed. There may still be collisions with fauna, both during the construction phase and in the operational phase.
	11	Oceanography and Hydrology	C	C	**During the construction and operation:** There may be a temporary change of disposal of sea water and water lines during the construction of the pillars of the bridge.
	12	Topography, Geology	B-	D	**During the construction** : There will be some change of topography as a result of movements of earth during the work. **During Operation:** There are no expected impacts at this stage.
Social Environment	13	Resettlement	B-	D	**Before and during the construction** : There is a need to occupy the land currently occupied by agricultural fields and/or fruit trees. Eventually it may also be necessary to remove housing and associated structures, although in very limited number (less than 10 houses). **During the phase of Operation:** No impact is expected
	14	Poverty	C	C	**Before, during and after the construction**: In this phase the information about the current situation is limited. In social studies the current level of poverty and potential impacts arising from the project will be assessed.
	15	Minority	C	C	**Before, during and after the construction**: In this phase the information about the current

Category	No.	Impact	Preliminary Impact Assessment		Comments
			PC/C	Operation	
		groups			situation is limited. In social studies the possible existence of minority groups will be identified and the potential impacts of the project evaluated.
	16	Regional economy (such as employment and living conditions)	B±	B＋	**Before and during the construction** ： During the construction increase the employment opportunities or business directed to workers are expected, which will contribute to the generation of income for families. The magnitude and significance of the impact will be evaluated during the preparation of studies. **During the phase of operation:** The project will result in an improvement in access to the Port of Nacala, which will contribute to a greater dynamism of the regional economy.
	17	Land use and natural resources	B-	B＋	**Before and during the construction:** The road passes through areas of natural vegetation, in addition to agricultural areas that will be affected. **During Operation:** The presence of this new road may induce the creation of new industries or services related to the port activity, given the best conditions of access created in the area of direct influence to the road design
	18	Use of water	B-	D	**During the construction** ： The construction works will require a level of water use which can cause contamination that may affect water usage by the local people. The extent and significance of this impact will be evaluated after the surveys on the use of water.
	19	Infrastructure and social equipment	C	D	**During the construction** ： The access to infrastructure and social amenities, such as markets schools, churches, cemeteries, water points, among others may be temporarily conditioned during the work. On the other hand, health centers may have greater affluence derived from the presence of non-resident workers in the area. The extent and significance of this impact will be evaluated after the surveys. **During Operation:** These impacts are not expected during operation, since this road will be solely for access to the port area.
	20	Social capital and decision-making mechanis	C	C	**Before, during and after the construction** ： During the collection of information of social nature the presence or absence of social organizations locations will be identified to see if the project impacts the local decision-making process.

Category	No.	Impact	Preliminary Impact Assessment		Comments
			PC/C	Operation	
		ms at regional level			
	21	Poor distribution of wealth (costs and benefits)	C	C	**Before, during and after the construction** : It is not expected that the project will affect the distribution of wealth, but this will be assessed during the preparation of studies.
	22	Regional conflicts	C	C	**Before, during and after the construction** : No regional conflicts are expected as a result of implementing the project, however this will be reviewed during the study.
	23	Cultural heritage	C	D	To date the only sites with a value identified in the surroundings of the location of the project are cemeteries. During the research for the social studies verifications will be made to see possible existence of other sites with heritage or cultural value and the potential impacts resulting from the implementation of the proposed project.
	24	Landscape	B-	C	**During the construction phase** The Bay of Nacala has associated scenic value that may be temporarily affected by movements of earth and construction of the bridge. **During Operation:** The presence of the new road and bridge, while new elements in the landscape of the Bay of Nacala, can generate impacts on the landscape that will be evaluated.
	25	Gender	B-	C	**During the construction and operation** : There may be a limitation of women's access to places of gathering firewood, water and/or seafood, to be investigated and evaluated during the social field work
	26	Children's rights	D	D	Activities affecting the rights of the children, such as child labor, are not expected.
	27	Infectious diseases such as HIV/AIDS	B-	D	**During the construction** : There may be a greater spread of infectious diseases, particularly those of sexual transmission, as a result of labor. **During Operation:** This type of impacts is not expected during the operational phase.
	28	Working conditions (including security)	B-	D	**During the construction** : Some of the activities of the construction will expose workers to agents that may have adverse health effects, such as dust, exhaust gases or toxic substances. On the other hand, there will be activities with risks to safety. **During Operation:**

Category	No.	Impact	Preliminary Impact Assessment		Comments
			PC/C	Operation	
					This type of impacts is not expected during the operation phase, as there will be no workers engaged in the operation of the road.
Other	29	Accidents	B-	B-	**During the construction** : Accidents can be caused in the construction area or as a result of the movement of vehicles and work equipment, affecting workers and/or local communities. **During Operation:** It is possible that accidents occur involving vehicles in circulation in the new road. On the other hand, reduction of road accidents on the national road is expected due to the diversion of traffic to the new road.
	30	Transboundary effects, climate change	C	C	**During the construction** : Increase in temporary and located emissions of greenhouse gases (GHG) is expected as a result of emissions of vehicles and equipment of combustion associated with the work, alongside with clearance of vegetation in the project implementation area. **During Operation:** An increase in GHG emissions is expected as a result of increased heavy traffic to and from the port area. However at the regional level, the reduction of traffic congestion will result in a reduction of GHG emissions.

The terms of reference of this study were approved by DPTADER in a letter dated 9 December 2016.

As specific methodologies to be followed for the characterization of environmental descriptors pointed out as relevant and for the identification and assessment of impacts and mitigation measures, the ToRs included, briefly, the indications listed in the following table:

Table 11: ToR for the SIA - specific methodologies

Environmental Descriptor	Aspects to Consider	Methods to be used
Climate	1. Characterization of the climate classification in the area of influence of the project, average temperatures, average annual rainfall and seasonal distribution, patterns of prevailing winds, risk of cyclone and trends related to climate change. 2. Identification of situations of vulnerability to climate change; 3. Analysis of possible changes	1. Collect and review of secondary information available 2. Field work (observations, interviews)

Environmental Descriptor	Aspects to Consider	Methods to be used
	can be induced by the project	
Oceanography	1. Characterization and prediction of effects in relation to the bathymetry, tidal, patterns of currents and sediment transport; 2. Idem with regard to water quality and sediment	1. Compilation and review of secondary data. 2. Analysis of information systematized in the context of other studies
Geology, geomorphology and Geotechnics	1. Evaluation of possible situations of instability of land caused or exacerbated by the construction and presence of the road	1. Analysis of secondary information, including geological mapping and geomorphology 2. Analysis of information included in the engineering project
Resources Land	1. Identification of uses of waters in the area crossed by the project; 2. Characterization of water quality 3. Evaluation of the implications of the project on the uses of water, 4. Analysis of the effects of changes in the drainage network 5. Analysis of potential effects on water quality as a result of discharges associated with the project	1. Collect and review of secondary information on the availability and quality of existing water resources (surface and groundwater), 2. Interviews and field work for identification of water uses 3. Sampling and analysis of samples of surface water 4. Examination of the draft drainage; 5. Analysis of information systematized in the context of other studies
Soils and land use	1. Characterization of soil types occurring in the area crossed by the project, including the problem of erosion; 2. Predicted effects can be induced by the project	1. Collect and review of secondary information; 2. Field surveys for characterization of soil types present along the route and the uses of the land there from
Landscape	1. Visual analysis of landscape and qualitative assessment of changes induced by the project	1. Collection and analysis of information on the physiography, land use and the possible points of observation and future
Air Quality	1. Characterization of air quality in the area crossed by the project; 2. Estimates of air quality in the surrounding area of the road design as a result of traffic emissions that will circulate in New Road	1. Collection of existing secondary information on air quality in the area crossed by the road; 2. Identification of emission sources and sensitive receptor; 3. Performing measurements of air quality; 4. Use of mathematical modeling for forecasting air quality.
Noise and vibration	1. Characterization of the	1. Collection of existing secondary

Environmental Descriptor	Aspects to Consider	Methods to be used
	acoustical environment and vibration in the area crossed by the project; 2. Estimates of the noise levels in the surrounding area of the road design as a result of traffic emissions that will circulate in New Road	information about the noise and vibrations in the crossed area; 2. Identification of sources of noise and vibration, and sensitive receptors; 3. Realization of measurements; 4. Use of mathematical modeling for forecasting future noise levels.
Biotic Environment	1. The study area for the conservation areas; 2. Characterization of the vegetation, flora and habitats inland and coastal states and species occurring with protection status. 3. Assessment of impacts related to loss of vegetation and habitats, whether in terrestrial environment as coastal states and the potential ecological impacts resulting from changes in the quality of the environment	1. Collection and analysis of secondary information (bibliography and thematic cartography); 2. Analysis of aerial images and observations in the field;
The socio-economic disadvantage	1. Characterization and evaluation of impacts on administrative and policy and hierarchy of power (including traditional), demography, population dynamics and patterns of human settlement, economic activities, infrastructure and social amenities, indicators of human development and vulnerable groups, patterns of land use and natural resources, cultural heritage and regional planning; 2. Assessing impacts in dwellings and associated structures and/or permanent or temporary destruction of farms and fruit trees	1. Analysis of secondary information collected through review of literature, complemented by primary information collected during field work, through interviews with government bodies and non-governmental organizations, local authorities and local communities 2. Preparation of a resettlement plan that will aim to compensate and replace or improve the living conditions of affected families.

5 Biophysical and socio-economic environment diagnosis

5.1 Methodology

The diagnosis of the biophysical and socio-economic environment, that is, the characterization of the reference situation consists in the description of the conditions of each descriptor in the current scenario, that is to say, in a situation immediately prior to the implementation of the project, allowing to later compare it with a future scenario involving the construction and operation of the project so as to determine the resulting environmental impact.

The characterization of the reference situation is fundamentally supported by the collection of existing bibliographic information and/or official data, by project elements and other associated ones (for example, the traffic forecasts) and by field work and consultation with relevant organizations.

As general methodological aspect, it is relevant do define the area of influence of the project.

Thus, the Direct Influence Area (IDA) corresponds to the area where direct impacts on the physical, biotic and socio-economic environment may occur. This is the area that will be physically occupied by construction works and new infrastructures. It will also count on a land strip where direct effects resulting from these works and the presence and operation of the infrastructures will be experienced.

The IDA will correspond to the 50-meter strip from each side of the road from the shoulders, in accordance with what the Land Law defines partial protection area for motorways and 4-lane roads.

The Indirect Influence Area (IIA) constitutes a more extended area, in which the influences of the proposed activity can occur, not directly, but through the possible side effects resulting from various activities associated with the project.

The whole area of the city of Nacala – Nacala Porto and the districts of Nacala – Nacala-a-Velha and Mossuril and, at a higher level, the Nampula province are considered the IIA of the project.

5.2 Climate and vulnerability to climate change effects

5.2.1 Climate

The climate in Nacala is, according to Köppen's classification, type AW, meaning tropical humid with two seasons: the rainy season from October to March and the dry season from April to September. In this kind of climate, the average annual precipitation is generally higher than the annual evaporation. AW climate is dry in winter and more extensive than in equatorial humid climates. This type of climate occupies a significant area of northern Mozambique.

The climate in this region is influenced by the south intertropical front. From November to April, with extremes in January and February, the front moves to the

south, then the highest values of temperature and precipitation occur, with strong monsoon rains often accompanied by thunderstorms, winds from northeast and tropical depressions or even cyclones.

In a more detailed manner and using the information available on the Portal site Climate-data.org (http://pt.climate-data.org/), resulting from processing by a climate model of the data obtained in thousands of weather stations around the world between 1982 and 2012, in relation to the variation of temperature and precipitation in Nacala, the following elements of characterization may be presented:

- In Nacala the average annual temperature is 24.9 °C. The average monthly temperature of December, the hottest month of the year, is 26.4°C. July is the month with a lower average temperature, 22.9°C.
- The average annual precipitation is 843 mm. In September, the driest month, the average precipitation is 7 mm. Most of the precipitation occurs in January, with an average of 196 mm.

Table 12: Climate for Nacala

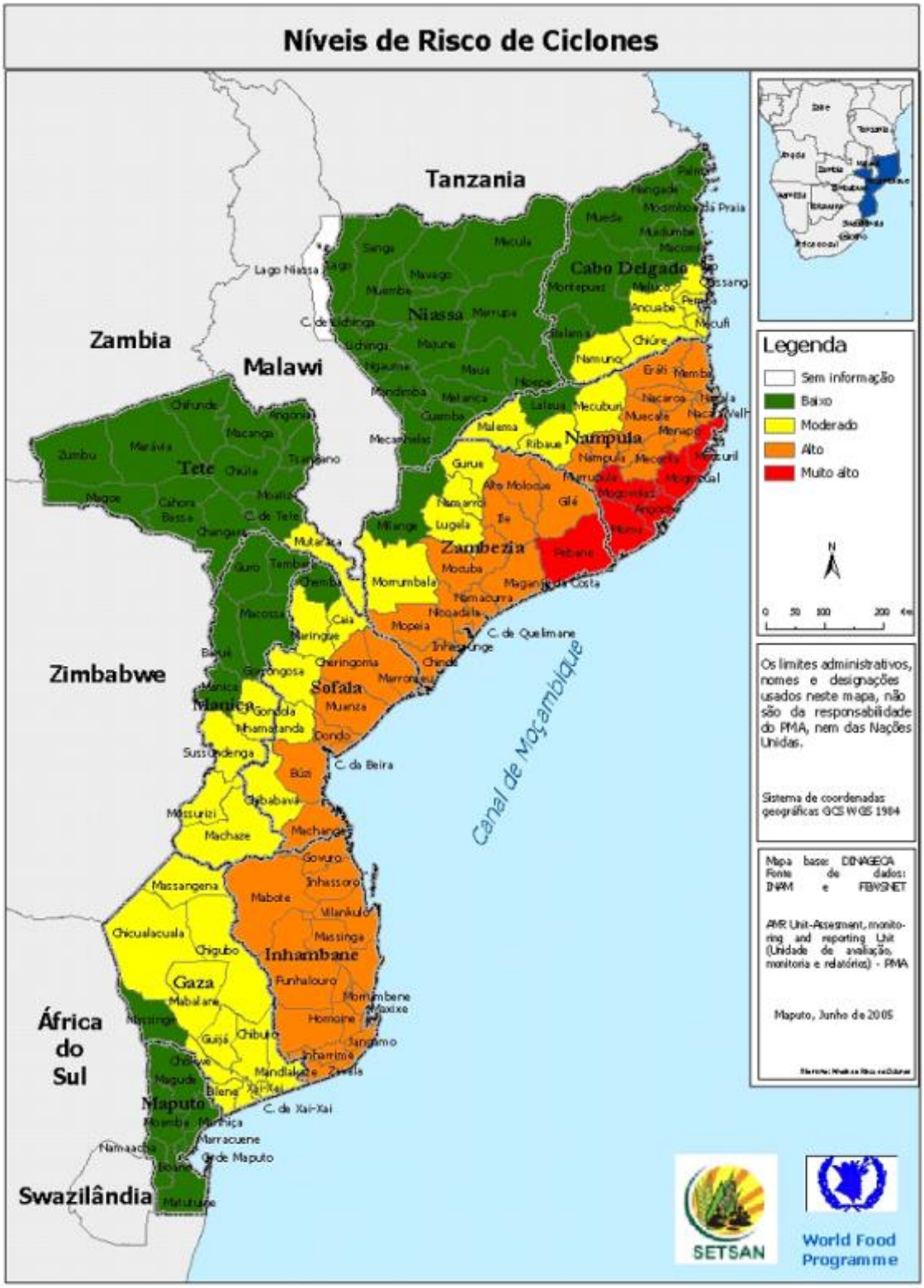
	Months											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Precipitation (mm)	196	184	167	69	14	17	10	10	7	8	36	125
Ave. Temp. (°C)	26.3	26.1	26.2	25.6	24.4	23.2	22.9	23.0	23.8	25.2	26.2	26.4
Max. Temp. (°C)	31.2	31.1	31.1	30.7	30.1	28.8	28.5	28.6	29.5	30.6	31.3	31.2
Min. Temp. (°C)	21.5	21.2	21.3	20.5	18.8	17.7	17.3	17.5	18.2	19.8	21.1	21.6

Source: Portal site Climate-data.org (http://pt.climate-data.org/)

The winds generally have moderate speed on the northern coast of Mozambique. In the summer the northeast and east winds prevail, while during the winter winds prevail from the south.

In the section related to air quality the elements of additional characterization relevant to the dispersion of atmospheric pollutants are presented.

The area where the project implementation is planned is considered of high risk of occurrence of cyclones, as the following Figure shows.



Source: CCCG, 2006

Figure 12 : High risk of occurrence of cyclones

5.2.2 Vulnerability to climate change effects

By using what is referred to in the National Strategy on Climate Change - ENMC (2013 - 2025), it can be noted that climate change in Mozambique may manifest mainly in the following aspects (those with greater relevance for the influence area of the project shall be retained):

- Atmospheric temperature range - with an average increase between 1,5°C to 3.0°C in the period between 2046 to 2065 and occurrence of more warm days and fewer cold days, with increased maximum and minimum temperature;
- Ocean temperature range - with rising average levels and change in the distribution and availability of fishery stocks and effects on marine ecosystems (such as, for example, corals);
- Precipitation patterns:
  - With irregular precipitation in terms of time of beginning and end, rainfall rate (intense precipitation phenomena in a short period of time) and duration of the rainy season (dry season), distorting the notions of "official" and "real start" of the agricultural season, which may result in some regions in the decrease of potential income by 25%;
  - With increasing reduction of potential levels of potential agricultural income by 20% in main crops which form the basis for food security and condition for the improvement of per capita income of Mozambican households.
- Increased frequency and intensity of extreme events (droughts, floods and cyclones)
  - Recurrent floods in identifiable locations which can be referred to as "risk areas" or "locations";
  - Cyclones and other strong winds;
  - Prolonged droughts.
- Rise in sea level: (15 cm, 30 cm and 45 cm as a result of thermal expansion and 15 cm, 110 cm and 415 cm as a result of reduction of continental ice in the years 2030, 2060 and 2100, respectively).
  - Identified areas with increased risk for occurrence of other natural adverse effects such as the loss and erosion of coastal areas, intrusion of saline water, desertification;
  - Reduction of available areas for the practice of agriculture in green or low areas.

It should be noted that the impacts and vulnerabilities identified in the ENMC are mainly related with responses such as water resources management, as well as the fact that Mozambique is exposed to extreme events, such as those associated with tropical cyclones.

The vulnerability factors identified in the ENMC associated specifically with the potential changes in precipitation patterns and temperature rise include:

- decrease in the amount of water available with desired quality for various purposes (human, wildlife, forests, agriculture, energy production, and industry use) due to lower precipitation, lower aquifer recharge, increased evapotranspiration, saline water intrusion and increased risk of bushfires propagation (lower relative humidity of the air)
- Higher risk of loss of lives, crops, forests and other natural heritage, soil erosion and damage to infrastructure associated with flooding by rising of sea level and storm surge, and extreme precipitation events - floods (and wind)
- Lower availability of biomass for energy purposes
- Change in the distribution and abundance of fisheries resources and marine biodiversity owing to water column heating and acidification and ultimately bleaching and death of corals
- Increased mortality and morbidity of man for the spread of diseases, and by more malnutrition, with effects aggravated in the most vulnerable groups
- Declining soil fertility due to erosion, deforestation, excessive bushfires and saline intrusion

5.3 Geomorphology, geology and soils

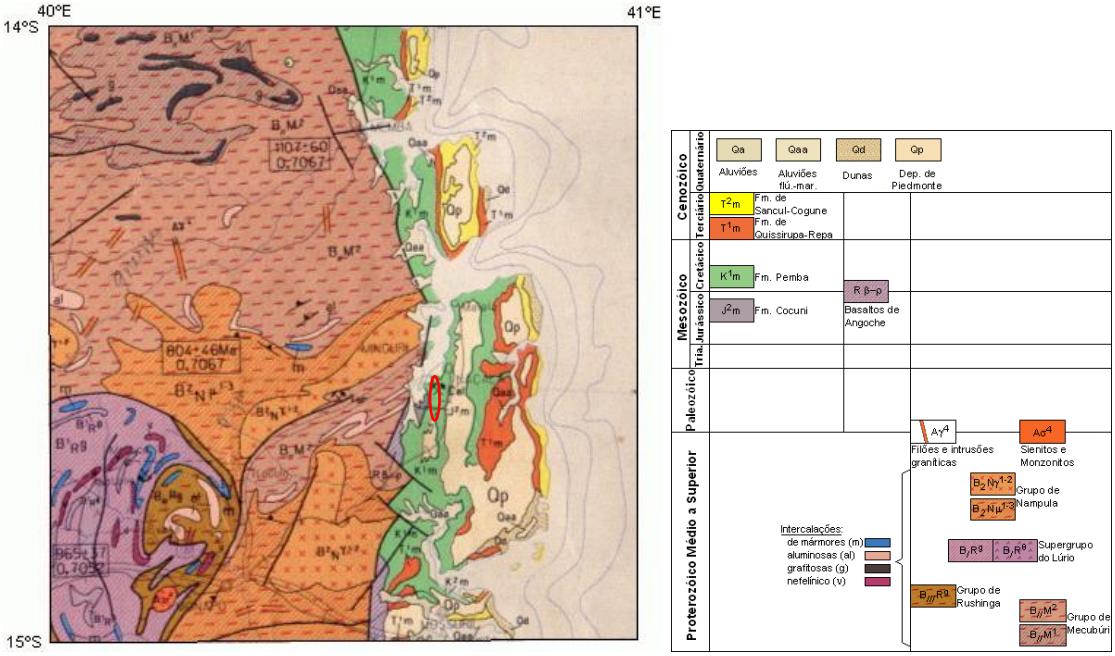
5.3.1 Background

The study area is located along the Bay of Nacala, integrated on the coastal plain of Mozambique, which sectiones along the coast in the northern and central region of the country, from the mouth of the Rovuma river to south of the Save river, with medium width ranging between 20 to 60 kilometers.

In the north, the coastal line is crossed by a succession of bays, including the bays of Memba, Fernão Veloso, Nacala and Condúcia, which are believed to have resulted from the coastal rebate caused by rejection of geological faults that affect the sedimentary formations, in recent times.

The Bay of Nacala stands out as the largest bay in the northern region of the country and the deepest in African eastern coast. It features a south-north orientation, with a total length of about 12 km and 800 meters in width, at the entrance, in Fernão Veloso.

In geological terms, the study area is marked by the occurrence of formations of the Proterozoic Medium and Superior period in inland areas, dominated by granites of Nampula formation, and latest sedimentary formations of Mesozoic and Cenozoic periods, in the coastal area, including sedimentary materials in the Pemba formation and sediments of the Quaternary, both essentially of marine origin.



Source: Geological Map of Mozambique (1:1,000.000), National Directorate of Geology - DNG (1987).

Figure 13 : Geological excerpt of the northeast Portion of Mozambique (Grau-Quadrado 1440).

5.3.2 Geomorphology

The area where the Access Road to the Port of Nacala will be constructed is located on the east side of the Bay of Nacala, which is a peninsula, integrated on the Coastal Plain.

In geomorphologic terms basically two units on this side of the Bay can be distinguished:

1) Beach and Plains (Quaternary sedimentary formations) which comprise

   - Sandy beach, consisting of white sand, usually with fragments of shells and corals, in general, a narrow strip with less than 0.5 meters wide, and occupying sea-mainland interface areas. These are slopes with angles of approximately 10º to 12º.
   - Supratidal plains with substrate swampy mangroves, consisting essentially of silt and organic sludge from secretions of organisms and accumulation of algae, crossed by numerous tidal channels.
   - Alluvial plains occur as small patches in areas topographically lower along the water lines, albeit with greater spatial expression along the coast.

2) Coastline, consisting of higher altitude and wavy areas, covered by Cretaceous sedimentary rocks, represented by clusters and stoneware, which are mechanically brittle and of weak cohesion and low resistance to wind and precipitation erosion.

Photography 1: Supratidal plains with mangroves

Photography 2: Sandy beach and alluvial plains, next to Km 1+400

Photography 3: Alluvial plains, old saltpans next to Km 2+750

Photography 4: Way coastline

The road corridor in analysis begins at the Port of Nacala, at a zero-meter altitude above sea level. In the initial section, with approximately 5 km in length, the road is located less than 1 km away from the coastline and crosses narrow sandy beaches, largely modified small mangroves and alluvium.

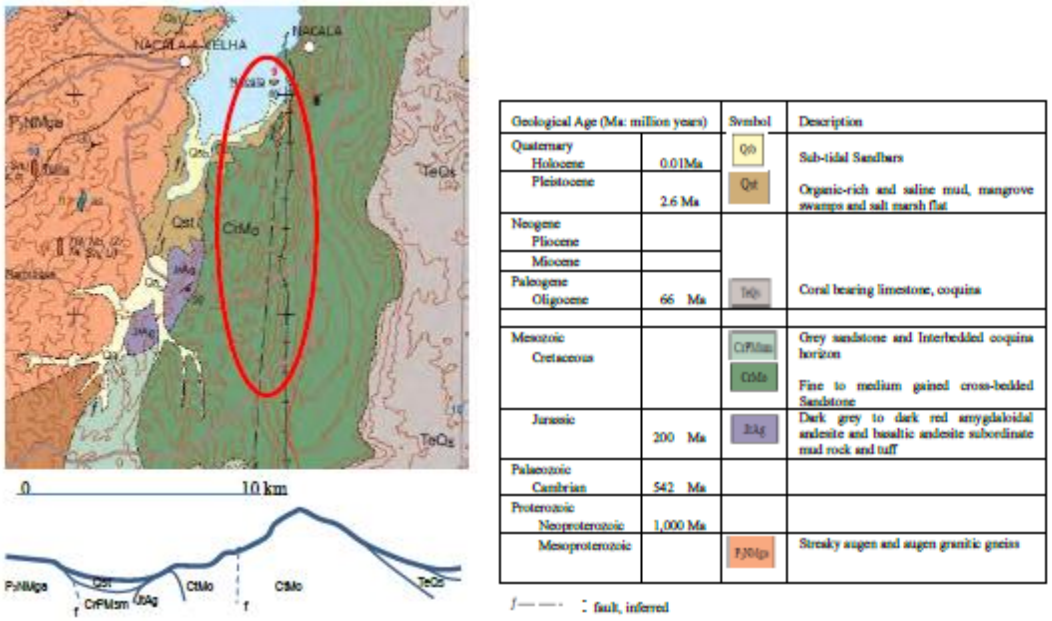
In the initial section the altitudes increase gradually and slightly between zero and 15 meters, as the distance between the road and the coastline also increases.

Approximately from Km 5+000, the road turns to the South, and after crossing a coastal alluvial plain area, the corridor covers a slight slope, up to a maximum altitude of 140 meters.

5.3.3 Geology

In geological terms the largest section covers Cretaceous sedimentary formations (CrPMsm and CtMo) consisting of marine sediments, such as stoneware, marls, limestone and sandstone. Along the coast there are recent formations (Quaternary period), which include subtidal sand, organic and saline sludge, mangroves and saline marshes.

As shown in the geological map 1/250 000 (Figure below), this area is crossed by a North-South direction fault. On the west side of the fault, the upper Cretaceous layer (CrPMsm) overrides the lower Cretaceous one (CtMo). The dip fault is unclear, but the eastern side is supposed to have risen against the western side (bay), creating a crest. The crest occurs throughout 35 km, with an altitude of 100 to 160 meters, with a steep slope between the crest and the fault.



Geological Age (Ma: million years)		Symbol	Description
Quaternary Holocene	0.01Ma	Qs	Sub-tidal Sandbars
Pleistocene	2.6 Ma	Qst	Organic-rich and saline mud, mangrove swamps and salt marsh flat
Neogene Pliocene			
Miocene			
Paleogene Oligocene	66 Ma	TeQs	Coral bearing limestone, coquina
Mesozoic Cretaceous		CrPMsm CtMo	Grey sandstone and Interbedded coquina horizon Fine to medium gained cross-bedded Sandstone
Jurassic	200 Ma	JtAg	Dark grey to dark red amygdaloidal andesite and basaltic andesite subordinate mud rock and tuff
Palaeozoic Cambrian	542 Ma		
Proterozoic Neoproterozoic	1,000 Ma		
Mesoproterozoic		PtNMgs	Streaky augen and augen granitic gneiss

: fault, inferred

Figure 14 : Extract from the geological map (National Directorate of Geology, 2006) and (JICA, 2016)

The crest has a wear area which is approximately 10m thick, extremely prone to erosion by rain water or water from seepage. Soil erosion has progressed easily in various existing points of the steep slope, especially along the east side of the fault. The existence of a clayey layer, underlying the wear layer, allows infiltrated waters to flow on the slope, causing erosion and even collapse of the slope.

The upper Cretaceous (CrPMsm) has gray sandstone, while the lower Cretaceous (CtMo) is characterized by fine to medium grain sandstone.

5.3.4 Soils

In the study area, a group of moderately deep and sandy soils associated with sediment from Karoo, Cretaceous or Tertiary, which occur in wavy terrain in the form of hills, with moderate vulnerability to erosion, prevail.

In low areas, dark color clayey soils with limited depth, imperfectly to moderately drained, occur. With regard to fertility, these soils are partially suitable for agricultural production mainly due to the limited depth.

On the slopes of the hills, brown to yellowish sandy soils occur, with low depth and from slightly excessive to moderate drainage, and prone to wind and precipitation erosion. With regard to fertility, in general, these are not very fertile soils due to low availability of nutrients and low water retention capacity, which are critical to the development of plants, and to limited depth of soil, as mentioned earlier.

Photography 5: Soil in the low area

Photography 6: Soil in slope

5.4 Water resources

5.4.1 Surface water resources

Hydrology

The most important aspect to retain in terms hydrology in the influence area of the project is related to lack of rivers for discharging into the bay. There are, however, several drainage lines, mostly with very small hydrographic basins. These drainage lines only have a water flow during the rainy season, after heavy and prolonged precipitation, while in the dry season only groundwater can be found, either through upwelling or runoff from excavations carried out by local communities for water collection.

In the context of the feasibility study carried out for the project 32 drainage lines crossing the road route were identified. One of these drainage lines drains a larger catchment (10.86 km^2) and is crossed by a 4.2 km section after its beginning at the Port of Nacala. Of the remaining, 8 drain areas exceeding 1 km^2 but under than 2 km^2 and one drains an area greater than 2 km^2 (2.99 Km^2, specifically). The other remaining drainage lines drain areas under 1 km^2.

The feasibility study included a hydrological study that aiming to provide the scaling elements of the hydraulic crossings to be incorporated into the road design. These hydraulic crossings will correspond to concrete elements aiming to allow a safe water flow that may be channeled via crossed drainage lines in during heavy precipitation, estimated with different recurrence periods (10 years in the case drainage lines with basins under 1 km^2, 20 year basins exceeding 1 m^2, and 50 years for the drainage line with the largest basin (10.86 km^2).

Quality of water

Drainage lines flowing into the bay in the initial part of road route discharge storm-water from suburban and industrial areas, presumably with a greater degree of contamination than the storm-water from areas with lower occupation density located further to the south.

As part of the preparation of this SEA, samples of water from 4 places along the road design were collected and subsequent analysis of these samples for evaluation of water quality carried out.

The location of these 4 sampling points is shown in the following Figure.

It should be noted that this component of field work was carried out on 9 and 10 October 2016, at a time when the flows of the water lines were very low or even zero. This aspect and the fact that it is a single round of sampling and analysis should be taken into account when considering the representativeness of the results obtained.

A brief description of sampling points in question may refer to:

- Point A: artificial water line that drains the high area of the Nacala city and industrial areas.
- Point B: drain line of crossed by road design around the Km 7+000, with no flow, but with some water accumulated in the depressions.
- Point C: water line at the point where the road design crosses the road R702, in an area where local communities collect water in small excavations conducted in its bed.
- Section D: water line located near the end of the road design (N12), in an area where local communities collect water for their basic needs.

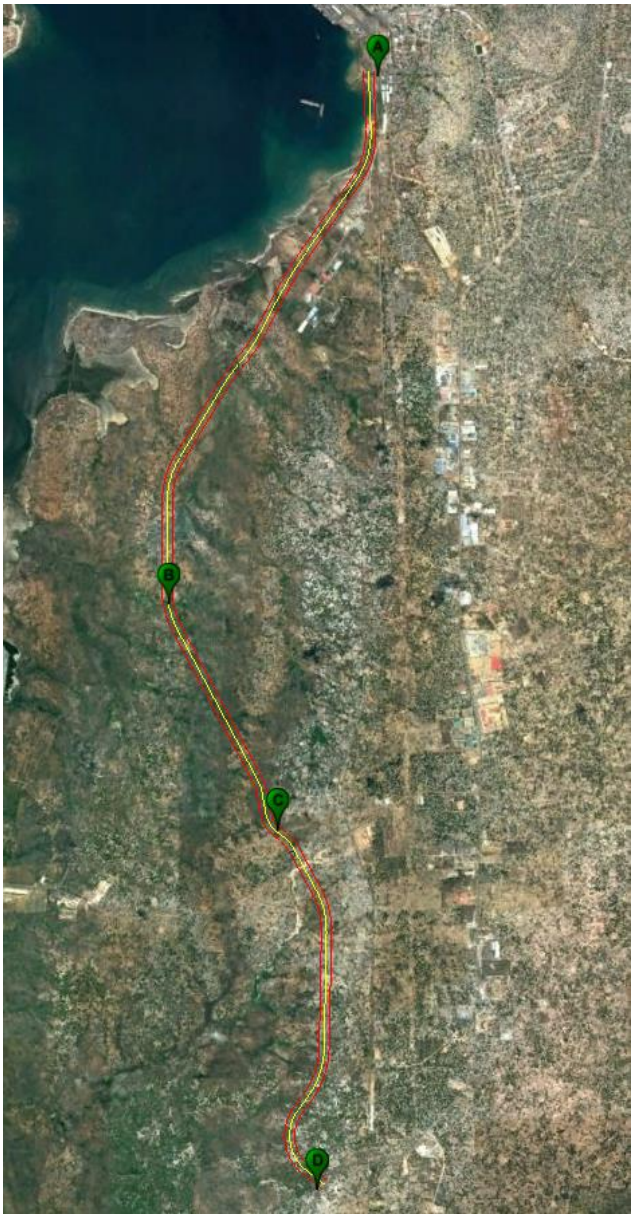


Figure 15 : Location of Sampling Points

The analyses were performed using a set of Lovibond equipment (namely a multi-parametric SensoDirect 150 sounding for measurements on the ground, a thermoreactor RD 125 and a photometer MD200) in addition to miscellaneous laboratory equipment.

The results obtained from the determinations are presented in the following Table.

Table 13: Results on the water quality analysis

Parâmetros	Qual. min. água superficial*	Ponto A	Ponto B	Ponto C	Ponto D
Sampling date		9/10/2016	9/10/2016	10/10/2016	10/10/2016
Temperature (°C)		30.1	25.3	25.5	28.5
pH	5.0 – 9.0	6.74	6.14	6.44	5.8
Electrical conductivity – EC (ms/cm)		1.54	0.51	0.383	8.82
Dissolved Oxygen – DO (% sat.)	50	9	23	26	11
Biochemical oxygen demand – BOD_5 (mg/l)	5	116	104	76	90
chemical oxygen demand – COD (mg/l)		535	683	356	868
Total suspended solids – SST (mg/l)		123	54	48	98
Total dissolved solids – SDT (mg/l)		1014	333	256	987
Clorides – Cl^- (mg/l)	250	220	94	82	425
Total Nitrogen – N_{tot} (mg/l)		7.29	1.82	3.47	5.36
Nitrates – NO_3^- (mg/l)		2.20	0.13	0.50	0.28
Nitrite – NO_2^- (mg/l)		0.24	0.25	0.34	0.19
Ammonium – NH_4^+ (mg/l)	1	0.89	0.12	0.45	1.43
Total phosphorus – F_{tot} (mg/l)	1	1.82	0.38	0.75	0.98
Sulfate – SO_4^{2-} (mg/l)	250	198.50	78.00	5.00	195.00
Arsenic – As (mg/l)	0.1	0.12	0.05	0.6	0.14
Cadmium – Cd (mg/l)	0.01	0.00	0.00	0.00	0.00
Lead – Pb (mg/l)	0.05	0.05	0.02	0.02	0.04
Copper – Cu (mg/l)	0.1	0.04	0.05	0.02	0.11
Chrómium – Cr (mg/l)	0.05	0.01	0.00	0.02	0.04
Iron – Fe (mg/l)		1.23	0.00	0.10	5.50
Manganese – Mn		0.00	0.01	0.00	0.05
Mercury – Hg (mg/l)	0.001	Nd	nd	nd	nd
Zinc – Zn (mg/l)	0.5	0.00	0.01	0.00	0.05

The Mozambican legislation does not establish minimum quality environmental objectives for surface waters or quality criteria for surface fresh water intended for the production of drinking water.

In any case, the results obtained show that the sampled water lines present low quality water, both in terms of the environment and as a source for production of

drinking water (after treatment) and, therefore, inappropriate for direct consumption (without treatment).

Despite the fact that during interpretation of the obtained results the fact that the sampling was performed in the dry season and the sampled water was stagnant should be taken into account, the following aspects can be emphasized:

- The low values of dissolved oxygen are compatible with the reduced agitation of water and with its high temperature, as well as with the high values of chemical and biological oxygen demand (COD and BOD), which mean that there is a presence of significant quantities of oxidisable matter.
- The high values of electrical conductivity and the high concentrations of chloride and total dissolved solids represent the presence of dissolved substances from contamination introduced by man, or salinization of water by dissolution of the salts which are naturally present in the soil;
- In Point A, as expected, the contamination associated with urbanized area and existing industries is becoming increasingly clear.

Better conclusions based on the quality of surface water resources in the study area will only be possible with more campaigns for sampling and analysis which cover different hydrological conditions and allow characterizing the various factors influencing the quality of water along annual cycles.

5.4.2 Underground water resources

With regard to underground water resources, it should be noted that there is a presence, in the influence area of the project, of a sedimentary aquifer system composed of Cretaceous and Tertiary rocks, as well as of Cenozoic deposits (Quaternary) of unconsolidated sediments of silt and beach sand.

The Quaternary aquifer unit is the one occurring in the coastal area of road direct influence and shows a typically low productivity and, because it is superficial aquifer which is close to the sea, high vulnerability to contamination by direct infiltration of pollutants and saline intrusion.

This aquifer unit is often subject to water catchment by local communities, who resort to small depth excavations which, in some cases, give rise to surface runoff. In some places there are also boreholes with hand pumps.

Figure 16 : Borehole equipped with hand pump (inoperative)

Figure 17 : Water collection in a small depth excavation

5.5 Oceanography

The consideration of an oceanography descriptor in this study is justified due to the proximity of the road to the Bay of Nacala and, especially, to the planned construction of a bridge with approximately 840 m in length, right at the beginning of the road design along the expansion area of the Port of Nacala, and which will pass through, though tangentially, a bay area.

The description of the basic situation for this descriptor is mainly based on studies carried out for the expansion of the Port of Nacala, namely the Environmental Impact Study of the Rehabilitation and Expansion of the Port of Nacala (Impact, 2012), which, in turn, explores diverse relevant information produced in the scope of the study "The Preparatory Survey on Nacala Porto Development Project in the Republic of Mozambique" (JICA, 2011).

5.5.1 Bathymetry

The Bay of Nacala with approximately 18 km in length (north-south) has 4 km wide and 20 m of average depth. The average volume of water on the bay is about 1.5 km^3, with a total surface area of 70 km^2. The largest part of the bay (approximately 80%) is deeper than 20 m. The depth in the entry channel to the Bay is over 60 m. The distance between the Port and the high seas is approximately 13 km away.

The area directly covered by the project and specifically by the bridge corresponds to an area on the edge of the intertidal bay which in large part is unearthed in the low tide. It is estimated that the maximum depth along the bridge design will be approximately 4 meters (in the high tide), with non-cohesive silts and sand.

5.5.2 Currents

The average speed of the currents in the bay during high tide is approximately 30 cm/s, while the speed during low tide is 10 cm/s. The current speed is greatly reduced because the depth at the mouth of the bay is 50 to 70 m.

In the context of the EIA on the extension of the Port, the currents in the Bay are modeled numerically. In the present situation (before the expansion of the Port) the current speed was 30 cm/s and the tides in the south area of the bay, where the Port is located, are delayed in relation to the tides in the adjacent oceanic area: when the tides rise in the oceanic area, the tides in the south area of the bay the tides fall and vice-versa.

The modeling for the residual currents (i.e., resulting from the currents of the rising and falling tides) led to a pattern of residual circulation in the area of the Port of Nacala in which, at the end of each tide cycle, there is a transportation out of the Porto, in the north of the bay and a daily movement in the same direction at about 10 m. This pattern favors a higher water renewal and consequent removal of sediment and possible pollutants liabilities (conservative, i.e., with slow deposition or degradation) from the Port area to the adjacent oceanic area where they will be diluted and dispersed. Approximately 4 km to the north of the Port the residual currents seem to be weak compared to currents of the Port area, thus reducing the dispersion of materials at the Bay.

In the situation after the expansion of the Port, the modeling suggests that the pattern of currents will be identical to the one before expansion.

5.5.3 Waves and tides

The height of the tides varies from 0.5 to 3 m between high tide and low tide, respectively. The tidal prism in the Bay of Nacala (the volume of water exchanged between the bay and the open sea during a complete cycle of low tide) varies from about 0.06 km^3 (during neap tides) to 0.2 km^3 (during the spring tides). It is during the spring tides that the largest part of the waters of the Bay is renewed.

The sea is calm most of the time, but the waves can reach 2 meters in height during strong storms. For example, in 1994, on the occasion of the cyclone Nadia (considered the strongest cyclone that struck Nacala in the last 60 years) the maximum height of the waves was about 2.35 m during spring tides.

The renewal of the water is done by tides, and most of the water is renewed in 2 days during the spring tides.

5.5.4 Quality of water

The waters of the Bay of Nacala have reduced turbidity and given their transparency it is possible to see the bottom of the sea.

One explanation for this is related to low concentrations of suspended sediments since there are no rivers draining into the Bay. The concentration of suspended sediments in the Bay of Nacala varies from 8 to 22 mg/l, and at the location of the Port the average concentration of suspended sediments is about 14 mg/l. Sedimentation rates are less than 3 cm per year.

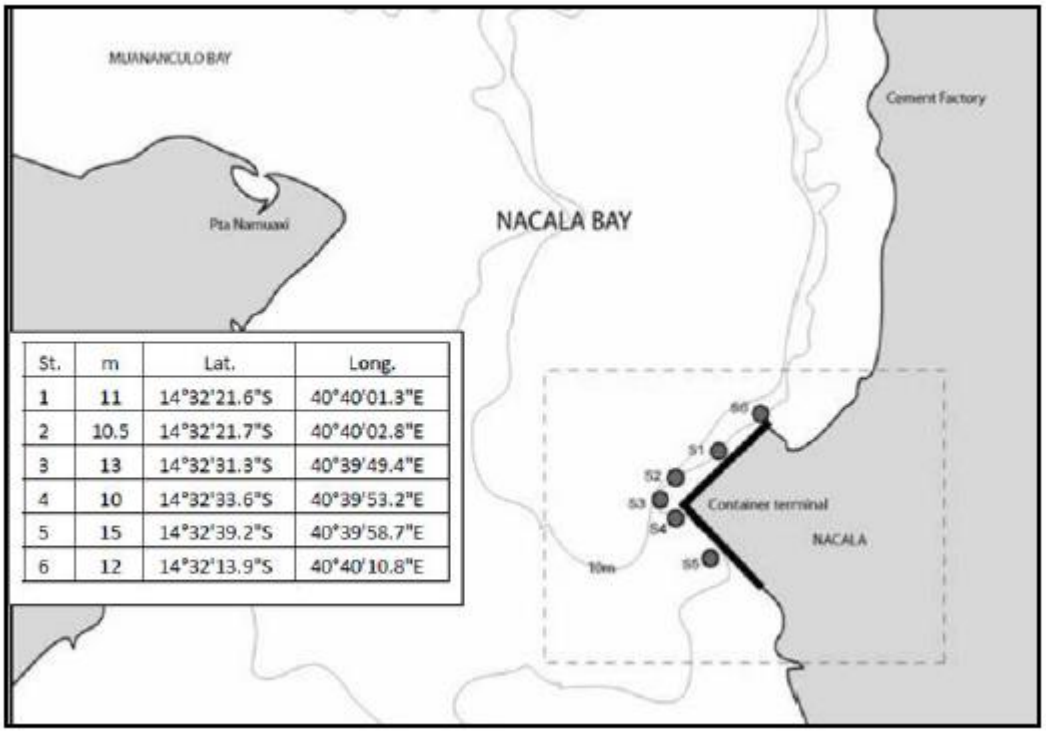
In summary, according to the study by JICA (2011) the water quality parameters in the Bay have the following characteristics:

Table 14: Water quality at Nacala Bay

Parameters	**Comments**
Temperature	The water temperature varies between 25-26°C, and tends to rise in shallower waters;
Salinity	The salinity varies, in general, between 34-35 PSU (g/kg), and tends to rise slightly in the superficial layer;
pH	The pH varies, in general, between 7.3-8.2
Dissolved Oxygen	The concentration of dissolved oxygen (DO) varies between approximately 5.7 and 6.1 mg/l;
Nutrients (nitrogen and phosphorus)	The concentration of total nitrogen (TN) and total phosphorus (TP), an indicator of richness in nutrients, was highly variable for TN between the locations and the layers and particularly high in the lower layer (0.96 mg/l) while TP ranged from <0.02- 0.04 mg/l and was less variable between the locations and the layers.
Hydrocarbons	The total concentration of hydrocarbons measured where they oil stains were observed (near the south pier of the port) was, in general, below or on the limit of quantification (0.2 mg/l).
Microbiological contamination	The highest values of E. coli in the superficial layer were recorded next to a period of heavy rain. However, even so, these were below (246 cfu/100 ml) the European standard of quality water (Guidelines 2006/7/EC) for “excellent quality”, which is 250 cfu/100ml.

5.5.5 Quality of sediments

The previously mentioned study carried out in 2011 by JICA included the characterization of quality of the sediments in the area surrounding the Port of Nacala. This characterization was done by collecting sediment samples at 6 points along the north and south pier of the Port.



St.	m	Lat.	Long.
1	11	14°32'21.6"S	40°40'01.3"E
2	10.5	14°32'21.7"S	40°40'02.8"E
3	13	14°32'31.3"S	40°39'49.4"E
4	10	14°32'33.6"S	40°39'53.2"E
5	15	14°32'39.2"S	40°39'58.7"E
6	12	14°32'13.9"S	40°40'10.8"E

Source: JICA (2011) in the EIA on the Expansion of the Nacala Port; Impact (2012)

Figure 18 : Location of sediment sampling points - JICA (2011)

The results obtained indicate a richness of sediments (particularly in their finest fraction - silts) in terms of nutrients (nitrogen, phosphorus and sulfur), possibly as a result of runoff from the south area of the Port and spill to the waters of the bay from bulk cargo handling.

Increased concentrations of heavy metals, particularly chromium, lead and nickel were also found. The possible sources of these substances are believed to be related, in the case of lead, to the use of lead in paint ships, spills of ethanol gasoline; in the case of chromium and nickel the sources included possible spill of clinker (which can count these metals, depending on the raw material and production process) or several runoffs from the Port area. Other metals were also identified but in lower concentrations in comparison with the screening values internationally recommended.

The characterization carried out detected the presence of toxic contaminants, especially DDT (Dichlorodiphenyltrichloroethane, a pesticide but sometimes also present in paint used for painting ships), TBT (tributyltin, an antifouling typically used in paint for ships) and PCB (polychlorinated biphenyls, a substance used in electrical equipment which can also be found as antifouling in paints for ships). The highest concentrations of these contaminants were found in the sampling points located along the north pier of the Port, more than 1 000 m from the point where the bridge is expected to begin in the project now under study.

5.6 Air quality

5.6.1 Methodology

The characterization of the reference situation, with respect to air quality, in the area project implementation area and its surroundings, was made on the basis of the following methodology:

- Identification and description of the applicable legal framework for air quality;
- Identification of the major sources of emissions of pollutants that contribute to the degradation of air quality in the project implementation area and its surroundings;
- Identification of sensitive receptors, with regard to air quality, in the vicinity of the project under analysis and in the vicinity of the main existing roads giving access to Nacala;
- Identification and characterization of meteorological variables that affect the dispersion of pollutants;
- Modeling of the concentration of pollutants in ambient air (NO_2, PM10 and $PM_{2.5}$) in the vicinity of N12 in the present situation (resulting in emissions associated with traffic) taking into account the traffic counts carried out within the context of this feasibility study;
- Execution of a campaign for measuring air quality in 5 points in the vicinity of the road design for the Access Road to the Port of Nacala, with measurement of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and total suspended particulates (TSP).

In this analysis the legal framework on air quality was taken into account which is presented in section 3.3. of this report and in the Annex 1, especially on ambient air quality standards.

Given the fact that the Mozambican legislation does not lay down the standards for ambient air concentrations of PM10 and PM2.5, the World Health Organization (WHO) guidelines were used, namely the Comprehensive Update of Guidelines for Air Quality, 2005. In Annex 1 WHO guidelines are also included regarding concentrations of PM10 and PM2,5 in the ambient air.

5.6.2 Identification of Main Sources of Emissions of Atmospheric Pollutants in Nacala

Nacala holds a strategic position in terms of economic development of the region and country for being located in the Mozambican coast, with natural conditions and a deep-water port and an international airport. In fact, massive industrial and logistics development is already taking place.

The industrial activity in Nacala is currently and mainly located along N12, north of R702 (150 ha) and next to the Port of Nacala.

In addition to the industrial activity, main sources of pollutants emission in Nacala include the traffic that moves in the main access roads to Nacala and to the Port of Nacala (N12 and R702) with a high percentage of heavy vehicles, traffic flowing on local access roads in the urban area (partly unpaved), movement of ships and handling of goods with around 4 million tons per year (PEDEC-Nacala), movement of diesel locomotives on the railway giving access to the Port of Nacala, and movement of aircraft at the international airport of Nacala.

The following Table shows the main sources of emissions of atmospheric pollutants.

Table 15: Main sources of pollutants emission

Source of pollutants emissions	Main pollutants emitted
N12 and R702 (movement of vehicles)	PM_{10}, $PM_{2.5}$, oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), hydrocarbons (HC).
Local roads (movement of vehicles) The movement of vehicles on unpaved roads will cause the suspension of particles significantly sometimes, depending on the moisture content of the soil which depends largely on rainfall.	Suspended particles including PM10, PM2.5, oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO2), hydrocarbons (HC).
Railway giving access to the Port of Nacala (diesel locomotives).	PM_{10}, $PM_{2.5}$, oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), hydrocarbons (HC).
International Airport of Nacala (aircraft).	PM_{10}, $PM_{2.5}$, oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), and hydrocarbons (HC).
Port of Nacala (ship engines and cargo handling, particularly clinker for cement plants).	Suspended particles including PM_{10} and $PM_{2.5}$, oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), and hydrocarbons (HC).
Coal Terminal in Nacala-a-Velha	Suspended particles including PM_{10} and $PM_{2.5}$.
Cement production: two units for cement milling from clinker, one next to the N12 (CINAC S.a.) and another in the north of Nacala(Cimentos de Moçambique S.A.).	Suspended particles including PM_{10} and $PM_{2.5}$.
Fuel logistics: Petromoc and BP	Volatile Organic Compounds (VOCs)
Industria Agroalimentar. Grupo Maiaia, IPAN, FARINAL, OLAM, APEL	Essentially suspended particles including PM_{10} and $PM_{2.5}$.
Production of vegetable oil and soap:	PM_{10}, $PM_{2,5}$, oxides of nitrogen (NOx),

Sociedade G.S Holding, Lda; Sociedade Saboeira de Nacala, Lda	carbon monoxide (CO), sulfur dioxide (SO_2), hydrocarbons (HC).
Plastic production: Royal plastics	PM_{10}, $PM_{2.5}$, oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), hydrocarbons (HC).
Burners for domestic fuel (coal, wood and paraffin)	PM_{10}, $PM_{2.5}$,, carbon monoxide (CO), sulfur dioxide (SO_2), heavy metals

Despite the economic development which is currently taking place in Nacala, there are no industrial units of massive scale, capable of consuming large quantities of fuel. On the other hand, current vehicle traffic is relatively low (maximum of 7500 cars per day on N12), despite the high percentage of heavy vehicles. So pollutant emissions associated with combustion, particularly SO_2, NOx and CO, are not high. It should be noted, however, that the use of coal, wood and paraffin in domestic burners as well as the movement of vehicles on unpaved roads is responsible for the emission of particles, in particular PM_{10} and $PM_{2.5}$ in quantities which affect the level of the air quality in residential areas.

With the establishment of Nacala Special Economic Zone, generating new investment opportunities, and given the strategic position of Nacala with its deep-water port, the development of three industrial zones with a total area of about 500 are planned for 2035. In the shorter term, the establishment of large scale industrial units is planned, namely an oil refinery and an integrated plant for the production of cement with the installation of a furnace for the production of clinker. The economic growth will generate on the other hand a greater volume of vehicle traffic. It is thus expected that the economic growth of Nacala even in the absence of the project under analysis will result in a significant increase of emissions of air pollutants, particularly SO_2, NOx, PM_{10} and $PM_{2.5}$.

5.6.3 Sensitive Receptors

The Project for the Access Road to the Port of Nacala runs through an area which is mainly dedicated for forestry and agriculture. The closest residences to the project are located around km 3+200 to the southeast of the road and around km 10+300, near the intersection of the road design with R702.

The following Figure shows the residential areas in relation with the area where the Project for the Access Road to the Port of Nacala is located.

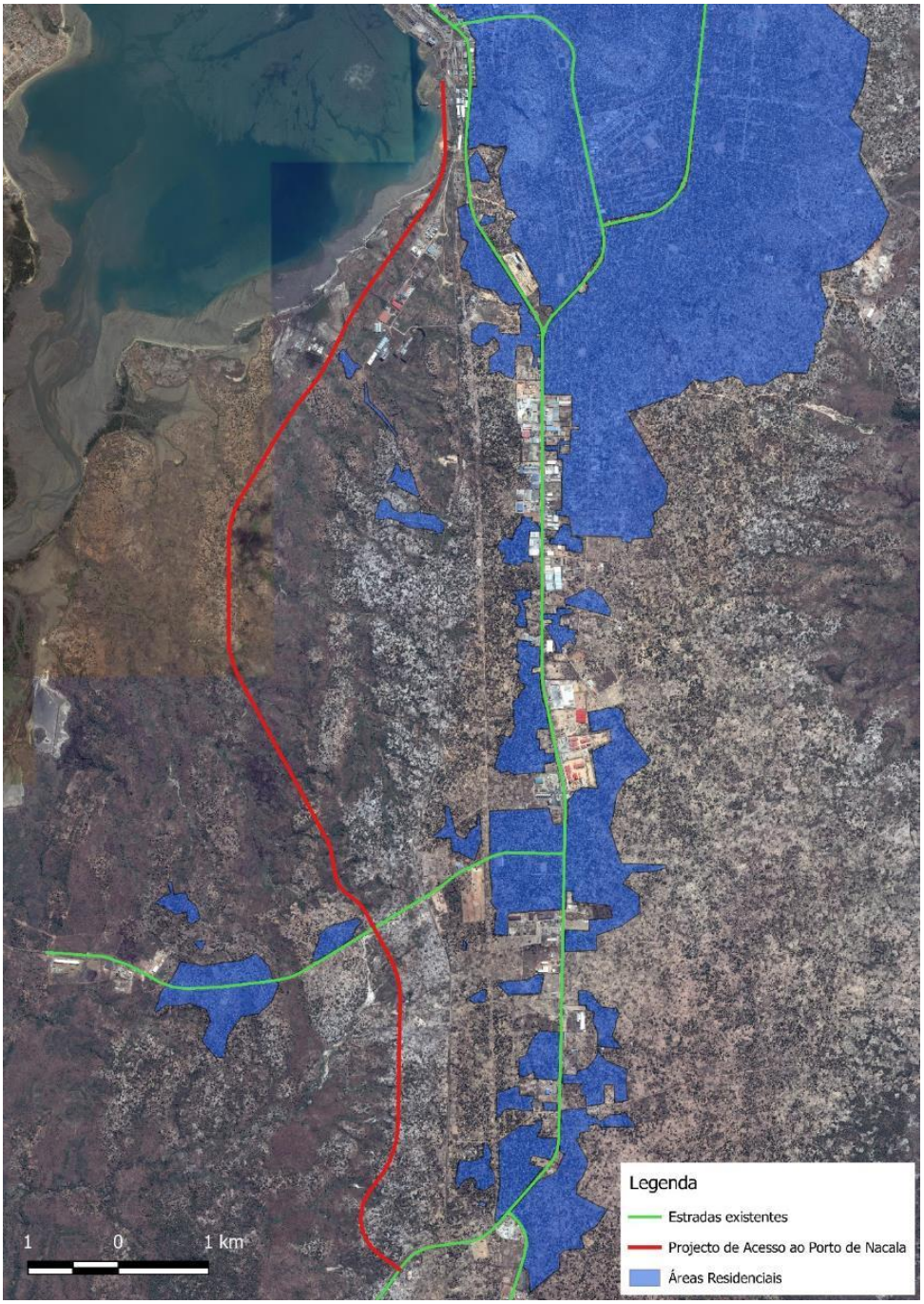


Figure 19 : Residential areas in relation with the area where the project is located

5.6.4 Conditions of Atmospheric Dispersion in the Study Area

The levels of atmospheric pollution in a given region depend primarily on the weather conditions which affect the dispersion of pollutants in the atmosphere.

For the characterization of atmospheric dispersion, it is important to know the current weather conditions, particularly the patterns of winds (speed and direction) because the transport of air pollutants is dependent on it. The atmospheric stability, which defines its dispersion ability, and the height of the layer of mixture, which defines the atmospheric space in which the dispersion of vertical air parameters can

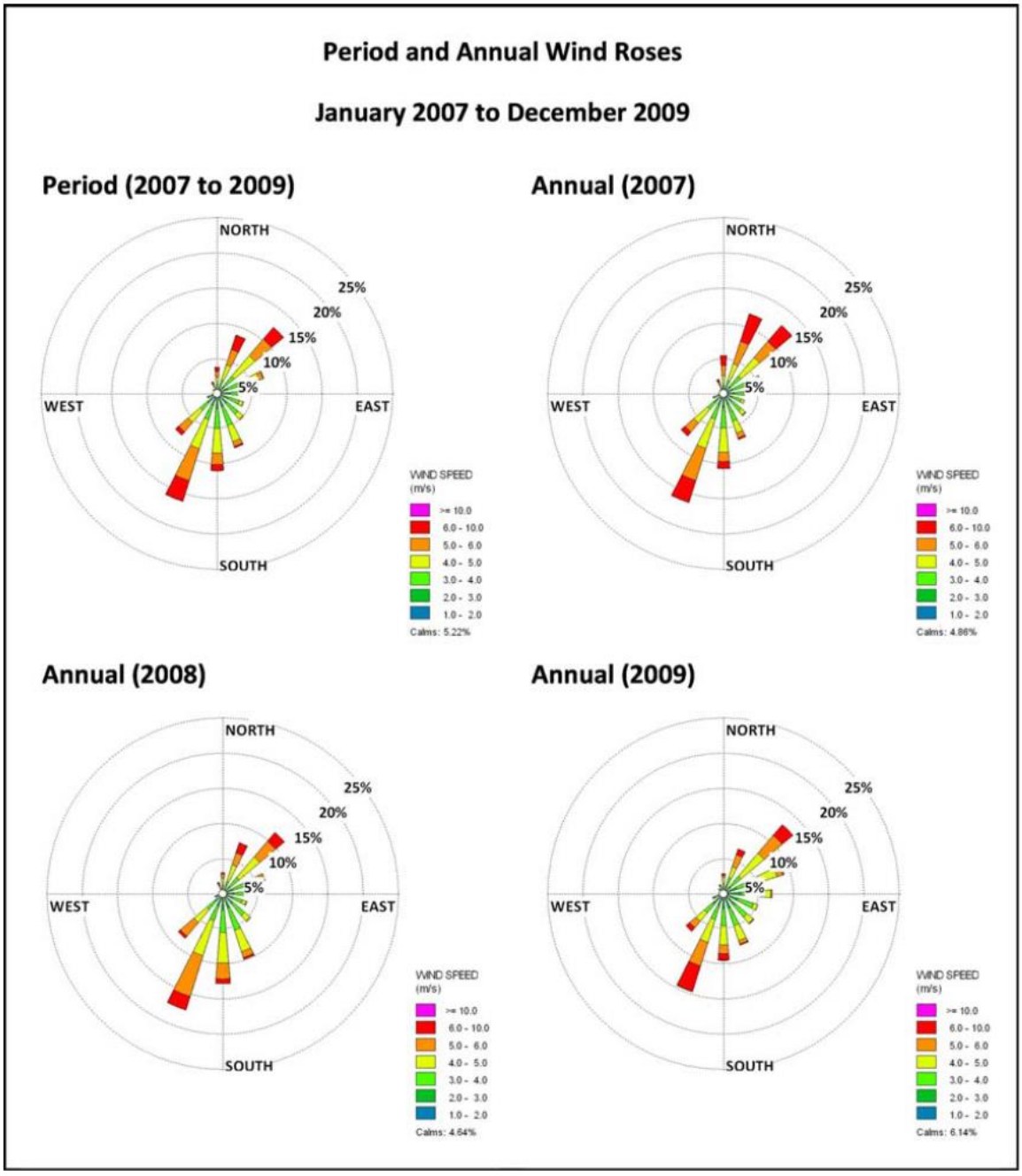
occur, are equally important. Precipitation also determines, to some extent, the dispersion of pollutants as it promotes the deposition of pollutants through wetting.

Topography is also another factor which affects dispersion of pollutants in the atmosphere.

From the point of view of morphology of the terrain, the study area does not show topographic accidents that may, in local terms, affect the atmospheric dispersion of pollutants.

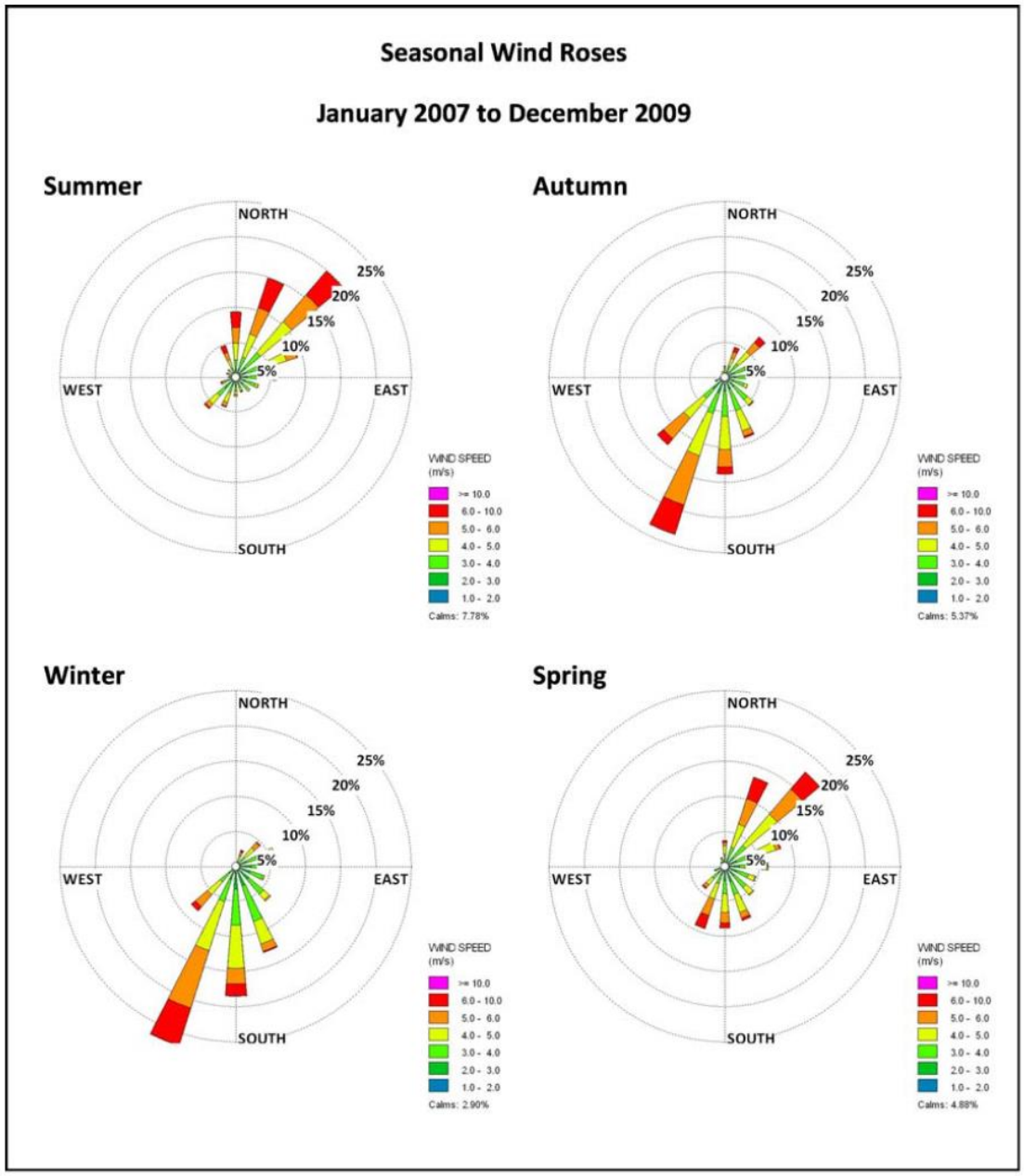
For the characterization of the winds in the study area, information available in the Environmental Impact Study of the Port Terminal and Railway Station of Nacala-a-Velha was used (Aurecon, 2010), which also used the meteorological data obtained by the Mesoescala Numerical Model MM5 (The Fifth-Generation Nca/Penn State Mesoscale Model) for the period 2007-2009. The data included the average wind speed per hour and the wind direction.

The wind roses (16 directions of the wind and 7 categories of wind speed) referring to the analyzed period (2007-2008) are shown in the following Figures.



Source: Aurecon, 2010

Figure 20 : Wind roses. Wind frequency and speed for each direction (annual average)



Source: Aurecon, 2010

Figure 21 : Wind roses. Wind frequency and speed for each direction (average per season)

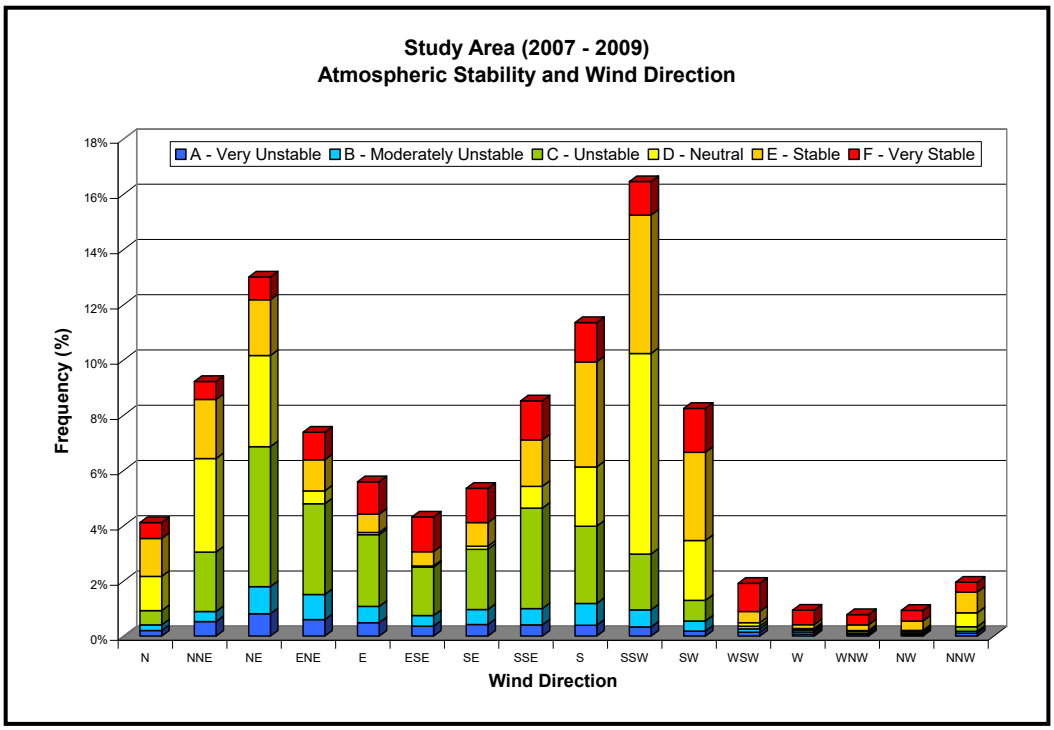
In annual terms (considering the average of three years) the winds blow predominantly from the south quadrant, with a frequency of approximately 35% (16% South-Southwest, 11% South and 8% South-Southeast), and Northeast with a frequency of approximately 22%. The percentage of calm winds (speeds lower than 1 Km/h) in terms of annual average is 5%.

Taking into account 4 seasons of the year, winds predominate from the south-southwest during the autumn and winter. During the summer and spring the winds predominate in the northeast.

The atmospheric stability determines the local convective processes. It is characterized by the vertical gradient of temperature, determining the vertical mixing of pollutants. The air temperature tends to decrease in height. During the day, with high temperatures at ground level, the hot air to the surface rises generating a situation of instability in the atmosphere. This turbulence in the atmosphere promotes the dispersion of vertical pollutant. However, in certain conditions a thermal inversion can occur, i.e., there may be a temperature rise in height, creating a layer of warm air in altitude that prevents the polluted air near the ground to rise and disperse.

According to Pasquill-Gifford, the classification of the atmospheric stability covers six categories, from unstable (Category A) to very stable (Category F).

The variation of the atmospheric stability, according to Pasquill-Gifford, with the wind direction for the study area (2007 2009) is shown in the following Figure.



Source: Aurecon, 2010

Figure 22 : Variation of atmospheric stability with the wind direction (2007 – 2009) according to Pasquill-Gifford

5.6.5 Modeling of air quality in the current situation

Modeling of the concentration of pollutants in ambient air (NO2, SO2, PM10 and PM2.5) was conducted in the vicinity of the N12 (resulting from emissions associated with traffic) taking into account the traffic counts carried out under this project.

Information made available by the SEDAC (Socioeconomic Data and Applications Center) produced and managed by NASA through EOSDIS (Earth Observing System Data and Information System) about the concentrations of PM2.5 on the earth's surface was used (grid with a resolution of 100 km^2). This information was obtained through satellite observations (satellites Aqua Terra) from the observation system Terra (EOS - Earth Observing System) of NASA.

With regard to the modeling the concentration of pollutants in ambient air (NO2, SO2, PM10 and PM2.5) in the vicinity of the N12, model Caline 4 was used taking into consideration the emission factors calculated by the calculation program COPERT 4 (Computer program to calculate emissions from road transpor, version 11.3 - June 2015).

A detailed description of the used methodology can be found is in the section "Impacts on Air Quality". The emission factors were calculated taking into account the characteristics of the Mozambican vehicle fleet, especially age, and also the sulfur content in the 500 ppm diesel fuel and in the 150 ppm gasoline.

The following table shows the values of concentration of nitrogen dioxide (NO2), the values of concentration of Nitrogen Dioxide (SO2), and the values of concentration of particulate matter (PM10 and PM2.5) at various distances from N12 taking into consideration South-Southwest (the most frequent in Nacala).

Table 16: Maximum hourly concentrations of NO2 and mean daily concentrations of PM10 and PM 2.5 - Current situation

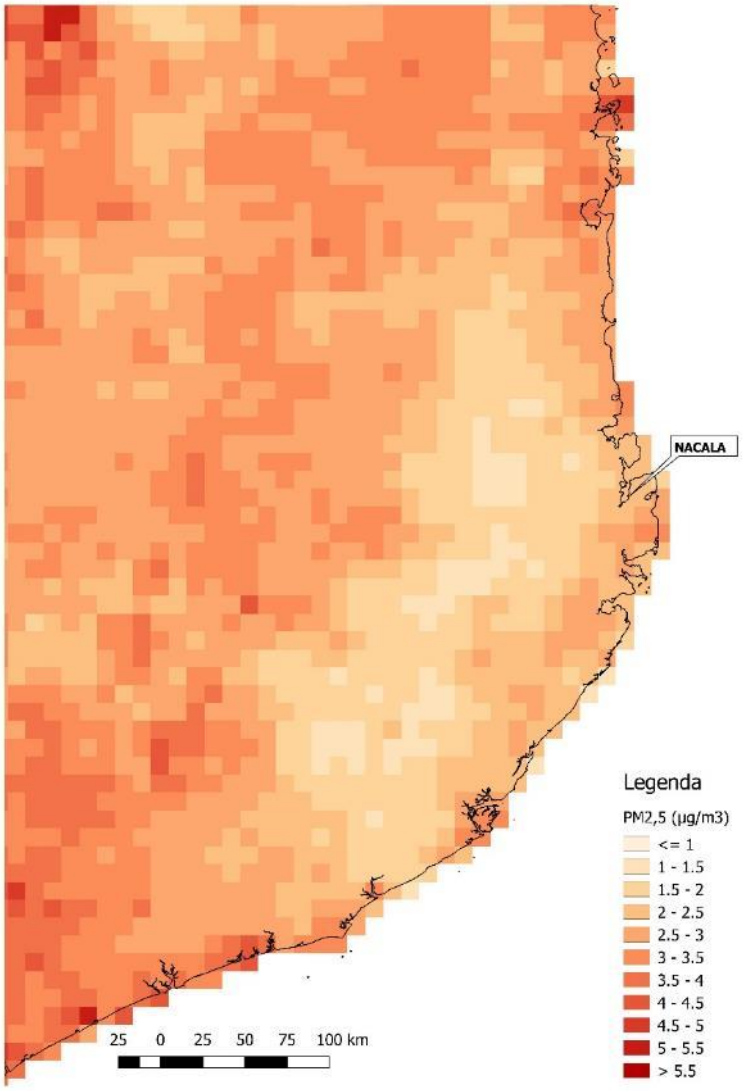
Distância to N12 (m)	(NO2) µg/m^3 (1 hour)	(SO2) µg/m^3 (1 hour)	(PM10) µg/m^3 (24 hour)	(PM2,5) µg/m^3 (24 hour)
10	15.5	6.03	4.7	4.0
20	11.4	4.44	3.3	2.8
30	9.3	3.59	2.7	2.3
40	7.8	3.04	2.2	1.9
50	6.8	2.63	1.9	1.6
100	4.3	1.68	1.1	0.9
150	3.2	1.25	0.8	0.7

The Table allows us to conclude that the concentration values of NO2, SO2, PM10 and PM2.5 obtained by modeling resulting from emissions from the traffic currently flowing in N12 are well below the Mozambican quality standards for NO2 (190 µg/m3) and SO2 (100 µg/m3) and below the limits set by WHO for PM10 (50 µg/m3) and PM2.5 (25 µg/m3).

The following Figure shows the grid of concentrations of PM2.5 (µg/m3) obtained through satellite images (SEDAC - NASA) corresponding to global annual values. The

values of concentration of PM2.5 in the region of Nacala are between 1 and 3.5 µg/m3, similar values obtained by modeling the emissions associated with the N12.

Given the above it is concluded that the concentrations of pollutants in the region of Nacala are well below air quality standards established by the national legislation or by WHO.



Source: Van Donkelaar, A., R.V. Martin, M. Brauer, and B.L. Boys. 2015. Global Annual PM2.5 Grids from MODIS and MISR and SeaWiFS Aerosol Optical Depth (AOD), 1998-2012. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). Http://dx.doi.org/10.7927/H4028PFS

Figure 23 : Grid of concentrations of PM2

5.6.6 Air Quality Measurements

Air quality measurements were carried out in 5 locations situated along the road design now under study or next to existing roads. The location of these measurement points is represented in the following Figure.

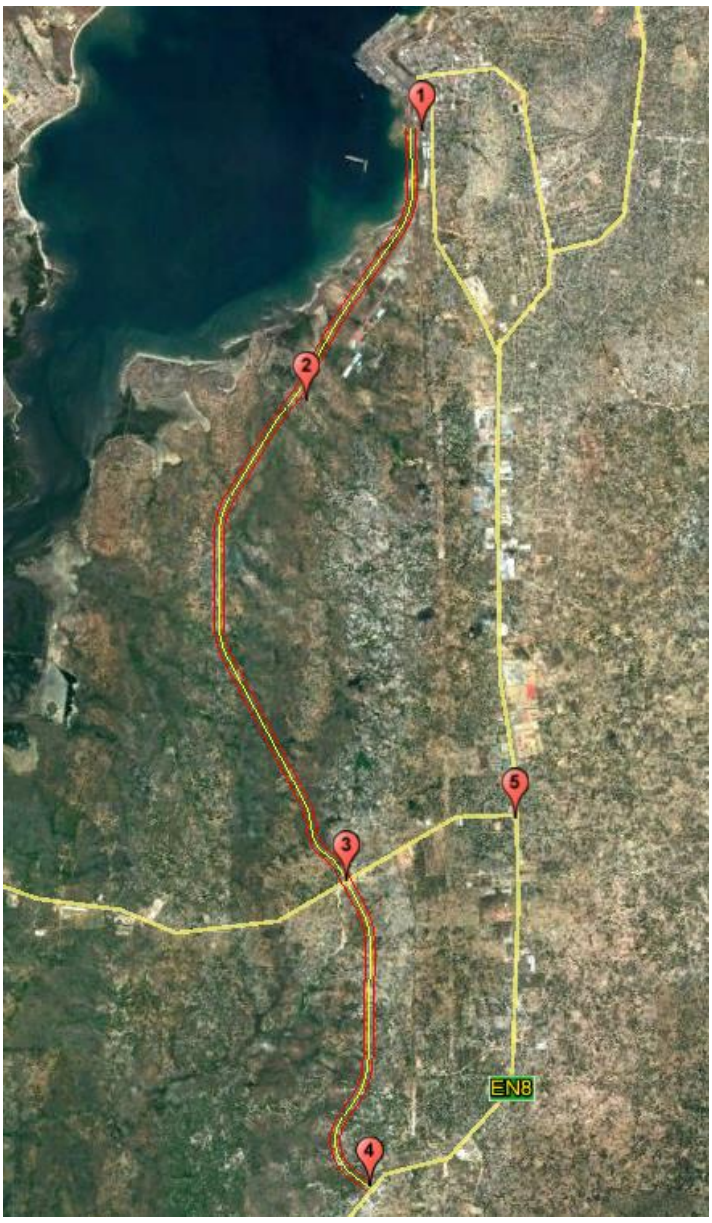


Figure 24 : Location of air quality measurement points

The following are the parameters measured:

- Nitrogen dioxide (NO2), sulfur dioxide (SO2) and carbon monoxide (CO), using the multi-gas portable analyzer MX6 iBRID (measurements for 30 minutes at each site);
- Total suspended particles (TSP) through the gravimetric method, using an SKC Sidekick pump (pumping for 5 hours at each location).

Table 17: Results of water quality measurements

Location	Coordinates	Date / time Measurements	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	CO ($\mu g/m^3$)	PTS ($\mu g/m^3$)
1	14°33'1.79"S 40°40'21.44"E	13Nov16	42.6	51.8	6 432	124
2	14°34'40.27"S 40°39'38.52"E	13Nov16	2.8	2.1	535	65
3	14°38'3.23"S 40°39'51.00"E	14Nov16	7.3	3.9	642	72
4	14°40'7.23"S 40°39'59.79"E	14Nov16	10.1	8.4	1052	81
5	14°37'38.76"S 40°41'0.91"E	14Nov16	24.4	17.2	1985	103

These results illustrate that the quality of air in the study area is degraded in a differentiated way. In fact, concentrations of pollutants higher than those at point 2 were found at the measuring points located closest to the existing roads (3, 4, and 5). The point that showed the worst air quality is point 1, which reflects the influence of vehicle traffic as well as the influence of emissions from the industrial units in the Port area, including the floating electricity generation station (which operates with the diesel) and is anchored in the Bay, about 800 m Southwest from the measuring point.

In any case, the values obtained did not show situations beyond the limits of quality standards set out in the legislation or in the applicable international guidelines.

The representativeness of the results obtained and consequently the considerations expressed above must be taken into account with reservations, given that they arise from a single measurement campaign.

5.7 Sound and Vibration

5.7.1 Ambient Noise

Methodology

For the characterization of environmental noise in the project area the following methodology was used:

- Identification and description of the applicable legal framework in the field of environmental noise;
- Identification and characterization of the main sources of noise in the study area;
- Identification of sensitive receptors in the vicinity of the project under analysis and in the vicinity of the main existing roads giving access to Nacala.

Modeling of noise levels in the vicinity of the N12 and R702 (resulting from noise emissions associated with traffic) was carried out taking into account the traffic

counts conducted under this project, which allowed characterizing the current situation of environmental noise in the surrounding of the main existing roads.

As mentioned in section 3.3 of this report noise emission standards are not legally defined yet.

In the absence of national standards in relation to thresholds for noise exposure, WHO and International Finance Corporation (IFC) guidelines were used.

According to WHO (1999), external environmental noise during the day should be below 55 dB(A), in order to avoid high discomfort in the vicinity of residential areas and schools, and at night it should be below 45 dB(A).

In the "Environmental, Health, and Safety (EHS) Guidelines" about noise management, IFC sets forth that the levels of noise shall not exceed those settled by WHO (1999) regarding external noise or increase in more than 3dB to the nearest sensitive receptors.

The following Table about noise levels was published by IFC based on WHO guidelines.

Table 18: Noise levels (external environment noise)

Receptor	LAeq (dBA) one hour	
	Day	Night
	07:00 - 22:00	22:00 - 07:00
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Acoustic Environment

Nacala holds a strategic position in terms of economic development of the region and country for being located in the Mozambican coast, with natural conditions and a deep-water port and an international airport. In fact, massive industrial and logistics development is already taking place.

The main sources of noise in the project area are the road traffic on the N12 and R702, rail traffic on the railway giving access to the Port of Nacala, Port activities, International Airport of Nacala and some noisier industrial activities, namely the two units for cement milling.

Sensitive Receptors

The Project for the Access Road to the Port of Nacala runs through an area which is mainly dedicated for forestry and agriculture. The closest residences to the project are located around km 3+200 to the southeast of the road and around km 10+300, near the intersection of the road design with R702.

On the other hand, the area surrounding the N12 is densely populated.

The following Figure shows the residential areas in relation with the area where the Project for the Access Road to the Port of Nacala is located.

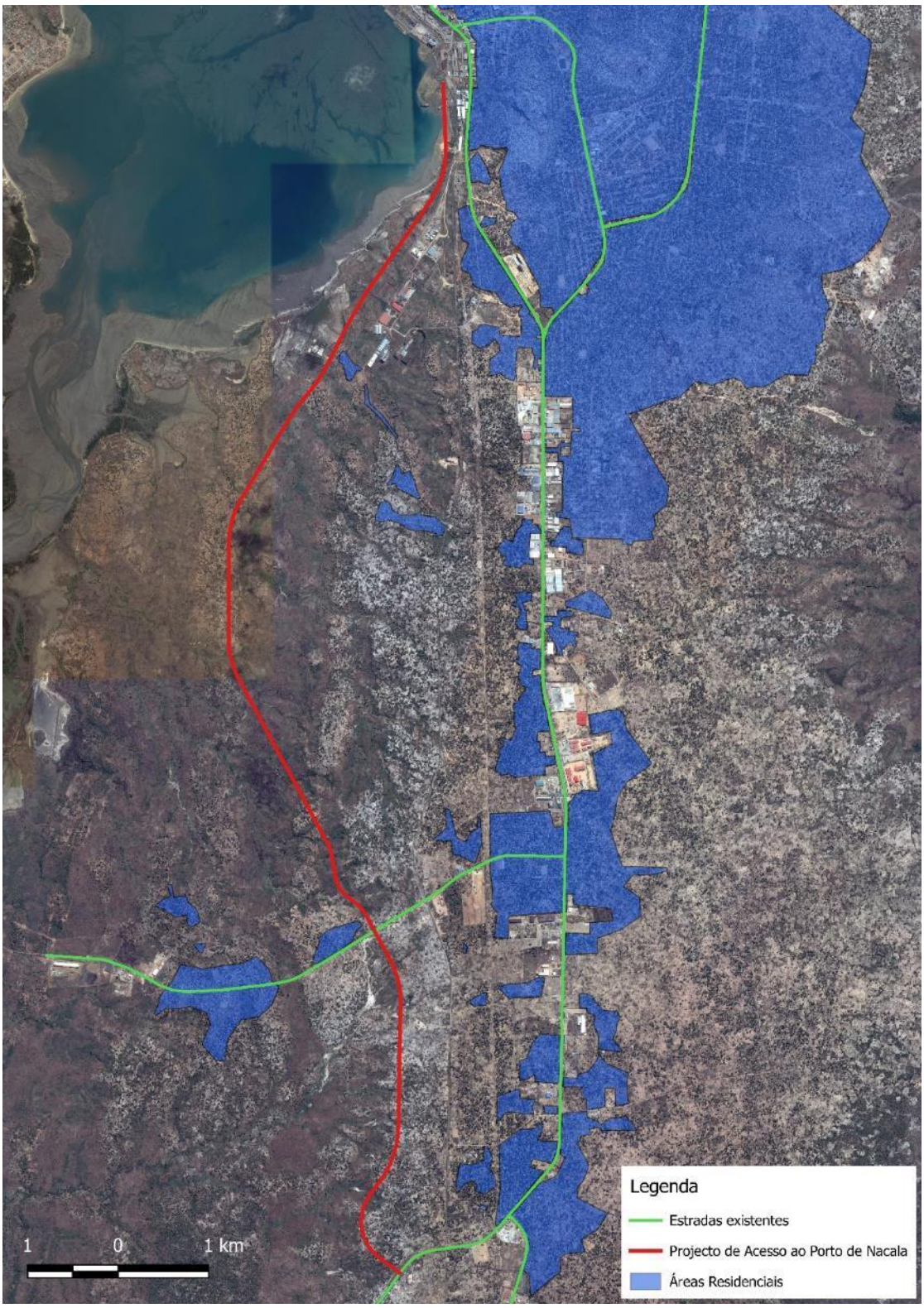


Figure 25 : Residential areas in relation with the area where the project is located

Assessment of the local noise

For the characterization of the existing acoustic environment noise in the influence area of the project, a campaign for measuring the levels of the environmental noise at five points located close to the project area was conducted.

The following Figure shows the geographical location of the points for acoustic assessment.

Acoustic measurements were performed on 7th and 8th December 2016 with an integrating sound level meter (Rion, NL18) and allowed recording the values of the noise indicator for LAeq in dB(A) at each point, so as to obtain representative results of external environmental noise levels in the 2 reference periods, day (from 7am to 22pm) and night (from 22pm to 7am), through sampling of appropriate duration (never less than 15 minutes).

The experimental procedures followed the recommendations described in the international standards such as ISO/FDIS 1996-2.

The following table shows recorded values

Table 19: Noise measurement results

Measuring point	Main noise sources	Day time LAeq dB(A	Night Time LAeq dB(A)
1	Far away traffic, Port	46.6	44.2
2	Natural noises	43.3	38.5
3	Traffic on R702	68.8	65.1
4	Traffic on N12	70.8	66.0
5	Traffic on N12 and R702	65.1	60.3

The analysis of the measured values allows concluding that the sound levels are very high along R702 and N12 due to traffic, even higher than the guide values set by WHO.

In relation to the measuring points at the Port of Nacala and close to residences located near the saltpans, the values are below guide values set by WHO.

The representativeness of the results obtained should be taken with reservations, given that they refer to single measurement campaign. The results of these measurements should be evaluated in conjunction with the noise maps indicating the current situation (see next item).

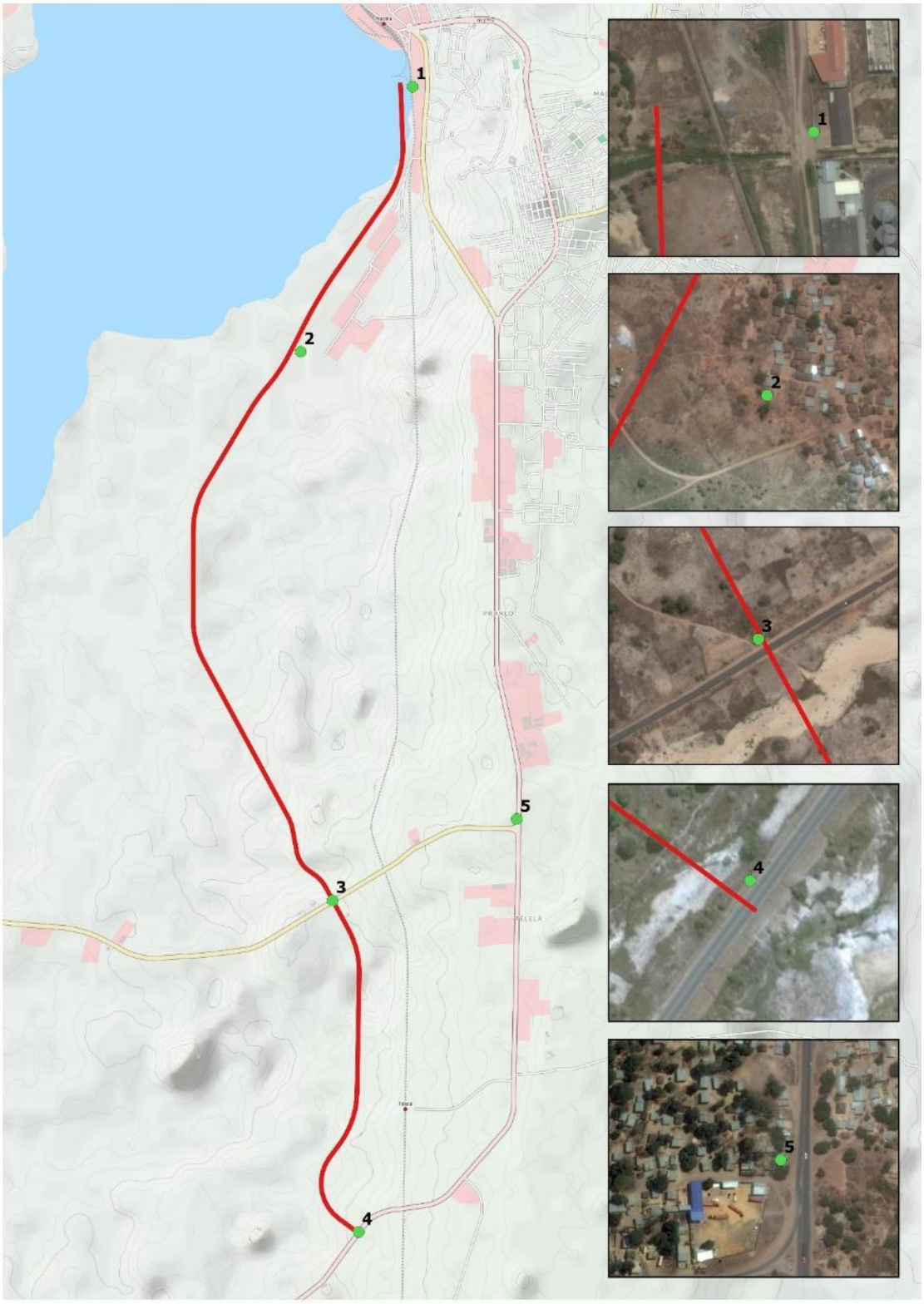


Figure 26 : Location of noise measuring points

Noise Maps for the Current Situation

Apart from carrying out the noise measuring campaign, noise maps representing the distribution of the sound levels for the current situation taking into account the

traffic that currently circulates in the R702 and N12 were drawn up, based on modeling.

The methodology used for the simulations of the noise levels of road traffic is described in detail in the Chapter discussing the analysis of impacts on noise descriptor.

Annex 2 presents the noise maps corresponding to the calculations made for each of the areas considered for modeling (Zones 1 to 4) for the current situation.

The analysis of the noise maps for the current situation meets the results of the measurements made. Thus it can be concluded that in the surrounding of the roads R702 and N12 noise levels are already high, and in the closest proximity noise levels are above the guide values set by WHO, which affects the nearest residences.

5.7.2 Vibrations

In the context of the Environmental Impact Assessment of the Port Terminal and Railway Station of Nacala-a-Velha[9] vibration measurements at various points were carried out, one of which (referred to as MPV01) located next to the intersection of the railway line to the Port of Nacala on road N12, about 600 m from the end of the road design for the Access Road to the Port of Nacala.

[9] Aurecon / Valley. Project for the Nacala Corridor - Port Terminal and Railway Station of Cidade de Nacala. Environmental Impact Assessment - Volume II: characterization of the reference situation. October 2010

Figure 27 : MPV01 Vibration Measurement Point

Source: Aurecon / Valley. Draft of the Nacala Corridor - Port Terminal and Railway Station of Cidade de Nacala. The Environmental Impact Study - Volume II: characterization of the reference situation. October 2010

In the absence of standards or specific guidelines regarding vibrations in Mozambique, the assessment criteria recommended by the Transport and Road Research Laboratory in England were used in the EIA above mentioned (Whiffen and Leonard, 1971). These have been set on the basis of the values of particle peak velocity (PPV):

Table 20: Criteria vibration evaluation

PPV of the vibration level* (mm/s)	Human reaction	Effect on buildings
0.15-0.30	Threshold of perception; possibility of intrusion.	It is unlikely the vibrations will cause damage of any kind.
2.0	Vibrations immediately perceived.	Maximum recommended value for ruins and ancient monuments.
2.5	Level at which the continuous vibration begin to disturb people.	No risks of architectural damages are expected (causing cracks in plaster) on buildings with quality construction and maintenance.
5.0	The vibrations are disturbing people in buildings (over relatively short periods of vibration).	Above this value architectural damages are expected (causing cracks in plaster) on buildings with quality construction.
10-15	The vibrations are considered uncomfortable by people subject to them continuously.	Above this value some structural damages are expected.
* Particle Peak Velocity on the vertical axis. The potential effects of amplification of the structural components of buildings are not taken into consideration.		

Source: Aurecon / Valley. Project for the Nacala Corridor - Port Terminal and Railway Station of Cidade de Nacala. Environmental Impact Assessment - Volume II: characterization of the reference situation. October 2010

The following vibration values (PPV) have been taken into account in the EIA above mentioned:

- Human perception: 0.15 mm/s;
- Poor construction quality buildings: 2.0 mm/s;
- Risk of damage to buildings with good construction quality and maintenance: 5.0 mm/s.

The values obtained in the measurements carried out in point MPV01 are as follow:

- Train to Nacala: 1 locomotives and 15 carriages (measured at 10 m distance from the rail): 2.69 mm/s
- Background level (without a passing-by train): 0.05 mm/s

These numbers show that the levels of vibration (background levels, in the context of the EIA, are those occurring most of the time, when there are no trains passing by on railway line) are low – lower than the highest criteria.

It is expected, therefore, that the vibration values in the area through which the road design run are, in the current situation, equally low and below the eligibility criteria established internationally.5.8. Ecology

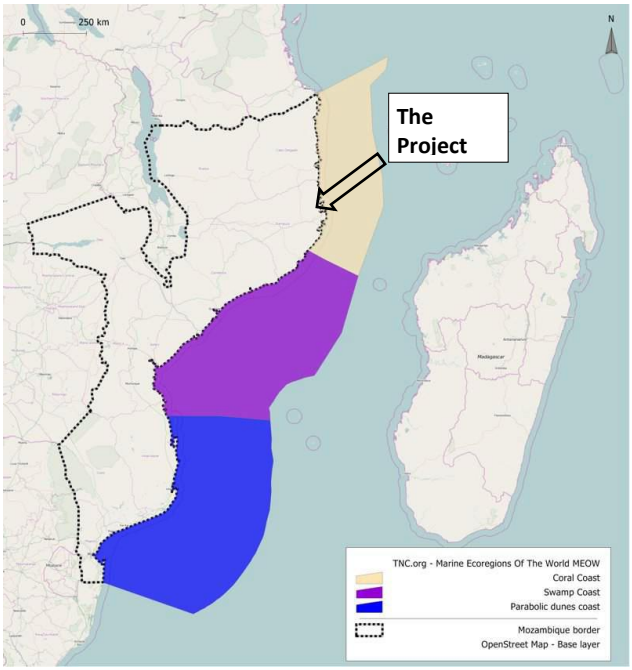
5.7.3 Marine Ecosystems

Background

In accordance with the biogeographic classification of coastal zones, established by the World Wide Fund for Nature - WWF, the coast of Mozambique is part of the Eastern African Marine Eco-region which develops between Somalia and the coast of KwaZulu-Natal, in South Africa. The Mozambican coast is divided into three major regions:

- Coral coast
- Swamps and
- Dunes.

Nacala region is integrated in the costa coral, which extends from Rovuma River to Angoche. Coral reefs, sea grass and mangroves occur along this coast.



Source: WWF, 2007

Figure 28 : Coastal eco-regions, occurring in the Mozambican coast

Marine Protection Areas

In the Mozambican coral coast there are two marine protection areas, legally established under the Law on Biodiversity Conservation (Law no.16/2014), namely:

- Quirimbas National Park (Decree no. 14/2002, of 6th June), located about 170 km north of Nacala, has a total area of 7,500 km^2, of which 1185 km^2 consist of marine protection area. The existence fringing reefs, sea grass and mangrove should be stressed.
- Ilhas Primeiras e Segundas Environmental Protected Area (Decree no.

42/2012, of 12th December), located about 200 km south of Nacala, has a total area of 10409 km^2. The main objective is the preservation and protection of marine species, coastal areas and their habitats.

At the level of Eastern African Marine Eco-region, key areas for biodiversity of global and sub-regional importance have been defined in a Strategic Framework for the Conservation of Biodiversity. In the coral region of Mozambique, in addition to the legally established conservation areas, Nacala-Mossuril area is identified as important for the conservation of biodiversity of Eastern African Marine Eco-region.

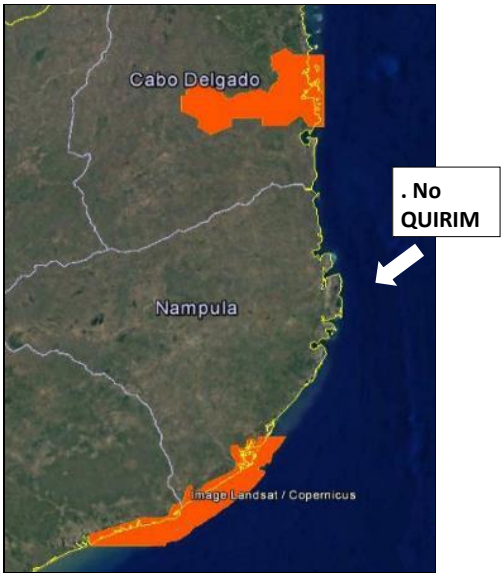


Figure 29 : Marine Protection Areas legally established in Mozambique, in the coral region

Figure 30 : Key conservation areas in the coral region of Mozambique

Nacala-Mossuril is considered an important area for the Eastern African Marine Eco-region. It is characterized by a great diversity of habitats, including the mangrove composed of eight species, sandy beaches, rocky beaches and coral reefs. Two species of sea turtles nest in the sandy beaches: the green turtle and the hawksbill turtle. There is a high diversity of coral reef fishes, gastropods and microalgae on coral reefs. Whales and dolphins are also common in the area.

The direct influence area of the project does not cover other areas legally established as biodiversity protection areas, but it is adjacent to Nacala-Mossuril, considered important for the conservation of the Eastern African Marine Eco-region biodiversity.

Coastal and marine habitats

Despite the lack of thorough and systematic studies about coastal and marine biological diversity of the Bay of Nacala, there are some preliminary studies conducted in the context of a research or regional characterization project (Burbidge et al. 1992; Telford et al. 1999; Battino, 2001), as well as in the context of

environmental impact studies of other projects, which contribute the identification and description of the habitats.

Thus, in the Bay of Nacala and adjacent coastal and marine areas the following habitats occur:

- Sandy Beaches
- Mangroves
- Corals
- Sea grass

In land adjacent to beaches and mangroves there are coastal plain areas in general quite modified by human activity, particularly by the construction of saltpans. Although these areas are less important for biodiversity they are habitat for some avifauna species.

Sandy and muddy beaches

Sandy and muddy beaches occur in the coast line of the interior of the Bay of Nacala, mangrove areas. These beaches are habitats for various invertebrate beings (crustaceans, mollusks and polychaetes) and sea birds, which find food here. They could also be habitat for sea turtles. However, according to the data collected, this does not happen inside the Bay, only on the adjacent coast.

The beach next to the area of construction of the new Access Road to the Port of Nacala is somewhat degraded, mainly by activities related to the Port of Nacala.

Mangroves

Mangroves occur in the muddy areas and are highly productive ecosystems, habitat for a wide diversity of fauna, including invertebrates, icthyofauna and avifauna.

Inside the Bay of Nacala mangroves occur in narrow strips along the bay, with great importance on the western side of the bay and in the interior far end, where they reach a maximum width of approximately 700 m.

On the eastern side of the bay only small patches of mangroves or isolated trees occur, which could be due to massive human pressure, resulting from its proximity to the city of Nacala-Porto, the presence of the port itself and saltpans, and to the pressure for timber for construction and firewood.

In general, these small patches of mangroves are disturbed (such as the case of the non-significant small residual patch in the area crossed by the road design) and trees such as *Avicenia marina, Bruguiera gymnorrhiza, Ceriops tagal e Rhizophora mucronata* may be seen. In terms of fauna, these patches of mangroves do not seem to be rich in diversity and abundance. Fiddler crabs (*Uca sp.*), red mangrove crab (*Neosarmatium africanum*), striped barnacle (*balanus amphitrite*), rock oysters

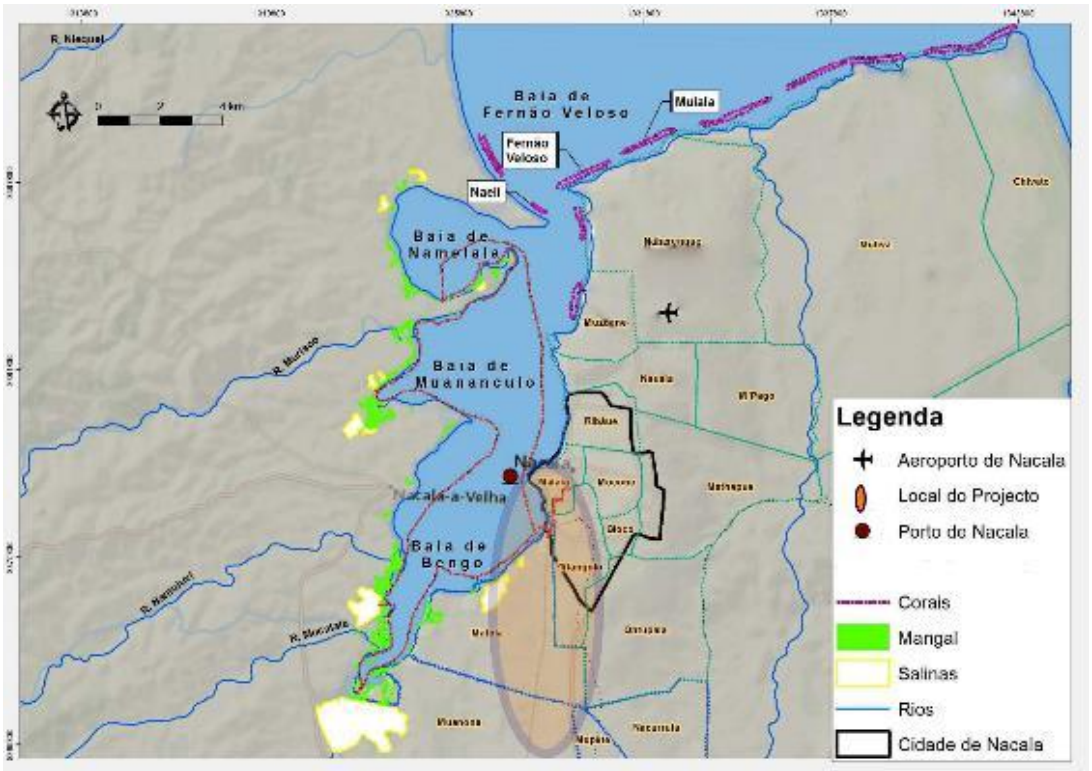
(*Saccostrea Cucullata)*), truncated mangrove snail (*cerithidea decollata*), mudskippers (*Periophtalmus sp.*) and Birds (*Egretta garzetta*).

Mangroves are protected by Regulation for the Prevention of Pollution and Marine and Coastal Environment (Decree no. 45/2006).

Corals

In the Mozambican coral coast the coral reefs appear in the form of fringing reefs almost continuously along the east coast of the islands and in the exposed areas of the mainland coast (Scheleyer et al., 1999). In general these coral reefs have high biodiversity and productivity, and are considered the healthiest in Western Indian Ocean (Obura, 2012).

There are coral reefs in the Northeast of the Bay of Nacala (north of the city of Nacala-Porto), although only in small and dispersed patches. In the Bay of Fernão Veloso (closer to the open sea) the reefs occur in more continuous manner.



Source: adapted from Impact 2016

Figure 31 : Coral reefs and mangroves in the bays of Nacala and Fernão Veloso

Corals are legally protected by Regulation for the Prevention of Pollution and Marine and Coastal Environment (Decree no. 45/2006) which prohibits harvesting coral, as well as "carrying out any activities that may damage existing or future corals, and their biodiversity."

However, corals are subject to various pressures. The main threats in this region are over-exploitation, destruction and silting. Corals are used by local populations for construction, production of lime and selling to tourists. Factors associated with erosion cause the transport of large quantities of sediment to the sea which then are deposited on the coral reefs causing their death. The abnormal sea water heating is another factor of degradation which causes corals bleaching and death. Coral destruction is also caused by over-fishing, especially when carried out by trawling and the use of dynamite (MITADER, 2002 - Strategy and Action Plan for the Conservation of Mozambican Biological Diversity).

No reefs in the area of direct influence of the new Access Road to the Port of Nacala were identified, neither in the adjacent areas.

Sea grass

Sea grass consists of higher plants, adapted to live submerged in salt water, constituting habitat for various fauna species, which find food and shelter here. In Eastern Africa, including Mozambique, is one of the regions of the planet that holds great diversity of sea grass, with 13 species, about 22% of the total worldwide.

Studies on the diversity of sea grass and seaweed (Massingue 2003) on the coast of the province of Nampula, between Nacala and Ilha de Mocambique, allowed to identify 12 species of sea grass, of which 10 have been identified in Relanzampo (next to the exit of the Bay of Fernão Veloso) in extensive areas.

In the context of the EIA of the Coal Terminal of Nacala-a-Velha (Rio Doce, 2010), beds of sea grass were observed on the west side of the bay, and three species of sea grass were confirmed, namely *Nonazostera capensis*, *Syringodium isoetifolium, Thalassodendron ciliatum*.

There is no indication of the existence of sea grass along the area of construction of the Access Road to the Port of Nacala.

Marine and coastal fauna

Marine mammals

On the east coast of Africa 33 species of marine mammals occur, namely whales, dolphins and dugong. According to MITADER (2009), on the coast of the province of Nampula eight species of marine mammals may occur.

Table 21: Marine mammal species occurring on the coast of the province of Nampula

Species	Conservation condition (IUCN, 2016)
Humpback dolphin (*Sousa plumbea*)	Almost threatened
Spinner dolphin (*Stenella longirostris*)	Insufficient data
Common bottlenose dolphin (*Tursiops truncatus*)	A little worrying
Risso's dolphin (*Grampus griseus*)	A little worrying
Melon-headed whale (*Peponocephala electra*)	A little worrying
Short-finned pilot whale (*Globicephala macrorhynchus*)	Insufficient data
Sperm whales (*Physeter macrocephalus*)	Vulnerable
Humpback whale (Megaptera novaeangliae)	A little worrying

Source: MITADERMITADER, 2009

Due to annual migration in this region large whales are normally observed from June to October. Some studies report the presence of spinner dolphins, common bottlenose and humpback whales inside the Bay of Nacala and the Bay of Fernão Veloso (Boane, 2003; quoted by Rio Doce Moçambique, 2006; Olsen et al., 2009).

Dolphins usually appear at bay in groups (adults and juveniles), which can reach tens, sometimes chasing shoals of tiny fish (anchovetas).

The humpback whale is often seen in the Bay of Fernão Veloso from July/August to October/November. There are cases in which these whales come into the Bay of Nacala following the channel (up to a depth of about 50 m and 100 m from the coast) and approaching the port of Nacala (Impact, 2016). The groups are typically composed of two to seven whales, and it is common to see the young ones as well. In recent years tour operators have noted a reduction in the amount of whales that visit the Bay, but do not know for sure what may have caused this. Some suggest it may be related to projects implemented in recent years in the Bay (Impact, 2016).

Therefore, the appearance of marine mammals near the construction area of the bridge for the Access Road to the Port of Nacala is not expected.

Sea turtles

In Mozambique there are five of the seven species of sea turtles occurring in the world (Costa et al., 2007; Videira et al., 2008), including: green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), olive ridley turtle (*Lepidochelys olivacea*), leatherback sea turtle (*Dermochelys coriacea*) and hawksbill sea turtle (*Eretmochelys imbricata*).

The northern coast of Mozambique (coral coast) was recently identified as one of the most important coastal corridors of migration of sea turtles in the western region of the Indian Ocean (Bourjea and Dalleau, 2015).

Corals and sea grass, habitats of sea turtles, are important places of food and shelter for some species such as the loggerhead sea turtle, green turtle and the hawksbill turtle.

Little is known about sea turtles in the province of Nampula, but it is known that they nest in sandy beaches along the coast and on the islands. Green turtles, hawksbill turtles and olive ridley turtles are the ones nesting in this region (Costa et al, 2007). There is indication of existence of nesting areas in the Bay of Fernão Veloso, in Chivato and Memba, but not inside the Bay of Nacala, which can be explained by the existing level of disturbance, although turtles are sometimes seen inside the Bay (Impact, 2016).

In the Ilhas Primeiras e Segundas, nesting of green sea turtles reaches its peak between August and October each year (Costa et al., 2007; Videira et al., 2008), which means the peak of nesting in the region of the Bay of Nacala shall occur during this same period.

As mentioned in section 3.3, sea turtles are protected species, and hunting turtles and harvesting their eggs is prohibited, "as well as any activity that may disrupt ecosystems and habitats and, in general, the development of sea turtles."

However, mortality caused by fishing and harvesting of turtle eggs for consumption is very common during spawning season. This practice is common in the region, particularly in the areas of Simuco and Siriza in Memba, at Baixo do Pinda, Relazampo beach (Bay of Fernão Veloso), Bay of Janga and Ponta Mussengue in Muananculo (Bay of Nacala), which are major nesting areas for sea turtles (Ling et al. 1997). In order to catch sea turtles, fishermen use trawl nets. Their shells are marketed at disembarkation centers and in the local market.

Avifauna

In coastal and open sea in northern Mozambique ten species of costal and sea birds occur, and some (such as herons and sea-shallow) use the continental platform and coastal habitats, and others use ocean habitats (albatrosses, petrels and shearwaters, geese and ponytails straw).

The study area is not recognized an area of great importance for birds, and it is not integrated in any of the 16 existing Important Biodiversity Areas (IBAs) in the country. However, given the existence of highly important habitats costal and sea birds, such as mangroves, saltpans, intertidal banks, beaches and sea with crystal clear waters, it is believed that this could have great importance for costal and sea birds.

According to Telford (1999) in Nacala-Porto and Nacala-a-Velha 62 bird species potentially occur, two of which are listed in the red list of species of South Africa (Brook, 1984), 44 species are residents; 14 are migratory, i.e., they seasonally migrate between Asia and Europe; 3 species migrate between various countries in Africa, mainly from Madagascar; and 5 are rare species. Migratory species find in coastal habitats suitable places for feeding and nesting. (ERM, 2006)

The following Table shows avifauna species likely to occur within the study area and the corresponding conservation in accordance with IUCN (2016).

Table 22: List of sea and costal avifauna species, with the conservation condition and probable occurrence in the study area

Species	Conservation condition (IUCN, 2016)
Malagasy pond heron (*ardeola Idae*)	In danger
Cape gannet (*Morus capensis*)	Vulnerable
Collared pratincole (*Glareola ocularis*)	Vulnerable
Eurasian curlew (*Numenius arquata*)	Almost threatened
African skimmer (*Rynchops flavirostrisII*)	Almost threatened
Curlew sandpiper (*calidris ferruginea*)	Almost threatened
Bar-tailed godwit (*limosa lapponica*)	Almost threatened
Black-tailed godwit (*Limosa limosa*)	Almost threatened
Eurasian oystercatcher (*Haematopus ostralegus*)	Almost threatened

Ichthyofauna

The diversity of habitats in the Bay of Nacala offers great abundance and diversity of fish.

At least five species (29 families) were identified in trawling in the Bay of Nacala (ERM, 2006). According to the composition of catches from the small-scale fishing, which constitute a good indicator of abundance of species and families, the leading families of fish in the Bay of Nacala are Scombridae (composed of saw-fishes, mackerel and tuna), Carangidae (horse mackerel, trevally, machopes, etc.) and Lutjanidae (snappers), and the most abundant species are: Bonito (*Auxis thazard*), Flying fish (*Cheilopogon cyanopterus*) and *Kyphosus bigibbus* (Impact, 2016).

The participatory mapping prepared during the focus group discussion with fishermen from Nacala-Porto under the EIA from another project (Impact, 2016) does not identify areas for fishing in the area (marginal) of the Bay that will be crossed by the bridge planned for the Access Road to the Port of Nacala.

5.7.4 Terrestrial ecosystems

Background

In accordance with the global classification established by WWF, the Project direct and indirect influence area is integrated into the Zanzibar-Inhambane Est-African Coastal Mosaic ecoregion.

This ecoregion, which extends through the coastal areas of Tanzania and Mozambique, constitutes a mosaic of savanna trees, spots of forests, thickets, swamps and some types of coastal vegetation, that give way to mangroves at the mouth of rivers and in bays. It is characterized by a high density of endemic species in the northern part (south of Tanzania) followed by an almost total absence of data on the central part (north and center of Mozambique). The southern part is again characterized by rare endemic species. The abundance of species is low for typically forestry species, which is strengthened by the abundant wooded forests species, savannas, wetlands and swamps that occupy large areas of non-forestry habitats in the ecoregion

Protected areas for the conservation of terrestrial biodiversity

As previously mentioned, in the northern region of the country there are two conservation areas under the Biodiversity Conservation Law (Law No.16/2014), both in the Zanzibar-Inhambane Est-African Coastal Mosaic ecoregion which, in addition to a marine and coastline component, covers terrestrial habitats, namely:

- Parque Nacional das Quirimbas (Decree no. 14/2002, of 6 June), located about 170 km north of Nacala has 5984 km2 of land area;
- Environmental Protection Area of the Ilhas Primeiras e Segundas (Decree no. 42/2012, of 12 December), located about 200 km south of Nacala, has a range of 205 km in length.

In addition, in Nampula Province there are five forest reserves legally established destined to preserve the forest:

- Mecuburi Forest Reserve (2300 km2),
- Ribaue Forest Reserve (52 km2)
- Baixo Pinda Forest Reserve (196 km2),
- Matibane Forest Reserve (512 km2)
- Mpalue Forest Reserve (51 km2)

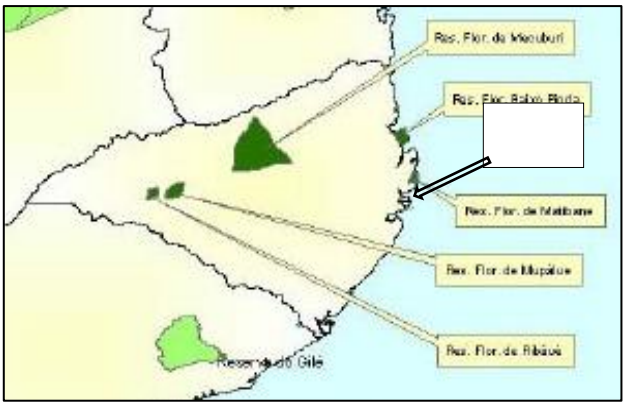


Figure 32 : Forest Reserves in Nampula Province

The Mapping of Mozambique Habitats (CEARN, 2015), performed as a basis for balances of biodiversity in Mozambique ranks as critical habitats (according to the IFC criteria) the areas mentioned above, classifying them as strictly not counterbalanceable, the Quirimbas National Park and Environmental Protection Area of the Ilhas Primeiras e Segundas.

- Reserva Florestal Matibane (512 km^2)
- Reserva Florestal Mpalue (51 km^2)

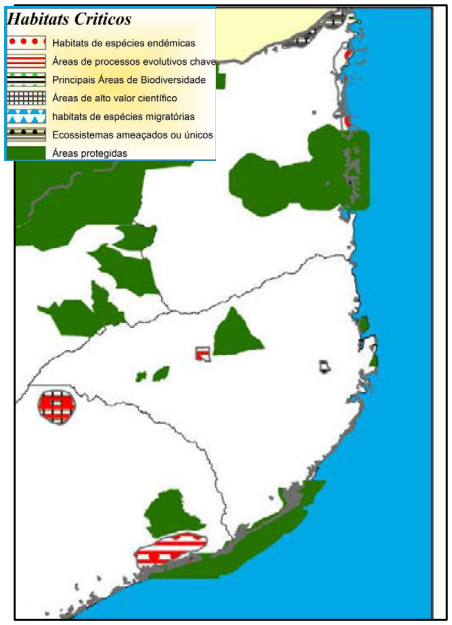


Figure 33 : Critical Habitats, according to criteria of the IFC

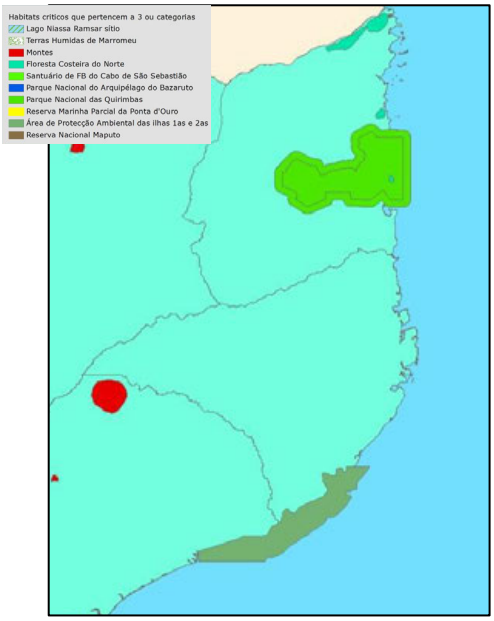


Figure 34 : Strictly critical Areas, not counter-balanceable

The Project implementation area does not include any conservation area nor areas of critical habitats.

5.8.2.3. Habitats

The area of direct influence of the project is dominated by anthropogenic action, resulting in areas modified primarily by agriculture. However, it is still possible to find remnants of natural terrestrial habitats, including shrub lands, grasslands and wetlands, although highly disturbed.

In most of the project construction area, especially up to km 7, habitats have been highly modified by agriculture. Between the km 7 and km 9.8 somewhat disturbed shrub lands occur. From then until the end of the road design there is mixture of agricultural areas, areas with dispersed fruit trees (cashew and mango trees) and small patches of natural vegetation.

Table 23: Habitats occurring along the study corridor

Km of the Project	Habitats	Ecological importance of the type of habitat	Level of disturbance	Ecological value
0.9 - 3.2	Wetlands alternating with secondary grasslands	High	High	Medium
3.2 - 7.2	Predominant agricultural areas, interspersed by small patches of grasslands and vegetation along water lines	Low	High	Very Low
7.2 to 10.2	Predominant secondary shrublands, interspersed by farms	Medium	Medium	Low
10.2 to 14. 5	Mixture of shrublands and grasslands (with cashew and mango trees), interspersed by farms	Low	High	Low

Flora and fauna

As previously mentioned, the area of direct influence of the project is much modified with very disturbed habitats.

As a result the flora and fauna in this area is very impoverished, and no species for conservation and that can affect the implementation of the Project have been identified.

5.7.5 Ecosystem Services

Ecosystems have the potential to create a set of goods and services crucial for human wellbeing and for generation of economic benefits, which together are referred to as ecosystem services. Thus, and as mentioned by the *Millennium Ecosystem Assessment*, ecosystems provide essential services to human wellbeing and development. This document distinguishes four categories of ecosystem services (MEA, 2005):

- Support Services: these services necessary for the production of all other ecosystem services (cycle of nutrients, formation of soil, primary production, etc.);
- Supply Services: these services are related to the products obtained from the ecosystems (production of food, drinking water, yarns and fibers, fuel, etc.);
- Regulation Services: benefits obtained from the regulation of ecosystem processes (sequestration of carbon, water supply, flood control, water

purification, waste treatment, pollination, prevention of soil erosion, etc.);

- Cultural Services: benefits obtained from ecosystems through spiritual enrichment, cognitive development, reflection, entertainment and aesthetic experiences.

The following Table identifies ecosystem services provided by habitats occurring in the Bay of Nacala and land adjacent area.

Table 24: Ecosystem services by habitat occurring within the study area

Habitat	Ecosystem Services			
	Support	Supply	Regulation	Cultural
Coral reefs	Nurseries, source of food and shelter; aggregation of species, relationships of symbiosis	Fish, crustaceans, construction material		Opportunity for recreational activities
Sea grass	Balance of nutrients, enrichment with organic nutrients		Mounting the substrate	
Mangroves	Nurseries, shelter for fish and invertebrates juveniles;	Fish, crustaceans, wood, firewood,	Coastal protection against erosion and extreme events (storms, cyclones), debugging and water purification; sequestration of carbon	
Sandy/muddy beaches	Habitat for avifauna and invertebrate organisms (crustaceans and mollusks)	Mollusks and crustaceans, construction material	Protection	Opportunity for tourism
Coastal plains	Habitat for avifauna	Construction materials Fishing Agricultural land	Damping floods	Opportunity for tourism related to bird watching
Alluvial		Construction		

plains		materials, Agricultural land, pastures, Pisces		
Forest		Construction materials Wood, firewood, wild fruits, honey, medicinal herbs	Soil Conservation Sequestration of carbon	

5.8 Land Use

The use and occupation of the land in Nacala-Porto had several contours along the history after independence. From 1975 to 1981 land subdivision and allocation were conducted in the immediate areas of the urban center of Nacala-Porto, as well as in the peripheral areas and today the plots allocated constitute the consolidation areas of the city of Nacala-Porto. In the period above, approximately 5000 to 7000 plots were demarcated both inside and outside the urban area. The second phase of land use dates from 1981 to 1985. During this period the Master Plan of the City was approved, which had guidance on land use within the urban space. From 1985 to 2004 the Master Plan was implemented and accompanied by a solid training and structuring of local government on planning and management of the soil.

There is currently a clear difference in the land occupation. Urban and populated areas are associated with the Port, particularly the railway line and dispersed housing occupancy areas, associated with agriculture and planting of fruit trees – mango and cashew trees.

The occupation of the urban perimeter and adjacent areas took place in the 1990s. During this period the number of occupations for the construction of warehouses and small industries located along EN12 and the south side of the city increased.

Approximately 2.400 acres make up the center of Nacala Porto and it is the occupied part with the highest density whose settlements are informal and associated with railway and port lines, industrial and commercial use, and services. There is also great population density along the road that connects the city to the beach of Naherenque (Fernão Veloso) to the north.

In the urban area there are three main types of urbanization, in accordance with the characteristics of occupation process, occupation standards, densities and levels of housing and infrastructure:

- **Urban areas**: Cidade Alta and Cidade Baixa;

- **Semi-urban areas**: plots in communal and expansion areas (Ontupaia[10], Nauaia, Muzuane, Ribaué and part of Triângulo);
- **Non-urban areas**: informal settlements (Triângulo - Nicandavala, Mocone).

Nacala Porto has made enormous progress for structuring and planning settlements in extremely difficult circumstances marked by progressive erosion of soils. Due to the need to regulate land occupation, and thus promote local development, in 2006 Nacala Port started preparing the Plan for Urban Structuring (PEU) which was approved in 2010 and ratified by the Minister for State Administration in 2011. PEU is currently in the implementation phase.

In the direct influence area of the project, the use of the land is primarily agricultural, with farm fields prevailing. Shrublands and secondary grasslands with fruit trees still occur, especially in the final part of the road design.

Saltpans, industrial areas (existing or planned) and the Bay of Nacala in the immediate surroundings should be noted. Human occupation (residences) is reduced and can only be seen near km 3+200, southeast of the road route, and at km 10+300, near the intersection of the Project with R702.

5.9 Waste Management

The city of Nacala-Porto is served by a system of solid waste collection under the responsibility of the Municipal Council of Nacala, more specifically the Cleaning and Sanitation Sector. The collection system covers Cidade Alta and Cidade Baixa and part of the peri-urban areas, including the main markets in the city, accessible by tractor. Waste from the major industrial units and Port are collected by a private company operating in Nacala.

In both cases, the waste collected is disposed of in two municipal landfills. The main landfill is located near the road dividing Nacala and Mossuril about 15km from the center of the city, and the other landfill is located about 7km away. There, waste is generally covered with earth or burned. Only the first landfill is fenced. However the implementation appropriate environmental management measures is still not satisfactory.

5.10 Landscape

In general, the project area landscape is not so unique. The main element adding value to the landscape is the Bay of Nacala. However, the artificial modifications, characterized by the presence of industrial units and infrastructure highly affect the beauty of this landscape.

[10] Current residence expansion area, where more than 8000 plots have recently been allocated

5.11 Socio-economy

5.11.1 Background

The city of Nacala-Porto is situated in the Bay of Nacala (Indian Ocean), in the northern province of Nampula, approximately 200 km from the city of Nampula, 500 km as the crow flies from the northern border of the country with Tanzania, about 1,800 km from the southern border with South Africa, and approximately 620 km from the western border with Malawi.

Its position on the Mozambican coast, its natural conditions and the deep-water port determine the importance and functions of this urban center, whose development is closely connected to regional perspective.

The city of Nacala-Porto is the terminal point of the transport corridor, composed of EN12 which connects to the capital of Nampula province and also through Nacala-Lichinga Nacala railway lines. The Port, which is considered as the third most important of the country after the ones of Maputo and Beira, combined with the railway infrastructure, which together form the Regional Transport Corridor, known as Nacala Corridor, make Nacala-Porto a city with potential for economic development.

The Access Road to the Port of Nacala in the analysis covers territory within Nacala municipality and within Nacala Porto district, particularly Maiaia/Mutiva and Muanona Administrative Posts, crossing eight (8) neighborhoods, including five (5) form the Administrative Post of Muanona (Conambia, Matola, Murrupelene and Lacone) and three (3) from the Administrative Post of Mutiva (Triangulo, Maiaia and Uthupaia).

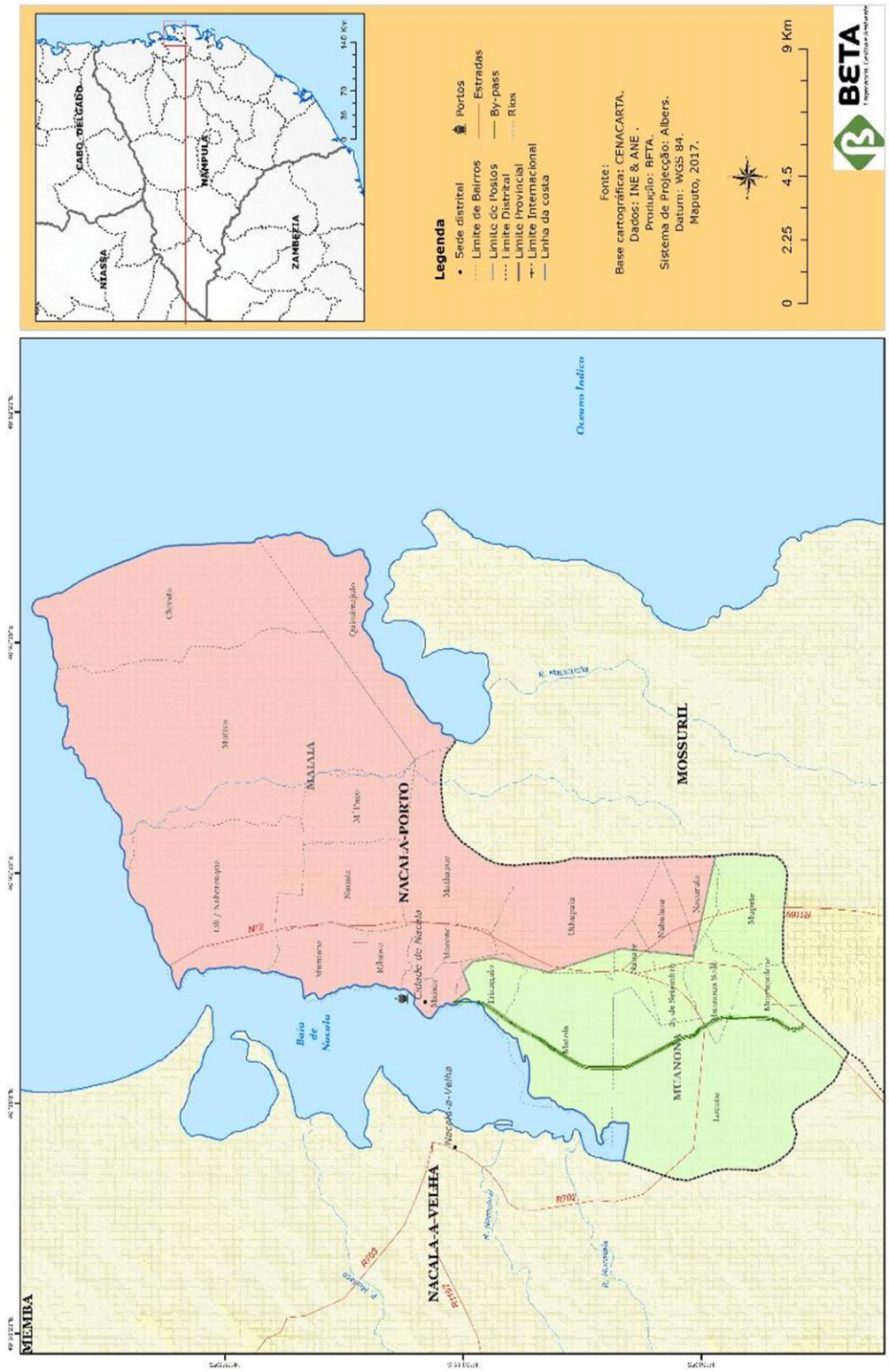


Figure 35: Geographical and administrative framework of the project on a local scale

5.11.2 Local governance

It is important to distinguish two types of governance in Nacala-Porto, District Administrator and the Municipality. The project is under the municipality governance, which takes into account Law no. 2/97 of 28th May. According to this law the governance of municipalities in Mozambique incorporates three major components: (i) the Municipal Assembly; (ii) the President of the Municipal Council and (iii) the Municipal Council. According to this law, while the Municipal Assembly is the deliberative entity, the President of the Municipal Council and the Municipal Council are executive entities. At the level of the municipality there working committees specialized in several areas of local development, particularly committees responsible for the social, economic, political, financial, legal and cultural sectors.[11]

This municipal governance structure is in turn supported, at the level of neighborhoods (smaller administrative units), by neighborhood secretaries whose responsibility is to serve as a link between the communities they represent and municipal government structures in Nacala Porto. Under the neighborhood secretaries, there are other community representatives, who party-political in nature. Neighborhood structures play a very important role in the study area, both in information dissemination and conflict resolution.

Nacala-Porto district is governed by the district Administrator who is appointed by the Minister for State Administration (MSA), based on the proposal by the provincial Governor. The Administrator is assisted by a Permanent Secretary and a set of sectors, specially the District Services for Economic Activities (SDAE), District Services for Planning and Infrastructure (SDPI), District Services for Health, Women and Social Welfare (SDSMAS) and District Services for Education, Youth and Technology (SDEJT). At district level, these services represent are the central units for planning and implementation of development plan in the country.

5.11.3 Demography and living conditions

As mentioned, the district is composed of two administrative posts, Mutiva and Muanona. The first district is the most populous with more than 80% of the district population. The summary of the administrative division as well as the demographic data from Census 2007 for each administrative unit are presented in the following Table.

[11] http://www.dno.gov.mz/docs/legislacao_interna/autarquias/LeiBasesAutarquias.pdf

Table 25: Population by Administrative Post and Neighborhood in the district of Nacala-Porto

NACALA-PORTO District	Total	Men	Women
	206,449	**102,342**	**104,107**
Maiaia/Mutiva Administrative Post	**172,064**	**85,751**	**86,313**
Maiaia/Mutiva Locality	172,064	85,751	86,313
Muzuane suburb	5,497	2,679	2,818
Lili/Nahereuque suburb	8,937	4,407	4,530
Bloco 1 suburb	8,499	4,268	4,231
Maiaia suburb	14,270	7,288	6,982
Mathapué suburb	27,238	13,558	13,680
Mocone suburb	26,437	13,241	13,196
Nauaia suburb	9,554	4,707	4,847
Uthupaia suburb	25,767	12,677	13,090
Ribawe suburb	12,179	5,984	6,195
Triangulo suburb	24,220	12,416	11,804
Quissimanjulo suburb	9,466	4,526	4,940
Posto Administrativo Muanona	**34,385**	**16,591**	**17,794**
Localidade Muanona	34,385	16,591	17,794
Locane suburb	3,611	1,756	1,855
Inaco suburb	969	467	502
Matola suburb	4,859	2,387	2,472
Mupete suburb	2,196	1,066	1,130
Muanona – Sede suburb	840	421	419
Mahelene suburb	2,367	1,113	1,254
Murrupulene suburb	3,399	1,679	1,720
Navevene suburb	966	455	511
Josina Machel suburb	470	229	241
Mutalane suburb	2,945	1,382	1,563
Namissica suburb	1,986	989	997
Muambe suburb	1,348	654	694
Nanare suburb	1,536	734	802
Nabulusa suburb	1,920	854	1,066
25 De Setembro suburb	4,139	2,005	2,134
Nacurula suburb	481	234	247
Teterrane suburb	353	166	187

Source: Data from the National Institute of Statistics, 2007

As indicated above and based on the results from the population 2007 Census, the district has 206.449 inhabitants, and approximately 246.161 inhabitants are projected to 2017, which represents an increase in 19.2% and an average annual growth rate of 1.75%[12]. This rate suggests that the population of Nacala-Porto grows slowly when compared to the national annual average rates which are above 2%[13]. This low rate of annual growth can be associated to factors such as low levels of fertility, high rates of infant mortality, or adoption contraceptive measures[14].

From the point of view of gender representation, the population of Nacala-Porto is mostly female. This fact is reflected in the population censuses conducted to date, including projections for future. As indicated above, 50.4% of the 206.449 inhabitants registered in the 2007 Census were women. This tendency of in the demographic matrix of Nacala-Porto is expected to continue in the coming years because, according to the projections for 2017, female population represents 51% and in 2025 could reach about 53%. [15]

The population of Nacala-Porto district of is remarkably young. According to the report of the "Annual Projections 2007-2040 the Total Urban and Rural Area Population of the Districts of Nampula Province" approximately 79.4% of the population of the district was between 0-35 years. However, youth population in the demographics of the district shall reduce to 76.3% in 2025 according to INE projections.

According to Poverty Mapping conducted in 2002 (MPF, 2002), it was estimated that Nacala-Porto district had an index of incidence of poverty of 0.55, one of the lowest in Nampula province. At district level, the Administrative Post of Mutiva had greater incidence of poverty (0.74), contrasting with the lowest index observed Maiaia (0.49). in addition, the depth and severity of poverty were more prominent in this Post, with 0.32 and 0.18, respectively. The Third National Evaluation of Poverty and Well-Being in Mozambique in 2010 (MPD, 2010) indicated that in general terms, and particularly in Nampula province there had been some improvement, derived mainly from progress in the non-monetary poverty indicators (especially in access to education and health), however no progress occurred in other poverty measurements. Thus it is estimated that the current situation is not very different from the one estimated in 2002, and there is therefore in the study area a significant percentage of population below the poverty line.

In the context of the Resettlement Plan, the incidence of vulnerable households was identified and 8.3% of surveyed households reported having a family member with

[12] Calculated based on the formuulaa on: http://www.endmemo.com/algebra/populationgrowth.php
[13] Em 2014 a taxa de crescimento populacional esta situada em 2.79% Segundo dados obtidos em: http://www.tradingeconomics.com/mozambique/population-growth-annual-percent-wb-data.html
[14] http://www.youth-policy.com/Policies/Mozambique%20Population%20Policy.pdf
[15] INE (2010). Annual Projections 2007-2040 the Total Urban and Rural Area Population of the Districts of Nampula province

chronic illness (mainly diabetes and asthma) and 8.1% reported having a family member with a physical disability. Only 2% of the households indicated widowhood.

5.11.4 Economic Activities

The economic potential of Nacala-Porto is greatly associated with the role played by the Port of Nacala in terms of international trade and local development, and through creation of jobs. Given that it is rated as largest natural deep-water port on the east coast of Africa, it allows the entry/exit of ships without limitations 24 hours/day and acts as the terminal of transport corridor with the road that connects the city of Nampula to inland countries, namely, Malawi and Zambia, which as a whole are called North Development Corridor. [16]

In addition, with the institution of Free Economic Zone, Nacala-Porto is a huge potential for investments in industrial areas. Some investments are visible in the areas adjacent to the Project (in Maiaia neighborhood, in the Administrative Post of Mutiva), namely the factory of cement (Cimentos de Moçambique), Railways of Mozambique (CFM) and the Port of Nacala.

Although a large part of activities in this area are closely related to large industry enterprises, the local population carry out other types of activities. Subsistence agriculture and livestock farming, and fishing are some of the major activities. However informal trade is also prevalent mainly in the center of the city of Nacala-Porto. Agriculture and livestock farming, and fishing activities are common in the periphery.

The description of the main economic activities of the district is as follow

Agriculture, livestock and fishing

As indicated in the previous section, agriculture, livestock and fishing are part of economic activities in Nacala-Porto. It should be noted that agriculture is mainly for family subsistence and that is not restricted exclusively to people living in the outskirts of the urban area. In this area, rainfed agriculture is practiced, which means that it depends on precipitation and on the use of rudimentary means of production. Cashew, maize, peanuts, cassava, cotton, among others are the main crops grown in Nacala-Porto. Cassava is basic food for the vast majority of the communities of Nacala-Porto[17]. Cashew and cotton are income generation crops.

Although livestock are not as highly practiced as agriculture, in recent years it has been growing rapidly, partly because of the improvement of livestock farming services. The responsible institutions in Nacala-Porto have improving over the last

[16] http://www.cfm.co.mz/index.php/pt/infraestruturas/cfm-norte/porto-de-nacala
[17] http://tim.sapo.mz/noticias/economia/criacao-de-gado-cresce-56-em-nacala-porto

three years in enrollment, vaccination and treatment of ticks[18]. Goats, cattle and chicken, and goats and chickens have the highest growth. Data from 2014 indicate that Nacala-Porto had about 1.671 goats and 12.000 chickens in the private sector and associations. [19]

As in other coastal areas of Mozambique, Nacala-Porto has an enormous potential for fishing activity. Artisanal fishing carried out individually or in associations, which are strongly supported by the Institute for Development of Small-scale Fishing (IDPPE). In many cases artisanal fishing is aimed at commercial purpose for both hotel industry and local consumption. Sometimes the IDPPE functions as the connecting link with industrial fishing. In addition to fishing, aquaculture has come too be important for the sustainability of fish in the sea and food security.

Some areas affected or crossed by the Project have an enormous potential for aquaculture. It should be stressed that Mahelene in the Administrative Post of Muanona has potential for the production of clams and Quissimajulo, in the Administrative Post of Mutiva, has potential for the production of seaweed. Aquapesca Lda is the major aquaculture company which only produces only small shrimp which are then sent to Quelimane for future growth.

In the area of direct influence, agricultural activity is the main means of survival, as evidenced in the Resettlement Plan. The majority (55.7%) of the households affected by the project indicate that agriculture is their main means of life and survival.

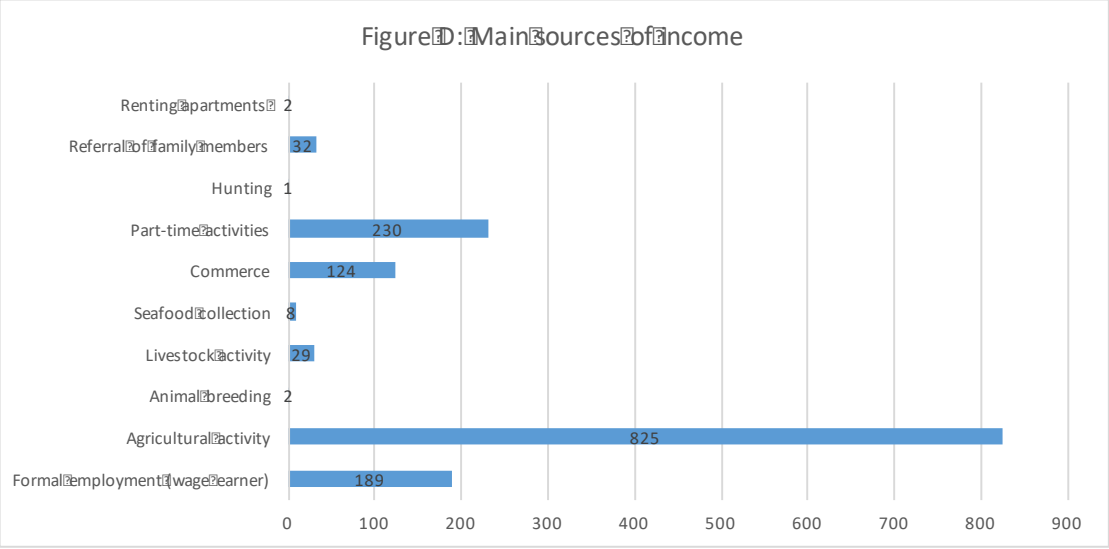


Figure 36 - Main sources of income of households directly affected by the Project

[18] http://tim.sapo.mz/noticias/economia/criacao-de-gado-cresce-56-em-nacala-porto
[19] http://tim.sapo.mz/noticias/economia/criacao-de-gado-cresce-56-em-nacala-porto

Tourism and Industry

The potential for tourism in Nacala-Porto is undeniable. The recent opening of the international airport sets up an important support infrastructure for tourism development. The airport is certified to receive both domestic and international flights. In addition, the operationalization of Nacala Special Economic Zone of Nacala increases the potential for attracting investment in several areas including the tourism sector, with a particular focus on business tourism. In fact, in recent times important tourism investments such as the construction of new hotels, resorts, lodges, among others have been achieved. Important tourist products include the sun, sea, beaches, sand, ecotourism, culture, sports, just to name a few. In Nacala there is a demand for beach tourism, especially on Fernão Veloso beach, where there are several hotel and catering infrastructure. Ecotourism occurs on adjacent beaches, with less tourist infrastructures. The Island of Mozambique, UNESCO Cultural Heritage is a point of attraction for cultural tourism, approximately 100 m south of Nacala.

With regard to industry, Nacala has running important industries, namely saltpans, cement industry, cutting and wood processing, processing of cashew and quarry. For the production of cement, the raw material (limestone) is extracted in Quissimajulo, outside the municipality. The cereal processing industry (millers) is also a big industry employing significant number of people. There are also other kinds industry, namely the production of raffia bags, production of zinc sheets, and extraction of salt in the Bay.

The new Access Road to the Port of Nacala runs through an area projected to become a development and industrial expansion area.

Trade

Trade is one of the most prominent activities in Nacala-Porto, partly due to its location, local industry and fishing activity. Currently, Nacala-Porto incorporates municipal markets, which are the basis of major increase in municipal accounts. In Maiaia, the influence area of the project, there is the highest concentration of commercial establishments, because it is the oldest and most consolidated city, while Cidade Baixa has the largest number of warehouses which sell various products in bulk.

5.11.5 Social services and infrastructures

Education

It is crucial to read the data on the social interactions services with some caution. In fact, they have as a reference base the year of 2015. Therefore, these data should serve as a reference for understanding the social dynamics on the project area and not only. In 2015, there were 57 educational establishments in Nacala-Porto. 7 of first degree primary education (grade 1 to grade 5); 33 of second grade primary

education (grade 6 to grade 7); 5 of first degree secondary education (grade 8 to grade 1); 3 of Basic Technical Vocational Education; 1 of medium technical vocational education; 1 teacher's training institute and 1 Portuguese school. Nacala Porto has an Agricultural Training Center located in the area of Mapaco and the basic level Polytechnic College. The technical level has the National Institute for Employment and Vocational Training (INEFP) located in Maiaia neighborhood and with the Nacala Female Technical and Professional Secondary School that teaches courses in accounting and auditing. In Nacala Porto there is also a higher education institution "Instituto Superior Politécnico de Nacala" under the aegis of the Polytechnic University and another higher education institution belonging to the Pedagogical University.

With regard to the school coverage, although there is no reliable data, the results of the socioeconomic studies reveal that there is still a need for expansion of education in Nacala-Porto. The lack of teachers persists, resulting in overloading of some teachers, although this problem has been deeply settled as compared to previous years.

The distribution of schools by the territory continues to be uneven as it was in the past. As a general rule, the neighborhoods of downtown have a higher concentration of schools. Thus, children from outlying neighborhoods are potentially deprived of equal opportunity, in relation to the urban area or city center.

Health

According to data from 2015, in Nacala Porto there are 6 main types of health facilities, namely (i) secondary level hospital; (ii) type A hospital; (iii) type 2 hospital; type B hospital; (iv) type B hospital; (v) type C hospital; and (vi) health post. The table below summarizes the type of hospital and the number of existing units.

Table 26: Health Facilities

Types of health facilities	Characteristics	No of existing units
Secondary Level	Those with a role to provide Secondary heath care, constituting the first reference level for patients who cannot find solution to their health problems in health centers (primary level) and that do not need to be addressed in tertiary or quaternary level hospitals.	
Type A	The type A health center - is intended to serve the population within a radius of 1 to 4 km from 40.000 to 100.000 inhabitants located in cities or neighborhoods. Performs the same tasks as those of type a B health center but provides assistance to a greater number of population and offers more and better qualified staff.	
Type 2	Type I and II Health Centers - considered rural health	

Types of health facilities	Characteristics	No of existing units
	centers, located in a rural area and that primarily serve the rural population. The type II health center corresponds to a health unit smaller in size than the type I, in particular, physical infrastructure, organization, equipment, staff allocation and direct influence area (between 7.500 to 20.000 inhabitants for type II and 16.000 to 35.000 inhabitants for type I).	
Type B	The type B health center - is intended to serve the population within a radius of 2 to 4 km from 18.000 to 48.000 inhabitants located in the high population density towns or the most populous. It performs the same tasks as a type I rural health center with the exception of labor care for type B health centers that have an annexed maternity.	
Type C	Type C health center - is intended to serve the population within a radius of 4 km from 10.000 to 25.000 inhabitants located in less populous villages and neighborhoods. It performs the same tasks as a type II rural health center the with the exception of labor care for type C health centers that have an annexed maternity.	
Health Clinic	Health Posts - units that are intended to serve, in the rural area, less than 7.500 inhabitants and in the urban area, less than 10.000 inhabitants.	
Price		

There is also a network of private hospitals units, namely the Clinica Capricórnio, Nacala Healthcare and Clínica Sorridente. In Nacala Porto, the main diseases reported by district health services include malaria, diarrhea, dysentery, cholera and Sexually Transmitted Infections (STIs). Due to the efforts of the government there is a record of reducing cases of deaths by malaria, diarrhea and dysentery as result of the distribution of mosquito nets to pregnant women, intermittent preventive treatment for pregnant women, application of chlorine in water from protected wells, promotion of the use of disinfectants (certeza), education and public awareness campaigns in health facilities and communities. The rate of infection by HIV/AIDS is situated in 19%, in a universe of 6,000 patients and of which 13.3% is in treatment.

Water and sanitation

Nacala-Porto was widely known as a district with serious problems in terms of water and sanitation. Restrictions in water supply, as well as the occurrence of diarrheal

diseases marked in great measure the recent history of the city. However, as a result of huge investments made by the Fund for Investment and Sponsorship of Water Supply (FIPAG), Nacala-Porto greatly improved from 2014, when the rehabilitation and modernization of the rainwater retention dam was completed, and the coverage by the water supply network began to be approximately 110 thousand consumers. The water consumed in the city of Nacala-Porto is captured in the dam located 30 Km from the city built under the river Muehecula.

However, not all communities benefit from piped water from the FIPAG system. Residents of some neighborhoods (Triangulo and Ribaué) rely on other neighborhoods to obtain water. The rate of mean coverage of Nampula province is at 46% for the year 2016[20] and in Nacala-Porto city the dilemma of water supply to the population is even higher, with a coverage rate of 26%, despite ongoing investment.

It should be noted, however, that in addition to the system, access to water is also done through small water supply systems. Very recently, a new water supply system was inaugurated, with the capacity to supply 8.500 inhabitants, serving the communities of the neighborhoods of Mahelene, Lile and Chalaua-Muaco.[21]

In the questionnaires conducted within the framework of the Resettlement Plan it was observed that the vast majority of families affected by the Project does not have a water distribution network, and they resort to alternative sources (mainly traditional wells and boreholes) and piped water from the neighbor, which probably happens when the family owning the farm lives in an area covered by the water supply system.

In terms of distances travelled from home to the closer source, considering all public and private sources, only 3,6% (54HHs) get water within their backyard, whereas 32.2% (479 HHs) get water less than 15 min away; 22.2% (330 HHs) between 15 to 30 min walking distance; 13,2% (196HHs) between 30 and 45 minutes away; 18.5% (276 HHs) between 45 minutes to 1 hour; 9.7% (144 HHs) requires more than 1 hour to get.

Electrical Energy

The supply of electrical energy to Nacala-Porto comes from the national energy transportation network, having as the main source the Cahora Bassa Hydropower Plant (HCB) with a capacity of 110 kV. The high voltage line from Cahora Bassa Hydropower Plant, passing through the Nampula city, is then derived to several districts of the province, including the city of Nacala-Porto. The coverage does not exceed 50%, being that the suburban and peri-urban areas still face serious problems of energy. These neighborhoods resort to alternative sources such as lighting petroleum (the overwhelming majority) and firewood (only a minority). So the

[20] Http://nandiiwe.blogspot.com/2016/05/nampula-mocambique-aumenta-cobertura-de.html
[21] Http://www.jornalnoticias.co.mz/index.php/sociedade/43433-novas-fontes-de-agua-para-nacala-porto.html

network expansion has not kept pace with the rapid population growth and urban development of Nacala Porto.

Currently the supply to the transmission grid in the northern region of the country is reinforced by the generation of energy in a Floating Thermoelectric Plant with the capacity of 100 MW, which is currently anchored in the Nacala bay.

The presence of a power line tower associated with the floating plant which is currently anchored in the Nacala bay should also be noted. This tower, which did not exist at the site during the preparation of the feasibility study, interferes with the planned bridge that will be built in the initial section of the road design now under study.

Figure 37 : Location of the floating plant and the power line tower

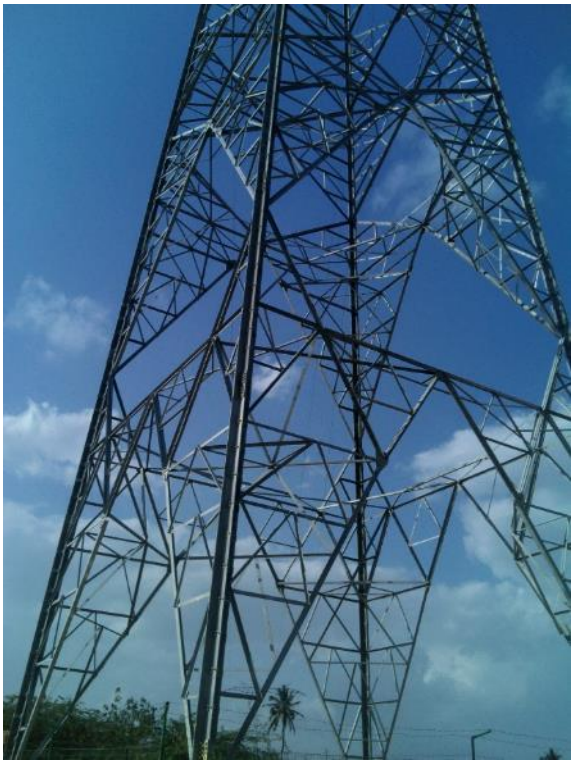


Figure 38 : A view of the power line tower

Transportation infrastructure

In terms of road, Nacala-Porto is served by the National Road N12, which connects the City of Nacala to the capital of the Province (Nampula), via Namialo, R702 which establishes the connection to the Nacala-a-Velha District and R1169, towards Matibane (Mossuril District). The city has a network of paved roads in the upper and lower cities and dirt roads in the peri-urban areas.
In the project implementation area, local populations walk to the farm (machambas) and clearly with the works of the Project, they will have to cross the infrastructure implementation corridor.

Currently the road access to the Port of Nacala is done via N12 and streets of the municipality, crossing shopping and residential areas, which results in traffic jam. Recent statistics show that traffic can reach up to 100 heavy vehicles/day creating embarrassment to the movement not only of vehicles, but also of people.

As mentioned, Nacala-Porto has an international airport designed to receive domestic and international flights.

The Port of Nacala is one of the most important poles of development of Mozambique and Africa. Its deep waters allow the movement of ship 24 hours per day, which makes it one of the most important of the east coast of Africa. This port is the terminal of the Nacala Corridor, served by a rail way connecting the coast to the Malawi and the city of Lichinga, in Niassa, passing through the city of Nampula and other districts. This rail track has begins in the village of Moatize, in the

province of Tete, where they develop mining projects for coal extraction, which is exported from the Nacala-a-Velha Coal Port Terminal.

The installed capacity of cargo handling at the Port of Nacala is very high. In fact, the Port of Nacala, currently, has a general cargo Terminal, able to handle 2 million tons annually. It features 8 warehouses with a total surface of 21,000 m2; it has a container terminal with 327 meters of length and 15 meters of depth, 30,000 TEUs annual handling capacity and 62,000 m2 of paved area for the storage of 2,750 containers; 1-25 tones park portico for 20 feet containers. The Port of Nacala also has a Terminal for liquid bulk cargoes linked to the BP-Mozambique fuel tanks (18,000 tons) and Petromoc (35,000 tons) by a pipeline of 3,5km and tanks with a total capacity of 2,400 tons for palm oil and food, belonging to the Malawi's Lever Brothers.

Recent data obtained from company Portos do Norte, an entity that is responsible for the management of the terminal and for handling of all types of cargo at the Port of Nacala, shows the types, volumes, origin and destination of goods entered the Port over the last four years (2013-2015).

Table 27: Type, volume and movement of cargo at the Port of Nacala

Type of cargo	Origin	Destination	Regime	Volume/Ton
Clinker	Vietnam	Nacala	Importation	772.727
Cement	Vietnam	Nacala	Importation	762.224
Wheat	Canada/Russia	Nacala/Malawi/Zimbabwe	Importation	877.922
Fertilizers	Hong Kong	Malawi	Importation	83.025
Rice	Vietnam/China	Nacala	Importation	4.000
Maize	South Africa	Malawi	Importation	10.000
Equipment/Vehicles	China/Japan	Nacala	Importation	263.693
Zinc Rolls	China	Nacala	Importation	18,543.63
Frozen fish	Namibia/Spain	Nacala	Importation	23.143
Wheat bran	Nacala	Iraq	Exports	100.960
Banana	NPL/Namialo	Doha/Debrali/ SaudiArabia	Exports	179.890
Cashew nuts	Nampula	India	Exports	52.370
Agricultural products	NPL/Zambezia	India	Exports	117.940
Wood	NPL/Zambezia	China	Exports	185.440
Sugar	Malawi	Spain	Export/Transit	141.925
Tobacco	Malawi	Russia	Export /Transit	11.370

Type of cargo	Origin	Destination	Regime	Volume/Ton
Tea	Malawi/Gurúe	India/China/	Export /Transit	78.310
Cotton	Nampula/Niassa	Portugal	Export	83.780

5.11.6 Cultural and religion heritage, graves and sacred sites

In the areas the project direct influence, in particular the districts Conambia, Matola, Murrupene and Lacano in the Administrative Post of Muanona and the neighborhoods of Triângulo, Maiaia and Uthupaia in the Administrative Post of Mutiva, no historic sites of cultural importance were, nor in its vicinity which may directly or indirectly influence the execution of the project. Some places of worship, including churches, mosques can be found in Maiaia, but without any interference by the project.

However three places of worship (worship of spirits/ancestors) were found in the corridor of the Project as well as 67 graves.

Highlighted reference should be given to the designated Central Cemetery, whose known delimitation (see the following figure) enables noting that part of it is within the protection area of the road design, although it is not directly affected by the construction of the road itself.

Currently this cemetery is no longer used and the survey carried out allowed to identify more than 2,000 graves. It should be noted that this survey was not completed due to the difficulty of locating some graves, but also due to identified risk of opportunistic exploitation. The public consultation carried out allows noting that the community in general is unfavorable to exhumation of the bodies buried in this cemetery.

Figure 39 : Location of the floating plant and the power line tower

6 Identification and Impact Assessment/ Mitigation and/or Enhancement Measures

6.1 Methodology

The **identification and impacts assessment** allows foreseeing the significant environmental effects that the project may cause on the environment.

The analysis begins with the task of **identifying** the impacts, corresponding to the prediction of the nature of the interactions between the Project and its environmental and social surroundings, in other words, the relation between the Project actions, impact primary causes and the environmental factors in which the effects are produced.

Following the identification, the **assessment** (in other words, the description and valuation) of the impacts that have been identified as plausible focusing over the ones that were considered potentially significant will take place.

This is done by using a set of criteria that are indicated below (not all impacts will need to be assessed according to all criteria), using a qualitative scale but as objective as possible.

The criteria to be used correspond to those which are generally accepted as good practice in studies of this nature and include the following:

- With regards to its character, the impacts will be classified as positive or negative.
- The magnitude (absolute significance) of the impacts will be classified as high, moderate, or reduced.
- In accordance with the geographical scope of influence, , the impacts will be classified as local, regional or national, taking into account the size of the area in which its effects are felt.
- The probability of occurrence or degree of certainty of the impacts will be determined based on the knowledge of the characteristics of each of the actions and of each environmental factor, allowing to classify each of the impacts as certain, probable or improbable.
- Regarding the duration, the impacts will be considered temporary if they occur only during a certain period, being permanent otherwise.
- With regards to reversibility, it will be considered that the impacts will be irreversible or reversible depending on whether the corresponding effects remain in time or are canceled, in the medium or long term, namely when the respective cause ceases.
- Regarding the time lag the impacts will be considered immediate since they occur during or immediately after the construction phase of the Project. If they are only disclosed in the long term, they will be classified as medium (substantially up to five years) or long term.
- In addition to that, and whenever justifiable, the type of impact will be distinguished, that is, if it is a direct impact - one that is directly determined by the Project or an indirect impact - that which is induced by the activities Related to the Project.
- The impacts will also be analyzed regarding its minimizing possibility, that is, if the mitigation measures are possible (impacts likely to be minimized) or if its effects will be felt with the same intensity regardless of all precautions that may be taken (impacts unlikely to be minimized).
- Shall also be noted the eventual cumulative impacts, that is, impacts determined or induced by the Project which shall be added to the already existing or foreseen disturbances as a result of other projects over any of the considered environmental factors.

- Finally, an attempt will be made to assign a significance (overall assessment) to the environmental impacts determined by the Project, for which a qualitative assessment methodology will be adopted, which will attempt to clearly convey the global significance of the environmental impacts determined by the Project In the biophysical and socio-economic context in which it is inserted. The assignment of the degree of significance of each impact will take into account the result of the classification attributed to the impact on the remaining criteria but also the sensitivity of the EIA team to the consequences of that impact in a global context; Therefore, there may be impacts with similar classifications in the various parameters that have a distinct classification in the scope of significance.

The following table presents a systematization of the criteria for determining the significance of impacts:

Table 28: Criteria to determine impacts significance

Significance	Relation with other assessment criteria	Measures
Low or reduced (less significant impact)	An environmental change is foreseen, but the impact magnitude is reduced and within the acceptable standards, and/or the receiver is of low sensitivity/value. Spatial impact and temporarily limited	Mitigation of negative impacts not necessary, requiring always the observation of good practices. Positive impact enhancement measures should be considered if they involve an effort compatible with the expected benefit
Medium or moderate (significant impact)	Impact that may exceed acceptable limits and standards and / or the receiver is moderately sensitive / valuable.	The mitigation of negative impacts is necessary and justifiable the enhancement of positive impacts
High or extreme (very significant impact)	Impact in which the limits or acceptable standards may be frankly exceeded, or when changes of great magnitude occur in resources/receivers highly valued/sensitive. Impact which may be long term or affect a great area.	If the negative impacts cannot be mitigated it may be justifiable an intervention at decision level regarding the Project.

6.2 Impacts on the Climate

It is not foreseen that the Project may have any relevant climatic or microclimatic effects on its influence area.

It is not, therefore, justifiable the impact assessment on the climate.

Moreover, the characteristics of the region climate, namely in terms of precipitation pattern and its hydrological implications are duly observed in the engineering studies already conducted, in particular regarding the drainage of the future road.

In the context of climate changes may be discussed the effects of greenhouse gas emissions (GEE, of which the most common is the carbon dioxide, CO2) which as a result of the increase of its concentration has a determining role on the global warming.

The GEE emission associated to the Project shall be verified both during the construction phase (emissions by the machinery during works), as well as during the operation (emission from the vehicles that will use the road).

The quantity of GEE emitted by the machinery engines directly involved in the works (temporary) of construction is insignificant compared to the total of GEE emitted in Mozambique. On the other hand, the deforestation inherent to the road construction will also mean a reduction in the CO2 fixation capacity by the plants eliminated. The relevance of this reduction is extremely low even at local level and does not translate into any relevant impact.

During the operation phase the future road will have a traffic flow with some intensity, however, it should be observed that part of it (induced by the Port) corresponding to vehicles that will stop using the N12 (in other words, it will mean a traffic transfer and not the generation of "new" traffic, and should also be highlighted that the new road will contribute to reduce fuel consumption and, in the long run, the GEE emissions). In any case, the meaning of the GEE emissions of the traffic that will use the road in study under the context of total country GEE (and, by addition, of the region and planet).

In short and in practical terms, the indirect impacts of the Project in terms of global warming shall be insignificant.

6.3 Impacts in the Geology and Soils

As described on Section 4.3, in the area under study there are many sedimentary geological formations, extremely erodible to water and wind. The main impacts resulting from the construction of the Access Road to the Port Nacala will occur essentially during the construction phase, although some may also occur during the operation phase, as described below.

6.3.1 Construction Phase

Erosion

During this phase, the deforestation and earthwork activities will expose the soils to erosive agents, creating erosion development areas, as it is already occurring in some locations. These phenomenon result in the loss of soils (including superficial soils) and may also lead to topographic changes (i.e. ravines), especially along the slopes.

Both cases will result in negative local impacts, whose magnitude may be from low to high, requiring the adoption of mitigation measures. The probability of occurrence of these impacts is high due to the susceptibility of the area to erosion. It should also be highlighted that during the selection of alternatives to the road design, one of the criteria considered was to avoid crossing areas with higher risk of erosion, which is translated into a mitigation of negative impacts having as objective to prevent the occurrence of impact.

Soil compaction and deforestation

In the area of campsite establishment and other temporary facilities linked to the construction works (as temporary accesses) shall occur soil compaction as a result of machinery and vehicles movement which may affect the future use upon the conclusion of works (local impact of medium to long term magnitude).

It is not foreseen the execution of activities (such as pumping large quantities of groundwater) which may result in the deforestation of land, therefore, such impacts are not expected.

Contamination of Soils and Waste Management

There is a possibility of contamination of soils by discharges or leakages of effluents and dangerous substances (such as fuel, oils or paints) generated during the works or by deposit of waste. This is a negative local impact which is likely, and requires the implementation of mitigating measures.

The works campsite installation area is place particularly susceptible to the occurrence of leakages and where may be a temporary storage of waste while it is not removed to its final suitable destination. It is therefore, recommended to the undertaking to implement specific measures of environmental management, including the Emergency and Contingency of Accidents Program in which the measures for prevention of leakage of dangerous substances are systematized as well as the actions to be carried.

The construction process foreseen for the bridge includes the execution of foundation stakes through a method of gathering materials resulting from the drilling (which will include sediments that nay have a certain degree of contamination, besides coming mixed with salted water, discouraging its direct

deposition on the soil), which is conducted to series of tanks where the separation of water and solids is done for controlled depositions.

It is assumed that these solid materials will be deposited in a waterproof area to be located in plots alongside the road or even in the Port expansion area (where it is foreseen the construction of a cel for controlled deposition of drained material from the bay) therefore, with no relevant impacts in terms of soil contamination.

It is foreseen that the road construction will entail more volumes of landfill than excavation. Admitting that the aim will be to maximize the usage during the landfill resulting from the excavations, however, it is not foreseen if the deposition of remaining land may have significant negative impacts.

Still in terms of waste recycling during the construction phase, the vegetal biomass resulting from deforestation of the road side shall be managed in collaboration with the local community who shall value it Impact that may exceed acceptable limits and standards and / or the receiver is moderately sensitive / value it. In any case, no relevant impact is foreseen with this waste.

6.3.2 Operation Phase

Erosion

During this phase, the impact on geology and soils may arise from the erosion of excavation slopes and landfill, as well as from erosion from the discharge points of the drainage system.

It is again important to highlight that the project already prevents the occurrence of this impact, by selecting an alternative to the road design which avoids areas with higher erosion risk rate.

The road drainage project will ensure the routing of running waters and minimize the risk of erosion of slopes. In addition, the project proposes the application of a multifunctional geotextile fabric to protect the slopes, at the landfill slopes and excavations. This fabric has the advantage of acting as anti-erosion from the start soon as applied, which gives an added advantage compared to other methods such as, sprinkling or applying vegetation. It is expected that this method promotes efficiently the establishment of vegetation. Thus, there shall not be the occurrence of significant negative impacts. However, it is important to consider the monitoring of slopes, especially the higher altitude ones and during the first year until the re-vegetation takes place and stabilizes.

In order to minimize the risk of erosion downstream the road water drainage system discharge points, the project already foresees the protection of discharge locations with concrete and gabion coating. These measures will therefore mitigate the occurrence of such impacts, not allowing for the occurrence of significant negative impacts. In any way, these points shall be monitored upon the occurrence of heavy

rainfall, in order to verify whether the protection is being effective or if there is a need for reinforcement.

Contamination of soils resulting from accidents

It should be considered the possibility of transport of dangerous substances and the possibility of accidents of vehicles with possible leakage of dangerous substances and contamination of adjacent soils. This kind of scenario is of low likelihood but may result in significant impacts (see specific section for risk assessment). The Emergency and Contingency of Accidents Program (section 6.6) establishes measures for the mitigation of these impacts.

6.4 Impacts on Oceanography

6.4.1 Construction Phase

The foreseen bridge is destined to cross a waterfront area of the Bay of Nacala and its 840 m of extension shall develop through dry land or over aquatic environment with a maximum depth estimated in 4 meters (high tide).

This introduction is relevant to support the statement that the construction (and the presence of the bridge already built, at the operation phase) is not going to imply any relevant change of physical shape to the topography, the currents, the waves or the tides in the interior of the bay. At the least, these kinds of effects may be limited to an area immediately adjacent and of very small dimension in which the bridge develops on aquatic environment, very close to the margin.

In terms of water quality and the Bay sediments, the construction works are likely to promote some resuspension of these, implying an increase on the turbidity and concentration of contaminants along the water column.

It is however important, to highlight the following aspects:

- Under the EIA scope of the Port of Nacala, the sampling points where more contaminated sediments have been found were more to the North and at a relevant distance from the area where the bridge construction is foreseen;
- The expected construction method for the bridge foresees, as described in section 2.3, the use of cofferdam (waterproof curtain sheet-pilling), aiming at mitigating the negative impacts on the Bay by minimizing the water contamination and the reduction of soil excavations and sediments);
- The solid material resulting from the drilling of stakes will be deposited on land in a controlled way (its discharge on the sea is not foreseen);
- The description of residual currents (that is, resulting from high and ebb tides) in the interior of the Bay points (as described on section 4.5.3) towards the existence of a pattern that allows for the renewal of the bay waters and the consequent dispersion and removal of pollutants.

- There are no fishing areas identified on bay site (waterfront) which shall be crossed by the bridge included on the Access Road to the Port of Nacala.

Base on this assumption we can assume that any resuspension phenomenon of sediments resulting from the construction works will not have significant negative impacts over the bay water quality or activities (such as fishing) related to such quality.

The bay water quality might still be influenced during the construction works by the contaminated downstream that are transported by water lines affluent to the bay, as it was discussed in greater detail on the section related to impact on water resources. In any way, attending to the great volume and transport capacity and natural dilution of the bay waters, it is most likely that any negative effects associated to the contamination may be transported by water lines that drain on the bay and likely affect relatively restricted areas, next to the confluence points.

6.4.2 Operation Phase

As previously mentioned, it is not expected that the presence of the bridge may imply any physical change significant to the topography, the currents, waves or tides in the interior of the bay.

It is unlikely, thus, any relevant change in terms of waste transport. At the least, these types of effects may be limited to an area immediately adjacent and very small in dimension where the bridge passes over water, very close to the margin.

In case of any change in terms of currents and sedimentation pattern, it is expected, concerning that the bridge pillars will be at a protected zone and near the margin (where the currents are currently less intense), that it will be in the sense of currents reduction and consequently increase the tendency to increase sedimentation (in other words the accumulation or sediments and not its erosion and resuspension) in this zone. Considering that this is a less deep zone currently and with no navigation relevance, there shall not be any significant impact.

In a nutshell, it is not expected the occurrence of significant impacts to the physical oceanography during the operation phase.

The water quality may be influenced during the operation phase by the contaminated downstream that may be transported by water lines as a result of traffic accidents where may be leakage of dangerous substances or simply the discharge of drainage waters from the road pavement during rainfall, as it is once more discussed in greater detail on the section related to impact over water resources.

In any way and similarly to what was said on the construction phase, the most likely is that any negative effects associated to the contamination may be transported in the operation phase by water lines that drain at the bay and affect relatively restricted areas next to the confluence points.

6.5 Impacts on Water Resources

6.5.1 Construction Phase

Impacts on the natural drainage network

As mentioned in the chapter - Description of the Project, there are specific solutions planned for cross drainage and for the longitudinal drainage of the road.

Thus, it can be stated that the effects on the natural drainage were taken into account, therefore, no significant negative impacts are expected on the runoff of tributaries.

The installation of hydraulic passageways alters the longitudinal profile of water lines in the sections traversed and, at times, it also alters the original alignment of said water lines, resulting in their artificialization in a particular area, which varies, depending greatly on the construction of the road, as well as on the longitudinal profile on the natural drainage network and the requirement to ensure an appropriate runoff of tributaries.

In the case under assessment, this sort of situations will always have a limited extension, which means the impacts therefrom will be negligible. Similarly, during the construction of hydraulic passageways there will be a temporary modification of the drainage network due to the need for a provisional diversion of water lines. Such impact shall be temporary and have a small impact on the natural drainage, as the runoff of tributaries will be assured.

It should be further noted that earthworks may result in negative impacts in the form of siltation/partial obstruction of the water lines due to the ground displacement associated with erosion resulting from intense rainfall which may occur during the works. This is a local and temporary negative impact, that can be recovered from through the implementation of appropriate mitigation measures.

Longitudinal drainage will ensure the water runs off from the road, being subsequently discharged in the crossing water lines, during intense rainfall periods that cause a short-lived increase in the water flow. These flows discharged into water lines may cause erosion of the ground at the point of discharge. However, in this particular case the small height of the ramp and the smooth topography of the traversed terrain make this a not too relevant scenario.

Impacts on water quality

The main impacts on water quality associated with the construction phase result mainly of the following construction activities:

- Clearing and earthworks;
- Construction of the road drainage pipes;
- Facilities and activities in the site and support facilities;

- Operation of machinery for the execution of the works.

Clearing and earthworks are the chief activities that will expose the soil to erosion factors. Such situations may, therefore, give rise to an increase in the entrainment of solid matters by rainwater and the consequent increase in concentration of suspended solids in surface water traversed by the road plan, particularly during a heavy precipitation spell.

The operation of the site and its ancillary facilities, may also be lead to an increase in solid flow carried by rainwater.

The episodic increase of concentration of suspended solids is a direct negative impact on the quality of surface water. In addition to the water quality aspects, the entrainment of solids may, as mentioned before, result in silting of water lines. However such would be a seasonal effect, partially minimizable and therefore, would not bear a critical impact.

Site activities may generate result in the contamination of water with hydrocarbons, heavy metals, suspended solids and organic matter; which in turn may cause contamination of surface and ground waters, if control measures are not taken in order to monitor the storage conditions and use of hazardous substances and waste, and to direct these effluents to appropriate treatment or recovery systems.

It is, therefore, appropriate, to adopt corrective and preventive measures for the mitigation of these potential impacts, as presented in the chapter on this topic.

The correct implementation of these measures will ensure that the operation and performance of the site does not result in severe or critical impacts on water quality.

During the construction phase, environmental emergencies involving the spillage of hazardous substances into the ground or to a water line, including diesel, gasoline, hydraulic oil and lubricating oil, may occur. The reason for the occurrence of a spillage may be an accidental situation, such as a hydraulic tube rupture on a machine, poor handling of substances, in particular during supply operations or during maintenance operations, or traffic accidents involving project vehicles.

Although the extent of the effect is hard to determine, the occasional occurrence of a spill of hazardous substances could be a negative effect on the quality of surface water and/or groundwater, and may represent a critical impact, depending on the characteristics of the spilled substance, the location where the spillage occurred (particularly if it is in proximity to a water line), and the number of occurrences.

Accordingly, it is recommended that the project include an Emergency and Accident Contingency Program, encompassing systematized measures to prevent the spillage of hazardous substances and providing for the actions to be taken if, in spite of precautionary measures, a spillage occurs.

Conflicts over Water Access

The execution of a large-scale project, such as the one under review, necessarily requires important amounts of water for use on the site, either to support the work or for direct use.

The natural water deposits in the traversed zone are very small and there is also a notable lack of water supply systems. As a result, local communities end up resorting to very poor (in terms of quantity and quality) natural water sources. In the current conditions, it doesn't seems unlikely that the amount of water needed for the project can be obtained locally (or directly in the area covered by the project); as a consequence, the contractor has to mobilize means to source the water elsewhere, probably where there is a supply system that can provide the required flow rates without prejudice to other users (local communities or commercial or industrial activities). It should also be taken into account that, for the production of concrete and for humidifying embankments the water used will have a compatible quality which is not necessarily potable.

Having made these observations, it is noted that no significant impacts are expected in terms of conflicts over the access to water during the construction phase.

6.5.2 Operation phase

Impacts on the natural drainage network

The negative impacts expected to take place during this phase are, essentially, the same as ones that have been identified for the construction phase. The potential remaining negative impacts in the operation phase are those that correspond to permanent changes in watercourses crossed by road, associated with the implementation of hydraulic structures to ensure cross-drainage to the road (restoration of water lines).

Impacts on water quality

The potential impacts associated with operation phase of highways relate to the discharge of pavement drainage waters during rainy periods.

Pavement drainage waters can drag the pollutants accumulated therein, namely: suspended solids, organic matter, heavy metals (copper, zinc, nickel, chromium and iron), and nutrients (nitrogen and phosphorus). Many of the pollutants originate in the pavement material, combustion byproducts, losses in the lubrication system, tyre degradation, shedding of particles of the brakes, corrosion and wear of components of motor vehicles, etc.

There are other pollutants from sources such as air pollution, soil erosion, waste and animals and vegetation, which can be transported from distant areas, by precipitation and the wind, contributing to the pollution of pavement water drainage of highways (Hvitved-Jacobsen Barbosa, 2000).

Among the main factors which affect the pollution of drainage waters of the road pavement, there is intensity and duration of precipitation, the duration of the rainy

period, the volume and characteristics of traffic circulating on the road, the characteristics of land use in the area of development of the road, highway maintenance, the characteristics of the pavement, the air quality in the area in which the road is constructed, the characteristics of pollutants etc. All these factors contribute to a great variability, whether in terms of space, time or of the quality of highway drainage waters.

The concentration of pollutants in the highway drainage waters in rural areas is usually lower than that of highways in urban areas.

The following table shows average values of pollutant concentration in highway drainage waters, obtained in various studies previously carried out in this field.

Table 29: Highway Drainage Water Quality

Parameters	IP4 Portugal TMD = 6000	A61 France TMD = 7000	A81 Germany TMD = 41000	UK	Highway Nigeria TMD = 30000	Highways TMD < 30.000 - USA	Highways TMD > 30.000 - USA
SST (mg/l)	8 - 147	65	137	11 - 105	158 – 284	41	142
BOD5 (mg/l)	-	-	-	8 - 25	19.2 –80.5	-	-
HC (mg/l)	-	0.3	5.5	-	-	-	-
COD (mg/l)	-	60	107	-	-	49	114
Zn (µg/l)	50 - 1462	390	360	20 - 1900	13 – 200	80	329
Pb (µg/l)	1 - 199.5	240	202	10 – 150	3 - 74	80	400
Cu (µg/l)	1 - 54.3	-	97	10 - 120	11 - 48	22	54

TMD-Average Daily Traffic; SST -Total Suspended Solids; COD- Chemical Oxygen Demand; BOD5- Biochemical Oxygen Demand; HC - Hydrocarbons; Cu-Copper; Pb – Lead; Zn - Zinc
Source: Driscoll,1990

The figures relate to studies in Europe, United States of America and a study in Nigeria. The values show the great variability that can exist on the same road and reflects the variability of factors influencing the pollution of drainage waters, highlighting the importance of the level of rainfall.

As regards the road now under assessment, an occurence of a great variability of values is expected, in particular between the dry season and rainy season, with the highest amounts of pollutants to be swept away when the first intense heavy rains occur after prolonged periods without rain.

it is reasonable to assume that the drainage waters of this road (which will have volumes of traffic of the same magnitude of some of the roads referred to in the above table) will have concentrations of pollutants also comparable to those listed above; where such is not expected to represent significant impacts.

The occurrence of traffic accidents involving vehicles transporting dangerous substances (for example fuel tankers) can always take place in a road similar to the one under study, which gives access to an important port area, from/to where these substances have to be transported, and has the potential to cause significant adverse effects on water quality (both on the surface and underground), which, once more, illustrates the importance of an Emergency and Accident Contingency Program. Section 7.7 establishes measures for the mitigation of these impacts.

6.6 Impacts on Air Quality

The methodology followed for the prediction and assessment of impacts on air quality in the operation was as follows:

- Characterization and quantification of emissions associated with vehicular traffic expected for the Nacala port access road and the concentration of pollutants in the air at various distances from the road (in the years: 2017, 2025 and 2035);
- Characterization and quantification of emissions associated with vehicular traffic in the N12 and estimate concentration of pollutants in the air at various distances from the road, either upon implementation of the Nacala port access road project (in the years 2025 and 2035) or in the event of a non-execution of the project (year 2025); with a view to assessing the positive impacts, associated with the project, on air quality around the N12 road.
- The analysis of the results, shall take as criteria for the evaluation of the impacts on air quality, the national legal framework and WHO guidelines on this matter.

6.6.1 Construction Phase

The main impacts on air quality during the construction of the access road to the port of Nacala, result mainly from dust emissions into the atmosphere, with consequent increase of the concentration of particulate matter in ambient air, associated with the activities carried out in the course of the work; including earthworks, as well as transport of materials along the site.

Dust emissions during the course of the work, and the consequent increase in particulate matter, can potentially reach a greater magnitude, particularly when the work is carried out in a dry season; especially PM_{10} and $PM_{2.5}$ fractions, given its importance in terms of ambient air quality.

Although not having the same importance in terms of impacts on air quality, the emission of air pollutants from combustion engines of various machinery that will be used in the work (mainly diesel engines) such as carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs) and particulate matter (PM_{10} and $PM_{2,.5}$) bears mentioning.

If measures are not taken to minimize the emission of dust during works, there will be a negative impact on air quality, with particular impact on residential areas near

the highway project. The deposition of dust in residential areas is likely to create discomfort.

The amount of dust emitted, depends on several factors, among which, the characteristics of the soil (soil type and particle size), the soil moisture content, which depends on the weather (rainfall) and the possible use of emission control measures such as spraying dust and circulation areas with water , erosive characteristics of the wind , volume of land, number of vehicles operating in a particular site, distances travelled, speed of movement of vehicles, etc.

Emission factors compiled by the North American Agency for the Environment (US EPA Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors, 5th Ed) AP-42 (section 13.2.2, Unpaved roads; section 13.2.3, Miscellaneous Sources, Heavy Construction Operations) point to the following values:

- Movement of heavy vehicles (40 t) on ground a ground made up of 20% thin granules: 2 kg (PM_{10})/km. vehicle;
- Scraper - during removal of topsoil: 5 kg (PM_{10})/km. vehicle;
- Earthwors with Bulldozer: 0.8 kg (PM_{10})/hora (10% moisture in the soil).

The wind erosion soil areas discovered, and stacks of access land and materials will not assume special significance given that the frequency of occurrence of strong winds with a speed exceeding 10 m/s (36 km/h) is very low in the study area.

Particle dispersion in the atmosphere depends on essentially physical nature processes such as advection and turbulent diffusion. Gravimetric deposition (function of particle size) and the wet deposition as well as the presence of obstacles (vegetation) are factors influencing the dispersion of particles.

Depending on the wind speed, most of the larger particles (between 30 and 100 µm >) fall over the first hundred meters. Small size, particles PM_{10} and $PM_{2,\ 5}$ with deposition velocities much smaller (0.3 cm/s for < PM10 and < 0.03 cm/s for PM2, .5), are more likely to be affected by atmospheric turbulence, and can be transported over long distances such as kilometers, depending on the speed of the wind. For small size particles the concentration decrease according to the distance to the source depends essentially on the mechanisms of dispersion into the atmosphere.

Several studies refer to a quick reduction in the concentration of PM10 depending on the distance, also depending on speed and atmospheric turbulence, which points to a reduction of about 90% at 50 to 100 metres from an unpaved road. It should be noted, however, that even with a 90% reduction, the concentration value of PM10 (µg/m3, 1 hour) at 100 metres may still be in hundreds, depending on the characteristics of the soil and heavy traffic, in addition to the windspeed.

The impacts on air quality associated with the emission of dust in the vicinity of construction areas (involving the movement of land and the circulation of vehicles) assume greater importance at distances of 100m from the source, considering larger

particles (> 30 µm) and small size particles. Dust deposition and the occurrence of high concentrations of PM10 are typically within this distance. For distances greater than 400 meters, the negative impacts on air quality will have little meaning (IAQM, 2016).

The access road to the port of Nacala is being constructed in the proximity of dwellings located near the salt pan (at distances starting from 65 meters) and close to the junction with the R702 (at distances starting from 70 meters). The construction of the access road to the port of Nacala could thus be responsible for negative impacts on air quality along these dwellings and may reach a high magnitude up to distances of approximately 100 meters from the road.

In this sense, measures should be taken to control dust emission, in the proximity of dwellings, in particular by spraying water on the movement paths of vehicles and earth-moving areas, in particular when there is the prolonged absence of rainfall.

The impacts associated with the emission of dust during the construction phase are characterized by being suspended on air, being temporary and reversible.

It may, therefore, be concluded that the expected increase in the concentration of particulate matter in ambient air, which may be of high magnitude in the most unfavorable conditions described above, and potentially cause discomfort to neighboring populations, taking into account the temporary nature of the Construction, and provided that appropriate mitigation measures are adopted, there is no prospect of significant negative impacts.

There is a possibility that the work involving the aggregation of sediments in the initial section of the road, including the drilling of the stakes for the foundations of the bridge can cause the release of odours, given the occurrence of mud. These odours may potentially be irritating, within limited to a few tens of meters but the absence of sensitive receivers (including housing areas) in the area means that it is a minor impact.

6.6.2 Operation phase

Methodology

Air quality impacts during the operation phase of the highway are of a permanent nature, and will be associated with the emission of air pollutants generated by the movement of motor vehicles.

The main air pollutants emitted by motor traffic are primarily associated with the operation of internal combustion engines (gasoline combustion, diesel or gas) and the evaporation of fuel in the engine and deposit. There is also the release of particles associated with the wear of friction materials, in particular due to braking and friction from the tyres in contact with the pavement, even if in reduced quantities. These particles are mostly deposited on the pavement of the road.

The pollutants released by the combustion processes of vehicle engines are: carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxides (NO_x), particulate matter (PM), that the PM_{10} and $PM_{2,5}$ fraction, hydrocarbons (HC), sulfur dioxide (SO_2) and heavy metals.

The quantity issued from various pollutants are variable, depending on numerous factors, such as the type and composition of the used fuel (gasoline, diesel or gas), the type of vehicles (power), the age and state of conservation, the speed of movement and the directions for use of the vehicle, as well as the characteristics of the road, (inclination) and condition of the pavement.

The concentrations of several pollutants in the atmosphere usually depend on the quantities emitted. However, this is also influenced by a variety of phenomena that occur after the emissions to the atmosphere, particularly dispersal mechanisms (wind speed, turbulence), and deposition and washing of the pollutants as well as natural degradation (chemical degradation of pollutants).

For the assessment of potential impacts on air quality, an ambient air pollutant concentrations estimate was made for the following pollutants: NO_2, SO_2, PM10 and PM2,5; during the operation phase, simulating the dispersion in the atmosphere through mathematical modeling.

In generic terms the methodology adopted was as follows:

- Determination of emission factors of pollutants NO_x, SO_2, PM10 and PM2,5 using COPERT4, 11.4 version, based on the structure of the vehicle fleet (age by type of vehicle) traffic forecasts made in the framework of the Nacala port access road project and the emission standards applicable to different vehicles, depending on their age (pre-Euro , Euro 1 to 6);
- Prediction of concentrations of air pollutants at different distances from the access road to the port of Nacala and the different distances from the N12; simulating the dispersion in the atmosphere through CALINE-4 model (Caltrans, 1989, Caltrans, 1998) of air pollutant dispersion from online sources, based on the traffic study carried out within the project under review, taking into account the following scenarios:
  - Project: simulations for the year 2025 and 2035
  - N12: simulations for the year 2025 with project; year 2025 with no project and 2035 with project;
- Assessment of the significance of impacts on air quality, taking into account the concentrations provided for and the limits set out in applicable national legislation for the analysed pollutants and the guiding values for air quality stipulated by the WHO.

Air Pollutants Dispersion Model

For the simulation of air pollutants dispersion model, BreezeRoads GIS Pro v5.1.0 program was used, developed by TrinityConsultants, which incorporates the Gaussian dispersion model of CALINE4 line sources (developed in the USA, by the California Department of Transportation, Caltrans, 1989, whose revised version is dated 1998), in addition to the, CAL3QHC and CAL3QHCR models.

BreezeRoads program, in addition to having an interface which allows for a greater input and output capacity of data and SIG capacity, it also allows for the amplification of modeling capacities of the CALINE4 and other models, particularly with respect to the number and extension of roads and number of receivers that can be modeled.

With the BreezeRoads and the CALINE4 module, concentrations of NO_2 pollutants (an hour on average) and PM10 e PM2,5 (average of 24 hours) were calculated in ambient air at several distances from the access road to the Nacala Port and N12.

To run the model, the following entry data must be in place:

- Project and N12 implementation and track width;
- Establishment of the receivers at various distances from the entry at a 300 meter track;
- Emission factors for each pollutant (g/vehi./hour);
- Traffic volume (average hourly traffic - TMH);
- Meteorological data (wind direction and speed; average air temperature, Pasquill-Gifford atmospheric stability classes and the height of the mixing layer).

In order to assess the most adverse situation, traffic values corresponding to Project section and the N12 section were considered, in which the estimated values for the traffic study are higher.

Emission factors estimate (NOx, PM10 and PM2,5)

NOx, PM10 and PM2,5 average emission factors estimate, PM10 e PM2,5 was performed based on the pollutant emission factors by vehicle, calculated by the COPERT 4 reference program (Computer programme to calculate emissions from road transport, version 11.3 - June 2015) from the European Environment Agency.

The emission factors associated with each type of vehicle (light passenger vehicles, heavy goods vehicle, and heavy-duty passenger vehicles) vary according to the cubic capacity, fuel, running speed and vehicle age, associated with a certain technology subject to a particular pollutant emission standard.

Based on these emission factors, an average emission factor determined per vehicle and per kilometer to entry with the CALINE 4 model. For determining the average emission factors, information on the composition of the existing vehicle fleet is needed, namely type of vehicles, fuel used and age of existing vehicles, in order to

get the percentage distribution of existing fleet based on the European standards on the restrictions of pollutant emissions by motor vehicles.

Information on the composition of existing vehicles in Mozambique is scarce, thus, a graduation work by Natália Isabel Magaia developed at the college of Engineering from the Eduardo Mondlane University, under the supervision of Dr. Eng. Jorge Nhambiu, as well as a fieldwork.

The study referred to shows the distribution of the car park of Maputo by type of vehicle and the European emission standard, and the distribution for the Nacala region was extrapolated based on the field work.

The following Table shows the distribution of vehicles into the categories and European standards used for the calculation of the emission factors.

Table 30: Distribution of vehicles into the categories and European Emissions Standards

	European Emission Standard								
Category	**Pre ECE (Gasolina) Convencional (Diesel)**	**ECE 15/00-01**	**ECE 15/02**	**ECE 15/03**	**ECE 15/04**	**EURO 1**	**EURO 2**	**EURO 3**	**EURO 4**
Cars Gasoline	4.2%	3.4%	1.1%	3.4%	26.5%	26.3%	23.2%	9.1%	2.9%
Cars Diesel	11.3%	-	-	-	-	40.7%	22.5%	23.1%	2.4%
Cars Goods	30.1%	-	-	-	-	48.2%	12.0%	4.8%	4.8%
Heavy	50.3%	-	-	-	-	29.5%	8.1%	8.1%	4%
Heavy Goods	35.7%	-	-	-	-	35.7%	19.4%	6.2%	3.1%

For the calculation of the emission factors, an average running speed of 100 km/h on the access road to the Nacala Port was considered and 70 km/h for the N12. Heavy-duty percentage was considered in line with the traffic study.

Average emission factors per vehicle (weighted average) were calculated considering the distribution of existing vehicles according to the European emission standards, traffic study, namely the percentage of heavy-duty and average running speed, and the COPERT 4 program for the calculation of the emission factors by category of vehicle and emission standard.

The following Table shows the emission factors calculated taking into account the scenarios considered for the project under study and for N12.

Table 31: Mean emission factors

Road	Scenario	Emision Factors (g/km/veículo)		
		NOx	PM_{10}	$PM_{2,5}$
Project	2025	4,3	0,14	0,13
	2035	4,7	0,15	0,14
N12	2025 com projecto	3,6	0,15	0,13
	2025 sem projecto	4,1	0,17	0,14
	2035	3,2	0,13	0,11

Meteorological scenarios

The meteorological conditions used for the pollutant dispersion simulation is shown in the table below. Adverse scenarios to pollutants dispersion were considered to calculate the hourly concentrations of NOx and average daily concentrations of PM10 and PM2,5, thus, allowing for the estimation of the maximum hourly value for NOx and the maximum daily value for PM10 and PM2,5.

The adverse conditions to pollutants dispersion are normally associated with situations of high atmospheric stability, which are only noticed in certain situations, especially at night, before sunrise, under clear sky and weak wind conditions.

For a simulation of daily average concentrations of PM10, a differentiated meteorological scenario was considered between the day and night periods, since they constitute two different periods as far as pollutants dispersion is concerned.

The direction of the most frequent winds in Nacala was considered, which blow south-southeast, which results in higher pollutants concentration values given the North/South alignment of both project and the N12. The meteorological conditions used for the simulation of pollutants dispersion are shown in the Table below.

Table 32: Meteorological scenarios considered for modeling pollutants dispersion

Meteorological parameters	**NO_2**	PM_{10} and $PM_{2,5}$
Predominant Wind Direction	South-Southeast	South-Southeast
Wind Speed (m/s)	1	Day: 2 Night: 1
Wind Variability (º)	5	5
Stability Class	F	Day: D Night: F Night: E
Height of Mixing Layer (m)	500	Day: 1000 Night: 500

Result Analysis and Impact Assessment

The Table below shows the concentration values of nitrogen dioxide (NO_2) - (hourly maximum values) and particulate matter concentration values (PM10 and PM2,5) - (daily average) at several Project and N12 distances found through simulations performed using the CALINE4 model, taking into account the scenarios and meteorological conditions considered.

Table 33: Hourly maximum concentration of NO2

Nitreogen Dioxide (NO_2) µg/m^3					
Distância to the road	**Project**		**N12**		
	2025	**2035**	**2025 without project**	**2025 with project**	**2035 with project**
10	38.5	63.5	41.8	18.8	29.2
20	34.8	57.2	30.0	13.7	21.0
30	32.3	53.0	24.0	11.1	16.9
40	27.3	44.6	20.2	9.3	14.2
50	18.1	29.5	17.4	8.0	12.2
100	7.8	12.6	11.2	5.2	7.8
150	6.3	10.2	8.4	3.8	5.9
200	5.0	8.0	6.7	3.0	4.7
300	2.8	4.6	4.6	2.0	3.2

Table 34: Daily mean concentrations of PM10

Partículas < 10 µm (PM_{10}) µg/m^3					
Distance to the road	**Project**		**N12**		
	2025	**2035**	**2025 without project**	**2025 with project**	**2035 with project**
10	8.4	14.4	12.7	5.9	8.9
20	7.4	12.8	8.8	4.2	6.2
30	6.7	11.7	7.0	3.3	4.9
40	5.5	9.7	5.9	2.8	4.1
50	3.5	6.3	5.0	2.4	3.5
100	1.1	2.2	3.0	1.4	2.1
150	0.9	1.8	2.1	1.0	1.5
200	0.7	1.4	1.6	0.7	1.1
300	0.4	0.7	1.0	0.5	0.7

Table 35: Hourly mean concentrations of PM2,5

Partículas < 2,5 µm ($PM_{2,5}$) µg/m^3					
Distance to the road	**Project**		**N12**		
	2025	**2035**	**2025 without project**	**2025 with project**	**2035 with project**
10	8.0	13.7	10.8	5.0	7.6
20	7.0	12.2	7.5	3.6	5.3
30	6.4	11.1	6.0	2.8	4.2
40	5.2	9.2	5.0	2.4	3.5
50	3.3	6.0	4.3	2.0	3.0
100	1.0	2.1	2.6	1.2	1.8
150	0.9	1.7	1.8	0.9	1.3
200	0.7	1.3	1.4	0.6	0.9
300	0.4	0.7	0.9	0.4	0.6

Based on the analysis of the Tables, one may conclude that the concentration values of NO_2, PM10 and PM2, 5 from the modeling resulting from traffic emissions associated with the access road Project to the Nacala Port and to the N12, for any of the considered scenarios, are below the national air quality standards for NO_2 (190 µg/m^3) and below the limits of the WHO for PM10 (50 µg/m^3) and PM2,5 (25 µg/m^3).

However, the access road project to the Nacala Port shall be responsible for an increase in the concentrations of air pollutants, which will promptly have an expressive magnitude, affecting particularly the residential areas in the vicinities.

It should be noted, however, that the simulated values refer to the most adverse situations and, for this reason, do not represent the average pollutant concentrations. On the other hand, the natural and renewed existing vehicles over the years were not considered, thus, the simulated values for 2025 and 2035 will increase. The magnitude of the impact on average air quality will be lower.

In this context, it can be concluded that air pollutant emissions associated with the Project will represent a direct and permanent negative impact on air quality, with a relevant magnitude only in specific circumstances (most adverse situations to pollutants dispersion, which will have a reduced frequency of occurrence). Altogether, these impacts are considered not significant since the legally established values or the standard guidelines of the WHO are not exceeded.

As for the sensitive receivers located in the vicinities of the N12, it is found that the Nacala Port access Project will have a positive impact on air quality, resulting from the traffic transfer from N12 to the Nacala Port access road.

6.7 Noise and Vibrations

From the ambient noise point of view, the most sensitive areas are the residential, school, hospital and leisure or any other areas, which require low noise levels by nature. The World Health Organization (WHO) and the IFC (International Finance Corporation) stipulate that the exterior ambient noise during day period in the vicinity of residential buildings and schools must be below 55 dB(A), LAeq,day, and 45 dB(A), LAeq for night period.

The assessment of the importance of the impacts on the sound environment, resulting from the Project, was carried out based on the estimation of noise levels for both the construction and the operation stages, using the limits defined by the World Health Organization (WHO) as assessment criteria.

As for the construction of road infrastructure, vibrations may be caused by the earthwork and compaction of pavement layers needed to ensure work quality and roads longer lifespan.

The vibrations caused by the traffic on current road construction under moderate maintenance conditions are typically reduced and unlikely to cause impacts on the buildings and humans in the vicinity of these roads (the existence of a protection lane just like the planned lane for this road is enough for preventing impacts of this kind).

6.7.1 Construction Stage

The construction stage shall include, as already mentioned, activities that will likely cause high levels of noise in the vicinities of the construction sites. In general, operations resulting in high noise emissions, either at the level of the construction yards or construction sites are as follows:

- Earth movement, with the operation and circulation of tracked excavators, loading shovels, scrapers, dumpers, and graders;
- Circulation of heavy-duty vehicles (earth and construction materials) on the access roads to the construction site;
- Operation of equipment and machinery used in the construction for the various road elements (equipment for the execution of piles, track mixers, concrete pumps, pavers, compacting cylinders, pneumatic hammers).

The noise made by the heavy equipment, such as tracked excavators, excavators, compacting cylinders, etc., in certain construction operations, or the use of pneumatic hammers will result in high levels.

Typical noise levels for civil construction equipment are between 75 dB(A) – 85 dB(A) at a distance of about 10 meters.

The values vary based on the dimension/capacity of the equipment and operation technology. During the construction works, it is found, on the one hand, that not all the operations are continuous and, on the other hand, there is a significant variation

of sound levels at a certain area, due to the handling of mobile equipment. However, the earth movement stage implies the operation of heavy equipment, practically continuously during this stage.

The equipment radiate spherical sound waves, thus, the decay of sound energy is inversely proportional to the square of the distance, in other words, it reduces 6 dB for the double of the distance.

Considering the simultaneous operation of two equipment at a distance of 20 meters from one another, and the noise caused by each being 80 dB(A) at a distance of 10 meters, a noise level of LAeq of 69 dB(A) is found at a distance of 50 meters from the construction site.

At a distance of 100 meters, the values will be 63 dB(A). From the 250 meters, the values will be below 55 dB(A). At a distance of 500 meters, the values will be below 45 dB(A), considering the effects of dispersion and absorption in the atmosphere.

The calculated values are with reference to open space propagation (line of site), and sound energy can be expected, namely due to soil absorption and because of obstacles to sound wave propagation.

Thus, it is considered that the noise made during some construction operations, namely in the stages of earth movement, may result in a sensitive temporary increase of ambient noise levels in the vicinities of the construction site.

As mentioned in the description of the reference situation, the houses in the vicinities of the road at km 3+250 (45 m away from the nearest houses) and km 10+300, near the intersection with the R702 (70 m from the nearest houses). Considering the distance between the road and these residential areas, noise levels above 65dB(A) can be expected during the periods of using noisy equipment in the vicinities of the houses, namely during the earth movement stage and some road construction stages.

Thus, during the road construction, direct negative impact is likely to happen, sometimes, with high magnitude, around the sound environment of the nearest residences to the road, which may be significant, unless minimization measures are adopted, namely the limitation of works periods to daytime periods between 8:00AM to 8:00PM at a distance of up to 500 meters from the residences.

The circulation of trucks for transporting earth and materials at the main access roads to the construction site (N12 and R702) may result in an increase in noise levels, around the road axles, when passing. Thus, circulation of heavy vehicles on these roads, with residences in the vicinities, may constitute a source of additional disturbance on the sound environment of these residential areas.

Considering the current traffic in these roads, support transport vehicles to the construction site are not expected to contribute with significant increase to the current noise levels in these roads. The magnitude of the impact will be reduced,

since the increase of noise levels shall be way below 3 dB(A) (order of magnitude expected in situations of double traffic).

As mentioned earlier, vibrations may be caused by the earth movement works and compaction of pavement layers.

These vibrations may be noticed from tens of meters away from the sites were they are originated, depending, among other factors, on the geology – the propagation of vibrations is more intense with larger distances at the superficial presence of rocky substrates than in sandy soils, for example. In the specific conditions of the road in question, and considering that there are few residences in the immediate vicinities of the area, induced vibration impacts that can be expected during the construction will be, in general, less significant.

However, in situations in which the (scarce) residences are much closer adverse effects may occur, especially considering that these residences are precarious and, thus, fragile. This aspect shall be taken into account for the environmental and social planning and management of construction works.

6.7.2 Operation Stage

In the operation stage, the expected negative impacts are associated with the noise made by the traffic of the Nacala Port access road.

Positive sound environment impacts are also expected in the surrounding areas to the current N12 and R702 due to the likely traffic reduction in these roads given the new access road to the Port.

Relevant impacts associated with vibrations made by the traffic in the new road are not expected, thus, this subject will not be developed in the new sections.

Methodology

Road traffic noise is produced by the circulation of vehicles. The number of vehicles by time unit (average traffic) is a very important factor in the generation of noise, but there are other factors such as the type of vehicle, average circulation speed, geometry of the road, unevenness between the road and the surrounding soil, as well as the characteristics of the floor and the land.

The assessment of the main impacts on the sound environment associated with the project in question was carried out based on the estimated levels of road traffic noise at the access road to the port and existing roads (N12 and R702).

The road traffic noise study was carried out using the modeling software for the emission and propagation of noise - CadnaA (developed by the German company DatakustikGmbH) using the French calculation method - NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB) publish in the French norm - XPS 31-133.

The CadnaA model consider the following as input data: all the geometrical parameters influencing the acoustic propagation (topography and nature of the

terrain, geometry of the roads (cross-sectional and longitudinal profile with the consideration of the landfills, excavations and viaducts), buildings, and natural and artificial barriers (walls and other obstacles to sound propagation); meteorological parameters (wind); and the characterization of sound sources (nr. of vehicles/hour in the considered reference periods (daytime and night), % of heavy vehicles, average speed and type of pavement).

The model allows for the preparation of noise maps, represented by isophonic lines, from the estimation of sound levels from receiving points defined by a mesh of points in a pre-defined calculation area.

For the current study, a regular estimation mesh was defined for the receiving points, with 5 m by 5 m, at a 2 m height from the ground.

For preparing the noise maps and later impact assessment, estimation areas of the vicinity of the Project near the residential areas were considered. Thus, the following estimation areas were defined: Nacala Port (identified as Area 1); km 3+250, the saline area (Area 2); and km 10+300, at the intersection with the R702 (Area 3). For the Project positive impact assessment in the existing residential areas along the N12 and R702 an estimation area was defined at the intersection of N12 with the R702 (Area 4).

For the estimation of noise levels and preparation of noise maps, the following scenarios were considered, which were defined based on the traffic study developed in the context of the current project:

- Current situation – current traffic at N12 and R702 (Area 1, Area 3 e Area 4);
- Future situation with the project-2017 (Area 2 and Area 3);
- Future situation with the project -2025 (Area 1, Area 2, Area 3 and Area 4);
- Future situation with the project -2035 (Zona 1, Zona 2, Zona 3 e Zona 4);

Future situation without the project – traffic in 2025 at N12 and R702 (Area 1, Area 3 and Area 4)

Figure 40 : Impact assessment areas in the noise descriptor

Input and parameterization data of the acoustic model

Altimetry and implementation of the Nacala port access road project

The preparation of noise maps requires data on the altimetry of the terrain, including contour lines and/or dimensional points. From this data, the simulation program generates a digital terrain model (DTM). The terrain elevation data was obtained through the CAD drawing of the Nacala port access road project.

The information pertaining to the transverse and longitudinal profile of the project was obtained from a project log and a 'kml' mapping the project area on Google Earth. The transverse profile has been determined to be 2 x 2 circulation routes.

Buildings and other obstacles

The data on the buildings and other construction elements (such as walls), was obtained by aerial photography from Google Earth. In order to build the a #D model

of the area, an average height was assigned to each type of building: 3 meters for residential buildings and 6 metres for other buildings and industrial structures.

Traffic

Traffic data used for modelling noise levels are described in section 2.3.3.

The vehicular speed considered were the speeds indicated in the traffic study:

- 100 km/hour for the Nacala port access road project (project speed) and it was considered to be 90 km/h for heavy vehicles;
- 80 km/h for the roads N12 and R702 and 70 km/h for heavy vehicles.

All of the above considering a conventional asphalt pavement without sound absorption characteristics.

Calculation Parameters

The calculation of the noise maps was made from the insertion of a grid with equidistant points. The model calculates noise levels for each of the points by adding the inputs from all noise sources considered, also taking into account the propagation paths and the attenuations, in accordance with the guidelines of the French calculation method "NMPB Routes 1996" (road traffic).

For the calculation of noise maps a regular calculation grid was set, with receptive points 5m by 5m to 2m tall.

Acoustic modelling results and impacts assessment

The modeling of road traffic noise levels using the CadnaA software was carried out taking into account the data, assumptions and scenarios described above.

The noise indicator used was Laeq - expressed in dB (A), with values calculated for daytime (7:00 am to 10:00 pm) and for the night time (10:00 pm to 7:00 am), in accordance with World Health Organization (WHO) and IFC (International Finance Corporation) guidelines.

Based on the modeling , noise maps were designed detailing the distribution of sound levels through isophonic curves and areas bounded by them, to which a certain class of LAeq values expressed in dB (A) corresponds.

Annex 2 shows the noise maps corresponding to the calculations carried out in each of the Areas considered for modeling (areas 1 to 4) considering each of the scenarios described above.

The analysis of noise maps from Area 1, where the access road to the port of Nacala becomes a viaduct, in relative proximity to Nacala, the road will have no major negative impacts for the dwellings of Nacala in any reference year. On the contrary, the noise maps clearly show positive impacts in the sound environment of Nacala,

associated with the transfer of traffic from the N12 to the new access road to the port.

The following figure shows a 3D image of Area 1.

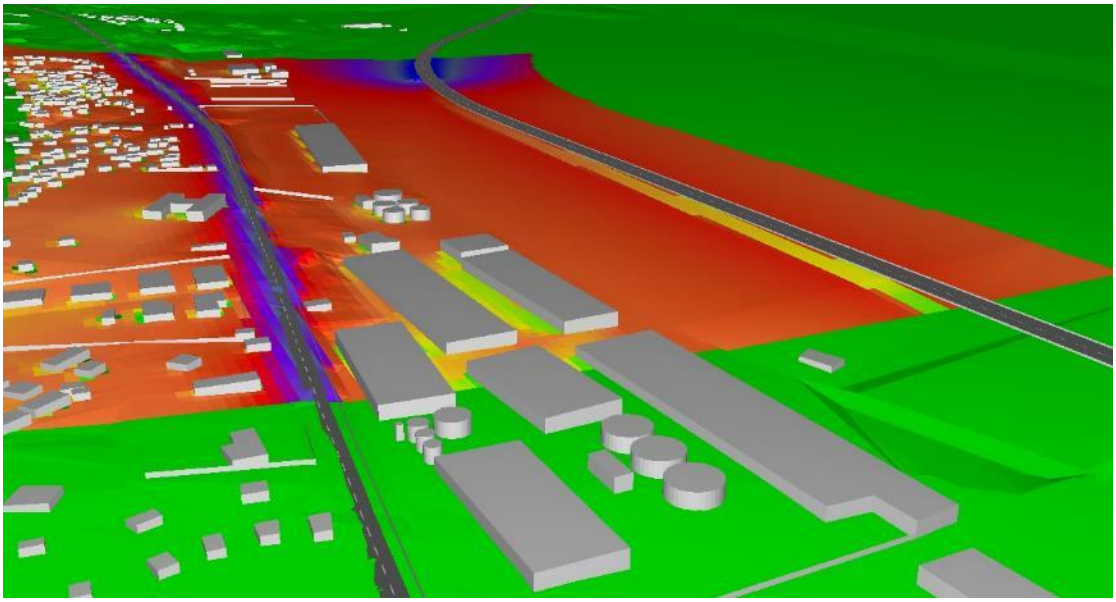


Figure 41 : North-South View in 3D - Area 1 (year 2025, daytime)

As regards Area 2, were the road project is carried out quite near a residential area, the road will have a negative impact on the sound environment of the area, starting from the very beginning of the works. The predicted values for the year 2017, for the homes closest to the project exceed the guide values stipulated by the WHO (LAeq > 55 DB(a) during the day and LAeq > 45 dB (A). The magnitude of the impact will be higher for dwellings along the road and will be increased over the years due to the expected growth in the volume of traffic. the noise level expected for the year of commencement of operation of the project is already likely to induce high degrees of discomfort , as it is a quiet residential area, although it will not exceed the value of 60 DB(a) during the day and less than 55 DB(a) at night time.

The impact of the road will be negative, constant, high and potentially significant .

The following figure shows a 3D image of the Area 2.

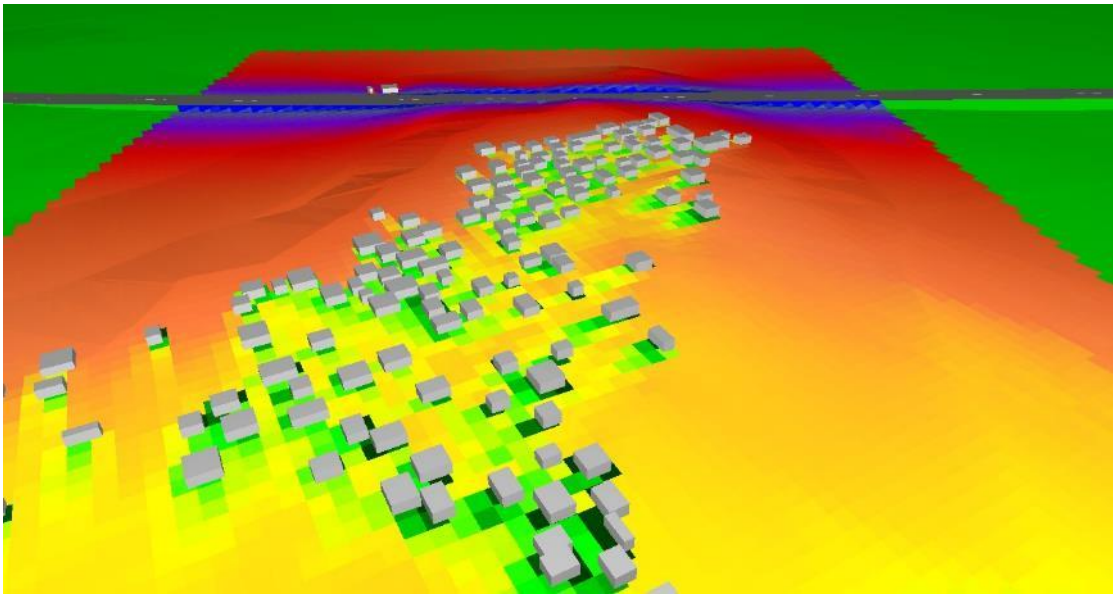


Figure 42 : East-West Views in 3D; Area 2 (year 2017, daytime)

Area 3 corresponds to the area where the access road to the port of Nacala intersects with the R702 and has a residential area located along its segment. At present the noise levels (LAeq) for the homes closest to the R702 already exceed 55 DB(a) during the day and 45 dB (A) at night.

With regard to dwellings near the R702 and away from the access road to the port of Nacala, the impacts associated with the project will be positive although small. High noise levels at which these dwellings shall always be associated with the traffic in the R702. Regardless of the project these homes will always be subject to noise levels exceeding 55 DB(a) during the day and 45 DB(a) at night, with a possibility of an increase in the noise level as traffic on the R702 grows.

In relation to the dwellings that are away from the R702 and closest to the access road to the port of Nacala, an increase in noise levels associated with the project is expected.

In the year of commencement of operations, the noise levels during the day will go from 50 dB (A) to 55 dB (A). During night period, noise levels will reach slightly higher values, from 45 dB (A) to values exceeding 50 dB (A); which exceeds WHO guide values for the night time. With the increase of traffic envisaged for 2025, noise will exceed the values stipulated by the WHO and are already likely to induce discomfort, despite not exceeding the value of 60 DB(a) during the day and less than 55 DB(a) at night time. With the values of the year 2035 traffic noise levels will be above 60 DB(a) during the day and above 55 DB(a) at night time.

It should be noted, however, that noise levels along these homes will suffer increases even without the project as, regardless of the execution of works, there

will be an increase of traffic on the R702. The magnitude of the project's impact in these dwellings is thus relatively low.

The impact of the project will be negative, constant, of relatively small but potentially significant magnitude (since it will further contribute to exceed the guide values stipulated by the WHO.

The following figure shows a 3D image of Area 3.

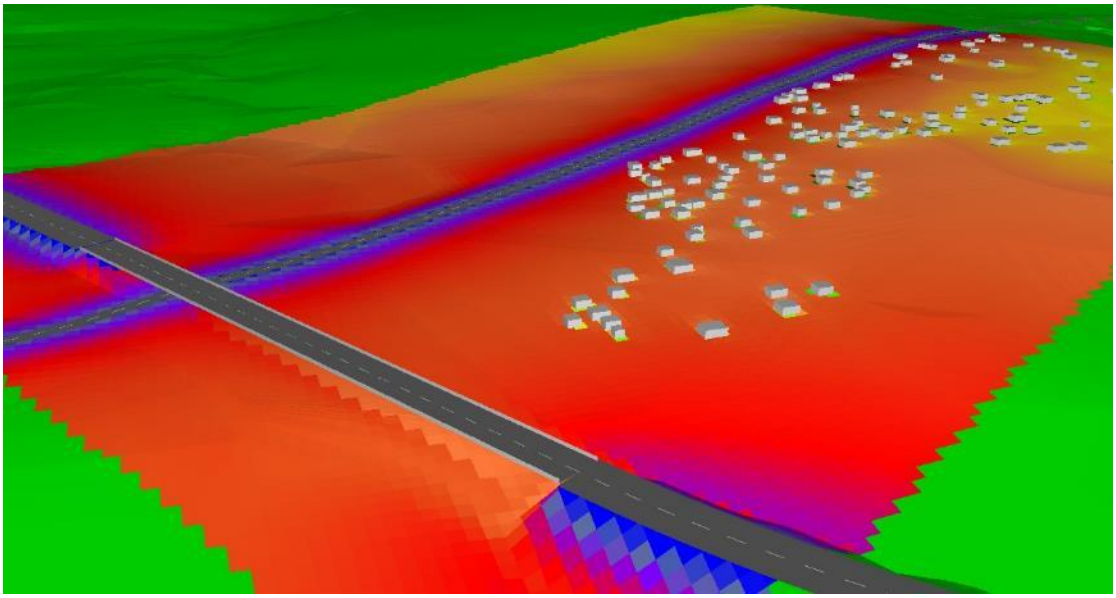


Figure 43 : East-West Views in 3D; Area 3 (year 2017, daytime)

Area 4 aims to represent the impacts of the project to the housing areas along the N12 and R702 that currently constitute the preferential access to the port of Nacala.

The analysis of noise maps shows that the project in question will have a very positive impact, medium to high magnitude, in the soundscape of dwellings located along the N12 and R702. It should be noted however that, despite the positive impact, the nearest dwellings located along the N12 and R702 will continue to be subject to levels of noise (LAeq) exceeding the guide values stipulated by the WHO and that the tendency for noise levels will be to increase, regardless of the implementation of the project.

The impact of the project will be positive, constant, and medium to high magnitude.

The following figure shows a 3D image of Area 4.

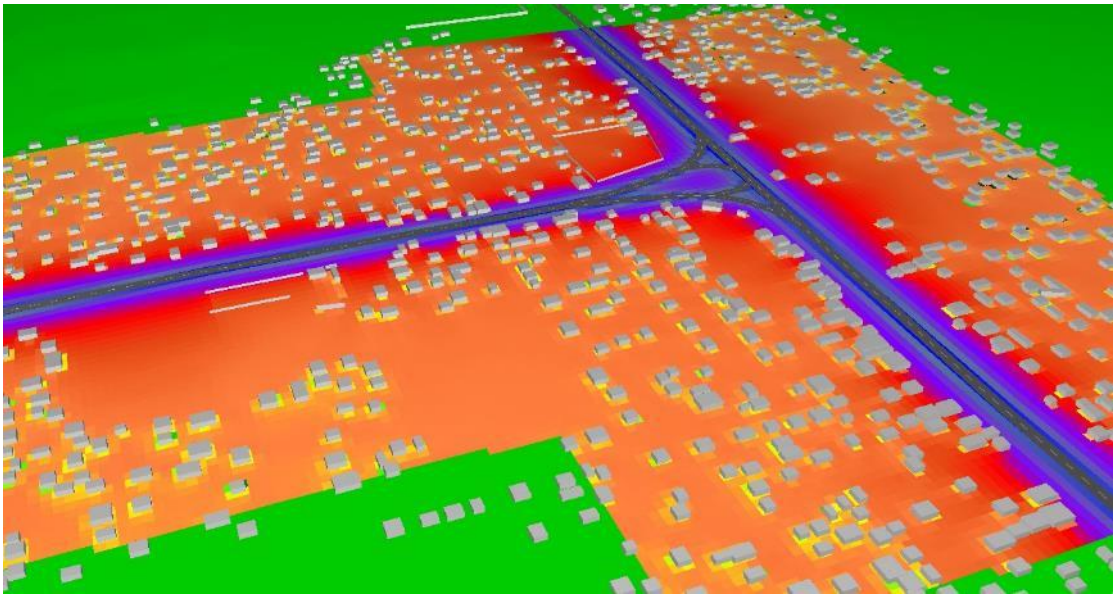


Figure 44 : South-North View in 3D; Area 4 (current situation, daytime)

In view of the above, and taking into account the predicted values presented on the noise maps, it is concluded that the access to the port of Nacala will be responsible for a negative impact, potentially significant and permanent in the sound environment of the dwellings located at km 3+25 and 10 km+300, where the expected LAeq indicator values for the daytime period and for night time exceed the guide values stipulated by the WHO, in particular when the traffic volume near the values expected for 2025.

Taking into account the uncertainty commonly associated with forecasting models, including the volume of traffic, it is recommended the implementation of Noise Level Monitoring Program at the homes located closest to the access road to the port of Nacala, right from the beginning of project operations, to allow competence to be assessed, taking into account the evolution of traffic values and the need to implement protective measures.

6.8 Impacts on Marine and Coastal Ecosystems

The area of influence of the project, does not cover any biodiversity conservation area legally established, but is integrated in an area of high value to the coastal and marine biodiversity, important in terms of the East African Marine Ecoregion. This classification is due to the presence of habitats of great importance for biodiversity, such as coral reefs, seagrass and mangroves, as well as by the presence of species with conservation status, with emphasis on marine mammals and sea turtles.

Thus, the indirect influence of the project area has some sensitivity in terms of marine and coastal biodiversity, which should be duly considered.

The access to the port of Nacala, on the initial section (at about 900 m), develops into an overpass over the Bay of Nacala and coastal strip, characterized by a sandy/muddy beach and a small patch of mangrove, both already with some level of degradation. From km 0 + 900 the road develops into an embankment, less than 100 meters from the high tide line, passing through areas relatively modified, probably formerly occupied by mangroves, particularly in the case of the salt pans located in the proximity of the road design between km 2+700 and 3+700. The fact that the habitats covered by the project are already quite modified will reduce the magnitude and significance of potential negative impacts in the area of direct influence.

6.8.1 Construction Phase

The construction of the overpass of the initial section of the access to the port of Nacala will interfere directly and indirectly on marine and coastal ecosystems and may cause the following negative impacts:

Disturbance of benthic and tectonics organisms, due to the deterioration in the quality of sea water as a result of the re-suspension of sediments. Even with the adoption of the expected construction processes, which reflect the objective of minimizing this type of phenomena, it must be considered that for certain periods of the work there might be an increase in water turbidity, dissolved oxygen reduction and release of nutrients and contaminants to the water column. This negative impact may affect biodiversity (mainly benthic organisms) in a restricted area adjacent to the work areas; it is not expected that a plume of contamination that, with the conditions of carriage and dilution in the bay, is likely to cause relevant effects in outlying areas may occur.

This impact can be thus considered little to medium, considering that the feasibility study already provided for it in the construction processes, which should be properly implemented.

Disturbance of fauna species present on the beach and surrounding areas (birds and invertebrates), as well as aquatic species (primarily fish and invertebrates), during the work, due to the movement of vehicles and machinery and consequent emission of noise and dust, in addition to trampling. This will be a temporary impact, of low magnitude and little significance, as it is an area already upset; but should, however, be minimized by limiting the work area to what is strictly necessary.

Impact on the mangrove patch due to the cutting of mangrove trees or contamination, during the construction of the overpass and embankment. This is a small patch of mangrove already disturbed but which is, however, relevant and therefore, the effects on it constitute a moderately significant impact that, in the face of the planned path cannot be avoided but warrants the implementation of compensation measures, such as planting of existing seedlings of mangrove species as well as their maintenance.

Contamination of water quality, beach sand and/or mangrove due to runoff or spillage of waste and/or hazardous substances (i.e.. fuel, oils, paints, etc). This potential impact has already been discussed in sections concerning the Oceanography and water resources. Its prevention depends on the location of the work sites and locations where dangerous substances are stored or where repairs and maintenance of equipment is carried out.

6.8.2 Operation phase

During the operation phase the access road to the port of Nacala may cause the following impacts on biodiversity:

Pollution of the sea water, beach or mangrove by contaminated runoff (from the overpass transported by water lines discharging on the bay), especially in the event of an accident with vehicles transporting dangerous substances. The accidental spillage of hazardous substances, which is of low probability, can however result in a significant impact, although, as discussed in section concerning impacts on Oceanography, the extension of the area potentially affected by such an impact will be reduced from the outset and limited to the immediate vicinity of the point of discharge into the bay.

Development of colonies and benthic fauna in the pillars of viaduct, if such were to occur it would be a positive impact of the project for biodiversity.

6.9 Impacts on Terrestrial Ecosystems

The project implantation areas, as well as the indirect influence areas are in general modified, mainly by farming, leaving only small patches of natural vegetation. As such, the potential negative impacts will be negligible in general.

6.9.1 Construction phase

Loss of vegetation and habitats: as a result of natural vegetation felling and the ground cleaning, will have a certain impact, not quite considerable given the state of change already done. In any case, the vegetation loss should be minimized to what is absolutely necessary, especially in wetlands and forest. In the case of areas to be temporarily affected, measures for its recovery should be put in place.

Contamination of natural habitats by waste, wastewater or dangerous substances: this impact, in principle will be of low significance, given the low ecological value of the area of direct influence. However, **construction** management measures should be taken to avoid and/or minimize the contamination. It should be also necessary to implement measures to recover any area degraded as result of contamination.

6.9.2 The operation phase

Contamination of wetlands by water run-off from the road: This impact has already been discussed in the section pertaining to impacts on water resources. The impact may be significant in case of an accident caused by vehicles loaded with dangerous substances, especially if the drainage system of the road directs the runoff waters of the road towards wetlands, namely the saltpans located in the proximity of the road design between km 2+700 and 3+700. This aspect should be taken into consideration during the detailed engineering project development.

6.10 Impacts on Ecosystem Services

6.10.1 Construction phase

The loss of provisions (construction materials and energy) from the forest (timber, wood) and wet areas (Reed, grass), following the vegetation cutting in the working area. As mentioned, the forest areas are already very disturbed, mainly due to timber exploration as well as to firewood collection. Therefore the impact will be less significant it should be minimized to what is absolutely necessary.

Loss of trees from the local flora which offer wild fruits (such baobab, mafurreira and maçaniqueira), as a result of vegetation felling in the working area. The wild fruits are community food complement with traditional value. Some trees are part of tradition and cultural mores.

6.10.2 The operation phase

Inadequate access to provision available on the beach and mangrove (firewood, sand, crustaceans, mollusks, sea cucumbers, fish, etc) as the road will become a barrier between the Community and these habitats. The four lanes of the roads will somehow make the crossing difficult and there is a risk of accidents associated with. This is a significant impact which will require due consideration in the engineering details project development.

Damage to support and regulation services regulation provided by sea herbs, mangroves and coral reefs, may occur in the event of a significant spillage of dangerous substances the viaduct. It may happen in the event of an accident with the vehicle transporting these materials. The probability of occurrence is but it may lead to a significant impact; although, as discussed above, the extent of the area which may potentially be affected in such circumstances will be priori reduced and limited to the vicinity of the point of discharge into the bay.

6.11 Impacts on Land Use and Spatial Planning

The project will cross an inhabited area. It is largely unoccupied area or just used to subsistence agriculture practice. The construction of the new road the Nacala-Porto outskirts will be requalified or valued resulting in increased number of people

looking for land for different purposes (housing, commercial and industrial) along the corridor. This situation may lead to high levels of land conflicts, which may in a negative impact with variable magnitude and significance. The local leadership and committees to be created should ensure the set-up of extra-judicial mechanism for conflict resolution in order to minimize the impact.

As consequence of this process, lands used for agriculture purpose may serve for commercial and/or housing purpose, through spontaneous and unregulated occupations. Both situations will have negative impacts with variable magnitude and significance. However, the impact can be minimized with Nacala Municipality authorities' interventions, thus ensuring the compliance with the Structure Urban Plan and avoid new cluttered settlements

6.12 Impacts on Demography and Living Conditions

6.12.1 Construction phase

Impacts on Physical Movement

The road design of the new Access Road to the Port of Nacala was preceded by analysis of alternatives aiming to prevent affecting residential buildings, as per international best practices recommendations.

During the inventory of affected infrastructures and good conducted within the resettlement plan for this project, none habitation building was likely to be affected; so there is no need of population resettlement. It's only foreseen the possibility of removing of office building (built with conventional materials) belonging saltpan and fence wall belonging to a local service provider. In both cases, the compensations will be done through reconstruction and monetary payment. The impact will be, therefore, local with low magnitude and significance.

Impacts on poverty

In the area affected by the project the incidence of poverty is relevant. The people livelihood is mainly subsistence farming in small parcels of land (farms), complemented by trees with economic value (mainly fruit trees). The odd jobs (informal, intermittent and/or seasonal activities) are the second largest source of income. In the case of populations closer to the beach, the collection of seafood and fishing are also sources relevant source of income.

The loss of farms and fruit trees will thus be the negative impact of the project, which may contribute negatively to increase the levels of poverty, if alternatives of generating income for affected households are not put in place. This will affect especially the most vulnerable households (with lower income, with disabled people, chronically ill family members, or families headed by widows, children or women). The monetary compensation for the loss of crops and fruit trees will mitigate the situation, but only for a short term; unless specific alternatives measures to support

the community to generate income are put in place (e.g. chickens and cattle farming or establishment of a business).

The employment during the construction phase may also contribute to the increase of household income and consequently reducing the level of poverty.

Thus, it is expected that during the construction phase will be a positive impact, i.e. a contribution to the alleviation of poverty, given the compensation and income generation opportunities direct or indirectly created by this project. Direct opportunities should be in case of employment in the road construction and indirect through providers of services (such as restaurants), informal business, among others. The impact will be local, short term with low magnitude and significance.

Impacts on Minority Groups

There were no ethnic minorities or minority groups that are particularly vulnerable, so it is not foreseen any impact in that regard, both in the construction or operational phases.

Socio –cultural impacts

During the construction phase, in the event of the contractor hire people from other administrative posts, districts or even from other provinces, it may lead to social conflicts between these groups and local population, taking into account the difference cultural habits.

On the other hand, the emergence of a group of employees from local population (who used to rely on subsistence farming) hired by the contractor may be a source of social conflicts as well.

Bad relationship, disrespect for the customs and traditions of the local population, anti-social behavior from the project employees (for example: language perceived as disrespectful, verbal and physical attacks, excessive alcohol consumption, involvement with local women and socially inadequate reactions to complaints, etc.) may result in conflicts between these and the residents

These are short term and local negative impacts with low occurrence probabilities during the construction phase.

Impacts on social capital and in decision-making mechanisms

The implementation of the project and its´ Environmental Management Plan as well as Resettlement Plan will require the establishment of relations among ANE, the contractor, supervisors and other service providers with the municipal and district authorities, the local structures and other stakeholders. This is an opportunity to strengthen the governance system, which will bring a positive impact of the project.

The risk of work accidents

The road construction offers a risk of work accidents. It will be necessary to avoid any situation that may put at risk the health and life of employees during the work execution. This will reduce the risk of accidents and eventually fatalities.

This impact is assessed as negative, local and temporary and of uncertain probability. The magnitude can be moderate to high, depending on the severity of the accident(s) and the number of employees involved. It is expected to have, however, a moderate significance.

As such, it is necessary to put in place the mitigations measures presented in the Risk Analysis chapter. The chapter includes specific provisions for work accident prevention with emphasis on the protection and specific safety equipment (including individual protection equipment) to each type of activity. The employee awareness is this subject is another aspect to be taken into consideration.

The risk of accidents involving community members

The presence of construction yards and construction activities taking place close to inhabited areas is always a risk factor for accidents which may affect community members. Such accidents can result from unauthorized access of people to risk areas. It may also occur in public places close to areas where works are being carried out without being duly signposted and delimited. These are negative impacts with local scope and likelihood is uncertain.

The mitigation measures in this study include specific provisions for the prevention, right in the beginning of work execution. This includes training and employee awareness on work safety, security and access control to the construction yards and the fences, signposting and the conditioning of the pedestrian and vehicle circulation.

6.12.2 The Operation Phase

Impact on living conditions

The construction of new road to access port of Nacala will, largely, allow the easier access of heavy loaded trucks, thus increasing the quality of life of people living in the surrounding areas to existing accesses. This will also reduce accidents and tress people are subjected to due to the high truck traffic, noise and vibration.

Impact on poverty

There is the risk of families with farms in areas surrounding those affected by the road construction who have been compensated areas be enticed to give way their lands for money, by opportunists following the increased value of lands due to road construction. This could have profound implications in lifestyle of the populations and exacerbate situations of poverty of families already vulnerable. The negative

impact will be local with low to moderate significance. The local authorities should be alert to this situation and raise awareness to the populations on the inherent risks.

Barrier Effect

The four lanes new road will create a barrier for free movement of people and access to farms, social services, to the beach (where they do fishing and get seafood) and other provisions (wood, charcoal and grass). It may create a risk of run over by vehicles as indicated in the risk analysis section.

During the meetings held with community, areas of crossing were the risks are higher were identified, in the following neighborhoods:

- Murrupelane - crossing for access to the water point
- Locone -crossing for access to school and health clinic,
- Matola - crossing to go to farms, saltpans and beach.

When working on the engineering project details these aspects should be taken under consideration, in order to identify measures to be included in the draft that can minimize the barriers effect and the risk of run over by vehicles. These measures should be discussed with representatives of local communities, which can include vertical and horizontal signposting, protection or even crossings (preferably less). Before and during road construction there should be awareness sessions on road safety for people, including in schools and other social facilities nearby

6.13 Impacts on Economic Activities

6.13.1 Construction phase

Impacts on Economic Activities

The loss of cultivated areas and different cultures (including fruit trees) will be the negative impact of greater relevance. According to surveys conducted on the ground, a total of 1,431,218 square kilometers will be taken from local communities for road construction. The table below summarizes the number of families (PAPs) with goods (farms, crops, trees) to be affected.

Table 34: Number of families with assets to be allocated

Administrative Post	Total no. of HHs	No. Of HHs with loss of farm/crop	No. Of HHs with loss of trees
Muanona	1.325	1.292	989
Mutiva	163	160	107
Totals	1.488	1.452	1.096

With regard to the loss of trees, the inventory conducted indicated that 1.096 PAPs will lose 22.984 trees of different varieties. Pertaining the loss of crops, since the inventory was conducted in dry season and most crops are annual (not perennials), the results were based on the information provided by the farms owners, with the real risk of opportunism leading to overestimation of farms/crops which have been actually affected. This value requires, therefore, verification by the company to be hired for the resettlement plan implementation.

As defined in the resettlement plan, the families affected will be compensated monetarily for the loss of crops and fruit trees.

It is an irreversible local level negative impact with moderated magnitude and significance.

Impacts on the Local Economy (employment and provision of services)

The creation of jobs and the opportunity to provide services directly or indirectly associated with the work will temporarily increase the economic dynamics of Nacala-Porto, during the construction phase.

It is a positive impact with moderated magnitude and significance, depending on the number of employees and local suppliers involved. In order to maximize the impact, it is recommended to focus on hiring of local labor, including members of the households directly affected (including women) by the process of resettlement. As per the law, the child labor is prohibited, and the contractor is responsible for ensuring that this does not happen.

6.13.2 The Operation Phase

Impacts on Economic Activities

The construction of new access road to the port of Nacala, integrated into the strategies of Economic Development of the Nacala Corridor (PEDEC), will generate positive impacts, associated with quick access to the port and city of Nacala for people and goods. The new road will be integrated in the existing network (linking with N12 and R702). It will also attract new investments, contributing to the increase of the competitiveness of the Port and greater dynamism of economic activities associated with it. This positive impact will have, therefore, an expanded geographic scope area extended (regional), with magnitude and significance.

6.14 Impacts on social services and infrastructure

The project is not expecting to affect public infrastructures, apart from foreseen temporary interference with traffic in identified places where the new road will cross with N12 and R702, during the construction phase.

It is assumed that the floating power plant that is currently anchored in Nacala bay can be demobilized before the construction of the road. Therefore, the tower of the transmission line that interferes with the bridge to be built in the initial section of the road design under consideration also might already be dismantled at that time.

The work involving these facilities may cause some inconveniences in the road traffic and electric power supply with temporary negative impact. However, this can be minimized with careful management work which may result in less time of services disruption. This will be a temporary impact with low magnitude and significance.

6.15 Impacts on Public Health

Some negative impacts expected with the construction of the highway can be anticipated, particularly contamination and the spread of diseases - especially STIs with emphasis on HIV and gonorrhea's resulting from occasional sexual relations between local people and staff working under the road project. Sometimes these projects are the reason for social disintegration, when local women engage with workers of the project.

Malaria, a common disease in these areas, may increase if adequate measures on stagnant waters that are the result of discharges during the construction process are nor taken. Stagnant pools of water are favorable environments for the reproduction of mosquitoes and spreading of malaria.

Contamination of water, air and sound pollution are other potential impacts of the project on public health.

In either case it is expected that the resulting impacts will be local, temporary and of low magnitude and significance. Such impacts should, however, be minimized through the implementation of awareness raising campaigns to the population, regarding the risk of increased STIs; covering areas of stagnant waters and implementation of mitigation measures related to risk of contamination of waters, emission of dust and noise

6.16 Impacts on Cultural and Religious Heritage, Graves and Sacred Sites

Impacts on historic heritage or archaeological heritage

As described above no historic sites of cultural importance were identified in the corridor where the Project will be implemented. However, there is always the possibility to occur archeological finds or with historical value (mainly along the graves or places of worship), which if they occur, they will require the notification to local authorities, as provided for in national legislation.

Impacts on graves and sacred sites

Along the project implantation corridor 67 graves and 3 places of worship were identified that are directly affected by the construction of the road, thus affecting

the spirituality of affected families. These negative impacts are irreversible with local coverage, moderate magnitude and low significance.

The compensation implies the exhumation and transfer of corpses and holding of traditional ceremonies, with costs borne by ANE. The majority of affected households consider that the direct involvement of local leaders in this process is important.

In the case of the Central Cemetery, the results of the public consultation carried out indicate that the action to favor has to be based on the prevention of interference caused by the project, which would require a detailed analysis as part of the development of engineering studies.

6.17 Impacts on Landscape

6.17.1 Construction Phase

During the execution of works there will, inevitably, be deterioration in visual space, as a result of the various activities that will take place along the route and in the building sites and other affected areas.

However, as mentioned in the characterization of the reference situation, the visual sensitivity of the crossed areas can be considered low and the aesthetic quality of the landscape where the project under examination will be implemented can be considered as being from moderate to low.

Given the temporary nature of construction works, the impacts on the landscape can be considered as minor.

The construction of the road will not imply the execution of landfills or important excavations and the more visually striking structure to be built will be the bridge at the beginning of the tracing, next to the port of Nacala, i.e. in an area already heavily artificialized.

6.17.2 Operation Phase

The presence of road, in the operation phase, will offer new opportunities for sightseeing over the Nacala bay, a valuable element in terms of landscape and, thus, may admit the occurrence of a positive impact, even if minor.

6.18 Cumulative Impacts

Cumulative impacts are those that are determined or induced by the Project and that will add to already existing or planned disturbances as a result of other projects on any of the environmental factors considered. In other words, cumulative impacts can be defined as the total impacts on a given resource, ecosystem and human community of all actions, regardless of their promoter.

In this case, it is considered that the planned expansion of the port of Nacala and the road now under study have the potential to induce cumulative impacts, especially and most directly in the interaction with the Nacala bay.

Indeed, although the road project expects the interaction with the bay only a section of reduced length (approximately 900 m), this will occur near the expansion area of the port.

The fact that there is evidence of the existence of sediments with increased levels of nutrients and heavy metals requires special attention, taking into consideration that the indirect influence area of the project (the whole bay and the underlying marine area).

Thus, in spite the fact that the impacts on the water quality of the sea and on the marine ecosystems directly associated with the road project is considered to insignificant, the cumulative impacts arising from all the interventions expected assume greater importance.

In order to compensate for the cumulative nature of the impacts it is recommended to try to take advantage of possible synergies in terms of mitigation measures, such as, for example, the use of the solutions envisaged for the management of contaminated sediments that will be mobilized in more relevant quantities in the context of the expansion of the port to also manage the materials that, in smaller quantities, may result from the construction works of the road project and, specifically, the bridge included therein.

6.19 Risk Analysis

A risk can be defined as the probability of unexpected occurrence of a given undesirable event, with certain negative consequences on the environment.

The human activity *per si* generates actions likely to cause situations of potential risk that may designate as technological risks. Technological risk situations include accidents in industries, accidents involving dangerous goods transport, urban fires, explosions, gas leaks of hazardous materials, among others.

On the other hand, risks of natural origin, such as earthquakes, floods or cyclones are to be considered. These risks, despite being of natural origin, are often exacerbated by the way societies interact with nature, in particular at the level of occupation of areas that are most vulnerable to phenomena such as those indicated above, eventually leading to a worsening of their consequences.

In this chapter we present an analysis of hazards associated with construction and operation of infrastructures included in the Project.

Thus, a prior identification, based on professional judgment of the technical team, of the main risks associated with the different actions occurring in the construction and operation phases was conducted, a qualitative assessment of such risks (in terms of likelihood and consequences), and also comments on the measures for prevention, reduction and control of the risks analyzed were presented.

For the identification of risks, the construction and operation phases were separately considered, as well as the origin of the risks, particularly if these are:

- risks triggered by factors directly related to the Project (internal factors) or
- risks triggered by external factors to the Project, such as natural phenomena, and which may affect areas related to the Project or be aggravated by the Project.

The evaluation criteria adopted were as follows:

- Probability: from 1 (unlikely) to 5 (highly likely)
- Consequences: from 1 (light damage on people or the environment) to 5 (death of multiple people or destruction of habitats or natural resources)
- Rating: from 1 (low risk) to 25 (very serious risk), obtained by multiplying the scores assigned to the "probability" and the "consequences"

In the following paragraphs, a highlight was given to risks with a rating higher than 9 or with probability or consequences rated as 4 or 5 (i.e., the risks evaluated globally as more serious or that have a higher probability of occurrence or more burdensome potential consequences.

6.19.1 Construction phase

Table 36: Risk assessment during construction phase

Risk	Causes / Factors	Likelihood	Consequences	Evaluation
Traffic accident involving machinery or vehicles that circulate on the roads N12 and R702 in the areas of intersections with the Work	Internal	4	4	16
Accidental spillage of fuel or hazardous substance in the construction site	Internal	4	3	12
Fire	Internal/ External	3	3	9
Occupational accident (affecting only construction workers)	Internal	5	4	20
Trampling of pedestrians in the area of the Works	Internal	3	4	12
Occurrence of cyclone during construction Works	External	3	43	9
Occurrence of floods during the construction of roads	External	2	43	6

In the analysis carried out, it is assumed, based on indication provided by municipality representatives during a site visit, that the electricity transition line tower that is currently present in the area where the construction of the bridge is

planned will have been removed at the beginning of the construction work. It is also understood that the bathymetry of the bay in the area surrounding the bridge planning is sufficiently shallower to prevent large ships from approaching the margin to a point where they can collide with the bridge (under construction or already built).

They are, therefore, highlighted as more serious the risks associated with

- "traffic accident involving vehicles or machinery of the Works or vehicles that circulate on the roads N12 and R702 in the areas of cross-breeding with the Work"
- "accidental spillage of fuel or hazardous substance in the construction site"
- "Occupational Accident involving only construction workers"
- "trampling of pedestrians in the area of the Work"

These risks should deserve particular attention in the phases of preparation and planning of construction Works and, subsequently, during its implementation, without prejudice to the adoption of management measures of general risks, always giving priority to the implementation of the precautionary principle. In most cases, the applicable measures are already described in the chapter on mitigation measures of key environmental impacts.

Moreover, in some cases, measures for the prevention of such risks, that are justifiable in the construction phase, shall remain valid for the operation period.

6.19.2 Operation phase

Table 37: Risk assessment during operation

Risk	Causes / Factors	Likelihood	Consequences	Evaluation
Traffic accident not involving spills of dangerous substances	Internal	5	4	20
Traffic accident with spillage of hazardous substances	Internal	3	5	15
Trampling of pedestrians	Internal/ External	4	4	16
Occurrence of flood or fire, interfering with the operation of the road	External	3	2	6

In this phase, the main risks with origin in internal factors have to do, understandably, with traffic that will circulate in new facilities and with the accidents that may result from this traffic.

There is also a set of risks originated by external factors that may result in the disruption of normal operation of new facilities.

6.20 Summary of impacts and risks

The pre-construction phase, regarded as the one in which the engineering project will be developed and a broad range of preparatory activities for the physical implementation of the Project shall assume an important role in relation to various impacts, especially social impacts.

During the construction phase the expected biophysical and socio-economic impacts are, in general, negative, except the impacts associated with the job creation.

During the operation phase, the biophysical impacts will, in general, be negative but insignificant along the route of the new road. The new road infrastructure will decongest the existing road (N12) which gives access to the Nacala port, which indicates that, in the operation phase, positive impacts will be observed, especially in terms of air quality and noise in the areas adjacent to this roadway.

On the other hand, the socio-economic impacts shall be in essence, and in line with the objectives intended for the Project, positive and very significant, particularly as a result of important improvement of accessibility to the port of Nacala.

In the context of preparation of ToRs for the EAS now being presented , a preliminary assessment of the impacts of the project has been conducted. Based on the results of the study presented now, the following is an update of this preliminary evaluation, in which the following encoding is used:

- A+/-: Significant positive / negative impact expected;
- B+/-: Minor positive / negative impact expected;
- C+/-: Significance of the positive / negative impact is unknown (need for more detailed analysis, with clarification of the impact in the course of work);
- D: Unexpected impact.

Table 38: Impact Summary

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
Pollution Control	1	Air Pollution	B—	B—	B—	B±	**During Construction:** Air quality deterioration is expected due to the temporary emission of dust, SOx, NOx etc, to the atmosphere as a result of the earth movement and mobilization of vehicles and machinery during works. **During Operation:** A negative impact on air quality is expected due to the increase in traffic volume and consequent atmospheric emissions. On the other hand, an improvement in the quality of the air in the surrounding area of the national road is expected due to the diversion of traffic to the new road.	**Construction Phase:** QAC1: Temporary degradation of air quality (dust, gas, odors). **Operational Phase:** QAO1: Degradation of air quality due to traffic emissions on the access road to Nacala Port. QAO2: Improved air quality in the N12 envelope (due to the decongestion provided by the new road)
	2	Water contaminatio n	B—	B—	B—	B-	**During Construction:** An increase in the turbidity of the water in the sea and in the water lines surrounding the Site and drilling sites is expected. In the yard there will be residual water, namely sanitary facilities and workshops that may pollute the water. **During Operation:** The impact of runoff water on the road is expected to be insignificant, except in the case of an accident involving the transport of hazardous substances (see below).	**Construction Phase:** OC1: Degradation of water quality of Nacala Bay by resuspension of sediments. OC2: Degradation of the water quality of Nacala Bay by pollutant discharges carried by the water lines. RHC2: Degradation of water quality **Operation Phase:** RHO2: Bay water quality degradation by pollutant discharges carried by the water lines.
	3	Waste	B-	B-	B-	D	**During Construction:** The deforestation on the area for the new road will result in woody material (firewood and bush), soils from excavation and other materials resulting from perforations for bridge construction. On the other hand, diferente types of solid waste will be generated on the camp site. **During Operation:** The expected impacts are negligible.	**Construction Phase:** GSC2: Soil Contamination OC1: Degradation of water quality of Nacala Bay by resuspension of sediments

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
	4	Soil Pollution	C-	B-	B-	D	**During Construction:** The impact resulting from the deposit of timber and land is negligible. The possibility of Soil pollution caused by the deposition of materials resulting from drilling in Nacala Bay, which may contain contaminated sediments. It is also necessary to consider the possibility of soil pollution caused by the leakage of dangerous substances in workshops or work zones by construction machineries, although these impacts can be considered punctual and insignificant. **During Operation:** These impacts are not expected at this stage.	**Construction Phase:** GSC2: Soil Contamination OC1: Degradation of water quality of Nacala Bay by resuspension of sediments
	5	Noise/vibration	B—	B—	B—	B±	**During Construction:** An increase in noise and vibration is expected in the surroundings of the site (including possible quarries and borrow pits) as well as on the access roads to the site where vehicles and equipmentwill be circulated. **During Operation:** A negative impact on the Project environment is expected due to the increase in traffic volume and consequent increase in noise and vibration. On the other hand, a reduction of noise and vibrations in the surrounding area of the national road is expected as a result of the deviation of traffic to the new road.	**Construction phase:** RVC1: Temporary degradation of the acoustic environment. RVC2: Increase of vibrations near precarious housing **Operation Phase:** RVO1: Degradation of the acoustic environment due to the noise emitted by the access road to the Port of Nacala. RVO2: Improvement of the acoustic environment in the surroundings of the N12 (by the decongestion provided by the new road).
	6	Erosion and land abatement	C-	B-	B-	B-	**During Construction:** Earthworks and changes in the drainage network during construction may cause some occasional increases in erosion, but may also help to correct some existing situations. Activities such pumping of large quantities of groundwater are not expected to not result in land abatement. **During Operation:** Erosion may occur along the road slopes, as well as erosion on downstream caused by the drainage system discharge points.	**Construction phase:** GSC1: Soil loss due to erosion **Operation Phase:** GSO1: Erosion
	7	Odors	B—	D	D	D	**During Construction and Operation:** Only when performing some work in the initial section of the road,	

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
							namely the drilling the forfoundations to install piles for the bridge, there may be the release of odors, due to the occurrence of sludge. It will, however, be a very specific and localized situation, the impact of which is expected to be insignificante.	
	8	Sediment deposition	B—	B—	B—	D	**During Construction:** There is the possibility of deposition of sand or sludge generated during the execution of the foundations of the bridge, but it is expected that the resulting impact will be insignificant. **During Operation:** No impact is expected at this stage	**Construction Phase:** OC1: Degradation of water quality of Nacala Bay by resuspension of sediments
Biotic Environment	9	Conservation areas	D	D	D	D	**During Construction and Operation:** There are no conservation areas in the area of project implementation, or in the vicinity.	
	10	Ecosystems	C—	B—	B—	B±	**During Construction:** The Project will occupy areas that may have some interest in terms of biodiversity, such as coastal zones, wetlands and small spots of natural vegetation in a terrestrial environment. **During operation:** The insignificant impacts on water quality may also have ainsignificant impact in ecological terms. The colonization and development of benthic fauna in the bridge piles can be considered as positive.	**Construction Phase:** EMCC1: Disruption of benthic and nectonic organisms EMCC2: Disturbance of species on beaches and adjacent areas EMCC3: Mangle spotting ETC1: Loss of vegetation and natural habitats ETC2: Contamination of natural habitats by waste, effluent or hazardous substances SEcoC1: Loss of forest and wetland provision services SEcoC2: Loss of local flora trees **Operation Phase:** EMCO1: Ecological damages due to the reduction of the quality of the bay waters EMCO2: Colonization and development of benthic fauna on the bridge piles ETO1: Contamination of wetlands by run-off water SEcoO2: Damage to the support and regulation services provided by seagrass, mangroves and corals

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
	11	Oceanography and Hydrology	C—	D	B-	B-	**During Construction:** No significant change in the flow of sea water and water lines is expected as a result of the construction and presence of the bridge piles. There may be occasional changes in the natural drainage network and low water quality degradation phenomena in the Bay. **During operation:** Changes in the natural drainage network initiated during the construction phase	**Construction Phase:** OC1: Degradation of water quality of Nacala Bay by resuspended osediments OC2: Degradation of the water quality of Nacala Bay by pollutant discharged by the water lines RHC1: Alteration and artificialization of the natural drainage network **Operation Phase:** RHO1: Alteration and artificialization of the natural drainage network (started in the construction phase)
	12	Topography, Geology	B—	B—	B—	D	**During Construction:** There will be some alteration in the topography as a result of the earthworks during road works without this alteration having any significant impact, other than some loss of soil due to erosion. **During Operation:** No impacts are expected at this stage.	**Construction phase:** GSC1: Soil loss due to erosion
Social Environment	13	Resettlement	B—	B-	B-	D	**Before and During Construction:** No provision is made for residential buildings. Just an office building. There will, however, be the need to occupy lands currently occupied by agricultural fields and / or trees. **During Operation:** Once the construction work is completed no additional allocation is expected that may require resettlement or compensation.	**Pre-construction phase:** SEPC1: Interference with land rights and resettlement of households by economic displacement SEC1: Impacts of economic displacement
	14	Poverty	C±	B^+	B^+	B-	**During Construction**: There may be a contribution to poverty reduction in the local population due to opportunities for direct or indirect employment or income generation through other activities indirectly related to the work. **During the Operation Phase:** There will be a risk of deterioration of living conditions due to loss of adjacent agricultural areas, despite compensations that have been	**Construction Phase:** SEC2: Contribution to poverty alleviation SEC6: Employment Opportunities and Service Delivery **Operation Phase:** SEO2: Risk of deterioration of the poverty situation, due to the loss of subsistency farms by poor families in areas adjacent to the new

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
							paid.	road.
	15	Minority Groups	C±	D	D	D	**Before, During and After Construction:** No ethnic minorities or minority groups have been identified as being particularly vulnerable, and this impact is not expected to occur at both the construction and operational stages	
	16	Regional economy (such as employment and living conditions)	B±	B+	B+	A+	**Before and During Construction:** During construction it is expected that employment or business opportunities will increase for the workers, which will contribute to the generation of income of the families. **During the Operation Phase:** The Project will result in improved access to the Port of Nacala, which is expected to contribute to a greater dynamism of the regional economy.	**Before and During Construction:** During construction it is expected that employment or business opportunities will increase for the workers, which will contribute to the generation of income of the families. **During the Operation Phase:** The Project will result in improved access to the Port of Nacala, which is expected to contribute to a greater dynamism of the regional economy.

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
	17	Land Use and natural resources	B—	B—	B—	B±	**Before and During Construction:** The road crosses zones of natural vegetation, in addition to agricultural areas that will be affected. The valuation of land adjacent to the new road may create a search for land along the corridor for different purposes (housing, commercial and industrial), which may result in disorderly settlements **During Operation:** The presence of this new road could induce the implantation of new industries or services related to the port activity, given the best conditions of access created in the area of direct influence to the route. Conversely, there may be difficulties in accessing provision services provided on the beach.	**Construction Phase:** UTC1: Allocation of crop areas, diverse crops and trees SEcoC1: Loss of forest and wetland provision services SEcoC2: Loss of local flora trees **Operational Phase:** SEO1: Improvement of living conditions in the areas adjacent to the current access to the Port of Nacala SEcoO1: Difficulty of access to provision services provided on the beach.
	18	Water usage	B—	B—	B—	D	**During Construction:** Construction work will require water use and may cause contamination but is not expected to affect water use by people.	**Construction Phase:** RHC3: Conflicts in access to water
	19	Infrastructures and social equipments	C±	B±	B±	B+	**During Construction:** Access to infrastructure and social facilities, such as markets schools, churches, cemeteries, water points, among others may be temporarily conditioned during the construction phase. **During Operation:** By decongesting the entire road network and creating new accessibility, the future road will have benefits for communities throughout the area.	**Construction Phase:** SEC7: Traffic disturbance on EN12 and R702 and on power lines UTC2: Possible interference with power transmission line tower **Operational Phase:** SEO1: Improvement of living conditions in the areas adjacent to the current access to the Port of Nacala.
	20	Social capital and decision-	C±	B+	D	D		

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
		making mechanisms at regional level						
	21	Poor distribution of wealth (costs and benefits	C±	B-	B-	D	**Before, during and after Construction:** The project may adversely affect the distribution of wealth, especially in the construction phase.	**Construction Phase:** SEC4: Barrier Effect SEC5: Loss of farms, crops and fruit trees)
	22	Conflicts	C±	D	B-	D	**During the Construction phase:** Possibility of conflicts between local communities and workers from other regions	**Construction Phase:** SEC3: Socio-cultural conflicts with workers from outside the project area
	23	Cultural and religious heritage and traditions	C-	B-	B-	D	**During the Construction Phase:** No historical sites of cultural importance were identified in the project's corridor. The construction of the road will involve with fields and sacred sites, which may involve exhumation and transference and performance of traditional ceremonies.	**Construction Phase:** SEC9: Discovery of historical or archaeological heritage SEC10: Interference with Campas and Sacred Places
	24	Landscape	B-	B-	B-	B+	**During the Construction Phase:** The Bay of Nacala has an associated scenic value that may be temporarily affected by land movements and bridge construction. **During Operation:** The presence of the new road and bridge will provide new points of view of the Bay	**Construction Phase:** PC1: Temporary Landscape Degradation **Operation Phase:** PO1: Availability of more views taken on the Bay
	25	Gender	B—	B—	B—	B-	**During Construction and Operation:** There may be a limitation of women's access to the collection of firewood, water and / or shellfish	**Construction Phase:** SEC4: Barrier Effect SEC5: Loss of farms, crops and fruit trees) **Operation Phase:** SEO2: Risk of deterioration of the poverty situation, due to the loss of machambas by poor families, with machambas in areas adjacent to the new road **Operation Phase:** SEO3: Barrier effect on the pedestrian circulation of populations
	26	Rights of the	D	D	D	D	Activities that affect the rights of the child, such as child labor, are not	

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
		child					expected.	
	27	Infectious diseases, such as HIV / AIDS	B-	B-	B-	D	**During Construction:** There may be a greater spread of infectious diseases, especially those of sexual transmission, as a result of labor.	**Construction Phase:** SEC8: Risk of STI and malaria increase
	28	Working conditions (including safety)	B-	B-	B-	D	**During Construction:** Some construction activities will expose workers to agents that may have adverse health effects, such as dust, exhaust fumes or toxic substances. On the other hand, there will be activities with safety risks, such as the execution of work at height. **During Operation:** The number of workers assigned to the maintenance of the road and the sporadic nature of the maintenance work make this type of impact unimpressive (accidents must be counted - next point).	**Construction Phase:** RC1: Road accident involving vehicles or machinery of the work or vehicles that circulate on roads N12 and R702 in the areas of intersection with the work RC3: Accident involving only construction workers
Outros	29	Accidents	B-	B-	B-	B-	**During Construction:** Accidents may occur in the construction area or as a result of the circulation of vehicles and work equipment, affecting workers and / or local communities. There may also be an accident involving the spillage of fuel or other hazardous substances on the shipyard. **During Operation:** It is possible that there will be accidents with vehicles in circulation in the new. On the other hand, the reduction of road accidents on the national road is expected due to the diversion of traffic to the new road.	**Construction Phase:** RC1: Road accident involving vehicles or machinery of the work or vehicles that circulate on the roads N12 and R702 in the areas of intersection with the work RC2: Accidental spillage of fuel or hazardous substance in the yard RC4: Pedestrians in construction zone RC5: Cyclone occurrence during construction **Operation Phase:** RO1: Road accident not involving spillage of hazardous substances RO2: Road accident involving spillage of hazardous substances RO3: Pedestrian knockdown
	30	Transboundary effects, climate	C	D	B+/-	B+/-	**During Construction:** The temporary and localized increase in the emission of greenhouse gases (GHG) as a result of emissions from vehicles and combustion	

Category	Nº	Impact	Preliminary Impact Assessment/TdR)		Impact assessment updated at EAS		Observations	Detailed impacts analyzed and to be considered for environmental management purposes
			Pre-Constrution /Construction	Pre-Construção / Construction	Pre-Construction / Construction	Operation		
		change					equipment associated with the work is considered insignificant. **During Operation:** An increase in GHG emissions is expected as a result of increased traffic of heavy vehicles to and from the port area. However at the regional level, reducing traffic congestion will result in a reduction in GHG emissions. Overall, this insignificant impact	

7 Environmental Management Plan

7.1 Introduction

The Environmental Impact Assessment (EIA) identifies and evaluates the environmental impacts resulting from the *Access Road to the Port of Nacala* and recommends mitigation measures and/or empowerment of negative or positive impacts, following the concept of the hierarchy of mitigation. Cost to carry out the mitigation measures will be generally included in the construction cost except for those stipulated under '7.9 Cost Estimation'.

For the definition of the requirements for the environmental management of the Project, the impacts systematized in the table below were considered, indicating its meaning for each (positive or negative) and the corresponding significance (low, moderate or high).

Table 39: Impact systematization for project management

Descriptor	Impact	Nature and Significance
PRE-CONSTRUCTION PHASE (PC)		
Socio-economy (SE)	SEPC1: Interference with rights to land and resettlement of households for economic displacement	Negative / Moderated
CONSTRUCTION PHASE (C)		
Geology and soils (GS)	GSC1: soil loss by erosion	Negative / Moderated
	GSC2: contamination of soils	Negative / Reduced
Oceanography (O)	OC1: Degradation of water quality in the Nacala bay by resuspension of sediments	Negative / Reduced
	OC2: Degradation of water quality in the Nacala bay by discharges of pollutants carried by the water lines	Negative / Reduced
Water Resources (RH)	RHC1: Change and artificialization of the natural drainage network	Negative / Reduced
	RHC2: Degradation of water quality	Negative / Moderated
	RHC3: Conflicts in access to water	Negative / Reduced
Air Quality (QA)	QAC1: Temporary degradation of air quality (dust, gases, smells)	Negative / Reduced
Noise and vibration (RV)	RVC1: Temporary degradation of the acoustic environment	Negative / Reduced
	RVC2: Increased vibration close precarious buildings	Negative / Reduced
Marine and coastal ecosystems (EMC)	EMCC1: Disruption of benthic and nektonic organisms	Negative / Reduced
	EMCC2: Disturbance of the species on the beaches and adjacent areas	Negative / Reduced
	EMCC3: Hampering of mangrove spots	Negative / Moderated
Terrestrial ecosystems (ET)	ETC1: loss of natural vegetation and habitats	Negative / Reduced
	ETC2: Contamination of natural habitats by waste,	Negative / Reduced

Descriptor	Impact	Nature and Significance
	wastewater or dangerous substances	
Ecosystem services (SEco)	SEcoC1: Loss of services for provision of forest and wet areas	Negative / Reduced
	SEcoC2: Loss of trees in the local flora	Negative / Reduced
Use of the land (UT)	UTC1: Hampering of crop areas, and different crop, trees (see socio-economics)	Negative / High
	UTC2: Possible interference with the power line tower	Negative / Moderated
Landscape	PC1: Temporary degradation of the landscape	Negative / Reduced
Socio-economy (SE)	SEC1: Impacts on physical displacement	Negative / Reduced
	SEC2: contribution to the alleviation of poverty	Positive / Reduced
	SEC3: Socio-cultural conflicts with staff from outside the area of the project implantation	Negative / Reduced
	SEC4: Barrier effect	Negative Moderate /
	SEC5:Loss of farms, crops and fruit trees)	Negative Moderate /
	SEC6: employment opportunities and provision of services	Positive / Moderate
	SEC7: Disruption to traffic on the EN12 and R702 and in the electricity power lines	Negative / Reduced
	SEC8: Risk of STIs and malaria increase	Positive / Reduced
	SEC9: Discovery of historical or archeological traces	Positive / Low to moderate
	SEC10: Need for removal of graves and sacred sites	Negative Moderate /
Risks (R)	RC1: Traffic accident involving vehicles or machinery or vehicles that circulate on the roads N12 and R702 in the intersection areas with the Work	Moderate risk
	RC2: Accidental spillage of fuel or hazardous substance in the construction site	Moderate risk
	RC3: Occupational accident involving only construction workers	Serious Risk
	RC4: Trampling of pedestrians at the Work area	Moderate risk
OPERATION PHASE		
Geology and soils	GSO1: Erosion	Negative / Reduced
Oceanography	OO1: Degradation of water quality in the Bay due to the discharges of pollutants carried by the water	Negative / Reduced

Descriptor	Impact	Nature and Significance
	lines	
Water Resources	RHO1: Change and artificialization of the network of natural drainage (started in the construction phase)	Negative / Reduced
	RHO2: Degradation of water quality in the bay due to the discharges of pollutants carried by the water lines	Negative / Reduced
Air Quality	DAO1: Degradation of air quality due to emissions from traffic on the access road to the Port of Nacala	Negative / Reduced
	DAO2: Improvement of air quality in the surrounding of N12 (due to the decongestion resulting from the new road)	Positive / Reduced
Noise and vibration	QAO1: Degradation of the acoustic environment due to the noise on the access road to the Port of Nacala	Negative / Reduced
	QAO2: Improvement of the acoustic environment in the surroundings of N12 (due to the decongestion resulting from the new road)	Positive / Reduced
Marine and coastal ecosystems	EMCO1: Environmental damage due to the reduction of the water quality in the Bay	Negative / Reduced
	EMCO2: Colonization and development of benthic fauna on the pillars of the viaduct	Positive / Reduced
Terrestrial ecosystems	ETO1: Contamination of moist areas by the road run-off water	Negative / Reduced
Ecosystem services	SEcoO1: Difficulty accessing provision services made available on the beach and mangrove	Negative / Moderated
	SEcoO2: Damage to the supporting services and regulation provided by marine herbs, mangroves and coral reefs	Negative / Reduced
Landscape	PO1: Availability of more sightseeing points on the Bay	Positive / Reduced
Socio-economics	SEO1: Improvement of living conditions in areas adjacent to the existing accesses to the Port of Nacala I	Positive / Moderated
	SEO2: Risk of deterioration of the poverty situation, loss of farms by poor families who have farms in areas adjacent to the new road	Negative / Reduced
	SEO3: Barrier effect on pedestrian populations' circulation:	Negative / Reduced
	SEO4: Contribution to the increase of Port of Nacala's competitiveness and consequent to the increase of economic dynamics in the region	Positive / Moderated
Risks	RO1: Traffic accident not involving spills of dangerous substances	Serious Risk
	RO2: Traffic accident with spillage of hazardous	Moderate risk

Descriptor	Impact	Nature and Significance
	substances	
	RO3: Trampling of pedestrians	Moderate risk

Thus, after the evaluation of the project impacts, the next task is to identify the main **environmental mitigation measures** necessary, which shall include, ideally, measures for the prevention of negative impacts, remedial measures for the relievable negative impacts, measures to compensate the inevitable negative impacts and measures to empower the positive impacts.

It is thus intended, whenever possible, to define technically acceptable, workable and efficient measures, in terms of cost to the identified environmental and social impacts, so as to avoid unnecessary damage to the environment, protect valuable or limited resources, natural areas, habitats and ecosystems and protect the people and their social environment.

The strategy and mitigation measures are based on the concept of mitigation hierarchy.

Thus, the mitigation measures may consist of various types of action, such as the following:

- Change in design, location and sizing of certain specific components of the project, with the aim of **preventing** the occurrence of impacts;
- The introduction of additional measures (engineering controls, equipment not expected previously) and creation or change of plans and operational procedures, involving the Applicant and other entities, in order to **minimize** the magnitude and significance of the impacts that might not have been possible to prevent;
- As a last option, **replacement, restoration or compensation** for damages or losses caused by the Project, providing at least the same conditions (preferably better) than the pre-existing.

In each case, together with a description of the measure, re-evaluation of the impact on the assumption of its effective implementation shall also be applied.

In this Environmental Management Plan (EMP) these measures are presented as environmental specifications, so as to be easily identified, indicating the person responsible for implementation of the measure.

The aim of this EMP will be to control the potential negative environmental impacts of the project and enhance any positive environmental impact. The effective implementation of the EMP will ensure that the project will be conducted and managed in an environmentally reasonable and responsible manner.

The envisaged monitoring program will allow, in its turn, to obtain objective information about the degree of implementation of the EMP and about the evolution of certain environmental parameters considered relevant.

The EMP is a dynamic document subject to changes according to changes/variations in the project. As some of the details of the project are still unknown, it is hoped that this document will be updated, especially after the preparation of the Detailed Design. Any substantial change to the EMP must be approved by the ANE-DM (refer to the organizational and management structure in next section).

7.2 Organizational and Management Structure

7.2.1 Basic principles

This EMP is presented having as its main focus the construction phase, for which it is assumed that ANE and the Contractor shall undertake to carry out the works:

- complying with the legal requirements and good practice
- respecting the local communities, their heritage and natural resources and.
- considering, in the management of their activities, the protection of the health of their staff and the general public.

7.2.2 Responsibilities

In order to ensure the correct development and effective implementation of the EMP, it will be necessary to identify and define the responsibilities and powers of various people and organizations involved with the project.

The following entities are involved in the implementation of the EMP:

- ANE - Monitoring Department (ANE-DM);
- Resident engineer (RE);
- Environmental Supervisor (ES);
- Environmental Officer (EO);
- Contractor.

The ANE – DM representative will be responsible for:

- Establishing and maintaining regular and pro-active communication with the RE, ES and the Contractor, namely through the assigned EO.
- Reviewing and approving the integration in the Detailed Design of mitigation measures recommended in the SEA.
- During the construction, perform periodic visits and inspections at the construction site so as to make an environmental audit of the implementation of the project EMP.
- Review and comment on environmental reports produced by the Resident Engineer and/or Contractor.
- Report on the environmental management situation of the project to funding agencies and/or MITADER whenever necessary.

The Resident Engineer (RE) is indicated by the Supervisory Consultant (Supervision) and he is required to:

- Be familiar with the content of the EMP.
- Conduct the daily monitoring through the Land Book Registration and ensure compliance by the Contractor of Environmental Specifications.
- Review and approve the sketches produced by the Contractor in connection with the outline of the construction site, camping, access roads, etc.
- Indicate and control the work areas in accordance with the approved outline of the construction site, including environmental and social sensitivity.
- Advise on materials that can be used to designate the areas of work and the materials to be used in the contract if and when necessary.
- Communicate verbally to ANE-DM, with at least 10 days in advance, any proposed action that can have a negative impact on the environment.
- Perform assessments of damages where incidents, accidents and serious infringements inside/outside the construction site occur.
- Review and approve all areas that are rehabilitated by the Contractor.
- Review received complaints and give instructions as needed.
- Accompany ANE-DM during inspections at the site and/or inform in writing to the ANE-DM on infringements to the Environmental Specifications and issue instructions to the Contractor under advice from the ANE-DM
- Discuss with the ANE-DM the application of penalties for infringements of the Environmental Specifications and other possible restrictive measures when necessary.
- Issue fines as and when necessary.
- Imposes Temporary Suspensions of Work when there serious environmental crime and failure have occurred.
- Keep record of complaints from the public and report them to the Contractor and ANE-DM.
- Facilitate a pro-active communication between stakeholders for the benefit of an effective environmental management.

The RE shall be required to keep regular contact with the ANE-DM regarding the level of compliance with the EMP achieved by the Contractor during the contract period.

The Environmental Supervisor (ES) should join the supervision team, having the following responsibilities:

- Be familiar with the content of the EMP.
- Implement, in the Detailed Design, mitigation measures recommended in the SEA.
- Submit to ANE-DM for approval, the Detailed Design integrating mitigation measures

recommended in the SEA.

- Advise the RE on environmental aspects.
- Review and approve the Contractor's Method Statements, required in the EMP.
- Monitor compliance with the Environmental Specifications by the Contractor, on a monthly basis and whenever requested by the RE.
- Establish a connection with the ANE-DM on the level of compliance with the EMP attained by the Contractor, on a regular basis throughout the duration of the contract.

The Environmental Officer (EO), an integral part of the Contractor's team shall have the following responsibilities:

- Be familiar with the content of the EMP.
- Check the legal requirements for construction work and ensure prior to the start of the activities to obtain licenses and authorizations (in particular for gravel sites and development of activities on the river bank).
- Training of workers and sub-contractors on environmental awareness and assure that all the staff involved in the construction knows the Environmental Specifications and its purpose and is properly aware of the need to comply with such specifications.
- Keep the records of the environmental training delivered to the construction team (including sub-contractors) throughout the duration of the contract.
- Define channels of communication with the local population, local authorities and other interested parties and/or affected.
- Monitor the effectiveness of the EMP implementation.
- Conduct daily inspections at the construction site (with the RE) to monitor the environmental performance and compliance with the Environmental Specifications.
- Report on environmental issues on a regular basis and whenever required by RE.
- Immediately notify the RE, verbally and in writing, in the event of an accident, infringements of environmental specifications and ensure the adoption of appropriate corrective action.
- Notify the RE, verbally and in writing, with at least 10 working days in advance about any activity that he/she believes that will have an adverse impact on the environment, so that mitigation measures are taken in a timely manner.

The Contractor shall have the following responsibilities:

- Be familiar with the content of the EMP.
- Comply with the environmental specifications set out in the EMP and subsequent revisions.
- Ensure the obtaining of authorization for land access for construction.
- Prepare the Method Declaration, activities program and sketches/plans to submit for

the RE's appraisal.

- Review the inspection reports of the construction site and take note of information/recommendations contained therein.
- Rehabilitate all areas affected by construction activities restoring them to the original state, as determined by the RE.
- Perform the necessary work within the designated area of work.
- Rehabilitate services, facilities, private/public properties and other areas adversely affected by construction activities outside the delineated limits in accordance with the RE's instructions.
- Communicate and contact frequently and openly with the RE so as to ensure an effective and pro-actively environmental management with the aim of preventing or reducing negative environmental impacts and increase the positive impacts.

The contractor will also build his own management system to ensure and monitor the implementation of the EMP and the Environmental Specifications associated therewith. This system should, at least, allow:

- The preparation of the methods statements for the execution of works, with explanation of how the applicable environmental specifications will be applied;
- The effective management and transparent manner of construction activities related to the environmental specifications.
- Regular reporting on environmental issues to the ER.
- The registration, in writing, of all the communication/correspondence about environmental issues with all relevant stakeholders and other parties.
- The development and implementation of emergency and contingency plans for the main range of accidents and emergencies that may be associated with this project.

7.3 Environmental Specifications

7.3.1 Detailed Design/Pre Construction Phase

Impacts to minimize/maximize	Description of the measure	Responsibility
Losses of buildings and/or associated structures, farms, crops, fruit trees	• Implement the PAR before the commencement of the construction work (confirmation/completion of survey carried out, payment of compensation to each of the affected households prior to the commencement of the work affecting this HH) - more detailed description in PAR	ANE + implementing entity of PAR
Risk of road accidents and, in particular, with pedestrians.	• Identification of possible mitigation measures to be included in the Project, through a participatory process involving representatives of local communities, especially in the neighborhoods of Murrupelane, Locone and Matola. These measures might entail speed limits, signaling of the pedestrian crossing areas, establishment of elevated crossings (preferably underpass), among others.	Designer +ES+ representatives of local communities

7.3.2 Construction phase

Preparation of the work

Impacts to minimize/maximize	Description of the measure	Responsibility
GSC1 (soil loss by erosion)	Work schedule: • The planning of the works must be done in manner that makes the work involving movements of land compatible with the rainy season. • The activities that involve more movement of land should as much as possible avoid the rainy season and especially the months of higher water flows - January, February and March	ANE + Contractor
SEC3: Socio-cultural conflicts with staff from outside the project implementation area SEC8: Risk of STIs and malaria increase Esa10: interference with graves and sacred sites RC4: Trampling of pedestrians in the construction area	Relationship with the communities and local organizations: • The construction work must be accompanied by the implementation of a scheme of relationships with communities, which ensures: ▪ The implementation of the communication plan established by ANE; ▪ The holding of public meetings at least in each Administrative Post and ideally in each affected village, before the commencement of the construction work; ▪ The creation and dissemination of appropriate communication channels to the socio cultural reality of each affected area with the intention of receiving requests for clarification, comments and complaints; ▪ The analysis and follow-up of the received contacts; ▪ The provision of up-to-date information to populations on the progress of the works and their implications. • The following are guidelines for the implementation of such scheme for the relationship with the public: ▪ Should be operational before the beginning of the Work and continue until the end of the same; ▪ should start with the holding of public meetings at least in each Administrative Post, ideally in each neighborhood. During these sessions the general planning of works and this scheme for the relationship with the public should be made known. ▪ the contractor shall indicate a person in charge of establishing communication between the project and the local population and their leaders. This person should be well acquainted with the Project and have expertise in the area of public relations in order to be able to intervene in cases of social conflict or filing of complaints, knowing how to forward or resolve the issues. ▪ All contacts made by the population and actions that are likely to follow should be recorded. As a rule, no request for information or complaint, shall be left without an answer; ▪ Prior to any relevant intervention and that may involve, for example, disturbances of circulation at some locations	ANE + Contractor

Impacts to minimize/maximize	Description of the measure	Responsibility
	affected by the works, the communities potentially affected should be promptly informed by means /initiatives appropriate to the socio-cultural reality of the location; ▪ the same procedure should be taken before new road becomes operational. The content of the information to be provided should highlight the risks associated with this new road. Specifically with the aim of preventing conflicts between the labor force and local communities: • Organize small induction meetings with workers from the outside with the aim of giving basic information about the uses and customs and set correct ways of behavior and relationship that these should have with the local population; • Carry out awareness of staff hired locally for them to keep attitudes and behaviors of respect for the local population; • The Contractor shall develop and implement codes of social conduct, in accordance with the cultural characteristics of the resident population and ensure that employees comply and follow the codes of social conduct drawn up; • If the staff hired is housed in a camping, this must be closed and norms to prevent access of strange people to the camp must be laid down. If the need to perform some specific ceremony related to sacred sites has been identified: • Before starting the Work, the contractor must contact the relevant traditional authority to carry out the required ceremony for the Work to take place smoothly.	
SEC2: Contribution to the alleviation of poverty SEC3: Socio-cultural conflicts with staff coming from outside the project implementation area SEC6: Job and services provision opportunities	Recruitment of labor: • In the recruitment of personnel for the construction works, priority should be given to local labor; • Give priority to hiring of local labor considering firstly the population residing in the neighborhoods traversed by the Project, where consistent with the needs for the proper execution of the work. • Carry out the recruitment in coordination with the authorities of the Administrative Posts and community leaders in the Project Area in order to give preference, whenever possible, to local residents, but avoiding giving the responsibility for the final contracting to local authorities (the State and community). This must be the contractor's responsibility. • Take all necessary measures to ensure that the process of hiring skilled labor is transparent and ensures an equitable distribution of available jobs to the population living in the neighborhoods of the Project Area. • Provide jobs for women, favoring the employment of those who are heads of households.	ANE + Contractor
General (prevention of all impacts and	Training and awareness of staff: • At the beginning of the Work training and awareness to	ANE + Contractor

Impacts to minimize/maximize	Description of the measure	Responsibility
risks)	undertaking team should be carried, in order to improve their knowledge about the actions that should be taken in order to prevent or minimize the environmental impact of their activities and to promote better relationship with the local populations. These training and awareness actions should be given by the contractor, taking the record of the attendance and contents, and include at least the following subjects: ▪ Environmental effects the project might cause and corresponding best practice and preventive and corrective measures to be taken; ▪ Rules and procedures for waste management in the Work; ▪ Security risks associated to works and corresponding measures and behaviors for the prevention, including the movement of vehicles used for the Work in the crossing of populated areas; ▪ First aid measures and actions in the event of an accident; ▪ General rules of relationship with local communities; ▪ Risks and prevention of sexually transmitted diseases. • Whenever new staff is admitted, similar training and awareness should be given. • In the course of the Work and as a result of the follow-up and monitoring activities, the need for complementary training and awareness may be determined, if it becomes apparent that the previous actions have not produced the desired effects.	
RVC2: Increase of vibration in precarious buildings	Surveys of buildings adjacent to the trace: • Implementation of surveys to buildings adjacent to places where the construction works will be carried out, particularly in the saline area. These surveys should be carried out before the commencement of the Works and after its completion, giving rise to records (including photographs) to identify the damage that may be caused by works (vibration) and that, as such, have to be repaired. • In cases where the survey conducted prior to the commencement of the Work identifies buildings that are in a state of such fragility that run the risk of collapsing as a result of the vibrations caused by the Works, their demolition should be promoted, with compensation or resettlement of its owners/beneficiaries	ANE + Contractor

Location and Operation of the Construction Sites

Impacts to minimize / maximize	Measure description	Responsibility
GSC1: Loss of soils by erosion OC2: Degradation of Nacala Bay water by water-borne polluting discharges RHC1: Artificial alteration of	Location of the Construction Sites: • The construction sites and machinery pools should preferably be located in infrastructured sites and within the road protection strip • Interventions in areas not affected or of great	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
the natural drainage network RHC2: Water quality degradation RVC1: Temporary degradation of the acoustic environment RVC2: Vibration increase in the unsteady construction houses. EMCC2: Disruption of species at beaches and adjacent areas ETC1: Vegetation and natural habitats loss SEC6: Loss of fields, cultures and fruit trees ETC2: Contamination of natural habitats by wastes, effluents or hazardous substances SEC1: Loss of bush and humid areas provision service SEC2: Loss of local flora trees SEC5: Loss of farms, crops and fruit trees SEC10: Interference with graves and sacred sites RC2: Accidental fuel or hazardous substances spill in the construction site	ecologic/natural value should be avoided, which should not be situated at the immediate proximity of the residential areas, wetlands or in areas where a vegetation or agricultural crops or fruit tress destruction is necessary or in areas where there is interference with graves and sacred sites. • The construction sites should not be installed in less than 250m to the coastline. In this area any activities that could result in contaminations, namely repairing and maintenance of equipment should be avoided.	
SEC8: Risk of STIs and malaria increase	STIs and HIV/AIDS spreading prevention: • Perform regular talks on HIV/AIDS with employees for awareness on STIs and HIV/AIDS including risk behavior/prostitution. • Perform STIs and HIV/AIDS regular awareness campaigns in the entire project influenced area, in close coordination with the health authorities at the Health Facility of the Administrative Post, with special focus on local communities and women of different age groups. • Implement awareness actions held by qualified and duly certified institutions/people; • Establish and implement a set of norms (or a Code of Conduct) for the employees;	ANE + Contractor
RC3: Work accident involving the construction employees only	Work accidents prevention: • Perform regular talks on safety at work, administered by the responsible/supervisors of the works; • Ensure that all employees know the area where the work will take place and the risks associated to specific activities; • Ensure that all machine operators/drivers are duly trained and certified to operate such machinery;	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
	• Appoint employees to control the machine positions and inform the drivers during the movement of heavy machines; • Provide life-jackets and buoys for the job to be done at the Bay with; • Where and when necessary, put platforms on which employees rely to perform their tasks safely; • Provide employees with Individual Protection Equipment (EPI) and ensure its compulsory and appropriate use. The minimum EPIs should be helmets, boots and protection clothes. Other EPIs, such as gloves, protection glasses, face and ear protectors, safety belt should be provided and used whenever conditions require; • Avoid any potential focus of fire in the working areas.	
RC4: Trampling of pedestrians in the construction area zone	Access safety and control: • The construction sites should be fenced and with controlled access, to prevent strangers to enter the site, keeping guarding service during the period of the works (until the construction sites are deactivated). Promotion of awareness campaigns to the communities about the works-related risks	ANE + Contractor
RHC3: Water access conflicts	Management of water supply to the works: • The Contractor should ensure that there is no harm or limitations to the population resulting from the works water needs satisfaction. For that to happen, if needed the Contractor should seek the necessary water where there is no shortage to the communities, even if the vehicles transporting water have to drive longer distances. • The use to be given to the different origins of the water must be in accordance with the respective quality. The supply of enough drinking water to satisfy the employees' needs while on duty should be given special attention.	ANE + Contractor
GSC2: Soils contamination OC2: Nacala Bay water quality degradation due to polluting discharges carried by the water lines RHC2: Water quality degradation RC2: Accidental fuel or hazardous substances spill at the construction site	Wastes and wastewater management: • The construction sites should have appropriate sanitary facilities in accordance with the number of employees. • The wastewaters from the sanitary facilities or any other wastewaters from other areas of the construction site should be drained and, if necessary, subject to an adequate treatment according to the type of contamination presented, previous to discharge at the receiving means. • The construction sites should have appropriate technical conditions to store all kind of wastes awaiting transportation to recycling, treatment or elimination. • The different kinds of wastes, duly signalized, should not be mixed or exposed to meteorological conditions that may cause its degradation or result in soil, water or	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
	air contamination. • The wastes originated in front of the working area should be store, separately, in appropriate containers, in order to be removed to the construction site in good conditions. • Once received at the construction site and until removed for recycling, treatment or elimination by duly certified/authorized operators, the different kinds of waste should be store at the conditions mentioned above.	
GSC2: Soils contamination OC2: Nacala Bay water quality degradation due to polluting discharges carried by the water lines RHC2: Water quality degradation RC2: Accidental fuel or hazardous substances spill at the construction site	Storage and handling of hazardous substances: • The storage and handling of oils, lubricants or other substances that can cause superficial or subterranean water and soils contamination should be done in specially arranged sites, for the safekeeping of environmental and human health values. • At least, if handling of oils and fuel is necessary, impermeable and limited areas to contain spills should be available.	ANE + Contractor
GSC2: Soils contamination OC2: Nacala Bay water quality degradation due to polluting discharges carried by the water lines RHC2: Water quality degradation RC2: Accidental fuel or hazardous substances spill at the construction site:	Machinery servicing and maintenance: • The machine servicing and maintenance should not be performed at the working place, but in duly prepared workshops. • When such work has to be done in the working place, all necessary measures to prevent soils and water contamination and waste collection should be taken, and the waste will be taken for recycling, treatment or elimination.	ANE + Contractor

Execution of works

Impacts to minimize / maximize	Measure description	Responsibility
RC1: Traffic accident involving vehicles or machinery of the works or vehicles circulating at N12 and R702 roads at the zones crossing with the works RC4: Trampling of pedestrians hitting in the construction area	Fencing and signaling of the works and conditioning of the pedestrian and vehicle circulation: • The Contractor should in all occasions ensure the signaling of the working areas, restricting the circulation of people, machinery and equipment only to the defined entrances and limiting the construction process actions to the intervention areas to avoid the affectation of areas which are not strictly necessary for the good execution of the work. • The fencing and signaling condition should be reinforced at the areas adjacent to the inhabited areas and in areas that are usually frequented by the local community and where there is major pedestrian's circulation.	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
	• No open excavation should be left at night or in off days (weekend or holidays) without appropriate signaling or protection.	
GSC1: Loss of soil by erosion ETC1: Loss of vegetation and natural habitats SECeco2: Loss of trees and local flora PC1: Landscape temporary degradation UTC1: Affectation of cropping areas and various cultures, trees, graves, praying sites and various infrastructures (see socioeconomics)	Deforestation activities : • Raise awareness to the deforestation and construction team about the need to preserve the flora and vegetation and the prevention of burnings; • The vegetation should, whenever technically feasible, be kept, cutting only when the project requires it; • The cutting of tree species should be extremely avoided; • The biomass resulting from the vegetation cutting should, as priority, given to the local communities for utilization; • Raise awareness to the teams involved in actions of construction and vegetation cutting about the need to preserve the fauna; • During the performance of the deforestation works, low mobility fauna species individuals (reptiles, amphibious and micro-mammals) should be scared or saved, through the capturing and releasing in parts of the natural vegetation not directly affected by the works. This measure intends to minimize the potential impact of the increase of hitting/burying risks of less mobility fauna species. • Perform deforestation actions during the dry season.	ANE + Contractor
GSC1: Loss of soils by erosion GSC2: Contamination of soils RHC1: Artificial alteration of the natural drainage network	Earth movement material management: • The soils resulting from the excavation operations, should, if possible, be reused for landfill purposes. The remaining quantitative that cannot be reused will be considered waste, and should be led to an appropriate destination, and cannot be indiscriminately spread in places where damage can be caused. • In all cases, the vegetal land (fertile soil layer) should be separated and stored carefully in order to allow its subsequent application in the replacement of the areas affected or for landscape integration of the slopes generated during the construction of the roads. Such material should be separated and stored in 2 meter high piles, which should be protected from erosive agents' action. • A temporary natural drainage system (for example through driving water with full sand sacs) should be implemented to divert eventual water running from the superficial soil deposition areas.	ANE + Contractor
GSC2: Contamination of soils	Cleaning of concrete mixers or concrete waste: • The water that cleans concrete mixers and waste that may be produced by the works should not be thrown to the soils, but collected for controlled deposition in places where they will not	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
	cause environmental damage.	
GSC1: Loss of soils by erosion RHC1:Artificial alteration of the natural drainage networks	Prevention of erosion: • In places where there are terrain drainage alterations (rain water routing), it should be ensured that the new discharge points are situated and built in such a way to prevent the rise of concentration of big flows that may result in localized erosion phenomenon; • If such discharge points are located in slopping lands the protection of the downstream area should be previewed, with the placement of winding that allows the decrease of the speed of the flow and protection of soils in these places. • A temporary natural drainage system (for example through driving water with full sand sacs) should be implemented to divert eventual water running from the superficial soil deposition areas.	ANE + Contractor
GSC2: Contamination of soils RHC2: Water quality degradation RC2: Accidental fuel or hazardous substances spill at the construction site	Behavior in cases of soil contamination: • In case of soil contamination by spill or leakage of effluents or hazardous substances, the contaminated soils should be removed and placed in sealed containers while taken for treatment or deposition in controlled landfill.	ANE + Contractor
GSC2: Contamination of soils OC1: Nacala Bay water quality degradation by re-suspension of sediments OC2: Nacala Bay water quality degradation by polluting discharges carried by the water lines RHC2: Water quality degradation EMCC1: Benthic and nektonic organisms disturbance EMCC2: Disturbance of the species at beaches and adjacent areas	Management of the material resulting from the drilling for the bridge foundations: • Rigorous application of the previewed constructive method for the execution of piles, namely the separation between water and solids, for controlled deposition. • The solid material should be deposited in an impermeable area to be identified in terrains adjacent to the layout or at the Port expansion area (where the construction of the controlled deposition of dredged material of the bay is previewed); • The water separated from the solids should be monitored about its level of contamination and treated as necessary before carried to the bay.	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
EMCC3: Affectation of the mangrove SEcoC1: Loss of bush and humid areas provision service		
QAC1: Temporary degradation of the air quality (dust, gases, smell) RVC1: Acoustic environment temporary degradation	Water quality preservation and noise reduction: • All equipment, machinery and vehicles affected to the works with combustion engines should be in good working conditions, in order to limit the undesired emission of atmospheric pollutants and noise. • When machinery and vehicles circulate in non-paved areas or land mobilization and as result dust that can cause damage is raised, such ways or working fronts should be watered in order to reduce the dust. During the watering, not drinkable water should be used (see point related to the water supply to the works); • The open sky burning of any urban industrial, toxic or dangerous waste or of material considered as scrap is not allowed • The construction works that may produce noise should be performed not during the normal resting period ate the surroundings of the residential areas.	ANE + Contractor
ETC1: Loss of vegetation and natural habitats SEcoC1: Loss of bush and humid areas provision service SEcoC2: Loss of trees and local flora UTC1: Affectation of cropping areas and various cultures, trees, graves, praying sites and various infrastructures	Fire prevention: • The performance of hot working (namely cutting and weltering works), as well as any other activity that involves fire should not be allowed in places with combustion material (namely dry vegetation) which may increase the risk for fire; • Any works or activities that imply fire risk should be preceded by cleaning of the grass or bush and performed in the presence of firefighting means immediately callable.	ANE + Contractor
GSC2: Contamination of soils OC2: Nacala Bay water quality degradation by polluting discharges carried by the water lines RHC2: Water quality degradation EMCC2: Disturbance	Emergency response: • Emergency procedures that allow a quick, agreed and effective performance in case of accident during the construction phase should be developed. In order to ensure an affective operation of these procedures, they should include a list of the responsible people (and the corresponding substitutes) to call in case of emergency. • First aids means (human and material) appropriate for the risks in presence and for the number of employees involved should be available at the construction sites and the personnel should be	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
of the species at beaches and adjacent areas ETC2: Contamination of natural habitats by wastes, effluents or hazardous substances SEcoC1: Loss of bush and humid areas provision service RC2: Accidental fuel or hazardous substances spill at the construction site	aware of the actions to be taken in case of emergency. • In places where hazardous substances are stored and/or handled means (absorbing products – sand or sawdust – containers to collect spilled products) should be available, which allow a quick action in case of spill occurrence in order to reduce the quantity of the spilled product and the extension of the affected area. The personnel on duty in such places should be specifically trained about the actions to take in case of spills. • In places where inflammable substances are stored and/or handled means of first intervention in case of fire (at least extinguishers appropriate for the substance in hand) should be available and the personnel should have specific training for its use. • During the duration of the construction works, the Contractor should ensure the capacity to promptly answer, even after hours or at weekends or holidays, for any accident or emergency situation related to the works (at the construction site or at any working front), and should, for that purpose, keep readiness state staff and in conditions to be hired.	
SEC9: Discovery of historical or archeological heritage	Management of discovery of historic or archaeological remains : • In the event of discovery of historic or archaeological remains, the works should be interrupted and the finding should be notified to the district authorities, for a definition of an action plan accordingly. The Contractor representative at the site will ensure that all findings are collected and recorded and that the works are not restarted without the authority's clearance.	ANE + Contractor

Conclusion of the works

Impacts to minimize / maximize	Measure description	Responsibility
GSC1: Loss of soils by erosion ETC1: Loss of vegetation and natural habitats SEcoC1: Loss of bush and humid areas provision service PC1: Temporary landscape degradation	Reposition of the affected areas: • After the installation of the infrastructures and the eviction of the places granted for the construction sites, the material pools and borrow areas, the affected areas should promptly be recovered, in order to put them back to their previous state, unless a future use that will benefit from maintenance of the existing condition is previewed and proven. • After the removal of all temporary structures, the compacted soils should be rehabilitated, through application of vegetal land (superficial soil) kept in piles and re-vegetation, using native vegetation for that purpose. • Due to the previewed affectation of the mangrove (even if i tis in a very disrupted) measures of compensation should be implemented, namely plantation of seedling of the existing	ANE + Contractor

Impacts to minimize / maximize	Measure description	Responsibility
	mangrove in alternative places	

7.3.3 Operation Phase

Impacts to minimize / maximize	Measure description	Responsibility
RO1: Traffic accident not involving hazardous substances spill RO2: RO1: Traffic accident with hazardous substances spill RO3: Pedestrians hitting	• The population information about the risks, behavior and preventive measures related to the new infrastructures before its opening for the traffic, the neighboring populations should be informed in time through the performance of public sessions and/or information leaflet. The content of the information to be delivered should emphasize the risks associated to the new road, namely according to the previewed traffic and its speed as well as the behavior that helps prevent such risks. The school community in that area should be specially aimed.	ANE
RHO1: Artificial alteration of the natural drainage network (started at the construction phase) RHO2: Degradation of the water quality of the Bay by polluting discharges carried by the water lines	• The hydraulic tramps that exist along the layout of the roads should be kept in conditions that ensure a good water flow. For that purpose a regular observation scheme should of all hydraulic tramps should be implemented in order to identify those which need cleaning (silt removal) in time and to perform the necessary interventions.	ANE
GSO1: Erosion RHO2: Degradation of the water quality of the Bay by polluting discharges carried by the water lines	• After the intensive rains, the landfill of the bridge joints should be monitored, to identify possible spots of erosion. Any damage should be immediately reported for a quick repairing.	ANE
QAO1: Degradation of the air quality due to the traffic emissions at the road that gives access to Nacala Port QAO2: Improvement of the air quality at the surrounding of N12 (due to the decongestion deriving from the opening of a new road) QAO1: Degradation of the acoustic environment due to the noise emitted at the road to Nacala Porto RO1: RO1: Traffic	• Adequate pavement maintenance and signaling of the new road in order to prevent risks of accidents and promote traffic flow, with less emission of pollutants and vehicle wear out.	ANE

Impacts to minimize / maximize	Measure description	Responsibility
accident not involving hazardous substances spill RO2: RO1: Traffic accident with hazardous substances spill RO3: Pedestrians hitting		
OO1: Degradation of the water quality of the Bay by polluting discharges carried by the water lines RHO2: Degradation of the water quality of the Bay by polluting discharges carried by the water lines EMCO1: Ecological damage by decrease of the water quality of the bay ETO1: Contamination of humid areas by waters running-off the road RO1: Traffic accident not involving hazardous substances spill RO2: Traffic accident with hazardous substances spill RO3: Pedestrians hitting	• ANE should have an emergency plan, where the acting measures and protocols for a prompt response in eventual emergency situation are systematized, in order to mitigate the environmental and social damage potentially resulting from it which will reestablish the power transportation service as quickly as possible. • Such planning should consider risks of: ▪ Natural disasters (earthquakes, extreme atmospheric phenomenon); ▪ Vandalism or sabotage acts; ▪ Accidents or fire in areas adjacent to the road ▪ The emergency plan should preview, at least: ▪ The protection and prevention measures to adopt; ▪ The communication protocols to adopt (for pre-warning, if applicable and possible, or for warning and alert) and the mechanisms for articulation with external entities; ▪ Procedures for operation resume; ▪ Procedures for information release.	ANE
SEO1: Difficulty in accessing the provision service at the beach and mangrove SEO3: Barrier effects at the pedestrian circulation for the people: RO3: Pedestrian hitting	• Maintenance of pedestrian crossings built to facilitate the road crossing by the community • Maintenance of the vertical and horizontal signalizing of the risk of pedestrians crossing	ANE

7.4 Environmental Education Program

The Contractor shall ensure the performance of an appropriate environmental education. All employees must undertake an introductory presentation about the environmental awareness. If possible, such presentation should be in the employees' mother tongue.

The environmental training and education must give reference to:

- Basic awareness and understanding of the main environmental characteristics of the construction site and surroundings.
- Understanding of the importance and reason for environment protection.
- Ways of minimizing environmental impacts.
- Fire prevention and management.
- Health risks related to the construction site, including prevention of diseases such as malaria and cholera.
- Awareness, prevention and minimization of risks related to HIV/AIDS and other STIs contraction and dissemination.

The training on environmental awareness must focus on:

- Water quality protection;
- Riparian habitat protection;
- Fields protection;
- Erosion risk minimization;
- Waste management;
- Dust management;
- Health risk management (malaria, cholera and STIs);

The Contractor must keep participation records.

The Contractor must install and provide employees with Environmental Information Posters about HIV/AIDS and other STIs.

The Environmental Information Posters must be available in the eating area and other areas indicated by the FA.

7.5 Communication Program

ANE and the Contractor will establish a communication system with the local community and authorities with regards to the construction activity, Including:

- The purpose and activities of the proposed project in the area;
- The long-term activities and the potential environmental and social impacts;
- How such activities will be conducted to ensure an appropriate environmental and social management;

- Employment Requirements and Employment Policy; and
- Contact details availability in case residents have queries, worries or complaints.

ANE and the Contractor will ensure the availability of a procedure for complaints records, defined but not limited to:

- Where the community members can address their issues/complaints;
- Means by which community members can address issues/complaints;
- How the community will be notified on the project-related opportunity and means of communication; and
- How these issues/complaints will be recorded, managed, answered and corrected if necessary.

The Contractor must keep a comments and complaints records. This record must must be kept available for ANE periodic revision purpose. The record must include but not limit to:

- Complainant / communicator name;
- Communicator contact details;
- Communication nature;
- Any action performed to correct the issue.

7.6 Emergency and Contingency Program for Accidents

The Accidents Emergency and Contingency Program, to be established, has as main purpose, based on the identification of the accidents potential causes and emergency situations, to define the response form for associated risks prevention and act in case of accident, minimizing its effect to the environment.

Given the different particularities of the construction and operation phases, specific plans for each of these two phases will be performed. It is up to the Contractor to draw up the plan for the construction phase, before the commencement of works and to ANE the review of the plan for the operation phase, before commencement.

In either case all the assessed risks will be considered, without prejudice of others wish may be identified during the development of the detailed project, preparation of the beginning of the construction and the operation of the new road.

Thus, at least the below risks have to be considered:

During the construction phase:

- Traffic accident involving machinery of the works or vehicles circulating in the N12 and R702 roads in the areas crossing with the works
- Accidental fuel or hazardous substances spill in the Construction Pool.
- Fire

- Accident at work (affecting employees of the construction only)
- Pedestrians hit in the works zone
- Occurrence of cyclone during the construction works
- Occurrence of floods during the construction works

During the operation phase:

- Traffic accident not involving hazardous substances spills
- Traffic accident involving hazardous substances spills
- Pedestrians hit
- Occurrence of floods or fire, interfering in the roads operations

7.7 Monitoring Program

An essential part of the monitoring to be implemented in the context of the EMP implementation during the construction phase corresponds to the daily checks to be performed by the Resident Engineer and the Environmental Auditor to ensure that the Contractor complies with the established environmental specifications, identifying any deviations and acting in the direction of corrective measures that are required to be promptly defined and put into practice.

In addition, the following sections provide a set of provisions for specific monitoring programs which briefly cover:

Table 40: Summary of the monitoring program

Descriptor	Phase	Location	Parameters	Frequency	Responsability
Oceanography	Construction and operation	To be carried out based on the results of the monitoring program that is implemented under the port expansion project			ANE to coordinate with Portos do Norte
Noise	Operation	Nearest habitations to the access road to the Port of Nacala located at km 3 + 200 and 10 + 300 of the project.	LAeq in dB (A) in the daytime and night reference periods	A campaign before the start of the road; One campaign per year after the start of the operation; Each campaign must be done on a business day and on a Sunday.	ANE
Road accidents	Operation	Areas of greater use for pedestrian crossing (districts of Murrupelane, Locone and	Number and consequence of accidents: Number, origin and destination of	Periodicity biweekly in the first three months of operation and monthly in the following months,	ANE (in liaison with police authorities and local leaders.

		Matola). Any accident occurring in the Port of Nacala Access must be registered.	persons crossing the road; Presence of the most vulnerable (children, the elderly, the disabled);	until the end of the first year of operation. Each campaign must be carried out on a business day and on a Sunday at the beginning and end of the day	

7.7.1 Oceanography

The Environmental Management Program (EMP) of the Nacala Port expansion encompasses an extensive monitoring program, among others, of the oceanography. Considering that the meaning of the impacts associated to the Port is more important than the ones which will be held in the roads considering the physical proximity between the works of the Port expansion and of the bridge included in the road project, it is recommended that the follow-up of the evolution of the oceanography descriptors at the project influence zone be done based on the results of the monitoring to be implemented in the Port expansion context.

For that purpose, it is recommended that ANE articulates with the entities responsible for the Port expansion to share such results.

7.7.2 Noise

The annual monitoring of the noise levels near the residences closer to the road that accesses Nacala port should be performed right since the start of the operation of the road.

Monitoring sites

The sites selected for monitoring are the residences closer to the road that gives access to Nacala Port situated at km 3+250 of the project and the residences closer to the road situated at km 10+300 of the project (See following Figure).

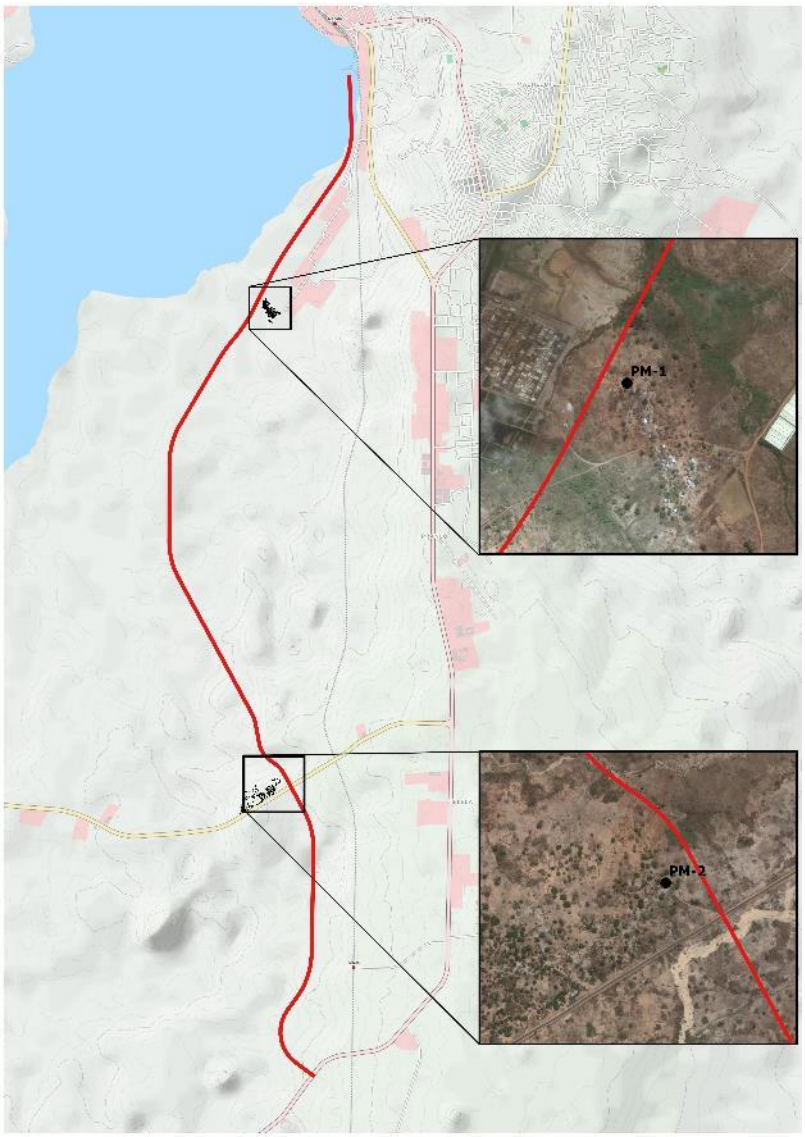


Figure 45 : Noise monitoring plan – sites to consider

Parameters to monitor

The equivalent continuous sound level should be measured, LAeq in dB(A) in the day reference periods (7AM to 10PM) and night (10MP to 7AM) to assess the impacts associated to the traffic that will circulate in the Nacala Port access road, taking into account the guiding values determined by WHO.

The following should also be recorded:

- The date of each measure;
- Starting and ending time of each measure;
- The sources of the prevailing noise;
- Traffic counting during the measure period;
- Meteorological conditions observed during the measure interval

Monitoring Frequency

A monitoring campaign should be performed before the entry into operation of the road and after the entry into operation an annual campaign should be performed.

Outcomes analysis

For each monitoring point, the monitoring outcomes should be analyzed considering the guiding values determined by the WHO.

If the monitoring outcomes are above the WHO guiding values a need for implementation of acoustic protection specific measures should be analyzed.

After the implementation of the minimizing measures, new monitoring campaigns should be performed to assess their effectiveness.

7.7.3 Road accidents

The new Nacala Port Access will be situated in the peri-urban area of the Nacala-Porto City, used for pedestrian circulation, namely children. Given that it's a 4 way road, mainly used by heavy vehicles, there will be risk for hitting accidents. Therefore, apart from the mitigation measures implementation, a monitoring of the pedestrian crossing points and potential accidents is needed in order to ensure whether additional measures will be necessary.

Monitoring sites

The three areas identified as of major pedestrian crossing use of the new access should be regularly monitored, namely in the neighborhoods of Murrupelane, Locone and Matola.

In addition, any accident occurring in the Nacala Port Access should be recorded. This will require an articulation between ANE, the police authorities and the local leadership.

Parameters to monitor

In sites of pedestrians crossing point major utilization the number of people crossing and the eventual presence of vulnerable people (children, aged and physical disabled), their origin and destiny must be monitored regularly.

Monitoring frequency

This monitoring should be performed during the first year of operation, in a fortnight basis in the first three months and monthly in the following months. It should be performed during weekdays and on a Sunday, at the beginning and end of the day.

Outcomes analysis

For each monitoring point the monitoring outcomes should be analyzed. If there is a major affluence of pedestrians crossing and/or running over the awareness campaigns on road safety should be reinforced and the possibility of implementation of other measures analyzed.

7.8 Management and Reports

The Contractor shall:

- Through OA, perform daily inspections at the construction site to ensure the compliance of the Environmental Specifications.
- Give weekly oral reports to FA and/or to ER, specifying either the EMPcompliance as well as the environmental behavior.
- Keep a record of more serious incidents (spill, harm, complaints, legal infractions, fines and penalties, etc.) as well as how the corrective and preventive actions are carried and submit it to the FA and/or ER during the weekly meetings for the assessment of the situation.

The FA shall:

- Perform regular verifications to ensure that the system of implementation of the EMP is working effectively. During these verifications the FA shall ensure that procedures which ensure the following are in place:
  - Updating of the used versions of the Method Declaration and of the EMP.
  - Recording of the EMP/Method Declaration deviations and non-compliance with corrective measures.
  - Appropriate training on environment to staff.
  - Availability of the emergency procedures and that staff is aware of them.
- Keep a record of more serious incidents (spill, harm, complaints, legal infractions, fines and penalties, etc.) and other documents related to EMP.

The ER Shall:

- Receive the information prepared by the FA about the environmental performance of the Contractor.
- Receive the reports and any documentation that the Contractor will submit during the construction, which is relevant for environmental management of the work. Then the ER shall report it to ANE together with their evaluation of the information provided as well as due recommendations for action.
- Support ANE in carrying out audits.

ANE-DM shall:

- Perform environmental audits to ensure the efficient operation of the EMP implementation system.
- Receive reports submitted by the ER focusing on the implementation of the EMP.
- Submit reports about environmental management of the project to funding agencies and/or local or national level environmental authorities whenever necessary.

7.9 Cost Estimation

An important part of the recommended measures in this EMP has to do with requirements compliance or with good practices that the Contractor should undertake in his current cost for the execution of the works.

On the other hand, other measures correspond to the engineering project solutions foreseen or to be developed in the following stages (for example the constructive processes for the construction of the bridge foundations or the safe pedestrians crossings to be implemented in certain zones of the design) and the budget estimation of these measures will be issued by the Project Designer.

Following is the cost estimation inherent to the activities not included in any of the above mentioned situations connected to this EMP:

Item	Quantification	Estimated cost (USD)
ANE project imputable expenses – Social Issues and Environment Unit (ANE – GAT) and dedicated mobilization of the Environment Auditor (FA) and Environmental Officer (OA)	40 Months @ 10 000 USD / month	400 000
Compensation for affectation of the mangroves –planting of existing mangrove seedlings and maintenance for 3 years	Global amount	15 000
Local communities communication/relationship program	Global amount	50 000
Accident monitoring (1st year of operation)	Global amount	10 000
Noise monitoring (4 campaigns during 3 years)	Global amount	12 500
Total		**487 500**

Added to these costs will be the ones inherent to the PAR implementation, which are detailed in the appropriate document.

8 Public participation

The environmental characterization presented in this report was carried out based on the collection and analysis of information published and publicly available, complemented by several interviews and meeting with a focus group held in November 2016.

In fact, a Focus Group meeting was held in Murrupelane, with members including all the heads/representatives of the neighborhoods affected by the new road, head of the Muanona and the representative of District Department for Economic Activities and a representative of the Municipal Council of Nacala Porto.

Subsequently meetings with key institutions, including Education, Health and Social Welfare, FIPAG, District Department for Economic Activities and Northern Ports, were held.

These activities have provided a set of relevant information, including the socioeconomic characterization presented in this study, relating to:

- Administrative division of the area crossed by the project, population and key staff;
- Access to and management of land;
- Main sources of income;
- Needs for crossings and social projects;
- Vulnerability and need for protection;
- Access to public services.

These aspects were also taken into account in the evaluation of the environmental and social impacts of the project and, subsequently, in the formulation of the Environmental Management Plan (EMP).

In the context of the EIA process, public consultation on the preliminary version of this SEA took place, under due regulation, with the production of a specific report which is provided in Annex 3.

From the public consultation, the following can be emphasized:

- Massive participation (about 1 000 people) at a meeting held in Nacala on 7th March 2017;
- The concerns expressed at this meeting relate primarily to:
  - Compatibility of the project with sacred sites and, specifically, the "Central Cemitry". The community objected in general to the possibility of exhumation of the graves;
  - Materialization of compensation by allocating goods, particularly in relation to the completion of the survey that has been carried out (in cases in which, for some reason, this survey is wrong or incomplete) and the methodology of payment of compensation (for example, when shall it take place and what shall the form of payment be?);
- With regards to these concerns it was clarified during the meeting that theses shall be taken into account in the following stages of the project implementation, particularly in the development of engineering studies and in the implementation of the Action Plan for Resettlement (PARA).

Furthermore, the results of the public consultation undertaken are properly considered and reflected in this SEA.

9 Conclusions

Provided the analysis of the Project potential impacts and in accordance with the current technical and scientific knowledge no environmental or social impacts that raise doubts about the sustainability or that can significantly condition its implementation was identified.

The pre-construction phase, seen as where the engineering project will be developed as well as a range of preparatory activities for the physical concretization of the Project will play an important role in terms of the impacts on the land and resettlement rights.

In the construction phase, the expected biophysical and socioeconomic impacts will, in general, be negative, except the impacts associated to employment creation.

In the exploration phase there is no prevision for significant biophysical impact, in general. On the other hand, the socioeconomic impact will be in the essential and aligned with the intended objectives for the Project, positive and very significant, namely as a consequence of the important improvement of the accessibility conditions to the Nacala Port.

The work performed leaded to the recommendation of a range of measures which will allow the correction or compensation of the expected negative impacts.

The adoption of such measures will be a very important aspect to ensure the intended Project sustainability.

During the work that leaded to the presentation of this research no knowledge gaps that could condition or limit in a determining way the conclusions hereby presented were identified.

Maputo, April 2017

Annex 1 – Air Quality Standards

The following table shows the air quality standards defined in the Regulation about Environmental Quality Standards and Emission of Effluents (Decree no. 18/2004, 15 September, as amended by Decree no. 67/2010, of December 31).

Mozambican Air Quality Standards

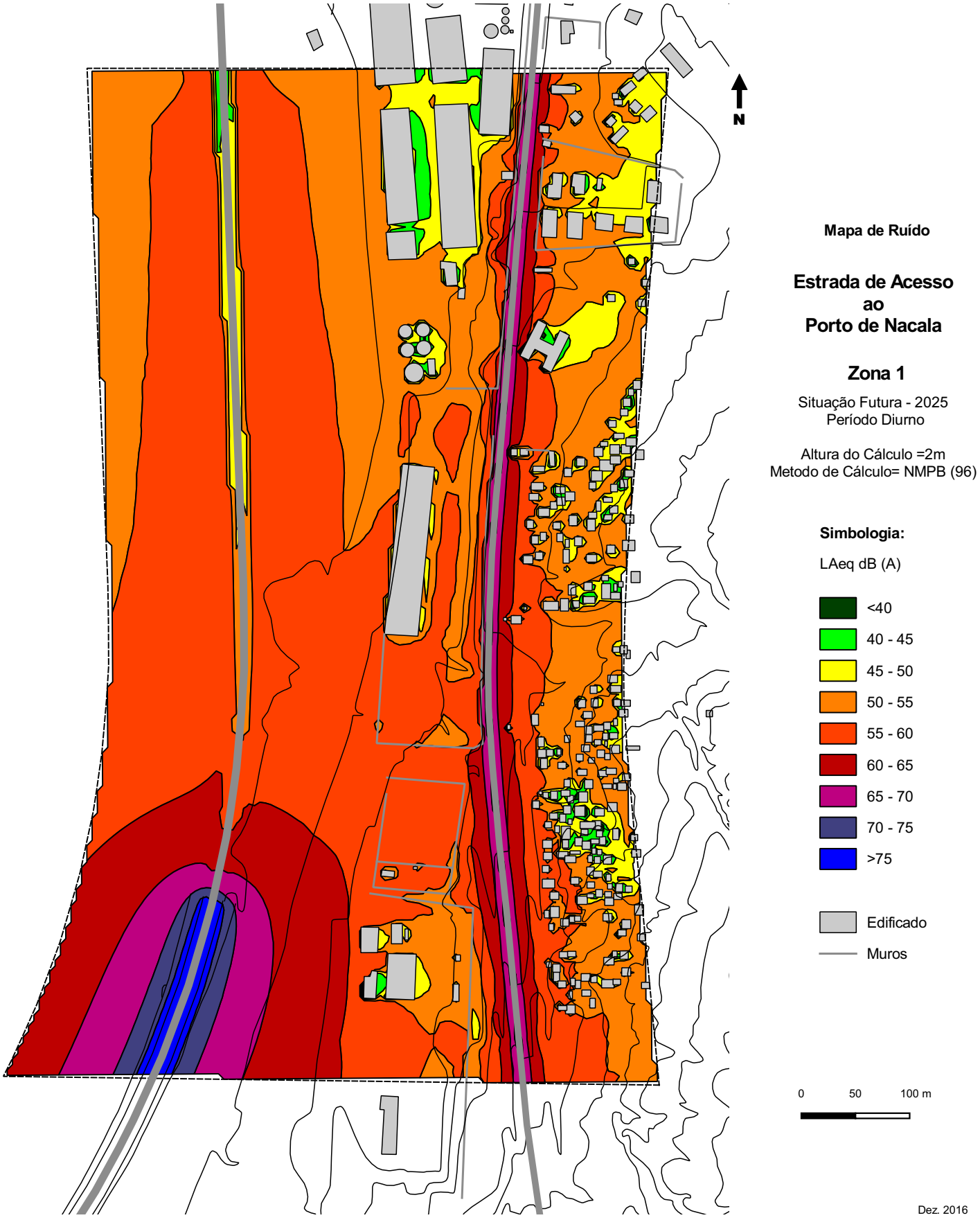
Poluente	**Padrões de qualidade do ar ambiente (µg/m³)**						
	10 minutos	**15 minutos**	**30 minutos**	**1 horas**	**8 horas**	**24 horas**	**Anual**
Dióxido de enxofre (SO_2)	500	-	-	800	-	100	40
Dióxido de nitrogénio (NO_2)	-	-	-	190	-	-	10
Monóxido de carbono (CO)	-	100 000	60 000	30 000	10 000	-	-
Ozono (O_3)				160	120	50	70
Partículas suspensas totais (PST)				-	-	150	60

In the absence of standards in Mozambique for ambient air concentrations of PM10 and PM2.5, the guidelines of the World Health Organization (WHO), in particular the Comprehensive Update of Guidelines for Air Quality recommended by the World Health Organization, 2005, were used. The following table shows WHO guidelines for ambient air concentrations of PM10 and PM2.5.

Guide values for air quality stipulated by the World Health Organization (PM10 and PM2.5)

Pollutant	**Reference period**	**Value guide (µg/m3)**
PM10	1 year	70 (intermediate target-1) 50 (intermediate target-2) 30 (intermediate target-3) **20 (guide)**
	24 hours (99th percentile)	150 (intermediate target-1) 100 (intermediate target-2) 75 (intermediate target-3) **50 (guide)**
PM2.5	1 year	35 (intermediate target-1) 25 (intermediate target-2) 15 (intermediate target-3) **10 (guide)**
	24 hours (99th percentile)	75 (intermediate target-1) 50 (intermediate target-2) 37.5 (intermediate target-3) **25 (guide)**

Annex 2 – Noise Maps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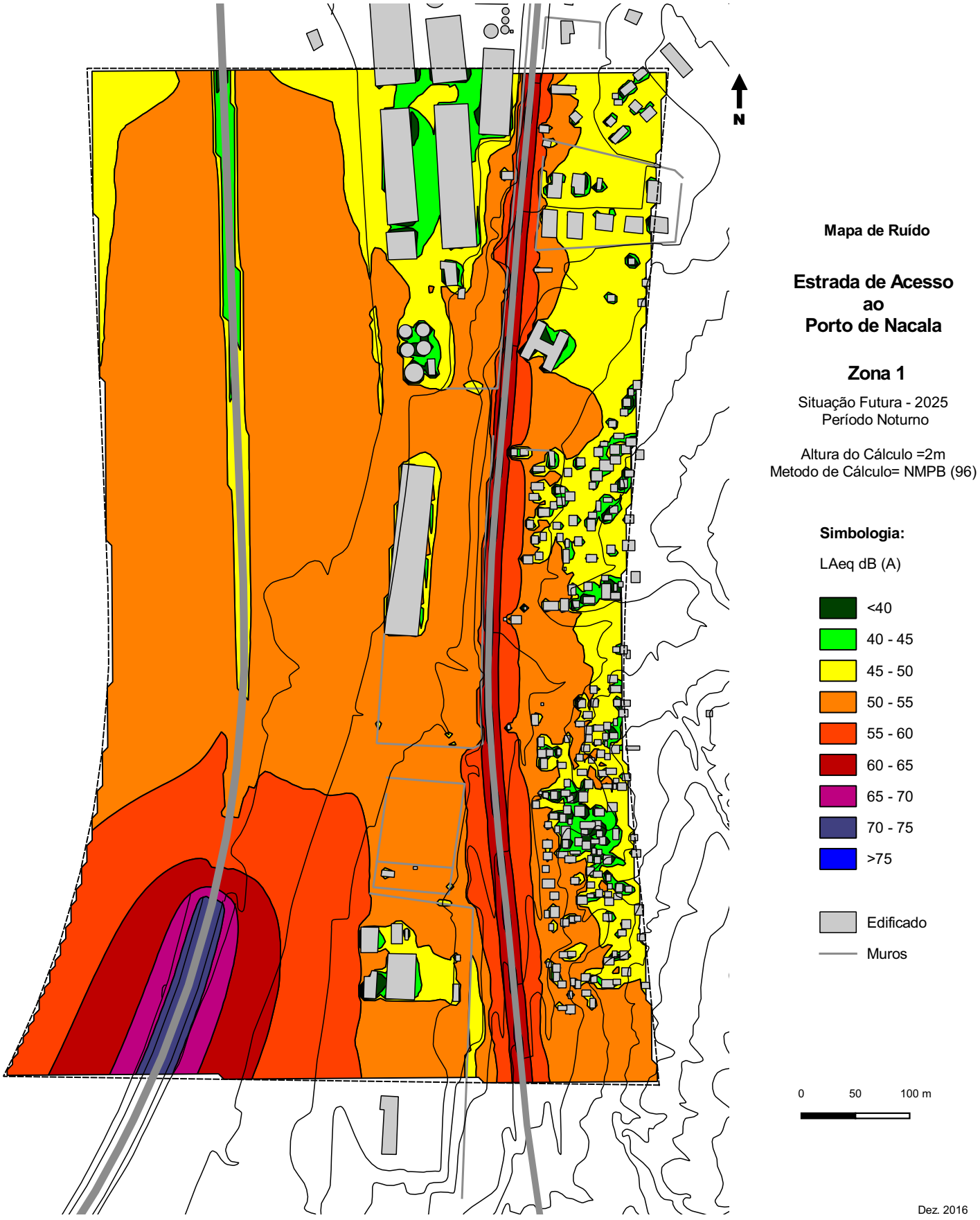
Mapa de Ruído
Estrada de Acesso
ao
Porto de Nacala
Zona 1
Situação Futura - 2025
Período Diurno
Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)
Simbologia:
LAeq dB (A)
<40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
>75
Edificado
Muros
0
50
100 m
Dez. 2016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Estrada de Acesso
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Porto de Nacala
Zona 1
Situação Futura - 2025
Período Noturno
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Metodo de Cálculo= NMPB (96)
Simbologia:
LAeq dB (A)
<40
40 - 45
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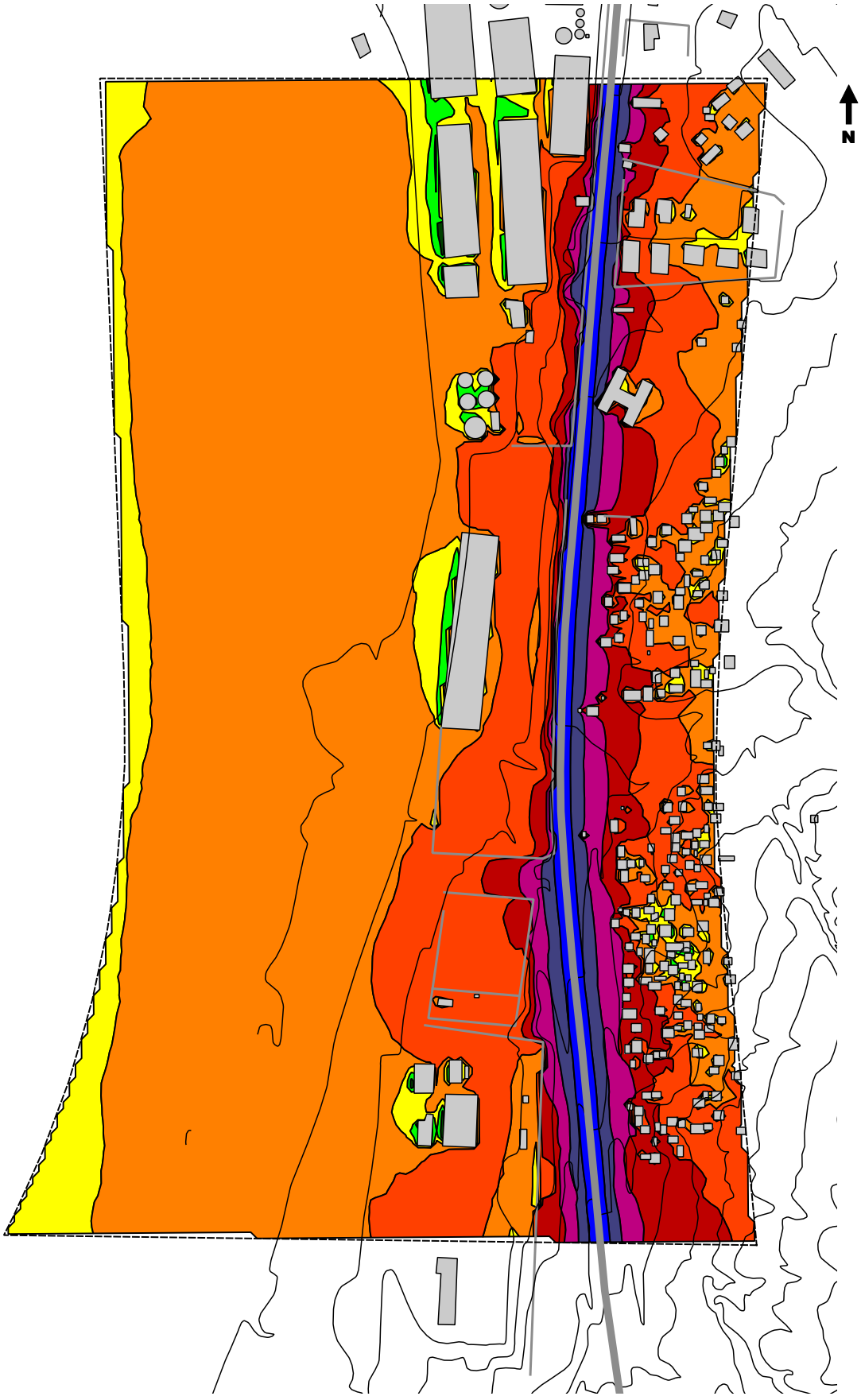
55 - 60
60 - 65
65 - 70
70 - 75
>75
Edificado
Muros
0
50
100 m
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 1

Situação Futura - 2025 S/Projeto
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

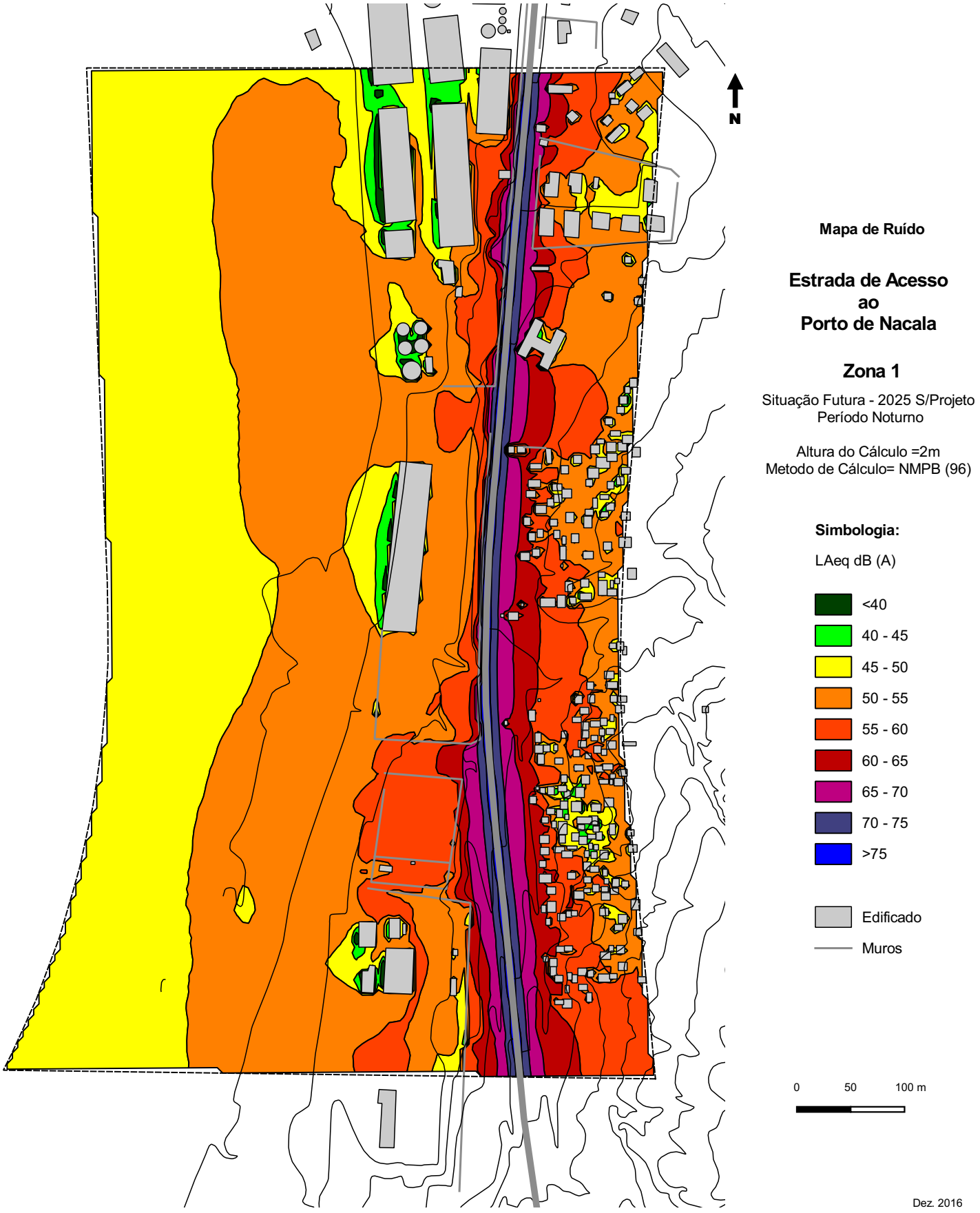
LAeq dB (A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

- Edificado
- Muros

0 50 100 m

Dez. 2016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Mapa de Ruído
Estrada de Acesso
ao
Porto de Nacala
Zona 1
Situação Futura - 2025 S/Projeto
Período Noturno
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Metodo de Cálculo= NMPB (96)
Simbologia:
LAeq dB (A)
<40
40 - 45
45 - 50
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55 - 60
60 - 65
65 - 70
70 - 75
>75
Edificado
Muros
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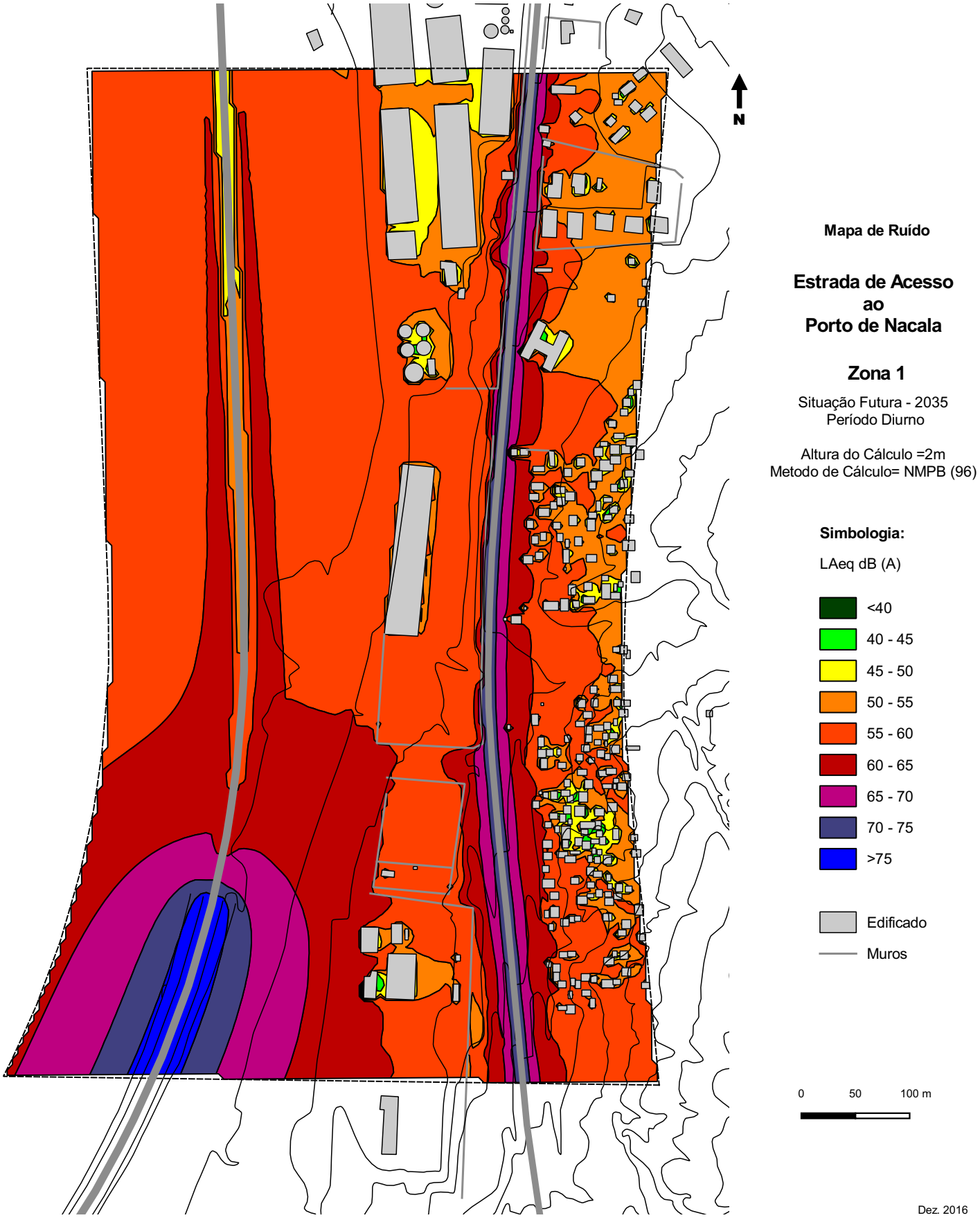
50
100 m
Dez. 2016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Estrada de Acesso
ao
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Zona 1
Situação Futura - 2035
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Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)
Simbologia:
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55 - 60
60 - 65
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70 - 75
>75
Edificado
Muros
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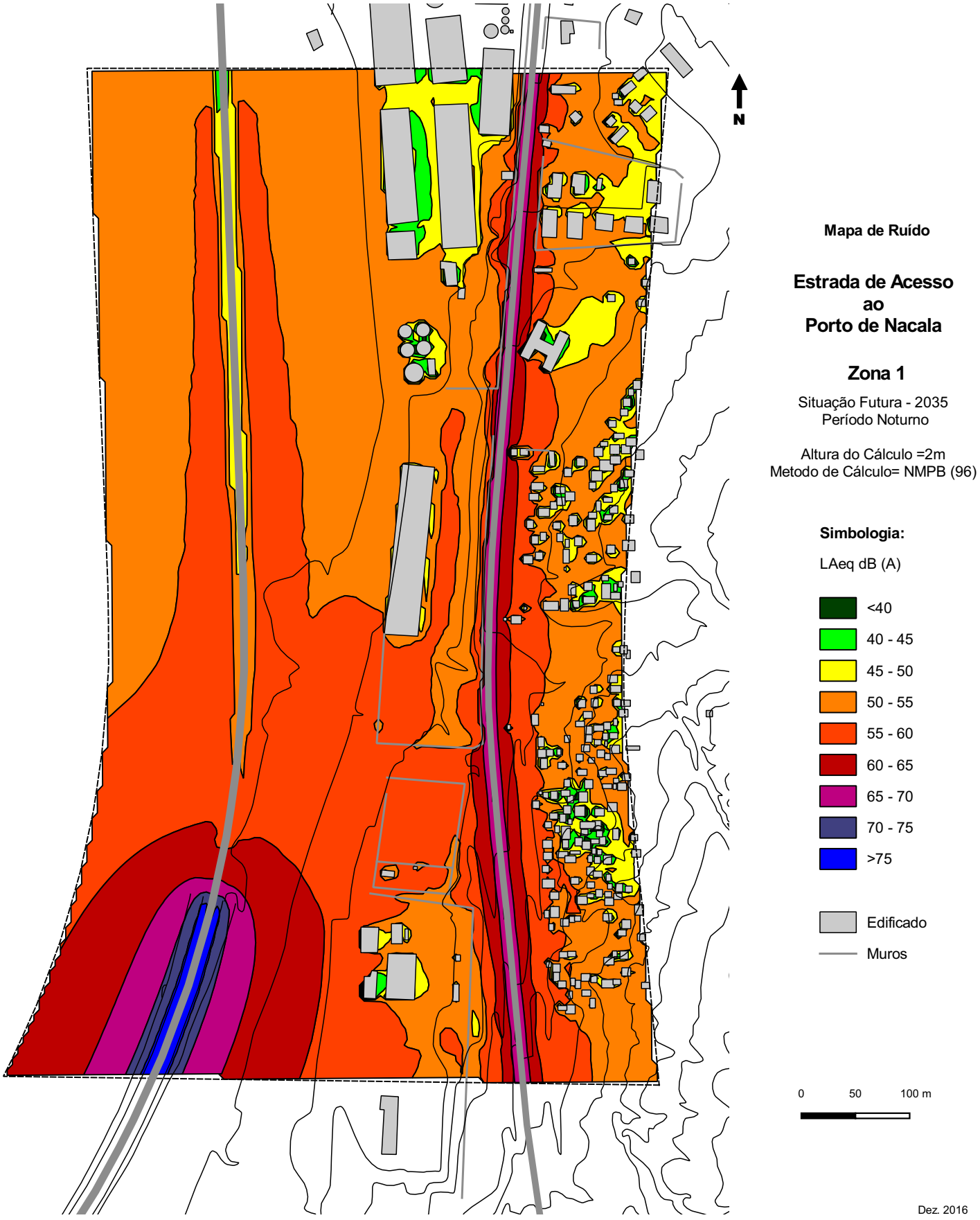
50
100 m
Dez. 2016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Estrada de Acesso
ao
Porto de Nacala
Zona 1
Situação Futura - 2035
Período Noturno
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Metodo de Cálculo= NMPB (96)
Simbologia:
LAeq dB (A)
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55 - 60
60 - 65
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70 - 75
>75
Edificado
Muros
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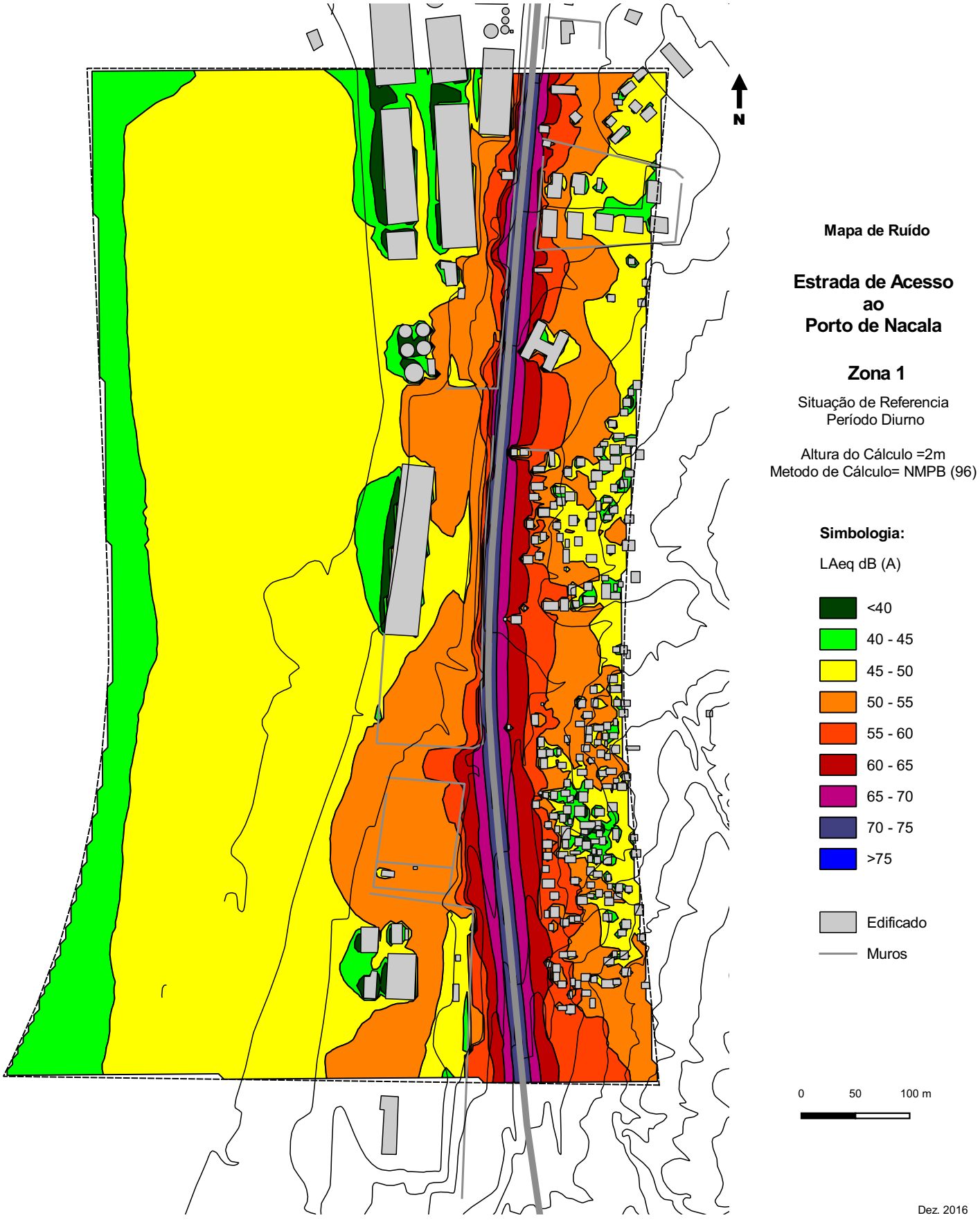
50
100 m
Dez. 2016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Estrada de Acesso
ao
Porto de Nacala
Zona 1
Situação de Referencia
Período Diurno
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Metodo de Cálculo= NMPB (96)
Simbologia:
LAeq dB (A)
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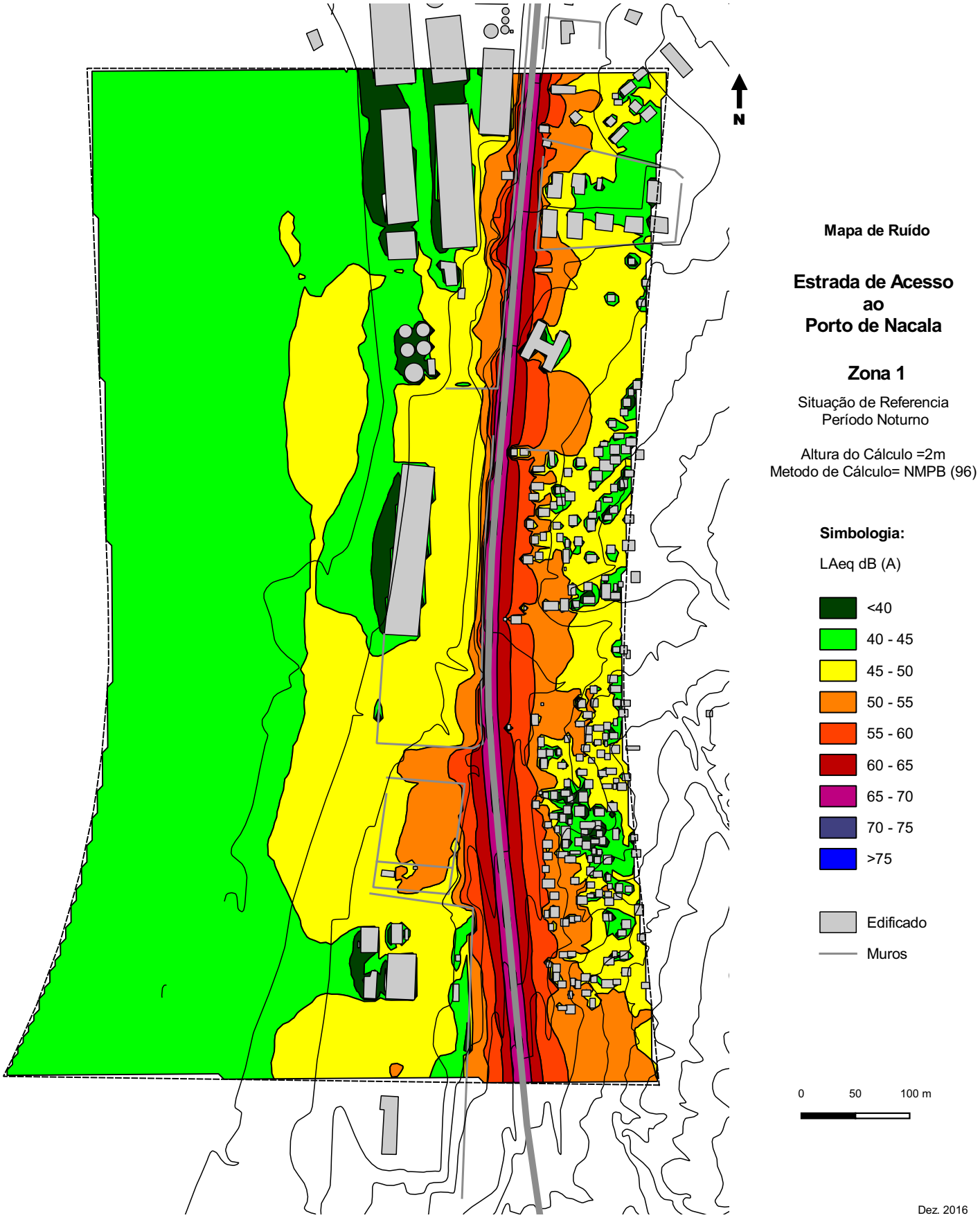
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
>75
Edificado
Muros
0
50
100 m
Dez. 2016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Mapa de Ruído
Estrada de Acesso
ao
Porto de Nacala
Zona 1
Situação de Referencia
Período Noturno
Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)
Simbologia:
LAeq dB (A)
<40
40 - 45
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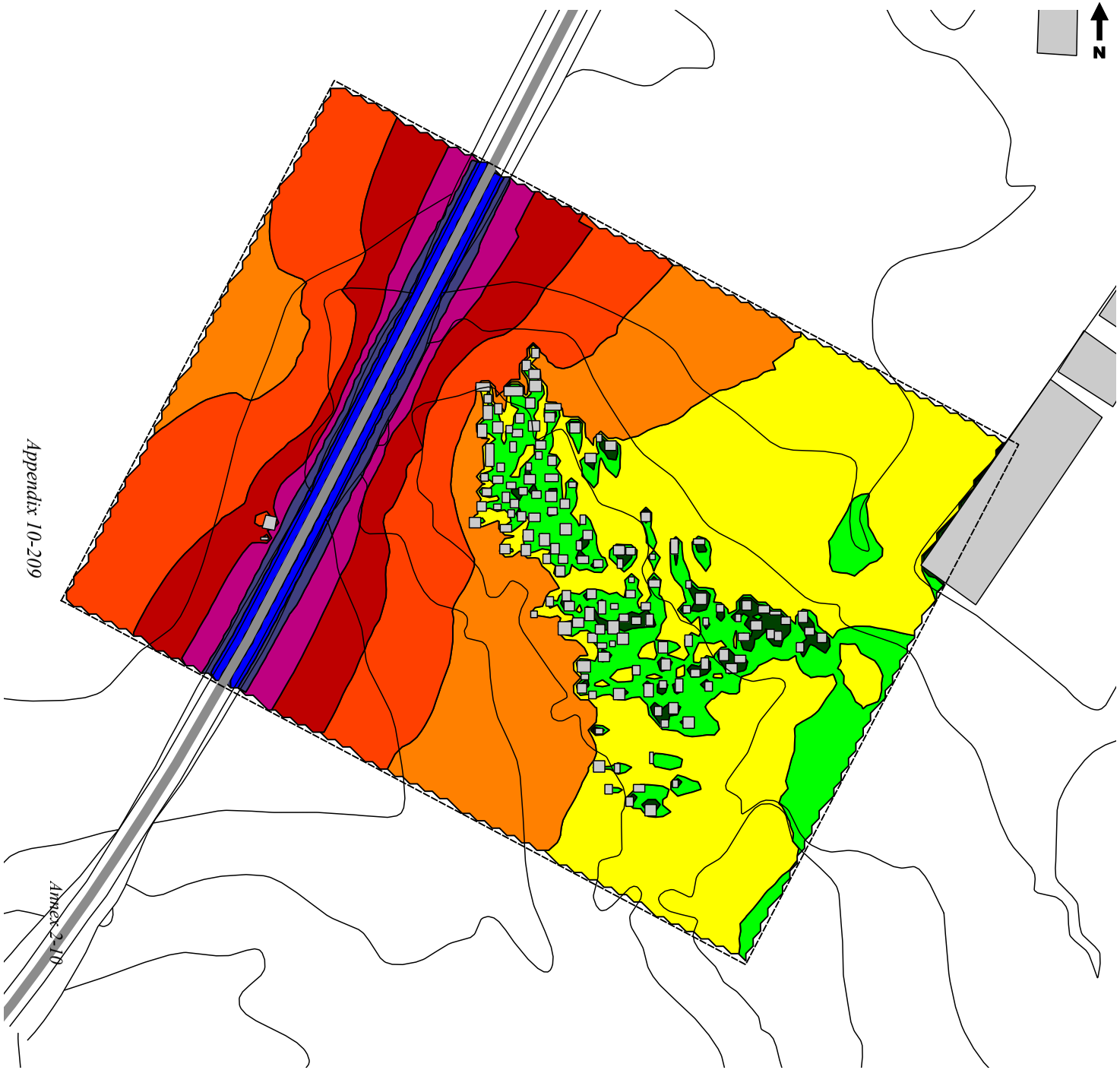
55 - 60
60 - 65
65 - 70
70 - 75
>75
Edificado
Muros
0
50
100 m
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 2

Situação Futura - 2017
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

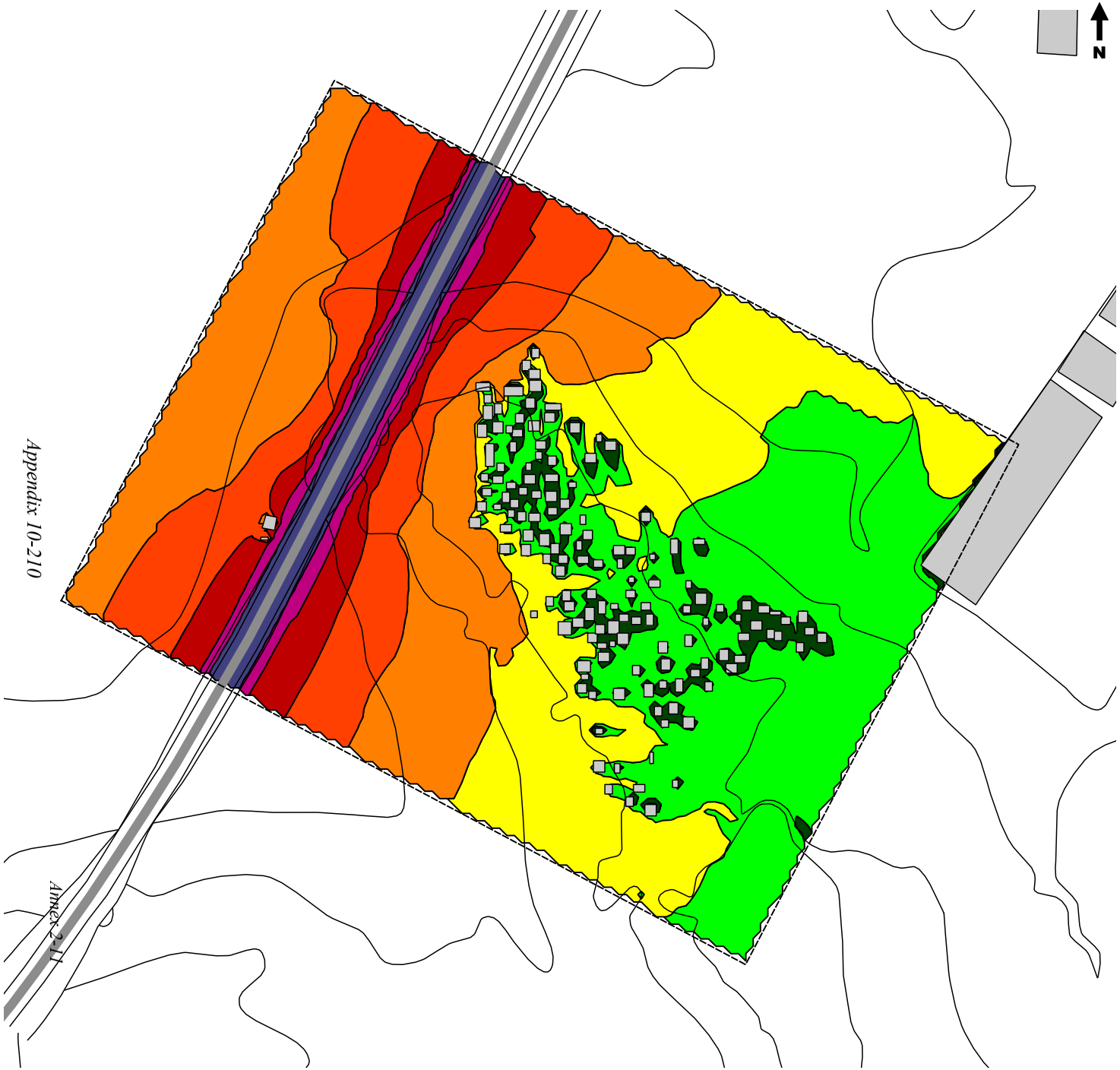
- Edificado
- Muros

0 50 100 m

Dez. 2016

Appendix 10-209

Annex 2-10



Appendix 10-210

Annex 2.11

Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 2

Situação Futura - 2017
Período Noturno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

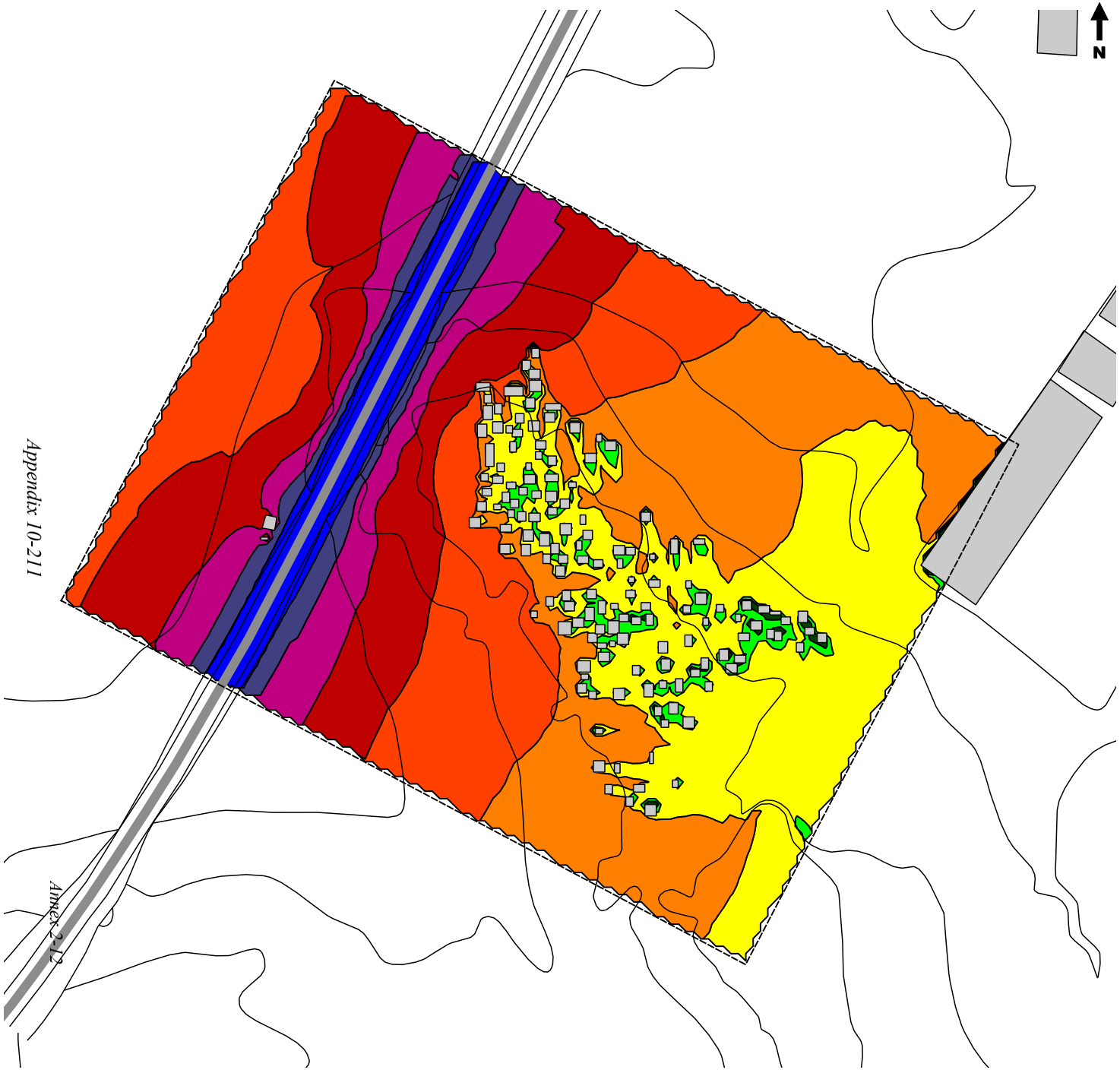
LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

- Edificado
- Muros

0 50 100 m

Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 2

Situação Futura - 2025
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

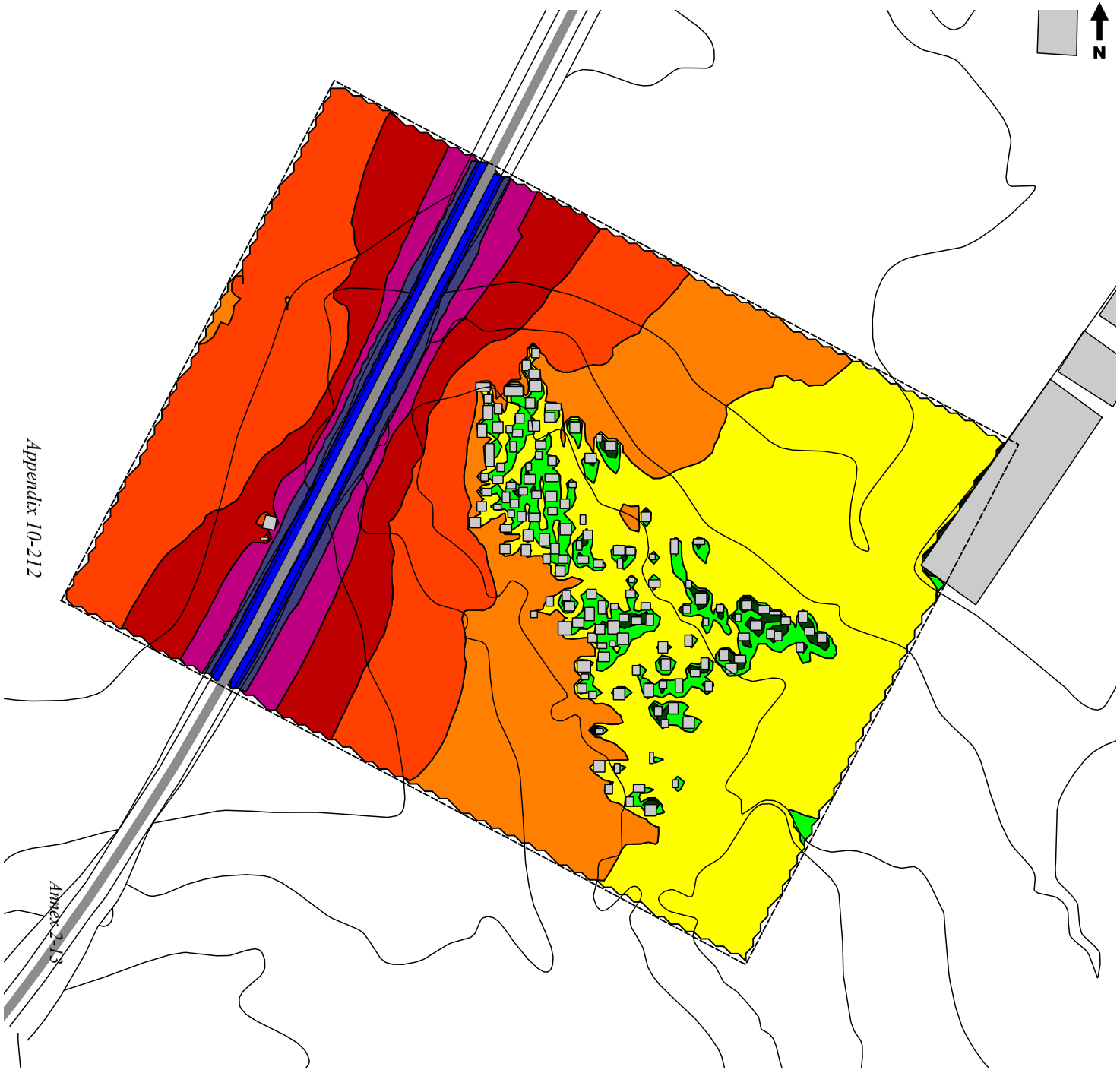
- Edificado
- Muros

0 50 100 m

Dez. 2016

Appendix 10-211

Annex 2.12



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 2

Situação Futura - 2025
Período Noturno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

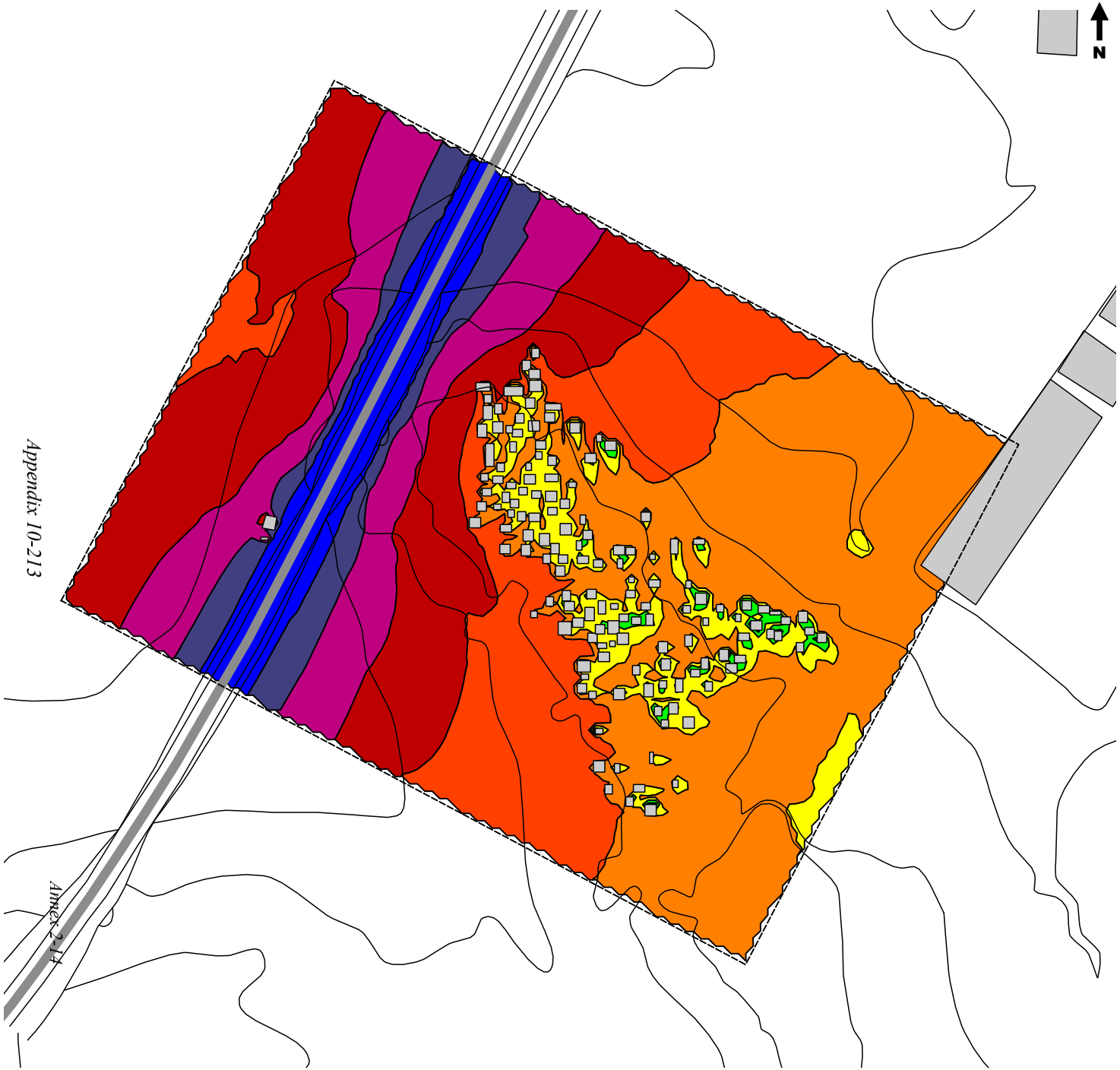
- Edificado
- Muros

0 50 100 m

Dez. 2016

Appendix 10-212

Annex 2-13



Appendix 10-213

Annex 2.14

Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 2

Situação Futura - 2035
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
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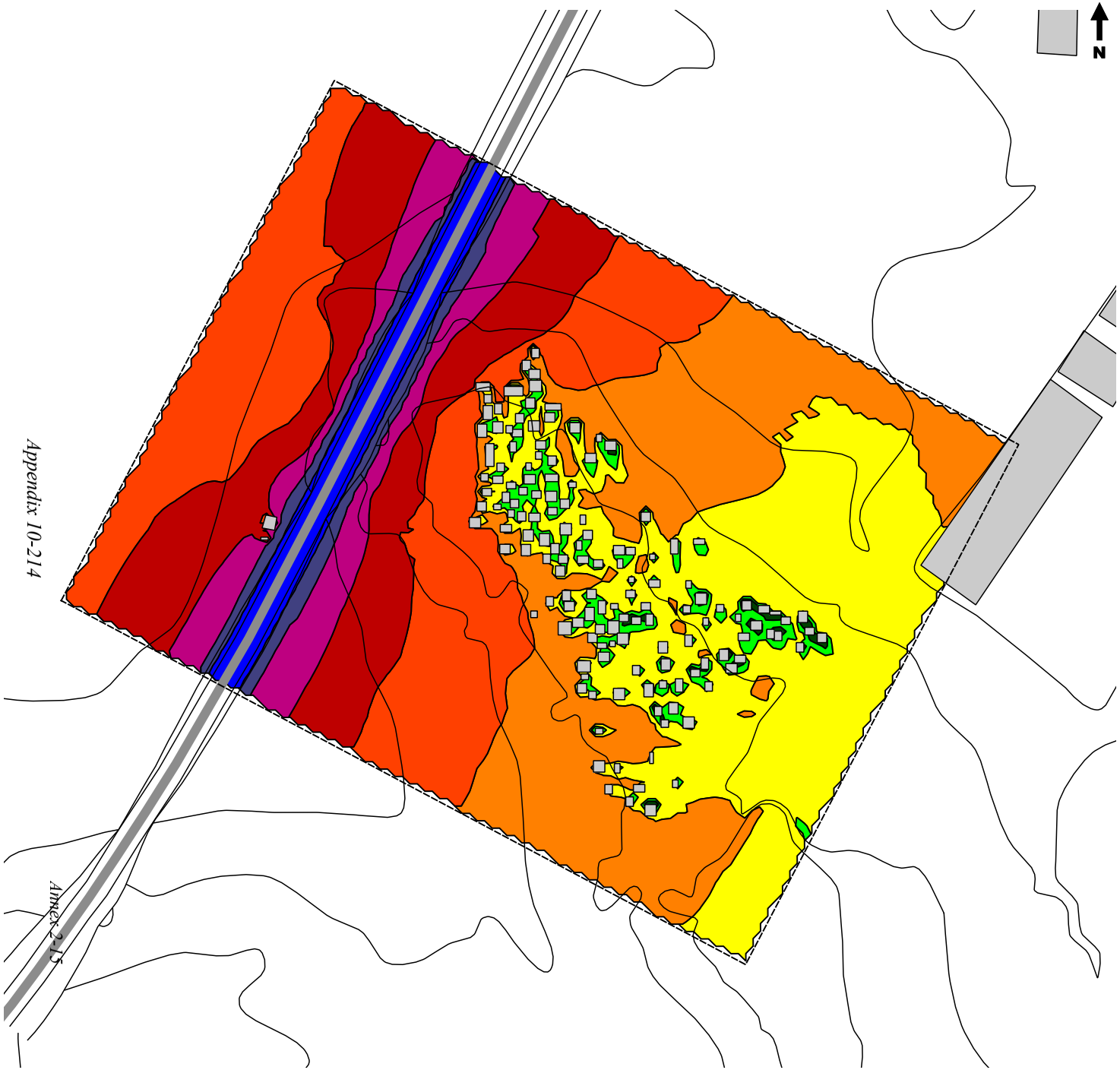
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

- Edificado
- Muros

0 50 100 m

Dez. 2016



Appendix 10-214

Annex 2-15

Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 2

Situação Futura - 2035
Período Noturno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

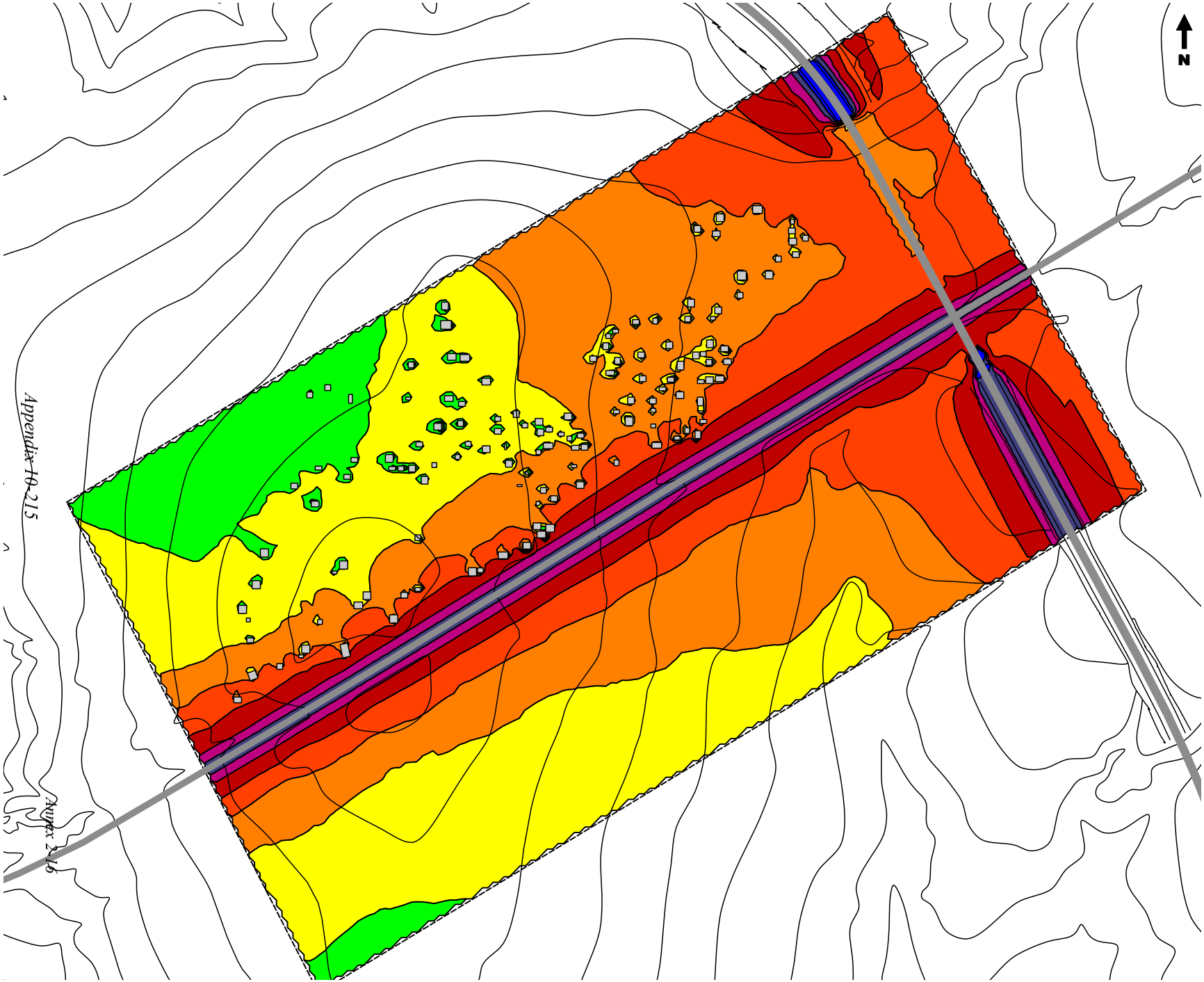
LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

- Edificado
- Muros

0 50 100 m

Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2017
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
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- 70 - 75
- >75

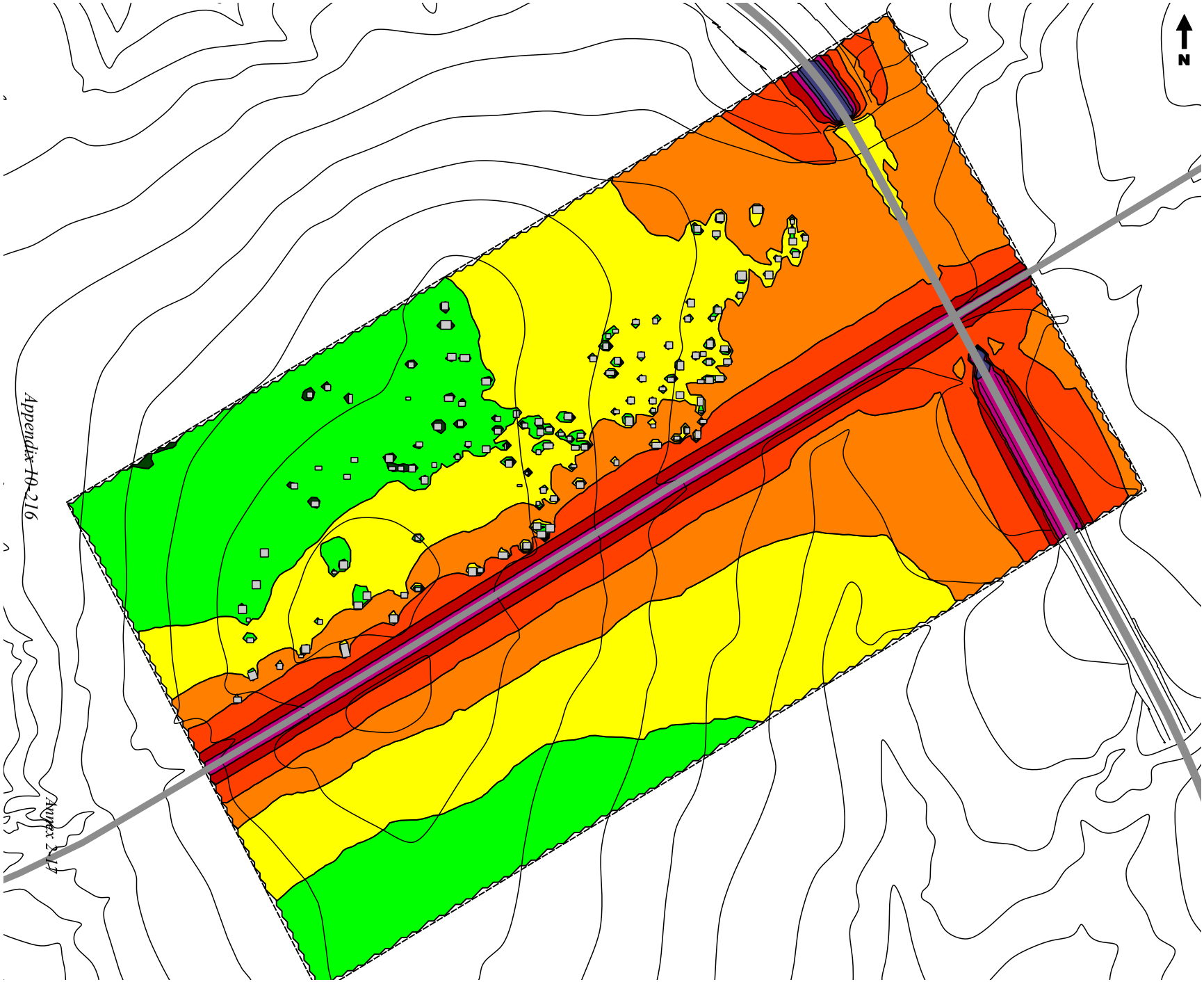
- Edificado
- Muros

0 50 100 m

Dez. 2016

Appendix H9.215

Annex 2.16



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2017
Período Noturno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Edificado

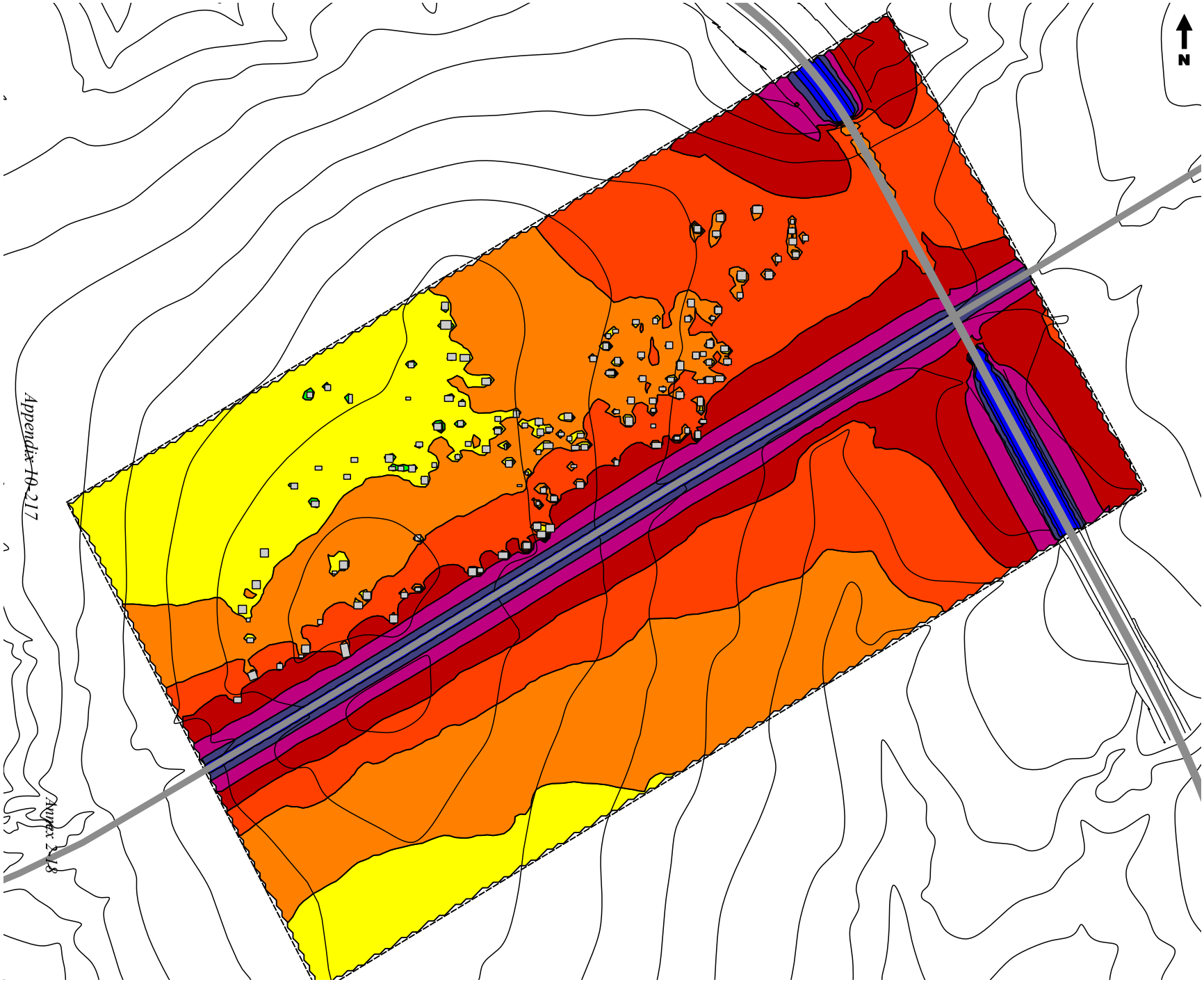
Muros

0 50 100 m

Dez. 2016

Appendix H9.216

Annex 2.17



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2025
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

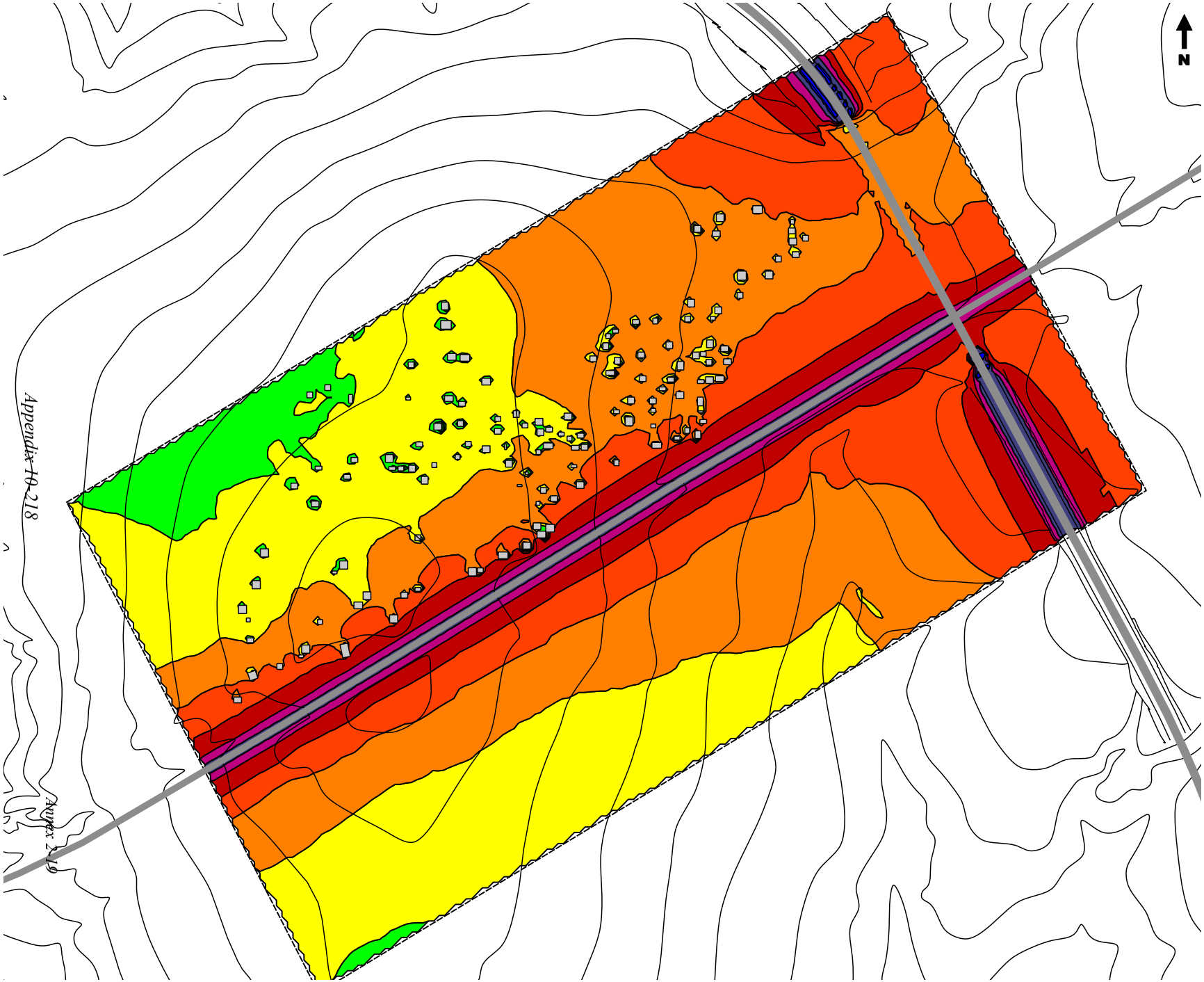
- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Edificado

Muros

0 50 100 m

Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2025
Período Noturno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Edificado

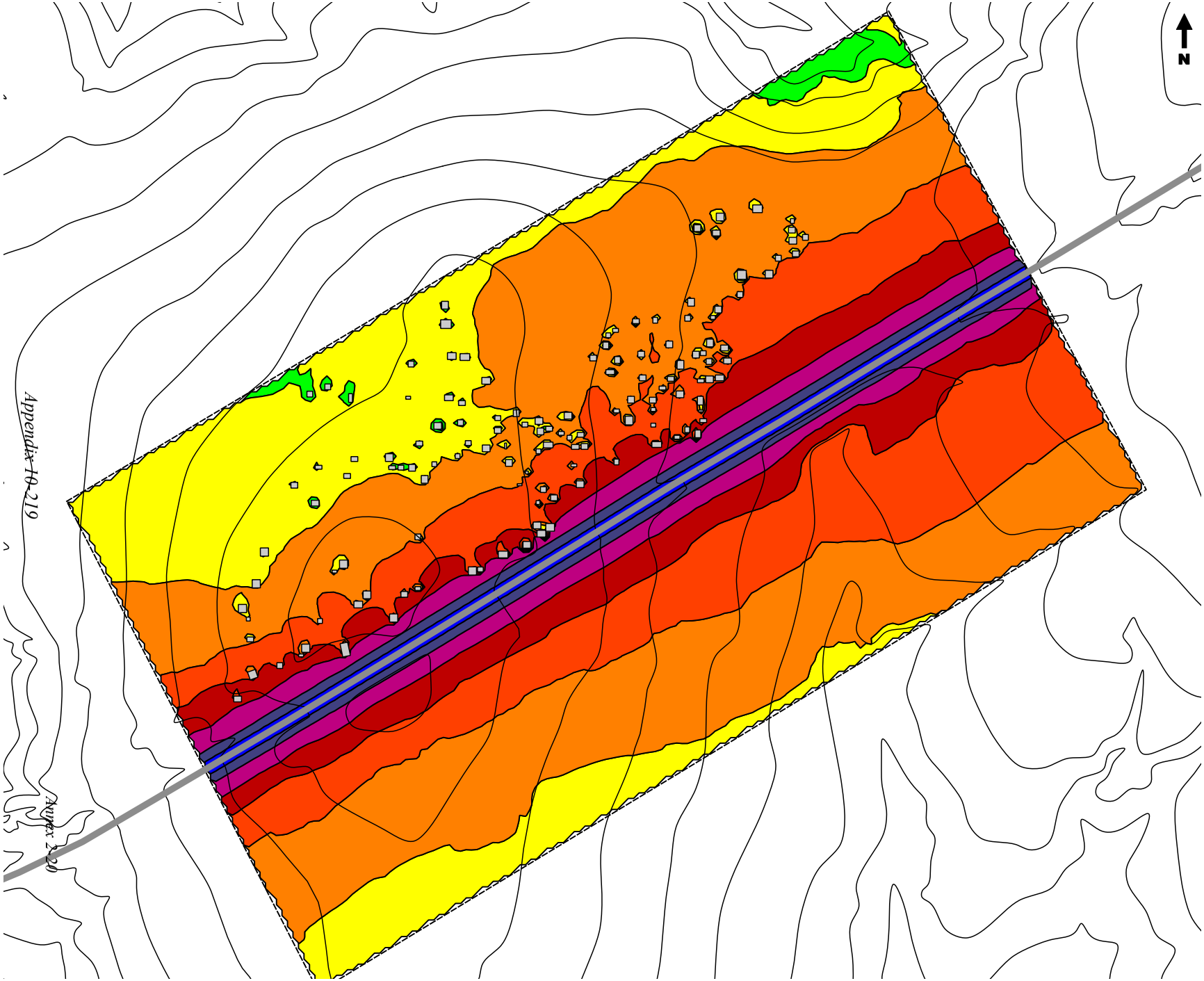
Muros

0 50 100 m

Dez. 2016

Appendix H9.218

Annex 218



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2025 S/Projeto
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Edificado

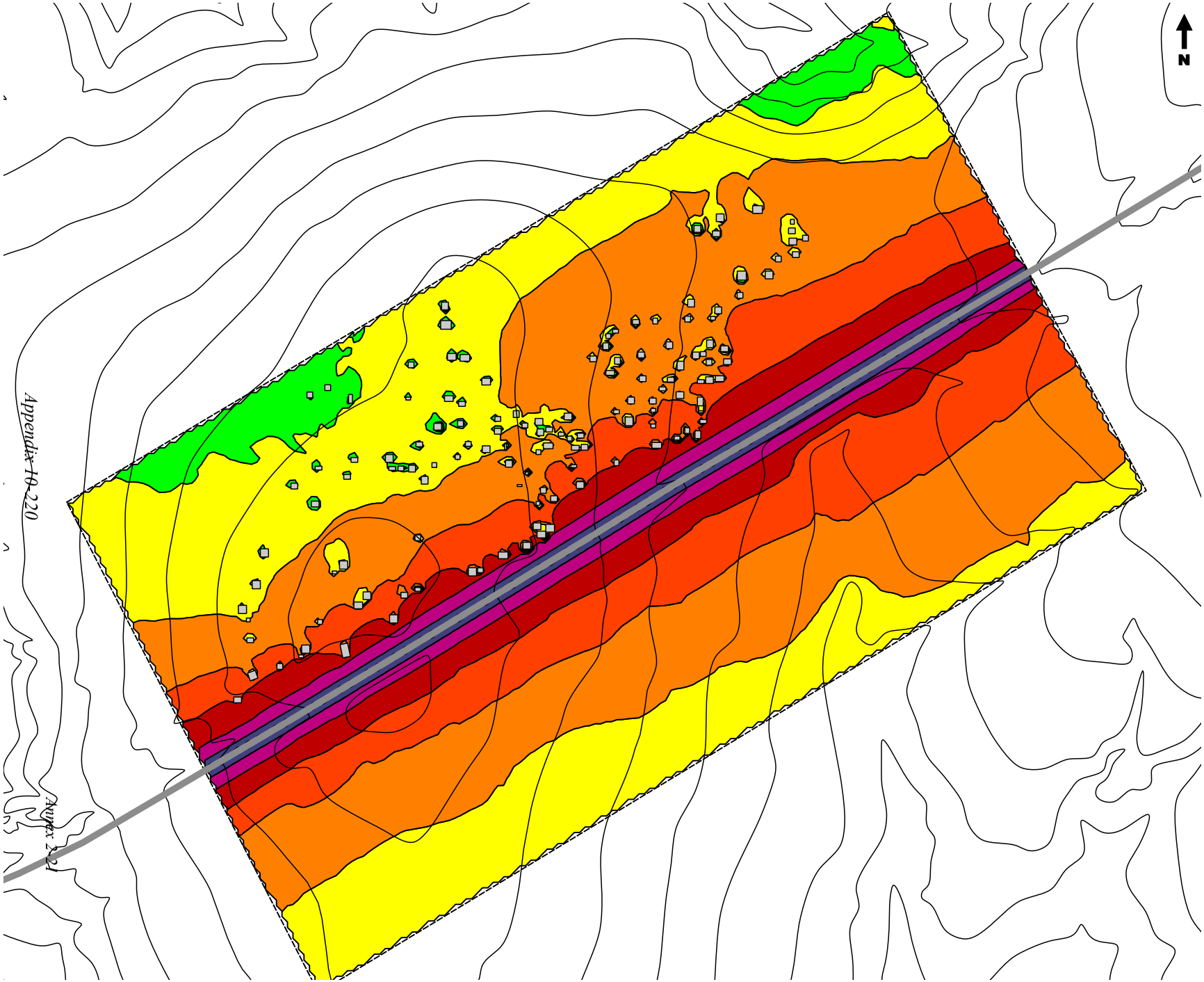
Muros

0 50 100 m

Dez. 2016

Appendix H9.219

Annex 2.20



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2025 S/Projeto
Período Noturno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

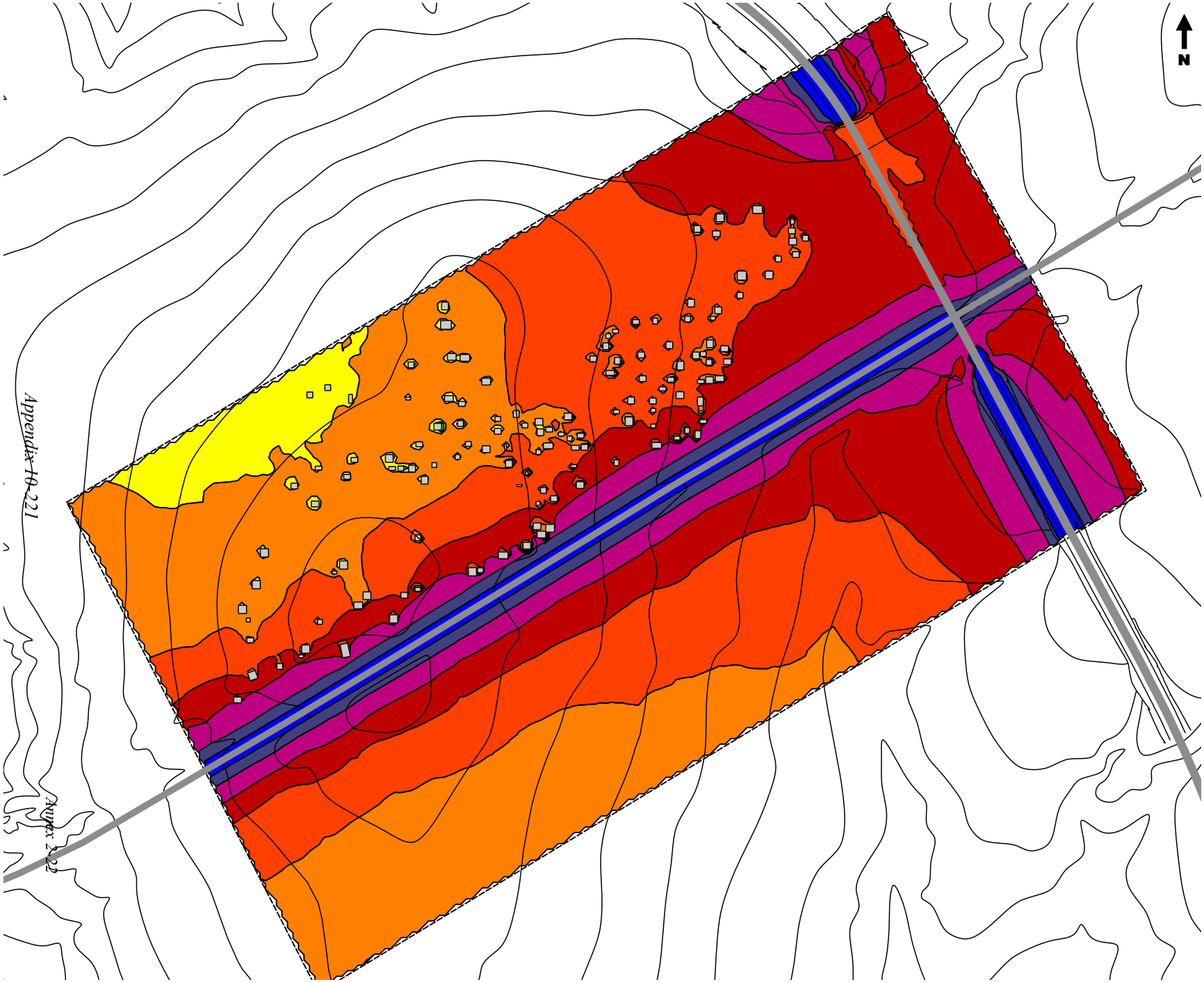
- Edificado
- Muros

0 50 100 m

Dez. 2016

Appendix H9.220

Annex 2.21



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2035
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

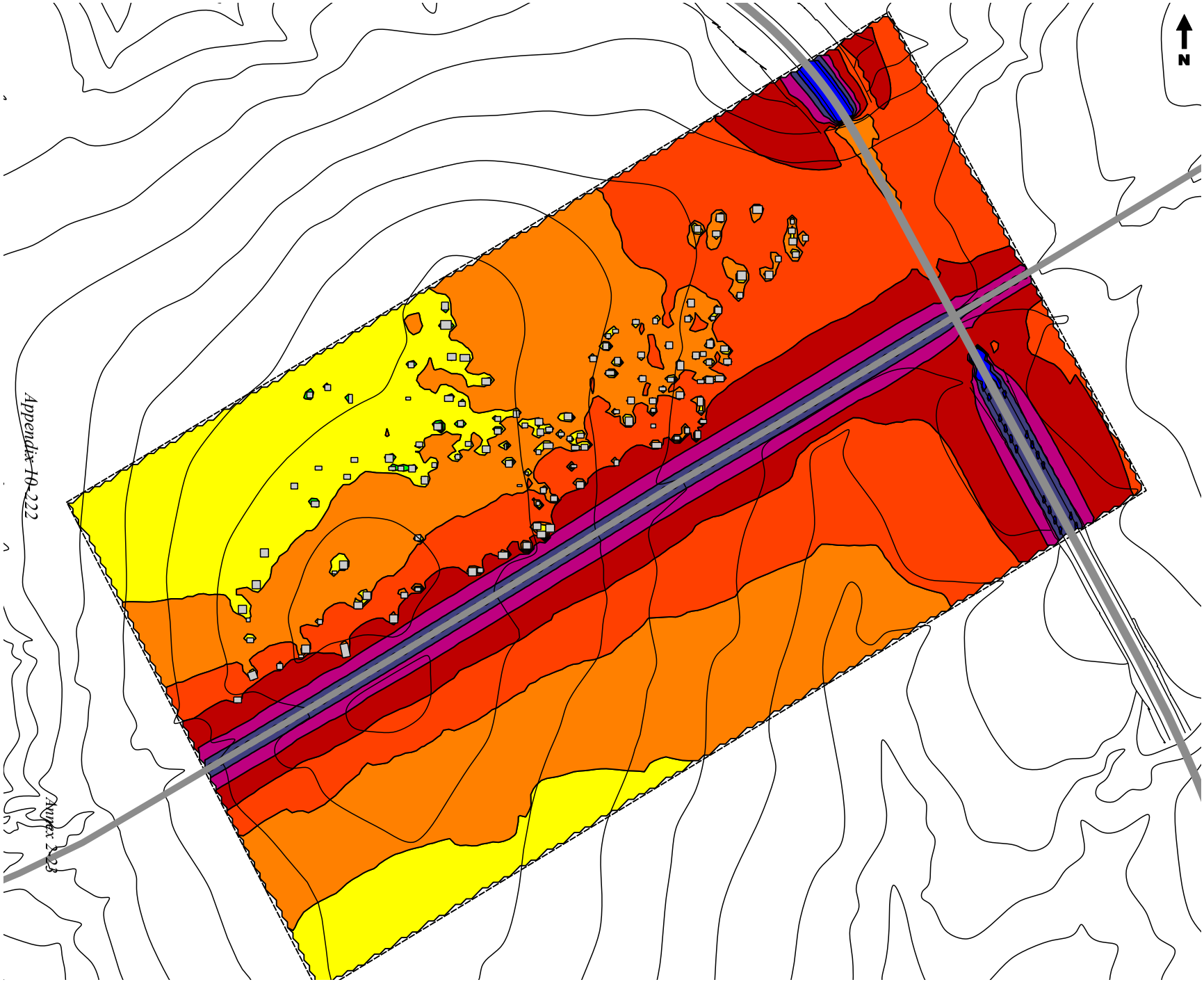
- Edificado
- Muros

0 50 100 m

Dez. 2016

Appendix H9.221

Annex 2.22



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação Futura - 2035
Período Noturno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

Simbologia:

LAeq dB(A)

- <40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Edificado

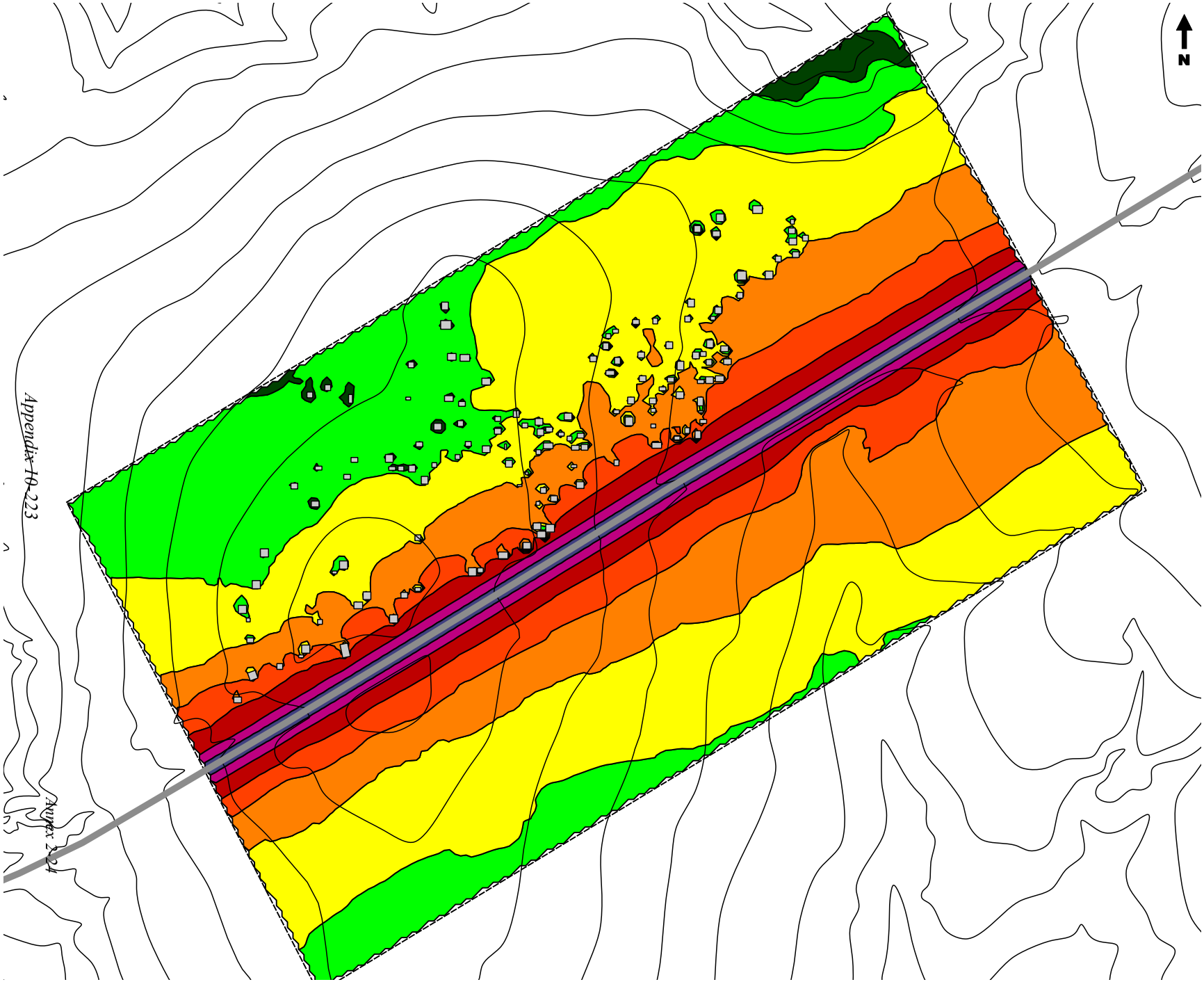
Muros

0 50 100 m

Dez. 2016

Appendix H9.222

Annex 222



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação de Referencia
Período Diurno

Altura do Cálculo =2m
Metodo de Cálculo= NMPB (96)

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- 60 - 65
- 65 - 70
- 70 - 75
- >75

Edificado

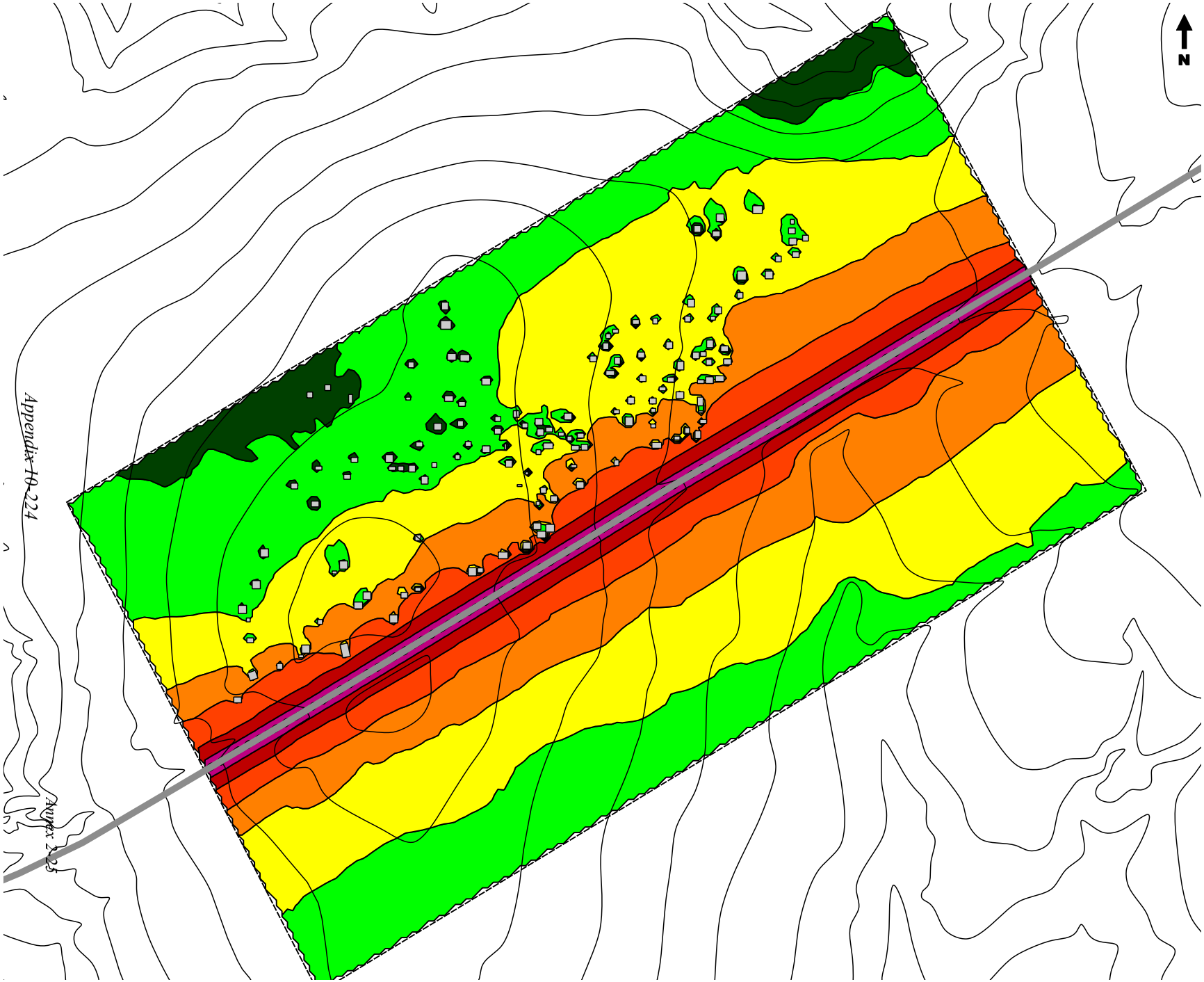
Muros

0 50 100 m

Dez. 2016

Appendix H9.223

Annex 223



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 3

Situação de Referencia
Período Noturno

Altura do Cálculo =2m
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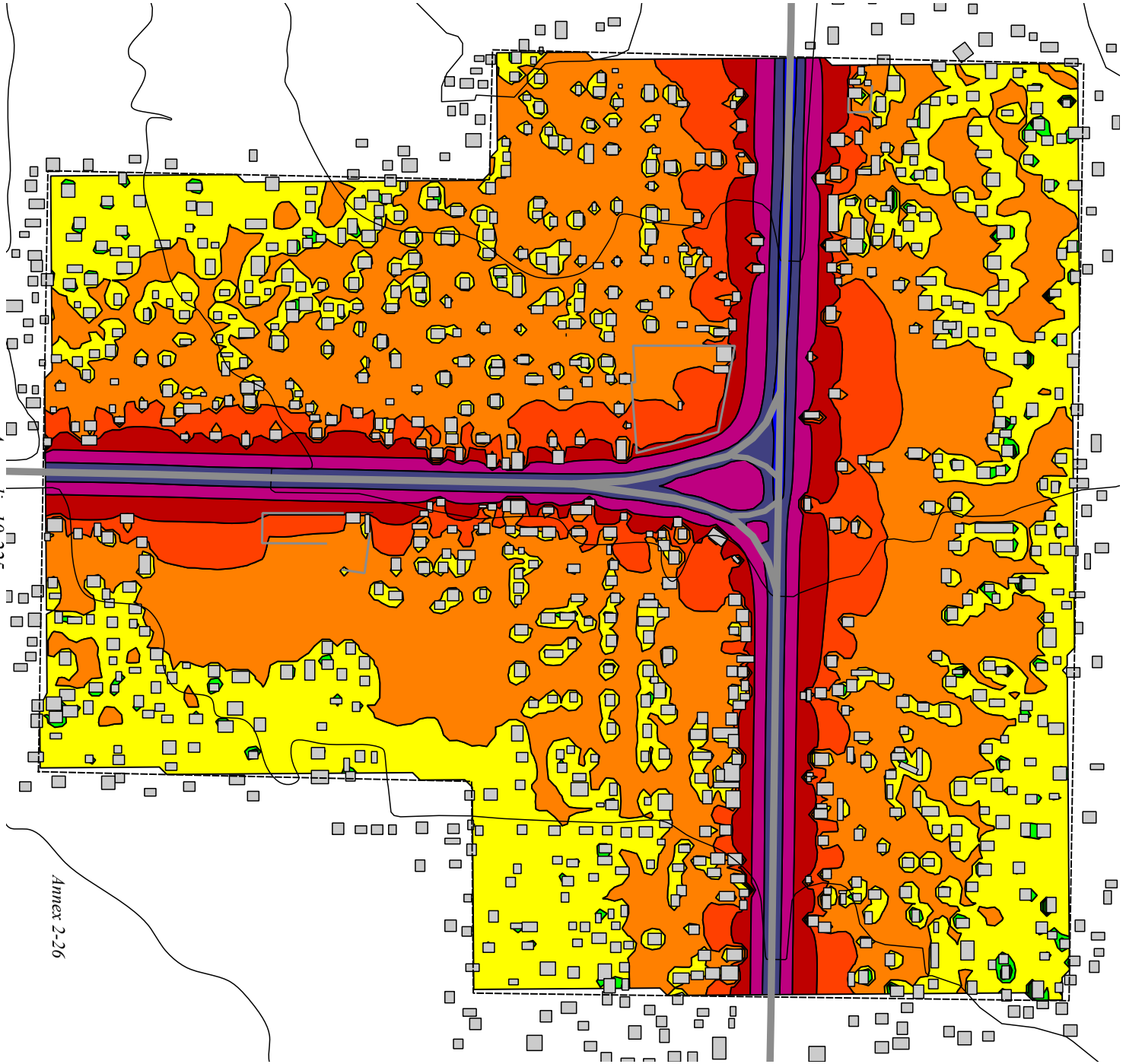
- Edificado
- Muros

0 50 100 m

Dez. 2016

Appendix H9.224

Annex 224



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

Situação Futura - 2025
Período Diurno

Altura do Cálculo =2m
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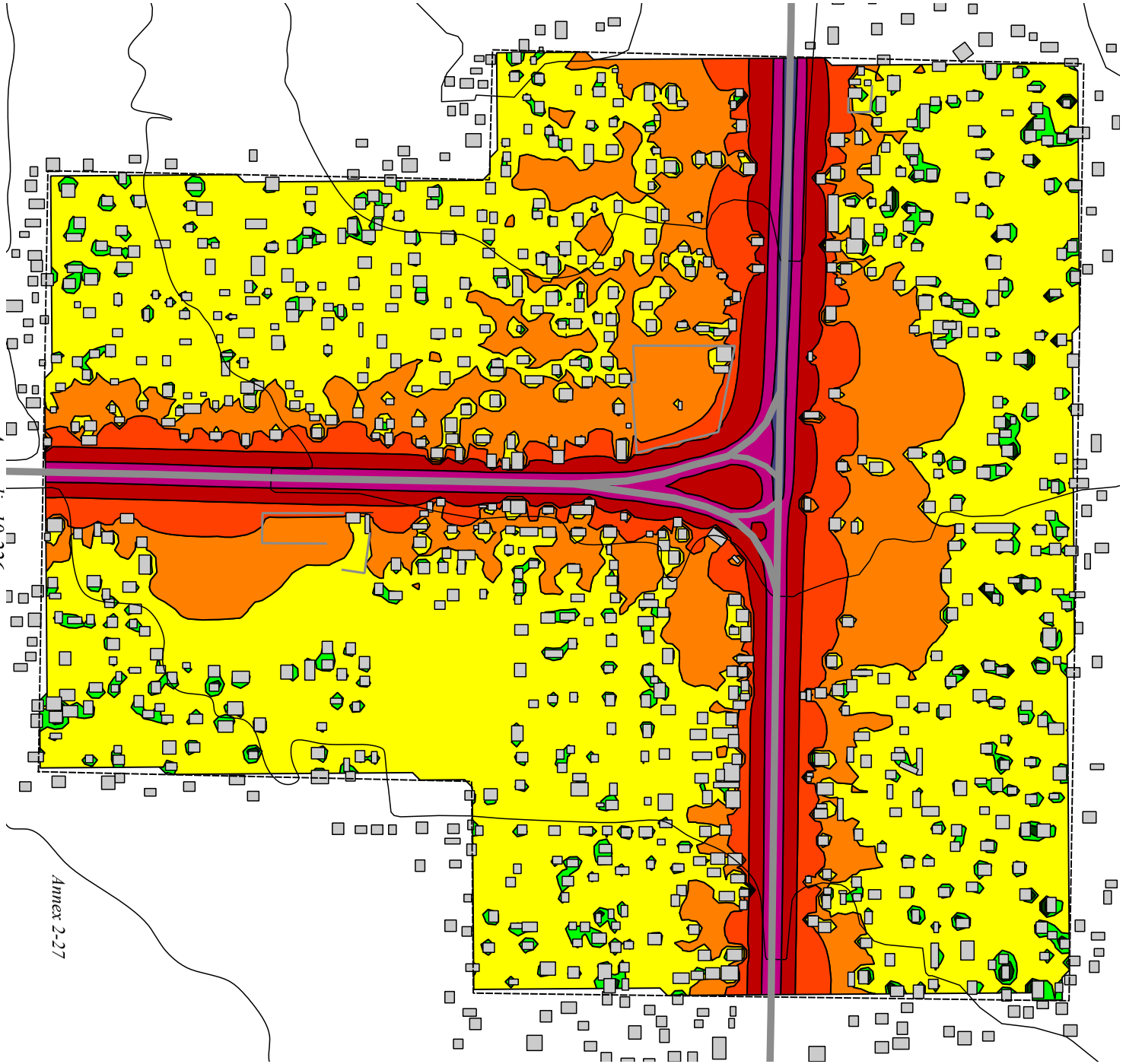
- Edificado
- Muros

0 50 100 m

Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

Situação Futura - 2025
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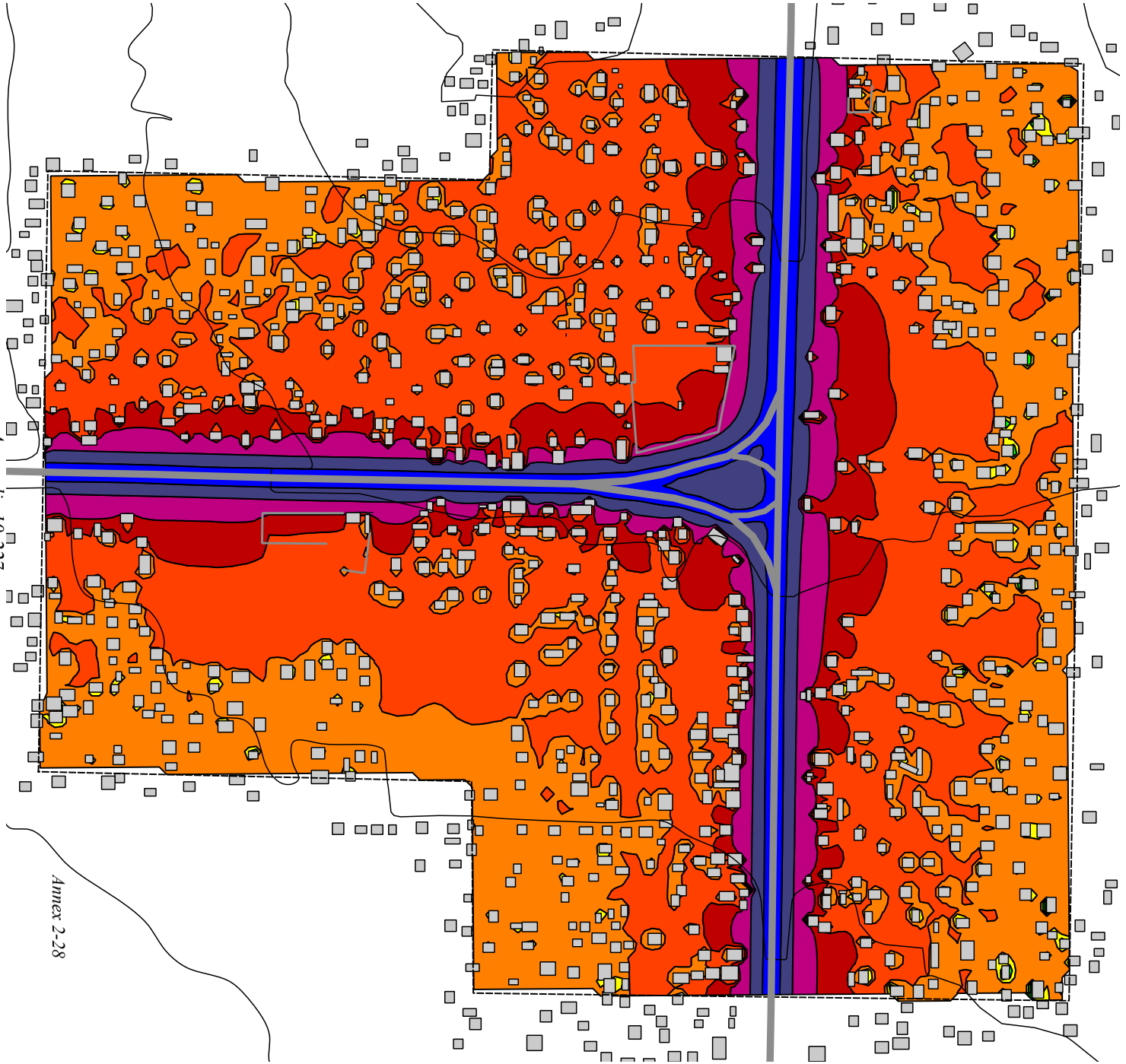
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

Situação Futura - 2025 S/Projeto
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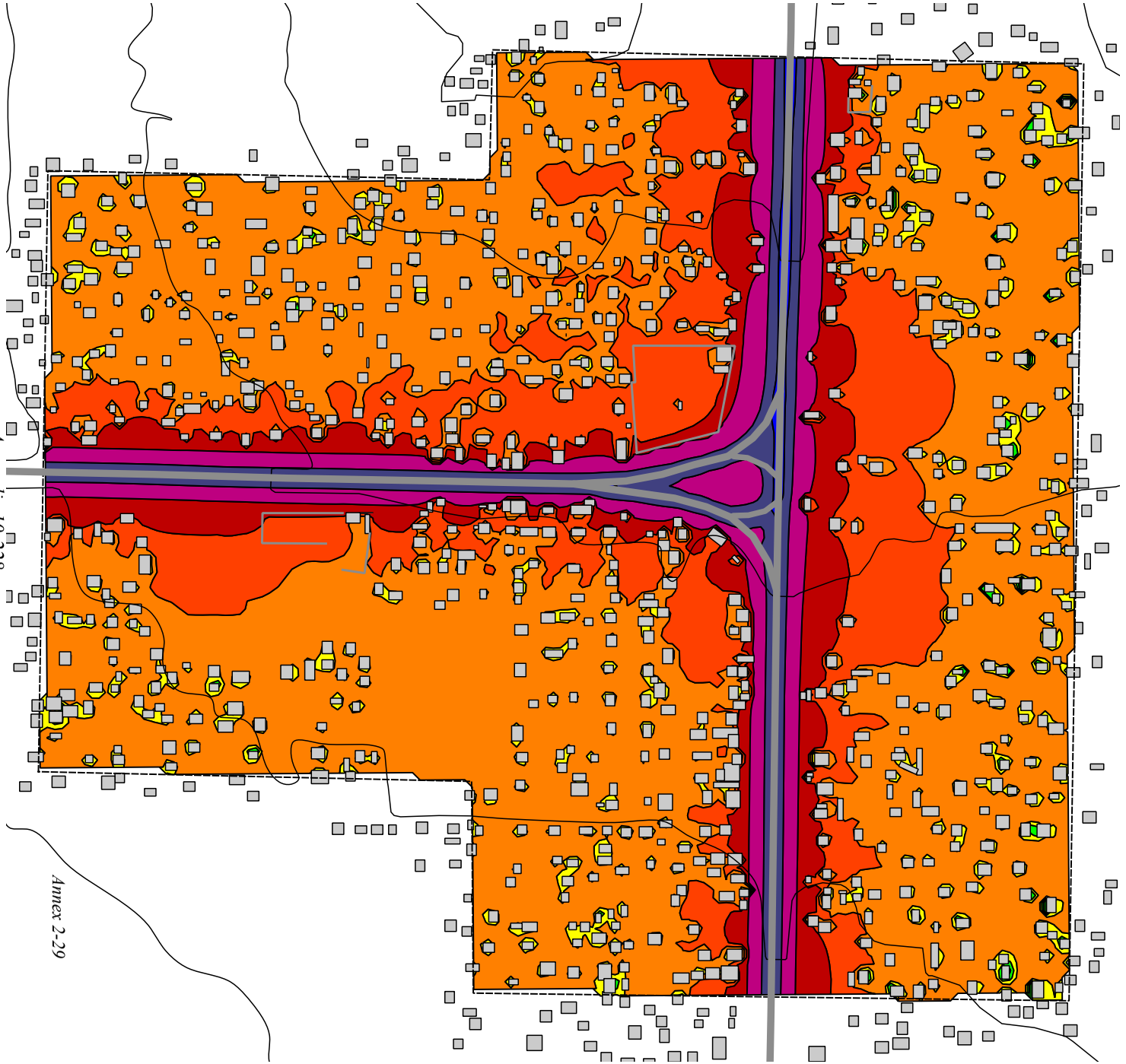
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

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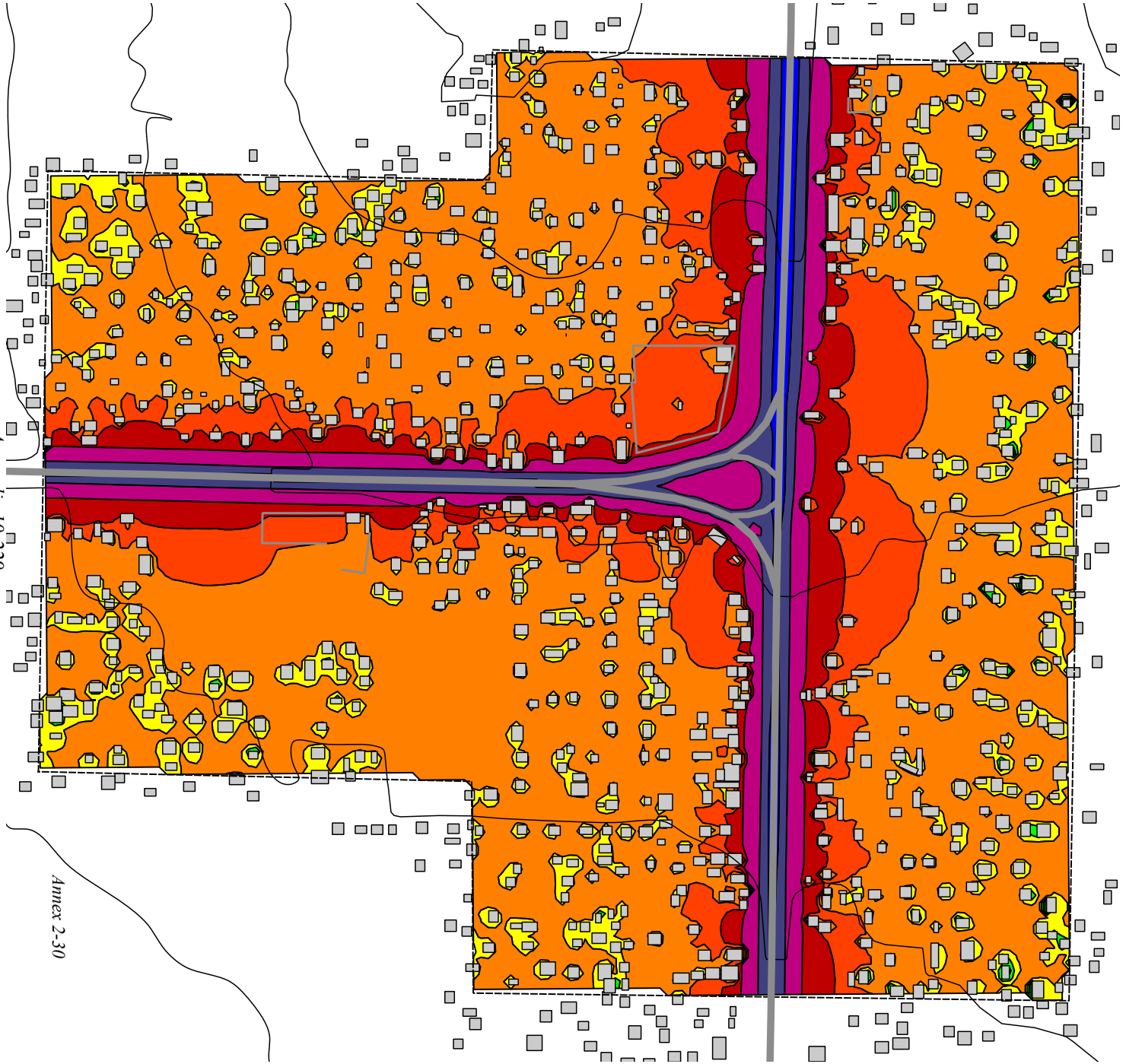
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

Situação Futura - 2035
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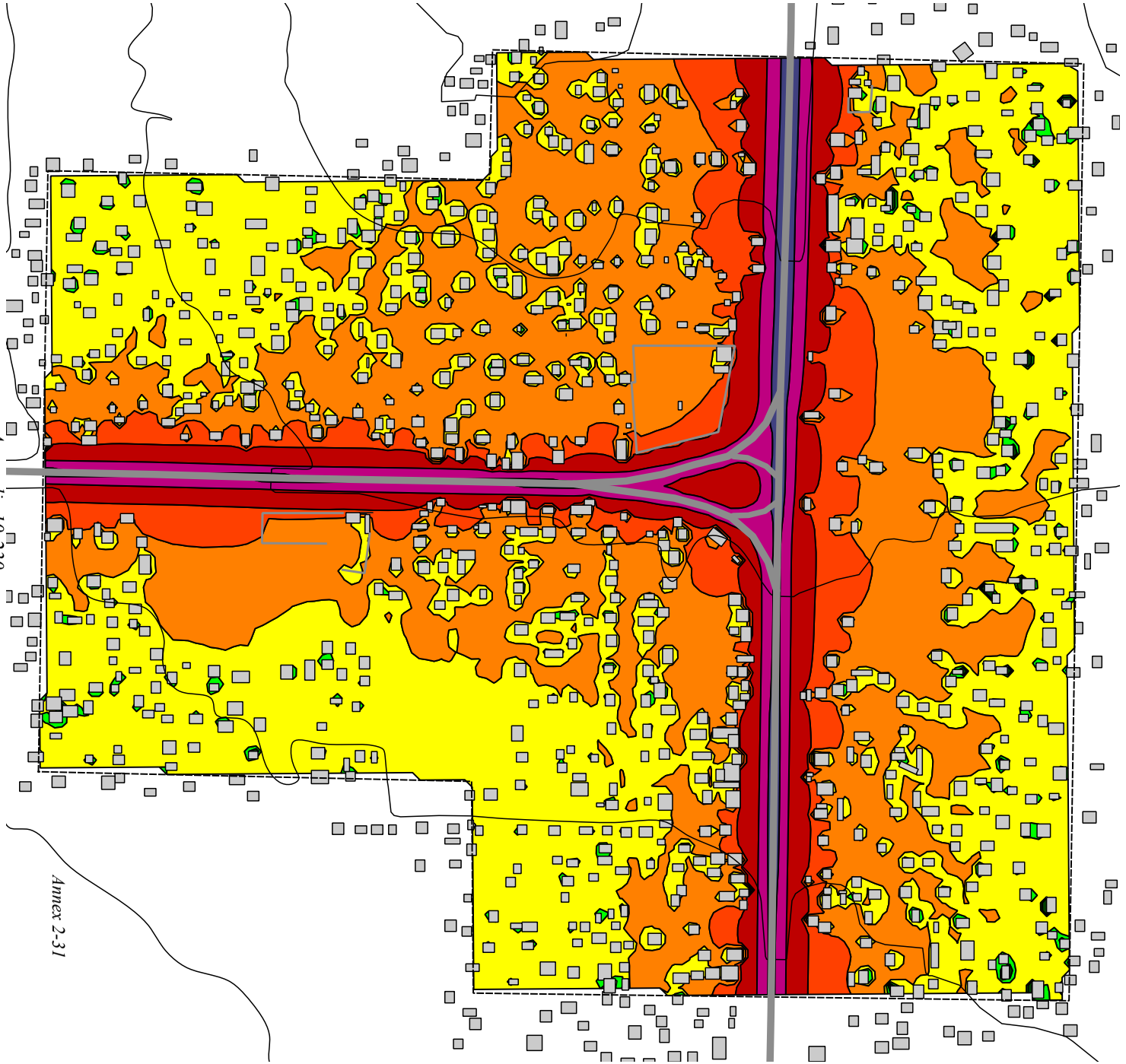
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

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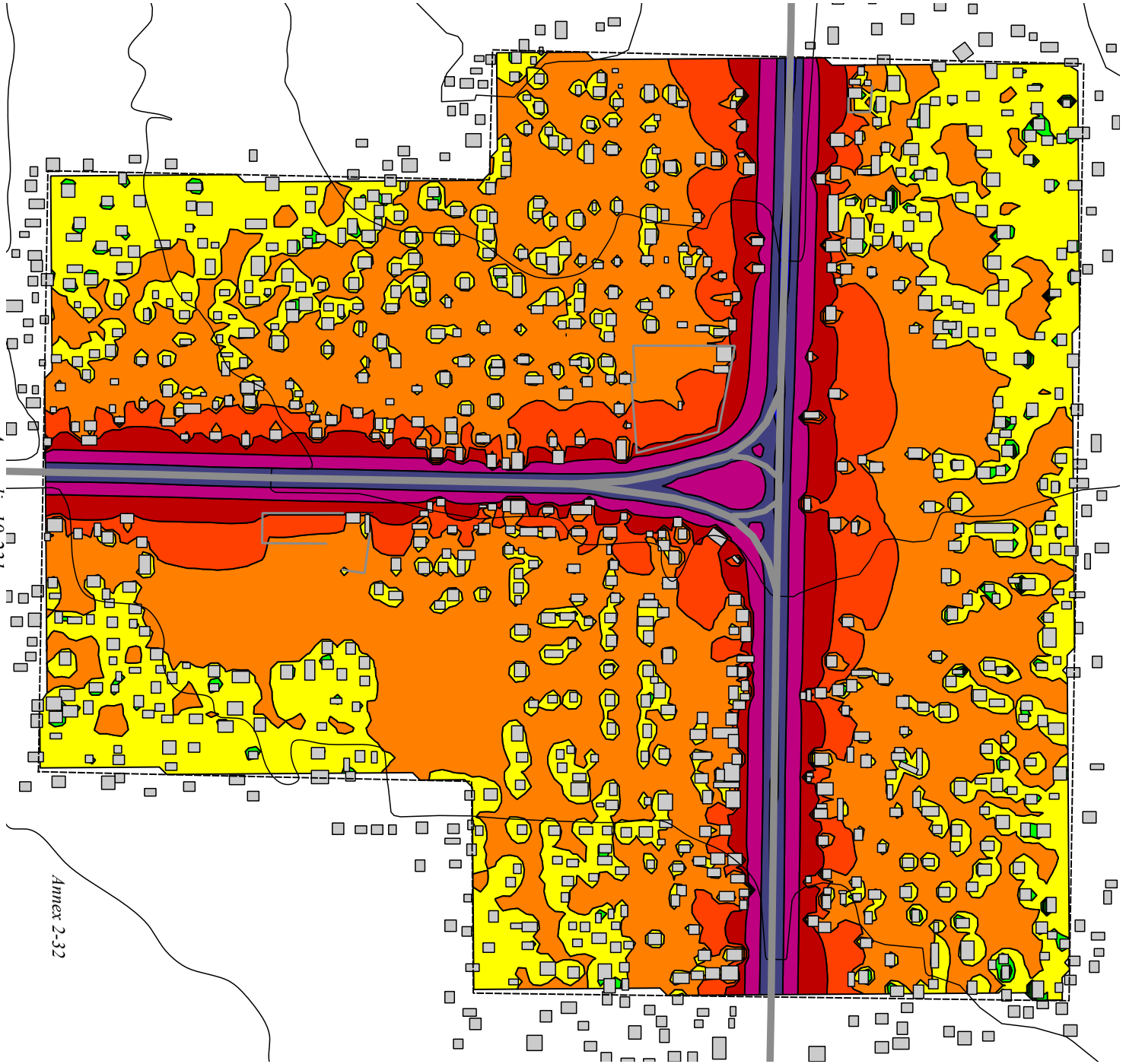
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

Situação de Referencia
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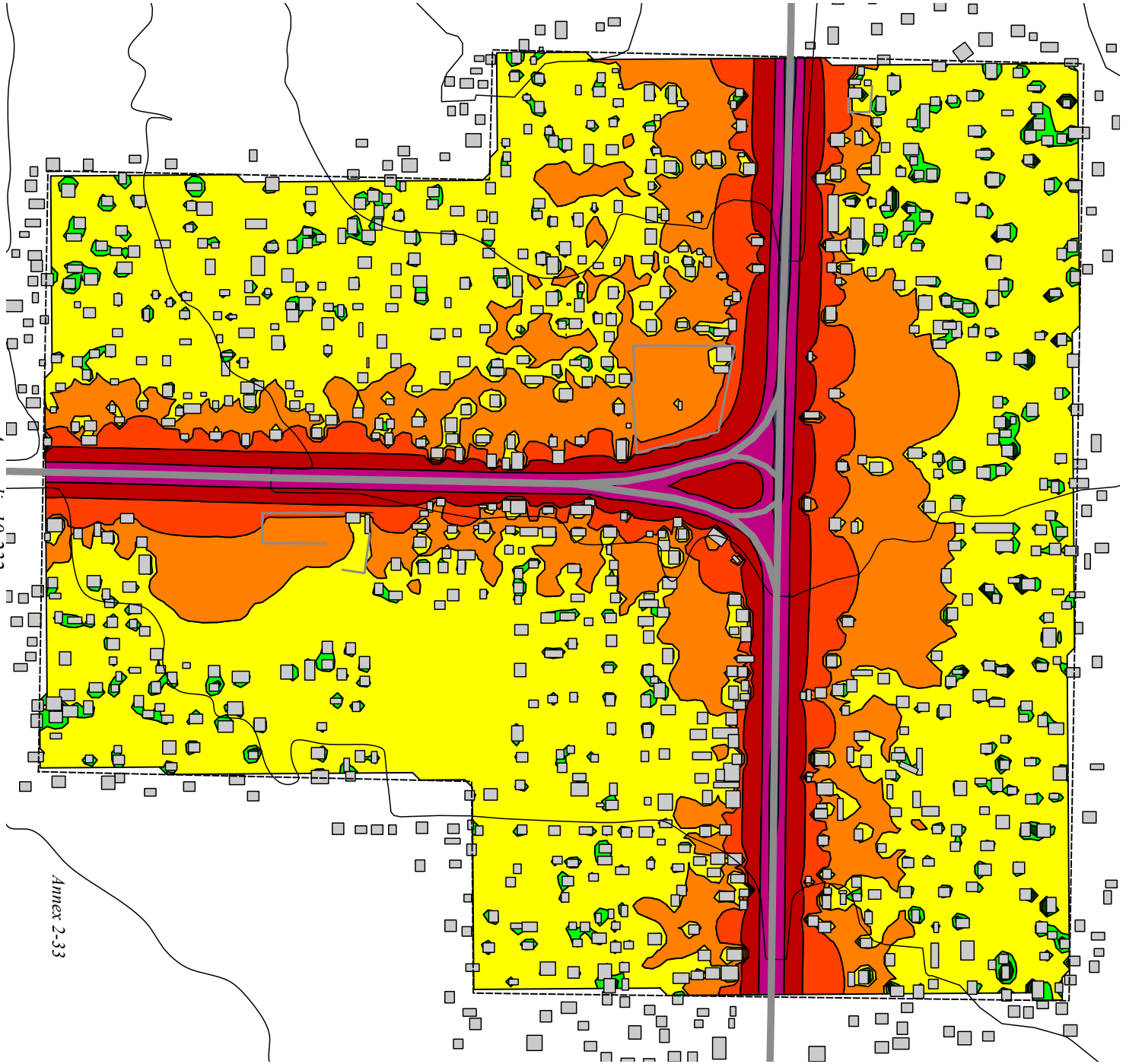
Dez. 2016



Mapa de Ruído

Estrada de Acesso ao Porto de Nacala

Zona 4

Situação de Referencia
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Dez. 2016

Annex 3 – Public consultation report (See Annex 5 in Appendix 11)