Volume F Preface

The Environmental Assessment (EA) for the Ambatovy Project (the project) is intended to meet the information requirements outlined in the Terms of Reference (ToR) in an easily understood and comprehensive package of information. Information is presented in 11 volumes that address specific subject areas. The volumes are as follows, and the structure of each volume is depicted in Figure 1:

- Volume A: Introduction
- Volume B: Environmental Assessment - Mine
- Volume C: Environmental Assessment - Slurry Pipeline
- Volume D: Environmental Assessment - Process Plant
- Volume E: Environmental Assessment - Tailings Facility
- Volume F: Environmental Assessment - Port Expansion
- Volume G: Environmental Assessment - Cumulative Effects
- Volume H: General Appendices
- Volume I: Physical Appendices
- Volume J: Biological Appendices
- Volume K: Social Appendices

Volume A introduces the EA and contains study area and methodological information pertaining to all disciplines and all project components.

For the convenience of readers who wish to read only specific parts of the EA, each of the assessment volumes B through F include descriptions of the project component being addressed. Therefore, a reader who is interested in one particular component may read the corresponding assessment volume.

Volume G contains a cumulative effects assessment that addresses the combined effects of the project components and cumulative effects of the whole project plus other foreseeable developments in Madagascar.

Where appropriate, the EA refers to separate documents in volumes H through K called Appendices, which contain additional technical and baseline information. These volumes also contain environmental assessment appendices for some disciplines with information of relevance to the environmental assessment for multiple components of the project. The glossary, acronyms and references for all volumes are listed in Volume H Appendices 12 and 13.

Figure 1 Environmental Impact Study Structure for the Ambatovy Project

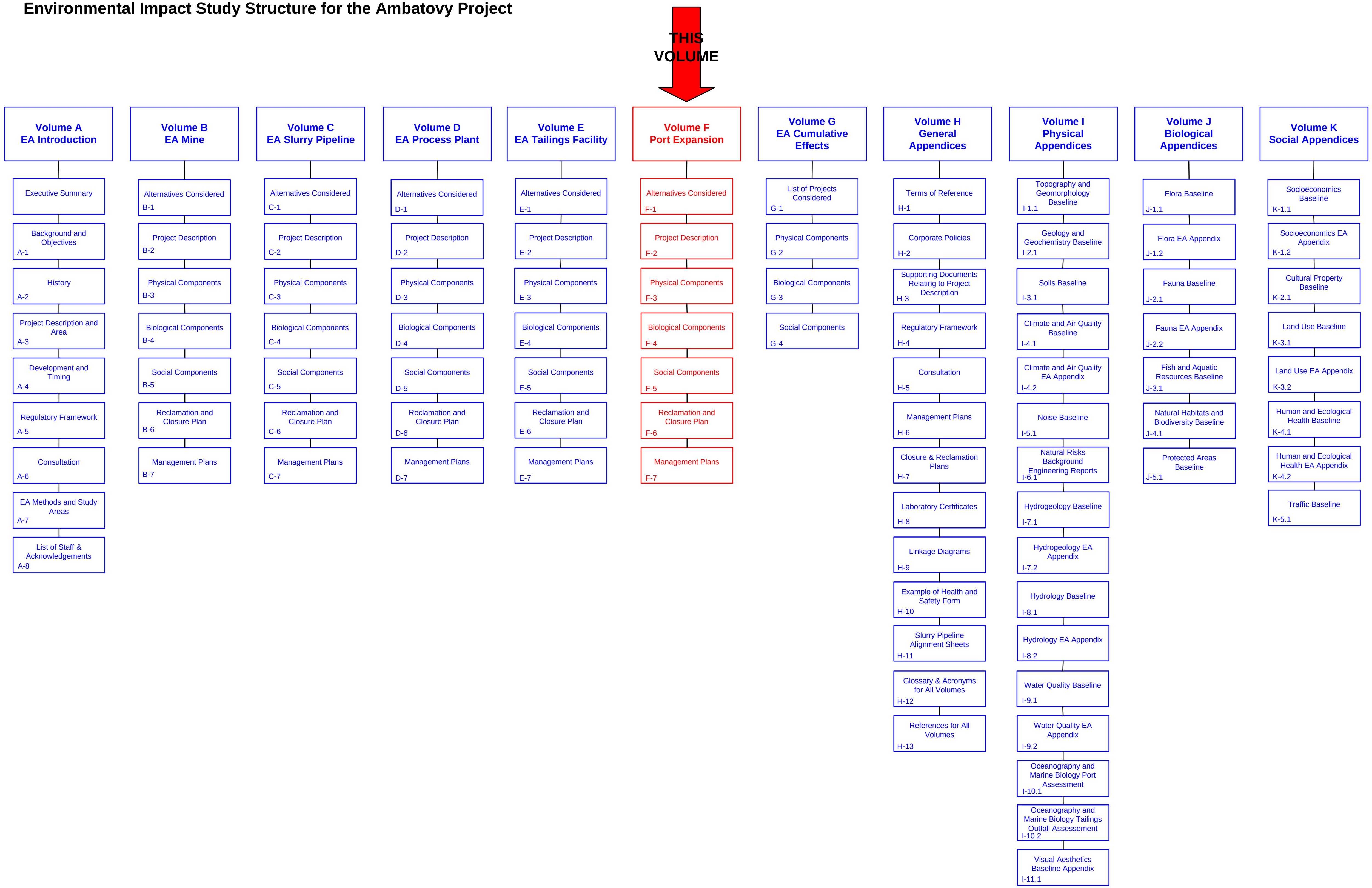


TABLE OF CONTENTS

SECTION **PAGE**

1 ALTERNATIVES CONSIDERED 1
1.1 INTRODUCTION 1
1.2 MOLE B: ASSESSMENT OF ALTERNATIVES 1
1.3 CONSTRUCTION PHASE 2
1.3.1 Operational Phase 4
1.4 CONCLUSIONS 6

2 PROJECT DESCRIPTION 8
2.1 PORT FACILITIES 8
2.1.1 Project Cargo Movements 8
2.1.2 Description of Existing Port Facilities 8
2.1.3 Assessment of Existing Port Capacity 10
2.1.4 Mole B Extension 10
2.1.5 Relocation of Existing Tanker Facilities 11
2.1.6 Vessel Manoeuvrability 11
2.1.7 Vessel Motion Study 12
2.1.8 Conclusion 12
2.2 MATERIALS HANDLING 12
2.3 TRANSPORTATION 13
2.3.1 Truck Option 13
2.3.2 Rail Option 13
2.4 RAIL TRANSPORTATION 14

3 PHYSICAL 16
3.1 CLIMATE AND AIR QUALITY 16
3.2 NOISE 16
3.2.1 Introduction 16
3.2.2 Study Areas 16
3.2.3 Baseline Summary 17
3.2.4 Impact Assessment 18
3.2.5 Conclusions 23
3.3 OCEANOGRAPHY 23
3.3.1 Introduction 23
3.3.2 Methods 24
3.3.3 Impact Assessment 28
3.3.4 Conclusions 39
3.4 NATURAL RISKS 43
3.4.1 Introduction 43
3.4.2 Study Area 43
3.4.3 Baseline Summary 44
3.4.4 Issue Scoping 44
3.4.5 Impact Assessment 45
3.5 WATER QUALITY 48
3.6 VISUAL AESTHETICS 48
3.6.1 Introduction 48
3.6.2 Study Area 49
3.6.3 Baseline Summary 49
3.6.4 Issue Scoping 50

3.6.5 Impact Assessment....50
3.6.6 Conclusions....53

4 BIOLOGICAL 54
4.1 MARINE ECOLOGY....54
4.2 NATURAL HABITATS AND BIODIVERSITY 54
4.3 PROTECTED AREAS 54

5 SOCIAL 55
5.1 SOCIOECONOMICS....55
5.2 CULTURAL PROPERTY....55
5.3 LAND USE....55
5.3.1 Introduction 55
5.3.2 Study Area 55
5.3.3 Baseline Summary....55
5.3.4 Issue Scoping....56
5.3.5 Assessment Methods....56
5.3.6 Impact Assessment....56
5.3.7 Mitigation....58
5.3.8 Conclusions....59
5.4 HUMAN AND ECOLOGICAL HEALTH 59
5.5 TRAFFIC....59

6 RECLAMATION AND CLOSURE PLAN 60

7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS 61
7.1 CONSTRUCTION AND OPERATIONS PHASE ACTIVITIES 61
7.1.1 Flora and Fauna Management Plans 61
7.1.2 Human Resource Development Plans....62
7.1.3 Procurement Plan 62
7.1.4 Other Socioeconomic Management Activities 62

LIST OF TABLES

Table 1-1 Risk Assessment For The Construction And Operational Phases Of The Harbour Expansion At Toamasina....2
Table 1-2 Summary Of Issues And Their Risk/Opportunity Ranking 7
Table 2-1 Port of Toamasina – Ambatovy Cargo Movement Through Mole B....8
Table 3.2-1 Summary of Existing Noise Levels, Ambatovy Project Process Plant 18
Table 3.2-2 Construction Equipment Sound Emissions 21
Table 3.2-3 Port Operations Sound Emissions....21
Table 3.3-1 Construction Phase Impacts on the Marine Environment from the Port Expansion. 40
Table 3.3-2 Operational Phase Impacts in the Marine Environment from the Port Expansion. 41
Table 3.4-1 Description of Risk Criteria for the Port Expansion 46
Table 3.6-1 Key Viewpoints: Port Area....49
Table 3.6-2 Impact Description Criteria for Visual Aesthetics....51
Table 3.6-3 Potential Effects and Residual Impacts for Visual Aesthetics 52
Table 3.6-4 Residual Impact Classification for Visual Aesthetics....53
Table 5.3-1 Land Use Impact Areas for the Port Expansion Local Study Area....58

LIST OF FIGURES

Figure 2.1-1 Toamasina Port Site Layout 9
Figure 5.3-1 Land Use Impact Areas Within the Port Sub-Local Study Area 57

1 ALTERNATIVES CONSIDERED

1.1 INTRODUCTION

An evaluation of potential port site alternatives in both the Brickaville and Toamasina areas was undertaken for the scoping portion of the Ambatovy Project (the project) development. The Brickaville area was initially investigated as the location for the plant site, leading to identification of potential port sites in the vicinity. The Toamasina area was subsequently reviewed and selected as the preferential area for the plant site location. Therefore, the port of Toamasina was selected for the port and several sites within the port were considered.

1.2 MOLE B: ASSESSMENT OF ALTERNATIVES

Coastal & Environmental Services of South Africa (CES) was mandated to assess the environmental risk of extending one of the three moles within the port during the pre-feasibility phase. The alternatives analysis undertaken in the pre-feasibility is presented below.

The potential exists for the expansion of any one of the three moles currently in use in the Port of Toamasina. The method of construction at all three would be the same in that it would be built as an open pile construction, either from a piling barge or out from the existing quay. All three have sufficient open space in front of them to accommodate the needs of the project. The environmental issues surrounding each option, however, differ slightly and in so doing point to a preferred option.

Table 1.1 contains a risk assessment for the construction and operational phases for the three moles in the harbour. The risk that biophysical impacts have on the project are rated as zero, one, two or three, which conforms to zero, low, moderate and high risk respectively.

Table 1-1 Risk Assessment For The Construction And Operational Phases Of The Harbour Expansion At Toamasina

			Mole A	Mole B	Mole C
construction phase	requirements	piling	Y	Y	Y
		dredging	Y	N	N
		breakwater	N	N	Y
	biophysical impacts	sensitive habitats	2	1	2
		marine fauna	2	1	1
		water quality	3	1	1
		fuel spill	0	1	0
		total	**7**	**4**	**4**
operational phase	biophysical impacts	sensitive habitats	1	1	2
		marine fauna	1	1	2
		water quality	2	2	2
		fuel spill	0	0	0
		total	**4**	**4**	**6**

Note: 0=no risk, 1=low risk, 2=moderate risk, 3=high risk

1.3 CONSTRUCTION PHASE

Issue 1: Sensitive Habitats

Risk/Opportunity Assessment

The baseline report (Volume I, Appendix 10.1, Attachment 1) highlighted the degraded state of the harbour environment. While such an area would be expected to have several sensitive marine habitat types in its pristine state, its use as an operational harbour have heavily impacted all such habitats. In addition the pollution that enters the harbour from numerous sources outside of the harbour has contributed to the decline of a functioning marine ecosystem. The nearest sensitive habitats are coral reefs located at Le Grand Recif and south of the breakwater at Recif de la Pointe and Recif du Sud. Observations detailed in the baseline report (Volume I, Appendix 10.1, Attachment 1) indicate that these reefs are far from pristine and are in poor condition due to turbidity, storm damage, fishing activities and ENSO-related bleaching. Pollution from the harbour does not appear to have had any significant impact on these habitats.

Due to the degraded nature of the marine habitats within the harbour, construction is unlikely to have any high impact. While the method of mole construction itself would be the same at all three sites, preparation in terms of dredging is likely to be required if Mole A is used and the larger vessels are to be accommodated. Due to the activity of dredging, toxins currently contained in the sediment would be disturbed and released into the water. While the area under consideration is badly polluted and turbidity is naturally high, the disposal site for the spoil is likely to become contaminated thus having a detrimental effect on the marine habitat. The extension of Mole C would require that the southern breakwater be extended so as to afford the new structure sufficient protection from cyclonic seas. While the extended breakwater would narrow the southern pass and be closer to the reef at Le Grand Recif, the affects on the habitat would not be significant. Sediment transport will probably not be affected to any great extent although tidal currents in the harbour may be altered slightly. The seabed that would be covered by the new breakwater appears to be sand and so no reef would be impacted.

In terms of sensitive habitats the risk of extending Mole B or C is low, but due to the contaminated dredge spoil disposal issue, the risk of extending Mole A is ranked moderate to high.

Issue 2: Marine Fauna (Other Than Corals)

Risk/Opportunity Assessment

Construction activities will add to the activity and noise levels currently experienced in the confines of the harbour. However, it is unlikely that marine associated fauna would be affected as the port is used extensively and there is an almost continuous stream of ship traffic and operational noise at present. Slow moving benthic marine organisms and small fish (juveniles and larvae) may be affected by dredging activities at Mole A through entrainment and the release of toxins currently bound within the sediment. Similarly, these organisms may be affected at the chosen disposal site either through smothering or being exposed to toxic compounds.

In terms of marine fauna other than corals, the risk of extending Mole B or C is low, but due to dredging and disposal activities at the Mole A site, the risk to slow moving organisms is ranked moderate.

Issue 3: Water quality

Risk/opportunity assessment

Water quality within the harbour is poor. Although construction activities are likely to stir up bottom sediment and hence contribute to turbidity, naturally high turbidity levels would ensure the any impact is minimal. Dredging activities would also contribute to turbidity, but more significantly would release toxic materials currently bound within the sediment. While the affect of this at the dredge site is likely to be minimal, impacts at the disposal site could be more severe.

In terms of water quality, the risk of extending Mole B or C is low. Due to dredging and disposal activities associated with Mole A extension, the risk within the harbour is low but is ranked high at the disposal site.

Issue 4: Fuel Spill

Risk/Opportunity Assessment

The situation regarding fuel spills at Mole A or C would remain unchanged as there is no increased risk from a proposed extension. However, the situation regarding Mole B is different. Temporary arrangements for the offloading of fuel vessels may need to be made during the construction phase. The most likely scenario is a mooring off to the north of the construction activities and an extended pipeline to the existing pump station. An increase in the length of pipeline carrying fuel increases the chance of a spill or leak into the surrounding water.

In terms of a fuel spill or leak, the risk of extending Mole A or C is zero, while the risk associated with Mole B is probably low.

In summary, it is predicted that the environmental risk of extending Mole A is moderate due to the issue of dredge spoil disposal. The risk of extending Mole C from an environmental aspect is low since nearby habitats are already degraded and sediment transport is unlikely to be affected. Despite the increased risk of a fuel spill, the risk of extending Mole B is ranked low.

1.3.1 Operational Phase

The risks to the marine environment during the operational phase of the expanded harbour are again split into those related to sensitive habitats, marine fauna, water quality and fuel spills as they pertain to either Mole A, B or C. In an environment that is already heavily impacted by harbour related activities it is unlikely that additional shipping related activity will be cause for concern providing it is properly managed. The import of certain substances for mining and processing related activities (e.g., sulphur) are associated with risk if not correctly handled.

Issue 5: Sensitive Habitats

Risk/Opportunity Assessment

There are no sensitive habitats that are likely to be affected by the operation of an extended quay at either the Mole A or B site. The extension of Mole C, however, does raise the risk of impacts on the reef on the southern edge at Le Grand Recif.

Pollutants from ships or from the mole surface that enter the water are much closer to the reef than those arising from present sources. Although the reef is already degraded, the situation could be exacerbated if the situation was allowed to deteriorate further.

In terms of sensitive habitats, operation of Mole A or B presents a low risk. Due to the proximity of an extended Mole C to the reef, the risk would probably be moderate.

Issue 6: Marine Fauna (Other Than Corals)

Risk/Opportunity Assessment

Marine fauna at the actual sites of Mole A, B and C are unlikely to be affected more than they are at present as a result of shipping and harbour activity. The risk to marine fauna associated with the nearby reef at Le Grand Recif will most likely be increased due to the proximity of an extended Mole C.

In terms of marine fauna (excluding corals), operation of Mole A or B presents a low risk. Due to the proximity of an extended Mole C to the reef, the risk would be moderate.

Issue 7: Water Quality

Risk/Opportunity Assessment

An increase in the number of ships as well as berth occupancy rates at the extended mole is likely to result in an increase in levels of contaminants entering the water, either from the ships themselves or from land based activities.

In terms of water quality the risk at all three moles would be moderate due to the possibility of import and export product spills.

Issue 8: Fuel Spill

Risk/Opportunity Assessment

The chances of a fuel spill or leak would be the same at any of the three moles as berth occupancy would be increased and hence the risk of an accident. The extension of Mole B, however, does provide an opportunity for the current fuel offloading system to be upgraded as part of the harbour expansion project. The efficiency and safety can be enhanced through improvements in that section of the harbour. However, there is consideration by the hydrocarbon supplier to construct a new hydrocarbon terminal south of the Port of Toamasina, in which case hydrocarbons would be piped to the plant site.

In terms of fuel spills during the operational phase the risk is low. There exists a moderate opportunity to upgrade the current fuel facility at Mole B.

In summary, it is probable that the environmental risk of operating an extended Mole A or B is low, while the risk of operating an extended Mole C is moderate due to its proximity to the southern tip of Le Grand Recif. A moderate opportunity exists for upgrading current infrastructure at Mole B.

1.4 CONCLUSIONS

Table 1.2 summarises the alternative assessment risk or opportunity for each issue discussed. The confidence of these risks or opportunities occurring are also indicated (Table 1.2).

Environmental considerations show that extension of Mole A is the least preferred alternative, with Mole B and Mole C being similar. However, the additional costs involved with extending the breakwater could preclude the Mole C option. The chosen alternative is Mole B and it is assumed that no dredging will be needed. To reduce impacts associated with the construction and operation of Mole B, stringent safety guidelines need to be adhered to that would limit the chances of a fuel leak. In addition, the current fuel spill contingency plan in the port needs to be reviewed to ensure a rapid and effective response should the need arise.

Table 1-2 Summary Of Issues And Their Risk/Opportunity Ranking

Issue	Category (Risk/Opportunity)
Construction Phase	
issue 1: sensitive habitats	mole a - moderate to high risk
	mole b & c - low risk
issue 2: marine fauna (other than corals)	mole a - moderate risk
	mole b & c - low risk
issue 3: water quality	mole a - low risk in harbour
	mole a - high risk at dredge spoil disposal site
	mole b & c - low risk
issue 4: fuel spill	mole b - low risk
	mole a & c - zero risk
Operational Phase	
issue 5: sensitive habitats	mole a & b - low risk
	mole c - moderate risk
issue 6: marine fauna (other than corals)	mole a & b - low risk
	mole c - moderate risk
issue 7: water quality	mole a, b & c - moderate risk
issue 8: fuel spill	mole a & b - low risk
	mole c - moderate risk
	mole b - moderate opportunity

2.1 PORT FACILITIES

This section summarizes the recommended option of extending Mole B within the port of Toamasina, for importing and exporting materials for the project, including a description of the existing port facilities and the options considered. The proposed port layout is shown in Figure 2.1-1.

2.1.1 Project Cargo Movements

The east side of the extended mole would be dedicated to project use, and the west side of the mole would have shared access for the life of the mine. Moreover, the mole would be designed to handle the following cargo:

Table 2-1 Port of Toamasina – Ambatovy Cargo Movement Through Mole B

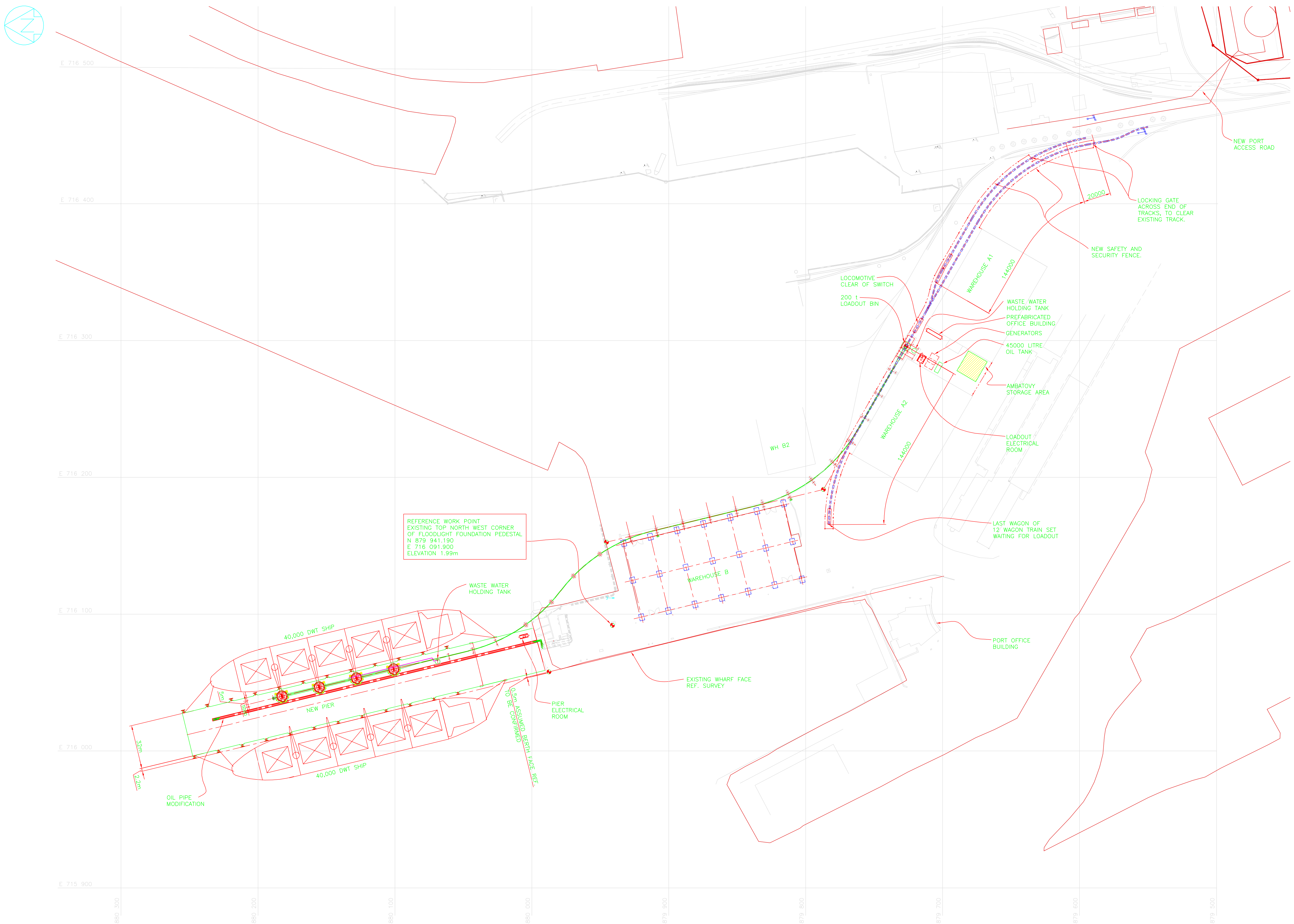
Material	Import / Export	Description	Annual Quantity (Tonnes Nominal)
sulphur	import	dry bulk	700,000
coal	import	dry bulk	300,000
limestone [a]	import	dry bulk	1,600,000
Nickel/cobalt sulphide	export	dry bulk	117,000
total			**2,717,000**

[a] Limestone requirement is 1.5 – 1.6 Mt/a depending on limestone grade.

It is expected that the new mole would have the capacity to handle two 40,000 dry weight (dwt) ships at the same time, with one ship moored on each side of the mole.

2.1.2 Description of Existing Port Facilities

Toamasina is situated on the east coast of Madagascar. It is the principal port of Madagascar and serves the capital city, Antananarivo, about 300 km inland by road or rail. The port is equipped to handle various cargoes including bulk grain, cement, chrome ore, containers, petroleum products, general cargo and passenger traffic.



PLAN

1:1000

NOTE:

1. ALL DIMENSIONS ARE IN METRES.

NOTE:

1. *TOUTES LES DIMENSIONS SONT EN MÈTRES.*

PRELIMINARY

2006/02/28

10 0 10 20 30 40 50 60 70 80 90 100m

SCALE IN METRES

NOTES:

1. BERTH SITE PLAN IS REPRODUCED FROM SEPTEPHA–Sari SURVEY DATED NOVEMBER 2005.
2. THE SITE PLAN OF EXISTING HANGER FACILITIES IS FROM THE SURVEY OF MR. MAURICE AND REPRODUCED FROM PDF DATED DECEMBER 2005.
3. PART OUTLINE SITE PLAN OF EXISTING ROAD AND RAILS IS REPRODUCED FROM SITE PLAN OF MADAGASCAR INTERNATIONAL, CONTAINER TERMINAL SERVICES LTD. DATED OCTOBER 2005.

FIGURE 2. 1–1

DWG. No.	REFERENCE	REF. No.

REV	BY	APPD	DESCRIPTION	YR	MO	DA
P3	PM	JS	ISSUED FOR FINAL REPORT	06	02	28
P2	PM	JS	ISSUED FOR DRAFT REPORT REVIEW	06	01	15
P1	PM	JS	ISSUED FOR CLIENT REVIEW	05	11	25

APPROVED	DRAWN PM	05	11	18
DATE	CHECK			
SCALE 1:1000	DESIGN			
A0. 142899–2000	DES. CHK.			
	CAD FILE: Drawing 142899–2000			

speed and precision worldwide

Sandwell

CLIENT Dynatec Corporation
Metallurgical Technologies Division

PROJECT AMBATOVY PROJECT MADAGASCAR

TITLE
TOAMASINA PORT
TOAMASINA PORT SITE LAYOUT
PORT DE TOAMASINA
PLAN D'AMÉNAGEMENT DE L'EXTENSION DU PORT DE TOAMASINA

DWG. 156972–2000 | REV P3

The present port operates in three main sections (Moles A, B and C) and is protected from large cyclone waves by an isolated breakwater. Mole A is used for smaller vessels but is equipped with a slipway for roll-on roll-off vessels; Mole B is deeper and is presently used as a fuel berth; and Mole C is a deepwater container berth. The present moles are generally of concrete block wall construction backfilled with native materials. There is also a small harbour where cargo is loaded/unloaded with a “lighter” or flat-bottomed barge. This harbour has a narrow space between two piers in which vessels may dock. There are two entrance channels but only the north passage is in use. Currently about 1,500,000 tonnes of cargo are handled annually.

2.1.3 Assessment of Existing Port Capacity

The existing deepwater berths and offloading facilities at Toamasina have a berth occupancy in excess of 66%. Planned improvements to the container handling system will offer some short-term improvement but the expected general traffic growth will soon reverse this trend. The Ambatovy Project requires at least the full-time use of a berth and cannot be accommodated within the existing infrastructure.

The three moles at the Toamasina port each have their advantages and limitations. A detailed study was done to assess the present state of each mole, and its suitability for use by the project for commodity import and export. The expansion of Mole B was considered the most feasible for the following reasons:

- the berth and its approach are deep enough to accept 40,000 dwt vessels without dredging;
- berthing is sheltered; a preliminary wave motion assessment concluded that vessel motions would be negligible; and
- both sides of the mole may be used for berthing, thus increasing the availability of the berth.

2.1.4 Mole B Extension

Several possible structural options exist for the construction of the proposed new berth to accommodate 40,000 dwt ocean carriers.

The three structural options proposed were:

- concrete block wall;
- concrete counter-fort wall; and

- open-piled trestle.

In general, it is possible to construct any of the options noted above, however taking into consideration cost and technical merits, an open piled structure would be the best solution for the project. The proposed extension will take the form of an open-piled trestle structure with tubular steel piles supporting an in-situ cast concrete deck.

Generally, an open-piled trestle will comprise tubular steel piles, driven and socketed into the limestone bed of the harbour, supporting a concrete deck. The deck will eventually allow vehicle access for general container handling and will support the bulk materials loading and offloading equipment and conveyors.

This represents the lowest cost construction option and provides a typical fit-for-purpose solution, which does not offer the option of handling significant quantities of any other type of cargo. Provided water depths are adequate for navigation, no other dredging is required. This option also has the least potential for creating environmental problems with minimal interference with existing water movement patterns within the harbour.

The extension will be about 250 m long and 32 m wide. The structure will be equipped with fenders and bollards suitable for 40,000 dwt class bulk carriers. The existing portion of Mole B will continue to be used for general cargo.

The structure will be designed taking into account, vessel berthing and mooring as well as environmental loads. It is assumed however that the berth would be vacated during cyclone activity.

An initial investigation of the wave penetration through the gap between Grand Recif and the breakwater indicated that wave penetration would not be a problem.

2.1.5 Relocation of Existing Tanker Facilities

The existing tanker loading/offloading facility at the end of Mole B is scheduled to be relocated to the new end of Mole B.

2.1.6 Vessel Manoeuvrability

With the finite size of the port area, any extension will impact on current port activities. To minimize the impact on vessel maneuverability, particularly at

Mole C, the proposed extension does not follow the existing orientation of Mole B but has been angled westwards to allow more clearance. A master mariner has opined that the proposed solution, although affecting the operations of Mole C, is practical. The chief pilot of the port is supportive of the proposed Mole B extension but did express a possible need for specialized tugs to more easily maneuver vessels exiting from Mole C in particular. This will need to be addressed during detailed engineering.

2.1.7 Vessel Motion Study

The preliminary vessel motion study carried out by ZLH Consulting Engineers & Naval Architects assessed the operability of the extended mole (Mole B) and the proposed relocation of the liquid unloading system from Mole B. Their findings were that the expected operability of both Mole B and Mole C would exceed 90%.

2.1.8 Conclusion

For the project requirements, an open-piled trestle structure to be constructed at Mole B is proposed.

The economic incentive to proceed with the open-trestle design is significant. For bulk materials a filled gravity structure such as a block wall has no real technical advantages other than maintenance issues, which are probably not significant over a relatively short 20-to 30-year service life. The proposed solution is not intended to address Toamasina port infrastructure problems.

2.2 MATERIALS HANDLING

The plant will import several different materials for its operation, the highest amounts being limestone, coal and sulphur, with smaller quantities of reagents. Nickel sulphide concentrate will be exported from the plant. Transportation of these materials will take place through the port of Toamasina.

The total quantities of bulk materials anticipated to be imported and exported yearly through Toamasina port are listed in Table 2-1.

Different methods of bulk materials handling were studied, such as conveyor systems, involving an overland pipe conveyor to the plant, and truck and railroad transport. Since the overland conveyor requires an extensive capital investment, it was decided to focus mainly on truck and railroad transport.

When off-loading major consumables, the off-loading operation will run 24 hours per day under the supervision of security personnel.

Nickel and cobalt could be shipped out in containers from Mole C.

2.3 TRANSPORTATION

With regards to the transportation of materials from the port to the process plant, SNC-Lavalin conducted an alternative transport simulation study. Two options were considered: transportation by trucks; and transportation by rail. The study assumed peak ship-unloading rates of 1,000 t/h and 1,200 t/h, and the simulation indicates that both alternatives are viable. Results are summarized below.

2.3.1 Truck Option

Truck transportation offers more flexibility than rail. The trucks are loaded directly at the port and unloaded at the plant unloading station or at the stockpiles when different materials are transported.

From a social and environmental point of view, the truck option will require modifications to the existing road, modification of an existing bridge, and modifications to cope with the road congestion created by social and commercial traffic. In addition, the truck option presents the risk of material spillage or accidents.

From a capital cost point of view, the truck option requires a small investment and offers the possibility of being contracted out to a local transportation entrepreneur. The simulation study shows that the required maximum truck fleet size is 40 trucks when unloading bulk material at a rate of 1,200 t/h (two ships at berth), plus four trucks for other materials required at the plant. The fleet would be considerably reduced when unloading from one ship. The trucking cycle (port-to-plant-to-port) is about 1.5 hours.

2.3.2 Rail Option

The rail option has the advantage of a clean and reliable method of transportation with less impact on the environment and local social life. However, it requires a higher capital cost and close cooperation with, and dependency on, Madarail Co; (the local rail company serving the port). This option does not offer the flexibility provided by truck operation.

2.3.2.1 Selected Option

For its reliability and limited social and environmental impact, the rail alternative was selected for the base case and the truck alternative remains an option.

2.4 RAIL TRANSPORTATION

Rail transportation methods would require minimum equipment for material handling at the port and plant. Ship unloading for the rail option would take place under the following conditions (as per Madarail information)[1]:

Number of trains:	4
Operation:	24 hours per day
Number of cars per train:	23
Railcar capacity:	44 tonnes
Distance to plant:	10 km

Madarail has quoted rail transport to the plant. The offer from Madarail requires the plant owner to invest in the following equipment and infrastructure (other than loading facilities at the port and unloading facilities at the plant):

- three kilometres of track at the process plant site;
- rehabilitation of an existing locomotive;
- five new full locomotives;
- two new shunting locomotives; and
- 56 new railcars.

The following equipment for loading and unloading would be required at the port:

- four rail-mounted 50 t receiving hoppers with belt feeders;
- collecting belt conveyors; and
- a 200 t buffer/rail loading bin with loading gates and dust collection.

The environmental control systems include a water spray dust control system at the receiving hopper, wind screens and/or enclosures at the belt conveyor and bin level controls to prevent overfilling.

[1] Since this analysis was completed, a higher frequency of smaller trains has been selected to meet the demands of rail transport between the port and the plant.

The following equipment for loading and unloading would be required at the process plant:

- a train unloading stations consisting of one underground 50 t receiving hopper with belt feeder;
- extension of existing belt conveyor transporting materials to the stockpiles for loading from the feeder under the receiving hoppers;
- one new collecting belt conveyor to receive material from the second unloading station. This conveyor would unload on a temporary stockpile; and
- a railcar scale.

The environment control systems include water sprays, wind screens and dust collection units.

3 PHYSICAL

3.1 CLIMATE AND AIR QUALITY

The effects of the port expansion on air emissions are addressed together with other effects of the project on air quality in the Toamasina area in Volume D, Section 3.3.

3.2 NOISE

3.2.1 Introduction

The noise assessment of the Ambatovy Project (the project) provides a complete impact analysis of the proposed project and identifies the potential effects of sound emissions associated with the proposed project activities. In this volume of the Environmental Assessment (EA), project activities associated with the planned port expansion in Toamasina are assessed. Information is provided on existing noise levels in the area as well as the potential for changes in noise levels to result from project activities.

The focus of the noise assessment is on a qualitative determination of the potential for changes to the existing ambient noise levels due to project operations. The effects of noise on marine wildlife are assessed in Volume F, Section 3.3. Noise is also an input to the analysis of social effects in Volume F, Section 5.1.

An introduction to the key concepts used in the assessment has been provided in Volume B, Section 3.5.1.

3.2.2 Study Areas

The noise assessment is a qualitative assessment of the area occupied by the proposed port facility for sound emitted from construction and operation activities.

3.2.3 Baseline Summary

3.2.3.1 Introduction

A baseline noise study was completed for the project to establish existing noise levels at the proposed development areas as well as to provide information for the noise impact assessment. Establishing existing noise levels was also necessary in order to use the World Bank noise criteria.

3.2.3.2 Methods

Since Madagascar does not have established guidelines or regulations concerning noise measurements, the study was performed to meet the requirements of the World Bank. The World Bank requires noise be assessed at receptors that lie outside the project boundary based on the following time periods:

- daytime hours (7:00 AM to 10:00 PM)
- night-time hours (10:00 PM to 7:00 AM) (WB, 1998)

One, 24-hour survey was done at each selected monitoring location to represent existing noise levels at community receptors around the plant. Surveys of this type and duration provide information on daily variability in noise levels. The sound level meter used recorded average (L_{eq}) and maximum (L_{max}) sound pressure levels once per minute during the monitoring period.

Weather data was measured at monitoring locations during each 24-hour survey period. Noise measurements are most accurate during weather conditions conducive to low relative humidity, warm temperatures (below 35°C), low winds and no cloud cover. Weather information was recorded throughout the monitoring period and action taken where necessary to ensure conditions remained optimal during noise measurement.

Specific locations near the port expansion were not selected for monitoring as noise from project operations is not expected to be continuous and activity locations have not been resolved. Of the locations nearer the plant site, where baseline measurements were taken, noise levels at Fiadanana or the R2 were likely most similar. Therefore, Fiadanana noise levels have been used as representative of residential areas near the port, making the conservative assumption that such residential areas exist in areas potentially affected by the project.

Detailed information regarding noise monitoring location selection and monitoring methods are provided in Volume I, Appendix 5.1.

3.2.3.3 Summary of Results

A summary of existing noise levels at Fiadanana is provided in Table 3.2-1.

Table 3.2-1 Summary of Existing Noise Levels, Ambatovy Project Process Plant

Location	Period	Quietest Hour L_{eq} [dBA]	Period L_{eq} [dBA]
Fiadanana	day	50	52
	night	44	49

Detailed noise measurements including tables of hourly noise levels and graphs of 1-minute raw data are provided in Volume I, Appendix 5.1.

Other short-term measurements taken within the city by Coastal and Environmental Services (South Africa) as part of the marine assessment (Volume I, Appendix 10.1, Attachment 1) indicate that higher baselines may occur in areas near existing port activity. Short-term (5 minute) measurements taken at mid-day and during evening hours averaged between 58 and 72 dBA with maximums (as L_{max}) as high as 92 dBA. The source of these noise levels was primarily traffic on local roads, including transport trucks waiting for access to docking facilities. These values cannot be used as a definition of baseline in residential areas, however, as they are located in commercial or industrial areas of the city.

3.2.4 Impact Assessment

3.2.4.1 Issue Scoping

Port site factors that may affect noise levels include:

- noise from ships;
- noise generated by dockside equipment including trucks, forklifts, cranes, a conveyor belt and miscellaneous motors or generators;
- increased traffic on the port access roads, particularly during the construction phase, but also during operations may lead to localized increases in noise levels; and
- increased railway traffic, 24 hours per day.

Most noise effects are expected to occur during the construction and operation phases of the project. Changes in noise due to the project may have an effect on human and marine wildlife health. This results in one key question for noise:

Key Question N-1 What Effect Will Noise From the Ambatovy Port Have on Sensitive Receptors?

3.2.4.2 Assessment Methods

The key indicator which will be used to assess potential changes in noise levels is the equivalent sound level or L_{eq}. This indicator is a logarithmic average that represents noise levels measured over a selected period of time and is measured in A-weighted decibels (dBA) to mirror the response of the human ear. This type of average is commonly used in an environmental (outdoor) context as it takes into account natural variations in sound.

The qualitative assessment of changes in noise levels for the port expansion was accomplished by:

- establishing baseline noise levels at potential receptors;
- determining the sources of sound generated by dockside activity; and
- calculating the distance from project related noise that would experience noise levels over the World Bank criteria.

Activities or equipment that have sound emissions were determined based on information contained in the project description and client-supplied equipment lists. Sound emissions for the various sources were based on noise measurements from similar equipment, manufacturer data or standard sound emission formulae.

Calculations were conducted using formulae consistent with International Standards Organization (ISO) acoustic standards and World Bank criteria, providing L_{eq} noise levels over selected time periods.

The effects of noise on wildlife are assessed in the wildlife component. Noise predictions provided for the wildlife assessment are presented here for information purposes only.

The effects of noise from road and rail traffic has been assessed separately under Volume D, Section 5.5.

3.2.4.3 Residual Impact Criteria

Criteria used for noise are the World Bank noise standards for mining activity:

- an hourly L_{eq} noise level of 55 dBA between 7:00 am and 10:00 pm (daytime) and;
- an hourly L_{eq} noise level of 45 dBA between 10:00 pm and 7:00 am (nighttime); or
- a maximum increase in background levels of 3 dBA (applied where background is higher than 55 or 45 dBA respectively).

Criteria are applied at receptors (homes or communities) outside the project boundary. At the port, the boundary is at the outer edge of residential areas of Toamasina, outside the industrial port area.

Residual impacts are not being assessed for the port as the majority of noise occurs either during construction, which is a limited duration, or intermittently during operations, whenever a ship is at the dock. This assessment is only intended to provide information on localized effects which may occur during construction and operation of the port facility.

3.2.4.4 Mitigation

Mitigation or noise controls considered in the port assessment are as follows:

- all heavy equipment will be fitted with standard silencers (mufflers);
- construction ‘best management practice’ for maintaining equipment will be observed; and
- vehicles and motorized dock equipment will be fitted with silencers (mufflers).

3.2.4.5 Sound Emissions

Table 3.2-2 lists noise levels for typical construction equipment that may be used for port construction.

The number and type of noise sources will also depend on the level of construction activity. For a congested location such as a dock, multiple activities on the site are expected, such as material deliveries, filling, concrete mixing and pile driving may potentially all occur at the same time within the dock area.

During operations, noise sources are expected to be similar to cranes loading and unloading equipment from the ships, trucks for transport and various loaders and forklifts. Table 3.2-3 lists noise levels for typical construction equipment that may be used for port operation.

Table 3.2-2 Construction Equipment Sound Emissions

Source	Sound Output (at distance)
bulldozers (2)[a]	87 dBA (15 m)
dump trucks[b]	82-89 dBA (12 m)
front-end loader[b]	79-93 dBA (15 m)
vibratory compactor[a]	87 dBA (12 m)
generator, small[a]	76 dBA (15 m)
pile driving [b]	98 dBA (1 m from engines), 132 dBA (Peak from impact)
backhoe[b]	87-99 dBA (9 m)
backhoe, idling[b]	74 dBA (9 m)
cranes (diesel)[a]	95 dBA (1 m)

(a) Source: May 1978.
(b) Source: Cowan 1994.

Table 3.2-3 Port Operations Sound Emissions

Source	Sound Output (at distance)
dump/transport trucks[b]	82-89 dBA (12 m)
front-end loader[b]	79-93 dBA (15 m)
forklift (diesel, 2 tonne)	75 dBA (1 m)
cranes (stationary)[a]	86-88 dBA (15 m)

(a) Source: May 1978.
(b) Source: Cowan 1994.

3.2.4.6 Residual Impact Analysis

Noise impacts from the port facility are possible for both construction and operation activities. The present level of detail regarding scheduling of construction and operations activity is not sufficient to provide detailed modelling of expected noise levels from the port. However based on the types of noise sources expected on the site the following analysis is provided.

Construction

During construction, the loudest activity is expected to be pile driving and backfilling of dock supports. The nature of this activity will result in continuous noise from equipment engines and impulsive noise from the impacting the piles to set them into the sediments. Impulsive noise is generally the source found to be more irritating to people. As well, the impulses from pile driving are by far the loudest source expected during construction. Careful scheduling of this activity should be considered in order to avoid affecting nearby receivers (e.g., pile driving should only occur during the day).

Other construction activity will be similar to pipeline construction, where several large diesel engine active in a small area. Attenuation calculated based on four, 1,500 HP diesel engine machines will result in noise levels of 45 dBA within 500 to 700 m of the activity. Noise levels will vary based on the level of activity on the site, but will end once construction is complete.

Due to the localized effects for noise and expected short duration of construction, noise impacts are not expected.

Operation

Toamasina is the nation's chief port and handles about 80% of the nation’s imports and exports. In 2003, the port handled 1.5 million tons of traffic, of which 800,000 tons were in containers. The port area already sees a high level of shipping-related activity, therefore the additional ships coming into the port are not expected to have a significant effect on noise levels. Localized effects may occur due to ship engines idling at dockside and trucks/railcar loading and unloading. However, these sound emissions will be intermittent, based on whether there is a ship at the dock.

Since loading and unloading of ships during project operations is expected to be intermittent and the area already sees a significant amount of ship loading and unloading activity, noise impacts are not expected.

3.2.4.7 Prediction Confidence

The calculation of outdoor noise attenuation is conducted using standard algorithms and assumptions that tend to simplify the acoustic environment. Noise, whether natural or man-made, is normally variable over time. The algorithms and the L_{eq} indicator account for that variability, but do not predict it. The variation of noise sources over time can be addressed in the CadnaA model in many ways, depending on the noise source being assessed and the level of detail required.

The quality and relevance of noise predictions from the noise model is dependent on the data inputs. For the assessment, noise sources were established with actual field measurement or vendor sound emission data where possible to ensure the accuracy of sources.

3.2.4.8 Monitoring Plans

Since noise impacts are not expected, a monitoring program for noise is not considered necessary. As part of the on-going community relations program, a process for addressing noise complaints will be developed. Should a noise complaint be received during project operations, an investigation will be conducted to identify the source of the noise and determine possible solutions, if necessary. The investigation may include measurement/monitoring, interviews or modelling.

3.2.5 Conclusions

Noise generated by construction of the port facility is expected to be noticeable by people near the project site, particularly during the pile driving portion of dock construction. Issues regarding pile driving noise may be addressed through scheduling of the activity. Since all construction activity is of limited duration, noise effects are predicted to be negligible. Noise generated by operation of the port facility is also predicted to result in negligible changes in noise levels.

3.3 OCEANOGRAPHY

3.3.1 Introduction

This assessment provides impact analyses relating to the biological, physical and social environments at the site of the Toamasina Port Expansion. This assessment was conducted by Coastal & Environmental Services (CES) of South Africa. Baseline conditions are described in Volume J, Appendix 10.1, Attachment 1.

3.3.2 Methods

3.3.2.1 The Impact Evaluation Criteria

The rating system used for assessing issues in this study is primarily based on three criteria, namely:

- the relationship of the issue to temporal scales (Box 1);
- the relationship of the issue to spatial scales (Box 2); and
- the severity of the issue (Box 3).

These three criteria are combined to describe the overall importance rating, namely the environmental consequence (Box 4). In addition, the following parameters are used to describe the issues:

- the risk or likelihood of the issue occurring (Box 5); and
- the degree of confidence placed in the assessment of the issue (Box 6).

Temporal Scale

The temporal scale allows assessment of impact at various time scales.

Box 1: Temporal scale used in the EA.

Short term	Less than 5 years. Many construction phase impacts will be of a short duration.
Medium term	Between 5 and 20 years.
Long term	Between 20 and 40 years (a generation) and from a human perspective, essentially permanent.
Permanent	Over 40 years and resulting in a permanent and lasting change.

Spatial Scale

The spatial scale defines physical extent of the impact.

Box 2: Spatial scales used in assessing issues.

Household	This scale applies to households in the affected area.
Localised	A few hectares in extent, including port and immediate surrounds.
District	Toamasina Province.
Regional	Toamasina Province as well.
National	Madagascar.
International	International.

Magnitude Rating Scale

The magnitude scale was used to evaluate how severe negative or beneficial positive impacts would be, on a particular affected system (for ecological impacts) or a particular affected party. It is a methodology that attempts to remove any value judgments from the assessment, although it relies on the professional judgment of the specialist.

Box 3: Magnitude (can be negative or positive)

Very Severe	A >30% change in aspect affected.
Severe	A 10-30% change in aspect affected.
Moderately Severe	A 5-10% change in aspect affected.
Slight	A <5% change in aspect affected.
No Effect	No measurable change.

Environmental Consequence Scale

The environmental consequence scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological, social or both. The evaluation of the environmental consequence of an impact relies heavily on the values of the person making the judgment. For this reason impacts, especially of a social nature need to reflect the values of the affected society as well as consider the individual impact criteria ratings. A six-point Environmental Consequence scale has been applied (see Box 4).

In many cases scientists have to produce an assessment in the absence of all the relevant and necessary data. American legislation (Section 40, Code of Federal

Regulations (CFR) 1502.22) has considered these limitations, and makes the following recommendations:

"When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an Environmental Impact Statement (EIS) and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking if the incomplete information is essential to a reasoned choice among alternatives. If the overall costs of obtaining it are not exorbitant, the agency shall include the information in the EIS".

There are two acceptable procedures to follow to compensate for a shortage of data:

1. It is more important to identify likely environmental impacts than to precisely evaluate the more obvious impacts.

All assessors (the different specialists) try to evaluate all the largest impacts, recognising that precise evaluation is not possible. It is better to have a possible or unsure level of certainty on important issues than to be definite about unimportant issues.

2. It is important to be conservative when reporting likely environmental impacts.

Because of the fact that assessing impacts with a lack of data is more dependent on one's own scientific judgment, the rating on the certainty scale cannot be too high. If the evidence for a potential type of impact is not definitive in either direction, the conservative conclusion is that the impact cannot be ruled out with confidence, not that the impact is not proven. It is for these reasons that a degree of certainty scale has been provided, as well as the category Don't Know.

Box 4: The Environmental Consequence Rating Scale

VERY HIGH

These impacts would be considered by society as constituting a major and usually permanent change to the (natural and/or social) environment, and usually result in severe or very severe effects, or beneficial or very beneficial effects.

HIGH

These impacts will usually result in long term effects on the social and/or natural environment. Impacts rated as high will need to be considered by society as constituting an important and usually long term change to the (natural and/or social) environment. Society would probably view these impacts in a serious light.

MODERATE

These impacts will usually result in medium to long term effects on the social and/or natural environment. Impacts rated as moderate will need to be considered by society as constituting a fairly important and usually medium term change to the (natural and/or social) environment.

LOW

These impacts will usually result in medium to short term effects on the social and/or natural environment. Impacts rated as low will need to be considered by the public and/or the specialist as constituting a fairly unimportant and usually short term change to the (natural and/or social) environment. These impacts are not substantial and are likely to have little real effect.

NO IMPACT

There are no primary or secondary effects at all that are important to scientists or the public.

DON'T KNOW

In certain cases it may not be possible to determine the environmental consequence of an impact.

Risk Or Likelihood Scale

The risk or likelihood of an impact taking place as a result of project actions varies. There is no doubt that some impacts would occur if the port goes ahead, but certain other (usually secondary) impacts are not as likely, and may or may not result from the port. Although these impacts may be severe, the likelihood of them occurring may affect their overall environmental consequence and will be taken into account.

Box 5: The Risk or Likelihood Scale

Very unlikely to occur	The chance of these impacts occurring is extremely slim, e.g., an earthquake destroying back-of-port area.
Unlikely to occur	The risk of these impacts occurring is slight, but impacts such as a catastrophic shipping accident may occur.
May occur	The risk of these impacts is more likely, although not definite, for example the disturbance of the reef environments.
Will definitely occur	There is no chance that this impact will not occur, minor oil spills during refuelling.

Degree Of Certainty Or Confidence

It is also necessary to state the degree of certainty or confidence with which one has predicted the environmental consequence of an impact. For this reason, a 'degree of certainty' scale has been provided to describe how certain we are of our assessment.

Box 6: The Degree of Certainty or Confidence Used in This Study

Definite	More than 90% sure of a particular fact. To use this, one will need to have substantial supportive data.
Probable:	Over 70% sure of a particular fact or the likelihood of that impact occurring.
Possible	Only over 40% sure of a particular fact or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.

3.3.3 Impact Assessment

In the harbour expansion baseline report (Volume I, Appendix 10.1) it was indicated that the current port and bay environment is characterized by sandy to clay sediments, which have accumulated pollutants over time through direct deposition of substances contained in the water column. This, in turn, has created a species-poor environment, which should ideally not be further impacted upon.

The potential impacts of the proposed project are grouped into a range of issues, separated under construction and operational phases. Some impacts may occur in both phases, but are only discussed in the phase in which they predominantly occur.

During the construction and operation of the port there are a number of project actions that could impact the marine, nearshore and coastal environments. As detailed in Volume I, Appendix 10.1, Attachment 1, the principal project activities include:

- the construction of an open pile quay structure;
- the increase in shipping traffic with round the clock (24 hour a day) handling;
- refueling and general servicing of vessels;
- unloading and loading of various cargoes, which are potentially hazardous;
- the possible intrusion on the visual sense of place, by larger ships expected closer to shore and the additional lighting at night; and
- increase in expected noise levels during construction and operation phases.

The operational activities associated with the Ambatovy Project have been engineered for using contained handling systems, which if properly maintained should have a limited impact of the marine and social (Health and Safety) environments.

3.3.3.1 Construction Phase - Key Issues

The port and bay environment will, in the construction phase of the port, be impacted by the stockpiling, concrete works and handling of various construction materials. Due to the proximity of the beachfront, which is used for recreation purposes, the social environment may also be affected. A Construction Environmental Management Plan will be developed to mange the following potential impacts.

Issue 1. Specific Impacts On The Social Environment

Impact 1 – Impact of Land Based Noise

The impacts of land based noise are described in Volume F, Section 3.2.

Impact 2 – Change to Visual Sense of Place

The impacts on visual aesthetics are presented in Volume F, Section 3.6.

Issue 2. Impacts On The Near Shore Environment

Impact 1 – Marine Fauna (Other Than Corals) – Sediment Re-Suspension

Construction activities will be confined to the harbour. However, it is unlikely that marine fauna would be further affected as the port is used extensively and there is an almost continuous stream of ship traffic and operations at present. The open piling will disturb some the sediments and will cause re-suspension of any toxins. Slow moving benthic marine organisms and small fish (juveniles and larvae) are already impacted by the dredging activities at Mole A, both through entrainment and the release of toxins currently bound within the sediment.

Mitigation

Although piling and the related construction works would cause disturbance of the bottom sediments, the latest drilling techniques will be utilized. Furthermore, the drilling programme will take cognizance of the prevailing tidal/weather conditions. Some operators make use of a bubble curtain around the pile driver, which has been indicated in the literature to isolate the suspended sediments.

Residual Impact

Sediment re- suspension will affect marine fauna other than corals. However, in the context of an environment with existing baseline levels of silt and pollutants, construction will have a severe impact within a localized region of the port for a short duration. Through the use of the latest techniques, the impact would be moderately severe, but it is predicted that the environmental consequence of the impact associated with extending Mole B is low.

Impact 2 – Marine Fauna (Other Than Corals) – Underwater Noise

Construction activities will be confined to the harbour. However, it is unlikely that marine associated fauna would be affected as the port is used extensively and there is an almost continuous stream of ship traffic and operations at present. The pile driving will create acoustic noise, adding to current noise levels within the port region.

Mitigation

Although piling and the related construction works would contribute to the acoustic noise, the latest drilling techniques will be utilised. Some operators make use of a bubble curtain around the pile driver, which has been indicated in the literature as a means of reducing the acoustic noise.

Residual Impact

Underwater noise will affect marine fauna other than corals. However, in the context of an environment with existing baseline underwater noise, incremental effects due to project construction will have a slight impact within a localized region of the port for a short duration. Through the use of the latest techniques it is predicted that the environmental consequence of extending Mole B is low.

Impact 3 – Water Quality Changes

Water quality within the harbour is poor. The dredging activities at Mole A, would also contribute to a degrading in water quality, but more significantly would release toxic materials currently bound within the sediment. Construction activities are likely to stir up sediment and hence contribute to turbidity and pollutant levels.

Mitigation

Although piling and the related construction works would contribute to a change in water quality, that the latest drilling techniques will be utilized. Furthermore, the drilling programme will take cognizance of the prevailing tidal/weather conditions. Due consideration will be given to construction materials and pouring of concrete. Stockpile areas and batching plants will not be in close proximity to the construction area. Containment areas, bunds and emergency spill procedures should always be in place

Residual Impact

Water quality changes will occur, but due to baseline conditions, the construction will have a slight impact within a localized region of the port for a short duration. Through the use of the latest techniques and proactive environmental management plans, it is predicted that the environmental consequence of extending Mole B would be low.

Impact 4 – Fuel Spills

Fuel spills pose a constant threat within a port environment particularly in Toamasina with the additional Galana operations. The current environment is impacted and additional spills could have a large cumulative impact. The port does have emergency response equipment, but it is not clear if there is a dedicated and trained team available. It is also not evident if the port had sufficient emergency response capacity to cope with additional shipping traffic.

Temporary arrangements for the offloading of fuel vessels will need to be made during the construction phase. The most likely scenario is a mooring to the north of construction activities and an extended pipeline to the existing pump station.

Any increase in the length of pipeline carrying fuel, increases the chance of a spill or leak into the surrounding waters during the construction phase.

Mitigation

In order to reduce any impacts associated with the construction of Mole B stringent safety guidelines need to be adhered to that would limit the chances of a fuel leak. American Petroleum Institute (API) specifications will apply to all pipelines and systems during this phase should be monitored and maintained frequently (daily). In addition, the current fuel spill contingency plan in the port needs to be reviewed to ensure a rapid and effective response should the need arise.

Residual Impact

Fuel spills may occur and depending on the amounts spilled, when compared to baseline conditions, could be severe. Spills can be rapidly contained thus remaining localized and having a short duration. If the current port response kits and spill contingency plans are upgraded the environmental consequence of this impact will be moderate.

Issue 3: Biological Contamination Through Introduced Organisms

Impact 1 - Impact of an Introduced Marine Invasive Organism

The possibility of the introduction of exotic marine organisms by ships will occur throughout the life of the port and as such it is an impact that occurs during both the construction and operational phases. The probability of a release and successful colonisation of invasive exotic organisms is exceptionally difficult to predict or calculate. However, the seriousness of this issue should not be underestimated, as the introduction of a single invasive species could result in a very significant permanent impact on the ecology of the coastal zone. This threat is not unique and is a problem faced by all ports around the world. The main mechanisms by which organisms could be introduced will be through ballast water of ships, which originate from their previous area of operation.

Mitigation

Ballast water can be dealt with in three general ways: treating the water prior to release into the harbour; transfer of ballast water to onshore tanks for treatment; and offshore disposal.

Transfer of ballast water to onshore tanks for treatment eliminates the issue of ballast water being released directly into the harbour. Treatment systems that can be applied include oil skimmers, and chemical or physical treatment, e.g., chlorination or ultra violet irradiation as applied to some European domestic or hospital wastes. Water to be returned after treatment can be checked that no organisms are still alive in it. However, there are currently no shore-side treatments available in Toamasina.

Treating the water while still on board and then releasing it is possible as is the offshore disposal and re-ballasting of water (water exchange). Independent validation of this procedure is problematical and water exchange is weather dependent. Treatment of the ballast water while still onboard and prior to release from the vessel would enable independent verification. It is essential that a ballast water plan be drawn up for the port prior to the operational phase of this project

Residual Impact

The introduction of an invasive exotic species to Malagasy coastal waters is unlikely, but if it occurs it will have a permanent and very severe negative effect on native communities and/or marine resource-based industries at the local, district, regional and national scale. The environmental significance of the impact would be very high. Mitigation in the form of a rigorous ballast water plan and extensive cleaning of the dredgers only serve to reduce the probability of occurrence but the impact will still be of very high environmental consequence if it occurs.

Summary

The construction of the proposed development will pose several risks to the currently impacted environment. However, there exists enough possible mitigation to limit the impact of construction due to the chosen locality and selecting appropriate construction methods. A construction management plan will be developed and an oil spill contingency plan be prepared for the Port Authorities.

Additional potential issues exist, but due to the fact that the proposed development is unlikely to have a measurable impact, they were not considered for detailed discussion. These include:

- change in bathymetry of the nearshore environment;
- impact on marine mammals as the area is an operational port;
- impact on fish due to current operational port; and
- impact on marine archaeological sites.

3.3.3.2 Operational Phase - Key Issues

Background

The risks to the marine environment during the operational phase of the expanded harbour are again split into those related to water quality, marine fauna and fuel spills pertaining to Mole B. In an environment that is already heavily impacted by harbour related activities, it is unlikely that additional shipping related activity will be cause for concern providing it is properly managed. Management plans will be developed to minimize potential risks, and further degrading the impacted environment. The import of substances for mine and process plant (e.g., coal and sulphur) and export of products, however, do require specific handling.

Issue 4: Pollution Associated With The Operation Of The Port

Impact 1 - Impact of General Ship and Port Waste

The present marine environment is impacted and the operation of a port will result in the introduction of a range of waste into the marine environment (e.g., solid ships' waste, plastic, paper etc.). This waste will result from rubbish and litter from the port and from the ships arriving in the port. There will be an increase in litter on the beaches and in the marine environment around the port. This litter (e.g., line, packing tapes etc.) will cause a visual impact on the environment as well as impacting on some of the fauna in the region, which may become entwined in, or ingest the litter.

Mitigation

The vast majority of this type of pollution can be prevented assuming an effective management system is in place. An operational phase port management plan will be compiled and that litter control will be incorporated into this plan. As required by MARPOL[1] adequate waste reception facilities will be made available at the port to dispose of ships' waste.

Residual Impact

The incorrect operation of the proposed port will result in substantial amounts of pollution being introduced into the environment, which will have a severe localized impact on the fauna and aesthetics of the area in the long term. The correct management of the port, which would involve deterrents and effective

[1] The International Convention for the prevention of pollution from ships (1973) and its Protocol adopted in 1978 (MARPOL 1973/1978) place an obligation on parties to ensure that ports provide adequate waste reception facilities to dispose of ships' waste (CEN 2000).

enforcement, could result in the impact being slight. The overall ecological environmental consequence of this impact is low (negative).

Impact 2 - Impact of Ship Associated Biocides

The fouling of ships' hulls is a major problem in the shipping industry as it reduces the efficiency of ships. The use of a variety of biocides on the hulls of ships has been standard practice for a number of years. These biocides are specifically designed to kill organisms such as mollusks that attach themselves to the hulls of ships. In recent years the accumulation of these biocides in ports and marinas has been identified as a major problem and efforts are under way to curb the use of biocides. The biocide treatments (e.g., antifouling paint) on the ship's hull not only prevents the successful attachment of organisms to the hull but unfortunately also leaches into the water column and could result in decreased spawning success and larval development, and death of invertebrate organisms in the port. The operation of the port has the potential to impact on invertebrate organisms within and immediately around the harbour.

Mitigation

Port authorities over the next few years aim to prohibit the use of certain antifouling paints such as Tributyltin (TBT). The stripping and repainting of hulls has been identified in other ports as a major source of biocides entering the environment, but these activities should be limited in the proposed development.

Residual Impact

While the issue of biocides in antifouling treatments is not unique to the current port, the operation of the port will result in a severe long term impact to the organisms within the port, and a moderately severe impact immediately around the port. The reduction of the use of biocide treatment may reduce the severity of this impact in the future. The overall environmental consequence of this impact is moderate (negative).

Impact 3 - Impact of Storm Water Runoff

Large areas within the back-of-port will be hard surfaces and will thus generate large quantities of stormwater runoff. This runoff could contain harmful substances such as hydrocarbons (oils).

Mitigation

As part of the Environmental Management System, the proponent and port authorities will develop a stormwater management plan and be responsible for the treatment and management of stormwater. Through regular cleanup of operations areas, contamination of stormwater will be minimized.

Residual Impact

Poor work area cleanup and poor management of stormwater originating from the port could result in a severe localized impact over the long term. The efficient and routine cleanup of this area will be carried out to minimize effects, resulting in only a slight impact. The overall ecological environmental consequence of this impact is low (negative).

Impact 4 - Impact of Material Spill During Cargo Transfers

The transfer of cargo in the port will result in the occasional spill during transfer. Risk assessments (WSP, 2001) indicated that the majority of worldwide spills below 7 tons were associated with the routine operations and loading and discharging within the port. In terms of the proposed operations, the greatest incidence of spills will be limited by the proposed engineering designs.

Mitigation

The fact that most pollution spills occur during transfers or normal port operations indicates that these accidents should be able to be managed. The correct training programme and careful management of port operations will be implemented. The enforcement of the health and safety programmes and operational standards will form part of the operational environmental management system for the port. The appropriate management of the port can reduce the occurrence of any spills but emergency containment plans will be drawn up in line with global best practice standards so that, in the case of a spill, it can be contained.

Residual Impact

Spills of the various products that will be transferred through the port may occur. Depending on the size and nature of the spills, they could result in a very severe impact in the short to medium term within and possibly immediately surrounding the port. With correct management, significant spills will be unlikely and if effectively contained, be of moderate severity. The overall environmental consequence is moderate (negative).

Impact 5 - Catastrophic Oil/Fuel Spill

The proposed Mole extension will be visited by large ships. The possibility exists that there could be a catastrophic oil/fuel spill. Large spills would impact significantly on various ecosystems within the bay, as well as a number of industries such as tourism and fishing. While large spills are unlikely, with approximately 7.3 occurring worldwide every year, the possibility does exist that such a spill may occur. The overall risk is, however, regarded as being low.

Mitigation

The correct management of the port can reduce the probability of a catastrophic event occurring. The availability of suitably trained people and the required equipment can significantly reduce the impact of a spill. The following mitigations are proposed based on international experiences:

- Internationally, prevention has become the focus of oil/fuel spill management. With proactive inspection of vessels being a key requirement of a spill management programme. Further, all tankers entering waters are obliged to have adequate insurance. However, non-tank vessels can also cause damaging spills. At present there are no requirements regarding insurance for non-tank vessels. The international shipping community is promoting a move to broaden the base of ships that must carry insurance. The proponent will support these moves and encourage the responsible state departments to support these international efforts.
- A comprehensive oil/fuel spill contingency plan will be established. The plan will address both containment and cleanup. It will adopt best practice techniques and be regularly audited.

Residual Impact

In the unlikely event of a major oil spill, the impact on the environment in the region will be very severe in the short to medium term. With sound management of the port and inspection of vessels, the likelihood of occurrence should decrease. If adequate oil spill containment structures are in place and are effectively deployed, the impact would probably be severe. While the potential risk of such an occurrence is low, the potential damage that a major oil spill could have on sensitive areas such as the various island groups in the bay results in the overall environmental consequence of this impact being very high.

Impact 6 - Air-Emissions Associated With Shipping

The shipping in the proposed port will result in the emission of gases such as carbon dioxide (CO_2), carbon monoxide (CO), sulphur dioxide (SO_2), hydrocarbon compounds (HC), oxides of nitrogen (NOx), and particulates (PM) into the atmosphere.

Residual Impact

The emission of gases associated with the ships at the proposed port expansion will probably result in a slight, localized, long-term impact. The overall environmental consequence of this impact is low.

Issue 5: Maintenance Dredging

Impact 1 - Impacts Associated With Maintenance Dredging

Due to the lack of a sand bypass system, a certain amount of maintenance dredging may be required in the long-term. The maintenance dredging could result in a range of impacts not encountered in the initial impact assessment, as it will not occur in a clean sands environment. Accumulated contaminants in the sediments e.g., hydrocarbons and heavy metals, will be re-suspended. While the projected dredge operations will be small, the suspension of any contaminants during dredging and disposal can result in a range of impacts on the environment. One cannot predict the exact impacts as the amount of material to be dredged and possible levels of contamination are unknown.

Mitigation

The London Convention clearly outlines the requirements that need to be met before dredging. Prior to any authorization for maintenance dredging, these requirements will need to be met by the dredging contractor and thus the impact on the environment should be low.

Residual Impact

The dredging of contaminated areas could result in a severe localized impact at both the dredging and disposal sites. With the required permitting and adherence to the guidelines, the impact should be slight. The overall environmental consequence of this impact is predicted to be low.

Issue 6: Risks Associated With Increased Shipping

Impact 1 - Increased Risk of Ship Collision

The port expansion will result in an increase in vessel traffic and as such there is an increased chance of ship collision.

Mitigation

The following mitigations will reduce the likelihood of collisions:

- the proponent will participate with port authorities in a revision of the future traffic movement control systems for the region.
- Revisions will ensure that the larger fishing ship movements will be integrated into the traffic control of the bay.

A coordinated approach to vessel traffic control by trained personnel will help to lower risks of vessel collision.

Residual Impact

The risk of ship collision will be higher. Collisions could occur and the impact on the environment may be very severe, depending on the severity of the collision and the size of any resulting spill. With the correct traffic control measures in place, collisions should be very unlikely. The large size of ships to berth at the expanded port and the fact that large spills are associated with collisions, means that while being very unlikely, the overall environmental consequence of a collision is high (negative).

3.3.3.3 Summary

A summary of the impact assessment for the proposed port expansion is shown in Table 3.3-1 and 3.3-2.

3.3.4 Conclusions

This assessment has dealt with the potential impacts on the marine environment that may arise from the port expansion at Toamasina. Based on the risk assessment presented in Volume F, Section 1, the expansion of Mole B is the preferred option. No reasons were found that would preclude the project from advancing.

3.3.4.1 Opportunities

The direct opportunities to add value from an environmental perspective are limited. The marine habitats within the harbour are severely degraded and any activity related to construction of Mole B and its subsequent operation will not result in any improvement. Similarly the nearby reef located at Le Grand Recife will not derive any benefit from these actions. Marine fisheries that make use of the infrastructure within the harbour or those artisan operators that fish within the confines of the port will not benefit from the project. An indirect opportunity, however, may be derived from the upgrading of the fuel facility at Mole B. This would enhance both efficiency and safety, thereby reducing the chances of accidental spills or leaks into the marine environment. In addition, the operation of a section of the port according to higher standards will raise awareness and standards for the whole port.

The socioeconomic opportunities provided by the capital expenditure of the proposed project, which includes expansion of the road, rail and electrical power generation infrastructure, outweighs the impact from the expansion of the port (Volume D, Appendix 5.1).

Table 3.3-1 Construction Phase Impacts on the Marine Environment from the Port Expansion.

Issue/Impact	Without Mitigation					With Mitigation	
	Risk	Temporal	Spatial	Cert.	Magnitude	Magnitude	Environmental Consequence
Issue 1: Specific Impacts On The Social Environment *							
Issue 2: Specific Impacts On The Near Shore Environment							
Impact 1: marine fauna (other than corals) – re-suspension	will occur	short term	localized	probable	severe	moderately severe	low
Impact 2: marine fauna (other than corals) – underwater noise	will occur	short term	localized	probable	slight	slight	low
Impact 3: water quality changes	will occur	short term	localized	probable	slight	slight	low
Impact 4: fuel spills	will occur	short term	localized	probable	moderately severe	slight	moderate
Issue 3: Biological Contamination Through Introduced Organisms							
Impact 1: impact of an introduced marine invasive organism	unlikely	permanent	national	probable	very severe	Very severe	very high

* See Volume F, Sections 3.2 and 3.6 for noise and visual assessments.

Table 3.3-2 Operational Phase Impacts in the Marine Environment from the Port Expansion.

Issue/Impact	Without Mitigation					With Mitigation	
	Risk	Temporal	Spatial	Cert.	Magnitude	Magnitude	Environmental Consequence
Issue 4: Pollution Associated With The Operation Of The Port							
Impact 1: impact of general ship and port waste	will occur	long term	localized	probable	severe	slight	low
Impact 2: impact of ship associated biocides	will occur	long term	localized	probable	severe	moderately severe	moderate
Impact 3: impact of storm water runoff	will occur	long term	localized	probable	severe	slight	low
Impact 4: impact of material spill during cargo transfers	may occur	medium term	localized	possible	very severe	moderately severe	moderate
Impact 5: catastrophic oil/fuel spills	unlikely	short to medium term	localized	probable	very severe	severe	very high
Impact 6: air-emissions associated with shipping	will occur	long term	localized	unlikely	slight	slight	low
Issue 5: Maintenance Dredging							
Impact 1: impacts associated with maintenance dredging	will occur	long term	localized	possible	severe	slight	low
Issue 6: Risks Associated With Increased Shipping							
Impact 1: increased risk of ship collision	may occur	long term	localized	possible	very severe	very severe	high

3.3.4.2 Environmental Issues

Although it is clear that construction activities and operation of the extended Mole B will impact on the immediate marine environment, the affected environment is degraded and if properly managed the cumulative impact should not be of high consequence.

The only construction impact of very high environmental consequence would be the impact of an introduced invasive marine organism. The problem of exotic invasives exists throughout the world's ports and is presently the focus of research interest. The impact is rated as very high due to the tremendous damage that invasive organisms can have. Mitigatory measures such as a strictly enforced ballast water plan will be implemented and the dredgers will be thoroughly cleaned prior to arrival in Malagasy waters. These measures will serve to reduce the possible incidence but cannot assure that no invasives are introduced.

The interim arrangement for offloading fuel carrying vessels during the construction phase needs to take preventative steps to ensure a minimal risk of fuel leaks. This was the only possible impact rated as moderate during the construction phase

Materials being brought in during the operational phase will be in large quantities. Spillage of these materials into the marine environment may have a moderate effect on biota. An occupational health and safety system together with a management plan will be put in place. This will coincide with, if not exceed the requirements of systems such as IS0 9001 (operations quality control) and ISO14001 (environmental management).

Many of the larger impacts discussed in this report in the operational phase rated as high or very potential high, can be mitigated through effective environmental management of the port. This will involve establishing a thorough operating environmental management system, including:

- a ballast water and dumping plan;
- oil spill contingency plans;
- wastewater and stormwater plans;
- adequate waste reception plan for ships' waste;
- a litter control plan; and
- a visual impact plan containing necessary actions, guidelines and requirements for reducing the visual impact of any construction.

This system will be regularly audited and updated.

3.3.4.3 Recommendations

The following recommendations are highlighted below:

- The fuel/oil spill contingency plan for the Port of Toamasina should be reviewed to ensure it conforms to international safety standards. The risk of a spill or leak will be increased during the construction phase when alternative arrangements and a longer pipeline are required to offload fuel-carrying vessels.
- Although dredging will not be required for the extension of Mole B, the dredging that will take place by Port Authorities as part of the rehabilitation of the Mole A area is of concern. The dredging operation itself is unlikely to raise any large issues; however, the disposal of spoil needs to be considered for several reasons. Firstly, the spoil will be contaminated and disposal will result in contamination of the chosen site. Secondly, the location of the disposal site in relation to the outfall is of concern because of possible cumulative impacts associated with outfall effluent and contaminated spoil.
- The public participation process will continue to be extensive and transparent to avoid any misunderstanding or conflict of interest that may hamper the development at a later stage.

3.4 NATURAL RISKS

3.4.1 Introduction

This section presents the Environmental Assessment (EA) for the risks of natural hazards to the public and environment due to the port expansion, as per the Ambatovy Project (the project) Terms of Reference.

3.4.2 Study Area

The port expansion Local Study Area (LSA) includes the part of the Toamasina natural risks study area around the port (Volume A, Figure 7.2-3), and immediately surrounding waters. The port of Toamasina will be used extensively during construction and operations for the plant's import and export requirements.

Natural hazards such as earthquakes and tsunamis can originate from a much larger regional area that was studied as appropriate to determine the potential impacts at the port expansion-site.

3.4.3 Baseline Summary

The EA is based on two separate studies on natural hazards (Dynatec 2005 and Baird 2005), which are provided in Volume I, Appendix 6.1. In these reference studies, the coastal area is described in terms of location, topography, geomorphology, climate, seismicity and the risks of tsunamis. Potential natural hazards, potential consequences of failure due to natural hazards and risks in the area of the port expansion were assessed.

Baseline data for natural hazards included climate data describing hydrological hazards and earthquake data describing seismicity hazards.

3.4.4 Issue Scoping

Five principal natural hazards are identified in the risk assessments (Dynatec 2005 and Baird 2005) as seismic, hydrological, wind, geotechnical and tsunami. Issues associated with each of these natural hazards are summarized as follows. All the issues identified from stakeholder consultation were included in these hazard scenarios.

Seismic Hazards

An earthquake could:

- cause a power failure and port shutdown;
- damage port structures; and
- rupture containment facilities such as fuel tanks.

Hydrological Hazards

Heavy rains from a tropical cyclone could trigger flooding from storm rains which inundate port infrastructure and containment areas.

Wind Hazards

High speed winds from a tropical cyclone could:

- cause a power failure and port shutdown;
- damage port structures;
- rupture fuel tanks;
- blow stockpiled materials off-site;
- damage temporary structures and scatter debris; and
- cause an elevated sea storm surge and high waves with the potential to flood parts of the port.

Geotechnical Hazard

Unforeseen geotechnical conditions could occur due to a seismic or hydrological event causing port damage.

Tsunami Hazard

A major tsunami could inundate the port, including Mole B, associated storage areas, buildings, supply roads and railways. Such an event could cause both environmental damage (washing stored fuel, chemicals and raw materials into the ocean) and pose a threat to the health of workers and those living in the area.

The key question for natural hazards is:

Key Question TG-1 Are the risks of natural hazards to the public and environment increased as a result of the port expansion?

3.4.5 Impact Assessment

3.4.5.1 Assessment Methods

A risk assessment was carried out for some of the natural hazards affecting the port within a plant site risk assessment (Dynatec, 2005) using a relative ranking system. For each of the five identified natural hazards described in Section 3.4.4, all potential hazard scenarios were first identified according to failure mode, associated consequences and planned risk mitigation measures. The residual risks for all hazard scenarios were then estimated using a relative risk ranking system. Acceptable risks were determined according to international standards to minimize risk to downstream public and environmental resources.

3.4.5.2 Assessment Criteria

The assessment criteria used for the assessment of natural risks are presented in Table 3.4-1. Five categories of risk are defined by likelihood of occurrence and magnitude of consequences. Overall risk is a product of the relative ranking for likelihood and consequence.

Table 3.4-1 Description of Risk Criteria for the Port Expansion

Ranking Categories	Likelihood of Occurrence (Probability)		Magnitude of Consequences		Overall Risk
extremely low	1	negligible chance of occurrence, <1:10,000 yr "doubt it will ever happen"	1	no fatalities possible, minor to no damage beyond owners property	1-5
low	2	not likely to occur, 1:1,000 to 1:10,000 yr "highly unlikely to happen"	2	no fatalities anticipated, minor damages beyond owners property	6-10
moderate	3	moderate frequency of occurrence 1:100 to 1:1,000 yr "it could happen"	3	no fatalities anticipated, moderate property damages	11-15
high	4	frequent occurrences, 1:10 to 1:100 yr "it has happened, or it probably will happen"	4	some fatalities possible, large property damages	16-20
extremely high	5	very frequent occurrences, >1:10 yr "happens all the time"	5	large number of fatalities possible, extreme property damages	21-25

3.4.5.3 Mitigation

A number of risk mitigation measures were identified in the reference reports (Dynatec, 2005 and Baird, 2005). The design basis and criteria for the port expansion will be based on maximum recorded regional natural hazard events to minimize risk to within recognized acceptable levels for surrounding public and environmental resources.

Risk mitigation measures were identified for all potential natural hazard scenarios. Mitigation is discussed in the referenced report under the five principal natural hazards: seismic, hydrologic, wind, geotechnical and tsunami. These risk mitigation measures include:

- Mole B and associated port receiving facilities are subject to tsunami effects and will be designed to withstand the high current velocities of such an event.
- Port structures will be designed for the maximum regional earthquake.
- An advanced weather reporting and emergency response plan will be implemented to shut down operations in advance of severe cyclonic storms or an oncoming tsunami. The emergency response program will be coordinated with the local communities to ensure that the public is not adversely affected by the project. Vessels will be removed from the port in such an event. The program will also ensure that the ability of the community to recover from such events is enhanced by the presence of resources available to the project.
- Port structures will be designed for wind loads from the strongest historical cyclones.
- Construction of facilities not designed for maximum winds will be minimized, good housekeeping will be maintained, and materials will be stowed prior to onset of cyclonic storms. Secure refuge will be provided for personnel in the event of a cyclonic storm.
- Foundations will be designed as appropriate for geotechnical conditions and the maximum regional earthquake.

3.4.5.4 Results

The results of the risk assessment are summarized from the reference reports (Dynatec, 2005 and Baird, 2005). The largest risks to the port are from an extreme wind event damaging temporary structures (during construction) and blowing airborne debris (moderate risk) and from a severe cyclone and associated storm surge (low risk). Lower risks are possible from a seismic event or from a tsunami (extremely low risks).

All of these risks will be planned for and managed. The risks of high wind events during construction activities will be managed through good housekeeping and stowing away materials prior to the onset of cyclonic storms. Secure refuge will be provided for personnel in the event of a cyclonic storm. An advanced weather reporting and emergency response plan will be implemented to shut down operations in advance of severe cyclonic storms and tsunamis, and allow ships to leave the port. Application of conservative seismic design parameters will address seismic concerns. Detailed geotechnical investigations have been completed to adequately characterize conditions for a suitable design.

3.4.5.5 Impact Analysis

Residual Impacts

Following mitigation, all but one of the identified residual risks during all project periods are in the extremely low or low categories. One moderate risk from an extreme wind event will be managed through actions to prevent damage and protect people. The estimated risks are within international standards to minimize risk to downstream public and environmental resources.

Prediction Confidence

The estimation of risk in the reference reports (Dynatec, 2005 and Baird, 2005) accounts for the variation in data and prediction confidence. However, risk ratings are also dependent on the success of the mitigations proposed, including those listed in Section 3.4.5.3. Overall, the prediction confidence for this assessment is considered medium.

Monitoring

Monitoring programs will be assessed during detailed design.

3.4.5.6 Conclusions

Following mitigation, increased risks of natural hazards to the public and environment as a result of the port expansion are estimated to be within international standards.

3.5 WATER QUALITY

The effects of the port expansion component of the Ambatovy Project on marine water quality are discussed in Section 3.3 of this Volume. The port expansion has no anticipated effects on fresh water quality.

3.6 VISUAL AESTHETICS

3.6.1 Introduction

This section presents the Environmental Assessment for the effects of the port expansion on visual aesthetics. As per the Ambatovy Project (the project) Terms of Reference, the potential impacts on the nearest habitations or frequented viewpoints are evaluated.

3.6.2 Study Area

The port Local Study Area (LSA) for visual aesthetics consists of an area surrounding the main port expansion and extending into the Indian Ocean and along the coast of Toamasina, as presented in Volume A, Figure 7.2-3. It includes the planned rail link between the port and process plant site and a 500 m buffer around the rail route.

3.6.3 Baseline Summary

The port expansion is planned in a highly visible location at Toamasina. However, the area is already highly urbanized and has a variety of existing industrial development, including the existing port. Despite the industrial nature of the site, views of the existing port are likely to be considered relatively scenic by some people, as they occur over a wide bay at the waterfront of Toamasina. Groups of people likely to be viewing the port include local residents, boaters and tourists.

The most prominent views toward the port expansion location occur from immediately adjacent coastal areas. The key viewpoints are summarized in Table 3.6-1. The baseline views from viewpoints P1 and P2 are presented in Volume I, Appendix 11.1, Attachment 1, Photographs 25 and 26.

Table 3.6-1 Key Viewpoints: Port Area

Viewpoint Number	Viewpoint Name	GPS Location (UTM Zone 39S)	Possible Viewers	Baseline View Characteristics
P1	Toamasina shoreline	E 332664 N 7992049	local residents tourists and travellers	urban area with existing industrial port
P2	Toamasina shoreline	E 332357 N 7992032	local residents tourists and travellers	urban area with existing industrial port

Note: GPS = global positioning system; UTM = universal transverse mercator.

Additional details concerning baseline conditions are provided in Volume I, Appendix 11.1.

3.6.4 Issue Scoping

In public consultations, the main question regarding aesthetics has been: how will changes in visual aesthetics affect tourism? However, tourism is not a large issue in the context of this industrial port. Potential changes that will be seen by local residents, as well as tourists and other visitors include:

- limited removal of vegetation as necessary from along the rail access corridor to the port from the process plant;
- generation of some locally visible fossil fuel emissions from machinery at the port and docking ships;
- added lighting; and
- construction of a variety of buildings, facilities and infrastructure which will be visible from outside of the port area.

The key question for visual aesthetics is:

Key Question VA-1 What Effect Will the Port Expansion Have on Visual Aesthetics?

Visual effects will occur during the construction, operation and closure phases of the project.

3.6.5 Impact Assessment

Effects on visual aesthetics will occur with the construction of new industrial facilities and the expansion of the existing mole B ('Quay B') within the port. Construction cranes and other machinery will represent visual impacts to nearby areas during the construction phase. Lighting may also affect visual aesthetics during construction.

During operations, views of facilities and lighting from the port site will continue to represent potential impact pathways.

3.6.5.1 Assessment Methods

A qualitative assessment was completed for the port expansion, using baseline photographs and on-site observations to describe current views. A general understanding of the size and layout of the planned port expansion facilities, and of the rail corridor linking the port and process plant, was used.

3.6.5.2 Assessment Criteria

The assessment criteria used for visual aesthetics are presented in Table 3.6-2.

Table 3.6-2 Impact Description Criteria for Visual Aesthetics

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
positive: change in landscape to more natural appearance **negative:** change in landscape to less natural appearance	**negligible:** no measurable effect on visual aesthetics **low:** key viewpoints allow distant or minor views of project effects **moderate:** key viewpoints allow direct but not overwhelming views of project effects **high:** key viewpoints allow for close-in, overwhelming views of project effects (views representing a large proportion of the visible landscape)	**local:** effect restricted to the LSA **regional:** effect extends beyond the LSA	**short term:** <3 years **medium term**: 3 to 30 years **long term:** >30 years	reversible or irreversible	**low:** views occur rarely **medium:** views occur intermittently **high:** views occur continuously

3.6.5.3 Mitigation

During construction, machinery and material stockpiles will be kept within the designated port industrial zone.

Fully shielded lights will be used for all major lighting apparatus at the port, and these lights will be directed downward or away from residential areas.

Port facilities, and the railway route linking the port and process plant will be maintained in an orderly state. Throughout operations, waste materials will be removed promptly from areas visible to the general public.

3.6.5.4 Results

The visual effect of the port expansion on people will vary widely based on personal perception. The perception of the aesthetics of the port will be affected mainly by the surrounding environment, which is an existing industrial port area (in the case of the port expansion) and an existing railway right-of-way (RoW) (in the case of the railway corridor). The new development will not present a substantially greater impact than the existing development, except during the construction phase. During construction, the presence of additional construction machinery will present a small additional effect on visual aesthetics.

Many people will have a clear and unobstructed view of the port expansion from Toamasina, but the view will not be substantially different than the existing view. This will not represent an impact to visual aesthetics during the operations or closure phases.

3.6.5.5 Impact Analysis

Residual Impacts

Following mitigation the residual effects during each project period are summarized in Table 3.6-3.

Table 3.6-3 Potential Effects and Residual Impacts for Visual Aesthetics

Project Period	Potential Effects	Mitigation	Residual Impacts
construction	changes in visible facilities and construction machinery changes in lighting	construction of quay expansion, storage areas and other buildings; presence of construction machinery use of fully shielded fixtures; direct light away from residential areas	low magnitude modification of visible facilities and machinery negligible
operations	changes in visible facilities and construction machinery	facilities and material stockpiles will be kept in the industrial zone the railway will be constructed along an existing rail RoW waste will be removed from visible areas promptly	negligible

The new development will not present a substantially greater impact than the existing development, except during the construction phase. During construction, the presence of additional construction machinery will present a low-magnitude effect on visual aesthetics. After construction, the expansion is expected to blend visually with existing industrial development, resulting in a negligible impact. In both cases, impacts are local in geographic extent, high in frequency, and are not reversible, as the facilities will be left after project closure for other uses. In all cases, the environmental consequences of visual impacts will be negligible.

Lighting from the expansion, both during construction and operations, will present a negligible impact during construction and operations, as mitigation will ensure than the new lighting will be less prominent than existing lighting at the port site. Lighting may be visible at a regional level, especially from the direction of the sea. The environmental consequence for lighting is negligible.

An overall residual impact classification for visual aesthetics for each key issue and each phase of the project is presented in Table 3.6-4.

Prediction Confidence

The existing appearance and setting of the areas to be developed for the port expansion are well known. Planned developments will be similar in appearance to existing ones. The prediction confidence level for this assessment is high.

Table 3.6-4 Residual Impact Classification for Visual Aesthetics

Phase	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Issue: Effect of Facilities and Machinery on Visual Aesthetics							
construction	negative	low	local	short-term	no	high	negligible
operations	negative	negligible	local	medium-term	no	high	negligible
Issue: Effects of Light Pollution							
construction and operations	negative	negligible	regional	medium-term	yes	high	negligible

Monitoring

No monitoring is proposed specifically for visual aesthetics.

3.6.6 Conclusions

The port expansion and the rail link between the port and the process plant will have negligible environmental consequences for visual aesthetics, because these developments will occur in areas already used as a port and as a rail RoW.

4 BIOLOGICAL

4.1 MARINE ECOLOGY

Effects on marine ecology are addressed in Section 3.3 of this Volume (Oceanography).

4.2 NATURAL HABITATS AND BIODIVERSITY

The effects of the Ambatovy Project (the project) on natural habitats and biodiversity in the area of the port expansion are addressed in Section 3.3 of this volume (Oceanography). Marine habitats may be affected, however terrestrial habitats will not, as the area to be developed is an existing industrial site.

4.3 PROTECTED AREAS

Effects on protected areas relating to the port expansion are addressed in combination with all effects occurring due to the Ambatovy Project in the Toamasina region. These effects are presented in the Process Plant volume (Volume D, Section 4.5).

5 SOCIAL

5.1 SOCIOECONOMICS

The socioeconomic assessment for the port expansion can be found in Volume D, Section 5.1.

5.2 CULTURAL PROPERTY

The port expansion will be developed in an existing industrial area and is not expected to have any impacts on cultural property.

5.3 LAND USE

5.3.1 Introduction

This section presents the Environmental Assessment for the effects of the port expansion and related infrastructure development on land use. As per the Ambatovy Project (the project) terms of reference, land use has been mapped in the port expansion local study area (LSA) and changes in land use areas predicted in comparison to baseline levels. The implications of changes in land use for people are discussed in the context of socioeconomic effects in Volume D, Section 5.1.

5.3.2 Study Area

The port expansion LSA is one-third of the Toamasina terrestrial LSA shown in Volume A, Section 7.2, Figure 7.2-3. This area includes the port area and the corridor for the railway between the port and the crossing of the Pangalanes Canal near the process plant.

5.3.3 Baseline Summary

Land use along the corridor of the railway between the process plant and port includes an existing right-of-way (RoW) (which can accommodate at least part of the additional rail development for the project), in addition to a coastal shrubby/herbaceous complex and the urban/industrial areas of Toamasina (Volume K, Appendix 3.1, Section 3.5.3).

The port of Toamasina supports a small commercial fishing fleet. Fishers vary from small-scale, artisanal fishers using locally made boats equipped with outboard engines, to commercial freezer trawlers. The entire Madagascar coastline is accessed by the larger ships, while the main area used by small-scale fishers is just south of Toamasina, to the east of the project. Other fishing areas in the area are Le Grand Recif, Ile Aux Prunes, and Nosy Faho (Volume K, Appendix 3.1, Section 3.5.4).

5.3.4 Issue Scoping

Key issues raised by the public relating to land use and the port expansion during public consultations include:

- effects of a vehicle and rail transport system between the port and plant site on adjacent urban areas within Toamasina;
- effects of the port expansion on the function of the existing port; and
- effects of the port expansion on fishing activity around Toamasina.

5.3.5 Assessment Methods

Land use changes are considered through a spatial analysis of the kinds of land use areas that will be altered by the project. The effects of land use impacts are social in nature and are addressed within the impact rating system in the socioeconomics section (Volume F, Section 5.1).

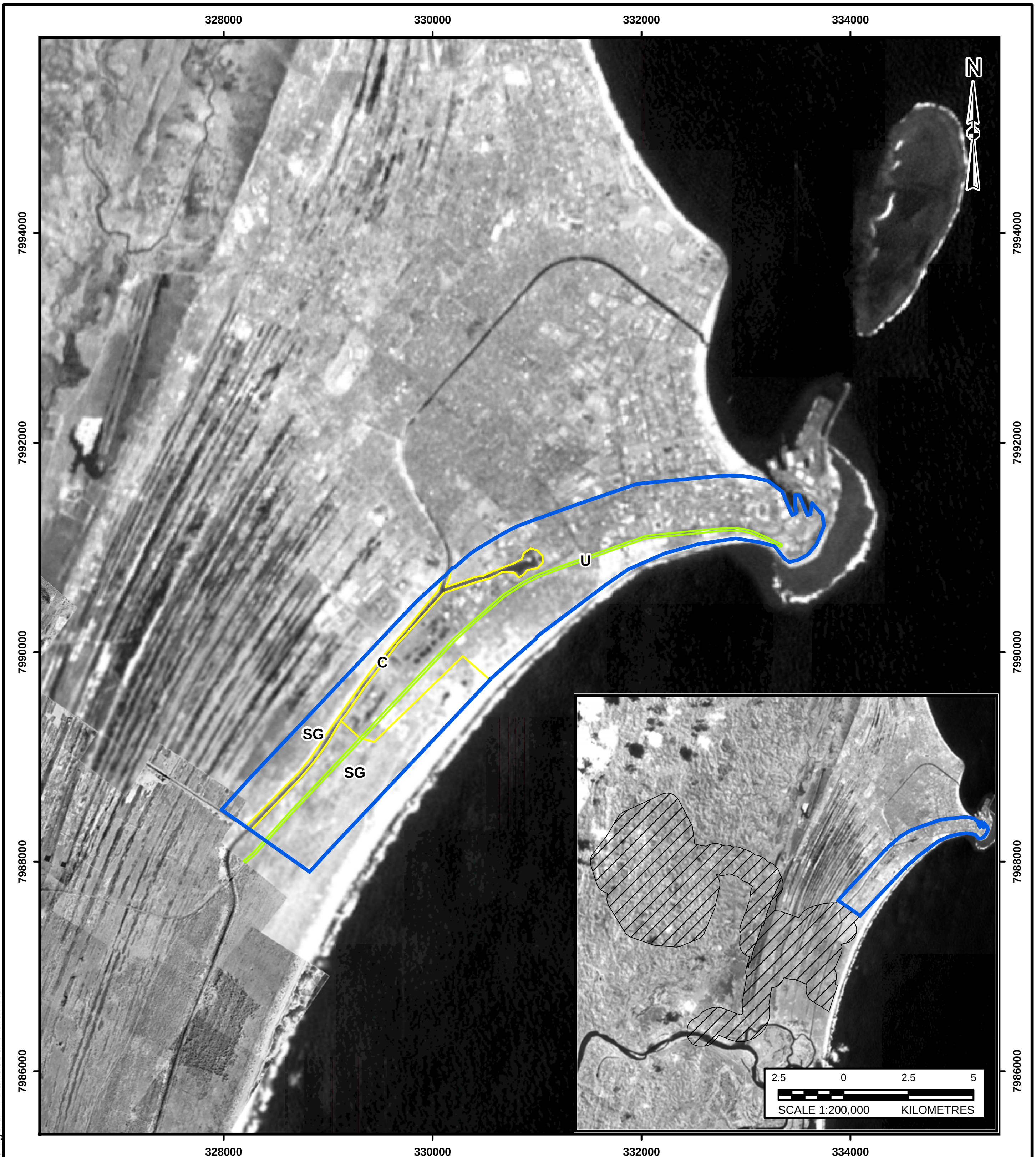
5.3.6 Impact Assessment

A linkage diagram for land use is presented in Volume H, Appendix 9. Potential impact pathways between the port expansion and changes in land use exist for:

- alteration of soils, terrain and vegetation (including urban areas); and
- changes in fish habitats and abundance.

Alteration of Soils, Terrain and Vegetation

The impacts of the project on areas with a variety of potential land uses are presented in Table 5.3-1. Impact areas are mapped in Figure 5.3-1. A narrow strip of lands along the existing railway right-of-way will be affected by the project. This land is not considered valuable for agriculture, but may support residences and other infrastructure, especially within Toamasina.



LEGEND

VEGETATION AND LAND USE CLASSIFICATION

VEGETATION/LAND USE TYPE

C CANAL

SG COASTAL SHRUBLAND/GRASSLAND COMPLEX

U URBAN

PORT FACILITY SUB-LOCAL STUDY AREA

CORRIDOR DISTURBANCE

REFERENCE

Landsat 7 Mosaic Image; Captured April/Sept. 2001
Aerial photograph Mosiac Images; Captured 2004
Datum: WGS 84 Projection: UTM Zone 39S

0.5 0 0.5 1
SCALE 1:50,000 KILOMETRES

PROJECT

AMBATOVY PROJECT

TITLE

LAND USE IMPACT AREAS WITHIN THE PORT SUB-LOCAL STUDY AREA

Golder Associates
Calgary, Alberta

PROJECT No. 03-1322-172.8000			SCALE AS SHOWN	REV. 0
DESIGN	GJ	03 Aug. 2005	FIGURE: 5.3-1	
GIS	TN	28 Oct. 2005		
CHECK	GJ	10 Feb. 2006		
REVIEW	DM	10 Feb. 2006		

i:/2003/03-1322/03-1322-172/mxd/Landuse/Fig5.3-1_Landuse_Port.mxd

Table 5.3-1 Land Use Impact Areas for the Port Expansion Local Study Area

Type of Area	Area within LSA (Baseline) (ha)	Area Impacted During Project (ha)	Proportion of Area in LSA Impacted (%)
coastal shrubland / grassland	197	3	2
urban areas	349	12	3
canal	23	0	0
totals	**569**	**15**	**3**

The most valuable land use areas within the port expansion LSA at present are developed urban areas. Within the LSA, 3% (12 ha) of urban areas will be impacted by the development of a rail corridor to the port. Much of the area affected will be an existing rail corridor that has space to accommodate most of the new planned development. The port itself will be an expansion of existing facilities and is not expected to have any negative effect on the existing operations. Effects on land owners in Toamasina are addressed in the socioeconomic section (Volume F, Section 5.1).

Changes in Fish Habitat and Abundance

The effect of the project on marine fisheries is addressed in the oceanography section (Volume F, Section 3.3). The port expansion itself is not expected to reduce opportunities for fishing vessels to use the port, as the capacity for ships to dock will be increased in proportion with the number of additional ships that will be docking.

5.3.7 Mitigation

Various alternatives have been considered to convey materials between the port expansion area and the process plant; concerns were expressed by local populations regarding the potential impacts of a vehicle transport system, and a rail link option almost entirely within an existing rail corridor is now proposed. Any land use conflicts within Toamasina regarding the further development of the rail corridor will be discussed in detail with governments at all levels and the local populations. Other socioeconomic mitigation and compensation measures have been developed for those directly or indirectly affected by the project, as described in the socioeconomics section (Volume F, Section 5.1).

5.3.8 Conclusions

The port expansion will have a small effect on land use, as only a small area is affected by the access corridor to the port and development at the port itself will not have a negative effect on existing operations. Effects along the railway route in urban areas may face land use issues which will be addressed in cooperation with local people and the municipal government of Toamasina. The magnitude of these impacts in socioeconomic terms are evaluated in Volume F, Section 5.1.

5.4 HUMAN AND ECOLOGICAL HEALTH

Ecological health and linkages to human health are addressed in Section 3.3 of this Volume (Oceanography). Further details of baseline conditions and of impact analysis modelling in the marine environment are given in Volume I, Appendix 10.1.

5.5 TRAFFIC

The Environmental Assessment for the effects of the port expansion on traffic is presented in Volume D, Section 5.5 in combination with the effects of the process plant and tailings facility on traffic in the immediate vicinity of Toamasina.

6 RECLAMATION AND CLOSURE PLAN

At the time of project completion, the Port expansion areas developed by the project will be provided to the City of Toamasina and the port authority to use in ongoing port operations. Buildings at the site with no useful function (based on discussions with stakeholders at the time of closure) will be dismantled and removed from the site at the time of project closure. Waste materials will be removed from the site and disposed of properly. Any areas of known or suspected soil contamination, such as fuel storage and transfer areas, will be assessed for contamination. If present, localized areas of contaminated soils or sediments will be remediated within a soil land farm, unless other alternatives are identified.

Reclamation and revegetation is not anticipated in the port expansion area.

7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

This section provides highlights of selected mitigation and monitoring that will form part of the management plans specific for the Ambatovy Project's (the project) port expansion. More detailed information is provided in the mitigation and monitoring sections of each Environmental Assessment (EA) discipline section. A full framework for the Environmental and Social Management Plan (ESMP) is provided in Appendix H, Section 6. Specific mitigation and monitoring plans are presented below. Section 7.1 presents activities to be performed for key management plans during construction and operations.

7.1 CONSTRUCTION AND OPERATIONS PHASE ACTIVITIES

The development of a specific construction environmental management plan is proposed (Volume F, Section 3.3), including spill response procedures, other procedures to reduce effects on marine life, waste management procedures and health and safety protocols. An ESMP will be produced to address the handling of materials passing in and out of the port and along the transport routes between the port and process plant. The Port of Toamasina's existing fuel/oil contingency plan will be reviewed to ensure it conforms to international safety standards. The risk of a spill or leak will be increased during the construction phase when alternative arrangements and a longer pipeline will be required to offload fuel-carrying vessels.

The disposal of spoil from any construction-related dredging activity will form part of the port's waste management plan, as spoil from the port is considered contaminated under baseline conditions.

7.1.1 Flora and Fauna Management Plans

The latest drilling techniques will be used to minimize acoustic noise which would have the potential to disturb marine fauna, and to minimize disturbance of sediments which may affect water quality. Emergency spill procedures will be designed and implemented rapidly if needed during construction to mitigate any contaminant releases into the water or adjacent shoreline areas.

7.1.2 Human Resource Development Plans

A Local Resource Development Initiative (LRDI) will be developed, which will include training programs for locals and small businesses to maximize the use of the local labour force and promote the further development of small and medium sized businesses. Residents of Toamasina and other nearby communities will preferentially become part of such programs relating to work at the port.

7.1.3 Procurement Plan

A procurement plan, part of the LRDI, will optimize involvement of local businesses initially and will increase their involvement over time.

7.1.4 Other Socioeconomic Management Activities

An HIV/AIDS program will be established and will be operational before project construction begins.

As part of a shared responsibility the proponent will participate in local and regional social development programs to assist the area in managing changes that may occur through such a large initiative as the Ambatovy Project.