Appendix 1

Approval letter of National EIA by the Ministry of Environment

République Islamique de Mauritanie
Honneur - Fraternité - Justice

Ministère de l'Environnement
et du Développement Durable

الجمهورية الإسلامية الموريتانية
شرف - إخاء - عدل

وزارة البيئة و التنمية المستدامة

N° [redacted]039...../Medd/M

Nouakchott, le 05 FEV 2019 انواكشوط في:

N°/Réf:
V/Réf:

Le Ministre الوزير

A
Madame le Ministre de l'Equipement et
des Transports

Objet : *Avis de faisabilité environnementale du Nouveau terminal à conteneurs et d'hydrocarbures au Port Autonome de Nouakchott dit Port de l'Amitié (PANPA) au profit de la société ARISE Mauritania S.A.*

Réf. 1 : Lettre N°281/MET/M du 26/10/2018
Réf. 2 : Lettre N°186/DCE/MEDD du 31/10/2018
Réf. 3 : Lettre N°189 /MEDD/DCE du 02/12/2018
Réf. 4 : Lettre ARISE Mauritania du 24/12/ 2018
Réf. 5 : Lettre N°007/MEDD/M du 15/01/ 2019

Suite à la transmission des termes de référence (Réf.1) du Projet cité en objet, j'ai l'honneur de vous notifier qu'une procédure d'Etude d'Impact sur l'Environnement (EIE) a été engagée par mon Département et menée à terme. Le déroulement et les conclusions de la procédure sont rapportés ci-après.

La société ARISE Mauritania a respecté les différentes étapes de la procédure de l'EIE : réalisation d'une réunion de cadrage des termes de référence et leur validation (Réf.2 et Réf.3), d'une phase d'information et de consultation du public et la transmission du rapport de l'EIE (Réf.4) suivie de l'enquête publique (Réf.5).

L'analyse du rapport de l'EIE montre que les principaux impacts potentiels des les phases de construction d'exploitation sur le milieu biophysique et humain sont identifiés ainsi que leurs sources :

- Emissions atmosphériques (poussières et gaz à effet de serre) : Impact potentiel sur la qualité de l'air ;
- Bruit et vibrations : Impact potentiel sur la faune et les habitations ;
- Dragage : Modification de la bathymétrie de la zone du projet ;
- Hydrocarbures et déchets solides et liquides : contamination du sol et du milieu marin.

Le Plan de Gestion Environnemental et Social (PGES) comporte des plans de gestion spécifiques à chacun des impacts potentiels identifiés pour maintenir l'impact général du Projet à un seuil tolérable par les récepteurs environnementaux concernés.

Les mesures préconisées doivent porter sur les aspects suivants :

- Les mesures de protection et de suivi de la qualité de l'air,
- Le traitement des eaux usées par la mise en place d'un système adapté,
- La protection des eaux, des sols, des sédiments marins et de la biodiversité (faune te flore), contre les contaminants et micro-contaminants,
- La réduction du bruit et vibrations,
- La gestion des déchets, des produits chimiques, carburants et autres produits dangereux.

Tenant compte de l'importance du Projet en question et la sensibilité du milieu dans lequel il est mis en œuvre, un rapport trimestriel sur l'état de mise en œuvre du PGES doit être élaboré et transmis à mon Département en vue de permettre un suivi régulier de sa conformité environnementale.

Par conséquent et au vu de ce qui précède, j'ai l'honneur d'accorder un avis favorable de faisabilité environnementale du Nouveau terminal à conteneurs et hydrocarbures au PANPA au profit de la société ARISE Mauritania S.A.

Amédi CAMARA

Ampliations :
-PM
-MSG/PR.
-DG/ARISE Mauritania

وزارة البيئة والتنمية المستدامة R.I.M / Ministère de l'Environnement et du Développement Durable
الوزير
Le Ministre

Appendix 2

Application letter for dredged spoil disposal site

ARISE
Mauritania

Réf : ARISE/NCT/00018

Monsieur le Directeur Général
des Infrastructures de Transport

Nouakchott, le 11 mars 2019

Objet : Demande d'autorisation de dépôt des produits de dragage résultant de la construction du nouveau terminal à conteneurs et à hydrocarbures du port de Nouakchott.

Monsieur le Directeur,

Comme vous le savez, la réalisation du nouveau terminal à conteneurs et à hydrocarbures requiert des travaux de dragage jusqu'à une profondeur de 15m, résultant en un volume de 3 à 5 millions de m3 de matériaux. Les zones de dragage et les zones envisagées pour le dépôt des matériaux dragués sont indiquées sur la carte fournie en **Annexe 1**.

Les zones de dépôts A et B sont deux des trois zones que le Ministère de l'Equipement et des Transports avait identifiées en 2011 pour les besoins de la réalisation des travaux d'extension du port de Nouakchott menées par la Société Nationale Chinoise des Travaux de Ponts et Chaussées (SNCTPC). Le procès-verbal de la réunion ayant arrêté ces zones de rejet est fourni en **Annexe 2**, ainsi que le schéma de localisation de ces zones fournie par la SNCTPC.

L'impact du dépôt des matériaux de dragage dans l'une de ces zones a été analysé dans le cadre de l'Etude d'Impact Environnementale (EIE) soumise au Ministère de l'Environnement et du Développement Durable. Sur la base de cette étude, notre projet a reçu un avis favorable le 5 février 2019 (**Annexe 3**).

En complément de l'EIE et afin de répondre aux exigences de nos investisseurs, une Etude d'Impact Environnementale et Sociale (EIES) selon les normes de performance de la Société Financière Internationale (SFI) est en cours d'exécution. Dans le cadre de cette étude, une campagne de prélèvement et d'analyse de l'environnement marin a été effectuée en janvier dernier dans la zone d'influence de notre projet. Les résultats de cette campagne sont fournis en **Annexe 4**.

Ainsi, considérant les éléments précédents, et dans le contexte et le respect de la règlementation mauritanienne, nous sollicitons de votre Ministère une autorisation d'utiliser les zones de dépôt des matériaux dragués telles que définies dans les documents ci-annexés.

Je vous prie d'agréer, Monsieur le Directeur Général, l'expression de ma haute considération.

Ministère de l'Economie et des Finances
Secrétariat Central
COURRIER ARRIVEE
Le : 13/03/2019
Enregistré sous le N° 1998

13/03/2019

MET
DGIT
Arrivée Le : 13/03/19
N° 202 DGFT

Mohit Agrawal

Mohit Agrawal
Directeur Général

ARISE MAURITANIA
ARISE Mauritania
BP 7303 Nouakchott - Mauritanie

13/03/2019
606

ARISE MAURITANIA
Port Autonome de Nouakchott - BP 7303 Nouakchott - Mauritanie
RCCM N° 98113/GU/19122/498 NIF : 00508135

Copie :

- Mme la Ministre de l'Equipement et des Transports.
- Monsieur le Ministre de l'Economie et des Finances

PJ : **Annexe 1** : Localisation des zones de dragage et des zones envisagées pour le rejet des sédiments dragués.
Annexe 2 : PV de la réunion du 5 Avril 2011 ayant arrêté les zones de rejet des produits de dragage résultant des travaux d'extension du port de Nouakchott.
Annexe 3 : Avis de faisabilité environnementale du Nouveau terminal à conteneur et d'hydrocarbures au profit de la société ARISE Mauritania S.A.
Annexe 4 : Rapport sur les inventaires marins réalisé par Magma et émis le 25 février 2019.

Appendix 3

Certificate of analysis of soil samples issued by Eurofins

Royal HaskoningDHV
Att. Schiphuis, Jan Jurjen
P0 Box 8520
3009 AM ROTTERDAM

Certificate of analysis

Date: 12-Feb-2019

Please find enclosed the analytical results of the test carried out for the project.

Certificate number/Version	2019011788/1
Your project number	NG SB20180079-01
Your project name	Mauritania soil samples
Your order number	
Samples received on	08-Feb-2019

This Certificate of Analysis shall not be reproduced except in full, without written approval of the laboratory. Interpretations and opinions are outside the scope of our accreditation, and all results relate only to samples supplied.

Soil samples will be stored for a period of 4 weeks and water samples for a period of 2 weeks after receipt of the samples at our laboratory. Without any additional request, samples will be disposed when the above mentioned periods have expired. If you require Eurofins Analytico to store the samples for a longer period, please complete this page and return it to Eurofins Analytico at least one businessday before the period is due to expire.
The costs of prolonged storage periods may be found in our pricelist.

Storage period:
Date: Name: Signature:

We are confident that we have performed the order in accordance with your expectations. If you have any remaining questions concerning this Certificate of Analysis, please don't hesitate to contact our Customer Service.

Yours sincerely,

Eurofins Analytico B.V.

Ing. A. Veldhuizen
Technical Manager

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Certificate of analysis

Your project number	NG SB20180079-01	Certificate number/Version	2019011788/1
Your project name	Mauritania soil samples	Start date	11-Feb-2019
Your order number		Report date	12-Feb-2019/08:09
		Annex	A,C,D
Sampled by	Ruart Leonor	Page	1/2
Sample matrix	Soil, Sediment		
Project agreement	4879 - RHDHV - Mauritanië project		

	Analysis	Unit	1	2	3	4	5
	Characteristics						
Q	Dry matter	% (w/w)	98.6	95.8	98.1	95.9	98.2
	Metals						
Q	Arsenic (As)	mg/kg dm	<5.0	<5.0	<5.0	<5.0	<5.0
Q	Barium (Ba)	mg/kg dm	150	170	120	59	42
Q	Cadmium (Cd)	mg/kg dm	<0.40	<0.40	<0.40	<0.40	<0.40
Q	Chromium (Cr)	mg/kg dm	<5.0	6.5	7.4	7.9	5.9
Q	Copper (Cu)	mg/kg dm	<5.0	7.7	5.2	<5.0	<5.0
Q	Mercury (Hg)	mg/kg dm	<0.10	<0.10	<0.10	<0.10	<0.10
Q	Molybdenum (Mo)	mg/kg dm	<1.5	<1.5	<1.5	<1.5	<1.5
Q	Nickel (Ni)	mg/kg dm	<5.0	<5.0	<5.0	<5.0	<5.0
Q	Lead (Pb)	mg/kg dm	<10	<10	<10	<10	<10
Q	Zinc (Zn)	mg/kg dm	19	52	17	8.2	11
	Petroleum Hydrocarbons						
	EPH (C10-C12)	mg/kg dm	<3.0	<3.0	<3.0	<3.0	<3.0
	EPH (C12-C16)	mg/kg dm	<5.0	<5.0	<5.0	<5.0	<5.0
	EPH (C16-C21)	mg/kg dm	<6.0	<6.0	<6.0	<6.0	<6.0
	EPH (C21-C30)	mg/kg dm	<12	16	<12	<12	18
	EPH (C30-C35)	mg/kg dm	7.4	14	<6.0	8.4	12
	EPH (C35-C40)	mg/kg dm	<6.0	6.7	<6.0	<6.0	<6.0
Q	EPH Sum (C10-C40)	mg/kg dm	<38	39	<38	<38	<38
	Chromatogram TPH (GC)			See annex			

No.	Sample description	Date sampling	Sample nr.
1	NCT-1T	23-Jan-2019	10525844
2	NCT-2T	23-Jan-2019	10525845
3	NCT-3T	23-Jan-2019	10525846
4	NCT-4T	23-Jan-2019	10525847
5	NCT-5T	23-Jan-2019	10525848

Q: Dutch Accreditation Council (RvA) accredited test
A: AP04 accredited test
S: AS SIKB recognized test
V: VLAREL recognized test
M: MCERTS accredited

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BTW/VAT No. NL 8043.14.883.B01

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TESTING
RvA L010

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Certificate of analysis

Your project number	NG SB20180079-01	Certificate number/Version	2019011788/1
Your project name	Mauritania soil samples	Start date	11-Feb-2019
Your order number		Report date	12-Feb-2019/08:09
		Annex	A,C,D
Sampled by	Ruart Leonor	Page	2/2
Sample matrix	Soil, Sediment		
Project agreement	4879 - RHDHV - Mauritanië project		

	Analysis	Unit	6	7	8	9
	Characteristics					
Q	Dry matter	% (w/w)	98.9	91.0	97.9	92.4
	Metals					
Q	Arsenic (As)	mg/kg dm	<5.0	<5.0	<5.0	<5.0
Q	Barium (Ba)	mg/kg dm	37	47	29	62
Q	Cadmium (Cd)	mg/kg dm	<0.40	<0.40	<0.40	<0.40
Q	Chromium (Cr)	mg/kg dm	<5.0	5.7	6.5	6.7
Q	Copper (Cu)	mg/kg dm	<5.0	<5.0	<5.0	<5.0
Q	Mercury (Hg)	mg/kg dm	<0.10	<0.10	<0.10	<0.10
Q	Molybdenum (Mo)	mg/kg dm	<1.5	<1.5	<1.5	<1.5
Q	Nickel (Ni)	mg/kg dm	<5.0	<5.0	<5.0	<5.0
Q	Lead (Pb)	mg/kg dm	<10	<10	<10	<10
Q	Zinc (Zn)	mg/kg dm	6.8	6.2	6.7	11
	Petroleum Hydrocarbons					
	EPH (C10-C12)	mg/kg dm	<3.0	<3.0	<3.0	<3.0
	EPH (C12-C16)	mg/kg dm	<5.0	<5.0	<5.0	<5.0
	EPH (C16-C21)	mg/kg dm	<6.0	<6.0	<6.0	<6.0
	EPH (C21-C30)	mg/kg dm	<12	<12	<12	<12
	EPH (C30-C35)	mg/kg dm	<6.0	<6.0	<6.0	<6.0
	EPH (C35-C40)	mg/kg dm	<6.0	<6.0	<6.0	<6.0
Q	EPH Sum (C10-C40)	mg/kg dm	<38	<38	<38	<38

No.	Sample description	Date sampling	Sample nr.
6	NCT-6T	23-Jan-2019	10525849
7	NCT-7T	23-Jan-2019	10525850
8	NCT-8T	23-Jan-2019	10525851
9	NCT-9T (o)	23-Jan-2019	10525852

Q: Dutch Accreditation Council (RvA) accredited test
A: AP04 accredited test
S: AS SIKB recognized test
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Annex (A) concerning subsample information referring to certificate of analysis 2019011788/1

Sample nr.	Drill-#	Description	From	To	Barcode	Sampling ID / Sample descriptio
10525844					1	NCT-1T
10525844					0520136406	NCT-1T
10525845					1	NCT-2T
10525845					0904105836	NCT-2T
10525846					1	NCT-3T
10525846					0904105835	NCT-3T
10525847					1	NCT-4T
10525847					0904105834	NCT-4T
10525848					1	NCT-5T
10525848					0904105833	NCT-5T
10525849					1	NCT-6T
10525849					0904105832	NCT-6T
10525850					1	NCT-7T
10525850					0904105831	NCT-7T
10525851					1	NCT-8T
10525851					0904105830	NCT-8T
10525852					1	NCT-9T (o)
10525852					0520136425	NCT-9T (o)

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Annex (C): method references belonging to certificate of analysis 2019011788/1

Analysis	Method	Technique	Method reference
Dry matter	W0104	Gravimetry	In accordance with NEN-EN 15934 & CMA 2/II/A.1
Arsenic (As)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Barium (Ba)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Cadmium (Cd)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Chromium(Cr)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Copper (Cu)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Mercury (Hg)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Molybdenum (Mo)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Nickel (Ni)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Lead (Pb)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
Zinc (Zn)	W0423	ICP-MS	Cf. NEN-EN-ISO 17294-2
EPH (C10-C40)	W0202	GC/FID	Eq. NEN-EN-ISO 16703
Chromatogram TPH (GC)	W0202	GC/FID	Eq. NEN-EN-ISO 16703

Additional information about the applied methods as well as the classification of the accuracy, are listed in our supplement: "Specification of methods of analyses", version June 2016.

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Annex (D) remarks concerning the sampling and preservation period 2019011788/1

Non compliance(s) of the criteria is(are) observed that may have influenced the accuracy of the test results of samples mentioned below.

Analysis	Sample nr.
The preservation term for this parameter has been expired.	
TPH (pretreatment)	10525844
	10525845
	10525846
	10525847
	10525848
	10525849
	10525850
	10525851
	10525852

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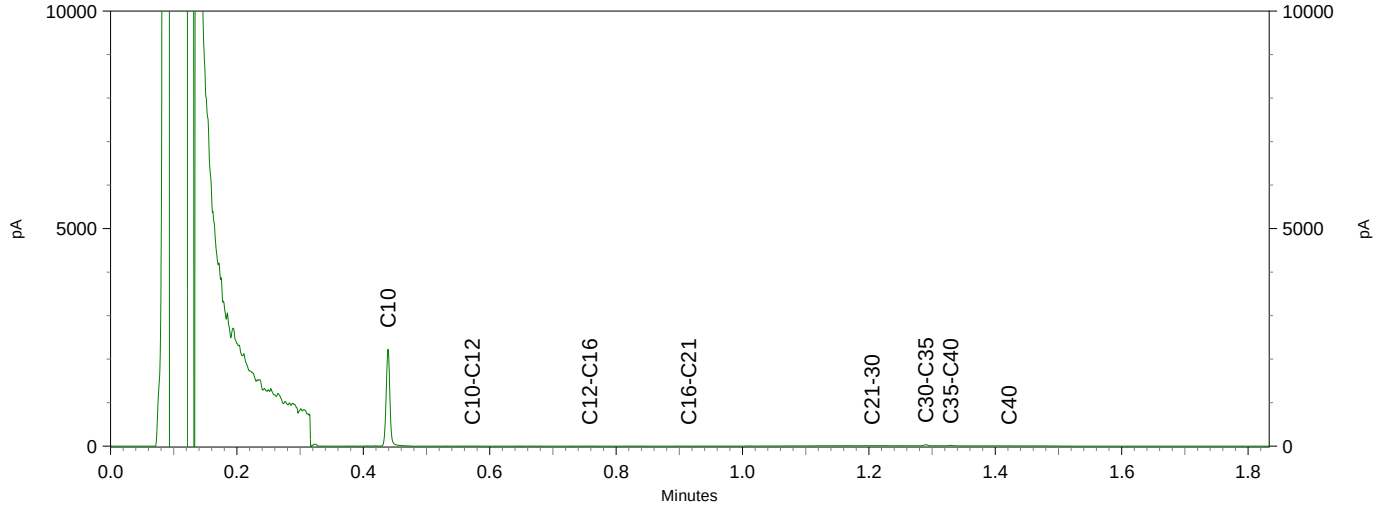
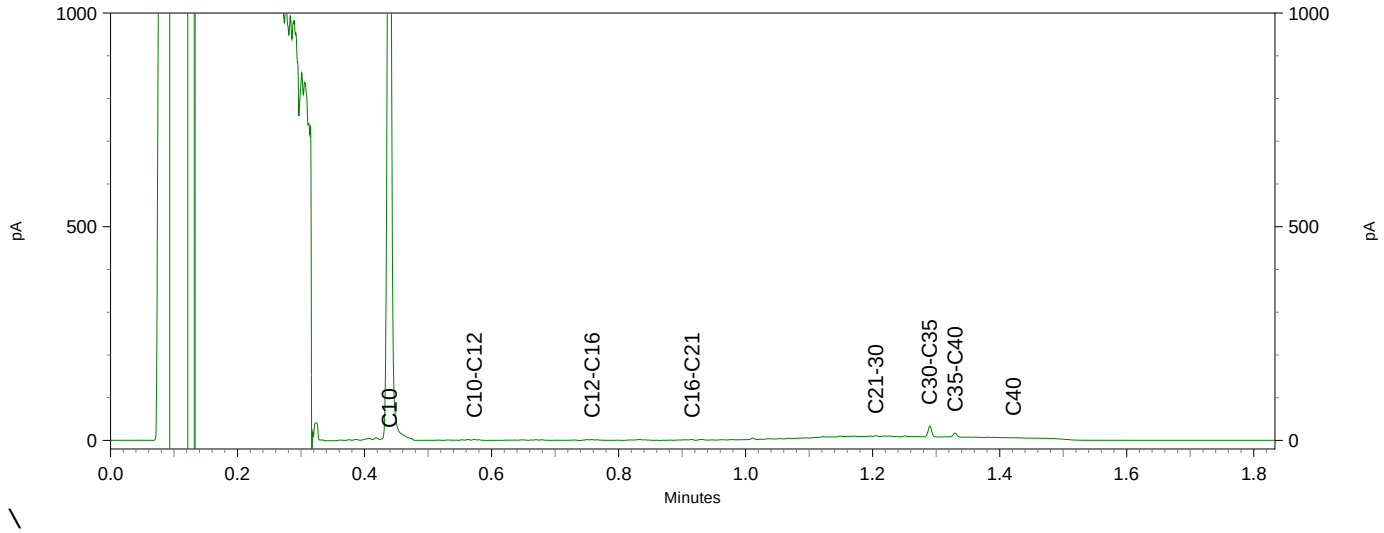
Chromatogram TPH/ Mineral Oil

Sample ID.: 10525845
Certificate no.: 2019011788
Sample description.: NCT-2T
V





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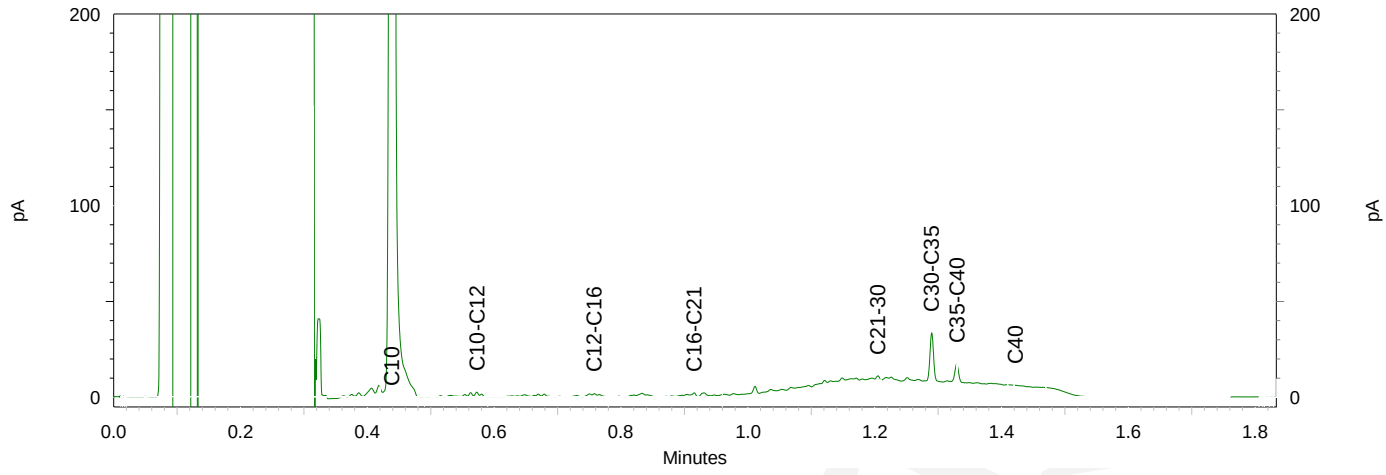

Appendix 4

ESIA - Marine survey report issued by Magma

Les activités de MAGMA sont régies par le décret du Conseil des Ministres N°0105-2015 paru au Journal Officiel n° 1337 de la République Islamique de Mauritanie en date du 15/06/2015.

Rev.	Date	Description	Prepared	Checked	Approved	
01	28/03/2018	FINAL REPORT	Laboratory Teams	S.HAMOUDY	A.KHALIFA	
00	12/03/2018	TEMPORARY REPORT	Laboratory Teams	S.HAMOUDY	A.KHALIFA	

INGENIERIE RECHERCHE IRC CONTROLE — INSHORE AND OFFSHORE GEOTECHNICAL ENGINEERING IN AFRICA — magma — WWW.MAGMA-GROUPE.COM

ARISE

PROJECT

NOUAKCHOTT CONTAINER TERMINAL IN MAURITANIA

ESIA – Marine survey

Report of Sampling and analysis mission

PROJECT No.	DATE	DOCUMENT No.	REVISION	PAGE
2019-A-197	28/03/2019	DC02019A197-01-00	01	1/42

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1. CONTEXT

ARISE is planning to construct and operate a new container and hydrocarbon terminal in the Port of Nouakchott, Mauritania. A detailed understanding of the environment and social baseline (or existing) conditions is required to predict the change and impacts that will be caused by the proposed Project.
It is in this context that Arise entrusted Magma with carrying out an investigation campaign on sediment and water in the project area.

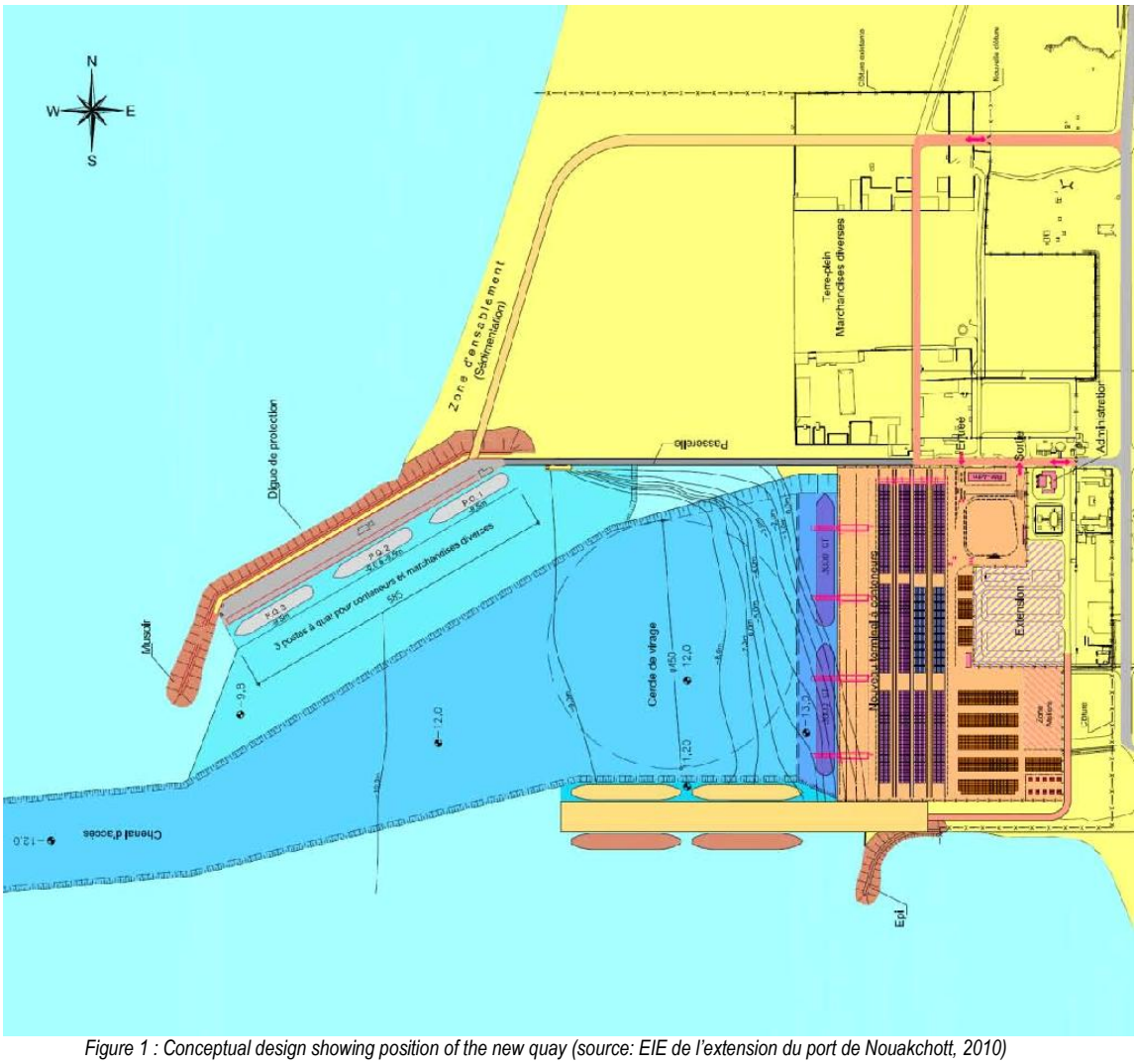


Figure 1 : Conceptual design showing position of the new quay (source: EIE de l'extension du port de Nouakchott, 2010)

The overall objective of this study is to characterize the spatial patterns of assemblages of the PANPA benthic fauna, in order to develop a program for monitoring the receiving environment to assess the impacts of dredging. and the deposit of dredging material.

The specific objectives of this study area are as follows:

- Characterize the structure of the benthic fauna community (abundance, species richness, diversity and similarity) in the excavation zones and receiving waste from dredging
- The mission is to carry out the following activities:

- Prepare and carry out the sampling campaign (water, sediment, physicochemical parameters in situ;
- Analyze water and sediment samples taken at sea

For this, his following actions are to be prepared:

- Rental of a boat
- Expertise for Sampling and measurement of physicochemical parameters
- Granulometry analysis and macroscopic description of sediments
- Biological analysis (Benthos)
- Writing the final report.

2. OBJECTIVES OF THE MISSION

For the purpose of a possible update and based on the scope of the ESIA, the intervention zones of this project, which are represented by the proposed entry channel, the turning basin and the pocket berth, as well as the potential disposal site, are to be studied primarily for water quality, sediment quality and benthic fauna.

For this, 16 marine sampling stations are recommended positioned as follows:

- Two sampling stations along the length of the proposed access channel
- Two control stations (one upstream and one downstream of the access channel),
- A sampling station in the circle turn
- A sampling station in the bunk pocket.
- Six sampling stations will be positioned at the proposed disposal sites
- Two control stations (one upstream and one downstream of the site).
- Two core drilling station on a depth of three meters

The monitoring stations will provide useful references to the baseline environment, but will also be needed when considering the potential impact of sediments resulting from dredging and disposal activities.

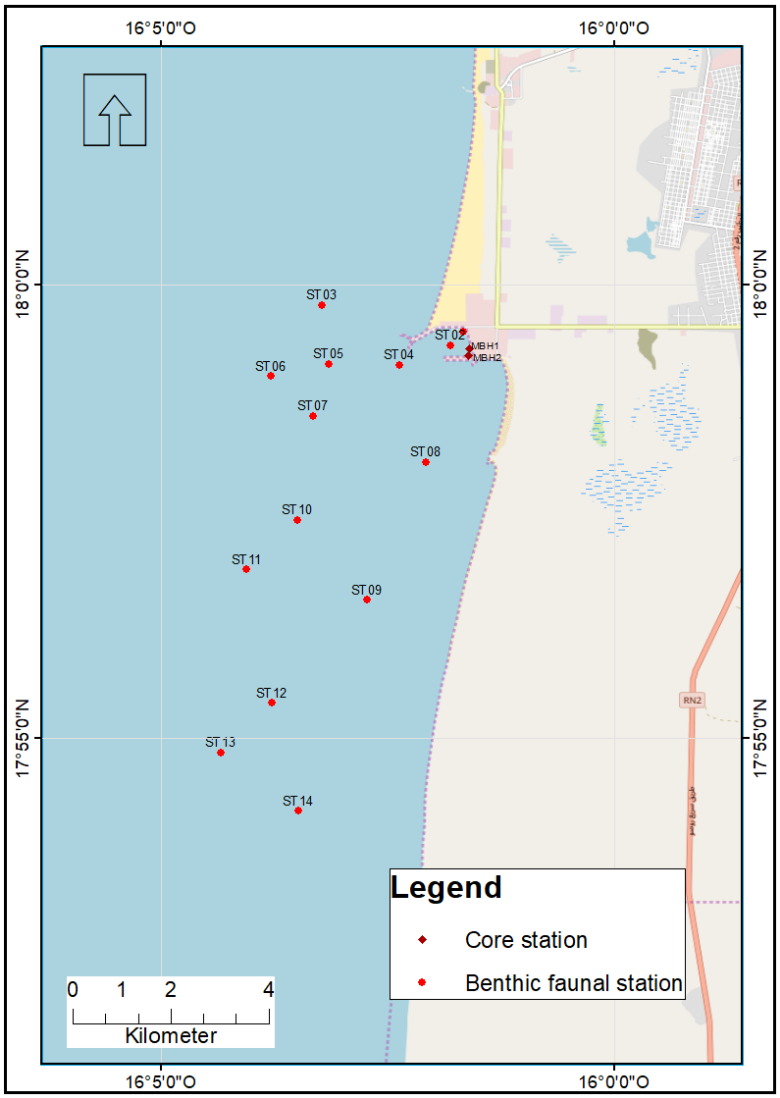


Figure 2: Location of sampling stations

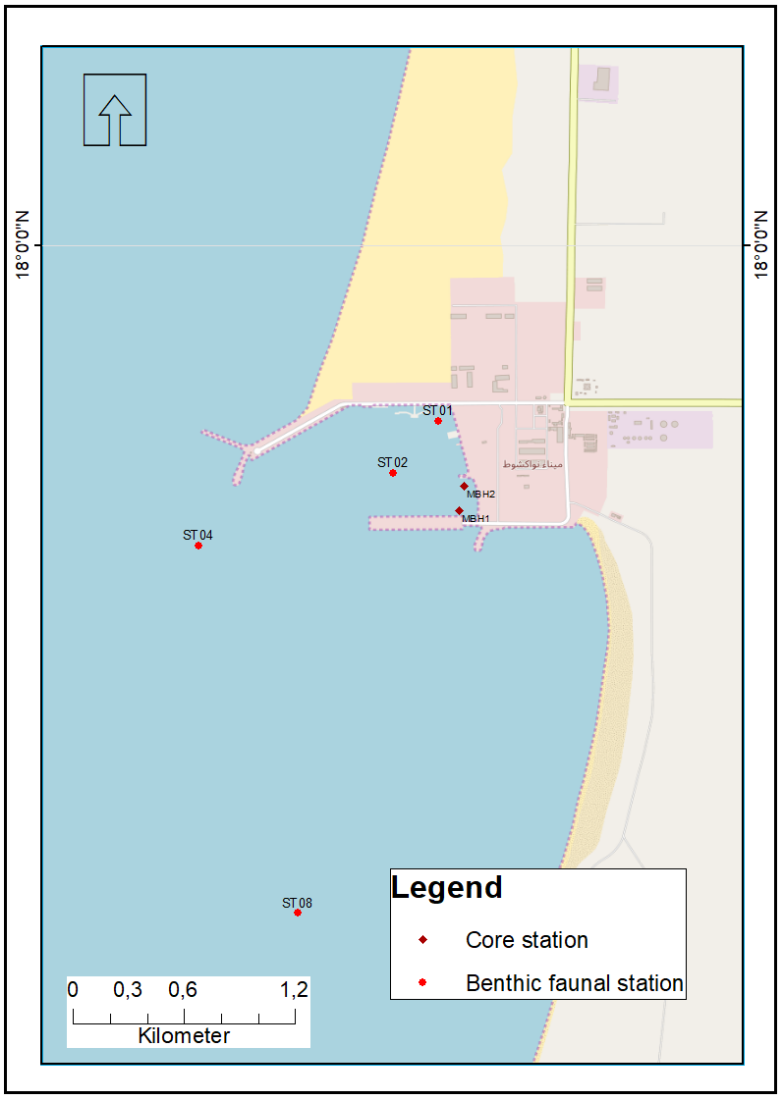


Figure 3: Location of sampling stations Zoom

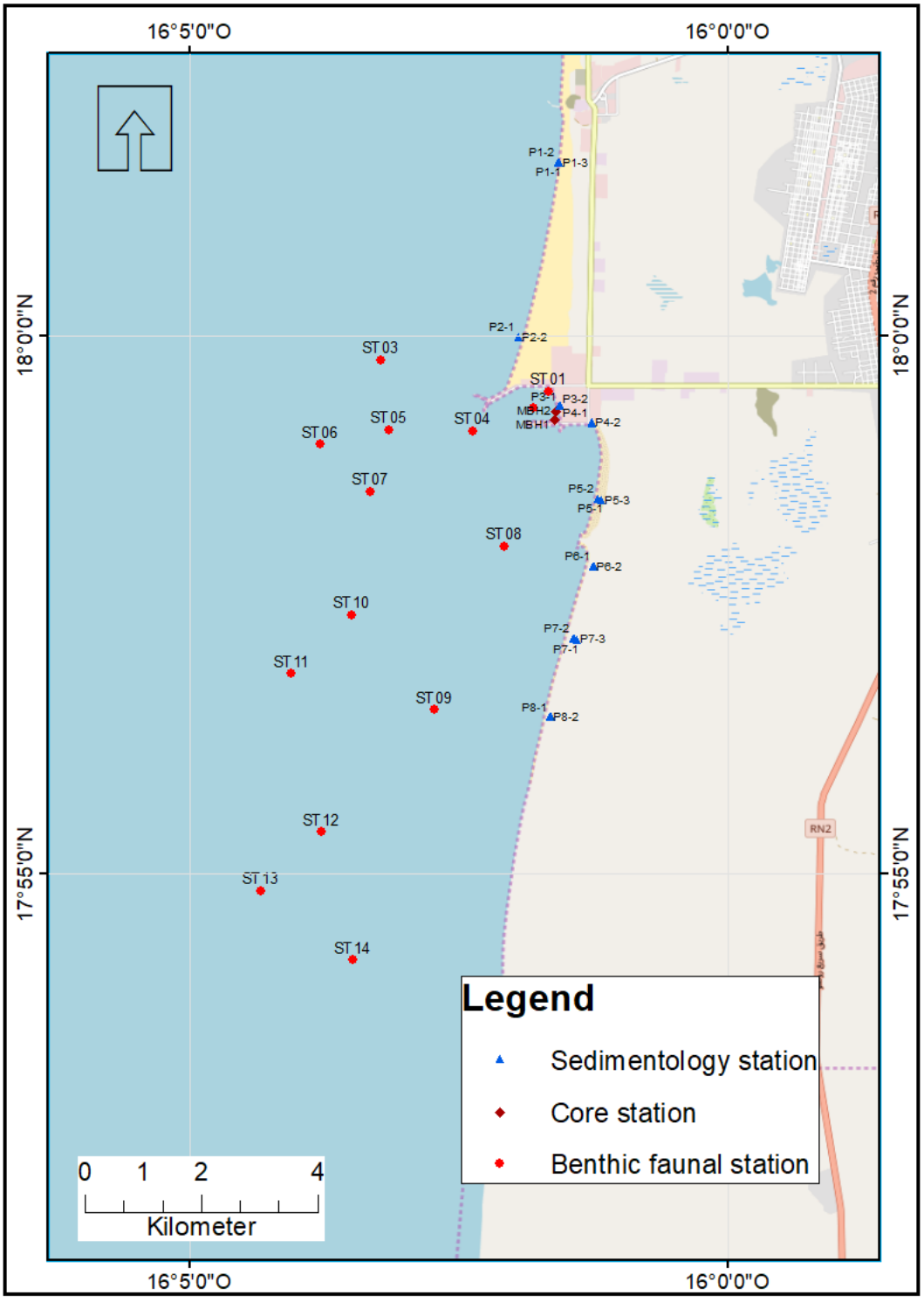


Figure 4: Location of all sampling stations

3. METHODOLOGY OF RECTIFIED WORK

The different components mentioned in the specifications of the project as well as the working methodology presented by the company MAGMA (see appendices) are both followed in the sampling mission except for some corrections in relation to the conditions on site. These changes mainly concern:

- The number of videos: is limited to eight instead of fourteen and this in agreement with all stakeholders of this mission.

- The conservation of the samples: The mode of conservation of the samples is changed, since these must be transported by plane (to Tunisia or to France) knowing that all the conservation products of the nutritive elements, the hydrocarbons and others, such as formalin is prohibited. The type of conservation is chosen in agreement with the head of mission with the experts of the analysis laboratory GreenLab. The preservation methods used all comply with ISO 5667 (see annexes).

4. SAMPLING MISSION

4.1. TEAM MEMBERS

The team performing the sampling mission is as follows:

- **Lotfi Hech**: Expert in Geology, Environmentalist and Team Leader
- **Audrey Van Mastrigt**: Biologist and Supervisor
- **Saikou Oumar KIDE**: Biologist
- **Ba Mamadou Lamba**: environmental chemistry engineer
- **Yaro Waly Ba**: Chimist
- **Salah Boughrara**: Diver
- **Kayta**: Diver





4.2. EQUIPMENT LIST

The material required for the mission is as follows:

- Control vessel
- Handheld GPS
- A manual multi-parameter probe (temperature, dissolved oxygen, pH, salinity, turbidity and water depth)
- 5L bottles and deployment equipment required
- 1 mm stainless steel sieve
- Refrigerator and freezer for storage of samples and coolers for transport to the laboratory
- Camera for photographing samples and underwater camera to characterize the seabed
- 1 Van Van 225 cm2 tipper
- for the pH allowing the measurement of the different physicochemical parameters.
- Vials for samples
- Plastic bags
- Collection cards
- Two coolers and insulated boxes filled with ice





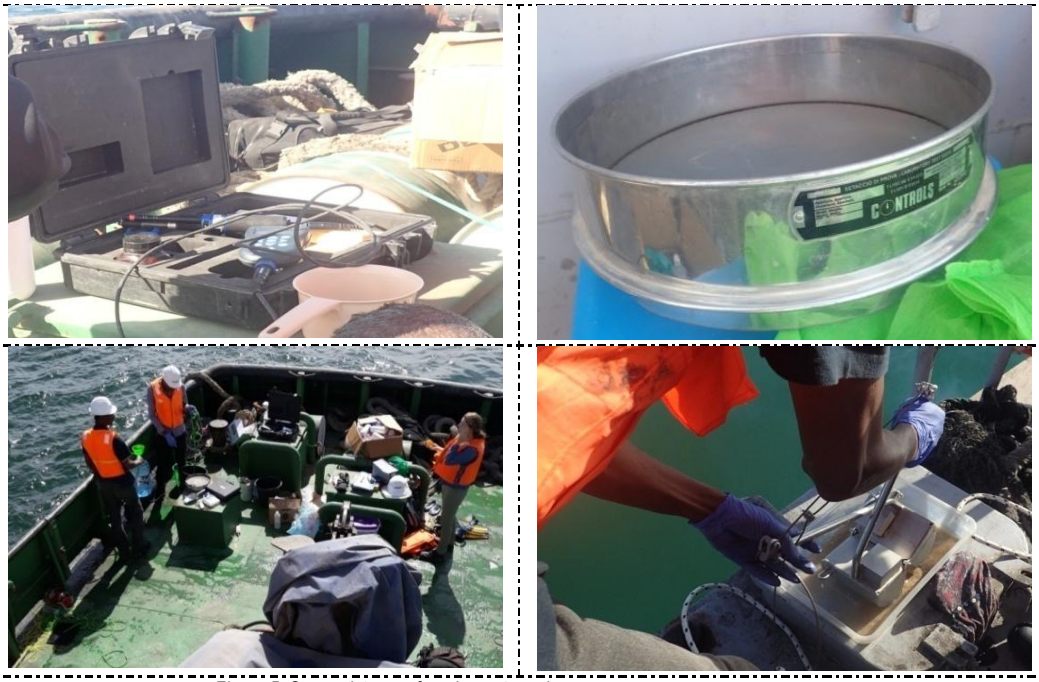



Figure 5: Some pictures of equipment used

4.3. SAMPLING MISSION

The sampling mission is carried out on fourteen stations by applying a sampling and conditioning program already prepared in advance and this concerns:

- The coordinates of the various stations
- Types of packaging
- The different tasks to be carried out on site
- The distribution of the different tasks on the members of the team

The following table summarizes these different conditions.

Samples	Characteristics	Granulometry	Physicochemical parameters	Heavy metals	Heavy metals	Nutrients + ammonium	Chlorophyll	benthic
Water	coordinates - moment - depth - volume - weather condition - wildlife present		On-site measurements (surf- Prof- Above seabed) of parameters (T, Salinity, Turbidity, pH, dissolved o2, total dissolved solids) **Bottle 1 liter cold**		**3 spittoons** **freezing**	**Bottle 1 liter** **freezing**	**1/2 liter bottle + aluminum** **freezing**	
sediments	coordinates - moment - depth - volume - weather condition - wildlife present	**Sachet 0.5 à 1 kg au froid**	**Bag 1 kg cold** **1 aluminum (TBT) freezing**		**1 spittoon** **freezing**	**Glass bottle** **freezing**		**3 X 500 g sieved** **Results in 3 spittoons** **freezing**

The program also mentions conditions to be met in the mission that are mainly related to:

- The methodology already mentioned
- The material intended for each sample, whether water, sediment
- The country of analysis
- The type of conservation
- The type of analysis he will undergo

The following table summarizes these different conditions.

Samples	Conditioning	Retention	Analyzes	Laboratory	Country
Water	Bottle 1 liter	Cold	Physicochemical parameters	GreenLab	Tunisia
	3 spittoons	freezing	Bacteriological analyzes	GreenLab	Tunisia
	Bottle 1 liter	freezing	Nutrients + ammonium	GreenLab	Tunisia
	1/2 liter in bottle	Freezing aluminum foil	Chlorophyll	GreenLab	Tunisia
Sediments	Bag 0.5 to 1 kg	Cold	Granulometry	Magma	Mauritanie
	Bag 1 kg	freezing	Physicochemical parameters Heavy metals	GreenLab	Tunisie
	50 to 100 g 2 aluminum foil bags	freezing	TBT	Laboratoire Eurofins	France
	1 crachoir	freezing	Bacteriological analyzes	GreenLab	Tunisia
	Glass bottle	freezing	HAP - HC - COT	GreenLab	Tunisia
	3 crachoirs	freezing n	Benthos	Magma	Mauritania





4.4. MEASUREMENTS AND INFORMATION ON SITE

In addition to taking samples, information about each station should be noted. This information mainly concerns coordinates, depth, metrological conditions, etc. This information is mentioned below.

Measurements and information on site

Sample ID	Replicate	Latitude	Longitude	Date	Start time of sample	End time of sample	Depth of seabed	General remarks
ST01	all replicates	175947,60	160165,84	23/01/2019	15:32	18:00	4	The sampling was done on the small pilot boat
ST02	all replicates	175939,53	160180,54	24/01/2019	11:14	11:56	10	The sampling was done on the small pilot boat
ST03	surface	175977,34	160323,72	25/01/2019	10:14	11:10	12,5	Because of problems with the small pilot the boat, the sampling was done on one of the tugboats from the port (23 m in length)
ST03	middepth	175975,43	160323,33	25/01/2019	10:14	11:10	12,5	sampling by tugboat, at first sample station we had some problems with the anchor
ST03	1m above seafloor	175975,53	160323,77	25/01/2019	10:14	11:10	12,5	sampling by tugboat
ST04	all replicates	175909,41	160237,62	25/01/2019	12:15		12	sampling by tugboat
ST05	all replicates	175911,82	160313,47	25/01/2019	16:00		14	sampling by tugboat
ST05b	all replicates	175913,18	160319,88	25/01/2019		17:05	14,8	sampling by tugboat
ST06	all replicates	175897,96	160377,11	25/01/2019	17:25		12,5	sampling by tugboat
ST06b	all replicates	175900,11	160384,02	25/01/2019			12,5	sampling by tugboat
ST07/7f	all replicates	175854,58	16033,30	26/01/2019			13	sampling by tugboat
ST08	all replicates	175804,27	160208,95	26/01/2019	17:45	18:15	12,5	sampling by tugboat
ST09	all replicates	175649,22	160273,25	27/01/2019	09:15	09:56	11	sampling by tugboat
ST10/10bis	all replicates	175741,61	160350,86	27/01/2019	10:05	11:00	12,2	sampling by tugboat
ST11	all replicates	175683,98	160408,30	27/01/2019	12:14	13:14	12,2	sampling by tugboat

ST12	all replicates	175536,30	160379,78	27/01/2019	13:30		13	sampling by tugboat
ST13	all replicates	175476,73	160435,56	27/01/2019	17:25	18:15	13,7	sampling by tugboat
ST14	all replicates	175415,33	160344,95	27/01/2019	18:21		12	sampling by tugboat
ST14b	all replicates	175414,67	160329,87	27/01/2019		18:45	11,7	sampling by tugboat

Station	Répétition	Latitude	Longitude	Date	Profondeur de l'eau en m	volume de l'échantillon (m3)	Classification des sédiments (sable, limon, etc.)	conditions météorologiques	Type de faune	Commentaires
ST01	T1	175947,60	160165,84	23/01/2019	4	0,1	sédiments fin		coquilles principalement écrasées	
	T2	175947,60	160165,84	23/01/2019	4	0,1	sédiments fin		coquilles principalement écrasées	
	T3	175947,60	160165,84	23/01/2019	4	0,1	sédiments fin		coquilles principalement écrasées	
ST02	T1	175939,53	160180,54	24/01/2019	10	0,1	limon		polychètes	
	T2	175939,53	160180,54	24/01/2019	10	0,1	limon		polychètes	
	T3	175939,53	160180,54	24/01/2019	10	0,1	limon		polychètes	

ST03	T1	175975,53	160323,77	25/01/2019	10	0,55	80% sable 20% boue		crustacés vivant et polychètes	lorsque le bateau a été ancré, nous avons commencé à prélever des échantillons benthiques; pendant la plongée, la profondeur a changé de 10 à 12 m
	T2	175975,53	160323,77	25/01/2019	10	0,55	80% sable 20% boue		crustacés vivant et polychètes	
	T3	175975,53	160323,77	25/01/2019	10	0,55	80% sable 20% boue		crustacés vivant et polychètes	
ST04	T1	175909,41	160237,62	25/01/2019	12	0,1	sable		crustacés, polycheates et bivalves broyés	
	T2	175909,41	160237,62	25/01/2019	12	0,1				
	T3	175909,41	160237,62	25/01/2019	12	0,1				
ST05	T1	175911,82	160313,47	25/01/2019	14	<0.01	sable			4 tentatives de collecte de sédiments ont été effectuées. Comme il s'agissait d'une zone rocheuse, la faune benthique des quatre

										échantillons choisis a été combinée.
	T2	175911,82	160313,47	25/01/2019	14	<0.01	sédiment très fin			
	T3	175911,82	160313,47	25/01/2019	14	<0.01	pas de sédiments			
	T4	175911,82	160313,47	25/01/2019	14	<0.01	roches		petit crabe	
ST05b	T1	175913,18	160319,88	25/01/2019	14	0,1	80% sable 20% boue		principalement des coquilles broyées, des polycheates et du crabe	pendant la plongée il y avait beaucoup de méduses
	T2	175913,18	160319,88	25/01/2019	14	0,1			principalement des coquilles broyées, des polycheates et du crabe	
	T3	175913,18	160319,88	25/01/2019	14	0,1			principalement des coquilles broyées, des polycheates et du crabe	
ST06	T1	175897,96	160377,11	25/01/2019	14,8	<0.01	Pas de sédiments dans l'échantillon		Porifera et Tunicate	4 tentatives de collecte de sédiments ont été effectuées. Comme il s'agissait d'une zone rocheuse, la faune benthique des

										quatre échantillons choisis a été combinée.
	T2	175897,96	160377,11	25/01/2019	14,8	<0.01	Pas de sédiments dans l'échantillon			Plongée: nombreux poissons dans cette région comme Thiouf
	T3	175897,96	160377,11	25/01/2019	14,8	<0.01	Pas de sédiments dans l'échantillon			
	T4	175897,96	160377,11	25/01/2019	14,8	<0.01	Pas de sédiments dans l'échantillon			
ST06b	T1	175900,11	160384,02	25/01/2019	14,8	0,1	limon		crabes vivants et gastéropodes	
	T2	175900,11	160384,02	25/01/2019	14,8	0,1	limon			
	T3	175900,11	160384,02	25/01/2019	14,8	0,1	limon		gastéropodes, polycheates, crustacés	
ST07/7f	T1	175854,58	16033,30	26/01/2019	12,5	0,1	sable	peu de vent	trois amphipodes vivants dans l'échantillon	le plongeur a confirmé qu'il s'agissait d'une zone sablonneuse où de petits poissons ont été vus

	T2	175854,58	16033,30	26/01/2019	12,5	0,1	sable	peu de vent	Gammaridea	
	T3	175854,58	16033,30	26/01/2019	12,5	0,1	sable	peu de vent	Gammaridea	
ST08	T1	175804,27	160208,95	26/01/2019	12,5	0,1	60% sable 40% boue	peu de vent	Pseudomyrambizi	le plongeur: eau très trouble faible visibilité
	T2	175804,27	160208,95	26/01/2019	12,5	0,1	60% sable 40% boue	peu de vent		
	T3	175804,27	160208,95	26/01/2019	12,5	0,1	60% sable 40% boue	peu de vent	polycheates	
ST09	T1	175649,22	160273,25	27/01/2019	11,5	0,1	80% boue 20% sable fin	E>W	principalement des matières mortes, des bivalves et des polycheates	le plongeur: visibilité faible, courant fort
	T2	175649,22	160273,25	27/01/2019	11,5	0,1	80% boue 20% sable fin	E>W	gastropods and polycheates	
	T3	175649,22	160273,25	27/01/2019	11,5	0,1	80% boue 20% sable fin	E>W	many polycheates	
ST10	T1	175741,61	160350,86	27/01/2019	12,2	0,1	50% boue 50% sable	E>W	gastropodes and polycheates	le plongeur: fort courant nord à sud mauvaise visibilité
	T2	175741,61	160350,86	27/01/2019	12,2	0,1	50% boue 50% sable	E>W	gastropode vivant, polycheates et crabe	
	T3	175741,61	160350,86	27/01/2019	12,2	0,1	50% boue 50% sable	E>W	pas des notes	
ST11/10bis	T1	175683,98	160408,30	27/01/2019	12,1	0,1	100% sable	E>W	petit gastéropodes et polycheate	le plongeur: grosses pierres de 1,5 mètre,

										beaucoup de poissons et un courant fort
	T2	175683,98	160408,30	27/01/2019	12,1	0,1	100% sable	E>W	Gammaridea et bivalves	
	T3	175683,98	160408,30	27/01/2019	12,1	0,03	sable et roche	E>W	moules, gastéropodes et copépodes	
ST12	T1	175536,30	160379,78	27/01/2019	12,7	0,075	sable et boue	E>W	copépode, crustacé et polycheate	le plongeur: mauvaise visibilité tout environnement sablonneux
	T2	175536,30	160379,78	27/01/2019	12,7	0,1	sable et boue	E>W	copépodes et polycheate	
	T3	175536,30	160379,78	27/01/2019	12,7	0,05	sable et boue	E>W	beaucoup de polycheates	
ST13	T1	175476,73	160435,56	27/01/2019	13,7	0,1	sable grossier	E>W	copépodes et gammaridea	le plongeur: pas de visibilité
	T2	175476,73	160435,56	27/01/2019	13,7	0,1	sable grossier	E>W	bivalve	
	T3	175476,73	160435,56	27/01/2019	13,7	0,1	sable grossier	E>W	polycheate, gastéropodes	
ST14	T1	175415,33	160344,95	27/01/2019	12	x	roche	E>W		Aucun échantillon n'a pu être prélevé à cause d'un fond marin rocheux
	T2	175415,33	160344,95	27/01/2019	12	x	roche	E>W		
	T3	175415,33	160344,95	27/01/2019	12	x	roche	E>W		

ST14b	T1	175414,67	160329,87	27/01/2019	11,7	0,1	sable and boue	E>W	polycheates	le plongeur: il faisait trop sombre pour prendre de bonnes photos et vidéos. Un plongeur a amené un rocher avec une petite étoile de mer / étoile de mer dessus
	T2	175414,67	160329,87	27/01/2019	11,7	0,1	sable and boue		polycheates	
	T3	175414,67	160329,87	27/01/2019	11,7	<0.1	roches			essayé à plusieurs reprises pour obtenir un échantillon, mais il n'était pas possible d'obtenir des sédiments

4.5. COLDING AND FREEZING

The samples, once taken, are put in cold boxes and then sent to the Magma laboratory to be placed in the cold or freezing according to the condition and preservation already mentioned. Once, the sampling mission is over, all the samples are packed to be transported to different destinations as previously described.





5. RESULT OF ANALYZES

5.1. WATER ANALYSIS

5.1.1. Physicochemical analyzes

Temperature, salinity and turbidity measurements are needed to determine the vertical stratification of water bodies. Turbidity is defined as the reduction of transparency of a liquid due to the presence of undissolved substances; it is a reflection of the particulate load in the water. The physicochemical analyzes show the following main findings:

- A pH ranging from 8 to 8.2 according to different temperatures from 17.2 to 20 ° C, an average of a pH of 8 slightly basic, which generally characterizes seawater.
- Electrical conductivity ranging from 50.5 103 to 54.7 103 according to different temperatures from 17.4 to 21.5 ° C, an average electrical conductivity of 54 103, including a salinity of 37g / liter which generally characterizes seawater and mainly the Atlantic Ocean having a salinity of the order of 33.7 to 37.9 g / l.
- A dissolved oxygen concentration ranging from 7.93 to 8.63 g / l in an average temperature of 18 ° c.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5
pH	-	8,0 à 18,4°C	8,1 à 18,4°C	8,0 à 18,4°C	8,1 à 18,1°C	8,1 à 18,0°C
Conductivité à 25°C	µS/cm	54,3 10^3 (Tm=18,0°C)	54,5 10^3 (Tm=18,0°C)	54,1 10^3 (Tm=18,0°C)	54,6 10^3 (Tm=18,3°C)	54,3 10^3 (Tm=17,4°C)
TDS	mg/L	25,2 10^3	27,1 10^3	32,8 10^3	27,7 10^3	31,9 10^3
Turbidité	NTU	0,57	3,0	0,27	0,16	0,10
MES	mg/L	4,5	5,6	4,9	4,8	4,8
Oxygène dissous	mg/L	7,93 à 18,2°C	8,02 à 17,7°C	7,98 à 17,7°C	8,19 à 17,4°C	7,93 à 17,8°C
Résidu Sec à 105°C	mg/L	43,6 10^3	42,5 10^3	42,9 10^3	42,3 10^3	42,9 10^3

Essai (s)	Unité	ST 6	ST 7	ST 8	ST 9	ST 10
pH	-	8,1 à 17,7°C	8,2 à 20,0°C	8,2 à 18,9°C	8,1 à 20,0°C	8,2 à 17,2°C
Conductivité à 25°C	µS/cm	54,3 10^3 (Tm=17,5°C)	52,3 10^3 (Tm=21,5 C°)	50,5 10^3 (Tm=18,0°C)	54,6 10^3 (Tm=18,0°C)	54,5 10^3 (Tm=17,9°C)
TDS	mg/L	31,7 10^3	33,2 10^3	30,2 10^3	29,1 10^3	30,3 10^3
Turbidité	NTU	<0,05	0,36	1,1	<0,05	<0,05
MES	mg/L	3,2	4,5	4,1	3,2	2,8
Oxygène dissous	mg/L	8,37 à 17,0°C	8,55 à 16,5°C	8,63 à 16,5°C	8,39 à 16,1°C	8,28 à 15,8°C
Résidu Sec à 105°C	mg/L	43,0 10^3	43,2 10^3	43,310^3	43,310^3	42,9 10^3

Essai (s)	Unité	ST 11	ST 12	ST 13	ST 14
pH	-	8,2 à 17,6°C	8,1 à 17,1°C	8,2 à 17,3°C	8,2 à 19,7°C
Conductivité à 25°C	µS/cm	54,4 10^3 (Tm=19,5°C)	54,6 10^3 (Tm=18,0°C)	54,7 10^3 (Tm=18,0°C)	54,5 10^3 (Tm=18,0°C)
TDS	mg/L	29,2 10^3	28,1 10^3	30,0 10^3	30,4 10^3
Turbidité	NTU	0,14	0,18	1,0	1,4
MES	mg/L	3,6	2,4	5,0	5,1
Oxygène dissous	mg/L	8,45 à 16,1°C	8,31 à 16,3°C	8,30 à 15,9°C	8,47 à 17,2°C
Résidu Sec à 105°C	mg/L	43,4 10^3	43,0 10^3	43,8 10^3	44,0 10^3

5.1.2. Analyzes of nutrients

Nutrient analyzes show the following key findings:

- The concentrations of Kjeldahl nitrogen and ammonia nitrogen in station 1 are the highest at 4.74 and 31.3 mg / l, respectively. In the marine environment, the predominant form of ammoniacal nitrogen is ammonium (NH4 +). Naturally, it comes from animal excretions and the bacterial degradation of nitrogenous organic compounds.
- Phosphorus and orthophosphate concentrations are all less than 1 g / l in the different sampled stations. In seawater, dissolved phosphorus is mainly present as orthophosphate ions (PO42-). The contents are generally very weak at the surface and increase with the depth below the euphotic zone.
- The concentrations of NO3 + NO2 are all less than 1 g / l in the different sampled stations. Indeed, the nitrate ion (NO3) is the stable oxidized form of nitrogen in aqueous solution. Nitrate ions enter the nitrogen cycle as the main support for the growth of phytoplankton, which, once degraded by bacteria, restores nitrogen to the system in mineral form (ie NO3). The rate of regeneration may sometimes be different from the rate of use, resulting in variable nitrate concentrations that may be a factor influencing phytoplankton growth.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5
Azote Kjeldahl	mgN/L	4,74	4,00	1,13	3,33	2,09
Azote Ammoniacal	µgNH_4^+/L	31,3	27,3	21,5	19,9	18,7
Nitrates	mgNO_3^-/L	<0,093	0,145	0,251	<0,093	<0,093
	mgN/L	<0,021	0,033	0,057	<0,021	<0,021
Nitrites	mgNO_2^-/L	<0,015	<0,015	0,018	<0,015	<0,015
	mgN/L	<0,005	<0,005	0,005	<0,005	<0,005
Phosphore total	mgP/L	0,028	0,030	0,034	0,029	0,035
Orthophosphates	mgP/L	0,025	0,029	0,020	0,026	0,020
	mgPO_4^{3-}/L	0,077	0,088	0,061	0,080	0,061

Essai (s)	Unité	ST 6	ST 7	ST 8	ST 9	ST 10
Azote Kjeldahl	mgN/L	3,89	<1	2,26	2,31	1,18
Azote Ammoniacal	µgNH_4^+/L	15,2	27,1	28,6	25,6	16,8
Nitrates	mgNO_3^-/L	0,263	0,541	0,184	0,195	<0,093
	mgN/L	0,059	0,122	0,042	0,044	<0,021
Nitrites	mgNO_2^-/L	0,015	<0,015	<0,015	<0,015	<0,015
	mgN/L	0,005	<0,005	<0,005	<0,005	<0,005
Phosphore total	mgP/L	0,043	0,048	0,044	0,048	0,045
Orthophosphates	mgP/L	0,040	0,033	0,039	0,044	0,044
	mgPO_4^{3-}/L	0,123	0,100	0,119	0,134	0,134

Essai (s)	Unité	ST 11	ST 12	ST 13	ST 14
Azote Kjeldahl	mgN/L	1,02	<1	1,80	<1
Azote Ammoniacal	µgNH_4^+/L	24,0	18,6	16,3	14,8
Nitrates	mgNO_3^-/L	0,291	0,249	0,094	0,294
	mgN/L	0,066	0,056	0,021	0,066
Nitrites	mgNO_2^-/L	<0,015	<0,015	<0,015	<0,015
	mgN/L	<0,005	<0,005	<0,005	<0,005
Phosphore total	mgP/L	0,035	0,035	0,048	0,034
Orthophosphates	mgP/L	0,033	0,024	0,026	0,014
	mgPO_4^{3-}/L	0,100	0,073	0,080	0,042

5.1.3. Bacteriological analysis

Microbiological analyzes are based on the search for indicator bacteria for faecal contamination. These bacteria are not pathogenic in themselves but their presence indicates a faecal contamination likely to cause the development in water of other microorganisms which are pathogenic (other bacteria, viruses, parasites, etc.). Most pathogenic microorganisms in the aquatic environment come from faecal soils: human and animal excrement, domestic wastewater, manure, slurry, dead animals, contaminated runoff, etc. The analyzes carried out mention the following results:

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
E. Coli	UFC/100ml	0	2	0	2	1	23	51
Entérocoques intestinaux	UFC/100ml	4	25	9	26	5	54	53

Essai (s)	Unité	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
E. Coli	UFC/100ml	58	72	81	37	52	40	64
Entérocoques intestinaux	UFC/100ml	24	48	65	22	28	64	52

Taking bathing water as reference and by French standards, the bacteriological analyzes of the different stations show concentrations of a good bathing water.

QUALITE DE L'EAU	E. COLI / 100 ml	ENTEROCOQUES / 100 ml
	EAUX DE MER	
BONNE	≤ 100	≤ 100
MOYENNE	> 100 et ≤ 1000	> 100 et ≤ 370
MAUVAISE	> 1000	> 370

5.1.4. Analyzes of chlorophyll a

Chlorophyll a is the pigment present in all plants that captures the light necessary for photosynthesis. Photosynthesis is a very important process that allows plants to transform carbon dioxide (CO2) into organic matter. In oceanography, the amount of chlorophyll a tells us about the amount of phytoplankton in the water. Indeed, the more phytoplankton, the more chlorophyll a.

Chlorophyll a results indicate concentrations ranging from 0.289 µg / L at the station to 2.72 µg / L at station 11.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5
Chlorophylle a	µg/L	0,380	1,079	1,246	0,760	0,395

Essai (s)	Unité	ST 6	ST 7	ST 8	ST 9	ST 10
Chlorophylle a	µg/L	0,486	0,806	0,775	0,289	0,737

Essai (s)	Unité	ST 11	ST 12	ST 13	ST 14
Chlorophylle a	µg/L	2,72	0,395	0,486	0,547

5.2. ANALYSIS OF SEDIMENTS

5.2.1. Particle size analysis

Particle size analysis is designed to determine the particle size distribution of the sediment particles. This analysis helps interpret geochemical data and assesses the physical effects of dredging and sediment deposition, particularly with regard to hydrodynamics and sediment dynamics. Sediment grain size can also be considered as a habitat variable for benthic communities and be part of the interpretation of contaminant bioavailability as well as the results of toxicity tests.

The results of the granulometric analysis show that the sediments consist of a dominant sandy texture (grain diameter between 2 and 0.063 mm), with the exception of the sample ST02 which has a fine texture (mud: silt and clay, diameter less than 0.063mm). This sand is usually fine to medium, with a fraction of mud (diameter less than 0.063 mm) varying between 5 and 44%. Statistical parameters

calculated from particle size curves between 63 mm and 0.063 mm (transformed on the bay of the phi unit) give the following results:

- The average (M) varies between 1.27 phi and 2.73 phi
- Asymmetry (sk), varies between -0.87 and 0.40
- The sorting coefficient (SO) varies between 0.39 and 1.30
- Modal size (Mod), varies between, 2 and 3 phi
- Kurtosis (k), varies between 0.55 and 9.84

Sample ID	D16 phi	D50 phi	D84 phi	D95 phi	D5 phi	D75 phi	D25 phi	Mean phi	Sk	K	So	Mod phi
ST1	1,7	2,1	3,2	3,5	1,4	2,3	1,9	2,33	0,40	2,15	0,69	2
ST3	1,1	2	3,2	3,4	0	3,2	1,8	2,10	-0,02	1,00	1,04	3,2
ST4	0	1,8	2	3,2	-2,1	1,9	1	1,27	-0,64	2,41	1,30	2
ST5	1,1	1,8	2,00	3,10	0,00	1,90	1,40	1,63	-0,36	2,54	0,70	2
ST6	1,9	3,1	3,2	3,2	1,2	3,1	2,6	2,73	-0,87	1,64	0,63	3,2
ST7	0,9	1,6	3,1	3,2	0	3,1	1	1,87	0,18	0,62	1,04	1,3
ST8	1,6	2,6	3,2	3,2	0	3,1	1,9	2,47	-0,44	1,09	0,89	3,2
ST9	1,9	3,1	3,2	3,2	1,5	3,1	2,5	2,73	-0,86	1,16	0,58	3,2
ST10	1,4	2,1	3,1	3,2	0,9	3,1	1,4	2,20	0,07	0,55	0,77	3,2
ST11	1,6	1,9	2	2,9	1	2	1,8	1,83	-0,22	3,89	0,39	2
ST12	1,9	2,6	3,1	3,2	0,8	3	2,9	2,53	-0,33	9,84	0,66	3,1
ST13	0,8	1,5	2,2	2,8	0,4	2	1	1,50	0,04	0,98	0,71	1,8
ST14	1,2	1,9	3,1	3,2	0,4	2,6	1,6	2,07	0,10	1,15	0,90	2

The details of the granulometric analysis are given in the appendices..

5.2.2. Physicochemical analyzes

Particle size analysis is designed to determine the particle size distribution of the sediment particles. This analysis helps interpret geochemical data and assesses the physical effects of dredging and sediment deposition, particularly with regard to hydrodynamics and sediment dynamics. Sediment grain size can also be considered as a habitat variable for benthic communities and be part of the interpretation of contaminant bioavailability as well as the results of toxicity tests.

The results of the granulometric analysis show that the sediments consist of a dominant sandy texture (grain diameter between 2 and 0.063 mm), with the exception of the sample ST02 which has a fine texture (mud: silt and clay, diameter less than 0.063mm). This sand is usually fine to medium, with a fraction of mud (diameter less than 0.063 mm) varying between 5 and 44%. Statistical parameters calculated from particle size curves between 63 mm and 0.063 mm (transformed on the bay of the phi unit) give the following results:.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
pH	-	8,5 à 19,8°C	8,4 à 20,0°C	8,5 à 19,9°C	8,6 à 21,1°C	8,8 à 21,3°C	8,6 à 21,4°C	9,0 à 21,5°C
Humidité	%	0,3	10,3	0,3	0,2	0,2	0,4	0,2

Matière Sèche	%	99,7	89,7	99,7	99,8	99,8	99,6	99,8
Perte au feu	mg/kgMS	3,1	61,6	5,2	4,9	3,5	9,1	4,5
Essai (s)	**Unité**	**ST 8**	**ST 9**	**ST 10**	**ST 11**	**ST 12**	**ST 13**	**ST 14**
pH	-	8,9 à 21,0°C	8,9 à 20,8°C	8,8 à 21,3°C	8,9 à 21,3°C	8,7 à 21,1°C	8,7 à 21,9°C	8,7 à 21,2°C
Humidité	%	0,4	0,4	0,3	0,2	0,4	0,2	0,4
Matière Sèche	%	99,6	99,6	99,7	99,8	99,6	99,8	99,6
Perte au feu	mg/kgMS	11,3	10,3	7,2	12,0	9,5	5,3	4,5

Essai (s)	Unité	MBH 1 (0-3m)	MBH2 (0-3m)
pH	-	9,0 à 18,9°C	9,0 à 18,9°C
Humidité	%	0,1	0,2
Matière Sèche	%	99,9	99,8
Perte au feu	mg/kgMS	3.5	4.1

5.2.3. Analysis of metals

Metals and metalloids are naturally occurring elements in the environment. Nevertheless, high concentrations observed in sediments are generally associated with anthropogenic sources. Depending on their origin and the conditions prevailing in the environment, the metals will be present in various forms more or less available for living organisms. Depending on the form, the metal will be more or less extractible by the methods of analysis of metals.

Analyzes show aluminum concentrations ranging from 793 to 19.5 103 mg / kg MS which represents the peak at ST2.

This mentions the composition of a sandy sediment rich in feldspars. The rest of the analyzes of the different metals, which are all below the standards used for the comparison (see annexes), do not mention any trace of contamination.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
Aluminium	mg/kgMS	739	19,5 10^3	1,54 10^3	1,24 10^3	1,21 10^3	3,47 10^3	1,54 10^3
Cadmium	mg/kgMS	<0,250	0,635	<0,250	<0,250	<0,250	<0,250	<0,250
Chrome	mg/kgMS	3,08	49,5	8,98	7,20	28,8	10,8	37,7
Cuivre	mg/kgMS	<2,00	22,3	<2,00	<2,00	<2,00	<2,00	<2,00
Nickel	mg/kgMS	<1,50	20,3	1,86	1,52	11,4	4,05	15,8
Plomb	mg/kgMS	<2,25	8,54	<2,25	<2,25	<2,25	<2,25	<2,25
Zinc	mg/kgMS	<2,25	44,1	2,65	2,63	<2,25	6,43	2,71
Arsenic	mg/kgMS	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25
Etain	mg/kgMS	<1,25	1,27	<1,25	<1,25	<1,25	<1,25	<1,25
Mercure	mg/kgMS	<0,090	0,222	<0,090	<0,090	<0,090	<0,090	<0,090

Essai (s)	Unité	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
Aluminium	mg/kgMS	3,28 10^3	9,83 10^3	2,38 10^3	957	2,96 10^3	1,53 10^3	2,48 10^3
Cadmium	mg/kgMS	<0,250	0,635	<0,250	<0,250	<0,250	<0,250	<0,250
Chrome	mg/kgMS	10,9	10,3	11,0	7,84	12,0	9,04	9,70
Cuivre	mg/kgMS	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00
Nickel	mg/kgMS	3,84	4,09	3,10	<1,50	3,90	2,14	3,26
Plomb	mg/kgMS	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25
Zinc	mg/kgMS	6,88	7,57	4,60	<2,25	5,80	2,55	4,60
Arsenic	mg/kgMS	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25
Etain	mg/kgMS	<1,25	<1,25	<1,25	<1,25	<1,25	<1,25	<1,25
Mercure	mg/kgMS	<0,090	<0,090	<0,090	<0,090	<0,090	<0,090	<0,090

Essai (s)	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
Aluminium	mg/kgMS	1,43 10^3	2,23 10^3
Cadmium	mg/kgMS	<0,250	<0,250
Chrome	mg/kgMS	3,53	4,04
Cuivre	mg/kgMS	<2,00	<2,00
Nickel	mg/kgMS	<1,50	1,87
Plomb	mg/kgMS	<2,25	<2,25
Zinc	mg/kgMS	<2,25	3,50
Arsenic	mg/kgMS	<2,25	<2,25
Etain	mg/kgMS	<1,25	<1,25
Mercure	mg/kgMS	<0 05	<0,05

5.2.4. Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are organic compounds composed of two or more benzene rings, of which at least two adjacent ones share at least two carbon atoms (fused rings). Heterocycles and alicyclic hydrocarbons may also be present.

In general, PAHs are divided into two groups: low molecular weight PAHs (2 and 3 benzene rings) and high molecular weight PAHs (more than 3 benzene rings). They are in the form of colored crystals with high melting and boiling points. However, some compounds in the PAH family have the property of volatilizing or sublimating at room temperature.

PAH test results show concentrations below the standards used for comparison (see annexes). The concentration which does not reach 10 µg / kg DM can in no case be a source of contamination.

Composés	Unité	Date d'exécution	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
Naphtalène	µg/kgMS	12/02/19	<10	<10	<10	<10	<10	<10	<10
1-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
2-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
Acénaphthylène			<10	<10	<10	<10	<10	<10	<10
Acénaphtène			<10	<10	<10	<10	<10	<10	<10
Fluorène			<10	<10	<10	<10	<10	<10	<10
Phénanthrène			<10	<10	<10	<10	<10	<10	<10
Anthracène			<10	<10	<10	<10	<10	<10	<10
Fluoranthène			<10	<10	<10	<10	<10	<10	<10
Pyrène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) anthracène			<10	<10	<10	<10	<10	<10	<10
Chrysene			<10	<10	<10	<10	<10	<10	<10

Benzo (b) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (k) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) pyrène			<10	<10	<10	<10	<10	<10	<10
Indeno (1,2,3-cd) pyrène			<10	<10	<10	<10	<10	<10	<10

Composés	Unité	Date d'exécution	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
Naphtalène	µg/kgMS	12/02/19	<10	<10	<10	<10	<10	<10	<10
1-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
2-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
Acénaphthylène			<10	<10	<10	<10	<10	<10	<10
Acénaphtène			<10	<10	<10	<10	<10	<10	<10
Fluorène			<10	<10	<10	<10	<10	<10	<10
Phénanthrène			<10	<10	<10	<10	<10	<10	<10
Anthracène			<10	<10	<10	<10	<10	<10	<10
Fluoranthène			<10	<10	<10	<10	<10	<10	<10
Pyrène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) anthracène			<10	<10	<10	<10	<10	<10	<10
Chrysene			<10	<10	<10	<10	<10	<10	<10
Benzo (b) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (k) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) pyrène			<10	<10	<10	<10	<10	<10	<10
Indeno (1,2,3-cd) pyrène			<10	<10	<10	<10	<10	<10	<10

Composés	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
Naphtalène	µg/kgMS	<10	<10
1-Méthyl Naphtalène		<10	<10
2-Méthyl Naphtalène		<10	<10
Acénaphthylène		<10	<10
Acénaphtène		<10	<10
Fluorène		<10	<10
Phénanthrène		<10	<10
Anthracène		<10	<10
Fluoranthène		<10	<10
Pyrène		<10	<10
Benzo (a) anthracène		<10	<10
Chrysene		<10	<10
Benzo (b) fluoranthène		<10	<10
Benzo (k) fluoranthène		<10	<10
Benzo (a) pyrène		<10	<10
Indeno (1,2,3-cd) pyrène		<10	<10

5.2.5. Analysis of total hydrocarbon concentration (THC)

The hydrocarbon index (THC) analysis results show concentrations below the standards used for the comparison (see annexes). The concentration ranges between 18 µg / kg DM in the ST11 station and

410 µg / kg DM in the ST2 station. These concentrations can not in any case be a source of contamination according to the adopted standard.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
Indice des hydrocarbures	mg/kgMS	180	410	200	240	240	82	140

Essai (s)	Unité	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
Indice des hydrocarbures	mg/kgMS	53	160	35	18	134	95	83

Essai (s)	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
Indice des hydrocarbures	mg/kgMS	110	24

5.2.6. PCB residues

Polychlorinated biphenyls (PCBs) are synthetic compounds formed from two benzene rings joined by one of their vertices and whose 10 hydrogen atoms may be substituted by as many chlorine atoms. PCBs are poorly soluble in water, but very soluble in fats, oils and non-polar liquids.

The results of PCB analyzes show concentrations below the standards used for comparison (see annexes). The concentration which does not reach 3 µg / kg DM can in no case be a source of contamination.

Essai (s)	Unité	Date d'exécution	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
PCB 28	µg/kgMS	13/02/19	<3	<3	<3	<3	<3	<3	<3
PCB 31			<3	<3	<3	<3	<3	<3	<3
PCB 52			<3	<3	<3	<3	<3	<3	<3
PCB 101			<3	<3	<3	<3	<3	<3	<3
PCB 118			<3	<3	<3	<3	<3	<3	<3
PCB 138			<3	<3	<3	<3	<3	<3	<3
PCB 153			<3	<3	<3	<3	<3	<3	<3
PCB 180			<3	<3	<3	<3	<3	<3	<3

Essai (s)	Unité	Date d'exécution	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
PCB 28	µg/kgMS	13/02/19	<3	<3	<3	<3	<3	<3	<3
PCB 31			<3	<3	<3	<3	<3	<3	<3
PCB 52			<3	<3	<3	<3	<3	<3	<3
PCB 101			<3	<3	<3	<3	<3	<3	<3

PCB 118			<3	<3	<3	<3	<3	<3	<3
PCB 138			<3	<3	<3	<3	<3	<3	<3
PCB 153			<3	<3	<3	<3	<3	<3	<3
PCB 180			<3	<3	<3	<3	<3	<3	<3

Essai (s)	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
PCB 28	µg/kgMS	<3	<3
PCB 31		<3	<3
PCB 52		<3	<3
PCB 101		<3	<3
PCB 118		<3	<3
PCB 138		<3	<3
PCB 153		<3	<3
PCB 180		<3	<3

5.2.7. Tributyltin analysis (TBT)

Butyltins (BT) are organometallic compounds used since 1960 as biocides in anti-fouling paints for ship hulls, as fungicides and insecticides, as wood preservatives and as stabilizers in polyvinyl chloride. Butyltins can be measured in sediments as tributyltin (TBT) and its degradation products dibutyltin (DBT) and monobutyltin (MBT). These substances are persistent in the environment and accumulate in aquatic organisms.

TBT test results show concentrations below the standards used for comparison (see annexes). The concentration which does not reach 2.5 µg / kg DM can not in any case be a source of contamination.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
TBT	µg/kgMS	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5

Essai (s)	Unité	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
TBT	µg/kgMS	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5

Essai (s)	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
TBT	µg/kgMS	<2.5	<2.5

5.2.8. Nutrient analysis

With carbon, nitrogen and phosphorus are the most important macronutrients in the aquatic environment. They are normally present in natural equilibrium in water, sediments and living organisms.

The equilibrium can be modified by their excessive contribution of anthropogenic sources. The excess of nitrogen and phosphorus can lead to different manifestations such as water blooms (algal blooms), the acceleration of eutrophication and the decrease of oxygen concentrations in the surface water and sediments.

The Kjeldahl method allows simultaneous determination of ammonia nitrogen and organic nitrogen present in sediments. These two forms of nitrogen result from the action of natural processes of decomposition on organic matter of natural or anthropogenic origin. Total phosphorus represents all of the phosphorus present as phosphates or organophosphorus compounds in sediments. As with nitrogen, decomposition of organic matter is a major source of phosphorus in sediments.

The ST2 station reports remarkable concentrations of Total Nitrogen and Total Phosphorus respectively of 4.39 103 mgN / kg MS and 1.18 103 mgP / kg MS. Concentrations of other stations range from 140 to 598 mgN / kg for total nitrogen and 92.1 and 291 mgP / kg for phosphorus.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
Azote total	mgN/kgMS	158	4,39 10^3	293	276	192	514	275
Phosphore total	mgP/kgMS	119	1,18 10^3	153	170	150	291	201

Essai (s)	Unité	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
Azote total	mg/kgMS	598	429	347	140	525	240	254
Phosphore total	mg/kgMS	243	272	197	92,1	254	177	211

Essai (s)	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
Azote total	mgN/kgMS	854	532
Phosphore total	mgP/kgMS	72,7	43,0

5.2.9. Total organic carbon (TOC) analyzes

In sediments, carbon is present in organic form, for example in humic substances and vegetable matter, and inorganic (carbonates, bicarbonates). The presence of organic carbon in sediments is an important determinant of the bioavailability of nonionic organic compounds. It also influences the bioavailability of metals.

Total Organic Carbon is an indicator of the amount of organic matter present in sediments. TOC particles have a high adsorption capacity for hydrophobic organic contaminants (PAHs, PCBs) and trace metal accumulation.

The measured TOC concentrations indicate values ranging from 2.2 g / kg DM to 4.7 g / kg DM for the majority of stations with a peak at the ST2 station 29.2 g / kg DM and a concentration <2 g / kg DM in stations ST1 and ST11.

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
COT	g/kgMS	<2	29,2	4,7	2,5	2,2	4,6	3,1

Essai (s)	Unité	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
COT	g/kgMS	4,3	4,5	4,2	<2	4,6	4,4	3,4

Essai (s)	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
COT	g/kgMS	1.5	0.4

5.2.10. Bacteriological analysis

Superficial sediments, sandy or muddy, provide a reservoir for enteric bacteria such as E. coli, Salmonella and Campylobacter. Resuspension of these sediments may cause contamination of shellfish growing areas or swimming nearby.
Bacteria present in sediments can be resuspended during tidal events, weather conditions, storms, heavy rain, high winds, boat passage, or dredging of harbor sediments.

In an aquatic ecosystem, bacteria intervene at different levels in the transformation of particulate or dissolved matter, organic or mineral, as well as in the production of biomass. Through their mineralization activity, aerobic heterotrophic bacteria consume oxygen, produce CO2 and release N and P in the form of nutrient salts that can be assimilated by primary producers (phytoplankton and macrophytes). In environments receiving a high organic load, the bacterial activity of mineralization leads to an abundance of nutrients that can stimulate phytoplanktonic activities.

Les essais réalisées mentionnent les trois stations ST7, ST8 et ST10 dénombrant une concentration de 1.5 10^3 with a peak of 3.5 10^3 in the core hole MBH 1 (0-3m).

Essai (s)	Unité	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
E. Coli	UFC/g	0	0	0	0	0	0	1,5 10^3

Essai (s)	Unité	ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
E. Coli	UFC/g	1,5 10^3	0	1,5 10^3	0	0	0	0

Essai (s)	Unité	MBH 1 (0-3m)	MBH 2 (0-3m)
E. Coli	UFC/g	3,5 10^3	2.0 10^2

5.3. FAUNA ANALYSIS

The abundance and diversity of annelid species (polychaetes) and the dominance of molluscs in benthic ecosystems are known to be indicators of a functioning environment. Ecological parameter

values, density, total biomass and diversity indices, are within good limits of a benthic community that has not undergone too much stress. The lack of variability in the specific diversity of the sampled stations shows that these benthic species are distributed according to other environmental factors, including the substrate, the physicochemical conditions of the environment, and so on..

Photo and video analyzes of habitats and benthic epifauna of the PANPA according to the SACFOR scale

Stations	Habitat types and sedimentary nature	Brown algae	Corals	Crabs	Echinoderms	Sponge	Bivalves	Gastropods	Bone fish
ST01	Soft sandy bottom + Habitats of organisms								
ST02	Non exploitables, visibilité trop faible								
ST03	Soft bottom Sandy + Shellfish Debris								
ST04	Soft bottom Sandy + rocks + Habitats of organisms								
ST05	Soft bottom Sandy + rocks + habitats of burrowing organisms + Habitats of Bernard l'Hermite								
ST06	Soft bottom Sandy + rocks + organisms in crusts and erect								
ST07	Soft bottom Sandy + brown algae								
ST08	Not exploitable, visibility too low								
ST09	Not exploitable, visibility too low								
ST10	Not exploitable, visibility too low								
ST11	Rocks + sponge colonies								
ST12	Not exploitable, visibility too low								
ST13	Not exploitable, visibility too low								
ST14	Not exploitable, visibility too low								

Abundant	*****	Common	****	Frequente	***	Occasionnal	**	Rare	*

The details of the benthic analysis are mentioned in the appendices

6. INTERPRETATION

6.1. MARINE WATERS

The recorded **pH** mentions an almost similar value, varying between 8 and 8.2, is considered normal given the pH of the seawater are neutral in nature.
SS rates are very low; the maximum of which has been recorded in the 2nd Station.
Measured **TDS** levels range from 25200 mg / l at Station S1 to 33200 mg / l at Station S7, demonstrating continued mineralization of these media.

Turbidity translates the presence of particles suspended in water (organic debris, clays, microscopic organisms ...). The results show that the 2nd station represents the highest rate (3 NTU) of all stations, which is already a low value and is also consistent with the **SS**. However, low turbidity does not allow microorganisms to attach to suspended particles, which confirms the bacteriological results obtained.

The concentration of **dissolved oxygen** at sea level at 20 ° C, which is in equilibrium with atmospheric pressure, is 8.8 mg / l of saturated O2. A very aerated water is generally supersaturated with oxygen (torrent), whereas a water loaded with organic matter degradable by microorganisms is under-saturated. This is the case of the results mentioned in all the stations is a water that well ventilated. Dissolved oxygen is therefore a useful parameter in the biological diagnosis of the water medium.

Nitrate concentration (NO3) recorded are low to negligible values in all stations. Nitrite is considered as a toxic element, its origin is linked to urban and industrial discharges, or to the reduction of nitrogen forms (nitrates and nitrites) under reduced conditions. In general, the results are small to negligible.

For the **Ammonium** results the first station represents the highest rate compared to the other stations but the values are low which mentions unpolluted water since the Ammonium comes from the reaction of minerals containing iron with nitrates. It is therefore an excellent indicator of water pollution by organic discharges of agricultural, domestic or industrial origin.

All the samples show the same trend in physico-chemical analyzes, except for the ST2 sample, which has high values relative to the others. Indeed, for the Loss on Fire, ST2 has a value of the order of 61 ppm for a value of 29.2 g / KgMS of TOC.

These values, let us conclude that the carbon existing in this sample is almost of inorganic origin (the organic carbon present in the sample is of the order of 30 mg / kgMS)

6.2. MARINE SEDIMENTS

Regarding the granulometric characteristics, the results showed that the sediments consist of a dominant sandy texture (grain diameter between 2 and 0.063 mm), with the exception of the sample ST02 which has a fine texture (0.063 mm). This sand is usually fine to medium, with a fraction of mud (0.063 mm) varying between 5 and 44%. These observations indicate a relatively strong hydrodynamism in the harbor, with a good renewal of the water and the contribution of materials.


ST 1
T1

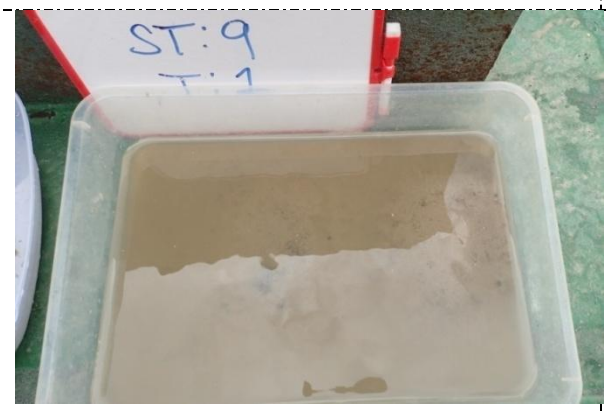

ST 2
T 2


ST: 7
T. 2


ST: 8
T: 3

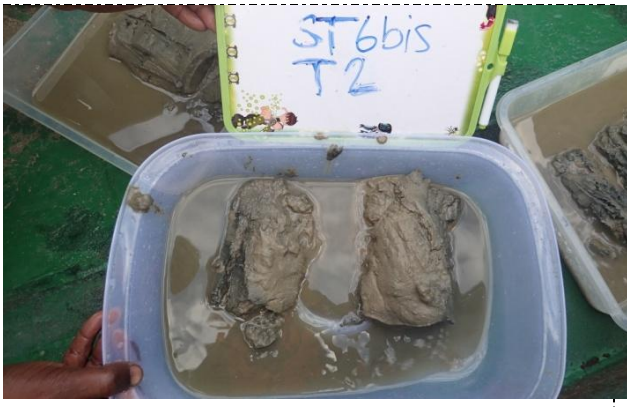

ST3
T2


ST 4
ST 2


ST: 9
T: 1


ST: 10
T: 2


ST5bis
T2


ST6bis
T2


ST:11
T:3


ST:12
T:2


ST:13
T:2


ST:14bis
T:1

Regarding hydrocarbons, the results highlighted:

- No significant contamination for all stations
- All samples have levels below the limit value of the adopted standards.

With regard to metals, the results showed low levels & below the limit values adopted for the different elements.

Regarding PAHs, the results showed very low levels and well below the adopted limit values.

For other contaminants, the results showed PCB and TBT levels below detection limits and adopted limit values.

Regarding the bacteriological result and specifically E.Coli, the average values 3500UFC / g and no contamination (limit values of bathing water), mention that the deposits of bacteria-laden particles will depend on the hydrodynamism in the sheltered shallow areas. currents and choppers.

The more the sediment is rich in organic matter, the longer the fecal bacteria will survive. Indeed, the survival times are very high and the T90 (time required for 90% of bacteria to disappear) can reach 14 days and exceptionally 40 days when conditions are favorable.

7. CONCLUSIONS

7.1. MARINE WATERS

The analyzed samples have the following characteristics :

- The **pH** of a neutral nature.
- **SS** rates are very low
- **TDS** rates show continued mineralization.
- The low turbidity and consistent with the SS and confirms the bacteriological results **E.Coli** and intestinal **enterococci** obtained.
- The concentration of Dissolved **Oxygen** shows a very aerated water is usually saturated with **oxygen** in accordance with the results in organic matter and the biological diagnosis.
- **Ammonium** concentration mentions unpolluted water

Thus, the marine waters of the dredging site do not contain any contamination, on the contrary they are well-aerated, oxygenated waters not mentioning any pollution.

7.2. SEDIMENTS

The analyzed samples have the following characteristics:

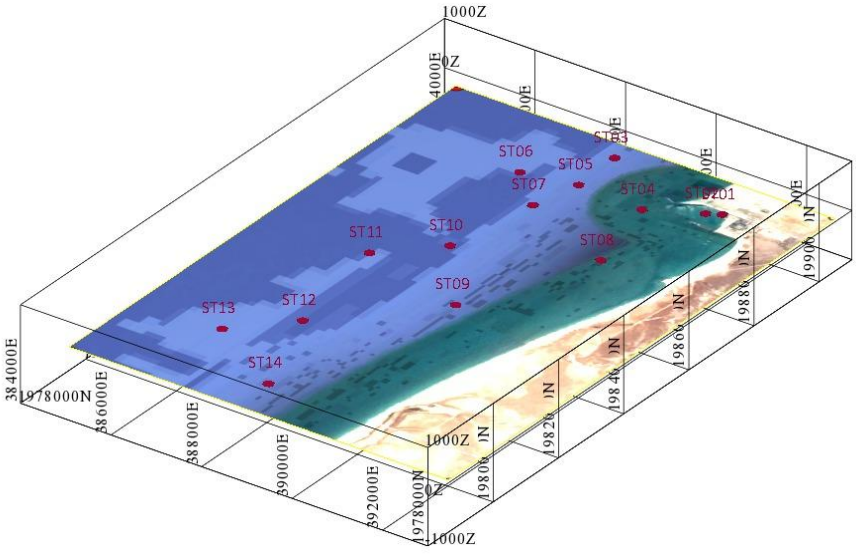
- Physico-chemical properties :
  - The particle size distribution shows the predominance of fine to medium sands
  - Very low amount of organic matter in the different samples. These parameters show a very low contaminant adsorption potential.
- For the 16 samples, the concentrations of contaminants (heavy metals, PCBs, PAHs, TBT) are all low or non-quantifiable and below the levels of the limit values adopted.
- The bacteriological population is absent in the majority of the stations except three stations and the two core holes mentioning average and momentary concentrations indicating a perfect concordance with the concentrations of the organic matter in the different samples.

Thus, the sediments to be dredged are not contaminated and can be treated and managed at sea or on land without any risk of contamination or other.

8. APPENDIX

8.1 WATER ANALYSIS
8.2 SEDIMENT PARTICLES
8.3 SEDIMENT CHEMICAL ANALYSIS
8.4 SEDIMENT TBT ANALYSIS
8.5 BENTHOS ANALYSIS

Les activités de MAGMA sont régies par le décret du Conseil des Ministres N°0105-2015 paru au Journal Officiel n° 1337 de la République Islamique de Mauritanie en date du 15/06/2015.



Rev.	Date	Description	Prepared	Checked	Approved	
01	28/03/2018	FINAL REPORT	Laboratory Teams	S.HAMOUDY	A.KHALIFA	
00	25/02/2019	TEMPORARY REPORT	Laboratory Teams	S.HAMOUDY	A.KHALIFA	

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PROJECT

NOUAKCHOTT CONTAINER TERMINAL IN MAURITANIA

ESIA – Marine survey

Report appendices

PROJECT No.	DATE	DOCUMENT No.	REVISION	PAGE
2019-A-197	28/03/2019	DC02019A197-02-00	01	1/132

Sommaire

1. **Water analysis**
2. **Sediment Particles**
3. **Sediment chemical analysis**
4. **Sediment TBT Analysis**
5. **Benthos Analysis**

1. Water analysis

greenLab
Laboratoire d'analyses environnementales, agricoles et industrielles

RAPPORT D'ESSAIS

Identification : 01/0299/0119

Date de réception : 31/01/19

Green Lab
50, Rue de l'Artisanat
Cherguia II,
2035 - Tunis

1- DEMANDEUR

MAGMA International
Adresse : Nouadhibou – Mauritanie.
Tél : 97418001.

Bon de Commande n°004-19 du 19-01-2019

2- DESCRIPTION DE(s) L'OBJET(s) SOUMIS A L'ESSAI

Quatorze échantillons d'eau de mer, prélevés à Nouakchott en Mauritanie et identifiés de ST1 à ST14.

3- ESSAI(s) DEMANDE(s)

pH, Conductivité, TDS, Turbidité, Oxygène dissous, Résidu Sec, MES, Nitrates, Nitrites, Azote Kjeldahl, Azote ammoniacal, Phosphore total, Orthophosphates, Chlorophylle a, Entérocoques intestinaux, E. Coli.

4- METHODE(s) D'ESSAI(s)

Essai (s)	Méthode (s)	Référence (s)
pH	Electrochimie	Rodier, 9ème édition
Conductivité, TDS	Electrochimie : Mesure effectuée à la température réelle « T_m °C » Résultat fourni après compensation à 25°C	NF EN 27888 (1994)
Oxygène dissous	Electrochimie	NF EN 25814
Turbidité	Néphélométrie	ISO 7027-1 (2016)
Résidu Sec	Gravimétrie	NF T 90-029 (2002)
MES	Filtration sur filtre en microfibres de verre de marque Sartorius MGC	NF EN 872 (2005)
Nitrates	Spectrophotométrie d'absorption moléculaire Méthode par réduction au Résorcinol	Journal « Marine Chemistry ». Vol. 99 (2006) p220-p226
Nitrites	Spectrométrie d'absorption moléculaire	NF EN 26777 (1993)
Azote Kjeldahl	Titrimétrie	NF EN 25663 (1994)
Azote ammoniacal	Spectrométrie d'absorption moléculaire	NF T 90-015-2 (2000)
Phosphore total et Orthophosphates	Spectrométrie d'absorption moléculaire	ISO 6878 (2004)
Chlorophylle a	Fluorimétrie extraction au Méthanol	-
Escherichia Coli	Membrane filtrante	ISO 9308-1 (2014)
Entérocoques intestinaux	Membrane filtrante	ISO 7899-2 (2000)

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5- RESULTAT(s)

5.1- Essais physico-chimiques

5.1.1- Stations de 1 à 5 :

Essai (s)	Unité	MAGMA International – Eaux de mer				
		ST 1	ST 2	ST 3	ST 4	ST 5
pH	-	8,0 à 18,4°C	8,1 à 18,4°C	8,0 à 18,4°C	8,1 à 18,1°C	8,1 à 18,0°C
*Conductivité à 25°C	µS/cm	54,3 10^3 (Tm=18,0°C)	54,5 10^3 (Tm=18,0°C)	54,1 10^3 (Tm=18,0°C)	54,6 10^3 (Tm=18,3°C)	54,3 10^3 (Tm=17,4°C)
TDS	mg/L	25,2 10^3	27,1 10^3	32,8 10^3	27,7 10^3	31,9 10^3
Turbidité	NTU	0,57	3,0	0,27	0,16	0,10
*MES	mg/L	4,5	5,6	4,9	4,8	4,8
Oxygène dissous	mg/L	7,93 à 18,2°C	8,02 à 17,7°C	7,98 à 17,7°C	8,19 à 17,4°C	7,93 à 17,8°C
*Résidu Sec à 105°C	mg/L	43,6 10^3	42,5 10^3	42,9 10^3	42,3 10^3	42,9 10^3
*Azote Kjeldahl	mgN/L	4,74	4,00	1,13	3,33	2,09
*Azote Ammoniacal	µgNH_4^+/L	31,3	27,3	21,5	19,9	18,7
Nitrates	mgNO_3^-/L	<0,093	0,145	0,251	<0,093	<0,093
	mgN/L	<0,021	0,033	0,057	<0,021	<0,021
*Nitrites	mgNO_2^-/L	<0,015	<0,015	0,018	<0,015	<0,015
	mgN/L	<0,005	<0,005	0,005	<0,005	<0,005
*Phosphore total	mgP/L	0,028	0,030	0,034	0,029	0,035
Orthophosphates	mgP/L	0,025	0,029	0,020	0,026	0,020
	mgPO_4^{3-}/L	0,077	0,088	0,061	0,080	0,061
Chlorophylle a	µg/L	0,380	1,079	1,246	0,760	0,395

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5.1.2- Stations de 6 à 10 :

Essai (s)	Unité	MAGMA International – Eaux de mer				
		ST 6	ST 7	ST 8	ST 9	ST 10
pH	-	8,1 à 17,7°C	8,2 à 20,0°C	8,2 à 18,9°C	8,1 à 20,0°C	8,2 à 17,2°C
*Conductivité à 25°C	µS/cm	54,3 10^3 (Tm=17,5°C)	52,3 10^3 (Tm=21,5 C°)	50,5 10^3 (Tm=18,0°C)	54,6 10^3 (Tm=18,0°C)	54,5 10^3 (Tm=17,9°C)
TDS	mg/L	31,7 10^3	33,2 10^3	30,2 10^3	29,1 10^3	30,3 10^3
Turbidité	NTU	<0,05	0,36	1,1	<0,05	<0,05
*MES	mg/L	3,2	4,5	4,1	3,2	2,8
Oxygène dissous	mg/L	8,37 à 17,0°C	8,55 à 16,5°C	8,63 à 16,5°C	8,39 à 16,1°C	8,28 à 15,8°C
*Résidu Sec à 105°C	mg/L	43,0 10^3	43,2 10^3	43,310^3	43,310^3	42,9 10^3
*Azote Kjeldahl	mgN/L	3,89	<1	2,26	2,31	1,18
*Azote Ammoniacal	µgNH_4^+/L	15,2	27,1	28,6	25,6	16,8
Nitrates	mgNO_3^-/L	0,263	0,541	0,184	0,195	<0,093
	mgN/L	0,059	0,122	0,042	0,044	<0,021
*Nitrites	mgNO_2^-/L	0,015	<0,015	<0,015	<0,015	<0,015
	mgN/L	0,005	<0,005	<0,005	<0,005	<0,005
*Phosphore total	mgP/L	0,043	0,048	0,044	0,048	0,045
Orthophosphates	mgP/L	0,040	0,033	0,039	0,044	0,044
	mgPO_4^{3-}/L	0,123	0,100	0,119	0,134	0,134
Chlorophylle a	µg/L	0,486	0,806	0,775	0,289	0,737

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5.1.3- Stations de 11 à 14 :

Essai (s)	Unité	MAGMA International – Eaux de mer			
		ST 11	ST 12	ST 13	ST 14
pH	-	8,2 à 17,6°C	8,1 à 17,1°C	8,2 à 17,3°C	8,2 à 19,7°C
*Conductivité à 25°C	µS/cm	54,4 10^3 (Tm=19,5°C)	54,6 10^3 (Tm=18,0°C)	54,7 10^3 (Tm=18,0°C)	54,5 10^3 (Tm=18,0°C)
TDS	mg/L	29,2 10^3	28,1 10^3	30,0 10^3	30,4 10^3
Turbidité	NTU	0,14	0,18	1,0	1,4
*MES	mg/L	3,6	2,4	5,0	5,1
Oxygène dissous	mg/L	8,45 à 16,1°C	8,31 à 16,3°C	8,30 à 15,9°C	8,47 à 17,2°C
*Résidu Sec à 105°C	mg/L	43,4 10^3	43,0 10^3	43,8 10^3	44,0 10^3
*Azote Kjeldahl	mgN/L	1,02	<1	1,80	<1
*Azote Ammoniacal	µgNH_4^+/L	24,0	18,6	16,3	14,8
Nitrates	mgNO_3^-/L	0,291	0,249	0,094	0,294
	mgN/L	0,066	0,056	0,021	0,066
*Nitrites	mgNO_2^-/L	<0,015	<0,015	<0,015	<0,015
	mgN/L	<0,005	<0,005	<0,005	<0,005
*Phosphore total	mgP/L	0,035	0,035	0,048	0,034
Orthophosphates	mgP/L	0,033	0,024	0,026	0,014
	mgPO_4^{3-}/L	0,100	0,073	0,080	0,042
Chlorophylle a	µg/L	2,72	0,395	0,486	0,547

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5.2- Essais bactériologiques

5.2.1- Station de 1 à 7

Essai (s)	Unité	MAGMA International – Eaux de mer						
		ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7
E. Coli	UFC/100ml	0	2	0	2	1	23	51
Entérocoques intestinaux	UFC/100ml	4	25	9	26	5	54	53

Essais réalisés du 31-01 au 04-02-2019.

5.2.2- Station de 8 à 14

Essai (s)	Unité	MAGMA International – Eaux de mer						
		ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
E. Coli	UFC/100ml	58	72	81	37	52	40	64
Entérocoques intestinaux	UFC/100ml	24	48	65	22	28	64	52

Essais réalisés du 31-01au 04-02-2019.

Dr. Ghanem ZAYANI
Responsable Technique

Habib GHANNOUCHI
Responsable du Laboratoire

Tunis, le 14 FEV. 2019

NB : Ce rapport d'essai ne concerne que le(s) objet(s) soumis à l'essai, il contient 5 page(s) et 0 annexe(s).
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TUNAC
ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005
NUMERO D'ACCREDITATION: 1-0066

2. Sediment Particles

Les activités de MAGMA sont régies par le décret du Conseil des Ministres N°0105-2015 paru au Journal Officiel n° 1337 de la République Islamique de Mauritanie en date du 15/06/2015.

00	25/02/2019	TEMPORARY REPORT	V.KENNOU	S.HAMOUDY	A.KHALIFA	
Rev.	Date	Description	Prepared	Checked	Approved	

INGENIERIE RECHERCHE IRC CONTROLE — ONSHORE AND OFFSHORE GEOTECHNICAL ENGINEERING IN AFRICA magma WWW.MAGMA-GROUPE.COM

ARISE

Royal HaskoningDHV Enhancing Society Together

PROJECT

NOUAKCHOTT CONTAINER TERMINAL IN MAURITANIA

ESIA – Marine survey- PSA

MISSION REPORT

PROJECT No.	DATE	DOCUMENT No.	REVISION	PAGE
2019-A-197	25/02/2019	DC02019A197-02-02	00	1/8

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1. CONTEXT

ARISE is planning to construct and operate a new container and hydrocarbon terminal in the Port of Nouakchott, Mauritania ('the Project'). A detailed understanding of the environment and social baseline (or existing) conditions is required to predict the change and impacts that will be caused by the proposed Project.

For this objective main, ARISE company has requested to the Laboratory MAGMA International the execution of survey for water quality, sediment quality and benthic fauna include the proposed entrance channel, the turning basin and berth pocket, and the potential disposal site. This report provides the results of the particle size analysis performed on the sediments samples.

2. SCOPE

According to the project specification, the particle size analysis should be carried out on 14 sediments samples. This includes 2 sample stations along the length of the proposed access channel (assuming it will be approximately 5km long) and 2 control stations (one upstream and one downstream of the access channel), 1 further sample station within the turning circle and 1 sample station within the berth pocket.
The sample location plan is given in the appendix. The list of samples with the coordinates of the locations is given in the table below:

Table 1 : Program of tests and coordinates of sampling(Coordinates system WGS84 UTM28)

Sample ID	X(m)	Y(m)	PSA
ST01	391201,23	1989520,71	1
ST02	390940,99	1989372,77	1
ST03	388418,23	1990084,07	1
ST04	389930,58	1988823,29	1
ST05	388479,28	1988901,56	1
ST06	387345,98	1988666,43	1
ST07	388241,6	1987822,18	1
ST08	390425,73	1986882,23	1
ST09	389274,79	1984028,27	1
ST10	387914,52	1985740,04	1
ST11	386894,57	1984683,59	1
ST12	387382,07	1981956,85	1
ST13	386390,65	1980863,92	1
ST14	388250,29	1979708,77	1
Total			14

3. TESTS PROCEDURES

According the project specifications each sample acquired from the survey will each sample must be subjected to the Particle size analysis (PSA). The sediments will be air dried and sieved over the range 64mm down to 0.063mm on the Wentworth scale. The particle size analysis is performed by the following the procedure:

- Afterwashing sample with distilled water thru a 63µm sieve; collect fine fraction in the bottom of the sieve assembly.
- Weigh a small plastic tray and label it by sample number; rinse the material retained in the 63µm sieve and put it into the plastic tray; this is the coarse fraction.
- Once the fractions are dry, obtain the dry weights of the trays.
- Than weight the empty bottom trays of the sieve assemblies.
- Shake the sieve, and collect the (<63mm) material in the bottom tray; weigh the bottom tray after sieving is completed.
- Transfer data into spreadsheet and determine relative weight of (<63mm, >63um)

4. RESULTS OF TESTS

4.1. FullParticle size

We have performed the particle size analysis on 14 sediments samples. The details of the tests with particle size curves and the samples picture are given in annexes. The summary of the resultsof the particles range between 63 mm and 0.063mm is given in the following table.

The sieve diameters are in mm and they are converted to ***phi*** using the Wentworth scale.

Table 2 : Results of full Particle sizeof the particles range between 63 mm and 0.063mm

P. diameter		Cumulative Retained %													
mm	Phi	ST01	ST02	ST03	ST04	S05	ST06	ST07	ST08	ST09	ST10	ST11	ST12	ST13	ST14
5	**-2,25**	0	-	0	0	0	0	0	0	0	0	0	0	0	0
4	**-2**	0	-	0,76	6,74	0,4	0	0,38	2,94	0	0	0,63	0	0,62	0
3,15	**-1,7**	0,73	-	1,01	7,55	0,54	0	0,5	3,23	0	0	0,71	0	0,73	0,78
2,5	**-1,3**	0,81	-	1,5	8,87	0,83	0	0,76	3,63	0	0	0,8	0	0,92	0,98
2	**-1**	0,9	-	1,95	9,96	1,08	0,45	1,05	3,99	0,18	0,34	0,89	0,3	2,46	1,22
1	**0**	2,01	-	4,67	16,72	3,36	0,71	4,29	5,49	0,66	1,83	1,57	0,98	3,19	3,29
0,8	**0,4**	2,6	-	5,73	18,82	4,47	0,94	6,24	5,95	0,96	2,43	1,77	1,5	4,67	4,52
0,63	**0,8**	3,98	-	7,93	21,38	6,77	1,18	11,74	6,94	1,55	3,77	2,19	3,55	12,64	7,33
0,4	**1,3**	15,56	-	18,55	31,97	21,94	6,71	39,21	12,94	4,26	12,52	7,42	7,82	39,38	17,29
0,32	**1,8**	36,12	-	24,37	43,21	52,56	11	54,58	16,88	6,46	28,85	16,88	9,88	71,16	31,33
0,25	**2**	74,73	-	51,46	84,34	88,84	19,87	66,23	41,31	19,35	46,89	87,76	29,66	76,51	66,17
0,2	**2,3**	76,58	-	51,69	84,91	89,57	20,76	66,55	42,37	20,7	59,41	88,5	35,96	87,89	72,56
0,16	**3,1**	84,61	-	53,07	87,17	92,39	32,52	73,05	58,73	47,38	74,08	95,81	78,13	98,7	82,78
0,1	**3,2**	98,83	-	90,95	99,02	99,38	96,37	98,54	96,38	95,71	99,08	99,8	98,9	99,7	98,86
0,08	**3,6**	99,48	-	97,39	99,84	99,91	99,35	99,81	99,14	98,8	99,74	99,91	99,88	99,92	99,73

P. diameter		Cumulative Retained %													
mm	Phi	ST01	ST02	ST03	ST04	S05	ST06	ST07	ST08	ST09	ST10	ST11	ST12	ST13	ST14
0,063	**4**	100	-	100	100	100	100	100	100	100	100	100	100	100	100
Mud %		3.6	98	37.7	8.4	5	44.2	11.3	23	34	22.4	7.7	29.2	16.3	30.8

NB: The sample ST02 has a fine texture, the almost particles have a diameter less than 0.063mm therefore the analysis by sieving can not perform on this sample. The complete particle size can be perform by hydrometer test

4.2. Statistical parameters

These parameters inform us about the sample deposition mode and the deposition environment. The most used parameters are:

- **The mean :** The size corresponding to 50% of the grains on the cumulative curve, it's calculated by the formula:

$$M = \frac{\varphi_{16} + \varphi_{50} + \varphi_{84}}{3}$$

- **The Skewness**: is a measure of the degree of asymmetry of the grain-size distribution. Folk and Ward (1957) proposedThe measure inclusive graphic Skewness, defined as:

$$Sk = \frac{\varphi_{84} + \varphi_{16} - 2\varphi_{50}}{2(\varphi_{84} - \varphi_{16})} + \frac{\varphi_{95} + \varphi_{5} - 2\varphi_{50}}{2(\varphi_{95} - \varphi_{5})}$$

- **Sorting Coefficient:** An accumulation of sediment can also be characterized by the grain size distribution. A sediment deposit can undergo sorting when a particle size range is removed by an agency such as a river or the wind. The sorting can be quantified using the Inclusive Graphic Standard Deviation

$$So = \frac{\varphi_{84} - \varphi_{16}}{4} + \frac{\varphi_{95} - \varphi_{5}}{6,6}$$

- **Kurtosis** or peakedness of the distribution is computed by comparing the spread in the central part of the distribution to the spread in the tails. Folknd Ward (1957) define graphic kurtosisas:

$$K = \frac{\varphi_{95} - \varphi_{5}}{2,44(\varphi_{75} - \varphi_{25})}$$

- **Modal size:** Is the most frequently-occurring particle diameter

The results of statistical parameters are given in the following table:

Table 3 : Statistical parameters

Sample ID	D16 phi	D50 phi	D84 phi	D95 phi	D5 phi	D75 phi	D25 phi	Mean phi	Sk	K	So	Mod phi
ST1	1,7	2,1	3,2	3,5	1,4	2,3	1,9	2,33	0,40	2,15	0,69	2
ST3	1,1	2	3,2	3,4	0	3,2	1,8	2,10	-0,02	1,00	1,04	3,2
ST4	0	1,8	2	3,2	-2,1	1,9	1	1,27	-0,64	2,41	1,30	2
ST5	1,1	1,8	2,00	3,10	0,00	1,90	1,40	1,63	-0,36	2,54	0,70	2
ST6	1,9	3,1	3,2	3,2	1,2	3,1	2,6	2,73	-0,87	1,64	0,63	3,2
ST7	0,9	1,6	3,1	3,2	0	3,1	1	1,87	0,18	0,62	1,04	1,3
ST8	1,6	2,6	3,2	3,2	0	3,1	1,9	2,47	-0,44	1,09	0,89	3,2
ST9	1,9	3,1	3,2	3,2	1,5	3,1	2,5	2,73	-0,86	1,16	0,58	3,2
ST10	1,4	2,1	3,1	3,2	0,9	3,1	1,4	2,20	0,07	0,55	0,77	3,2
ST11	1,6	1,9	2	2,9	1	2	1,8	1,83	-0,22	3,89	0,39	2
ST12	1,9	2,6	3,1	3,2	0,8	3	2,9	2,53	-0,33	9,84	0,66	3,1
ST13	0,8	1,5	2,2	2,8	0,4	2	1	1,50	0,04	0,98	0,71	1,8
ST14	1,2	1,9	3,1	3,2	0,4	2,6	1,6	2,07	0,10	1,15	0,90	2

5. CONCLUSION

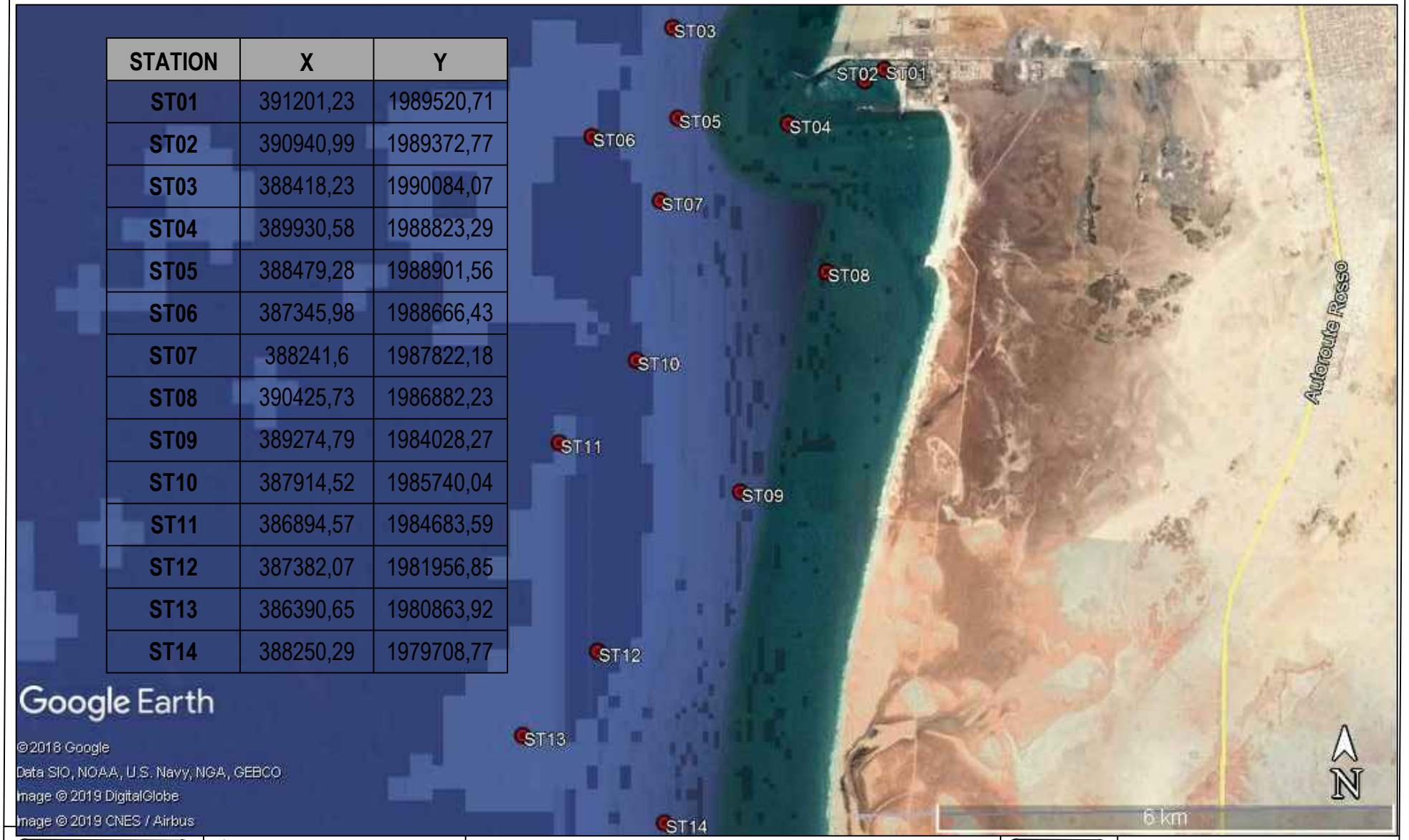
The results of the Particle size analysis show that the sediments consist of a dominant sandy texture (grain diameter between 2 and 0.063mm) accepting the ST02 sample, except the sample ST02 which has a fine texture (mud: silt and clay,diameter less than 0.063mm). This sand is generally fine to medium, with a mudfraction (diameter, less than 0.063mm)varyingbetween 5and 44%. The statistical parameters calculated form the particles size curves of the particles range between 63mm and 0.063mm (transformed on phi unity bay), give the following resultants:

- **The mean(M),** varies between, 1.27phi and 2.73 phi
- **The Skewness(sk),** varies between, -0,87 and 0.40
- **Sorting coefficient(SO),**varies between, 0.39 and 1.30
- **Modal size(Mod),** varies between, 2 and 3 phi
- **Kurtosis(k),** varies between, 0.55 and 9.84

ANNEXES

A: Locations plan

STATION	X	Y
ST01	391201,23	1989520,71
ST02	390940,99	1989372,77
ST03	388418,23	1990084,07
ST04	389930,58	1988823,29
ST05	388479,28	1988901,56
ST06	387345,98	1988666,43
ST07	388241,6	1987822,18
ST08	390425,73	1986882,23
ST09	389274,79	1984028,27
ST10	387914,52	1985740,04
ST11	386894,57	1984683,59
ST12	387382,07	1981956,85
ST13	386390,65	1980863,92
ST14	388250,29	1979708,77



ARISE

REPUBLIQUE ISLAMIQUE DE MAURITANIE

HONNEUR - FRATERNITE - JUSTICE

Marine survey

Sediment samples

Client :

ARISE

Plan N°	1
Echelle	1/2000
Date	Fab.2019

magma

B: Particle Size analysis

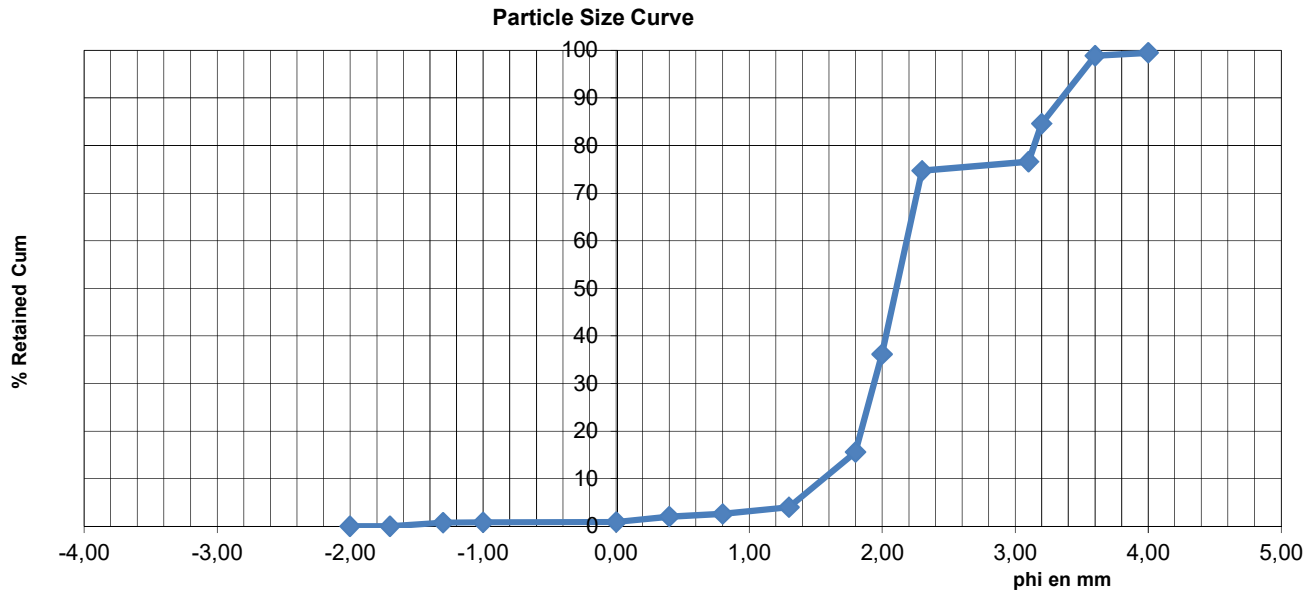
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-01-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1238,33 (g)**

% FINER IN SIEVE 0,063 mm **3.64**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1238,33 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	8,70	0,73	0,73	**99,27**
-1,30	1,00	0,08	0,81	**99,19**
-1,00	1,00	0,08	0,90	**99,10**
0,00	13,30	1,11	2,01	**97,99**
0,40	7,00	0,59	2,60	**97,40**
0,80	16,50	1,38	3,98	**96,02**
1,30	143,40	11,58	15,56	**84,44**
1,80	245,30	20,56	36,12	**63,88**
2,00	460,80	38,62	74,73	**25,27**
2,30	22,00	1,84	76,58	**23,42**
3,10	95,90	8,04	84,61	**15,39**
3,20	169,60	14,21	98,83	**1,17**
3,60	7,80	0,70	99,52	**0,48**
4,000	1,00	0,55	100	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	

OBSERVATIONS:

	Project: NOUAKCHOTT CONTAINERS TERMINAL **Client: ARISE**	**N.º Sample: ST-03-F** **Material Nature :**
TEST DATE ***31/01/2019***	**PRARTICLES SIZE ANALYSIS** **EN 933-1**	Code : FO/PRS/10 **Provenance:** **NKC-PORT**

TOTAL WEIGHT

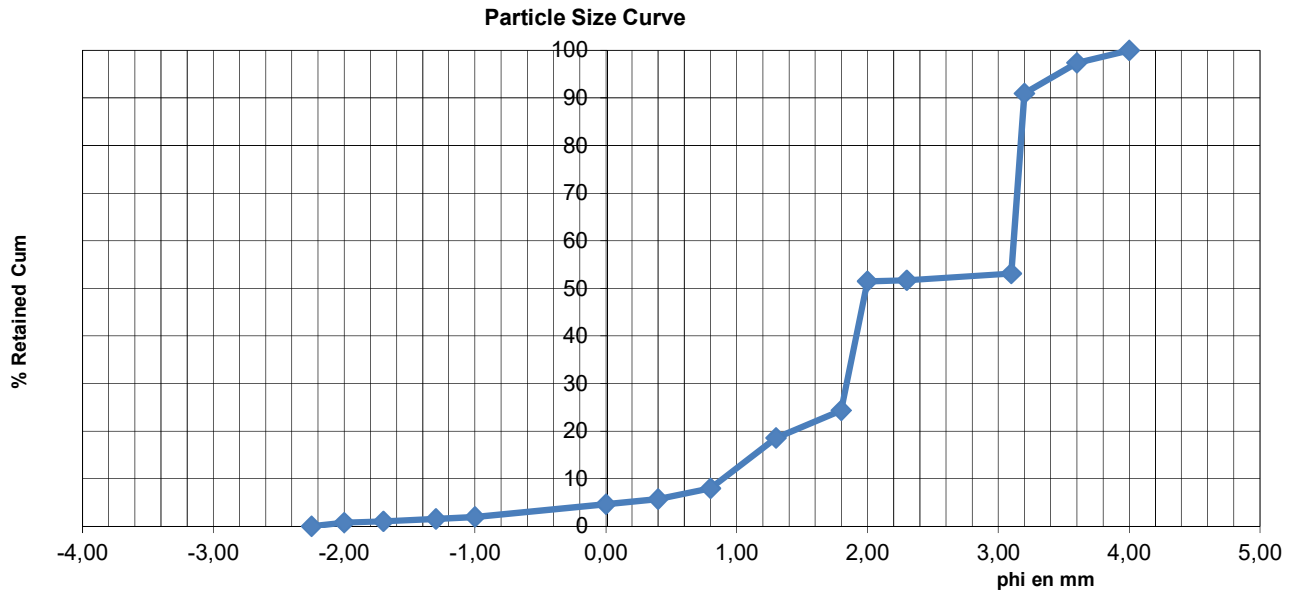
OF DRYED SAMPLE

1014,20 (g)

% FINER IN SIEVE
0,063 mm
37.70

TOTAL WEIGH IN SIEVE
63 mm-0,063 mm
1014,20 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	4,80	0,76	0,76	**99,24**
-1,70	1,60	0,25	1,01	**98,99**
-1,30	3,10	0,49	1,50	**98,50**
-1,00	2,80	0,44	1,95	**98,05**
0,00	17,20	2,72	4,67	**95,33**
0,40	6,70	1,06	5,73	**94,27**
0,80	13,90	2,20	7,93	**92,07**
1,30	67,10	10,62	18,55	**81,45**
1,80	36,80	5,82	24,37	**75,63**
2,00	171,10	27,08	51,46	**48,54**
2,30	1,50	0,24	51,69	**48,31**
3,10	8,70	1,38	53,07	**46,93**
3,20	239,30	37,88	90,95	**9,05**
3,60	40,70	6,44	97,39	**2,61**
4,000	16,50	2,61	100,00	**0,00**



SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-04-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT

OF DRYED SAMPLE

677,40 (g)

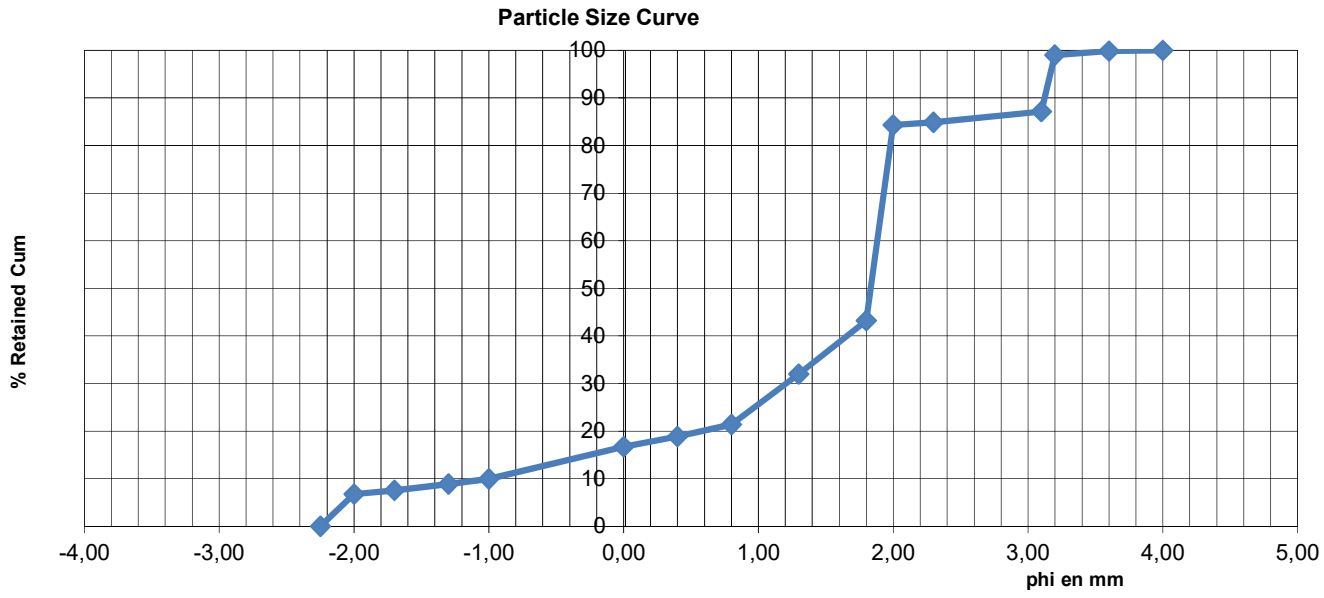
% FINER IN SIEVE 0,063 mm

8.44

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm

677,40 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	41,80	6,74	6,74	**93,26**
-1,70	5,00	0,81	7,55	**92,45**
-1,30	8,20	1,32	8,87	**91,13**
-1,00	6,80	1,10	9,96	**90,04**
0,00	41,90	6,76	16,72	**83,28**
0,40	13,00	2,10	18,82	**81,18**
0,80	15,90	2,56	21,38	**78,62**
1,30	65,70	10,59	31,97	**68,03**
1,80	69,70	11,24	43,21	**56,79**
2,00	255,10	41,13	84,34	**15,66**
2,30	3,50	0,56	84,91	**15,09**
3,10	14,00	2,26	87,17	**12,83**
3,20	73,50	11,85	99,02	**0,98**
3,60	5,10	0,82	99,84	**0,16**
4,000	1,00	0,16	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-05-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

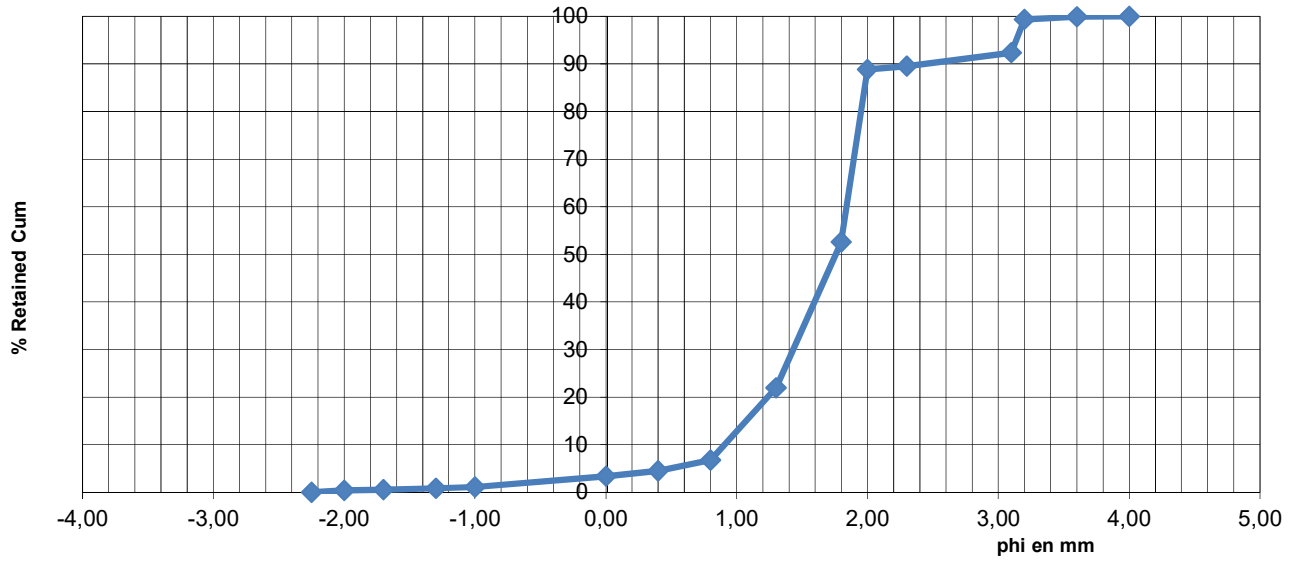
TOTAL WEIGHT OF DRYED SAMPLE
1183,90 (g)

% FINER IN SIEVE 0,063 mm
4.95

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm
1183,90 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	4,50	0,40	0,40	**99,60**
-1,70	1,60	0,14	0,54	**99,46**
-1,30	3,20	0,28	0,83	**99,17**
-1,00	2,90	0,26	1,08	**98,92**
0,00	25,60	2,27	3,36	**96,64**
0,40	12,50	1,11	4,47	**95,53**
0,80	25,90	2,30	6,77	**93,23**
1,30	170,70	15,17	21,94	**78,06**
1,80	344,60	30,62	52,56	**47,44**
2,00	408,20	36,27	88,84	**11,16**
2,30	8,20	0,73	89,57	**10,43**
3,10	31,80	2,83	92,39	**7,61**
3,20	78,60	6,98	99,38	**0,62**
3,60	6,00	0,53	99,91	**0,09**
4,000	1,00	0,09	100,00	**0,00**

Particle Size Curve



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

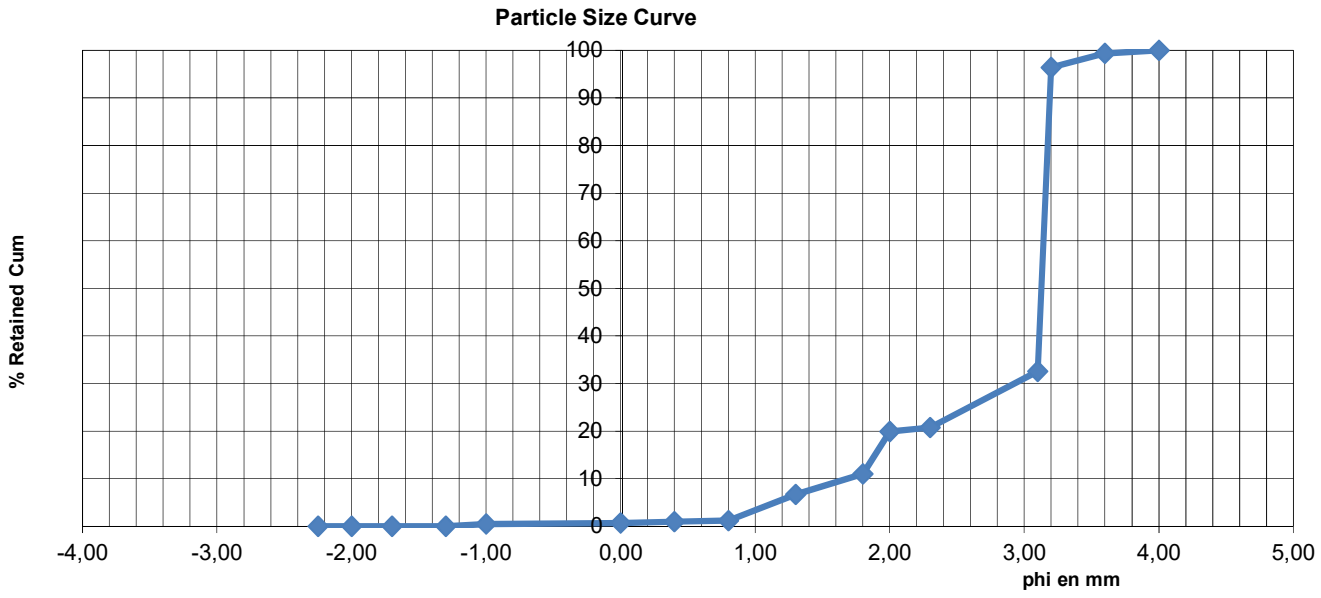
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-06-BIS-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **804,40 (g)**

% FINER IN SIEVE 0,063 mm **44.19**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **804,40 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	2,00	0,45	0,45	**99,55**
0,00	1,20	0,27	0,71	**99,29**
0,40	1,00	0,22	0,94	**99,06**
0,80	1,10	0,25	1,18	**98,82**
1,30	24,80	5,52	6,71	**93,29**
1,80	19,30	4,30	11,00	**89,00**
2,00	39,80	8,87	19,87	**80,13**
2,30	4,00	0,89	20,76	**79,24**
3,10	52,80	11,76	32,52	**67,48**
3,20	286,60	63,84	96,37	**3,63**
3,60	13,40	2,99	99,35	**0,65**
4,000	2,90	0,65	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-07-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

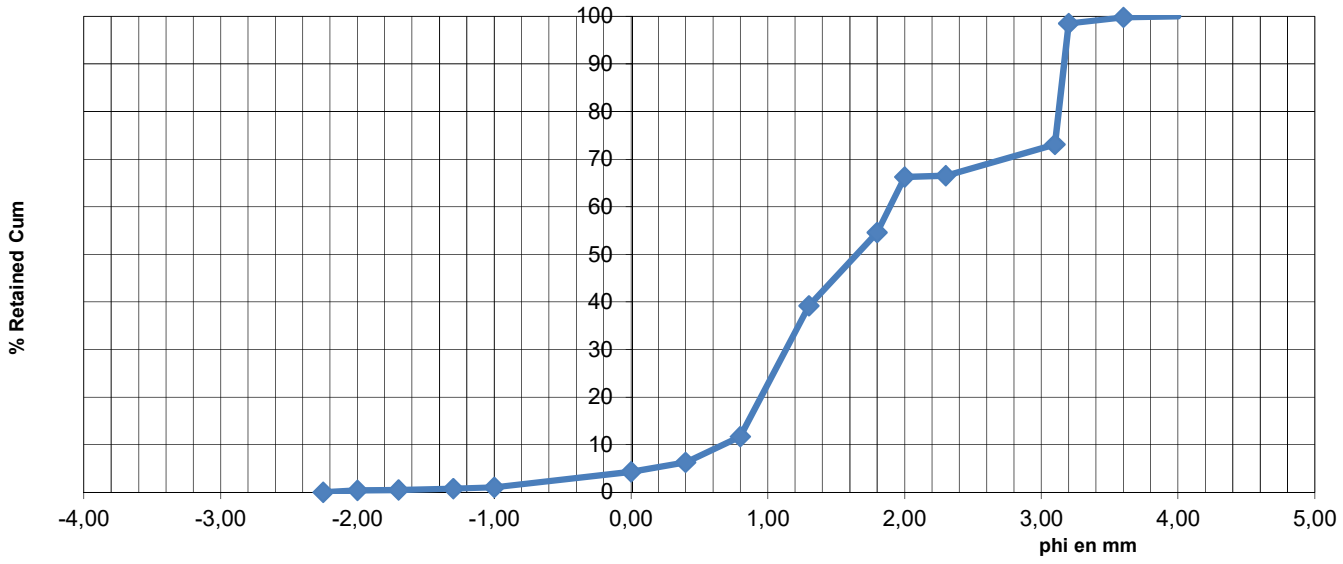
TOTAL WEIGHT OF DRYED SAMPLE
938,50 (g)

% FINER IN SIEVE 0,063 mm
11.32

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm
938,50 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	3,20	0,38	0,38	**99,62**
-1,70	1,00	0,12	0,50	**99,50**
-1,30	2,10	0,25	0,76	**99,24**
-1,00	2,40	0,29	1,05	**98,95**
0,00	27,00	3,24	4,29	**95,71**
0,40	16,20	1,95	6,24	**93,76**
0,80	45,80	5,50	11,74	**88,26**
1,30	228,60	27,47	39,21	**60,79**
1,80	127,90	15,37	54,58	**45,42**
2,00	97,00	11,66	66,23	**33,77**
2,30	2,60	0,31	66,55	**33,45**
3,10	54,10	6,50	73,05	**26,95**
3,20	212,13	25,49	98,54	**1,46**
3,60	10,60	1,27	99,81	**0,19**
4,000	1,60	0,19	100,00	**0,00**

Particle Size Curve



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

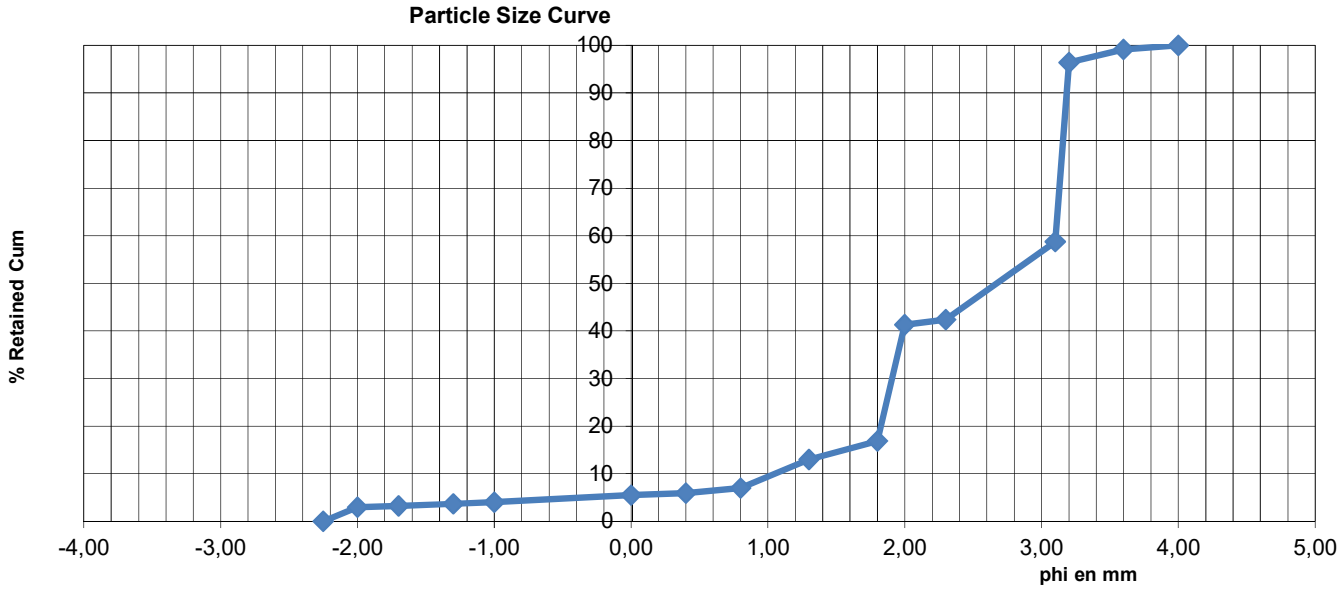
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-08-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE
768,00 (g)

% FINER IN SIEVE 0,063 mm
22.93

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm
768,00 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	17,40	2,94	2,94	**97,06**
-1,70	1,70	0,29	3,23	**96,77**
-1,30	2,40	0,41	3,63	**96,37**
-1,00	2,10	0,35	3,99	**96,01**
0,00	8,90	1,50	5,49	**94,51**
0,40	2,70	0,46	5,95	**94,05**
0,80	5,90	1,00	6,94	**93,06**
1,30	35,50	6,00	12,94	**87,06**
1,80	23,30	3,94	16,88	**83,12**
2,00	144,60	24,43	41,31	**58,69**
2,30	6,30	1,06	42,37	**57,63**
3,10	96,80	16,35	58,73	**41,27**
3,20	222,90	37,66	96,38	**3,62**
3,60	16,30	2,75	99,14	**0,86**
4,000	5,10	0,86	100,00	**0,00**



SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-09-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT

OF DRYED SAMPLE

947,00 (g)

% FINER IN SIEVE 0,063 mm

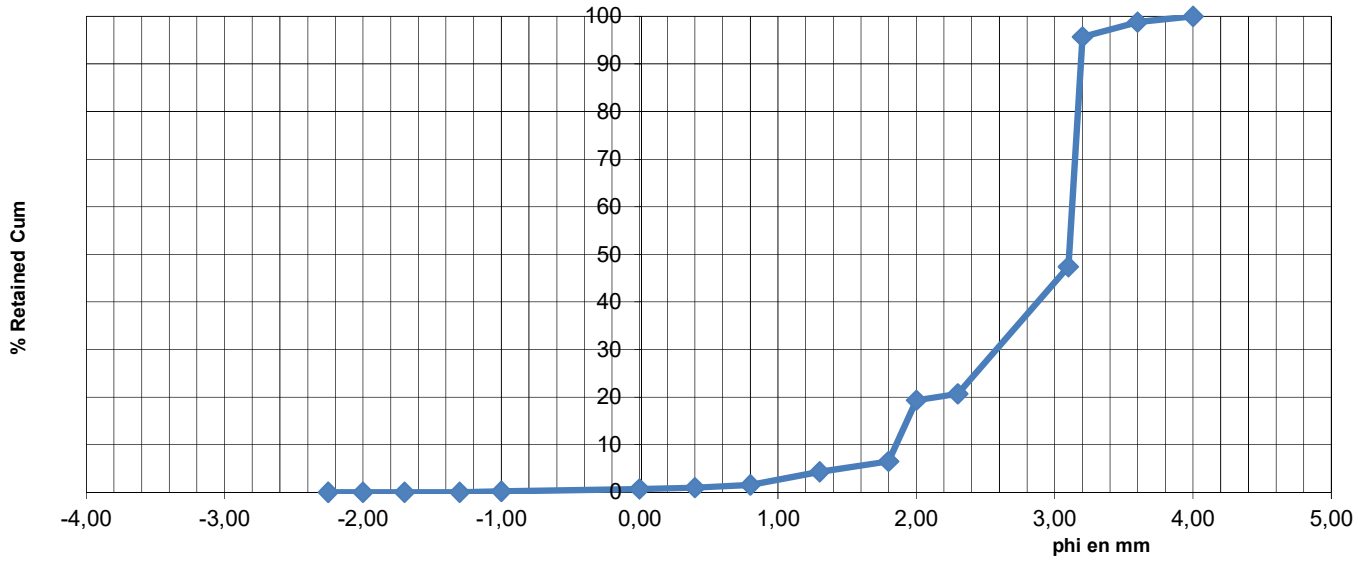
34.08

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm

947,00 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	1,10	0,18	0,18	**99,82**
0,00	3,00	0,48	0,66	**99,34**
0,40	1,90	0,30	0,96	**99,04**
0,80	3,70	0,59	1,55	**98,45**
1,30	16,90	2,71	4,26	**95,74**
1,80	13,70	2,19	6,46	**93,54**
2,00	80,50	12,89	19,35	**80,65**
2,30	8,40	1,35	20,70	**79,30**
3,10	166,60	26,69	47,38	**52,62**
3,20	301,70	48,33	95,71	**4,29**
3,60	19,30	3,09	98,80	**1,20**
4,000	7,50	1,20	100,00	**0,00**

Particle Size Curve



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

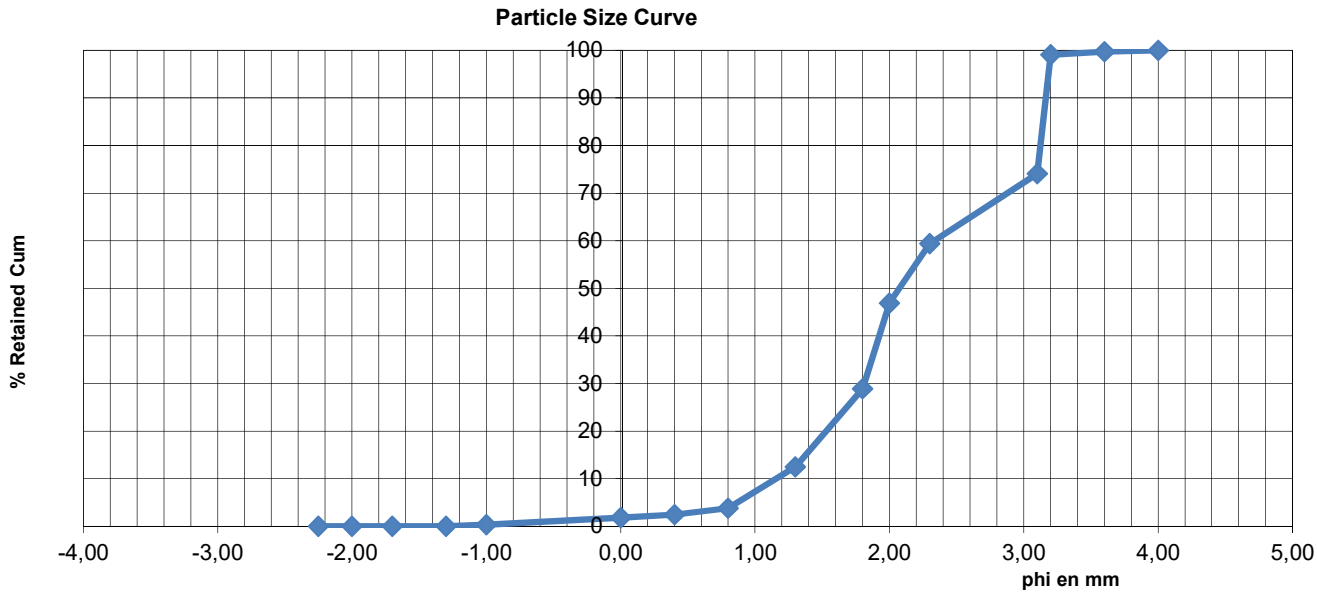
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-10-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1235,30 (g)**

% FINER IN SIEVE 0,063 mm **22.38**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1235,30 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	3,30	0,34	0,34	**99,66**
0,00	14,20	1,48	1,83	**98,17**
0,40	5,80	0,60	2,43	**97,57**
0,80	12,80	1,34	3,77	**96,23**
1,30	83,90	8,75	12,52	**87,48**
1,80	156,60	16,33	28,85	**71,15**
2,00	173,00	18,04	46,89	**53,11**
2,30	120,00	12,52	59,41	**40,59**
3,10	140,70	14,67	74,08	**25,92**
3,20	239,70	25,00	99,08	**0,92**
3,60	6,30	0,66	99,74	**0,26**
4,000	2,50	0,26	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

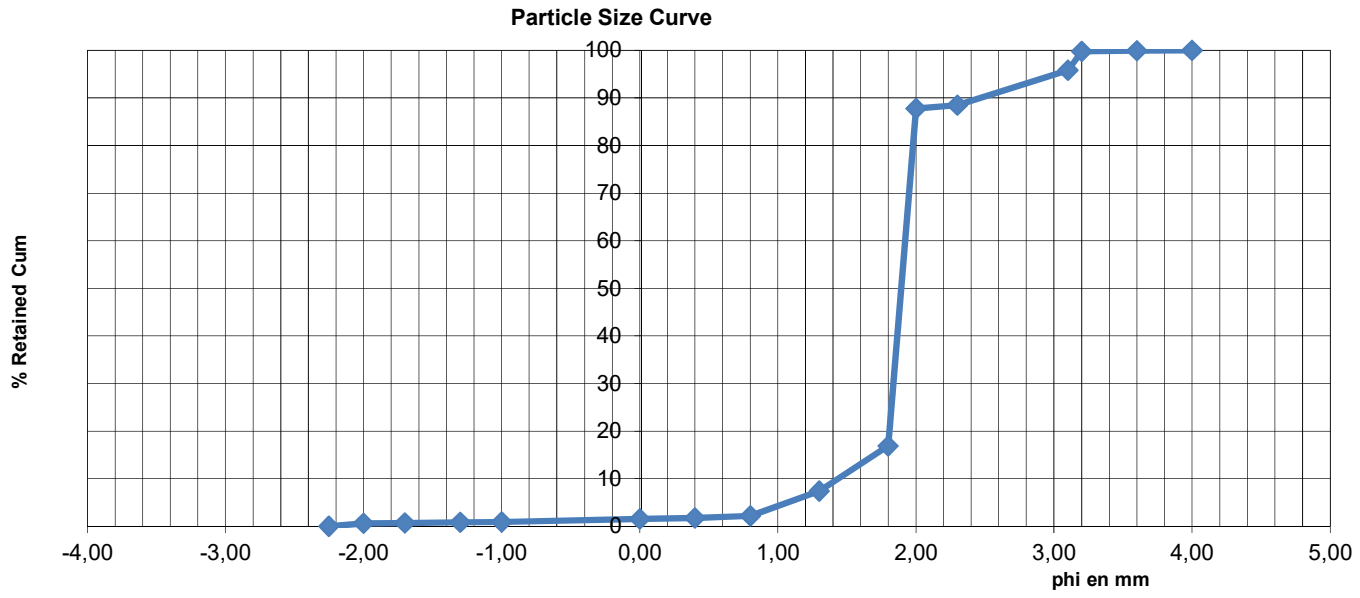
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-11-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1257,90 (g)**

% FINER IN SIEVE 0,063 mm 7.70

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1257,90 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	7,30	0,63	0,63	**99,37**
-1,70	1,00	0,09	0,71	**99,29**
-1,30	1,00	0,09	0,80	**99,20**
-1,00	1,00	0,09	0,89	**99,11**
0,00	7,90	0,68	1,57	**98,43**
0,40	2,30	0,20	1,77	**98,23**
0,80	4,90	0,42	2,19	**97,81**
1,30	60,80	5,24	7,42	**92,58**
1,80	109,80	9,46	16,88	**83,12**
2,00	823,00	70,88	87,76	**12,24**
2,30	8,60	0,74	88,50	**11,50**
3,10	84,90	7,31	95,81	**4,19**
3,20	46,30	3,99	99,80	**0,20**
3,60	1,30	0,11	99,91	**0,09**
4,000	1,00	0,09	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL ARISE — Client:	N.º Sample: ST-12-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT

OF DRYED SAMPLE

1185,40 (g)

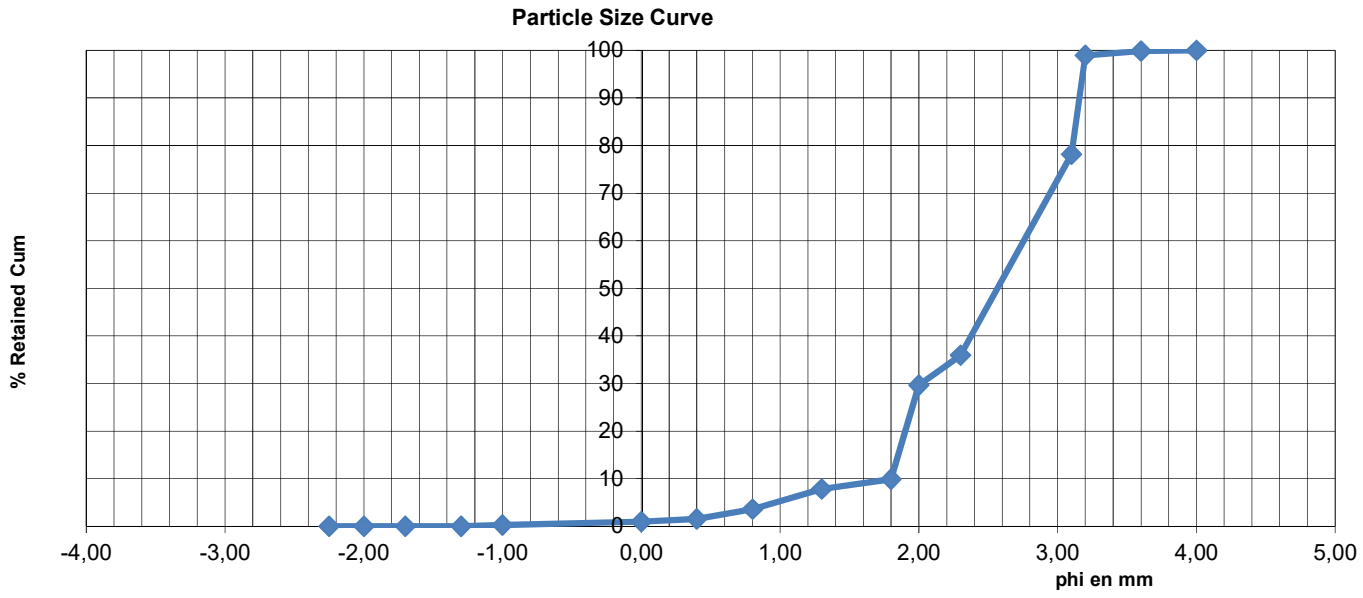
% FINER IN SIEVE 0,063 mm

29.21

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm

1185,40 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	2,50	0,30	0,30	**99,70**
0,00	5,70	0,68	0,98	**99,02**
0,40	4,40	0,52	1,50	**98,50**
0,80	17,20	2,05	3,55	**96,45**
1,30	35,80	4,27	7,82	**92,18**
1,80	17,30	2,06	9,88	**90,12**
2,00	166,00	19,78	29,66	**70,34**
2,30	52,90	6,30	35,96	**64,04**
3,10	353,90	42,17	78,13	**21,87**
3,20	174,30	20,77	98,90	**1,10**
3,60	8,20	0,98	99,88	**0,12**
4,000	1,00	0,12	100,00	**0,00**



SILT	SAND		GRAVEL		
	FINE	MEDIUM	COARSE	FINE	COARSE

OBSERVATIONS:

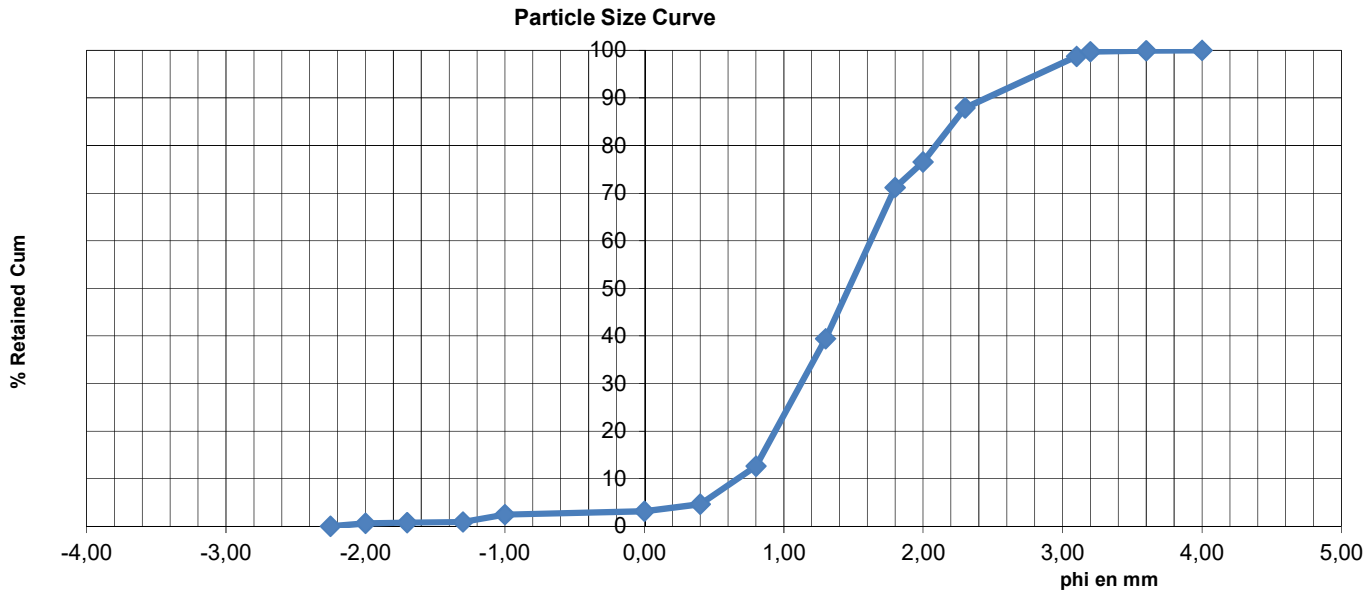
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL ARISE Client:	N.º Sample: ST-13-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1415,60 (g)**

% FINER IN SIEVE 0,063 mm 16.27

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1415,60 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	7,40	0,62	0,62	**99,38**
-1,70	1,30	0,11	0,73	**99,27**
-1,30	2,20	0,19	0,92	**99,08**
-1,00	18,20	1,54	2,46	**97,54**
0,00	8,70	0,73	3,19	**96,81**
0,40	17,50	1,48	4,67	**95,33**
0,80	94,50	7,97	12,64	**87,36**
1,30	317,00	26,74	39,38	**60,62**
1,80	376,70	31,78	71,16	**28,84**
2,00	63,40	5,35	76,51	**23,49**
2,30	134,90	11,38	87,89	**12,11**
3,10	128,10	10,81	98,70	**1,30**
3,20	11,80	1,00	99,70	**0,30**
3,60	2,60	0,22	99,92	**0,08**
4,000	1,00	0,08	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL ARISE Client:	N.º Sample: ST-14-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

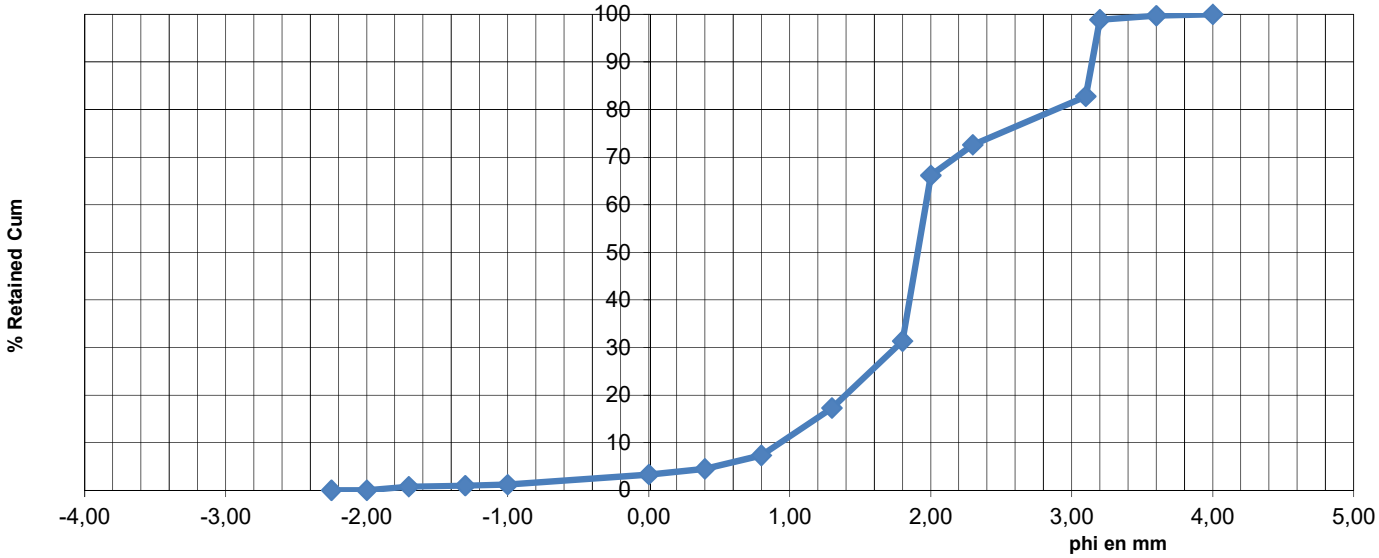
TOTAL WEIGHT OF DRYED SAMPLE **962,80 (g)**

% FINER IN SIEVE 0,063 mm **30.81**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **962,80 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	5,20	0,78	0,78	**99,22**
-1,30	1,30	0,20	0,98	**99,02**
-1,00	1,60	0,24	1,22	**98,78**
0,00	13,80	2,07	3,29	**96,71**
0,40	8,20	1,23	4,52	**95,48**
0,80	18,70	2,81	7,33	**92,67**
1,30	66,40	9,97	17,29	**82,71**
1,80	93,50	14,03	31,33	**68,67**
2,00	232,10	34,84	66,17	**33,83**
2,30	42,60	6,39	72,56	**27,44**
3,10	68,10	10,22	82,78	**17,22**
3,20	107,10	16,08	98,86	**1,14**
3,60	5,80	0,87	99,73	**0,27**
4,000	1,80	0,27	100,00	**0,00**

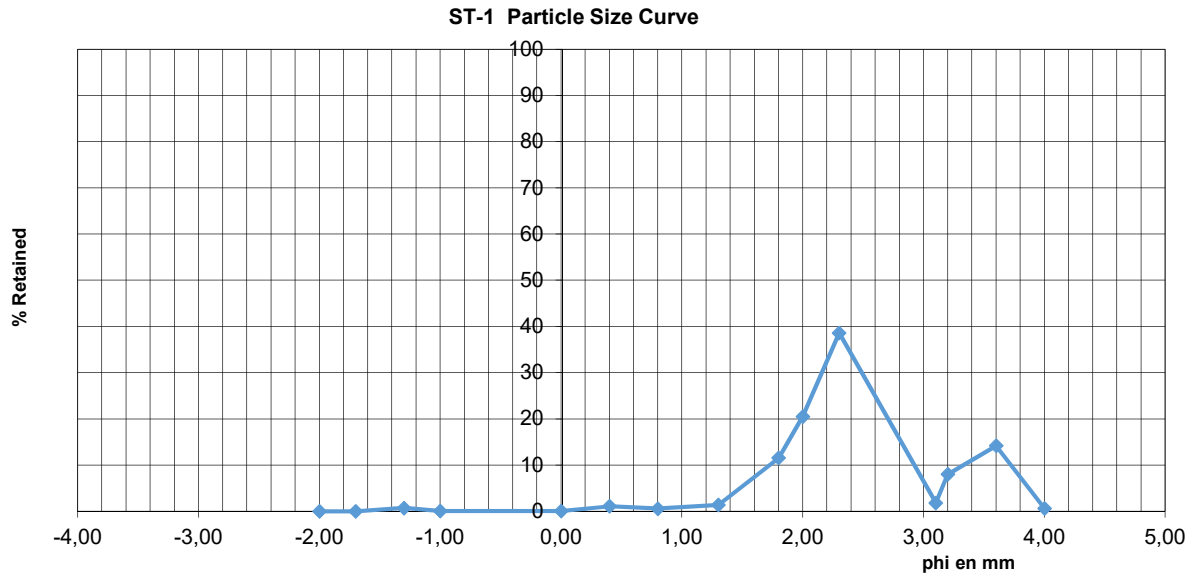
Particle Size Curve

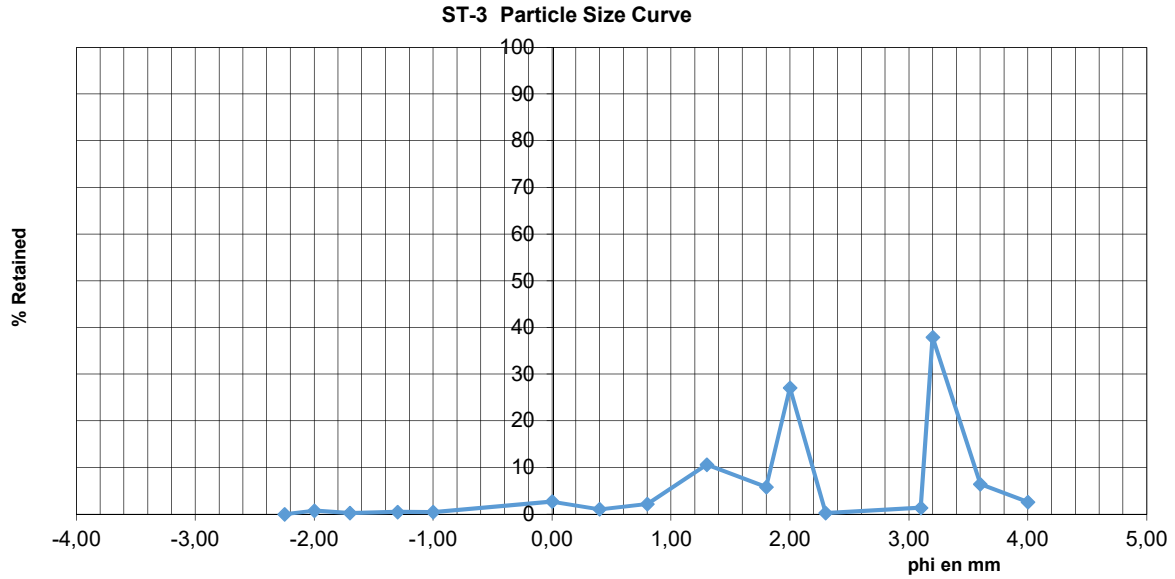


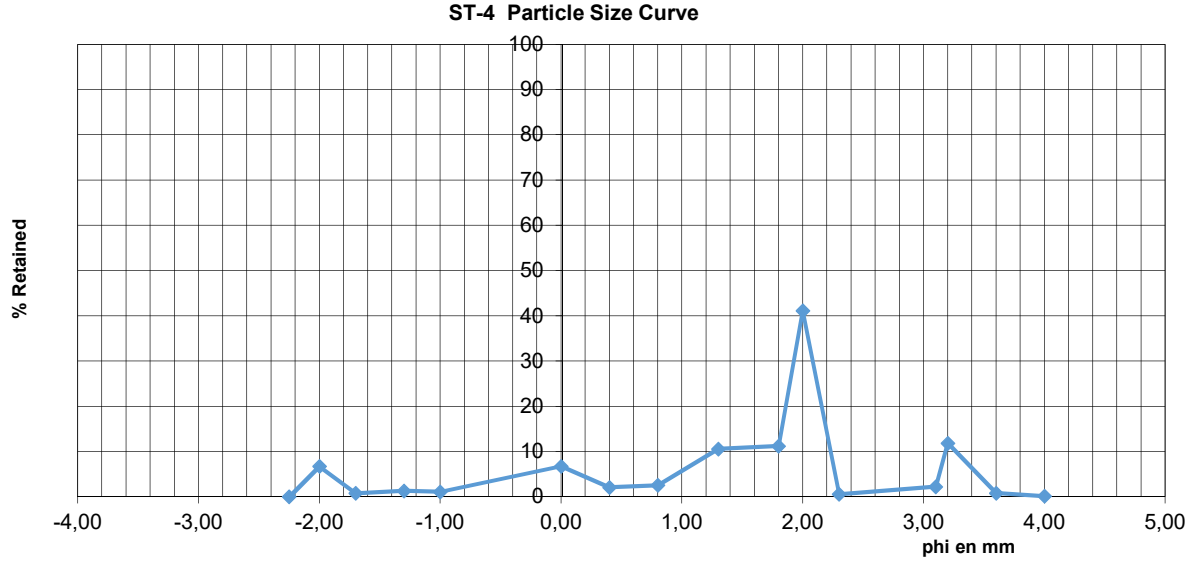
SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	

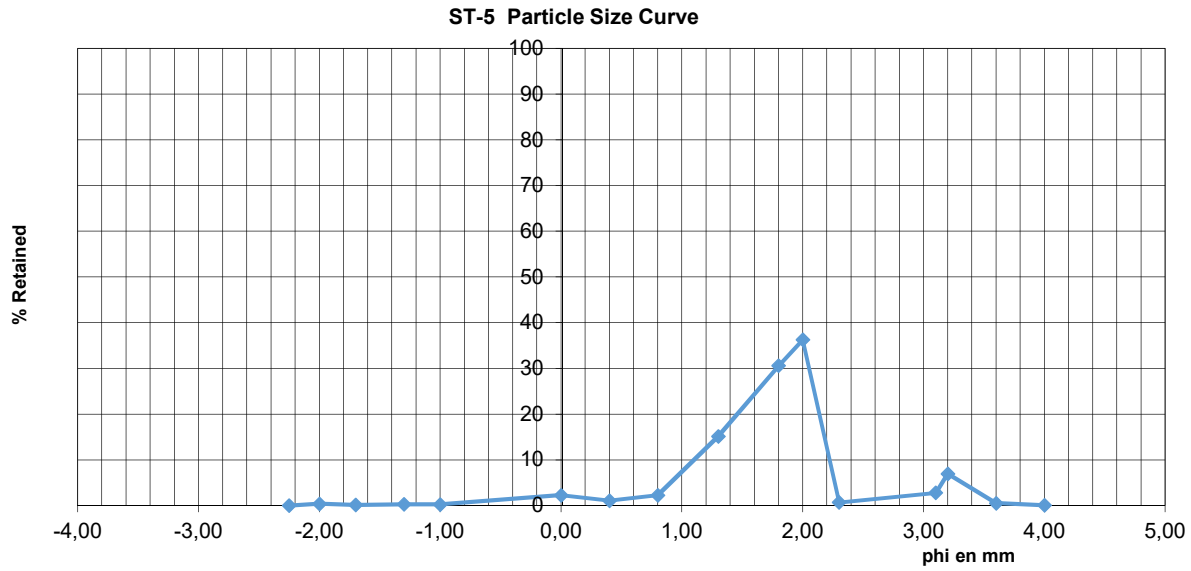
OBSERVATIONS:

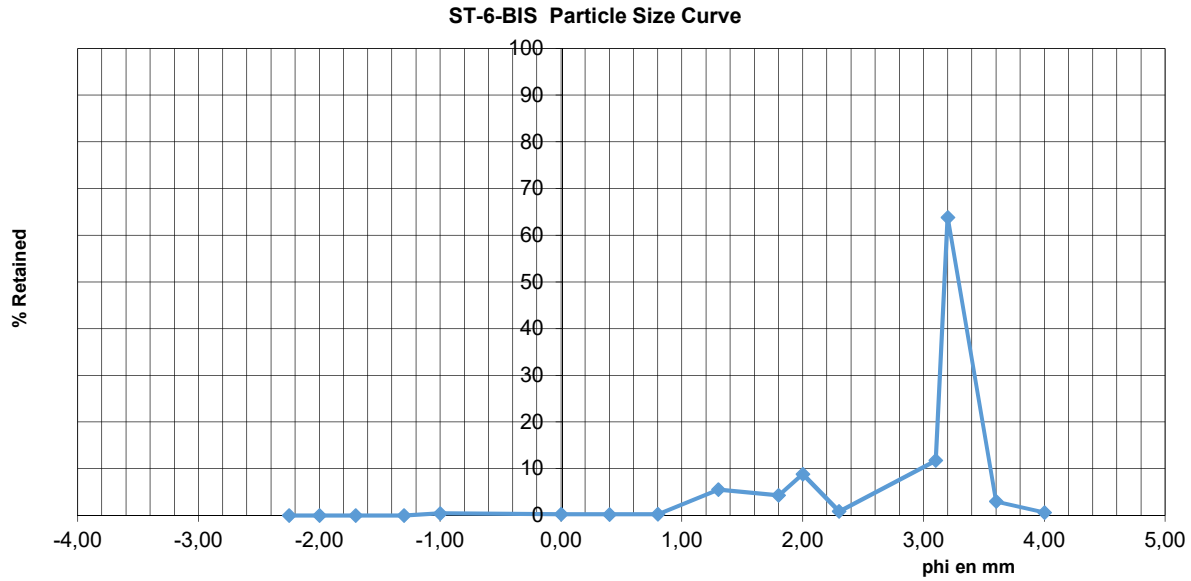
C: Modal of particle size

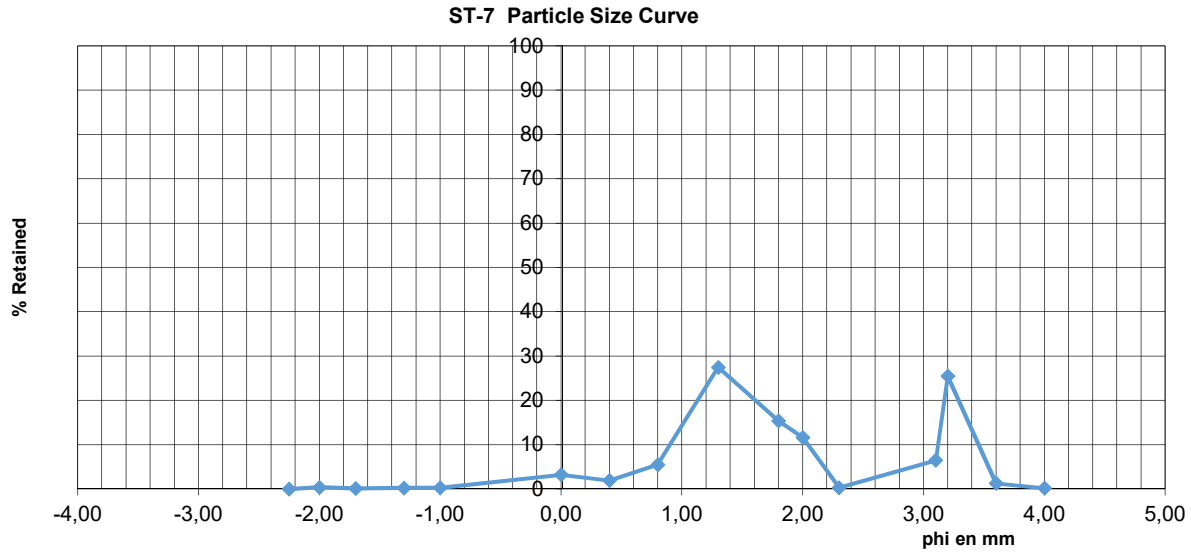

ST-1 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

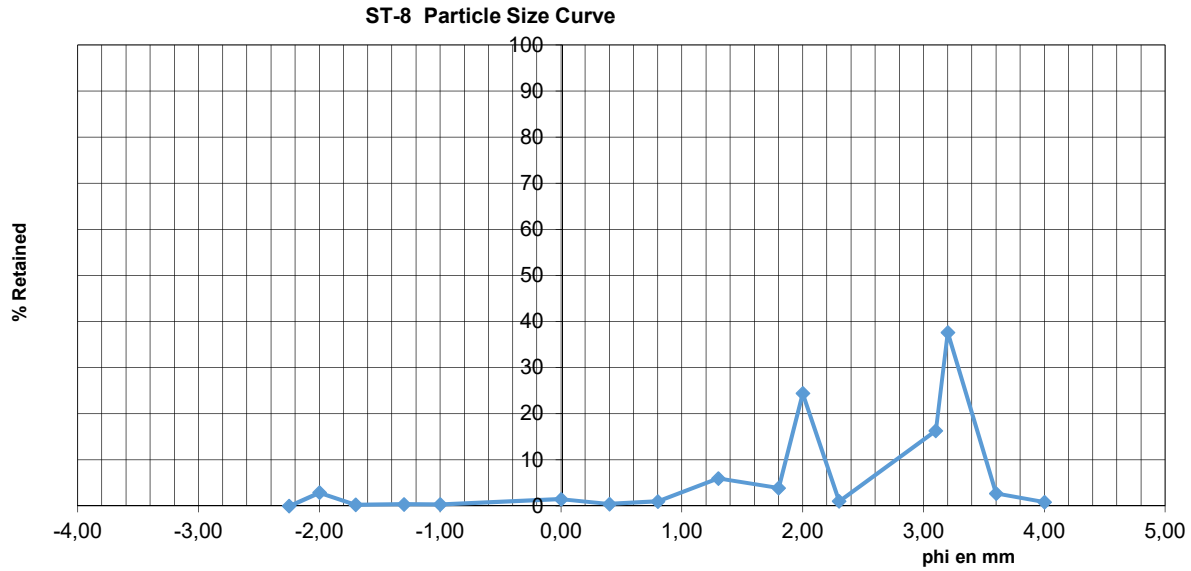

ST-3 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

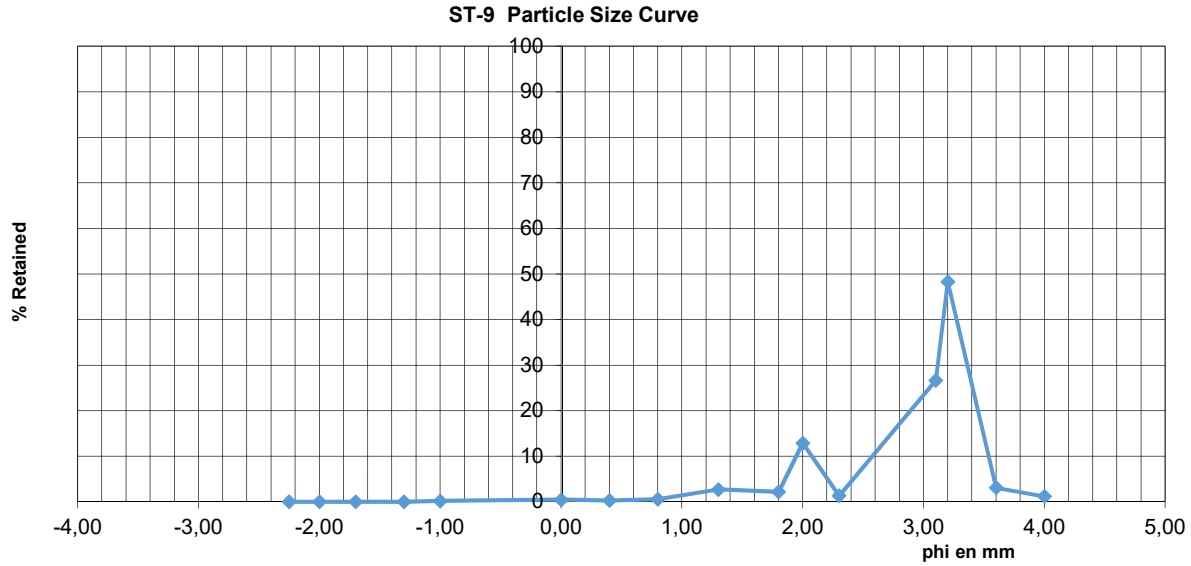

ST-4 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

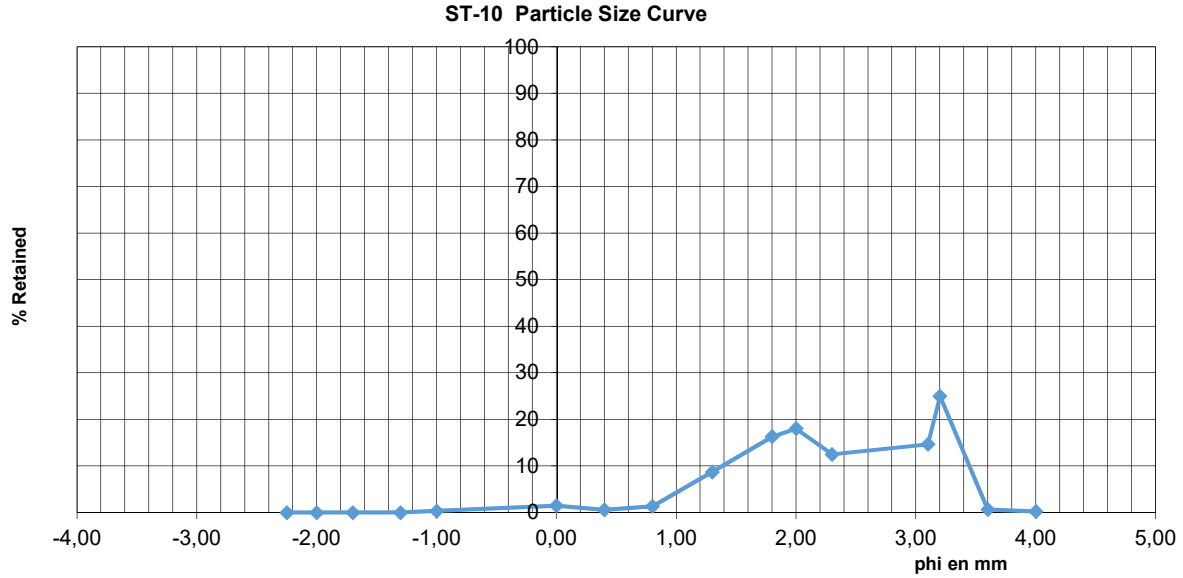

ST-5 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

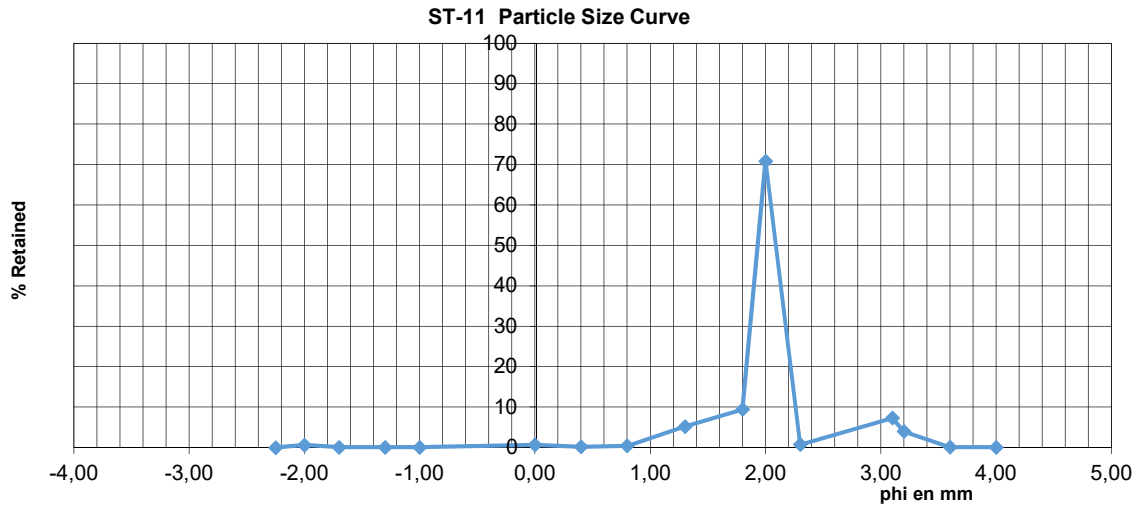

ST-6-BIS Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

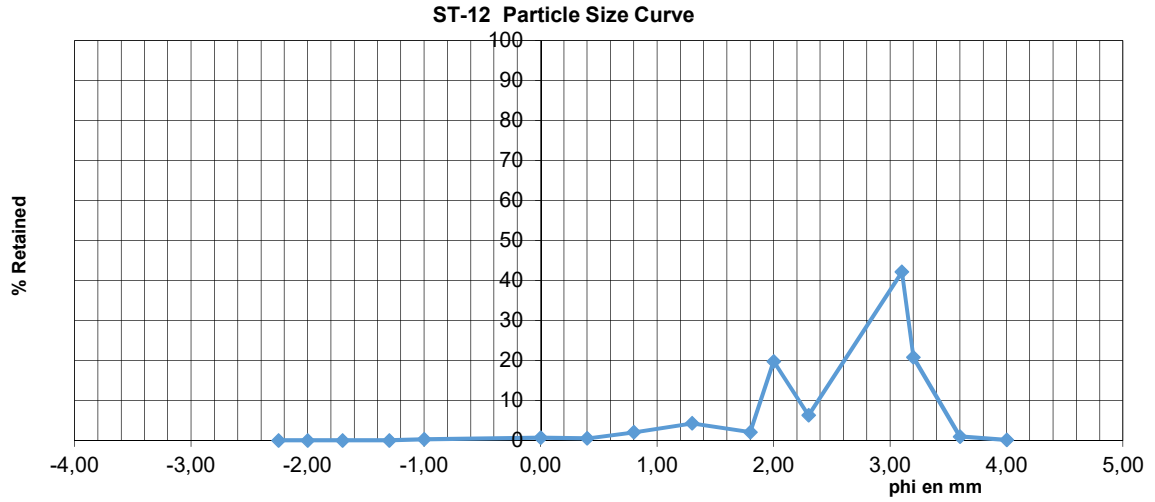

ST-7 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

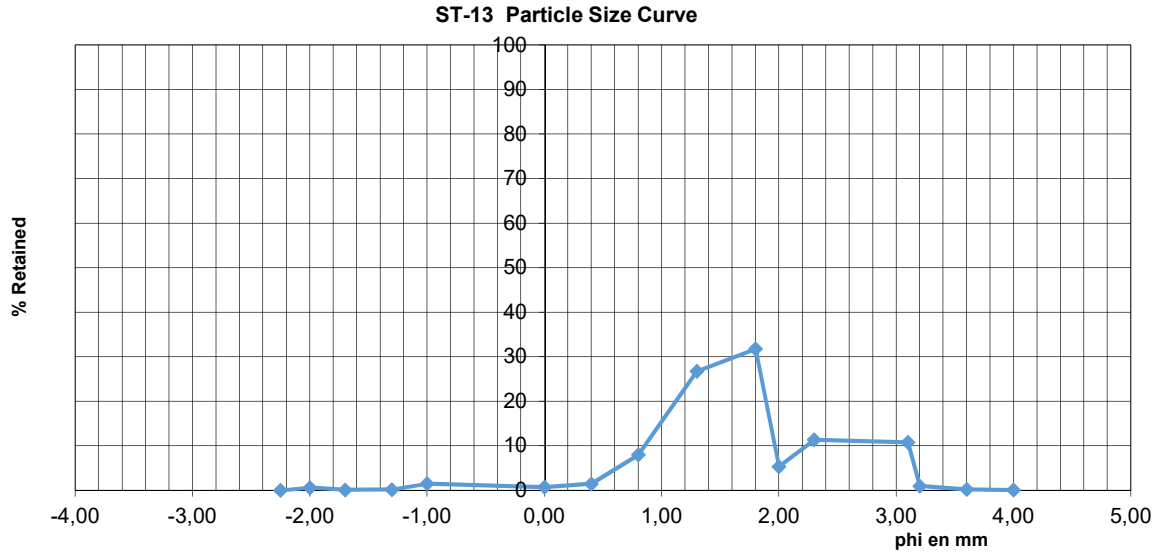

ST-8 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

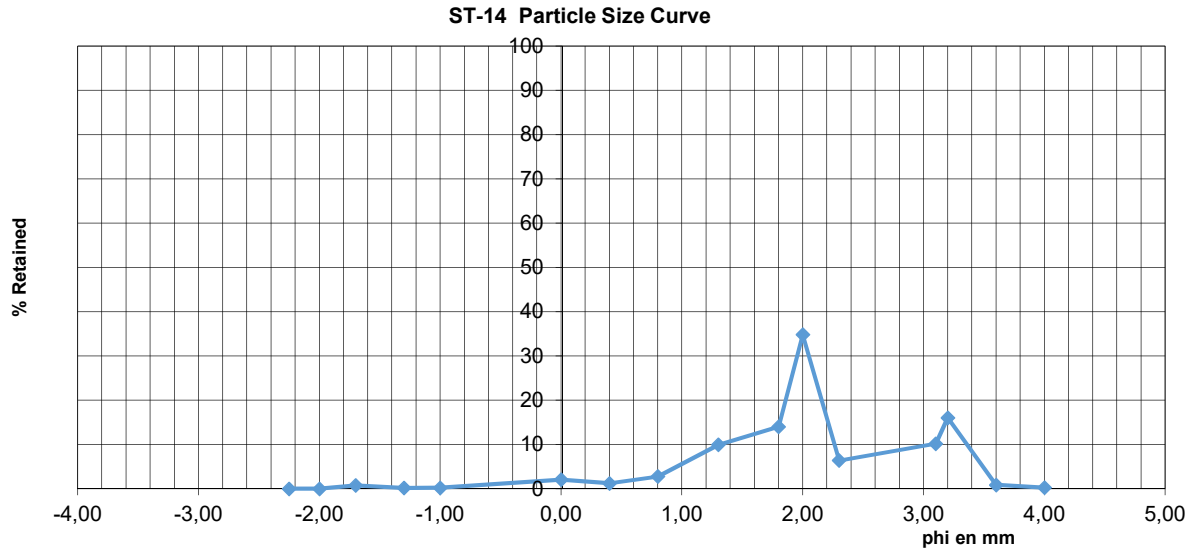

ST-9 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-10 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-11 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-12 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

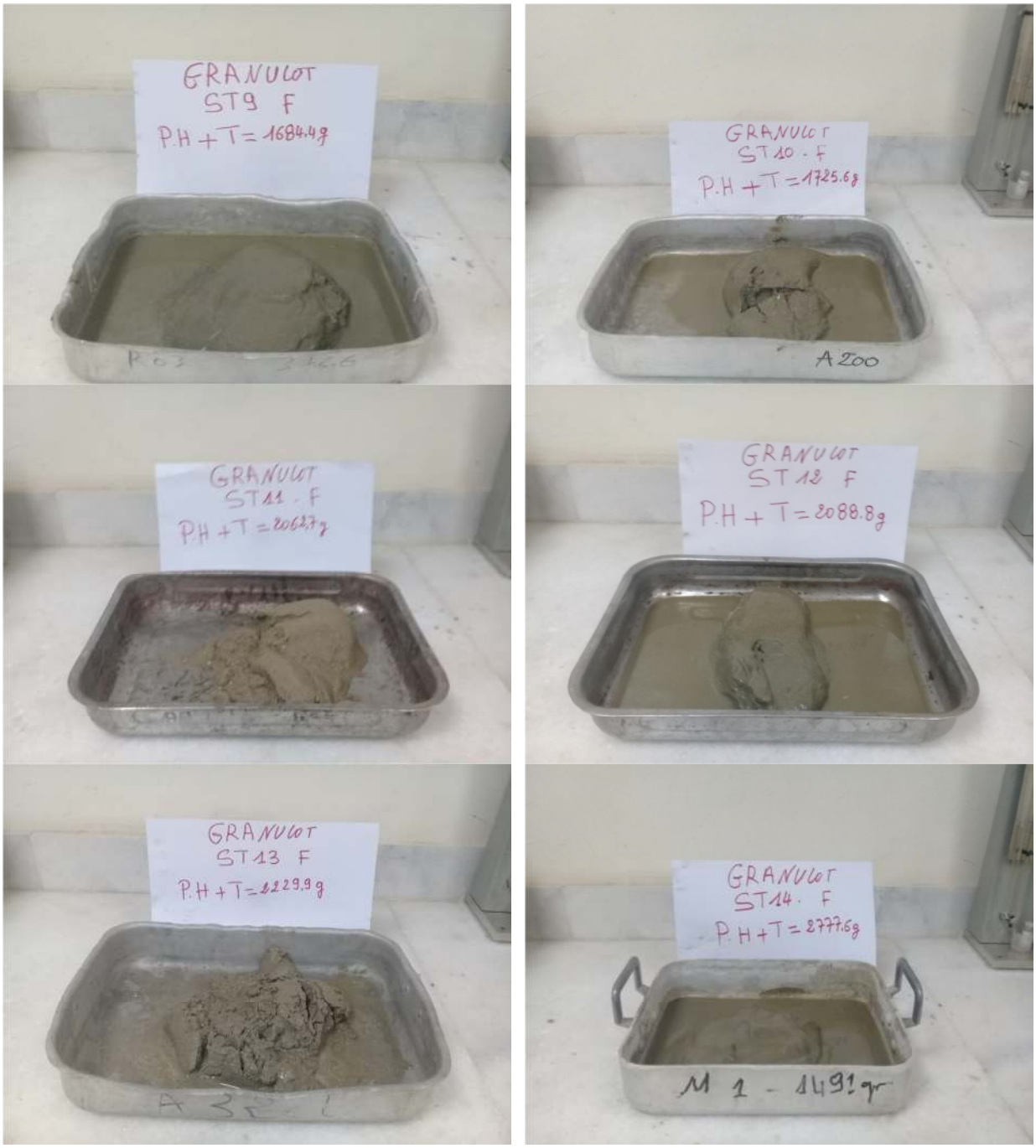

ST-13 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-14 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

D: Pictures of samples



PHOTOS OF SEDIMENT SAMPLES



PHOTOS OF SEDIMENT SAMPLES

Les activités de MAGMA sont régies par le décret du Conseil des Ministres N°0105-2015 paru au Journal Officiel n° 1337 de la République Islamique de Mauritanie en date du 15/06/2015.

Rev.	Date	Description	Prepared	Cheeked	Approved	
00	13/02/2019	Provisional Report	V.KENOU	C.BEDDI	A. KHALIFA	

OWNER		CLIENT
ARISE	magma Code : AD/PRS/04	ARISE

PROJET

NOUAKCHOTT CONTAINERS TERMINAL
MARINE SURVEY

TITRE

PARTICLE SIZE ANALYSISON SEDIMENT SAMPLES
2ND CAMPAIGN
RESULTS REPORT

AFFAIRE No.	DATE	DOCUMENT No.	REVISION	PAGE
2019/A197	13-03-2019	DC02019A197-PSA-02-01	0	11

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A: Particle Size analysis

B: Pictures of samples

1. CONTEXT

For this objective main, ARISE company has requested to the Laboratory MAGMA International the execution of survey for water quality, sediment quality and benthic fauna include the proposed entrance channel, the turning basin and berth pocket, and the potential disposal site. This report provides the results of the particle size analysis performed on the sediments samples.

2. SCOPE

According to the project specification, the particle size analysis should be carried out on 19 sediments samples, along the Nouakchott beach, especially at the locations specified by DHI.The sample location plan is given in the appendix. The list of samples with the coordinates of the locations is given in the table below:

Table 1 : Program of tests and coordinates of sampling (Coordinates system WGS84 UTM28)

Profile	Sample ID	X(m)	Y(m)	Z(m)	PSA
Profil 1	P1-1	391367.385	1993461.222	3.109	1
	P1-2	391361.513	1993461.590	2.421	1
	P1-3	391379.766	1993460.763	3.594	1
Profil 2	P2-1	390704.340	1990468.159	3.328	1
	P2-2	390696.208	1990469.386	2.522	1
Profil 3	P3-1	391374.024	1989271.869	3.770	1
	P3-2	391357.350	1989272.061	2.605	1
Profil 4	P4-1	391896.715	1988991.289	2.541	1
	P4-2	391892.444	1988985.861	1.992	1
Profil 5	P5-1	391987.232	1987680.604	2.820	1
	P5-2	391980.742	1987680.871	2.253	1
	P5-3	392034.781	1987657.926	3.131	1
Profil 6	P6-1	391920.667	1986519.705	2.979	1
	P6-2	391905.271	1986520.883	1.752	1
Profil 7	P7-1	391579.566	1985280.437	3.416	1
	P7-2	391560.037	1985284.097	1.776	1
	P7-3	391621.848	1985274.066	3.212	1
Profil 8	P8-1	391193.600	1983943.585	3.413	1
	P8-2	391187.201	1983944.739	2.748	1
	Total				19

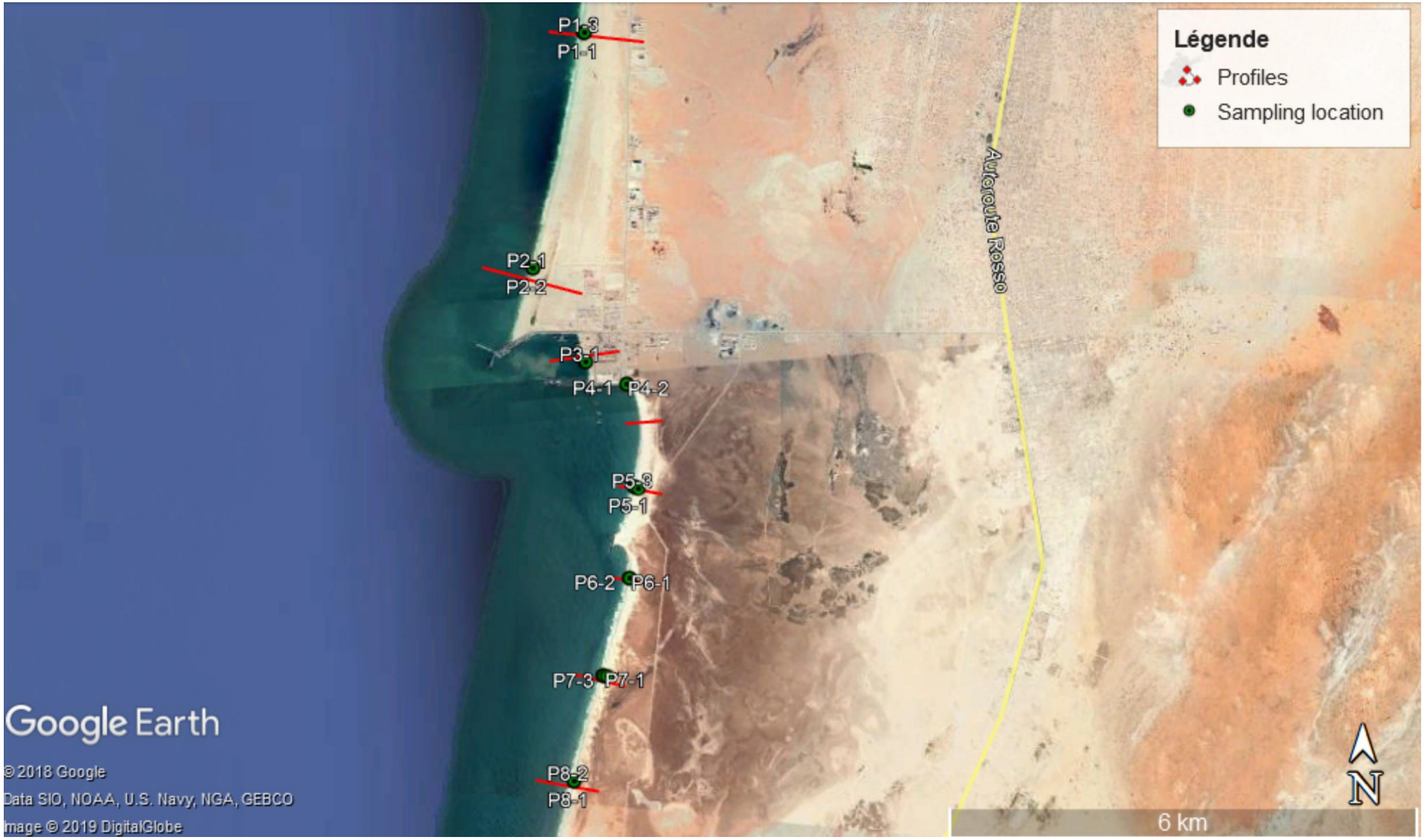


Figure 1 : Sampling location

3. TESTS PROCEDURES

According the project specifications each sample acquired from the survey will each sample must be subjected to the Particle size analysis (PSA). The sediments will be air dried and sieved over the range 64mm down to 0.063mm on the Wentworth scale. The particle size analysis is performed by the following the procedure:

- Afterwashing sample with distilled water thru a 63µm sieve; collect fine fraction in the bottom of the sieve assembly.
- Weigh a small plastic tray and label it by sample number; rinse the material retained in the 63µm sieve and put it into the plastic tray; this is the coarse fraction.
- Once the fractions are dry, obtain the dry weights of the trays.
- Than weight the empty bottom trays of the sieve assemblies.
- Shake the sieve, and collect the (<63mm) material in the bottom tray; weigh the bottom tray after sieving is completed.
- Transfer data into spreadsheet and determine relative weight of (<63mm, >63um)

4. RESULTS OF TESTS

4.1. FullParticle size

We have performed the particle size analysis on 14 sediments samples. The details of the tests with particle size curves and the samples picture are given in annexes. The summary of the resultsof the particles range between 63 mm and 0.063mm is given in the following table.

The sieve diameters are in mm and they are converted to ***phi*** using the Wentworth scale.

Table 2 : Results of full Particle size of the particles range between 63 mm and 0.063mm

P. diameter		Cumulative Retained %																		
mm	Phi	P1-1	P1-2	P1-3	P2-1	P2-2	P3-1	P3-2	P4-1	P4-2	P5-1	P5-2	P5-3	P6-1	P6-2	P7-1	P7-2	P7-3	P8-1	P8-2
37.5	-5,40																			
25	-4,70									1,8										
20	-4,40									4,1										
16	-4,00									4,3										
14.5	-3,85									4,5										
12.5	-3,50									4,6										
10	-3,20									4,8						9,2		7,6		
8	-3,00									5,3			0,3			10,7		8,1		
6.3	-2,40									5,8			0,6			13,3		8,5		
5	-2,25									6,3	1,0		1,3			14,8		8,8		
4	-2,00									6,7	1,9		3,4			16,3		9,2		
3,15	-1,70									7,0	2,1		4,8			17,2		9,3		
2	-1,00						0,1	1,2		7,7	3,3	0,2	12,0			19,3	0,5	9,4		
1	0,00				0,9		0,2	2,2	1,2	8,7	5,6	0,3	20,9	0,1		21,5	0,6	9,7		
0,8	0,40	0,14	0,2	0,4	3,3		0,3	11,6	1,3	9,3	7,3	0,4	24,4	0,3		22,1	0,7	9,9		0,7
0,63	0,80	0,5	0,5	0,9	8,9	0,2	6,9	71,1	1,6	10,3	10,0	0,6	29,3	10,3		23,0	0,7	10,2	1,1	1,2
0,4	1,30	64,3	25,2	14,4	44,9	17,4	45,4	97,1	14,0	39,3	22,9	10,0	39,8	27,3	13,6	31,1	6,7	14,4	11,6	49,4
0,32	1,80	84,9	45,0	43,6	78,8	35,1	77,3	98,4	32,6	82,6	40,9	24,7	52,1	89,2	48,3	65,0	49,4	31,9	24,6	73,8
0,25	2,00	97,6	96,1	94,9	98,7	95,4	95,7	99,1	84,6	97,5	93,6	96,6	95,9	94,0	95,8	94,6	98,3	93,2	82,6	96,0
0,2	2,30	98,4	98,2	96,1	99,0	97,1	97,2	99,5	90,4	98,9	95,2	97,5	96,7	98,6	96,7	95,6	99,0	94,7	85,7	97,1
0,16	3,10	99,6	99,4	98,9	99,6	99,7	98,8	99,6	98,0	99,6	97,9	98,9	98,5	99,7	98,4	97,5	99,5	96,8	94,9	98,6

P. diameter		Cumulative Retained %																	
mm	Phi	P1-1	P1-2	P1-3	P2-1	P2-2	P3-1	P3-2	P4-1	P4-2	P5-1	P5-2	P5-3	P6-1	P6-2	P7-1	P7-2	P7-3	P8-1	P8-2
0,1	3,20	99,9	99,8	99,8	99,8	99,8	99,7	99,8	99,5	99,8	99,8	99,7	99,8	99,8	99,7	99,7	99,8	99,4	99,4	99,8
0,08	3,60	99,9	99,9	99,9	99,9	99,9	99,9	99,9	99,8	99,9	99,9	99,9	99,9	99,9	99,9	99,9	99,9	99,8	99,8	99,9
0,063	4,000	100,0	100,0	100,0	100,0	100,0	100,0	100,0	99,9	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Mud %		1.7	1.2	1.6	2.7	1.1	1.1	18.2	2.1	1	2.4	1.5	1.2	2	1	1.1	1	2.7	14.4	25.4

4.2. Statistical parameters

These parameters inform us about the sample deposition mode and the deposition environment. The most used parameters are:

- **The mean :** The size corresponding to 50% of the grains on the cumulative curve, it's calculated by the formula:

$$M = \frac{\varphi_{16} + \varphi_{50} + \varphi_{84}}{3}$$

- **The Skewness**: is a measure of the degree of asymmetry of the grain-size distribution. Folk and Ward (1957) proposedThe measure inclusive graphic Skewness, defined as:

$$Sk = \frac{\varphi_{84} + \varphi_{16} - 2\varphi_{50}}{2(\varphi_{84} - \varphi_{16})} + \frac{\varphi_{95} + \varphi_{5} - 2\varphi_{50}}{2(\varphi_{95} - \varphi_{5})}$$

- **Sorting Coefficient:** An accumulation of sediment can also be characterized by the grain size distribution. A sediment deposit can undergo sorting when a particle size range is removed by an agency such as a river or the wind. The sorting can be quantified using the Inclusive Graphic Standard Deviation

$$So = \frac{\varphi_{84} - \varphi_{16}}{4} + \frac{\varphi_{95} - \varphi_{5}}{6,6}$$

- **Kurtosis** or peakedness of the distribution is computed by comparing the spread in the central part of the distribution to the spread in the tails.FolkndWard(1957)definegraphickurtosisas:

$$K = \frac{\varphi_{95} - \varphi_{5}}{2,44(\varphi_{75} - \varphi_{25})}$$

- **Modal size:** Is the most frequently-occurring particle diameter

The results of statistical parameters are given in the following table:

Table 3 : Statistical parameters

Sample ID	D16 phi	D50 phi	D84 phi	D95 phi	D5 phi	D75 phi	D25 phi	Mean phi	Sk	K	So	Mod phi
P1-1	0,9	1,2	1,8	1,9	0,9	1,5	1	1,300	0,367	0,820	0,377	1,30
P1-2	1,1	1,8	2	2	0,9	1,9	1,3	1,633	-0,596	0,751	0,392	2,00
P1-3	1,3	1,8	1,95	2	1	1,9	1,5	1,683	-0,569	1,025	0,314	2,00

Sample ID	D16 phi	D50 phi	D84 phi	D95 phi	D5 phi	D75 phi	D25 phi	Mean phi	Sk	K	So	Mod phi
P2-1	0,9	1,4	1,9	2	0,6	1,8	1	1,400	-0,071	0,717	0,462	1,30
P2-2	0,9	1,8	1,95	2,00	1,00	1,90	1,50	1,550	-0,657	1,025	0,414	2,00
P3-1	0,9	1,4	1,9	2	0,8	1,7	1	1,400	0,000	0,703	0,432	1,30
P3-2	0,4	0,65	1	1,3	0,2	0,9	0,5	0,683	0,174	1,127	0,317	0,80
P4-1	0,8	1,4	1,8	2,2	0,5	1,7	1,1	1,333	-0,129	1,161	0,508	1,80
P4-2	0,9	1,4	1,85	2	-2,4	1,7	1,1	1,383	-0,390	3,005	0,904	1,80
P5-1	1	1,8	2	2,4	2	1,9	1,4	1,600	0,700	0,328	0,311	2,00
P5-2	1,5	1,85	1,95	2	1	1,95	1,8	1,767	-0,628	2,732	0,264	2,00
P5-3	-0,8	1,8	1,9	2	-1,9	1,9	0,4	0,967	-0,912	1,066	1,266	2,00
P6-1	0,9	1,5	1,7	2,1	0,6	1,7	1,2	1,367	-0,350	1,230	0,427	1,80
P6-2	1,3	1,8	1,9	2	1	1,9	1,5	1,667	-0,633	1,025	0,302	2,00
P7-1	-2,2	1,6	1,9	2	-3,4	1,9	1	0,433	-0,853	2,459	1,843	1,88
P7-2	1,4	1,8	1,9	1,95	1,2	1,9	1,5	1,700	-0,600	0,768	0,239	2,00
P7-3	1,3	1,8	1,95	2,3	-3,5	1,9	1,6	1,683	-0,683	7,923	1,041	2,00
P8-1	1,4	1,9	2	3	1	2	1,8	1,767	-0,283	4,098	0,453	2,00
P8-2	0,9	1,3	1,9	2	0,85	1,8	1,1	1,367	0,209	0,673	0,424	1,30

5. CONCLUSION

The results of the Particle size analysis show that the sediments consist of a dominant sandy texture with shell trace in some locations (grain diameter between 2 and 0.063mm). This sand is generally fine, with a lowmud fraction (diameter, less than 0.063mm) generally less than 5%accepting the sample, AP3.2 AP8.1 and AP8.2 has a mud fraction varying between 14 and 25% (mud: silt and clay, diameter less than 0.063mm).The statistical parameters calculated form the particles size curves of the particles range between 63mm and 0.063mm (transformed on phi unity) give the following resultants:

- **The mean(M),** varies between, 0.43phi and 1,76 phi
- **The Skewness(sk),** varies between, -0,85 and 0.70
- **Sorting coefficient(SO),**varies between, 0.2and 1
- **Modal size(Mod),** varies between, 2 and 3 phi
- **Kurtosis(k),** varies between, 0.2 and 2 phi

ANNEXES

: Particle Size analysis

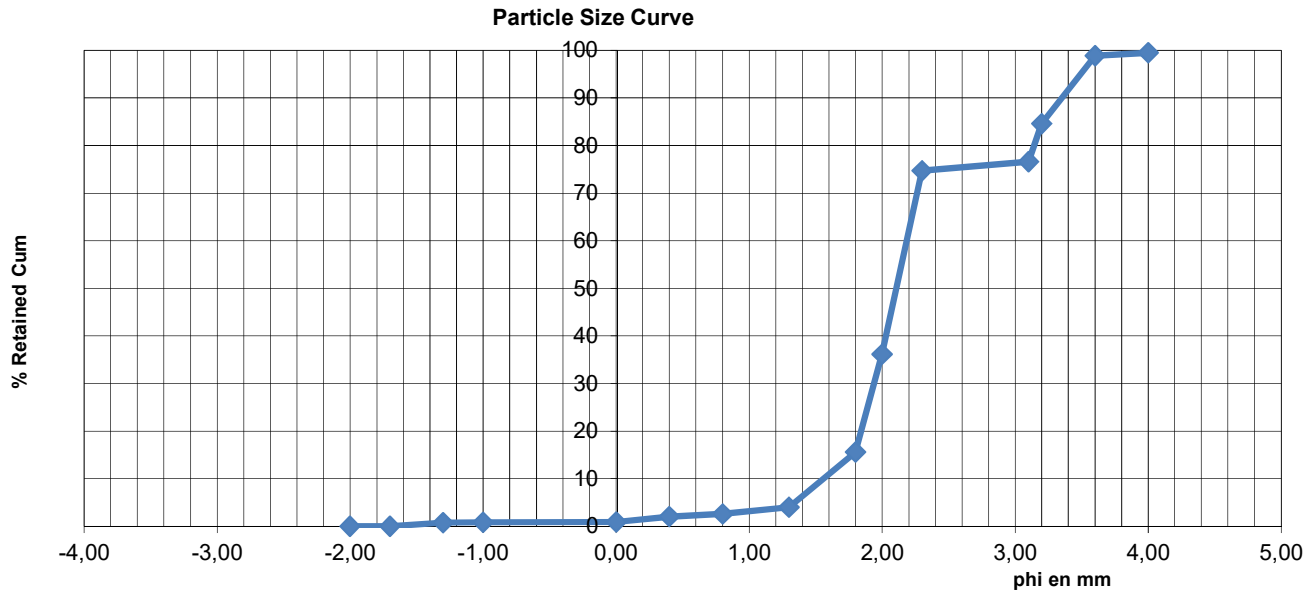
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-01-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1238,33 (g)**

% FINER IN SIEVE 0,063 mm **3.64**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1238,33 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	8,70	0,73	0,73	**99,27**
-1,30	1,00	0,08	0,81	**99,19**
-1,00	1,00	0,08	0,90	**99,10**
0,00	13,30	1,11	2,01	**97,99**
0,40	7,00	0,59	2,60	**97,40**
0,80	16,50	1,38	3,98	**96,02**
1,30	143,40	11,58	15,56	**84,44**
1,80	245,30	20,56	36,12	**63,88**
2,00	460,80	38,62	74,73	**25,27**
2,30	22,00	1,84	76,58	**23,42**
3,10	95,90	8,04	84,61	**15,39**
3,20	169,60	14,21	98,83	**1,17**
3,60	7,80	0,70	99,52	**0,48**
4,000	1,00	0,55	100	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	

OBSERVATIONS:

	Project: NOUAKCHOTT CONTAINERS TERMINAL **Client: ARISE**	**N.º Sample: ST-03-F** **Material Nature :**
TEST DATE ***31/01/2019***	**PRARTICLES SIZE ANALYSIS** **EN 933-1**	Code : FO/PRS/10 **Provenance:** **NKC-PORT**

TOTAL WEIGHT

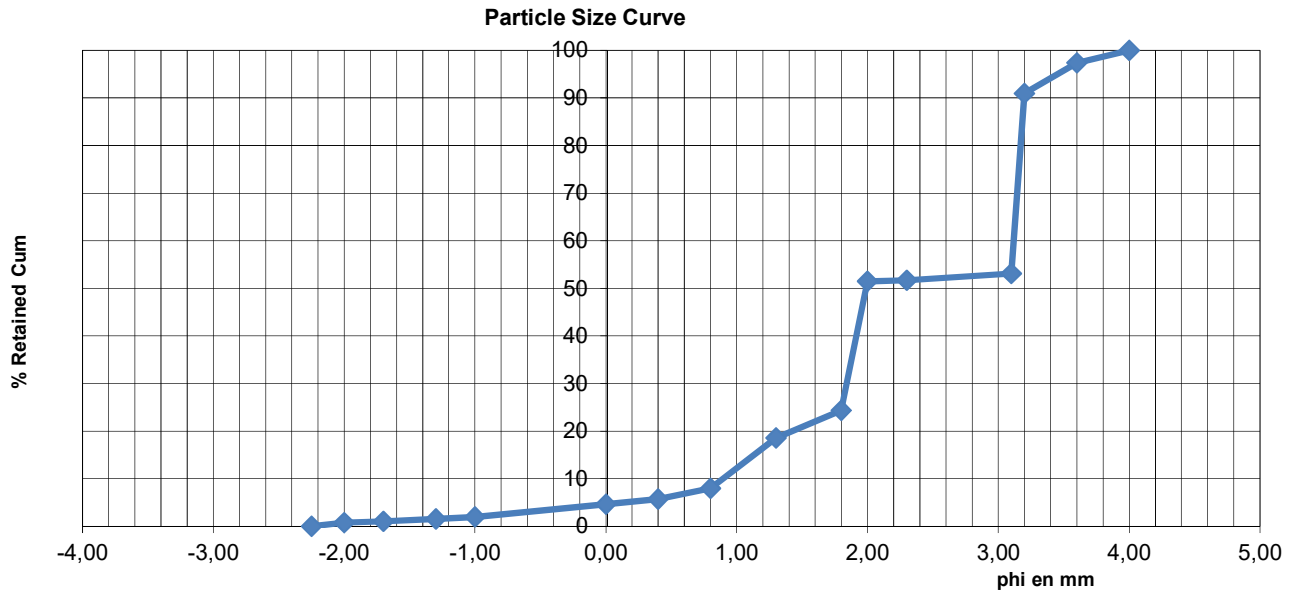
OF DRYED SAMPLE

1014,20 (g)

% FINER IN SIEVE
0,063 mm
37.70

TOTAL WEIGH IN SIEVE
63 mm-0,063 mm
1014,20 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	4,80	0,76	0,76	**99,24**
-1,70	1,60	0,25	1,01	**98,99**
-1,30	3,10	0,49	1,50	**98,50**
-1,00	2,80	0,44	1,95	**98,05**
0,00	17,20	2,72	4,67	**95,33**
0,40	6,70	1,06	5,73	**94,27**
0,80	13,90	2,20	7,93	**92,07**
1,30	67,10	10,62	18,55	**81,45**
1,80	36,80	5,82	24,37	**75,63**
2,00	171,10	27,08	51,46	**48,54**
2,30	1,50	0,24	51,69	**48,31**
3,10	8,70	1,38	53,07	**46,93**
3,20	239,30	37,88	90,95	**9,05**
3,60	40,70	6,44	97,39	**2,61**
4,000	16,50	2,61	100,00	**0,00**



SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-04-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT

OF DRYED SAMPLE

677,40 (g)

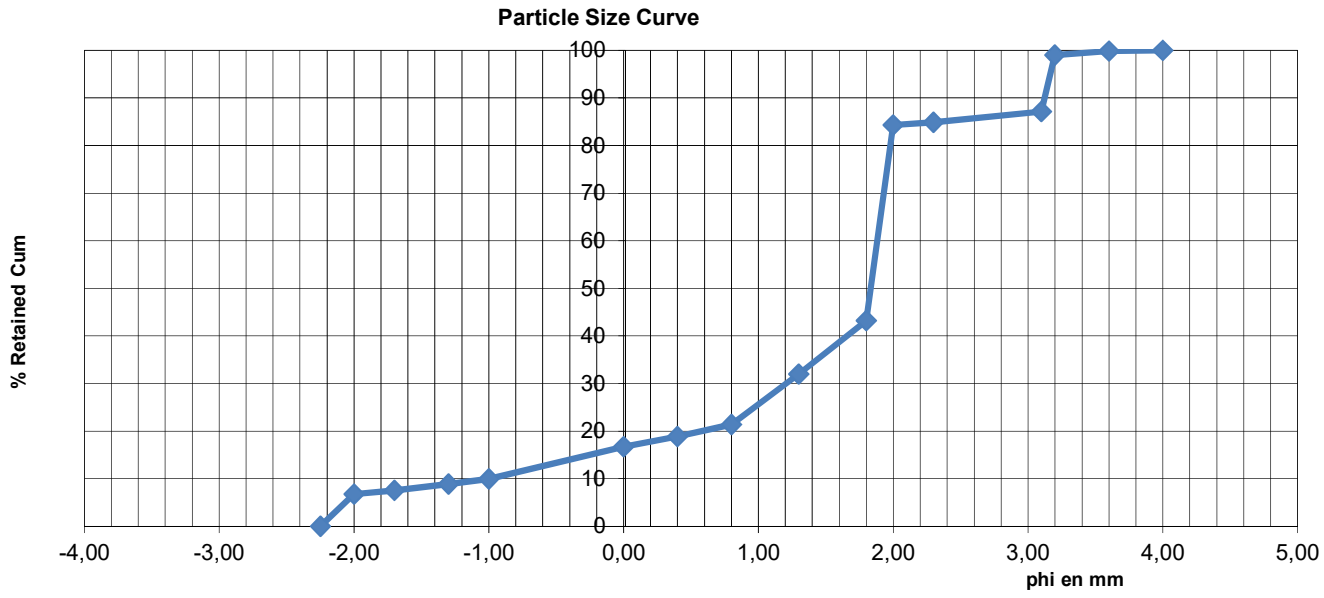
% FINER IN SIEVE 0,063 mm

8.44

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm

677,40 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	41,80	6,74	6,74	**93,26**
-1,70	5,00	0,81	7,55	**92,45**
-1,30	8,20	1,32	8,87	**91,13**
-1,00	6,80	1,10	9,96	**90,04**
0,00	41,90	6,76	16,72	**83,28**
0,40	13,00	2,10	18,82	**81,18**
0,80	15,90	2,56	21,38	**78,62**
1,30	65,70	10,59	31,97	**68,03**
1,80	69,70	11,24	43,21	**56,79**
2,00	255,10	41,13	84,34	**15,66**
2,30	3,50	0,56	84,91	**15,09**
3,10	14,00	2,26	87,17	**12,83**
3,20	73,50	11,85	99,02	**0,98**
3,60	5,10	0,82	99,84	**0,16**
4,000	1,00	0,16	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-05-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

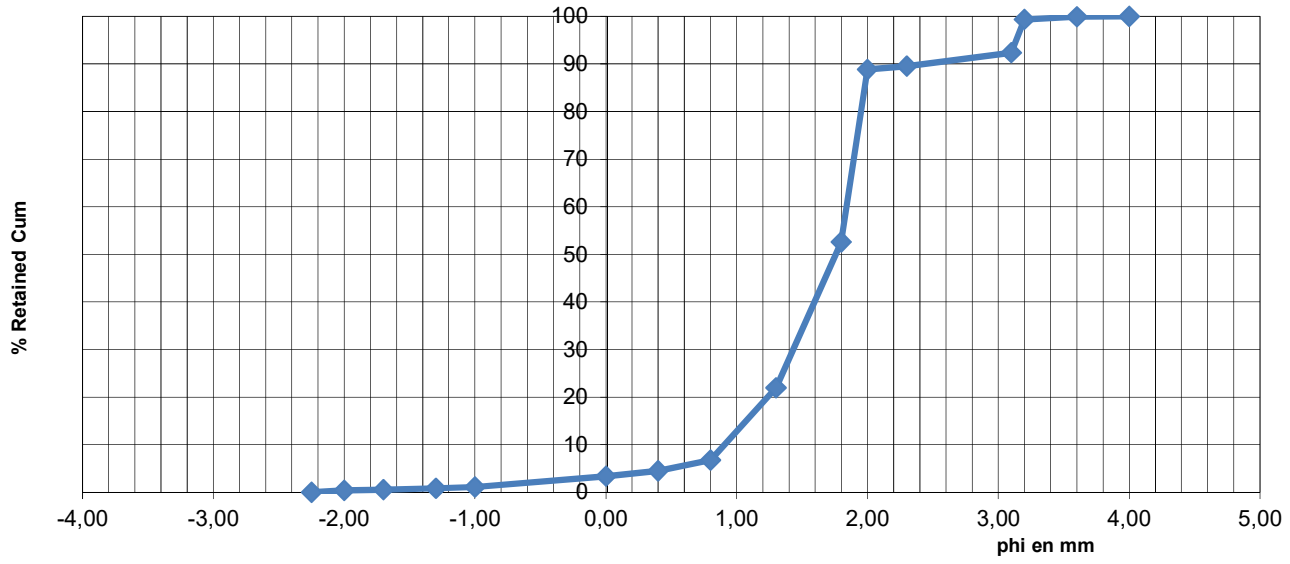
TOTAL WEIGHT OF DRYED SAMPLE
1183,90 (g)

% FINER IN SIEVE 0,063 mm
4.95

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm
1183,90 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	4,50	0,40	0,40	**99,60**
-1,70	1,60	0,14	0,54	**99,46**
-1,30	3,20	0,28	0,83	**99,17**
-1,00	2,90	0,26	1,08	**98,92**
0,00	25,60	2,27	3,36	**96,64**
0,40	12,50	1,11	4,47	**95,53**
0,80	25,90	2,30	6,77	**93,23**
1,30	170,70	15,17	21,94	**78,06**
1,80	344,60	30,62	52,56	**47,44**
2,00	408,20	36,27	88,84	**11,16**
2,30	8,20	0,73	89,57	**10,43**
3,10	31,80	2,83	92,39	**7,61**
3,20	78,60	6,98	99,38	**0,62**
3,60	6,00	0,53	99,91	**0,09**
4,000	1,00	0,09	100,00	**0,00**

Particle Size Curve



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

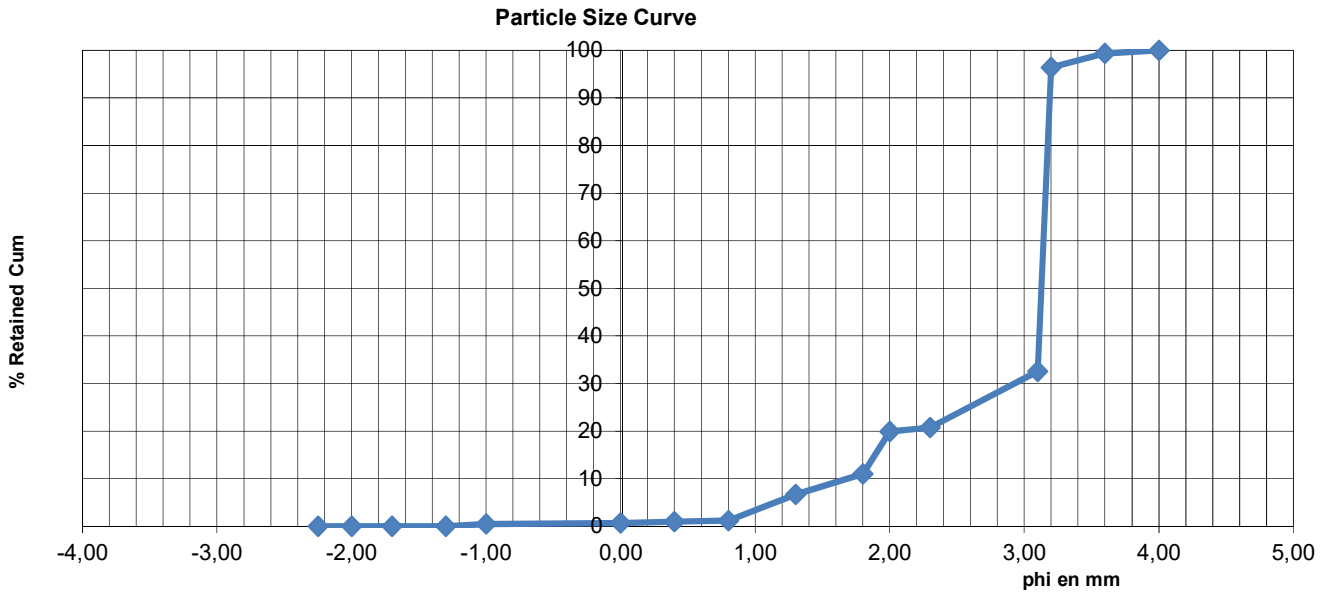
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-06-BIS-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **804,40 (g)**

% FINER IN SIEVE 0,063 mm **44.19**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **804,40 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	2,00	0,45	0,45	**99,55**
0,00	1,20	0,27	0,71	**99,29**
0,40	1,00	0,22	0,94	**99,06**
0,80	1,10	0,25	1,18	**98,82**
1,30	24,80	5,52	6,71	**93,29**
1,80	19,30	4,30	11,00	**89,00**
2,00	39,80	8,87	19,87	**80,13**
2,30	4,00	0,89	20,76	**79,24**
3,10	52,80	11,76	32,52	**67,48**
3,20	286,60	63,84	96,37	**3,63**
3,60	13,40	2,99	99,35	**0,65**
4,000	2,90	0,65	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-07-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

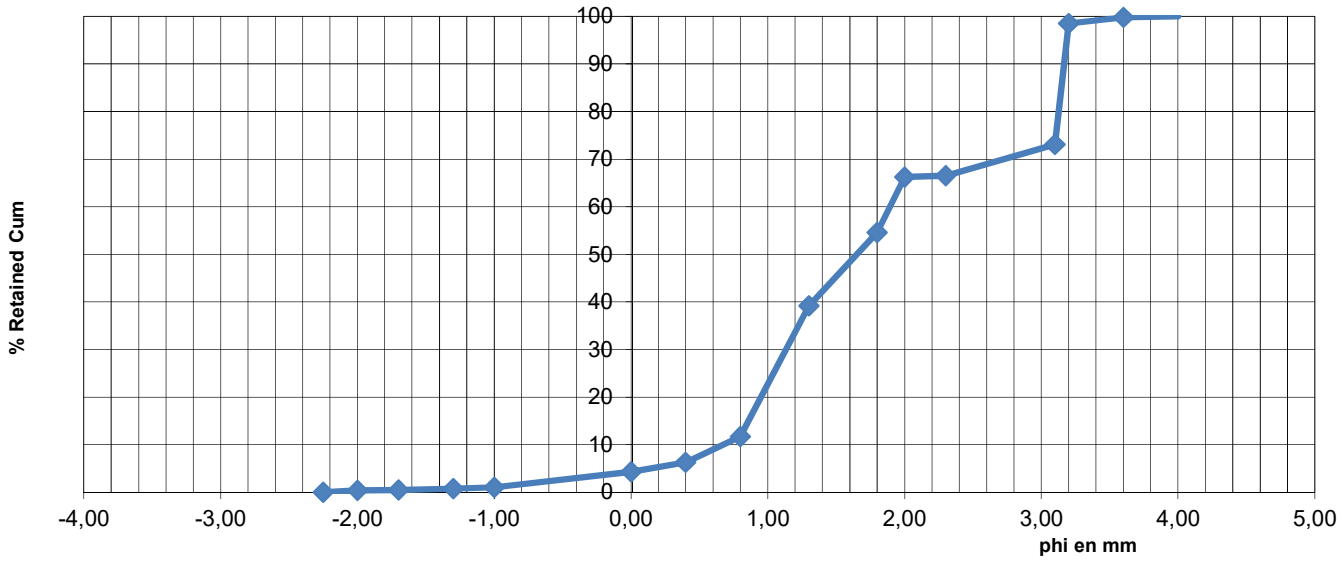
TOTAL WEIGHT OF DRYED SAMPLE
938,50 (g)

% FINER IN SIEVE 0,063 mm
11.32

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm
938,50 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	3,20	0,38	0,38	**99,62**
-1,70	1,00	0,12	0,50	**99,50**
-1,30	2,10	0,25	0,76	**99,24**
-1,00	2,40	0,29	1,05	**98,95**
0,00	27,00	3,24	4,29	**95,71**
0,40	16,20	1,95	6,24	**93,76**
0,80	45,80	5,50	11,74	**88,26**
1,30	228,60	27,47	39,21	**60,79**
1,80	127,90	15,37	54,58	**45,42**
2,00	97,00	11,66	66,23	**33,77**
2,30	2,60	0,31	66,55	**33,45**
3,10	54,10	6,50	73,05	**26,95**
3,20	212,13	25,49	98,54	**1,46**
3,60	10,60	1,27	99,81	**0,19**
4,000	1,60	0,19	100,00	**0,00**

Particle Size Curve



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

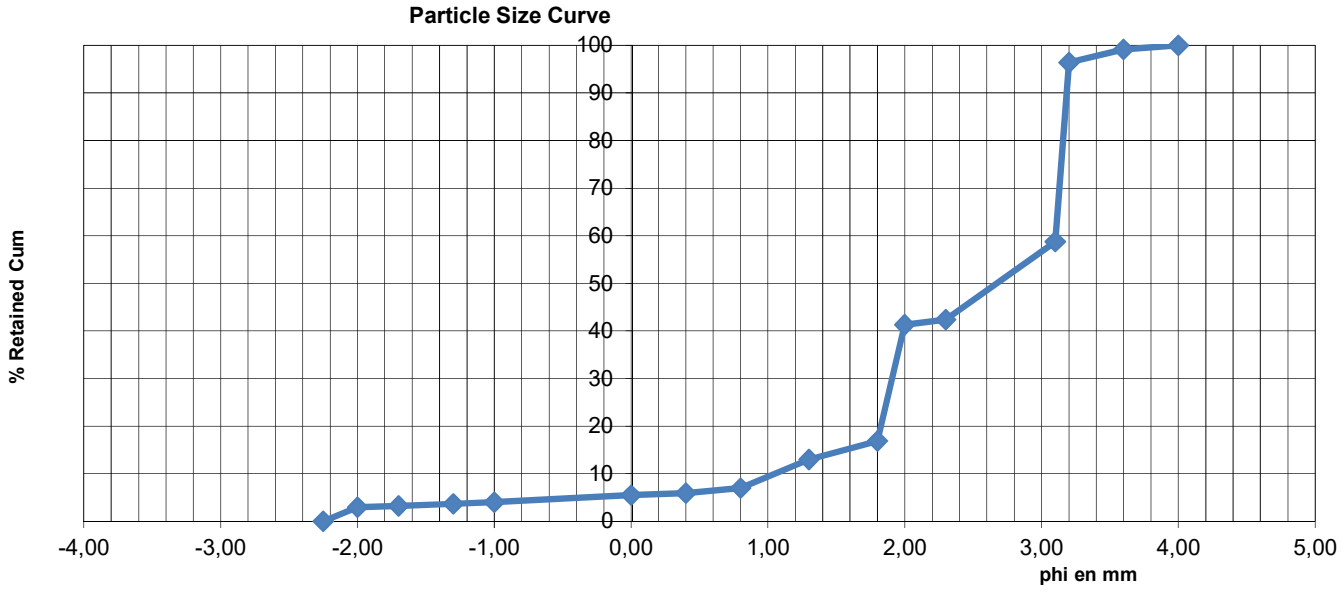
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-08-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE
768,00 (g)

% FINER IN SIEVE 0,063 mm
22.93

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm
768,00 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	17,40	2,94	2,94	**97,06**
-1,70	1,70	0,29	3,23	**96,77**
-1,30	2,40	0,41	3,63	**96,37**
-1,00	2,10	0,35	3,99	**96,01**
0,00	8,90	1,50	5,49	**94,51**
0,40	2,70	0,46	5,95	**94,05**
0,80	5,90	1,00	6,94	**93,06**
1,30	35,50	6,00	12,94	**87,06**
1,80	23,30	3,94	16,88	**83,12**
2,00	144,60	24,43	41,31	**58,69**
2,30	6,30	1,06	42,37	**57,63**
3,10	96,80	16,35	58,73	**41,27**
3,20	222,90	37,66	96,38	**3,62**
3,60	16,30	2,75	99,14	**0,86**
4,000	5,10	0,86	100,00	**0,00**



SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-09-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT

OF DRYED SAMPLE

947,00 (g)

% FINER IN SIEVE 0,063 mm

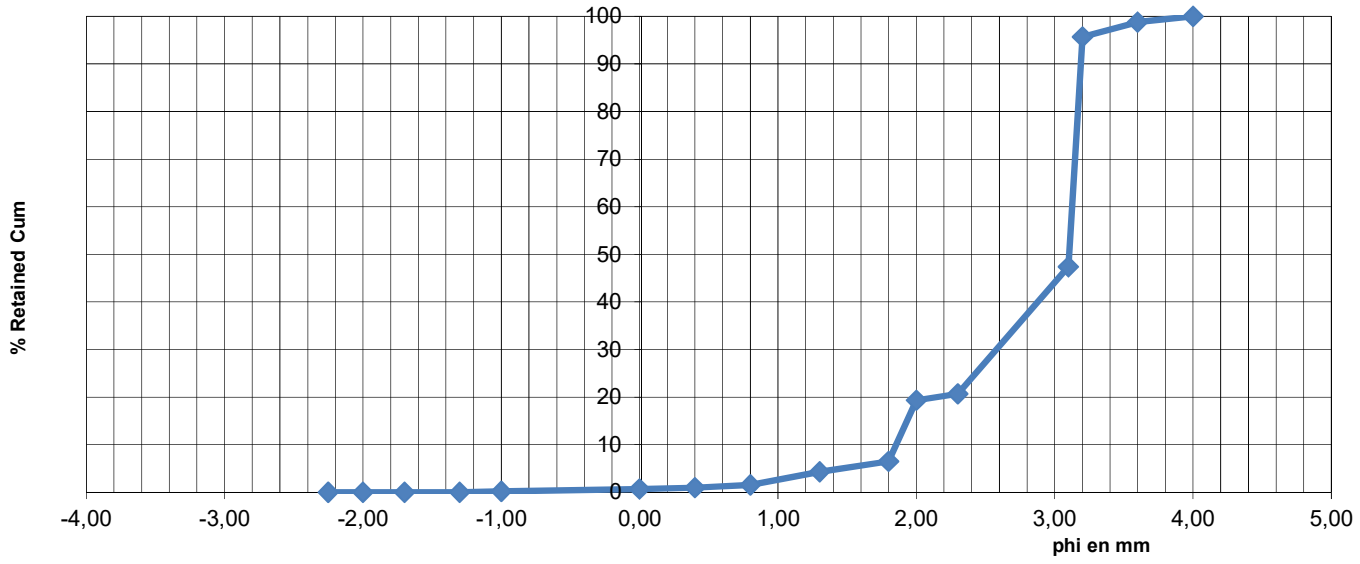
34.08

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm

947,00 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	1,10	0,18	0,18	**99,82**
0,00	3,00	0,48	0,66	**99,34**
0,40	1,90	0,30	0,96	**99,04**
0,80	3,70	0,59	1,55	**98,45**
1,30	16,90	2,71	4,26	**95,74**
1,80	13,70	2,19	6,46	**93,54**
2,00	80,50	12,89	19,35	**80,65**
2,30	8,40	1,35	20,70	**79,30**
3,10	166,60	26,69	47,38	**52,62**
3,20	301,70	48,33	95,71	**4,29**
3,60	19,30	3,09	98,80	**1,20**
4,000	7,50	1,20	100,00	**0,00**

Particle Size Curve



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

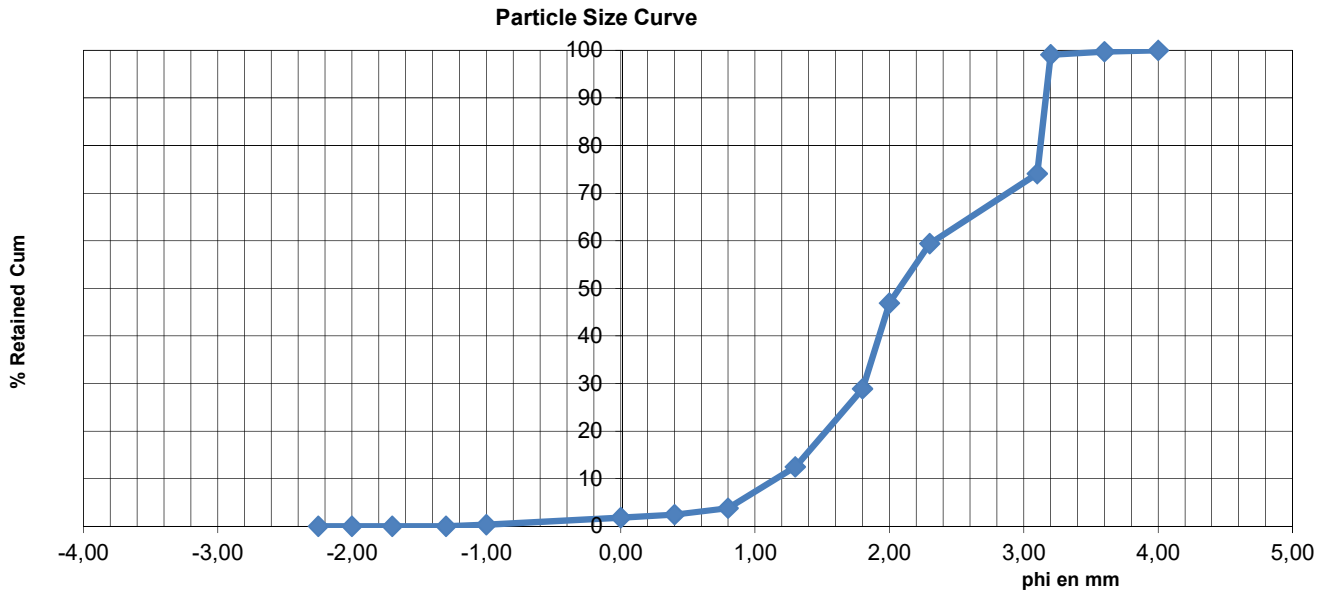
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-10-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1235,30 (g)**

% FINER IN SIEVE 0,063 mm **22.38**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1235,30 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	3,30	0,34	0,34	**99,66**
0,00	14,20	1,48	1,83	**98,17**
0,40	5,80	0,60	2,43	**97,57**
0,80	12,80	1,34	3,77	**96,23**
1,30	83,90	8,75	12,52	**87,48**
1,80	156,60	16,33	28,85	**71,15**
2,00	173,00	18,04	46,89	**53,11**
2,30	120,00	12,52	59,41	**40,59**
3,10	140,70	14,67	74,08	**25,92**
3,20	239,70	25,00	99,08	**0,92**
3,60	6,30	0,66	99,74	**0,26**
4,000	2,50	0,26	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

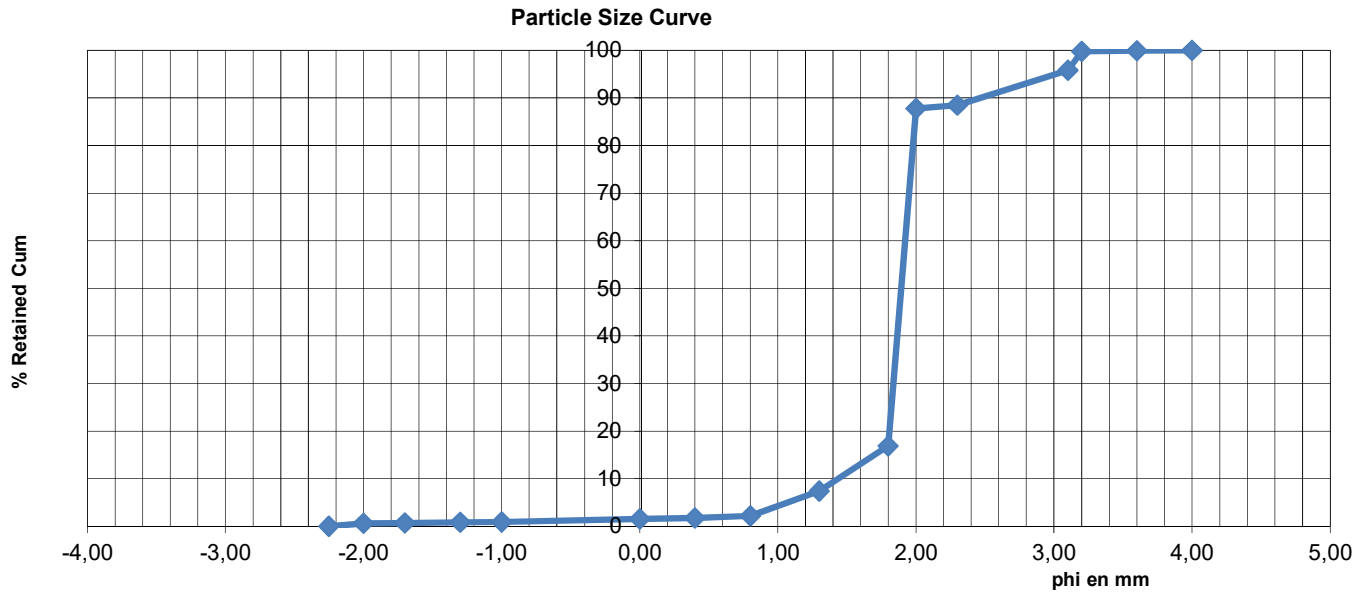
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL Client: ARISE	N.º Sample: ST-11-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1257,90 (g)**

% FINER IN SIEVE 0,063 mm 7.70

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1257,90 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	7,30	0,63	0,63	**99,37**
-1,70	1,00	0,09	0,71	**99,29**
-1,30	1,00	0,09	0,80	**99,20**
-1,00	1,00	0,09	0,89	**99,11**
0,00	7,90	0,68	1,57	**98,43**
0,40	2,30	0,20	1,77	**98,23**
0,80	4,90	0,42	2,19	**97,81**
1,30	60,80	5,24	7,42	**92,58**
1,80	109,80	9,46	16,88	**83,12**
2,00	823,00	70,88	87,76	**12,24**
2,30	8,60	0,74	88,50	**11,50**
3,10	84,90	7,31	95,81	**4,19**
3,20	46,30	3,99	99,80	**0,20**
3,60	1,30	0,11	99,91	**0,09**
4,000	1,00	0,09	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL ARISE — Client:	N.º Sample: ST-12-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT

OF DRYED SAMPLE

1185,40 (g)

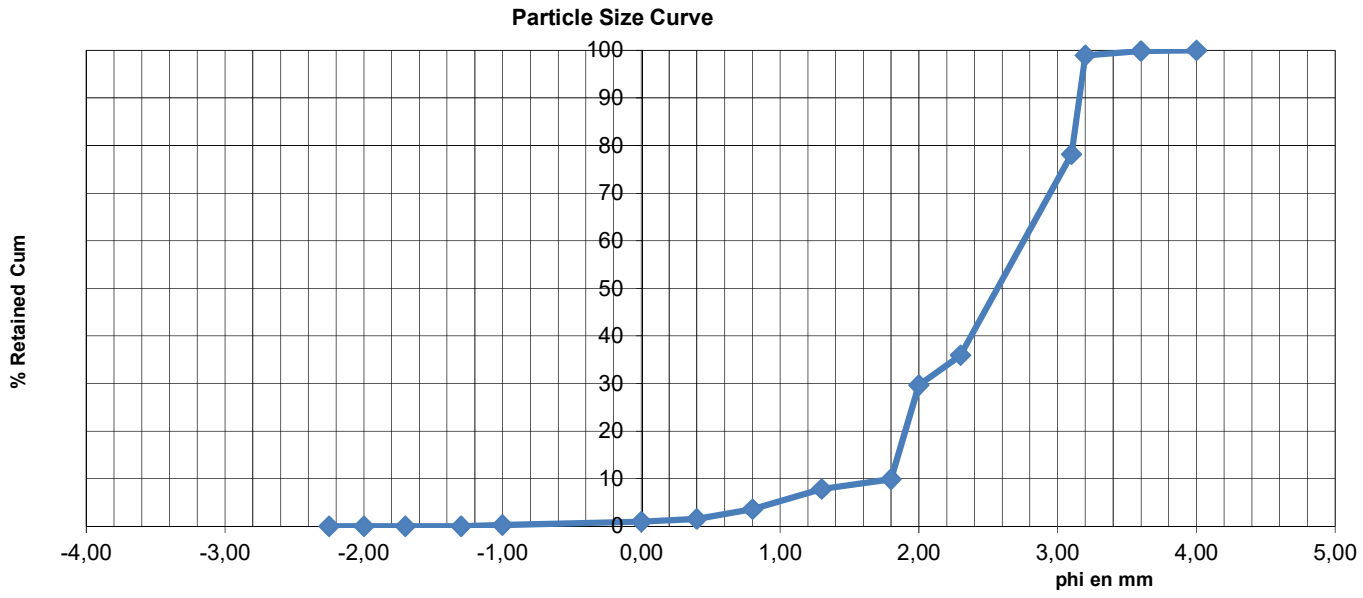
% FINER IN SIEVE 0,063 mm

29.21

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm

1185,40 (g)

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	0,00	0,00	0,00	**100,00**
-1,30	0,00	0,00	0,00	**100,00**
-1,00	2,50	0,30	0,30	**99,70**
0,00	5,70	0,68	0,98	**99,02**
0,40	4,40	0,52	1,50	**98,50**
0,80	17,20	2,05	3,55	**96,45**
1,30	35,80	4,27	7,82	**92,18**
1,80	17,30	2,06	9,88	**90,12**
2,00	166,00	19,78	29,66	**70,34**
2,30	52,90	6,30	35,96	**64,04**
3,10	353,90	42,17	78,13	**21,87**
3,20	174,30	20,77	98,90	**1,10**
3,60	8,20	0,98	99,88	**0,12**
4,000	1,00	0,12	100,00	**0,00**



SILT	SAND		GRAVEL		
	FINE	MEDIUM	COARSE	FINE	COARSE

OBSERVATIONS:

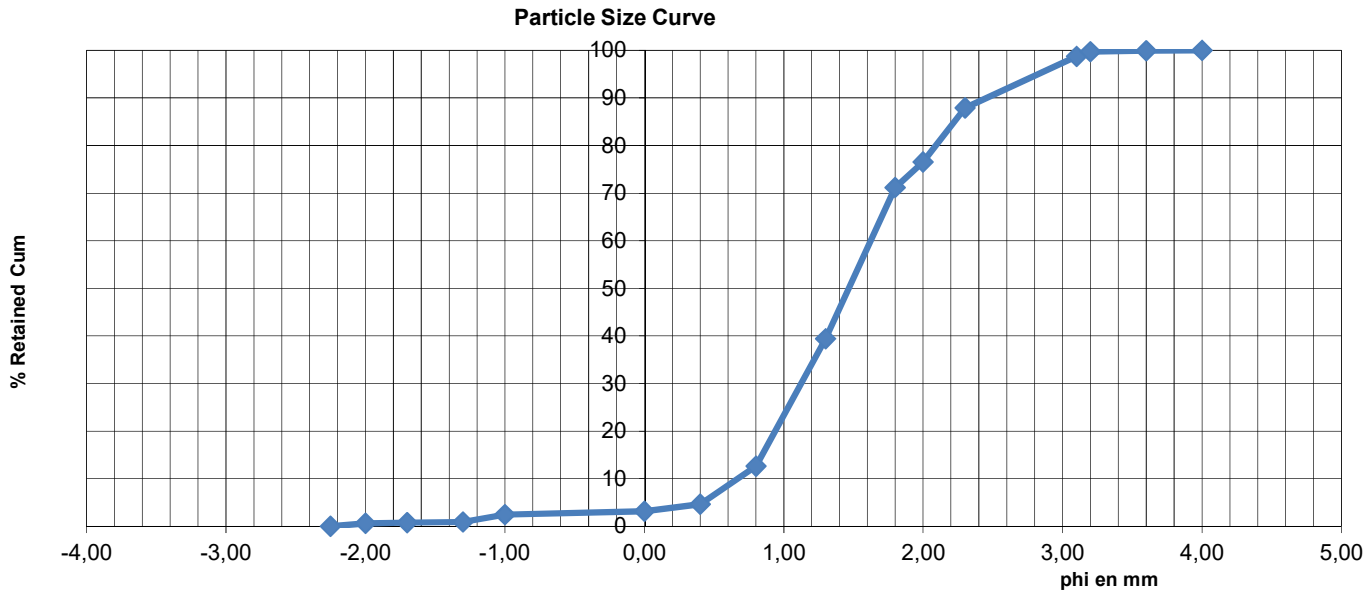
magma	Project: NOUAKCHOTT CONTAINERS TERMINAL ARISE Client:	N.º Sample: ST-13-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

TOTAL WEIGHT OF DRYED SAMPLE **1415,60 (g)**

% FINER IN SIEVE 0,063 mm 16.27

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **1415,60 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	7,40	0,62	0,62	**99,38**
-1,70	1,30	0,11	0,73	**99,27**
-1,30	2,20	0,19	0,92	**99,08**
-1,00	18,20	1,54	2,46	**97,54**
0,00	8,70	0,73	3,19	**96,81**
0,40	17,50	1,48	4,67	**95,33**
0,80	94,50	7,97	12,64	**87,36**
1,30	317,00	26,74	39,38	**60,62**
1,80	376,70	31,78	71,16	**28,84**
2,00	63,40	5,35	76,51	**23,49**
2,30	134,90	11,38	87,89	**12,11**
3,10	128,10	10,81	98,70	**1,30**
3,20	11,80	1,00	99,70	**0,30**
3,60	2,60	0,22	99,92	**0,08**
4,000	1,00	0,08	100,00	**0,00**



SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND		GRAVEL		

OBSERVATIONS:

magma	Project: NOUAKCHOTT CONTAINERS TERMINAL ARISE Client:	N.º Sample: ST-14-F Material Nature :
TEST DATE *31/01/2019*	**PRARTICLES SIZE ANALYSIS** EN 933-1	Code : FO/PRS/10 Provenance: NKC-PORT

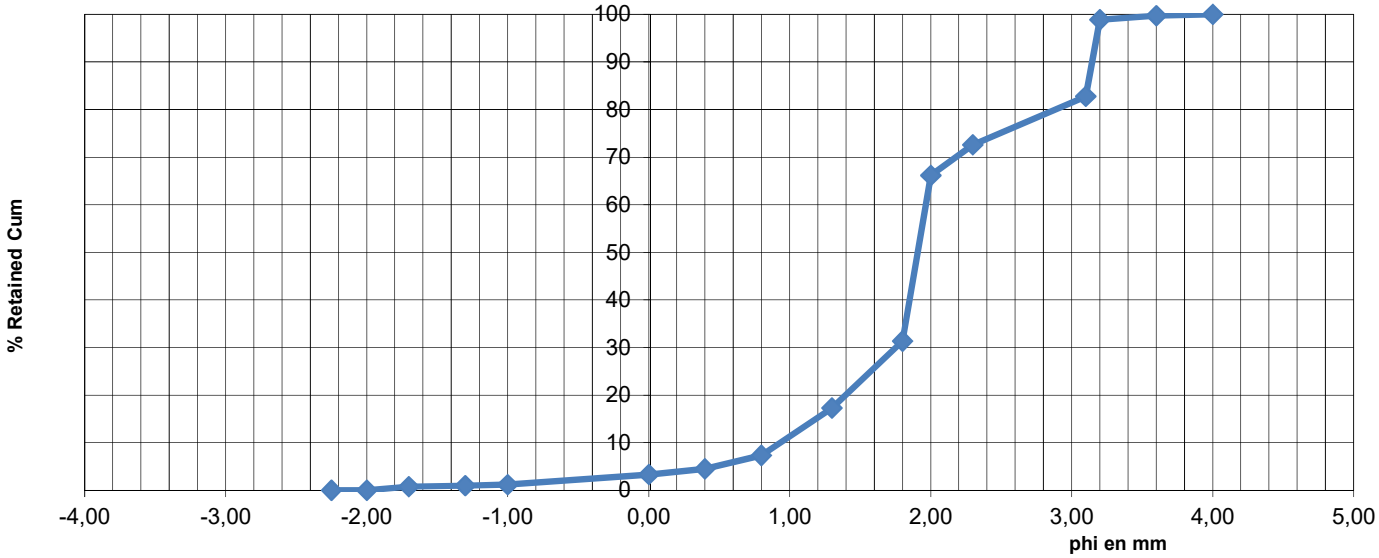
TOTAL WEIGHT OF DRYED SAMPLE **962,80 (g)**

% FINER IN SIEVE 0,063 mm **30.81**

TOTAL WEIGH IN SIEVE 63 mm-0,063 mm **962,80 (g)**

SIEVE phi	WEIGHT REFUS (g)	RETAINED (%)	RETAINED CUMULATED (%)	FINER CUMULATED (%)
-2,25	0,00	0,00	0,00	**100,00**
-2,00	0,00	0,00	0,00	**100,00**
-1,70	5,20	0,78	0,78	**99,22**
-1,30	1,30	0,20	0,98	**99,02**
-1,00	1,60	0,24	1,22	**98,78**
0,00	13,80	2,07	3,29	**96,71**
0,40	8,20	1,23	4,52	**95,48**
0,80	18,70	2,81	7,33	**92,67**
1,30	66,40	9,97	17,29	**82,71**
1,80	93,50	14,03	31,33	**68,67**
2,00	232,10	34,84	66,17	**33,83**
2,30	42,60	6,39	72,56	**27,44**
3,10	68,10	10,22	82,78	**17,22**
3,20	107,10	16,08	98,86	**1,14**
3,60	5,80	0,87	99,73	**0,27**
4,000	1,80	0,27	100,00	**0,00**

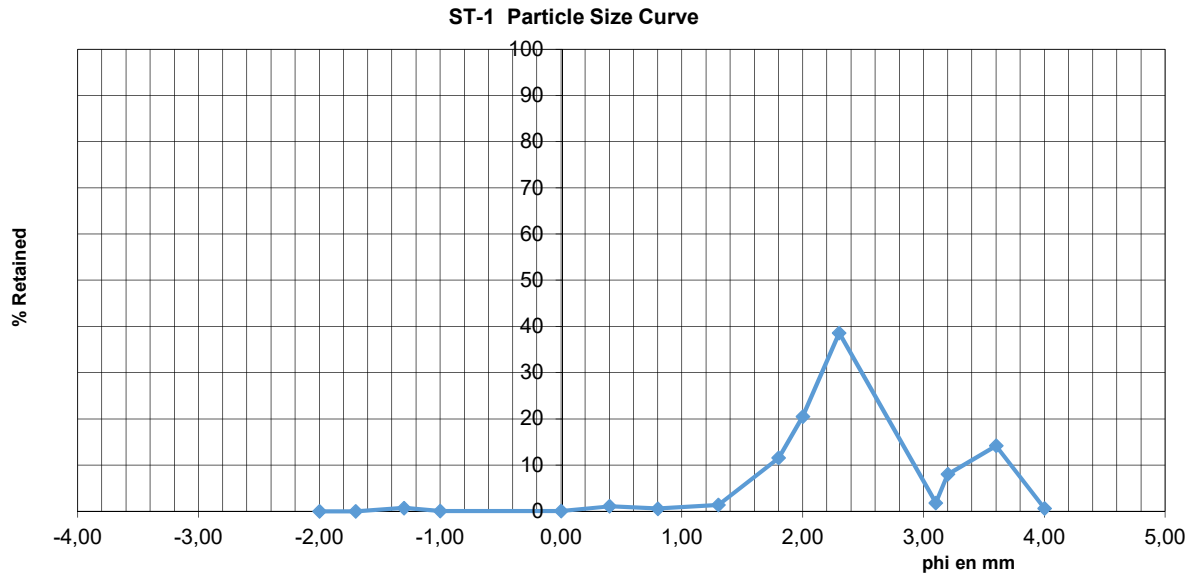
Particle Size Curve

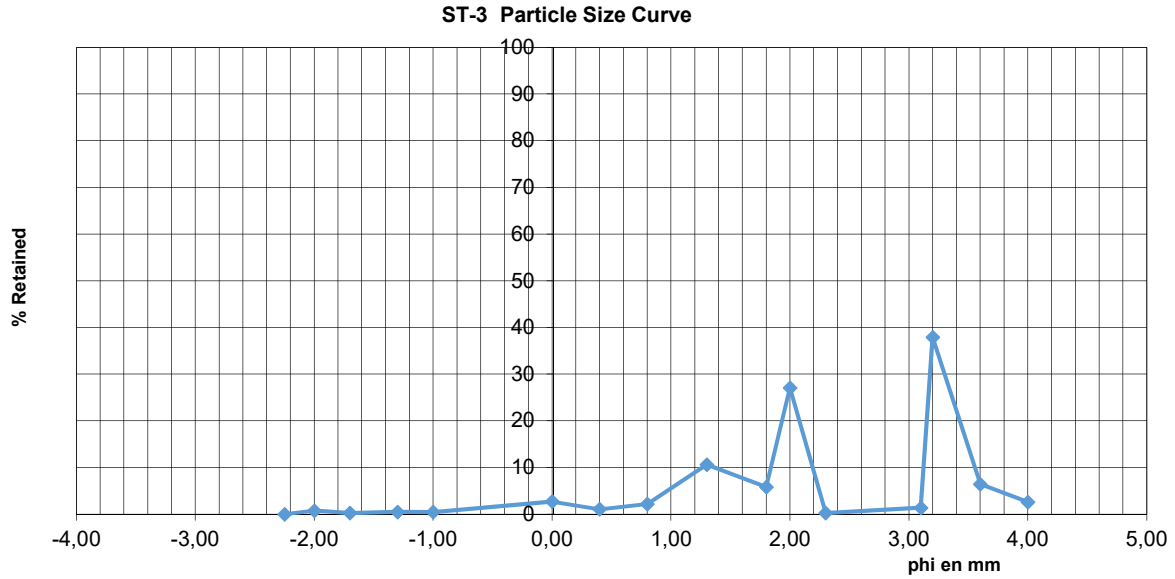


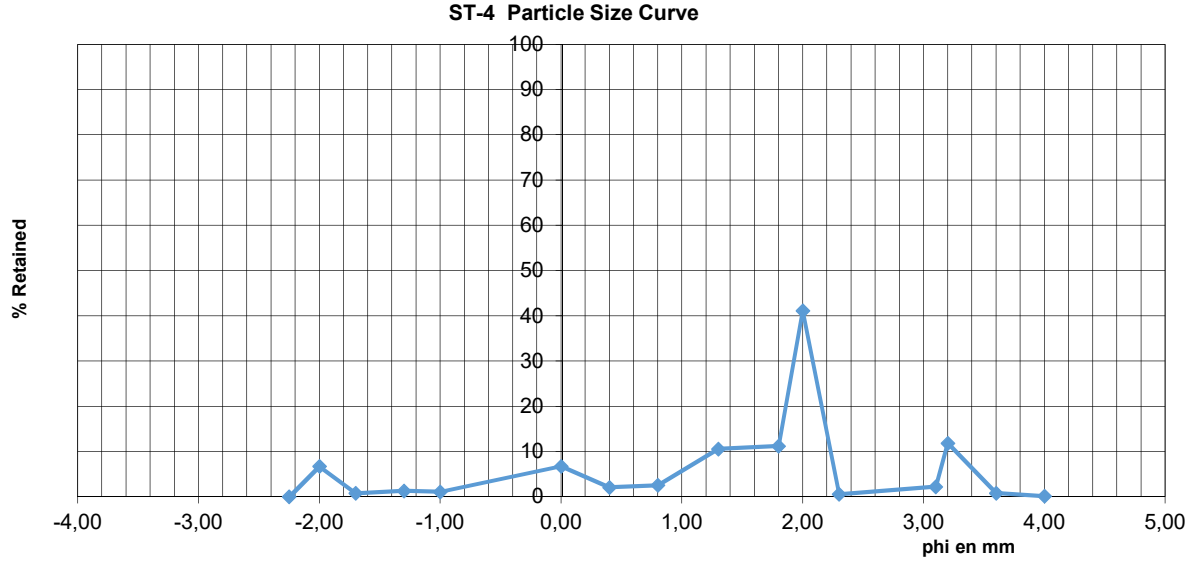
SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	

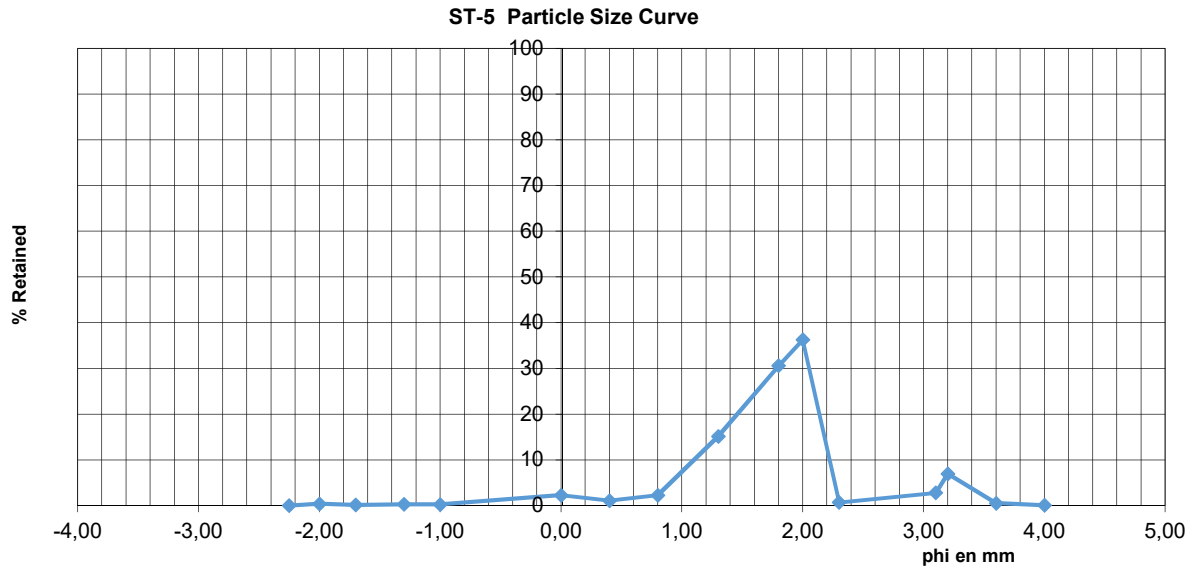
OBSERVATIONS:

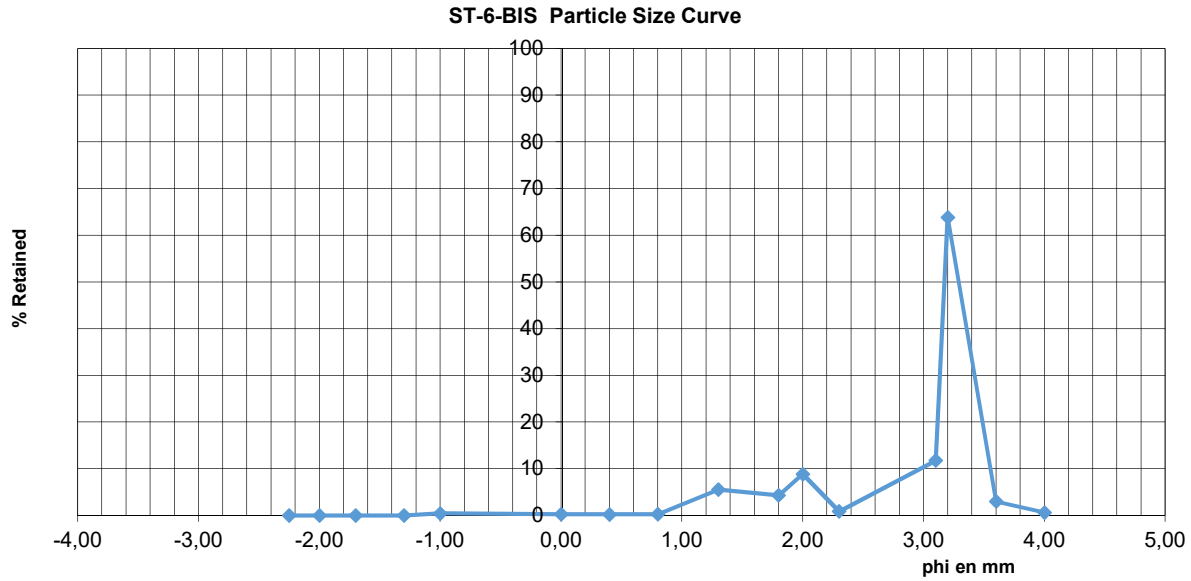
: Modal of particle size


ST-1 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-3 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-4 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-5 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-6-BIS Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
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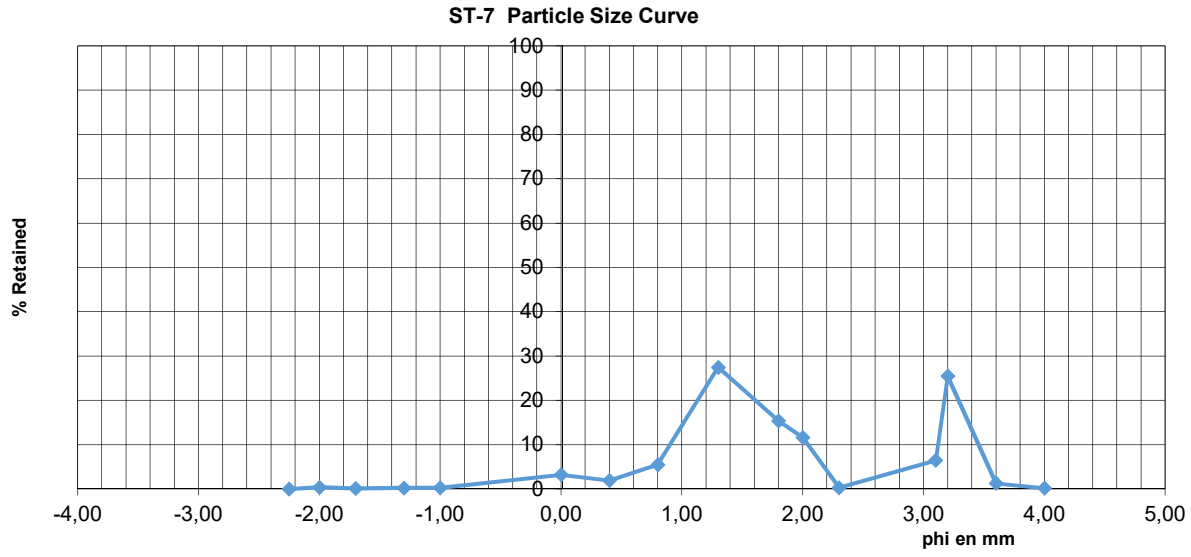
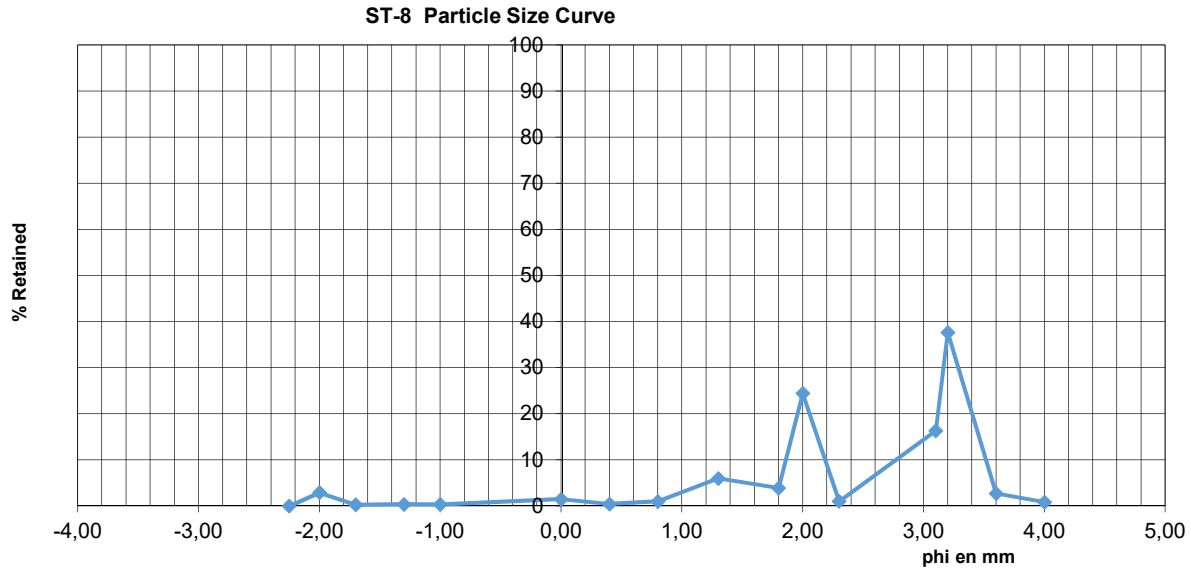
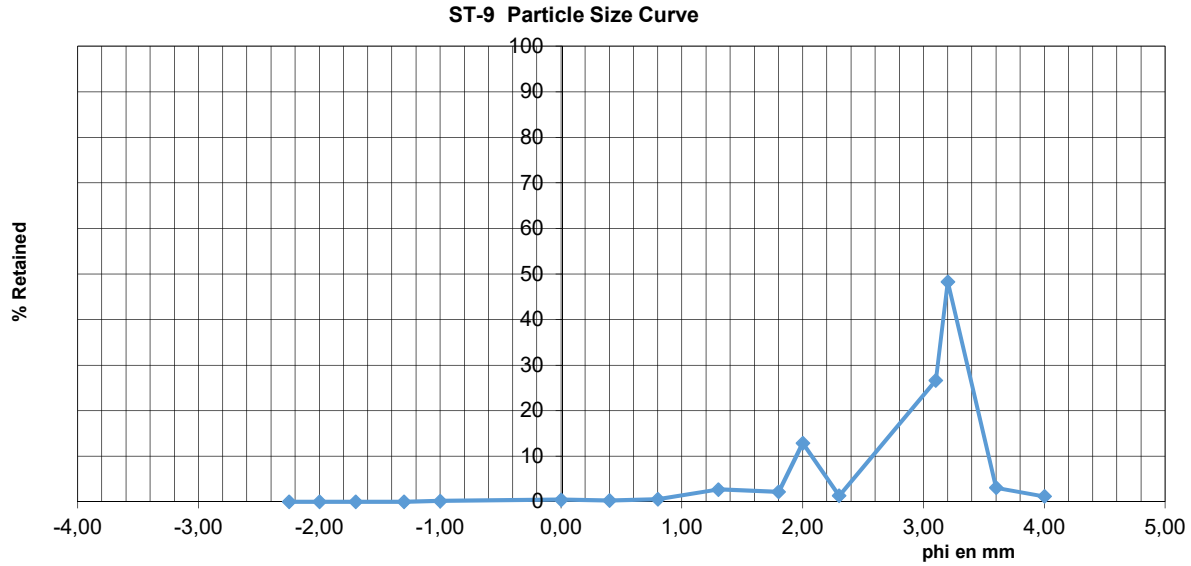
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-7 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-8 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-9 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
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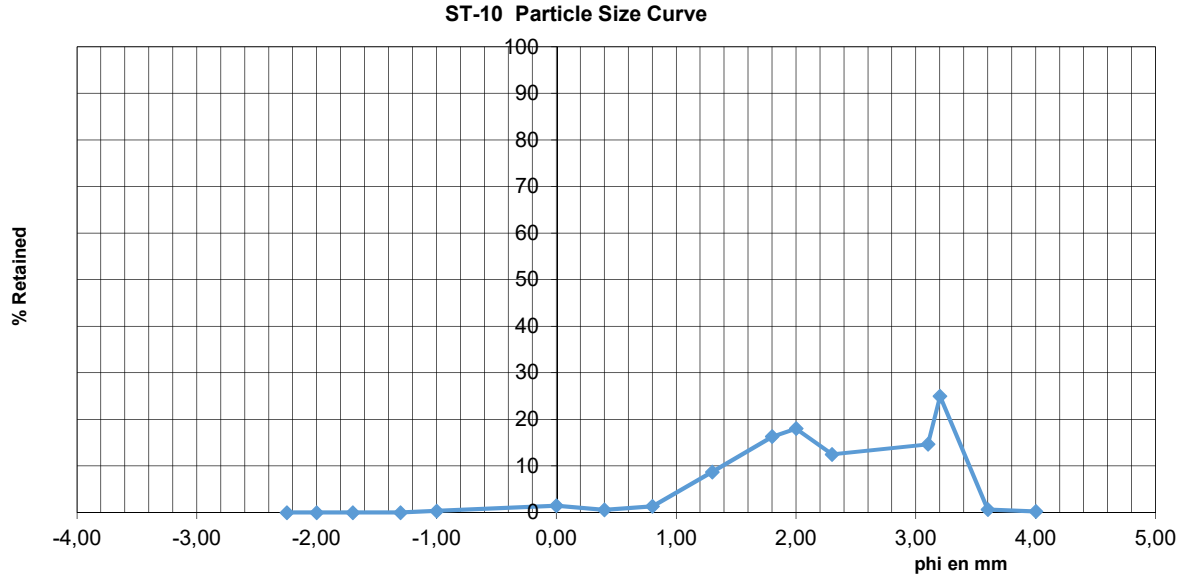
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-10 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
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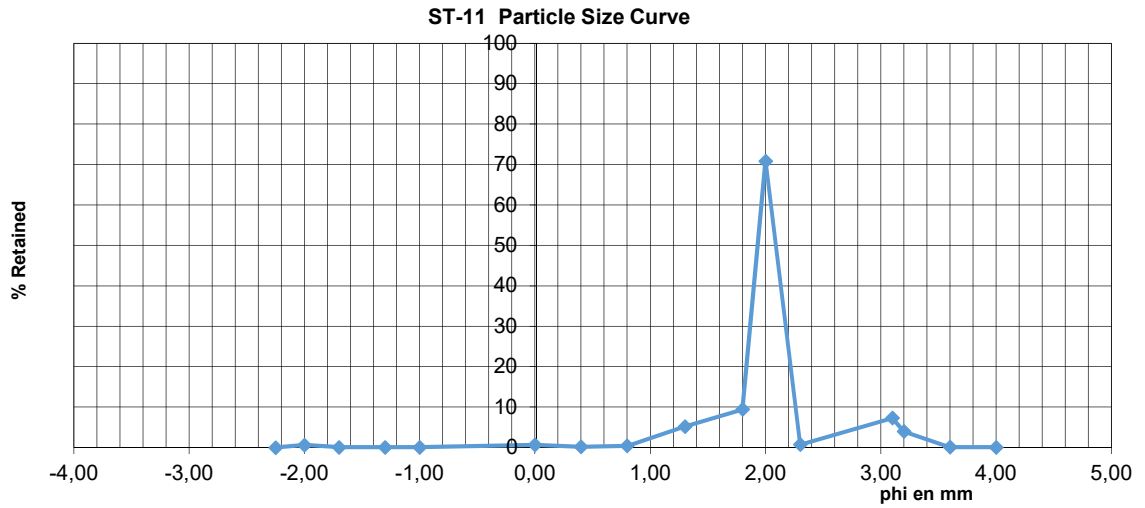
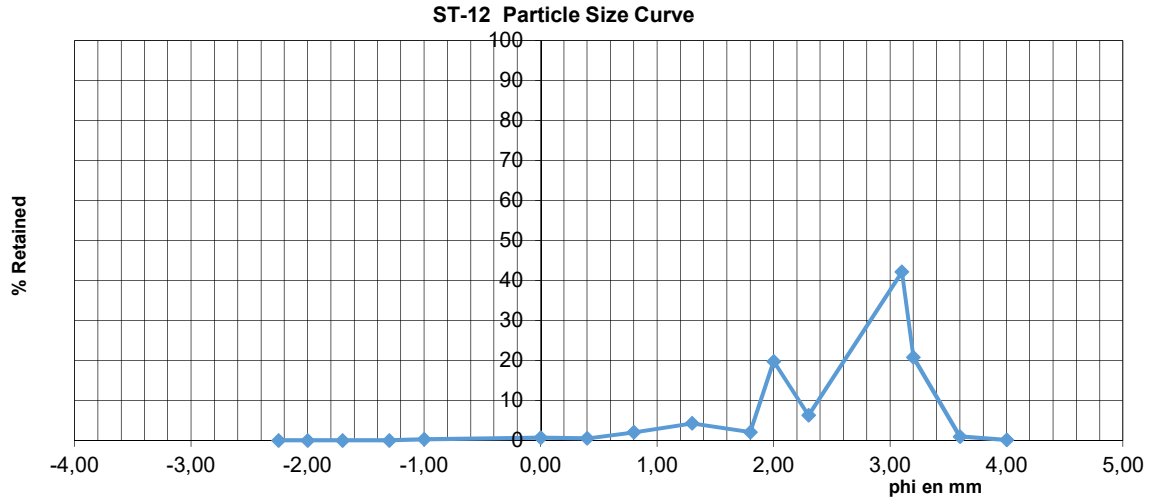
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-11 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-12 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
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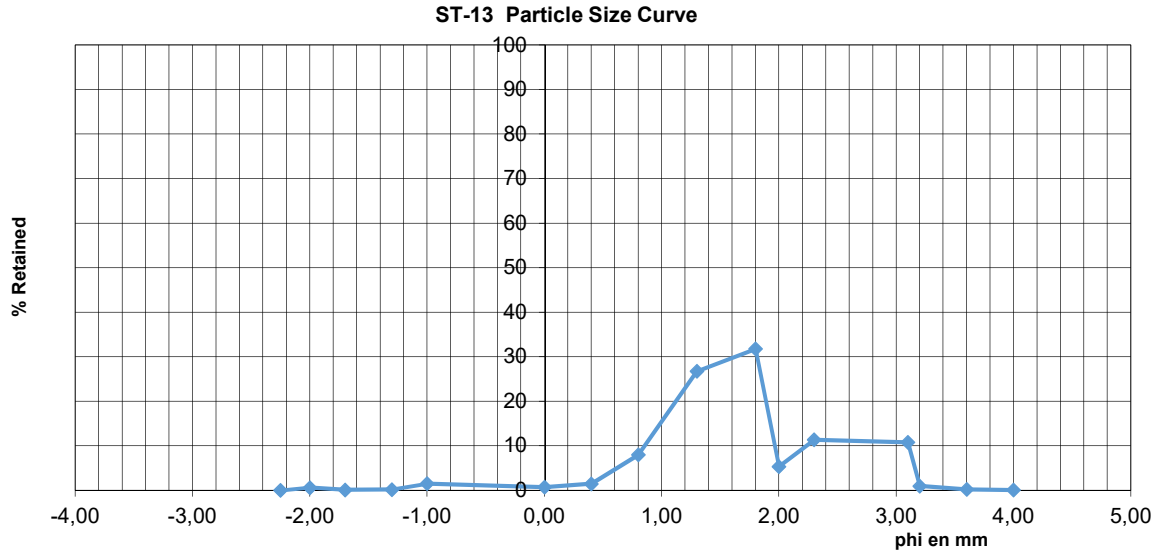
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-13 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
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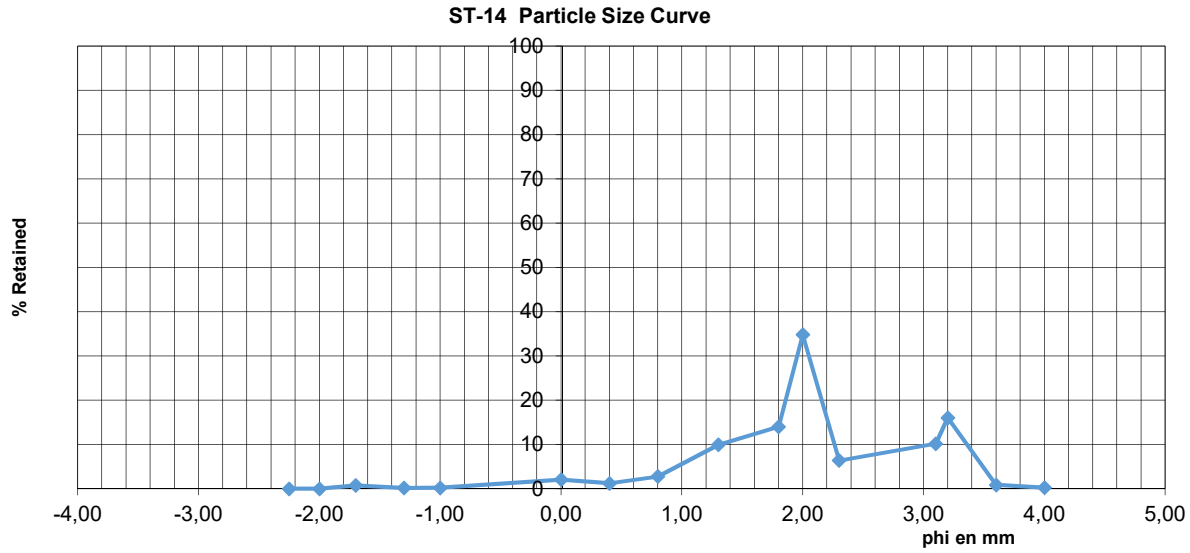
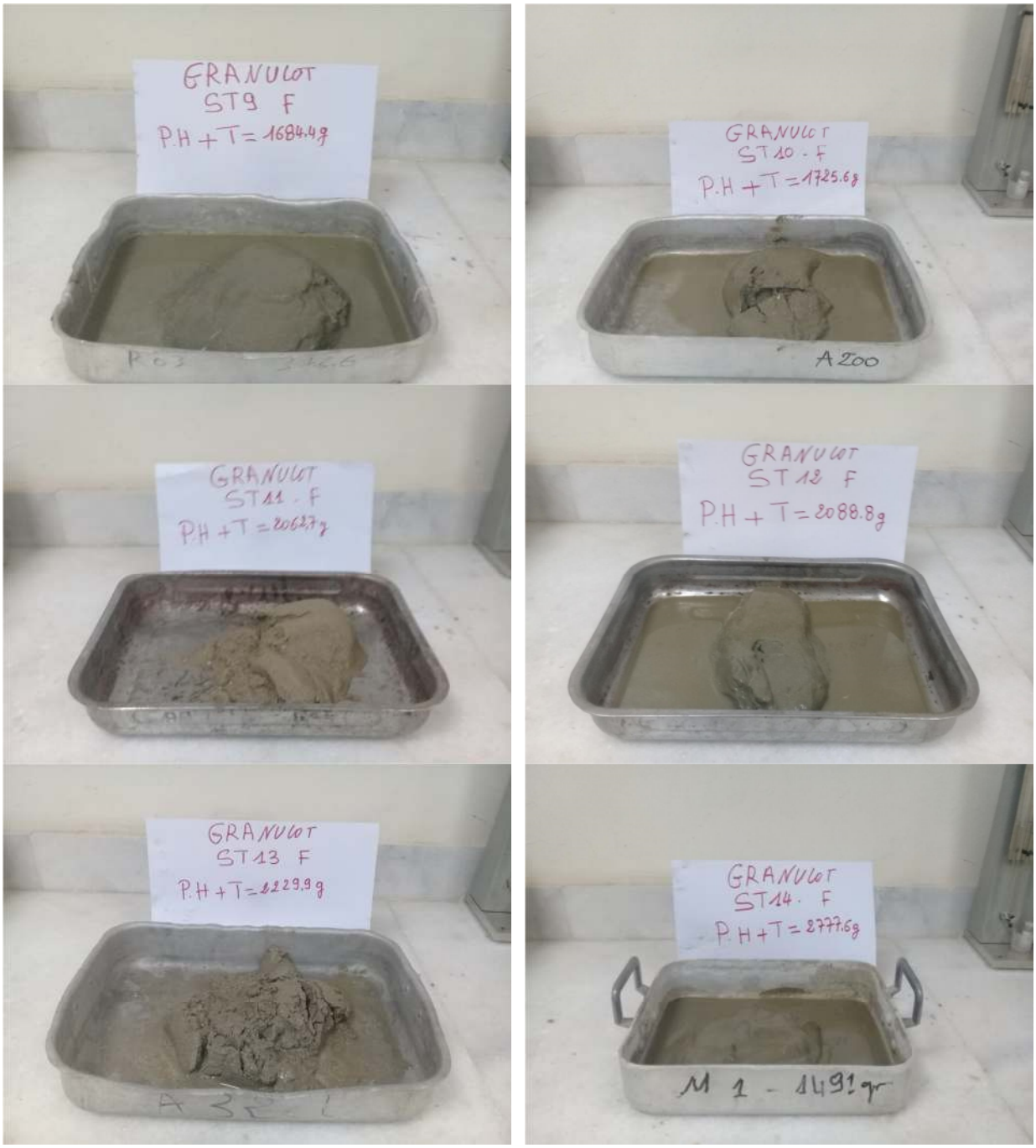
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm


ST-14 Particle Size Curve
% Retained
100
90
80
70
60
50
40
30
20
10
0
-4,00
-3,00
-2,00
-1,00
0,00
1,00
2,00
3,00
4,00
5,00
phi en mm

D: Pictures of samples



PHOTOS OF SEDIMENT SAMPLES



PHOTOS OF SEDIMENT SAMPLES

3. Sediment chemical analysis

RAPPORT D'ESSAIS

Identification : 01/0300/0119

Date de réception : 31/01/19

1- DEMANDEUR

MAGMA International
Adresse : Nouadhibou – Mauritanie.
Tél : 97418001.
Bon de Commande n°004-19 du 19-01-2019

2- DESCRIPTION DE(s) L'OBJET(s) SOUMIS A L'ESSAI

Quatorze échantillons de sédiments marins, prélevés à Nouakchott en Mauritanie et identifiés comme suit : (ST1, ST2, ST3, ST4, ST5 bis, ST6 bis, ST7, ST8,…….. et ST14).

3- ESSAI(s) DEMANDE(s)

pH, Matière sèche, Perte au feu, COT, Azote total, Phosphore total,Aluminium, Cadmium, Cuivre, Plomb, Zinc, Nickel, Chrome, Etain, Arsenic, Mercure,Indice des hydrocarbures, HAP, PCB, E. Coli.

4- METHODE(s) D'ESSAI(s)

Essai (s)	Méthode (s)	Référence (s)
pH	Electrochimie	NF EN 15933 (2012)
Matière Sèche	Gravimétrie	NT 91.32 (2003)
Perte au feu	Gravimétrie - Calcination	Rodier, 9ème édition
COT	Oxydation sulfochromique	NT 91.38 (2003)
Azote total	Titrimétrie	NT 91.15 (2003)
Indice des hydrocarbures	- Extraction Liquide/Solide au solvant - Chromatographie en Phase Gazeuse	- ISO/TR 11046 (1994) - NT 09.124-2 (2007)
Pt, Al, Cd, Cr, Cu, Ni, Pb, Zn, Sn, As	Digestion à l'eau régale dans un système fermé	NT 09.143 (2009)
	Emission optique - ICP	NT 09.193 (2010)
Mercure	Digestion à l'eau régale dans un système fermé	NT 09.143 (2009)
	ICP avec système hydrures	PERKIN ELMER (2008)
HAP	- Extraction solide/Liquide - Chromatographie en phase gazeuse couplée à la spectrométrie de masse	EPA 3550 C
PCB	Extraction solide/Liquide	EPA 3550 C
	Chromatographie en phase gazeuse (ECD)	NT ISO 6468 (1996)
E. Coli	Nombre Plus Probable	ISO 9308-2 (1990)

NB : Ce rapport d'essai ne concerne que le(s) objet(s) soumis à l'essai, il contient 5 page(s) et 0 annexe(s).
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ANALYSES
REFERENTIEL ISO/CEI 17025: 2005

Identification : 01/0300/0119

Date de réception : 31/01/19

5- RESULTAT(s)

5.1- Stations de 1 à 7 :

5.1.1- Essais physico-chimiques et microbiologiques

Essai (s)	Unité	MAGMA International – Sédiments marins						
		ST 1	ST 2	ST 3	ST 4	ST 5 bis	ST 6 bis	ST 7
pH	-	8,5 à 19,8°C	8,4 à 20,0°C	8,5 à 19,9°C	8,6 à 21,1°C	8,8 à 21,3°C	8,6 à 21,4°C	9,0 à 21,5°C
*Humidité	%	0,3	10,3	0,3	0,2	0,2	0,4	0,2
*Matière Sèche	%	99,7	89,7	99,7	99,8	99,8	99,6	99,8
Perte au feu	mg/kgMS	3,1	61,6	5,2	4,9	3,5	9,1	4,5
*COT	g/kgMS	<2	29,2	4,7	2,5	2,2	4,6	3,1
*Azote total	mgN/kgMS	158	$4,39\ 10^3$	293	276	192	514	275
*Phosphore total	mgP/kgMS	119	$1,18\ 10^3$	153	170	150	291	201
Indice des hydrocarbures	mg/kgMS	180	410	200	240	240	82	140
E. Coli	UFC/g	0	0	0	0	0	0	$1,5\ 10^3$

5.1.2- Métaux lourds

Essai (s)	Unité	MAGMA International – Sédiments marins						
		ST 1	ST 2	ST 3	ST 4	ST 5 bis	ST 6 bis	ST 7
*Aluminium	mg/kgMS	739	$19,5\ 10^3$	$1,54\ 10^3$	$1,24$	$1,21\ 10^3$	$3,47\ 10^3$	$1,54\ 10^3$
*Cadmium	mg/kgMS	<0,250	0,635	<0,250	<0,250	<0,250	<0,250	<0,250
*Chrome	mg/kgMS	3,08	49,5	8,98	7,20	28,8	10,8	37,7
*Cuivre	mg/kgMS	<2,00	22,3	<2,00	<2,00	<2,00	<2,00	<2,00
*Nickel	mg/kgMS	<1,50	20,3	1,86	1,52	11,4	4,05	15,8
*Plomb	mg/kgMS	<2,25	8,54	<2,25	<2,25	<2,25	<2,25	<2,25
*Zinc	mg/kgMS	<2,25	44,1	2,65	2,63	<2,25	6,43	2,71
*Arsenic	mg/kgMS	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25
Etain	mg/kgMS	<1,25	1,27	<1,25	<1,25	<1,25	<1,25	<1,25
Mercure	mg/kgMS	<0,090	0,222	<0,090	<0,090	<0,090	<0,090	<0,090

Date d'exécution : du 31-01au 12-02-2019

NB : Ce rapport d'essai ne concerne que le(s) objet(s) soumis à l'essai, il contient 5 page(s) et 0 annexe(s).
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ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005

Identification : 01/0300/0119

Date de réception : 31/01/19

5.1.3- Hydrocarbures aromatiques polycycliques « HAP »

Composés	Unité	Date d'exécution	MAGMA International – Sédiments marins						
			ST 1	ST 2	ST 3	ST 4	ST 5 bis	ST 6 bis	ST 7
Naphtalène	µg/kgMS	12/02/19	<10	<10	<10	<10	<10	<10	<10
1-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
2-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
Acénaphthylène			<10	<10	<10	<10	<10	<10	<10
Acénaphtène			<10	<10	<10	<10	<10	<10	<10
Fluorène			<10	<10	<10	<10	<10	<10	<10
Phénanthrène			<10	<10	<10	<10	<10	<10	<10
Anthracène			<10	<10	<10	<10	<10	<10	<10
Fluoranthène			<10	<10	<10	<10	<10	<10	<10
Pyrène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) anthracène			<10	<10	<10	<10	<10	<10	<10
Chrysene			<10	<10	<10	<10	<10	<10	<10
Benzo (b) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (k) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) pyrène			<10	<10	<10	<10	<10	<10	<10
Indeno (1,2,3-cd) pyrène			<10	<10	<10	<10	<10	<10	<10

5.1.4-Résidus de PCB

Essai (s)	Unité	Date d'exécution	MAGMA International – Sédiments marins						
			ST 1	ST 2	ST 3	ST 4	ST 5 bis	ST 6 bis	ST 7
PCB 28	µg/kgMS	13/02/19	<3	<3	<3	<3	<3	<3	<3
PCB 31			<3	<3	<3	<3	<3	<3	<3
PCB 52			<3	<3	<3	<3	<3	<3	<3
PCB 101			<3	<3	<3	<3	<3	<3	<3
PCB 118			<3	<3	<3	<3	<3	<3	<3
PCB 138			<3	<3	<3	<3	<3	<3	<3
PCB 153			<3	<3	<3	<3	<3	<3	<3
PCB 180			<3	<3	<3	<3	<3	<3	<3

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ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005

Identification : 01/0300/0119

Date de réception : 31/01/19

5.2- Stations de 8 à 14 :

5.2.1- Essais physico-chimiques et microbiologiques

Essai (s)	Unité	MAGMA International – Sédiments marins						
		ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
pH	-	8,9 à 21,0°C	8,9 à 20,8°C	8,8 à 21,3°C	8,9 à 21,3°C	8,7 à 21,1°C	8,7 à 21,9°C	8,7 à 21,2°C
*Humidité	%	0,4	0,4	0,3	0,2	0,4	0,2	0,4
*Matière Sèche	%	99,6	99,6	99,7	99,8	99,6	99,8	99,6
Perte au feu	mg/kgMS	11,3	10,3	7,2	12,0	9,5	5,3	4,5
*COT	g/kgMS	4,3	4,5	4,2	<2	4,6	4,4	3,4
*Azote total	mg/kgMS	598	429	347	140	525	240	254
*Phosphore total	mg/kgMS	243	272	197	92,1	254	177	211
Indice des hydrocarbures	mg/kgMS	53	160	35	18	134	95	83
E. Coli	UFC/g	$1,5\ 10^3$	0	$1,5\ 10^3$	0	0	0	0

5.2.2- Métaux lourds

Essai (s)	Unité	MAGMA International – Sédiments marins						
		ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
*Aluminium	mg/kgMS	$3,28\ 10^3$	$9,83\ 10^3$	$2,38\ 10^3$	957	$2,96\ 10^3$	$1,53\ 10^3$	$2,48\ 10^3$
*Cadmium	mg/kgMS	<0,250	0,635	<0,250	<0,250	<0,250	<0,250	<0,250
*Chrome	mg/kgMS	10,9	10,3	11,0	7,84	12,0	9,04	9,70
*Cuivre	mg/kgMS	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00
*Nickel	mg/kgMS	3,84	4,09	3,10	<1,50	3,90	2,14	3,26
*Plomb	mg/kgMS	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25
*Zinc	mg/kgMS	6,88	7,57	4,60	<2,25	5,80	2,55	4,60
*Arsenic	mg/kgMS	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25	<2,25
Etain	mg/kgMS	<1,25	<1,25	<1,25	<1,25	<1,25	<1,25	<1,25
Mercure	mg/kgMS	<0,090	<0,090	<0,090	<0,090	<0,090	<0,090	<0,090

Date d'exécution : du 31-01au 10-02-2019

NB : Ce rapport d'essai ne concerne que le(s) objet(s) soumis à l'essai, il contient 5 page(s) et 0 annexe(s).
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TUNAC
ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005

Identification : 01/0300/0119 Date de réception : 31/01/19

5.2.3- Hydrocarbures aromatiques polycycliques « HAP »

Composés	Unité	Date d'exécution	MAGMA International – Sédiments marins						
			ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
Naphtalène	µg/kgMS	12/02/19	<10	<10	<10	<10	<10	<10	<10
1-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
2-Méthyl Naphtalène			<10	<10	<10	<10	<10	<10	<10
Acénaphthylène			<10	<10	<10	<10	<10	<10	<10
Acénaphtène			<10	<10	<10	<10	<10	<10	<10
Fluorène			<10	<10	<10	<10	<10	<10	<10
Phénanthrène			<10	<10	<10	<10	<10	<10	<10
Anthracène			<10	<10	<10	<10	<10	<10	<10
Fluoranthène			<10	<10	<10	<10	<10	<10	<10
Pyrène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) anthracène			<10	<10	<10	<10	<10	<10	<10
Chrysene			<10	<10	<10	<10	<10	<10	<10
Benzo (b) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (k) fluoranthène			<10	<10	<10	<10	<10	<10	<10
Benzo (a) pyrène			<10	<10	<10	<10	<10	<10	<10
Indeno (1,2,3-cd) pyrène			<10	<10	<10	<10	<10	<10	<10

5.2.4-Résidus de PCB

Essai (s)	Unité	Date d'exécution	MAGMA International – Sédiments marins						
			ST 8	ST 9	ST 10	ST 11	ST 12	ST 13	ST 14
PCB 28	µg/kgMS	13/02/19	<3	<3	<3	<3	<3	<3	<3
PCB 31			<3	<3	<3	<3	<3	<3	<3
PCB 52			<3	<3	<3	<3	<3	<3	<3
PCB 101			<3	<3	<3	<3	<3	<3	<3
PCB 118			<3	<3	<3	<3	<3	<3	<3
PCB 138			<3	<3	<3	<3	<3	<3	<3
PCB 153			<3	<3	<3	<3	<3	<3	<3
PCB 180			<3	<3	<3	<3	<3	<3	<3

Dr. Ghanem ZAYANI
Responsable Technique

Habib GHANNOUCHI
Responsable du Laboratoire

Tunis, le 15 FEV. 2019

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E-mail: contact@greenlab.com.tn, Site web: http://www.greenlab.com.tn.

TUNAC
ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005

Les activités de MAGMA sont régies par le décret du Conseil des Ministres N°0105-2015 paru au Journal Officiel n° 1337 de la République Islamique de Mauritanie en date du 15/06/2015.

00	**18/03/2018**	**TEMPORARY REPORT**	**Laboratory Teams**	**S.HAMOUDY**	**A.KHALIFA**	
Rev.	**Date**	**Description**	**Prepared**	**Checked**	**Approved**	

INGENIERIE RECHERCHE IRC CONTROLE

ONSHORE AND OFFSHORE GEOTECHNICAL ENGINEERING IN AFRICA

magma

WWW.MAGMA-GROUPE.COM

ARISE

PROJECT

NOUAKCHOTT CONTAINER TERMINAL IN MAURITANIA

ESIA – Marine survey

Test sheets on the two samples (0 to -3m) taken from MBH01 and MBH02

PROJECT No.	DATE	DOCUMENT No.	REVISION	PAGE
2019-A-197	**18 /02/2019**	**DC02019A197-02-00**	**00**	**1/4**

RAPPORT D'ESSAIS

Identification : 01/0726/0319

Date de réception : 07/03/19

1- DEMANDEUR

MAGMA International
Adresse : Nouadhibou – Mauritanie.
Adresse : 7 bis, Rue Rachid EL Ayachi-2037-Ennasr.
Tél : 71 813 107 / 31 532 004 / 97 418 001.
Bon de Commande n°007-19 du 07-03-2019.

2- DESCRIPTION DE(s) L'OBJET(s) SOUMIS A L'ESSAI

Deux échantillons de sédiments marins, identifiés comme suit : (MBH 1 (0-3m) et MBH 2 (0-3m)).

3- ESSAI(s) DEMANDE(s)

pH, Matière sèche, Perte au feu, COT, Azote total, Phosphore total,Aluminium, Cadmium, Cuivre, Plomb, Zinc, Nickel, Chrome, Etain, Arsenic, Mercure,Indice des hydrocarbures, HAP, PCB, E. Coli.

4- METHODE(s) D'ESSAI(s)

Essai (s)	Méthode (s)	Référence (s)
pH	Electrochimie	NF EN 15933 (2012)
Matière Sèche	Gravimétrie	NT 91.32 (2003)
Perte au feu	Gravimétrie - Calcination	Rodier, 9ème édition
COT	Oxydation sulfochromique	NT 91.38 (2003)
Azote total	Titrimétrie	NT 91.15 (2003)
Indice des hydrocarbures	- Extraction Liquide/Solide au solvant - Chromatographie en Phase Gazeuse	- ISO/TR 11046 (1994) - NT 09.124-2 (2007)
Pt, Al, Cd, Cr, Cu, Ni, Pb, Zn, Sn, As	Digestion à l'eau régale dans un système fermé	NT 09.143 (2009)
	Emission optique - ICP	NT 09.193 (2010)
Mercure	Digestion à l'eau régale dans un système fermé	NT 09.143 (2009)
	ICP avec système hydrures	PERKIN ELMER (2008)
HAP	- Extraction solide/Liquide - Chromatographie en phase gazeuse couplée à la spectrométrie de masse	EPA 3550 C
PCB	Extraction solide/Liquide	EPA 3550 C
	Chromatographie en phase gazeuse (ECD)	NT ISO 6468 (1996)
E. Coli	Nombre Plus Probable	ISO 9308-2 (1990)

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TUNAC
ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005
NUMERO D'ACCREDITATION: 1-0066

Identification : 01/0726/0319

Date de réception : 07/03/19

5- RESULTAT(s)

5.1.1- Essais physico-chimiques et microbiologiques

Essai (s)	Unité	Date d'exécution	MAGMA International – Sédiments marins	
			MBH 1 (0-3m)	MBH 2 (0-3m)
pH	-	14/03/19	9,0 à 18,9°C	9,0 à 19,0°C
*Humidité	%	11/03/19	0,1	0,2
*Matière Sèche	%	11/03/19	99,9	99,8
Perte au feu	g/kgMS	11/03/19	3,5	4,1
*COT	g/kgMS	13/03/19	1,5	0,4
*Azote total	mgN/kgMS	08/03/19	854	532
*Phosphore total	mgP/kgMS	15/03/19	72,7	43,0
Indice des hydrocarbures	mg/kgMS	14/03/19	110	24
E. Coli	UFC/g	07-11/03/19	$3,5\ 10^2$	$2\ 10^2$

5.1.2- Métaux lourds

Essai (s)	Unité	Date d'exécution	MAGMA International – Sédiments marins	
			MBH 1 (0-3m)	MBH 2 (0-3m)
*Aluminium	mg/kgMS	13/03/19	$1,43\ 10^3$	$2,23\ 10^3$
*Cadmium	mg/kgMS		<0,250	<0,250
*Chrome	mg/kgMS		3,53	4,04
*Cuivre	mg/kgMS		<2,00	<2,00
*Nickel	mg/kgMS		<1,50	1,87
*Plomb	mg/kgMS		<2,25	<2,25
*Zinc	mg/kgMS		<2,25	3,50
*Arsenic	mg/kgMS	15/03/19	<2,25	<2,25
Etain	mg/kgMS		<1,25	<1,25
Mercure	mg/kgMS	14/03/19	<0,05	<0,05

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TUNAC
ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005

Identification : 01/0726/0319

Date de réception : 07/03/19

5.1.3- Hydrocarbures aromatiques polycycliques « HAP »

Composés	Unité	Date d'exécution	MAGMA International – Sédiments marins	
			MBH 1 (0-3m)	MBH 2 (0-3m)
Naphtalène	µg/kgMS	15/03/19	<10	<10
1-Méthyl Naphtalène			<10	<10
2-Méthyl Naphtalène			<10	<10
Acénaphthylène			<10	<10
Acénaphtène			<10	<10
Fluorène			<10	<10
Phénanthrène			<10	<10
Anthracène			<10	<10
Fluoranthène			<10	<10
Pyrène			<10	<10
Benzo (a) anthracène			<10	<10
Chrysene			<10	<10
Benzo (b) fluoranthène			<10	<10
Benzo (k) fluoranthène			<10	<10
Benzo (a) pyrène			<10	<10
Indeno (1,2,3-cd) pyrène			<10	<10

5.1.4-Résidus de PCB

Essai (s)	Unité	Date d'exécution	MAGMA International – Sédiments marins	
			MBH 1 (0-3m)	MBH 2 (0-3m)
PCB 28	µg/kgMS	13/03/19	<3	<3
PCB 31			<3	<3
PCB 52			<3	<3
PCB 101			<3	<3
PCB 118			<3	<3
PCB 138			<3	<3
PCB 153			<3	<3
PCB 180			<3	<3

Dr. Ghanem ZAYANI
Responsable Technique

Tunis, le 18 MARS 2019

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TUNAC
ANALYSES
REFERENTIEL: ISO/CEI 17025: 2005

4. Sediment TBT Analysis

EUROFINS ANALYSES POUR L'ENVIRONNEMENT FRANCE SAS

MAGMA INTERNATIONAL
Monsieur KHALIFA
7, Rue Rachid Ayachi
2001 TUNIS
TUNISIE

RAPPORT D'ANALYSE

Dossier N° : 19E014726
Version du : 25/02/2019
N° de rapport d'analyse : AR-19-LK-028011-01
Date de réception : 08/02/2019
Référence Dossier :

Coordinateur de projet client : Andréa Golfier / AndreaGolfier@eurofins.com / +33 3 88 02 33 86

N° Ech	Matrice		Référence échantillon
001	Sédiments	(SED)	ST7
002	Sédiments	(SED)	ST6c
003	Sédiments	(SED)	ST2c
004	Sédiments	(SED)	ST10c
005	Sédiments	(SED)	ST4c
006	Sédiments	(SED)	ST8c
007	Sédiments	(SED)	ST9c
008	Sédiments	(SED)	ST3c
009	Sédiments	(SED)	ST5c
010	Sédiments	(SED)	ST1c
011	Sédiments	(SED)	ST13c
012	Sédiments	(SED)	ST11
013	Sédiments	(SED)	ST12
014	Sédiments	(SED)	ST14

EUROFINS ANALYSES POUR L'ENVIRONNEMENT
FRANCE SAS

RAPPORT D'ANALYSE

Dossier N° : 19E014726
N° de rapport d'analyse : AR-19-LK-028011-01
Référence Dossier :

Version du : 25/02/2019
Date de réception : 08/02/2019

N° Echantillon		001	002	003	004	005	006
Référence client :		ST7	ST6c	ST2c	ST10c	ST4c	ST8c
Matrice :		SED	SED	SED	SED	SED	SED
Date de prélèvement :							
Date de début d'analyse :		12/02/2019	12/02/2019	12/02/2019	12/02/2019	12/02/2019	12/02/2019
Préparation Physico-Chimique							
XXS06 : **Séchage à 40°C**		* -	* -	* -	* -	* -	* -
XXS07 : **Refus Pondéral à 2 mm**	% P.B.	* 3.31	* 7.59	* 24.1	* 14.6	* 11.9	* 11.8
Organoétains							
LS2GL : **Tributylétain cation-Sn (TBT)**	µg/kg M.S.	* <2.5	* <2.5	* <2.5	* <2.5	* <2.5	* <2.5

EUROFINS ANALYSES POUR L'ENVIRONNEMENT
FRANCE SAS

RAPPORT D'ANALYSE

Dossier N° : 19E014726
N° de rapport d'analyse : AR-19-LK-028011-01
Référence Dossier :

Version du : 25/02/2019
Date de réception : 08/02/2019

N° Echantillon		007	008	009	010	011	012
Référence client :		ST9c	ST3c	ST5c	ST1c	ST13c	ST11
Matrice :		SED	SED	SED	SED	SED	SED
Date de prélèvement :							
Date de début d'analyse :		12/02/2019	12/02/2019	12/02/2019	12/02/2019	12/02/2019	15/02/2019
Préparation Physico-Chimique							
XXS06 : **Séchage à 40°C**		* -	* -	* -	* -	* -	* -
XXS07 : **Refus Pondéral à 2 mm**	% P.B.	* 8.29	* 5.22	* 2.96	* 1.76	* 5.28	* 5.68
Organoétains							
LS2GL : **Tributylétain cation-Sn (TBT)**	µg/kg M.S.	* <2.5	* <2.5	* <2.5	* <2.5	* <2.5	* <2.5

EUROFINS ANALYSES POUR L'ENVIRONNEMENT
FRANCE SAS

RAPPORT D'ANALYSE

Dossier N° : 19E014726
N° de rapport d'analyse : AR-19-LK-028011-01
Référence Dossier :

Version du : 25/02/2019
Date de réception : 08/02/2019

N° Echantillon		013	014
Référence client :		ST12	ST14
Matrice :		SED	SED
Date de prélèvement :			
Date de début d'analyse :		15/02/2019	15/02/2019
Préparation Physico-Chimique			
XXS06 : **Séchage à 40°C**		* -	* -
XXS07 : **Refus Pondéral à 2 mm**	% P.B.	* 7.66	* 5.84
Organoétains			
LS2GL : **Tributylétain cation-Sn (TBT)**	µg/kg M.S.	* <2.5	* <2.5

D : détecté / ND : non détecté

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Les résultats précédés du signe < correspondent aux limites de quantification, elles sont la responsabilité du laboratoire et fonction de la matrice.

Tous les éléments de traçabilité sont disponibles sur demande.

Pour les résultats issus d'une sous-traitance, les rapports émis par des laboratoires accrédités sont disponibles sur demande.

Laboratoire agréé par le ministre chargé de l'environnement - se reporter à la liste des laboratoires sur le site internet de gestion des agréments du ministère chargé de l'environnement : http://www.labeau.ecologie.gouv.fr

Laboratoire agréé pour la réalisation des prélèvements et des analyses terrains et/ou des analyses des paramètres du contrôle sanitaire des eaux – portée détaillée de l'agrément disponible sur demande.

Laboratoire agréé par le ministre chargé des installations classées conformément à l'arrêté du 11 Mars 2010. Mention des types d'analyses pour lesquels l'agrément a été délivré sur : www.eurofins.fr ou disponible sur demande.



Gilles Lacroix
Coordinateur Projets Clients

EUROFINS ANALYSES POUR L'ENVIRONNEMENT
FRANCE SAS

Annexe technique

Dossier N° : 19E014726

N° de rapport d'analyse :AR-19-LK-028011-01

Emetteur :

Commande EOL :

Nom projet :

Référence commande :

Sédiments

Code	Analyse	Principe et référence de la méthode	LQI	Unité	Prestation réalisée sur le site de :
LS2GL	Tributylétain cation-Sn (TBT)	GC/MS/MS [Dérivation, extraction Solide/Liquide] - XP T 90-250	2.5	µg Sn/kg M.S.	Eurofins Analyse pour l'Environnement France
XXS06	Séchage à 40°C	Séchage [Le laboratoire travaillera sur la fraction <à 2mm de l'échantillon sauf demande explicite du client] - NF ISO 11464 - NF EN 16179 (sol)			
XXS07	Refus Pondéral à 2 mm	Tamisage [Le laboratoire travaillera sur la fraction <à 2mm de l'échantillon sauf demande explicite du client] - NF ISO 11464 - NF EN 16179 (sol)	1	% P.B.	

EUROFINS ANALYSES POUR L'ENVIRONNEMENT FRANCE SAS

Annexe de traçabilité des échantillons

Cette traçabilité recense les flaconnages des échantillons scannés dans EOL sur le terrain avant envoi au laboratoire

Dossier N° : 19E014726

N° de rapport d'analyse : AR-19-LK-028011-01

Emetteur :

Commande EOL :

Nom projet :

Référence commande :

Sédiments

Référence Eurofins	Référence Client	Date&Heure Prélèvement	Code-barre	Nom flacon
19E014726-001	ST7			
19E014726-002	ST6c			
19E014726-003	ST2c			
19E014726-004	ST10c			
19E014726-005	ST4c			
19E014726-006	ST8c			
19E014726-007	ST9c			
19E014726-008	ST3c			
19E014726-009	ST5c			
19E014726-010	ST1c			
19E014726-011	ST13c			
19E014726-012	ST11			
19E014726-013	ST12			
19E014726-014	ST14			

MBH1 & MBH2
samples

EUROFINS ANALYSES POUR L'ENVIRONNEMENT FRANCE SAS

MAGMA INTERNATIONAL
Monsieur KHALIFA
7, Rue Rachid Ayachi
2001 TUNIS
TUNISIE

RAPPORT D'ANALYSE

Dossier N° : 19E029739
N° de rapport d'analyse : AR-19-LK-044073-01
Référence Dossier :

Version du : 22/03/2019
Date de réception : 14/03/2019

Coordinateur de projet client : Andréa Golfier / AndreaGolfier@eurofins.com / +33 3 88 02 33 86

N° Ech	Matrice		Référence échantillon
001	Sédiments	(SED)	MBH01 0-3
002	Sédiments	(SED)	MBH02 0-3
003	Sédiments	(SED)	MBH02 2-3
004	Sédiments	(SED)	MBH01 1-2
005	Sédiments	(SED)	MBH02 0-1
006	Sédiments	(SED)	MBH02 1-2
007	Sédiments	(SED)	MBH01 2-3
008	Sédiments	(SED)	MBH01 0-1

EUROFINS ANALYSES POUR L'ENVIRONNEMENT FRANCE SAS

RAPPORT D'ANALYSE

Dossier N° : 19E029739

Version du : 22/03/2019

N° de rapport d'analyse : AR-19-LK-044073-01

Date de réception : 14/03/2019

Référence Dossier :

N° Echantillon		001	002	003	004	005	006
Référence client :		MBH01 0-3 SED	MBH02 0-3 SED	MBH02 2-3 SED	MBH01 1-2 SED	MBH02 0-1 SED	MBH02 1-2 SED
Matrice :							
Date de prélèvement :							
Date de début d'analyse :		14/03/2019	14/03/2019	14/03/2019	14/03/2019	14/03/2019	14/03/2019
Administratif							
LS0IR : **Mise en réserve de l'échantillon (en option)**							
Préparation Physico-Chimique							
XXS06 : **Séchage à 40°C**		* -	* -	* -	* -	* -	* -
XXS07 : **Refus Pondéral à 2 mm**	% P.B.	* 19.4	* 7.48				
Mesures physiques							
LS08F : **Granulométrie laser à pas variable (0 à 2 000 µm) - Tranches : 2 / 20 / 63 / 200 / 2000 µm**							
Pourcentage cumulé 0.02µm à 2µm	%		* cf détails ci-joint				
Pourcentage cumulé 0.02µm à 20µm	%		* cf détails ci-joint				
Pourcentage cumulé 0.02µm à 63µm	%		* cf détails ci-joint				
Pourcentage cumulé 0.02µm à 200µm	%		* cf détails ci-joint				
Pourcentage cumulé 0.02µm à 2000µm	%		* cf détails ci-joint				
Organoétains							
LS2GL : **Tributylétain cation-Sn (TBT)**	µg/kg M.S.	* <2.5					

EUROFINS ANALYSES POUR L'ENVIRONNEMENT FRANCE SAS

RAPPORT D'ANALYSE

Dossier N° : 19E029739
N° de rapport d'analyse : AR-19-LK-044073-01
Référence Dossier :

Version du : 22/03/2019
Date de réception : 14/03/2019

N° Echantillon	007	008
Référence client :	MBH01 2-3	MBH01 0-1
Matrice :	SED	SED
Date de prélèvement :		
Date de début d'analyse :	14/03/2019	14/03/2019
Administratif		
LS0IR : **Mise en réserve de l'échantillon (en option)**		
Préparation Physico-Chimique		
XXS06 : **Séchage à 40°C**	* -	* -

D : détecté / ND : non détecté

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Anne-Charlotte Soulé De Lafont
Coordinateur Projets Clients

EUROFINS ANALYSES POUR L'ENVIRONNEMENT FRANCE SAS

Annexe technique

Dossier N° : 19E029739

N° de rapport d'analyse :AR-19-LK-044073-01

Emetteur :

Commande EOL :

Nom projet :

Référence commande :

Sédiments

Code	Analyse	Principe et référence de la méthode	LQI	Unité	Prestation réalisée sur le site de :
LS08F	Granulométrie laser à pas variable (0 à 2 000 µm) - Tranches : 2 / 20 / 63 / 200 / 2000 µm	Spectroscopie (Diffraction laser) - Méthode interne			Eurofins Analyse pour l'Environnement France
	Pourcentage cumulé 0.02µm à 2µm			%	
	Pourcentage cumulé 0.02µm à 20µm			%	
	Pourcentage cumulé 0.02µm à 63µm			%	
	Pourcentage cumulé 0.02µm à 200µm			%	
	Pourcentage cumulé 0.02µm à 2000µm			%	
LS0IR	Mise en réserve de l'échantillon (en option)				
LS2GL	Tributylétain cation-Sn (TBT)	GC/MS/MS [Dérivation, extraction Solide/Liquide] - XP T 90-250	2.5	µg Sn/kg M.S.	
XXS06	Séchage à 40°C	Séchage [Le laboratoire travaillera sur la fraction <à 2mm de l'échantillon sauf demande explicite du client] - NF ISO 11464 - NF EN 16179 (sol)			
XXS07	Refus Pondéral à 2 mm	Tamisage [Le laboratoire travaillera sur la fraction <à 2mm de l'échantillon sauf demande explicite du client] - NF ISO 11464 - NF EN 16179 (sol)	1	% P.B.	

EUROFINS ANALYSES POUR L'ENVIRONNEMENT FRANCE SAS

Annexe de traçabilité des échantillons

Cette traçabilité recense les flaconnages des échantillons scannés dans EOL sur le terrain avant envoi au laboratoire

Dossier N° : 19E029739

N° de rapport d'analyse : AR-19-LK-044073-01

Emetteur :

Commande EOL :

Nom projet :

Référence commande :

Sédiments

Référence Eurofins	Référence Client	Date&Heure Prélèvement	Code-barre	Nom flacon
19E029739-001	MBH01 0-3			
19E029739-002	MBH02 0-3			
19E029739-003	MBH02 2-3			
19E029739-004	MBH01 1-2			
19E029739-005	MBH02 0-1			
19E029739-006	MBH02 1-2			
19E029739-007	MBH01 2-3			
19E029739-008	MBH01 0-1			

Annexe au rapport d'analyse

LS08F : Granulométrie laser a pas variable
prestation réalisée sur le site de SAVERNE

NF EN ISO/IEC 17025:2005 COFRAC 1-1488
Méthode interne T-PS-WO22915

Référence de l'échantillon (Matrice) :
19e029739-002 (SED) - Average

Opérateur :
ffb4

Date de l'analyse :
mardi 19 mars 2019 17:18:45

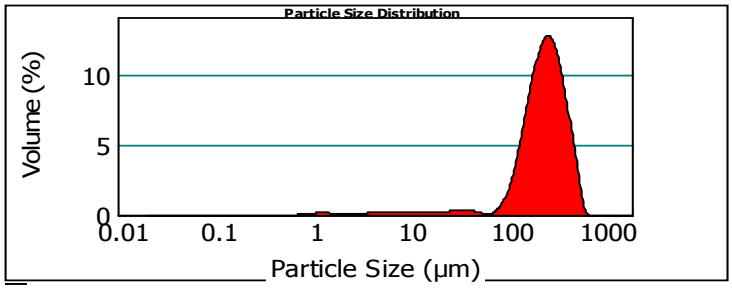
Résultat de la source :
Moyenne de 2 mesures

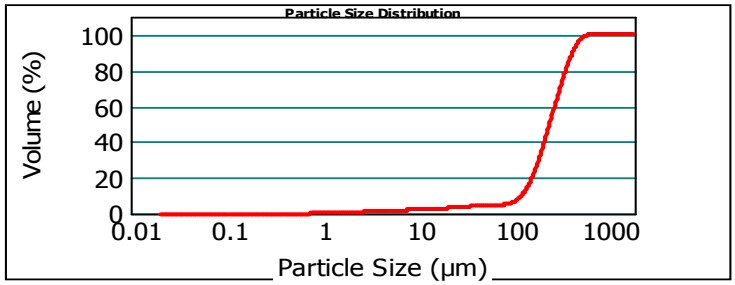
Données statistique

Surface spécifique : 0.0881 m²/g
Moyenne : 268.313 µm
Médiane : 255.344 µm
Variance : 15592.271 µm²
Ecart type : 124.869 µm
Rapport moyenne/mediane : 1.05 µm
Mode : 272.973 µm

* **Pourcentages cumulés :**
Percentage between 0.02 µm and 2.00 µm : 0.75%
Percentage between 0.02 µm and 20.00 µm : 2.94%
Percentage between 0.02 µm and 63.00 µm : 4.78%
Percentage between 0.02 µm and 200.00 µm : 30.97%
Percentage between 0.02 µm and 2000.00 µm : 100.00%

Pourcentages relatifs :
Percentage between 0.02 µm and 2.00 µm : 0.75%
Percentage between 2.00 µm and 20.00 µm : 2.19%
Percentage between 20.00 µm and 50.00 µm : 1.63%
Percentage between 50.00 µm and 200.00 µm : 26.40%
Percentage between 20.00 µm and 63.00 µm : 1.84%
Percentage between 63.00 µm and 200.00 µm : 26.19%
Percentage between 200.00 µm and 2000.00 µm : 69.03%





19e029739-002 (SED) - Average mardi 19 mars 2019 17:18:45

Size (µm)	Volume In %
0.020	0.17
1.000	0.58
2.000	0.16
2.500	0.37
4.000	0.72
8.000	

Size (µm)	Volume In %
8.000	0.25
10.000	0.40
15.000	0.06
16.000	0.22
20.000	0.61
30.000	

Size (µm)	Volume In %
30.000	0.61
40.000	0.41
50.000	0.21
63.000	1.19
100.000	9.11
150.000	

Size (µm)	Volume In %
150.000	15.89
200.000	17.27
250.000	15.32
300.000	21.24
400.000	10.59
500.000	

Size (µm)	Volume In %
500.000	4.11
600.000	0.51
800.000	0.00
900.000	0.00
1000.000	0.00
1500.000	

Size (µm)	Volume In %
1500.000	0.00
2000.000	

Size (µm)	Vol Under %
0.020	0.00
1.000	0.17
2.000	0.75
2.500	0.91
4.000	1.28

Size (µm)	Vol Under %
8.000	2.00
10.000	2.25
15.000	2.65
16.000	2.71
20.000	2.94

Size (µm)	Vol Under %
30.000	3.55
40.000	4.16
50.000	4.57
63.000	4.78
100.000	5.97

Size (µm)	Vol Under %
150.000	15.08
200.000	30.97
250.000	48.23
300.000	63.56
400.000	84.80

Size (µm)	Vol Under %
500.000	95.38
600.000	99.49
800.000	100.00
900.000	100.00
1000.000	100.00

Size (µm)	Vol Under %
1500.000	100.00
2000.000	100.00

Paramètre d'analyse

Type d'instrument : Malvern Mastersizer 2000
Gamme de mesure : Préparateur Hydro MU
0.020 µm à 2000 µm
Logiciel : Malvern Application 5.60
Modèle optique : Fraunhofer
Vitesse de la pompe : 3000 rpm

Durée d'analyse : 2 X 30 secondes
Indice de réfraction : 1.33
Liquide : Water 800 mL
Obscuration : 5.91 %

- L'alignement du laser est effectué avant chaque mesure

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5. Benthos Analysis

Les activités de MAGMA sont régies par le décret du Conseil des Ministres N°0105-2015 paru au Journal Officiel n° 1337 de la République Islamique de Mauritanie en date du 15/06/2015.

00	**19/02/2018**	**TEMPORARY REPORT**	**O.KIDE**	**S.HAMOUDY**	**A.KHALIFA**	
Rev.	**Date**	**Description**	**Prepared**	**Checked**	**Approved**	

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ARISE

PROJECT

NOUAKCHOTT CONTAINER TERMINAL IN MAURITANIA

ESIA – Marine survey- Benthic Fauna

MISSION REPORT

PROJECT No.	DATE	DOCUMENT No.	REVISION	PAGE
2019-A-197	**25/02/2019**	**DC02019A197-02-00**	**00**	**1/31**

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1. Introduction

Contexte

ARISE envisage de construire et d'exploiter un nouveau terminal pour conteneurs et hydrocarbures dans le port de Nouakchott, en Mauritanie. Une compréhension détaillée de l'environnement et des conditions sociales de base (ou existantes) est nécessaire pour prévoir le changement et les impacts qui seront causés par le projet proposé. De larges volumes de matériaux provenant du bassin portuaire et du chenal doivent être excavés, transportés et déposés en toute sécurité. Un nombre de sites de stockage potentiels adjacents situés à proximité des installations du PANPA ont été identifiés pour ce matériau. Cette opération de dragage et la mise en place de matériaux de dragage peuvent affecter la faune benthique par le biais des mécanismes suivants : (1) il entraînera une perte directe de la faune dans l'empreinte du dragage ; (2) la mise en place de matériaux de dragage entraînera l'étouffement de la plupart de la flore et de la faune benthiques au sein de la zone de dépôt des sédiments.

L'objectif général de cette étude est de caractériser les patterns spatiaux des assemblages de la faune benthique du PANPA, afin de mettre au point un l'élaboration d'un programme de surveillance de l'environnement récepteur permettant d'évaluer les impacts du dragage et du dépôt de matériaux de dragage.

Les objectifs spécifiques de cette zone d'étude sont les suivants : (1) caractériser la structure de la communauté de la faune benthique (abondance, richesse spécifique, diversité et similitude) dans les zones d'excavation et réceptrice des rebus du dragage et (2)fournir des recommandations concernant la conception et la mise en œuvre de ce programme de développement, y compris la réplication spatiale (site et échantillon) et temporelle, et les principales considérations concernant les influences environnementales confondantes.

La mission consiste à réaliser les activités suivantes : (1) Préparer et réaliser la campagne d'échantillonnage (eau, sédiment, paramètres physicochimiques in situ ; (2) Analyser les échantillons d'eau et de sédiments prélevés en mer et (3) Elaborer un rapport de situation par rapport à l'état de référence et les études des suivis précédents.

1) Location d'un navire
2) Expertise pour Echantillonnage et mesure des paramètres physico-chimiques
3) Analyse de la Granulométrie et description macroscopique des sédiments
4) Analyse biologique (Benthos)
5) Rédaction du Rapport final.

2. Moyens et Méthodologie de travail

2.1. Moyen nautique et humain

Lors des opérations de prélèvements nous avons utilisé deux navires de la Capitainerie du Port Autonome (Pilotine et remorqueur). Les prélèvements d'eau de mer et de sédiments sont faits manuellement, les navires ne disposaient pas d'équipements de treuils permettant la mise en œuvre de bennes et de la bouteille à renversement. Nous avons utilisé un GPS portable pour le positionnement des stations.



Photo 1Le navire utilisé pour les prélèvements et l'équipe à bord qui conduit les travaux

2.2. Matériels utilisés à bord

1 benne Van veen de 225 cm^2
2 sondes une multiparamètres (T°C, Turbidité, Oxygène dissout) et une autre uniquement pour le pH permettant la mesure des différents paramètres physico-chimiques.
Des flacons pour les échantillons
Des sachets en plastiques
Des fiches de collectes
Un tamis 1 mm (pour benthos)
Deux glacières et des caisses isothermes remplies de glace



Photo 2 Matériel de prélèvements de sédiments et d'eau de mer utilisé à bord

2.3. Localisation des stations de prélèvements

Le nombre de stations d'étude est fixé à 14 à la suite d'une réunion tenue dans les locaux du MAGMA/IRC. Cette réunion a permis de rediscuter des positions des stations et leur distribution dans les sites d'excavations, les sites témoins et ceux dans lesquels les dépôts sédimentaires seront effectués. Le nombre de stations par site est reparti de la sorte : (1) le bassin eux stations (ST01 et ST02), sites témoins trois stations (en aval et en amont du chenal ST04 et ST07). Trois (3) stations sont positionnées le long du chenal de navigation en eau profonde et en eau peu profonde afin de couvrir le maximum de superficie pouvant être affectée par les activités excavations. Trois zones de dépôts de rebus de sédiments sont localisées au sud-est du port, dans chacune des zones deux (2) stations d'échantillonnage sont positionnées pour avoir une bonne dispersion des stations dans ces sites. Une dernière station témoin (ST14) est positionnée à l'extrême sud de la zone C, la localisation des stations et les sites sont illustrés à la figure 1.

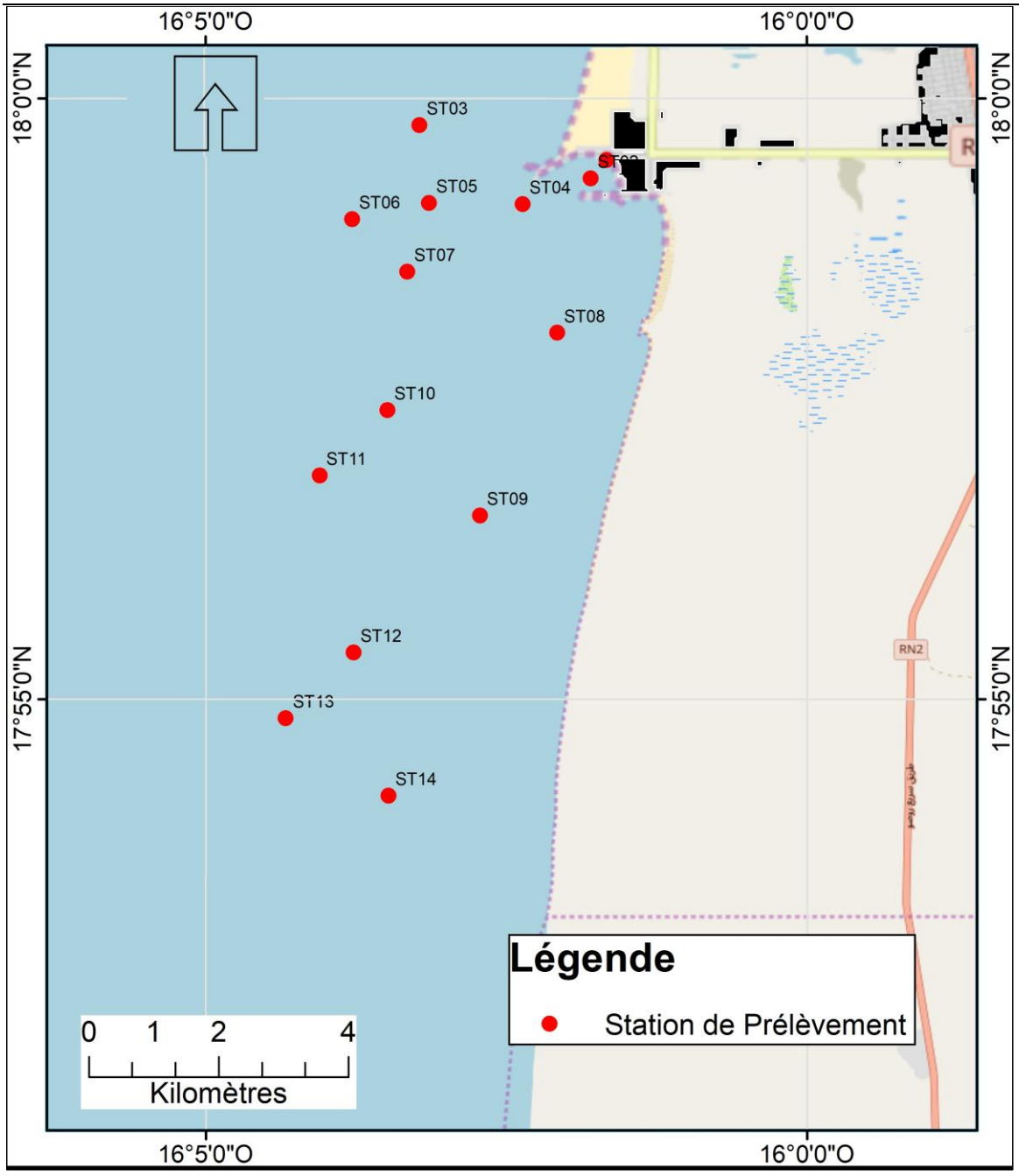

Figure 1 Localisation des sites et des stations d'échantillonnage

3. Echantillonnage

3.1. Sédiment-Benthos

L'échantillonnage des sédiments et du benthos a été réalisé à l'aide d'une benne de type Van veen de 0,0225 m² de surface. Cette benne est bien adaptée et fait remonter de petits volumes (environ1.5 kg) et

dans les rares cas où elle fait défaut d'autres essais sont effectués. Au moins six prélèvements de sédiments sont réalisés dans une station, une fois le sédiment à bord, nous procédons d'abord à l'échantillonnage pour la chimie, puis la granulométrie et le reste servira pour l'étude du benthos. Le sédiment du benthos est ainsi tamisé à travers 'un tamis de 1 mm de diamètre. Le refus est conservé dans au frais dans des flacons en plastique de 100 ml de volume avec toutes les indications sur la station.
Les flacons de plastique fournis par le laboratoire ont été remplis à ras bord pour limiter la présence d'air. Afin d'éviter toute contamination croisée, la benne était soigneusement lavée entre chaque station.
Les échantillons de la granulométrie sont conservés dans des sachets numérotés correspondant aux stations.

3.2. Eau de surface

Les échantillons d'eau de mer ont été réalisés à trois niveau de profondeurs (surface, mi- profondeur et près du fond) in situ après récupération avec une bouteille à renversement. Les mesures des paramètres environnementaux ont été effectuées à l'aide d'un appareil multifonction (T°, Sal, O2, TDS, Cond. Etc.) et un autre pour le pH. Ces mesures sont réalisées en deux (2) prises à mi- profondeur, la première pour les analyses in situ et la deuxième pour des analyses chimiques à réaliser aux laboratoires (en Tunisie, Green Lab).

3.3. Analyses fauniques

Au laboratoire, les 42 échantillons ont été triés du sédiment restant et les animaux contenus, ont été observés au moyen d'un stéréo-microscope (KRÜSS: MSZ5000-T-IL-TL) avec un grossissement de 7-45X. Tous les organismes marins ont été retirés de tous les échantillons et ont ensuite été déterminés. Les organismes récoltés dans les échantillons ont été identifiés au niveau de la classe, de l'ordre ou du sous-ordre pour la plupart des organismes. Les annélides ont été identifiés pour la plupart jusqu'au niveau générique ou spécifique lorsque la documentation disponible le permet, dans le cas contraire l'identification s'arrête à la famille. Plusieurs sources bibliographiques et Internet ont été utilisées pour identifier les individus dans le but de déterminer l'organisme observé au niveau taxonomique le plus bas possible Biodiversité de la faune benthique en générale (Campbell et al., (1979 ; Bos et al., 1998; Hayward & Ryland 2017 ; Ardovini & Cossignani, 2004 ; Fauvel, 1923, 1927) , des annélides polychètes (Fauvel & Rullier 1957, 1959; Intès & Le Loeuff, 1975, 1977; Bellan, 1960) et les mollusques (Pasteur-Humbert, 1962; González Pérez, 1995; Falciai, 1996; Hernández & Rolán, 2011). La nomenclature a été vérifiée et uniformisée à partir du registre mondial des espèces marines (WoRMS), l'encyclopédie de la vie (EOL), Système d'information taxonomique intégré (ITIS) et le catalogue de la vie (Catalogueoflife).

Les spécimens identifiés ont d'abord été comptés puis pesés avec une balance de précision (Sartorius analytic, AC 120 S, max 202 g et d 0.0001g) pour détecter le nombre d'individus, la masse humide et sèche individuelle de chaque espèce observée dans les prélèvements. En outre, des photos des espèces les plus représentatives et celles qui nécessitent une identification ont été prises. Pour cela, un stéréo-microscope avec une caméra connectée (VOPC93, Video-Okular für PC) a été utilisé.

4.Analyses des données

Toutes les informations enregistrées sur le nombre de taxons et leur poids humide et sec ont été saisies dans une feuille MS Excel qui a été utilisée pour les analyses statistiques. Les données collectées ont été standardisées en abondance (individus / m²) et la biomasse (poids humide ou sec / m²) des communautés ont été calculées par station comme étant la moyenne des sommes du poids et du nombre de tous les individus.

4.1. La diversité spécifique

Il a été procédé au calcul des descripteurs biologiques des communautés benthiques de la zone d'étude (la richesse, la diversité et l'équitabilité). La diversité spécifique a été mathématiquement caractérisée par :
(a) la richesse spécifique (S) :
(b) l'indice de diversité de Shannon-Weaver (H') :
Shannon et Weaver (Shannon & Weaver, 1949) $H' = -\sum_{i=1}^{S} p_i \, log_e p_i$
(c) l'indice de diversité de Simpson (Simpson, 1949) $1 - \lambda = 1 - \left(\sum_{i=1}^{S} p_i^2\right)$
(d) l'indices d'équitabilité de Pielou (J') ont été calculé comme suit :
Pielou (Pielou 1975) $j' = \frac{H'}{log_e}$ ou $j' = \frac{H'}{Hmax}$

où ***S*** = nombre total d'espèces dans une station, p_i = abondance relative de ***i***^{ème}espèce.
Pour les estimations de la richesse spécifique, de l'indice de diversité de Shannon, de l'indice de diversité de Simpson et de l'équitabilité de Pielou, les différences de ces indices de diversité entre les stations ont été comparées à l'aide d'une ANOVA et de tests post hoc de Tukey HSD.

4.2. Les analyses multivariées

La structure de la communauté benthique a été calculée à partir de la matrice de similarité de Bray-Curtis, les densités ont été transformées en utilisant la transformation de la racine carrée pour égaliser le poids de toutes les espèces présentes dans l'analyse et de réduire l'effet des espèces dominantes (Clarke 1993 ; Clarke & Warwick, 2001). Des analyses de similarités (ANOSIM, Clarke 1993) ont été utilisées pour tester d'éventuelles différences dans la structure de la communauté benthique entre les types d'habitats. En plus, l'analyse de la variance semi-paramétrique permutationnelle (PERMANOVA ; Warwick & Clarke, 1995 Anderson & Robinson, 2003 ; Anderson et al., 2008) a été utilisée pour tester l'effet des stations d'échantillonnage sur la composition faunistique de la communauté benthique.

Deux analyses multivariées de la communauté benthique ont été réalisées sur les mêmes données normalisées pour comparer la structure de la communauté entre les stations. La première, une analyse de classification ascendante hiérarchique (CAH), utilisant le coefficient de similarité de Bray-Curtis (Bray & Curtis, 1957). La CAH basée sur la distance moyenne non pondérée (UPGMA : Ludwig & Reynolds, 1988 ; Romesburg, 1990) calculée sur l'abondance a été appliqué pour lier les échantillons dans de groupes de

communautés benthiques. La seconde, une approche d'ordination multidimensionnelle non métrique (MDS) utilisant également l'indice de Bray Curtis, a été effectuée.
Une analyse SIMPER (Clarke 1993) a été réalisée (avec un seuil de 90%) sur les données transformées afin de déterminer quelles espèces étaient les plus responsables de la dissimilarité dans la structure de la communauté benthique entre les types d'habitats.

5. Analyses de l'imagerie des habitats et de l'épifaune benthique

Deux plongeurs ont effectué des prises photos ont été réalisée à chaque stations et pour celles impaires (ST01, ST03, ST05, ST07, ST09, ST11 et ST13) des enregistrements vidéos ont été réalisés. Des profils verticaux de sédiments aux stations d'échantillonnage ont été utilisés pour obtenir des images des habitats du fond et les organismes présents. Jusqu'à 6 déploiements ont été effectués à chaque station, sur un linéaire de 200 m. Les principaux paramètres évalués étaient la nature sédimentaire du fond, les types d'habitats et a présence d'organismes marins (toute faune visible, signes de remaniement du sédiment ou de bioturbation).

6. Résultats

6.1 Benthos

6.1.1 Estimations de la densité et de la biomasse des communautés benthiques

Au cours de cette campagne d'échantillonnage dans le port autonome de Nouakchott, la densité de la faune dans tous les stations de prélèvements était de 19111 individus par m^2, pour une biomasse totale de 2754 g par m^2. Les individus des taxons collectés sont répartis en 86 espèces différentes comprenant 62 familles, 34 ordres, 11 classes et 7 phylums (Annexe 1).La plus forte densité d'organismes benthiques (5200 indiv. × m^{-2}) et la biomasse la plus élevée (836 g × m^{-2}) ont été observées dans les stations réparties dans le chenal. Les valeurs de celles-ci dans les autres sites de prélèvements étaient les suivantes :4578 indiv. × m^{-2} et 297 g × m^{-2} dans la zone C ;2667 indiv. × m^{-2}et 565g × m^{-2} dans la zone B ;1911 indiv. × m^{-2} et442 g × m^{-2} à l'aval du chenal ;1822 indiv. × m^{-2} et 144 g × m^{-2} dans le bassin ; 1511 indiv. × m^{-2} et 212 g × m^{-2} dans la zone A et 1422 indiv. × m^{-2} et 258 g × m^{-2} en amont du chenal (tableau 1 et figure 2A-B).

L'analyse des coefficients de corrélation de Spearman entre la densité de la faune benthique du port et les sites de prélèvements révèle une faible dépendance entre ces variables entre le bassin, le chenal, l'aval, les zones B et C (r négatif et compris entre -0.23 et -0.04), mais aucune dépendance de ce type n'a été constatée. La densité est positivement corrélée aux sites sensés recueillir les rebus de dragage, les coefficients de corrélation sont compris entre 0.60 et 0.99, (tableau 1).

Tableau 1 densité, de biomasse et coefficients de corrélation de Spearman entre les sites étudiés

		Bassin	***Amont***	***Chenal***	***Aval***	***Zone A***	***Zone B***	***Zone C***
Densité de la faune benthique du Port Autonome de Nouakchott en individus x m^{-2}	***[indiv. × m–2]***	1822	1422	5200	1911	1511	2667	4578
	Bassin	1						
	Amont	**0.59**	1					
	Chenal	-0.20	0.40	1				
	Aval	-0.23	0.35	**0.94**	1			
	Zone A	**0.58**	**0.58**	**0.61**	**0.60**	1		
	Zone B	-0.23	0.38	**0.97**	**0.99**	**0.60**	1	
	Zone C	-0.04	0.39	**0.86**	**0.89**	**0.62**	**0.86**	1
Biomasse de la faune benthique du Port Autonome	***[g × m– 2]***	144	258	836	442	212	565	297
	Bassin	1						

de Nouakchott en g x m^{-2}	***Amont***	**0.50**	1					
	Chenal	**0.68**	**0.69**	1				
	Aval	-0.37	0.32	0.14	1			
	Zone A	**0.60**	**0.85**	**0.95**	0.32	1		
	Zone B	**0.75**	**0.624**	**0.98**	-0.04	**0.90**	1	
	Zone C	**0.76**	**0.69**	**0.75**	0.28	**0.80**	**0.70**	1

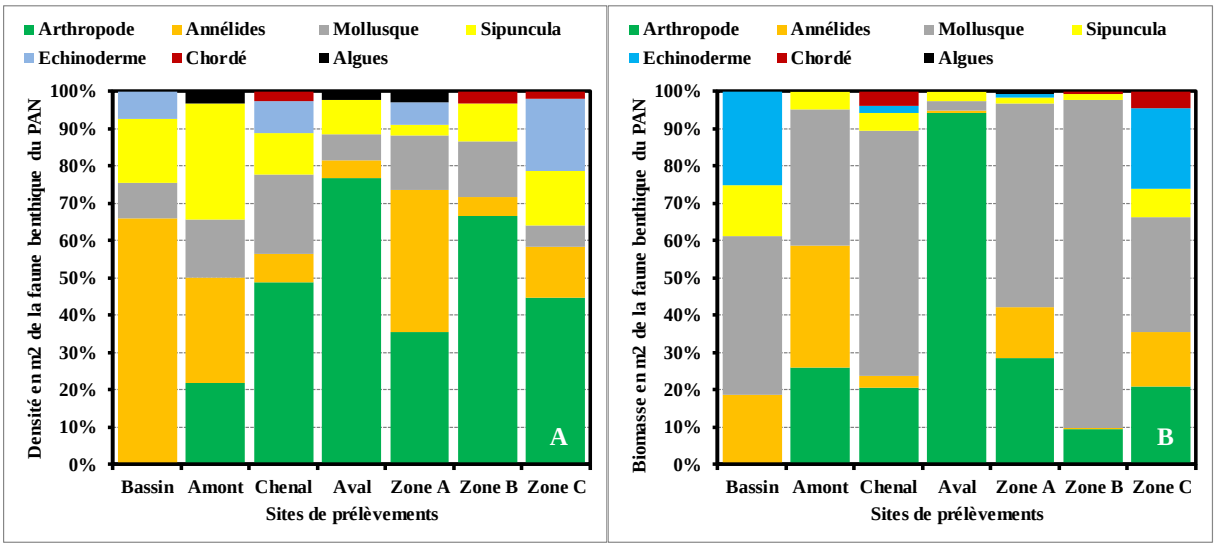

Figure 2 Pourcentage de la densité (A) et de la biomasse (B) de la faune benthique d'invertébrés des sites de prélèvements

La densité totale, la biomasse totale et le pourcentage des individus composant les groupes taxonomiques sont indiqués dans le tableau 2 et les figure 3A-B. Les arthropodes représentent le groupe le plus abondant (45.35%) à raison de 8667 individus au mètre carré et il est composé de 31 espèces. Le groupe taxonomique représentant les annélides vient en seconde position en densité (30.93%), dont les siponcles (2489 individus/m^2) et le polychète genre Nephtys (1911 individus/m^2). Les autres groupes peuvent être classés dans l'ordre décroissant suivant la densité par : Mollusques (13.26%) avec une diversité d'une trentaine d'espèces, puis les échinodermes (8.14%) et d'autres organismes marins (2.33%) regroupant des chordés (ascidies et l'amphioxus) et des débris d'algues, Figure 3A.

Suivant les stations, celle de ST05 présente la plus abondante densité (20.93%) par rapport à l'ensemble des stations échantillonnées et la station ST13 est la moins abondante en densité (1.40%).
La densité et la biomasse moyenne de la faune benthique totale étaient de 97 individus au mètre carré et 13.91 g au mètre carré de poids humide. Les échinodermes et les arthropodes étaient les groupes dominant avec des densités moyennes de 141 et 108 individus au mètre carré, respectivement.

Cependant, les biomasses moyennes des mollusques et des échinodermes prédominaient avec des valeurs de de 33.09et 10.68 g au mètre carré, respectivement.

En termes de biomasse spécifique, le crustacé décapode*Anapagurussp* (biomasse : 16.43%) est le plus dominant (sa densité : 10.00%) sur l'ensemble des autres espèces (en moyenne respectivement de 452.35 g/m^2 et 1911 individus/m^2). L'annélide polychète (*Cirratulus cirratus*) est présente en faible quantité en masse (0.001 g/m^2) et en nombre (44 individus/m^2).

Dans la littérature il a été plusieurs fois souligné l'importance des polychètes dans les environnements marins benthiques. Ce groupe taxonomique est un choix représentatif dans l'analyse de la santé des communautés benthiques, puisqu'il est généralement composé d'espèces les plus abondantes pris dans les échantillons benthiques (Dean, 2008).

Tableau 2 Nombre total d'espèces et le pourcentage des principaux groupes taxonomiques.

Groupe taxonomique	Densité	% numérique	Biomasse	% pondéral
Arthropodes	8667	13.26	829.63	51.67
Annélides	5911	45.35	332.72	30.13
Mollusques	2533	30.93	1422.78	12.08
Echinodermes	1556	8.14	117.46	4.27
Chordés	311	1.63	49.77	1.81
Algues	133	0.70	1.42	0.05
Totaux	19111	100	2754	100

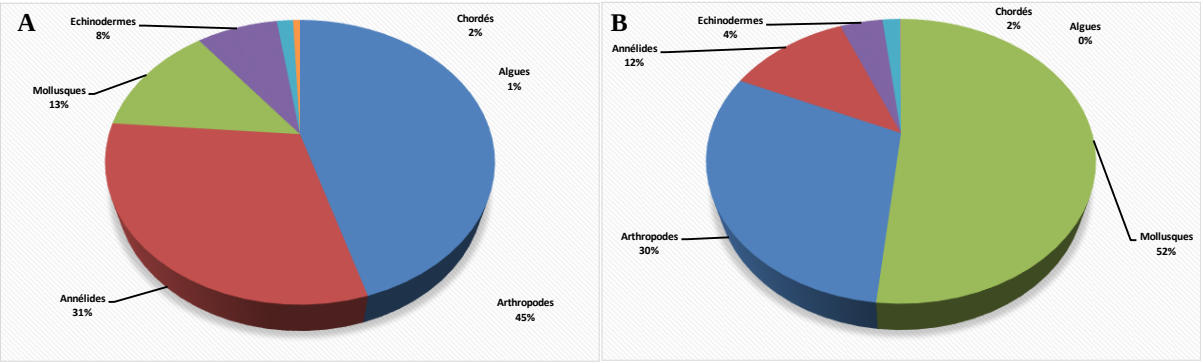

Figure 3 Composition taxinomique (A) de la densité (nombre d'individus/m^2) et (B) de la biomasse en (poids humide en g/m^2) dans le Port Autonome de Nouakchott.

6.1.2 Indices de diversité spécifique

La diversité des espèces de la faune benthique dans les écosystèmes aquatiques est liée à son abondance. Une diversité élevée pourrait indiquer une chaîne alimentaire plus large, une interaction interspécifique et une stabilité au sein de la communauté benthique marine. Dans toutes les stations échantillonnées au niveau du port autonome de Nouakchott, un total de 84 espèces d'invertébrés

benthiques a été dénombré. Ces espèces ont été subdivisées en six principaux groupes taxonomiques (Mollusques, Arthropodes, Annélides, Echinodermes, Chordés et Algues). Les indices de diversité calculés au niveau des stations d'échantillonnage (richesse spécifique, les indices hétérogènes de Shannon (H') et de Simpson, et l'équitabilité de Pielou de la faune benthique sont résumés dans le Tableau 3 et illustrés aux figures 4A-D.

Tableau 3 Indices de la diversité spécifique calculés pour les stations considérées : la richesse spécifique ; indice de Shannon-Wiener, indice de Simpson et l'indice d'équitabilité de Pielou.

Stations	Indices de diversité			
	Richesse spécifique (S)	Shannon (H')	Simpson (1-λ)	Pielou (J')
ST01	7	2.44	0.77	0.87
ST02	3	1.19	0.47	0.75
ST03	11	2.95	0.83	0.85
ST04	10	3.15	0.87	0.95
ST05	34	4.63	0.95	0.91
ST06	6	2.04	0.66	0.79
ST07	11	2.78	0.81	0.8
ST08	12	3.27	0.86	0.91
ST09	11	3.24	0.88	0.94
ST10	12	3.17	0.86	0.88
ST11	4	1.44	0.58	0.72
ST12	11	2.99	0.85	0.86
ST13	5	2.25	0.78	0.97
ST14	21	3.44	0.83	0.78

La plus grande diversité a été observée à la station ST05, la richesse spécifique s'élève à un nombre total de 34 espèces, la plus faible richesse (3 espèces) est observée au niveau des stations ST02 et la moyenne est de 11 espèces (±7.95). Les polychètes, les arthropodes et les mollusques sont présents dans plus de dix stations et constituent les groupes les plus occurrents (figure4A et tableau 3).
L'indice de diversité de Shannon, montre de valeurs très élevées supérieures à 3.10 au niveau des stations ST04, ST05, ST08, ST09, ST10 et ST14 (valeurs comprises entre 3.15-4.63). La plupart de ces stations sont profondes (>10 m), elles sont caractérisées par un sédiment de type sable moyen à fin sauf pour la station ST14 où le substrat est de type rocheux. Pour le reste des stations, les valeurs varient entre 2.04 et 2.99 et sont communes (ST01, ST03, ST06, ST07, ST12 et ST13). Les types sédimentaires constituant ces stations sont du sable finet de la vase sableuse. Par contre les plus faibles valeurs de cet indice ont été observées au niveau de deux statons (ST02 et ST11) dont la richesse spécifique est la plus basse,(Figure4B et tableau 3).

Les valeurs les plus élevées de l'indice de diversité de Simpson ont été obtenues dans 9 stations et il varie entre 0.81 et 0.95 (0.8611±0.041). Les faibles valeurs de l'indices ont été enregistrées dans quatre stations

(ST01, ST02, ST06, ST11 et ST13), les richesses spécifiques et les abondances dans ces stations sont aussi les plus basses (Figure 4C et tableau 3).

L'équitabilité de Pielou (J) n'était pas significativement différente dans les stations échantillonnées (p = 0.065). Néanmoins, les valeurs maximales ont été observées au niveau des douze stations (0.48-0.57~0.53± 0.063), et minimales aux stations ST02 et ST11 (0.72~0.75± 0.021). Les valeurs de cet indice d'équitabilité est proche de l'unité suggérant que ces stations abritent des espèces équitablement distribuée et auraient des abondances sensiblement similaires, (Figure 4D et tableau 3).

L'analyse de la variation (ANOVA) n'a pas détecté d'effets significatifs du facteur station sur la variabilité des quatre indices de diversité pris en compte dans cette étude.

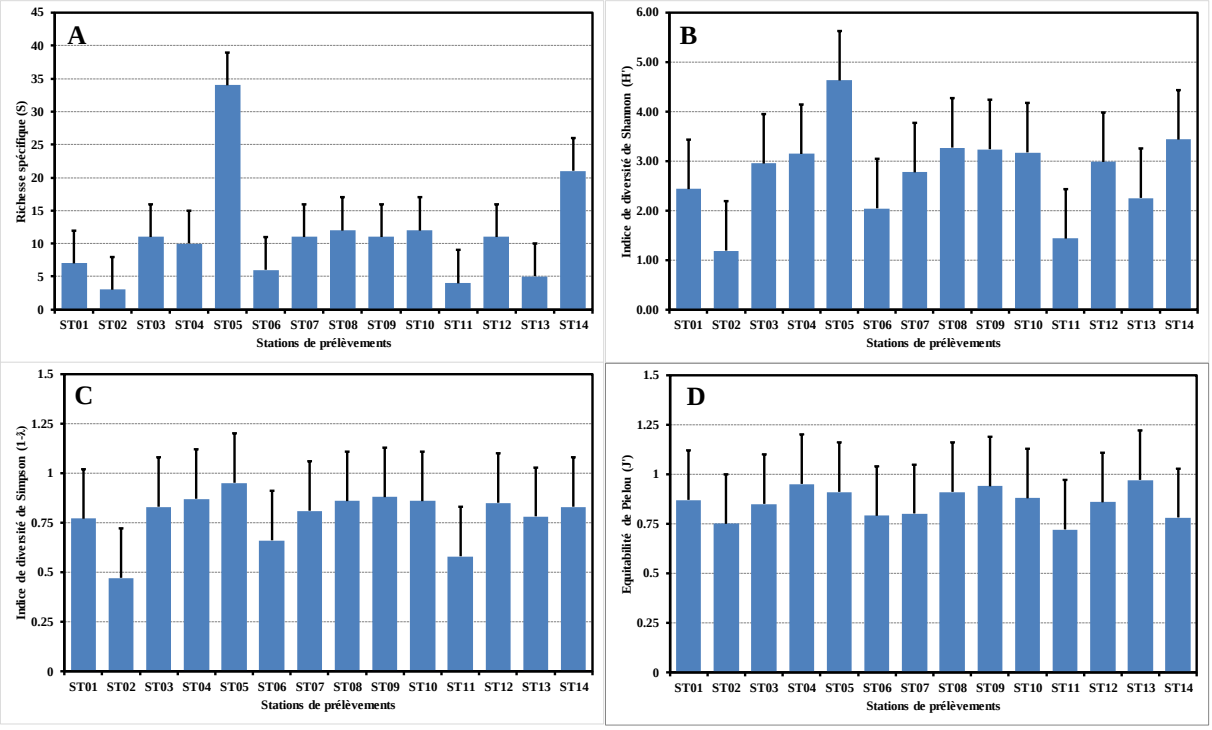

Figure 4 Indices de diversité spécifique calculés au niveau des stations d'échantillonnages : (A) Richesse spécifique, (B) Indice de diversité de Shannon (C)Indice de dominance de Simpson (D) et Indice d'équitabilité de Pielou

6.1.3 Analyse multivariée de la diversité de la communauté benthique

Les résultats de l'analyse de similarité (ANOSIM) à priori basés sur la densité des espèces n'ont révélé aucune différence significative de la communauté benthique parmi les types d'habitats au niveau de chaque station échantillonnée (R=1 et p=1 ns). Les différences de la composition de la communauté benthique entre les stations d'échantillonnages n'ont pas aussi été significatives (test PERMANOVA : les comparaisons des stations, df = 13, p =1=), par contre en tenant compte des sites abritant les différentes stations d'échantillonnage une partde la variation est observée au sein de la structure des communautés

benthiques (test PERMANOVA : la variable site explique 45 % de la variance et les comparaisons des sites, df = 6, pseudo-F=0.954 et p =0.609 ns).

En se positionnant à un niveau de similarité de 87%, le dendrogramme des similitudes entre les stations met en évidence deux groupes de stations clairement différenciés le long de la zone d'échantillonnages (Fig.5A). Quatre stations individuelles distinctes (ST03, ST04, ST05 et ST14) des deux premiers groupes. Le premier groupe constitué de trois stations (ST07, ST10 et ST12) et le second groupe de sept stations, figure 5B.

En effet, la séparation des stations selon le site n'apparaît pas clairement dans nos analyses (CAH et nMDS). Ces observations indiquent qu'aucun effet espace ne contribue au groupement de stations selon les communautés benthiques. En d'autres termes l'assemble des communautés benthiques dans la zone d'étude pourrait être dû à d'autres facteurs du milieu. Nous pouvons en citer entres autres la nature sédimentaire du fond et probablement les conditions environnantes des sites.

Le coefficient de contrainte (s) de l'ordination de nMDS est de 0.1293, il indique une ordination adéquate (le Stress < 0.2). Les espèces *Dosinia lupinus*, *Euclymene lumbricoide* et *Nephtys sp*sontresponsables de la structure de la communauté benthique au sein des stations, elles ont été identifiées par une analyse des pourcentages de similarité (SIMPER) sur les données d'abondance transformées. L'analyse SIMPER a démontré qu'en termes de pourcentage de contribution, les trois espèces ont expliqué la plupart de similarité moyenne (21.46 %) entre les différents types sédimentaires des stations d'échantillonnages. Les contributions moyennes de ces espèces étaient *Dosinia lupinus* (9.21 %), *Euclymene lumbricoide*(7.53 %) et *Nephtys sp*(4.72 %).

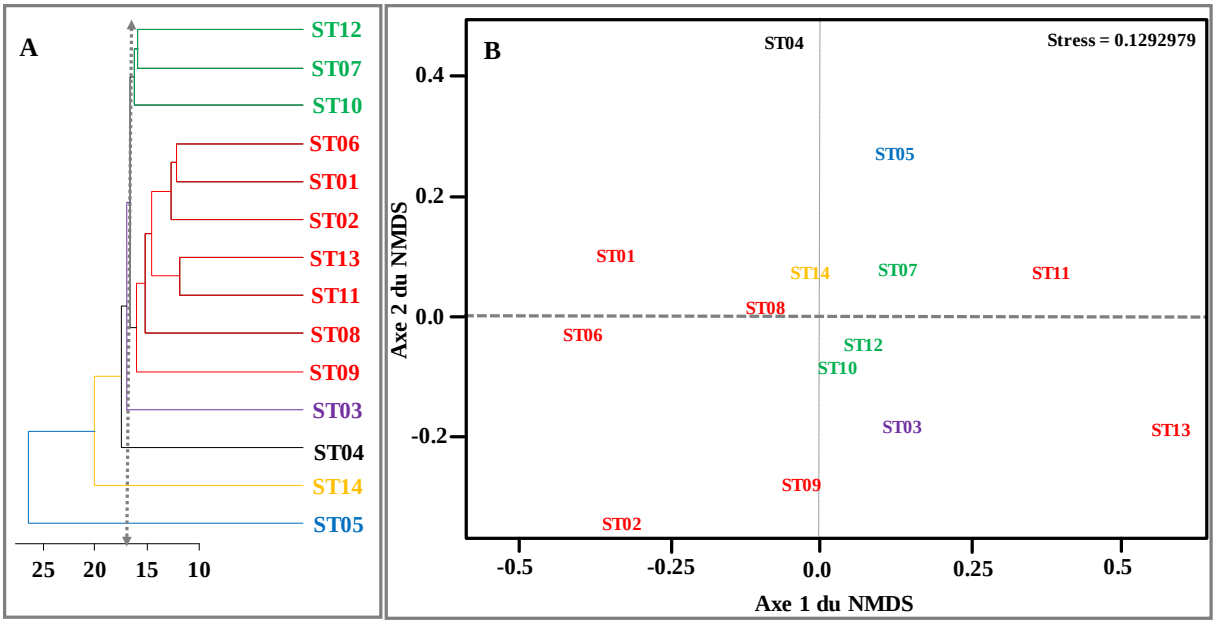

Figure 5 Dendrogramme (A) et Ordination MDS (B); les groupes obtenus à partir d'une analyse de classification des stations de prélèvements des communautés benthiques.

6.1.4. Interprétation des analyses photos et vidéos des habitats et de l'épifaune benthique du PANPA

Durant cette campagne des plongées sous-marines ont été effectuées par des spécialistes pour l'obtention des images photos et vidéos pour caractériser les types d'habitats et les l'occurrence des espèces dans ces écosystèmes. Des prises photos ont été prises dans toutes les 14 stations dans les différents sites du PANPA et seulement la moitié pour les vidéos. Le dérushage des photos et des vidéos de la plongée effectuée lors de cette campagne a permis de qualifier le substrat aux différentes stations (Tableau 4).
Ces informations scientifiques sont de très bonne qualité, les observations issues de ce dérushage ont permis aussi d'identifier des espèces présentes en collaboration avec les spécialistes du domaine dans le laboratoire. Sur l'ensemble des images collectées aux différentes stations de prélèvements, seulement la moitié a été exploitable et l'autre moitié était floue, la visibilité était faible pour observer les habitats et les espèces.
Le type sédimentaire le plus fréquemment rencontré est du sable fin attestant de l'activité d'érosion et de l'hydrodynamisme de la zone (Kidé & Bâ, 1994). Les fonds meubles sablonneux présentent de signes de présence d'habitats de crabes (ST01, ST03, ST05 et ST07) et de débris de coquilles de bivalves, ce type d'habitat est propice pour des organismes fouisseurs.

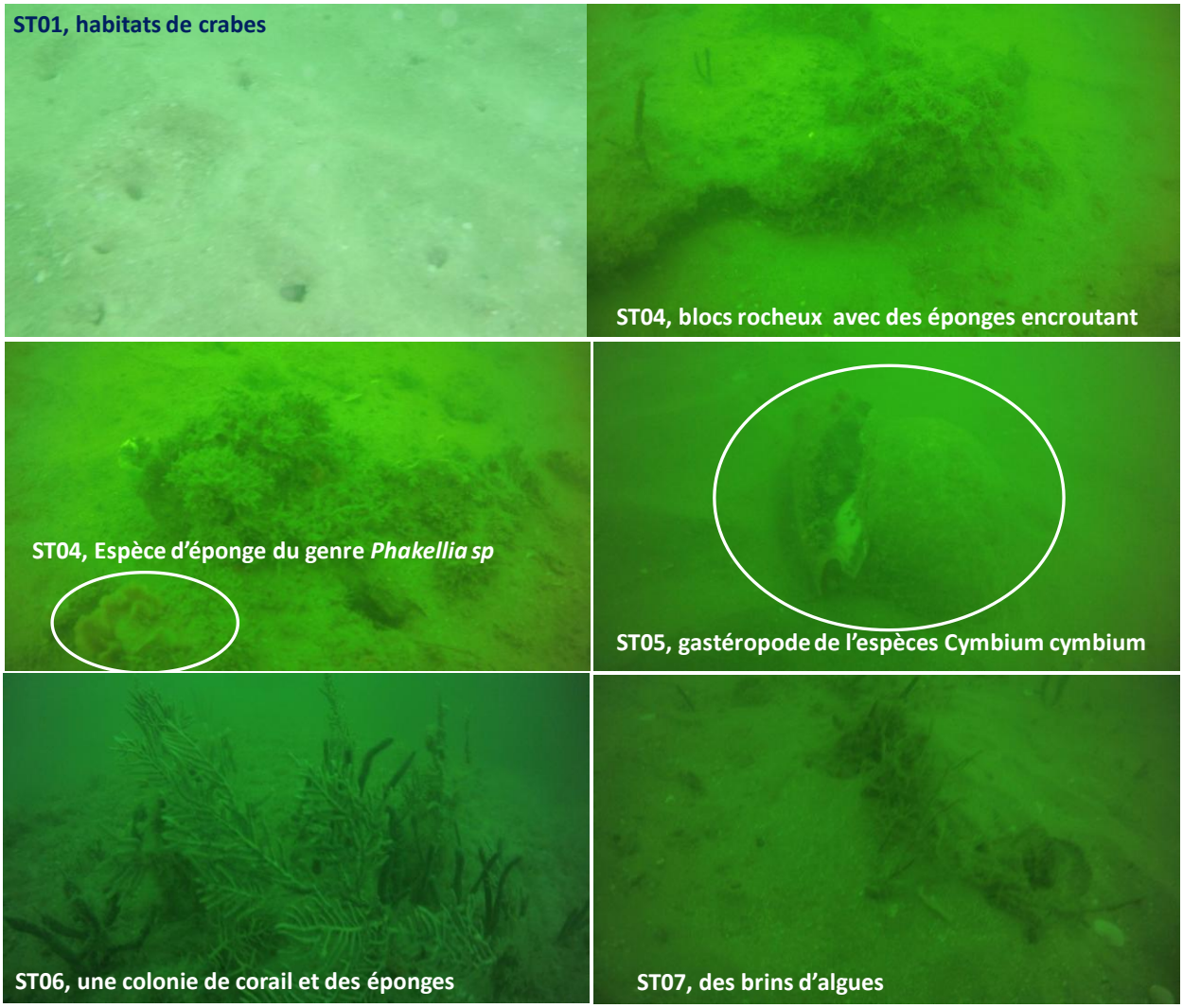

Photo 3 Communautés des fonds meubles, présence de massifs d'éponges et de coraux blancs vivants, des blocs rocheux, concrétionnés ou non, formant de nombreuses cavités et identification d'un genre d'éponge *Phakellia* et du mollusque gastéropode *Cymbium cymbium* (cercle blanc).

Dans les stations ST04, ST05, ST06, ST07 et ST11, des organismes dressés et encroutant ont été observée sous différents états, ils sont composés d'algues, d'éponges et du corail. L'exploitation des vidéos nous a permis d'observer des poissons en activité dans le milieu et des oursins près des affleurements rocheux constituant l'essentiel du fond de la ST11.

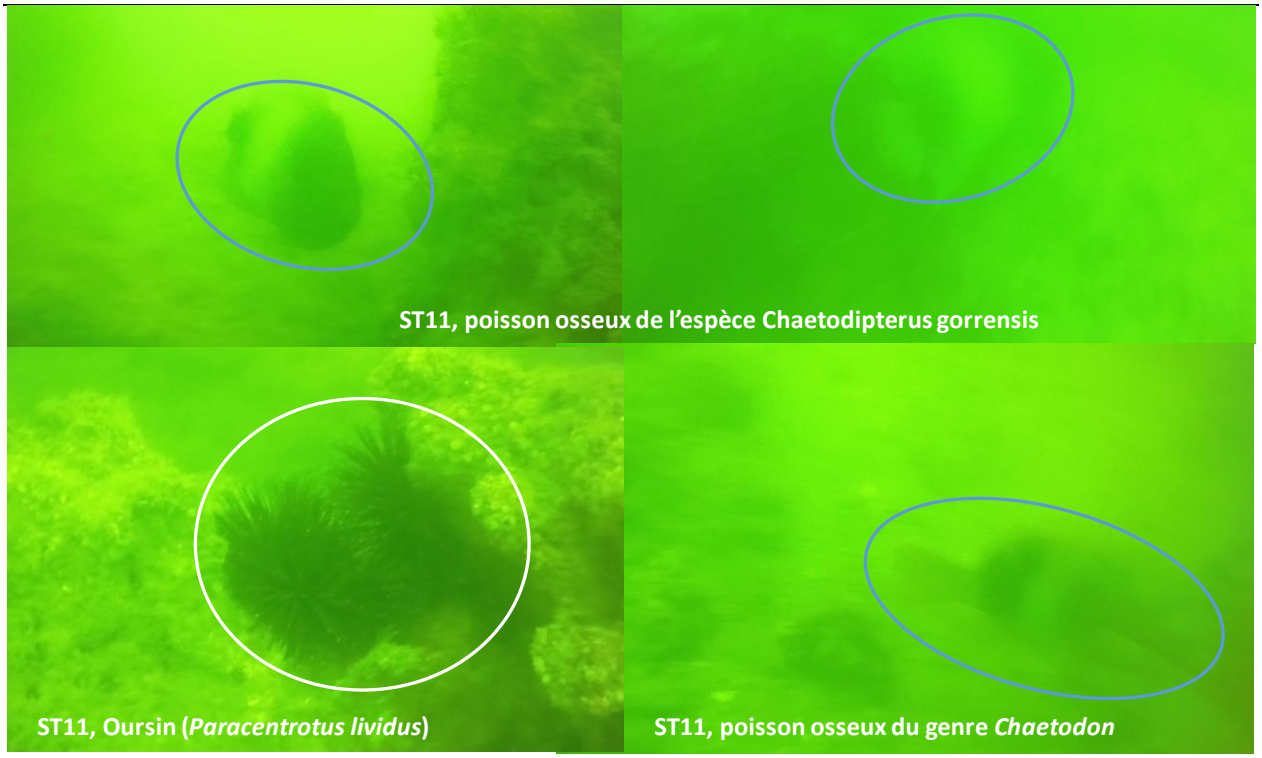

Photo 4 Prises sur la vidéo de la ST11, un fond rocheux abritant une diversité d'espèces de poissons (Cercles en bleu) et deux individus d'oursin (cercle en blanc).

L'analyse selon l'échelle de SACFOR, montre que les éponges, les crabes et les poissons sont les occurrentes classes d'organismes épibenthiques observés dans ces vidéos et photos, ils constituent des communautés abondantes dans cet écosystème. Les classes formant les coraux, les bivalves et les échinodermes sont communes dans cet écosystème et les algues et gastéropodes sont rares dans ces stations, voir Tableau 4 et Photos 3 et 4.

tableau4 Analyses photos et vidéos des habitats et l'épifaune benthique du PANPA selon l'échelle de SACFOR

Stations	Types d'habitats et la nature sédimentaire	Algues brunes	Coraux	Crabes	Echinodermes	Eponge	Bivalves	Gastéropodes	Poissons osseux
ST01	Fond meuble Sablonneux + Habitats d'organismes								
ST02	Non exploitables, visibilité trop faible								
ST03	fond meuble sablonneux + Débris de mollusques								
ST04	Fond meuble Sablonneux + roches + Habitats d'organismes								
ST05	Fond meuble Sablonneux + rochers + habitats d'organismes fouisseurs +Habitats de Bernard l'Hermite								
ST06	Fond meuble Sablonneux + roches + organismes en croûtes et dressé								
ST07	Fond meuble Sablonneux + bruns d'algues								
ST08	Non exploitables, visibilité trop faible								
ST09	Non exploitables, visibilité trop faible								
ST10	Non exploitables, visibilité trop faible								
ST11	Rochers + colonies d'éponges								
ST12	Non exploitables, visibilité trop faible								
ST13	Non exploitables, visibilité trop faible								
ST14	Non exploitables, visibilité trop faible								

Abondante	*****	Commune	****
Fréquente	***	Occasionnelle	**
Rare	*		

7.Conclusion

L'abondance et la diversité des espèces d'Annélides (polychètes) et la dominance des mollusques dans les écosystèmes benthiques sont connues pour être des indicateurs d'un milieu en bon état de fonctionnement. Les valeurs des paramètres écologiques, la densité, la biomasse totale et les indices de diversité, sont dans de bonnes limites d'une communauté benthiques qui n'a pas subi trop de stress. L'absence de variabilité de la diversité spécifique des stations échantillonnées montre que ces espèces benthiques sont distribuées suivant d'autres facteurs du milieu, entre autres le substrat, les conditions physico-chimique du milieu etc.

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http://www.marinespecies.org/index.p

Annexe Composition spécifique de la faune benthique du PANPA

Tableau 5 Composition taxonomique, la densité (indiv.*m-2)et la biomasse (g*m-2) de la faune benthique du PANPA.

Embranchement	Classe	Ordre	Famille	Nom taxonomique	Densité en ind.*m^{-2}	Biomasse en g*m-2
Algues	Algues			Algu brune**	267	2.84
Annélides	Polychète	Echiuroinea	Echiuridae	*Echiurus sp*	89	4.88
		Eunicida	Onuphidae	*Diopatra neopolitana*	178	18.27
		Phyllodocida	Nephtyidae	*Nephtys sp*	489	30.44
			Nereididae	*Nereis sp*	1422	37.64
			Polynoidae	*Polynoe sp*	178	0.71
		Polychète	Polychète	*Polychètes errante***	44	4.71
		Sabellide	Oweniidae	*Owenia fusiformis*	89	38.22
		Sedentaire	Arenicolidae	*Arenicola sp*	89	24.31
			Dorvellidae	*Annélide polychète*	44	0.40
			Hesionidae	*Annelide speculien*	44	0.31
			Maldanidae	*Euclymene lombricoides*	44	0.93
				Euclymene sp	44	13.51
				Euclymene veccili	44	0.04
			Oweniidae	*Owenia sp*	89	1.33
			Spionidae	*Annélides sédentaire***	44	11.56
				Streblospio benedicti	178	12.32
		Terebellida	Cirratulidae	*Cirratulus cirratus*	44	0.00
Arthropode	Branchiopode	Anomopode	Daphniidae	*Daphnia magna*	133	1.92
	Crustacé			*Crabe***	89	10.19

	Malacostraca	Amphipode	Ampeliscidae	*Ampelisca brevicornis*	1689	13.88
			Amphilochidae	*Amphilocus neopolitanus*	844	7.29
			Caprellidae	*Aeginina longicoris*	444	0.22
				Caprella scaura	44	0.04
				Caprella sp	44	0.04
				Pseudaeginella colombiensis	311	0.51
			Corophiide	*Corophiidae*	89	0.09
			Gammaridae	*Gammarus sp*	44	0.44
			Leucothoidae	*Leucothoe ubouhu*	44	0.44
		Cumacea	Diastylidae	*Diastylis bradyi*	1067	1.76
		Decapoda	Crangonidae	*Pontophilus sp*	178	3.47
			diogenidae	*Dardanus sp*	44	10.44
			Epialtidae	*Pisa tetraodon*	133	10.64
			leucoscidae	*Ilia nucleus*	44	0.49
			Majidae	*Maja squinado*	44	23.47
			Munididae	*Munida pilorhyncha*	89	1.07
			Pagruridae	*Anapagurus sp*	1911	452.35
				Pagurus sp	755	232.86
			Pilumnidae	*Pilumnus hirtellus*	44	1.67
			Pinnotheridae	*Pinotheridae*	44	0.20
			Porcellanidae	*Pisidia longicornis*	133	46.25
			Thoridae	*Thoralus sp*	44	3.87
		Euphausiacea	Euphausiidae	*Euphausiacea*	44	1.89
		isopodes	Sphaeromatidae	*Paracerceis sculpta*	44	0.93
		Leptostraca	Nebaliidae	*Nebalia bipes*	44	2.00

		Tanaidacea	Tanaissuidae	*Tanaissus lilljeborgi*	222	1.19
Chordé	Ascidiacea	Phlebobranchia	Ascidiidae	*Ascidiidae*	89	44.34
	Cephalocordé	Amphioxipome	Branchiostomitidae	*Branchiostoma lanceolatum*	222	5.43
Echinoderme	ophiuroida	Ophioscolecida	Ophiohelidae	*Ophiolepus sp*	1244	76.47
		ophiurida	ophiuridae	*Ophioclenella acies*	222	39.68
				Ophiura ophiura	44	1.00
				Ophiura sp	44	0.31
Mollusque	Bivalve	Cardiida	Cardiidae	*Cerastoderma edule*	44	306.09
			Donacidae	*Bivalve***	44	6.00
				Donax sp	133	21.20
			Solecurtidae	*Solecurtus strigilatus*	44	1.33
			carditidae	*Cardiocardita ajar*	133	82.13
		Lucinida	Lucinidae	*Ctena orbiculata*	44	3.13
		Nuculoida	Nuculidae	*Nucella lapillus*	44	3.55
		Veneroida	Veneridae	*Dosinia histria*	44	103.78
				Dosinia lupinus	89	10.80
				Dosinia sp	44	0.50
	Gastéropode	Caenogastropode	Turritellidae	*Turritela sp*	133	2.31
		Litorinimorpha	Naticidae	*Natica lineata*	89	31.98
				Natica fulminea	44	47.29
			Barleeiidae	*Barleeia sp*	44	48.67
			Charoniidae	*Charonia lampas*	44	4.22
				Naticoidea	44	47.29
		Neogastropoda	Marginellidae	*marginella glabella*	44	7.40
				Marginella simeri	44	31.56
				Marginella sp	44	10.00

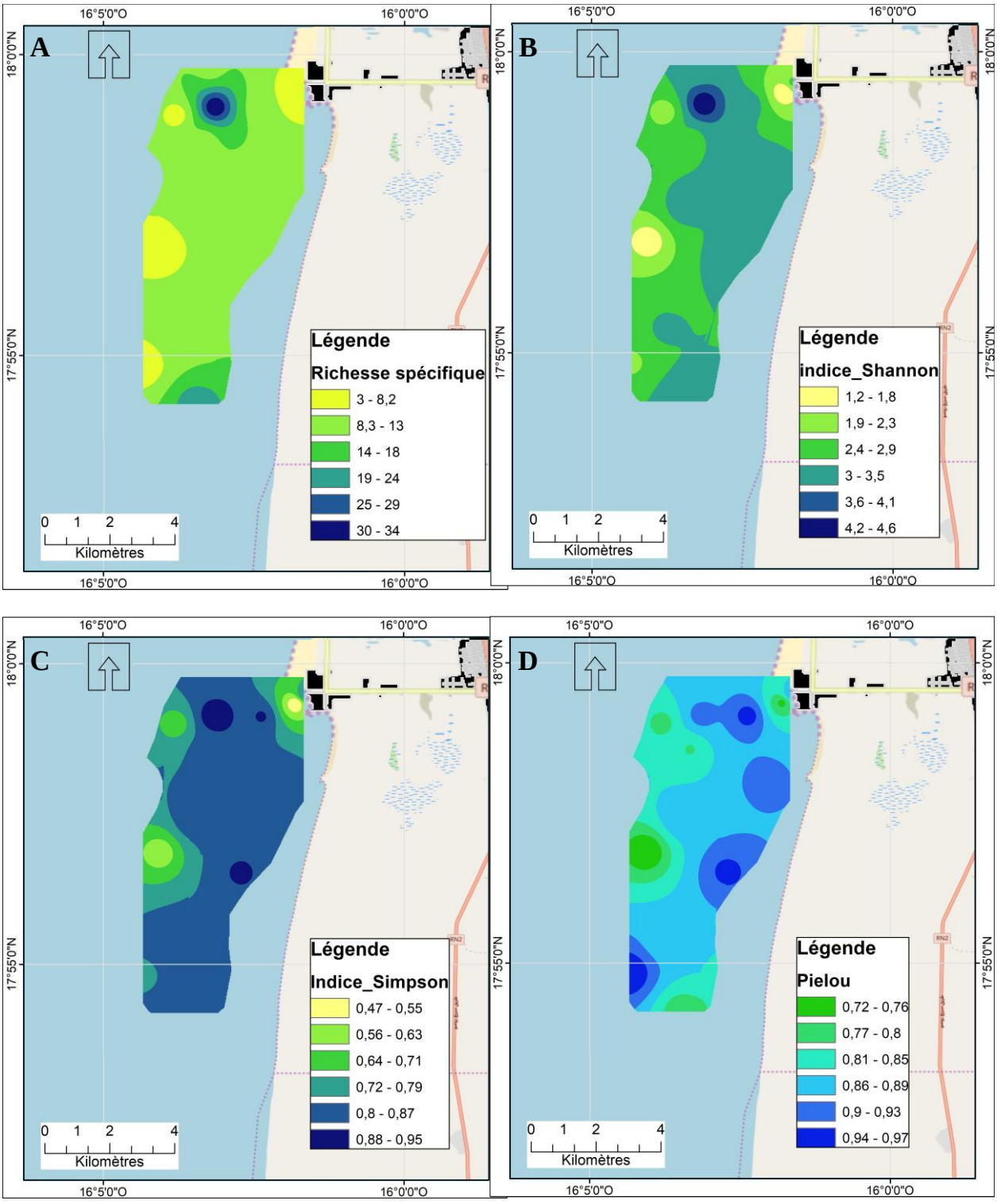
			Muricidae	*Tritonalis aciculata*	44	4.91
			Fasciolariidae	*Pustulatirus*	222	74.47
			Marginellidae	*Volvarina ampelusica*	311	222.76
			Nassaridae	*Nassarius reticulatus*	133	165.90
				Nassarius sp	267	62.52
				Nassarius vaucheri	222	145.68
		neotaemioglossa	hydrobiidae	*Peringia ulvae*	44	2.32
		Trochida	Phasianellidae	*Phasianella sp*	44	6.42
				*GAST99***	44	13.60
	Polyplacophora	Chitonida	Acanthochitonidae	*Acanthochitona crinita*	44	2.29
Sipunculiens	Sipunculidé	Golfingiida	Golfingiidae	*Thysanocardia nigra*	2489	119.91

Photographies des espèces benthiques observes dans les échantillons



Photo 5Quelques-unes des espèces de faune benthique identifies et photographiées sous la loupe binocculaire avec une camera incorporée.

Annexe Diversité de la faune benthique du PANPA



Appendix 5

Wave agitation, dredging impact assessment, hydro-sediment study issued by DHI

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Nouakchott – Port de l’amitié

Wave agitation, dredging impact assessment, hydro-sediment study



Groupe MAGMA
Progress report 4

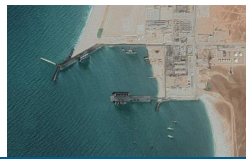
May 2019

The expert in WATER ENVIRONMENTS

Nouakchott – Port de l'amitié

Wave agitation, dredging impact assessment, hydro-sediment study

Prepared for	Groupe MAGMA
Represented by	KHALIFA Abderrahmane



Port de l'Amitié, source : GoogleEarth

Project manager	Fabrice Gouaud

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1 Introduction

DHI has been requested to provide a proposal for modelling services to MAGMA to support the project development of a new quay at Port de l'Amitié in Nouakchott, located in Mauritania.

These modelling studies include:

- A wave agitation study
- A hydro-sediment study
- An impact assessment of sediment discharge into ambient environment during:
    - dredging operations (excavation);
    - offshore disposal (dumping) of dredged material.



Figure 1.1: Site location

This document is the second progress report issued at this early stage of these studies. It contains:

- Updated data basis: from the provided documents, inhouse database;
- Wave propagation analyses;
- Wave agitation: model setup and results;
- Dredging impact assessment; high level study results (2D) and 3D modelling results;
- Hydro-sediment: shoreline evolution analysis and model results.

2 Data basis

2.1 Literature

MAGMA provided the following documents which will be exploited fir this mission:

- IRC/DHI: final report: étude de l'agitation dans le bassin du port de Nouakchott- december2009 ;
- IRC/ST-MARTIN PAYSAGE : revue de l'état des risques d'inondation de la ville de Nouakchott, rapport préliminaire volume 2 : modélisation numérique;
- Ahmed Ould ELMOUSTAPHA, thèse de l'université de Caen. Influence d'un ouvrage portuaire sur l'équilibre d'un Littoral soumis à un fort transit sédimentaire : L'exemple du port de Nouakchott (Mauritanie).

2.2 Topography and bathymetry

The following datasets have been used to describe the bathymetry and topography of the area:

- Data from the bathymetric survey of the port basin, the navigation channel and the dredge spoil disposal sites carried out in February 2019 (see Figure 2.1 and Ref. /5/);
- Data from surveys carried out in 2013 (see Figure 2.2);
- Data from a wave disturbance study carried out in the port of Nouakchott in 2009 (see Figure 2.3 and Ref. /6/).
- Data from CMAP, a worldwide bathymetric database of digital nautical charts (see Figure 2.4).

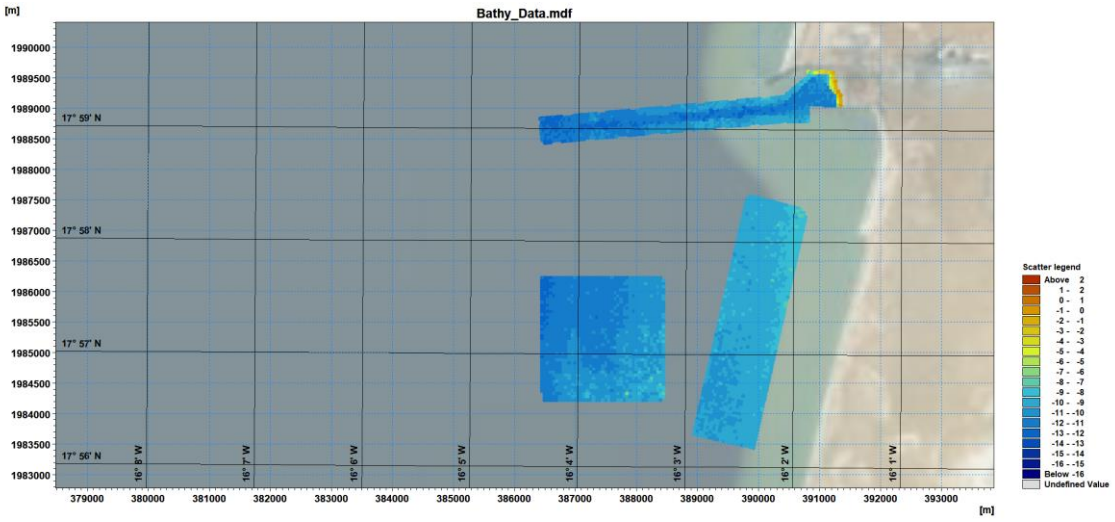

Figure 2.1: Bathymetric survey of 2019.

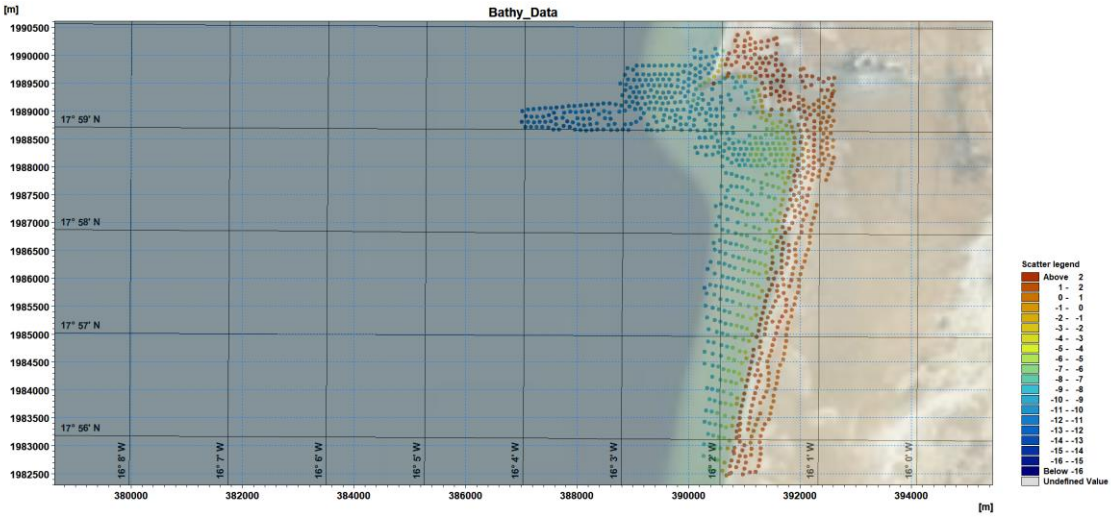

Figure 2.2: Bathymetric survey of the 2013.

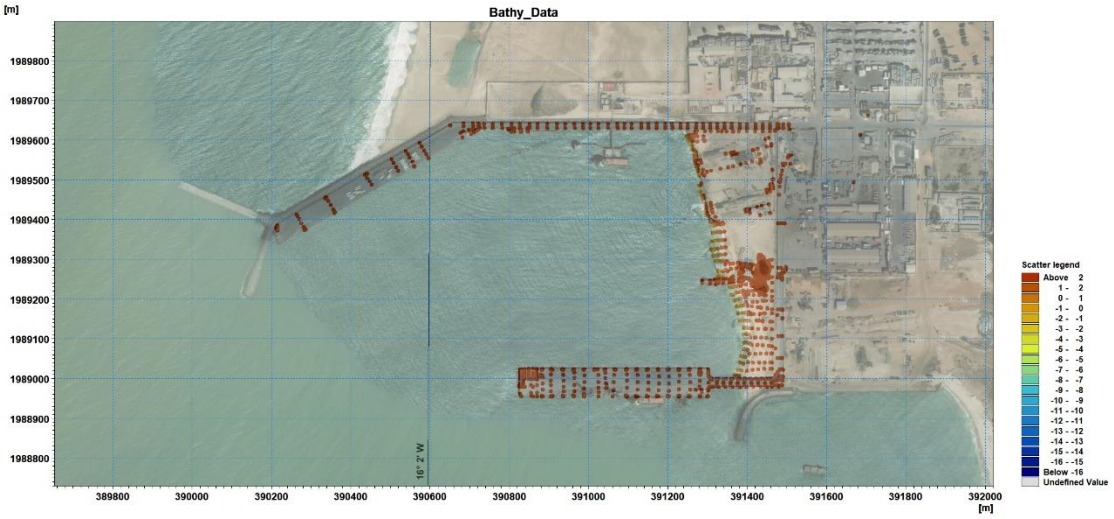

Figure 2.3: Topographic data from the 2009 study.

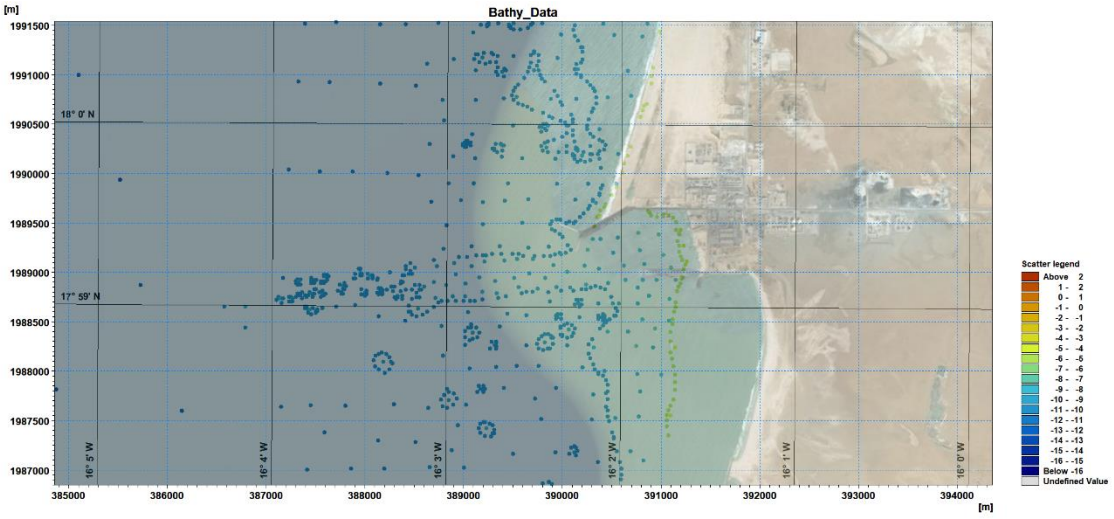

Figure 2.4: CMAP data.

2.3 Sediment analysis

MAGMA has provided in “PARTICLE SIZE ANALYSIS ON SEDIMENT SAMPLES, RESULTS REPORT, 2019 » data regarding the sediment size distribution along the Nouakchott shoreline and it shallow water area.

Except sample ST02 which is mainly composed by fine sediment (diameter < 0.063mm), the distribution of the sediment size is relatively similar all along the studied area.

Further sample have been analysed to complete the coverage of the area, especially along the beach (see section 6.1.2). Results have been exploited to calibrate the sediment transport model.

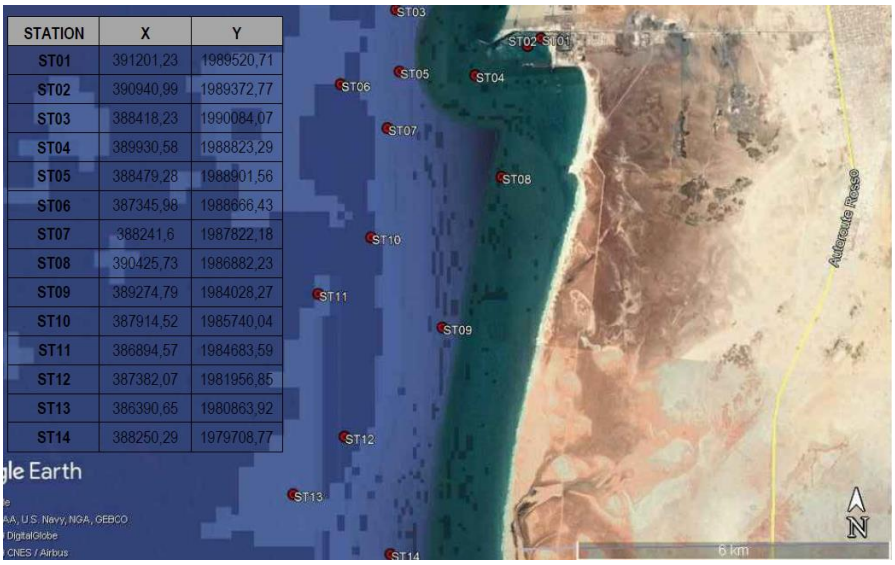

Figure 2.5: Location of sediment samples.

Table 2.1: Particle size distribution.

Table 2 : Results of full Particle size of the particles range between 63 mm and 0.063mm

P. diameter		Cumulative Retained %													
mm	Phi	ST01	ST02	ST03	ST04	S05	ST06	ST07	ST08	ST09	ST10	ST11	ST12	ST13	ST14
5	**-2,25**	0	-	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	**-2**	0	-	0,76	6,74	0,4	0	0,38	2,94	0	0	0,63	0	0,62	0
3,15	**-1,7**	0,73	-	1,01	7,55	0,54	0	0,5	3,23	0	0	0,71	0	0,73	0,78
2,5	**-1,3**	0,81	-	1,5	8,87	0,83	0	0,76	3,63	0	0	0,8	0	0,92	0,98
2	**-1**	0,9	-	1,95	9,96	1,08	0,45	1,05	3,99	0,18	0,34	0,89	0,3	2,46	1,22
1	**0**	2,01	-	4,67	16,72	3,36	0,71	4,29	5,49	0,66	1,83	1,57	0,98	3,19	3,29
0,8	**0,4**	2,6	-	5,73	18,82	4,47	0,94	6,24	5,95	0,96	2,43	1,77	1,5	4,67	4,52
0,63	**0,8**	3,98	-	7,93	21,38	6,77	1,18	11,74	6,94	1,55	3,77	2,19	3,55	12,64	7,33
0,4	**1,3**	15,56	-	18,55	31,97	21,94	6,71	39,21	12,94	4,26	12,52	7,42	7,82	39,38	17,29
0,32	**1,8**	36,12	-	24,37	43,21	52,56	11	54,58	16,88	6,46	28,85	16,88	9,88	71,16	31,33
0,25	**2**	74,73	-	51,46	84,34	88,84	19,87	66,23	41,31	19,35	46,89	87,76	29,66	76,51	66,17
0,2	**2,3**	76,58	-	51,69	84,91	89,57	20,76	66,55	42,37	20,7	59,41	88,5	35,96	87,89	72,56
0,16	**3,1**	84,61	-	53,07	87,17	92,39	32,52	73,05	58,73	47,38	74,08	95,81	78,13	98,7	82,78
0,1	**3,2**	98,83	-	90,95	99,02	99,38	96,37	98,54	96,38	95,71	99,08	99,8	98,9	99,7	98,86
0,08	**3,6**	99,48	-	97,39	99,84	99,91	99,35	99,81	99,14	98,8	99,74	99,91	99,88	99,92	99,73

P. diameter		Cumulative Retained %													
mm	Phi	ST01	ST02	ST03	ST04	S05	ST06	ST07	ST08	ST09	ST10	ST11	ST12	ST13	ST14
0,063	**4**	100	-	100	100	100	100	100	100	100	100	100	100	100	100
Mud %		3.6	98	37.7	8.4	5	44.2	11.3	23	34	22.4	7.7	29.2	16.3	30.8

2.4 Water level

Water levels have been extracted from /2/ and are referenced to Nouakchott Port's reference, which is located 0.256 m above Chart Datum.

Table 2.2: Characteristic astronomical values of Water Level (Ref. /7/).

Highest Sea Level	2.05
Mean High Water Level	1.44
Mean Sea Level	0.97
Mean Low Water Level	0.51
Lowest Sea Level	0.03
Maximum Tide Range	1.66
Mean Tide Range	0.93
Minimum Tide Range	0.22

Further analysis were undertaken based on the Global Tide Model. This model is available on a 0.125*0.125 degree resolution grid for the major 10 constituent in the tidal spectra. The model is utilising the latest year's multimission measurement from TOPEX/Poseidon, JASON 1 and JASON 2 satellite altimetry for sea level residual analysis. Based on these measurements, harmonic coefficients have been calculated. The provided constituents consider the semi diurnal M2, S2, K2, N2, the diurnal S1, K1, O1, P1, Q1 and the shallow water constituent M4.

To avoid uncertainty with the mean sea level taken from the literature, we needed to get more data of the mean water level provided by the Permanent Service for Mean Sea Level (PSMSL).

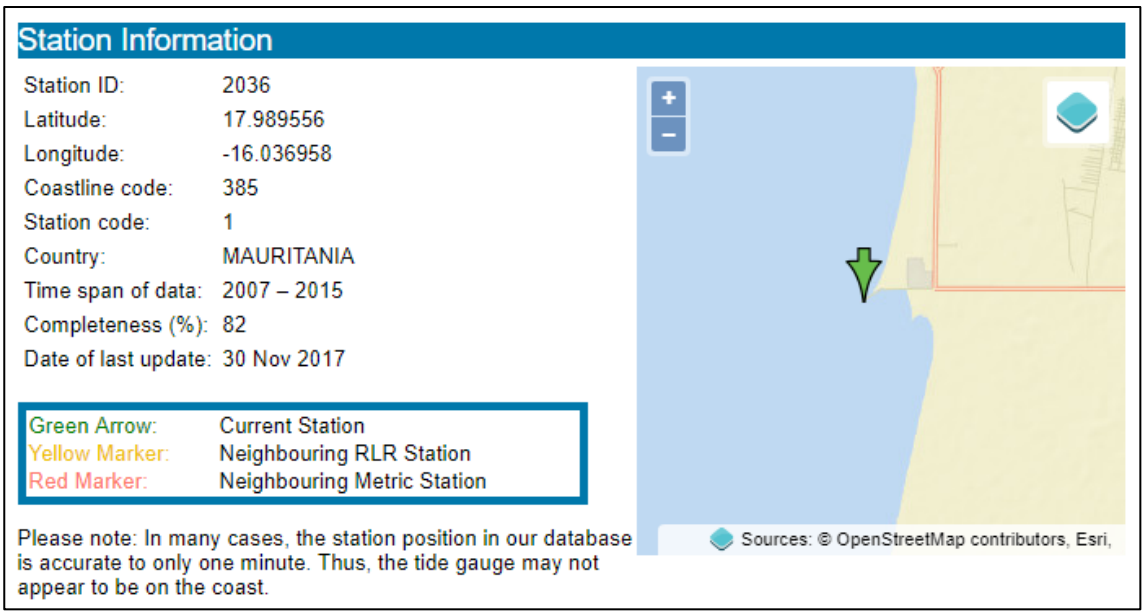

Figure 2.6: Information of the PSMSL station located in the harbour of Nouakchott (https://www.psmsl.org/data/obtaining/stations/2036.php).

The PSMSL has provided sea level data with a time span between 01/05/2007 and 02/09/2015.

It is important to point out that the zero of the series is the local Chart Datum. It is also worth mentioning that sea level measures were interrupted during shorts periods of time but, as the values of sea level have been interpolated before further work, it was not too annoying.

Then, a harmonic analysis of the sea level has been conducted for the purpose of getting mean water level (see below).

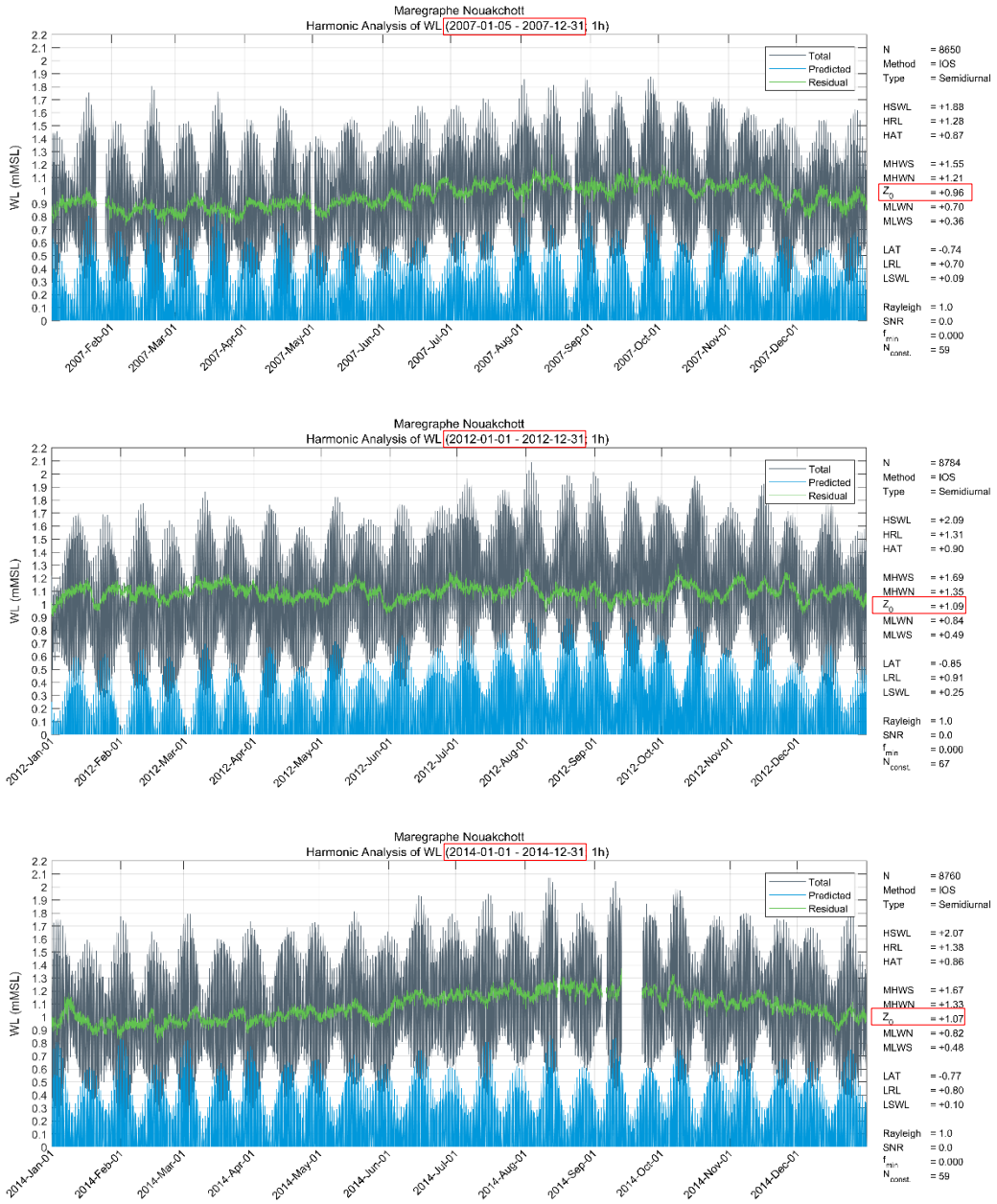

Figure 2.7: Harmonic analysis of the water level extracted from the PSMSL data during 3 periods of time.

The mean sea level can be obtained through the analysis: it has been evaluated to 1.03 meters. The results constitute a pretty constituent estimation of the mean water level; as a matter of fact; the time span is large enough to be pretty accurate and, in addition, the evaluation is very close to the 0.97 meters reference acquired in 1995. The slight increase of the value can be explained because of sea-level rise between 1995 and 2015.

Table 2.3: Comparison between characteristic astronomical values of Water Level from reference and evaluated.

	Ref. /7/	DHI 2019
Highest Sea Level	2.05	2.11
HAT	-	2.01
MHWS	-	1.63
Mean High Water Level	1.44	-
MHWN	-	1.29
Mean Sea Level	0.97	1.03
MLWN	-	0.78
Mean Low Water Level	0.51	-
MLWS	-	0.44
LAT	-	0.19
Lowest Sea Level	0.03	0.09
Maximum Tide Range	1.66	1.82
Mean Tide Range Spring	-	1.19
Mean Tide Range	0.93	-
Mean Tide Range Neap	-	0.51
Minimum Tide Range	0.22	-

HAT / LAT is the highest / lowest level that can be expected to occur under average meteorological conditions and under any combination of astronomical conditions.

MHWS / MHWN is the average of the two successive high waters during those periods of 24 hours when the range of the tide is at its greatest / least.

MLWS / MLWN is the average of the two successive low waters during those periods of 24 hours when the range of the tide is at its greatest / least.

3 Wave propagation from offshore to the shore

3.1 DHI's wave hindcast model of Cape Verde

DHI developed a wave hindcast model of Cape Verde (Figure 3.1). This wave model provides wave data (Hs, Tp, MWD, …) for a 20-year period (from 1997 to 2016) with a time step of 1 hour. This model was forced by wave conditions extracted from DHI's global wave model, and by CFSR wind data. This model was not intialy constructed to study the Mauritanian coast. Therefore, its resolution around Nouakchott has been adjusted and refined to be considered reliable for a proper characterisation of the local wave conditions for the purpose of the present study.

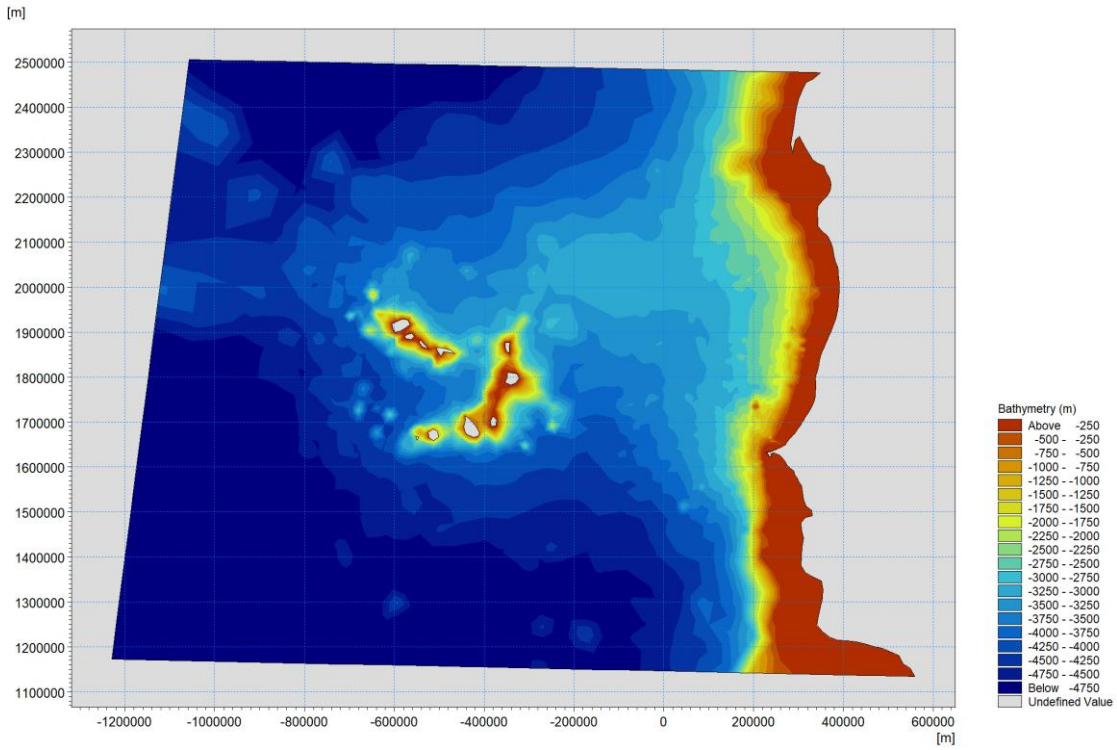

Figure 3.1: Extension of DHI's wave hindcast model of Cape Verde.

3.2 Statistical analysis

Time series of waves were extracted on three points in front of Nouakchott, shown on Figure 3.2, by -11 m LAT, -70m LAT and -123 m LAT.

The wave roses at these three points are shown on Figure 3.3. They illustrate how the wave heights decrease when getting closer to the coast, and how the main wave directions significantly turn from NW offshore to WNW closer to the coast.

The frequency of occurrence of wave heights and peak periods depending on the mean direction of the incoming waves are shown from Table 3.1 to Table 2.8 respectively for the point at -123 m LAT, -70m LAT and -11m LAT.

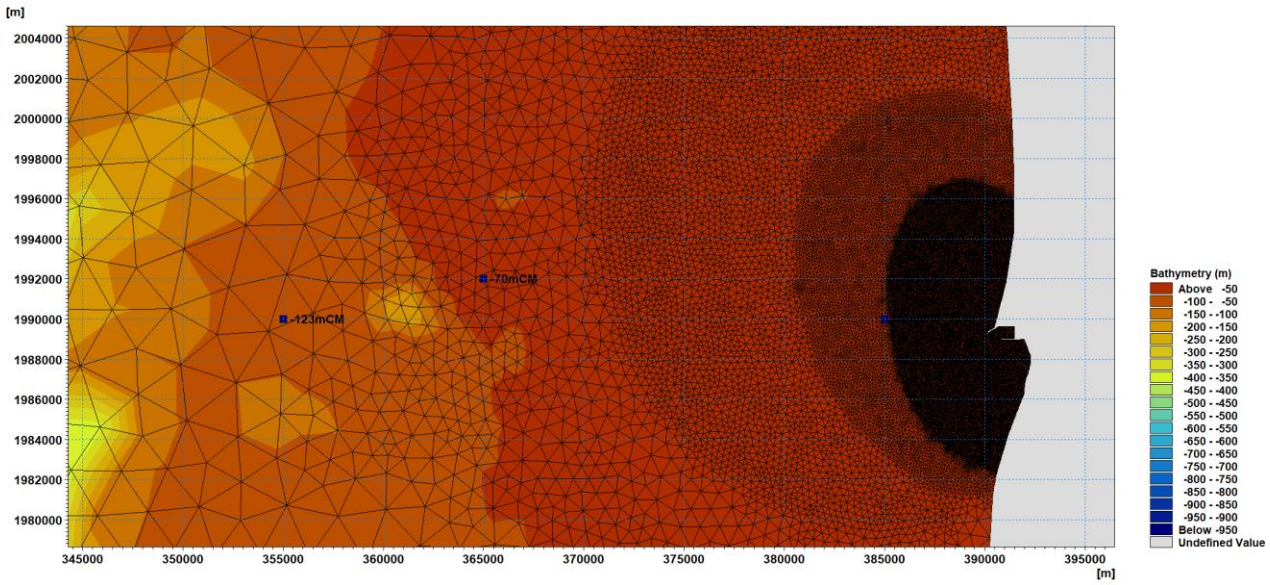

Figure 3.2: Location of the time series of waves extracted.

Main mean wave directions

- Waves from West-North-West are largely dominating, they represent 63% of the waves at the point at -11m LAT. It is also the main direction of the highest waves reaching the site (only 0.1% of significant wave heights exceed 2.5 m, and they are associated with the WNW direction).
- Waves from NW and NNW represent around 16% of the wave conditions.
- Waves from West represent 15.92% of the wave conditions.
- Waves from WSW are less frequent, they represent 2.32% of the wave conditions.

Main significant wave heights

The most frequent wave heights are between 0.5 and 1 m (~51% of the time), and between 1 and 1.5 m (~40.5% of the time).

Main peak periods

The most frequent peak periods are between 6 and 8 s (~46% of the wave conditions) and between 8 and 10 s (~40.5% of the wave conditions).

3.3 Selection of the wave conditions for the wave agitation model

The layout of the harbour protects the port against the predominant wave conditions from NWN and NW. Therefore, the wave agitation study focuses, at least on a first stage, on wave conditions from West (270°N) and from South-West (247.5°N). These waves conditions are associated with a significant wave height of 1 m at -11 m LAT and a peak period of 8 s (see **Erreur ! Source du renvoi introuvable.**).

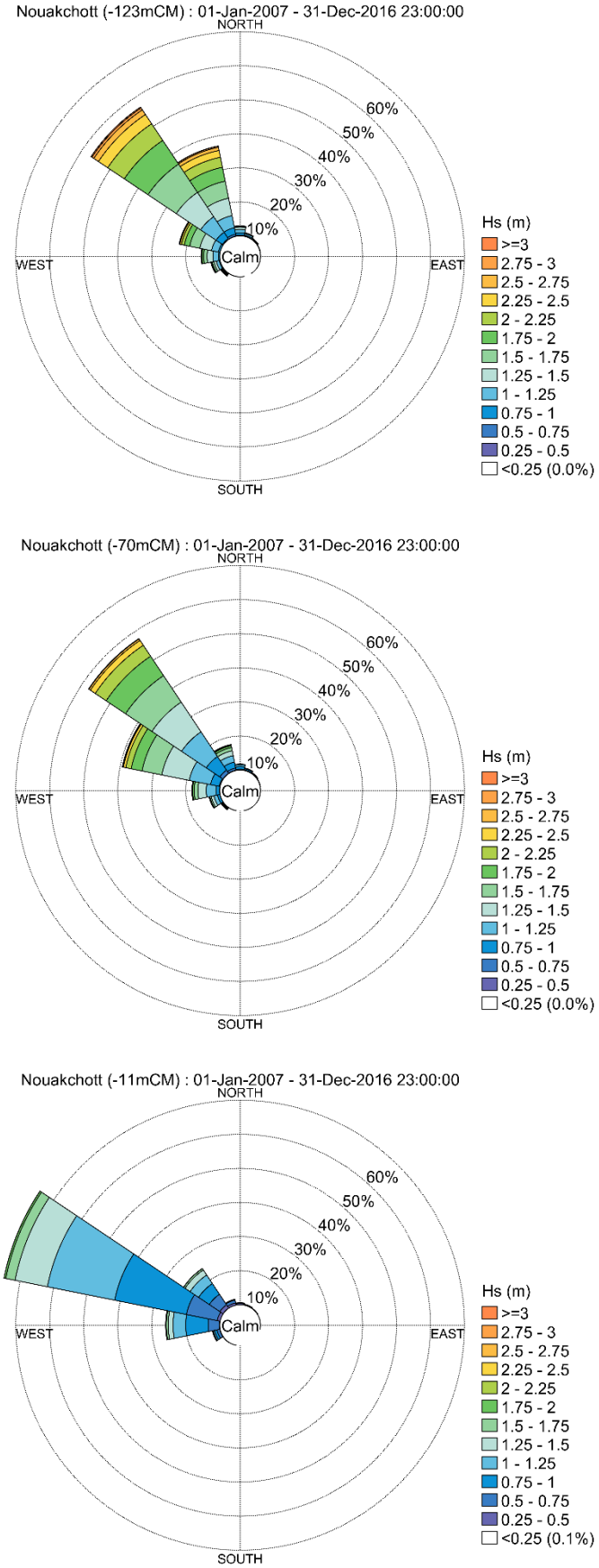

Figure 3.3: Wave roses in front of Nouakchott at -123mLAT (top), -70mLAT (middle) and -11 m LAT (bottom) for the period 2007 – 2016.

Table 3.1: Frequency of wave heights per incoming wave direction in front of Nouakchott at -123mLAT.

Hs/Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
<0.5m	0.03	0.02	0.02	0.01	0	0	0	0	0	0	0	0	0	0	0.01	0.07	0.15
0.5-1m	0.88	0.35	0.17	0.04	0	0	0	0	0	0.01	0.16	0.27	0.33	0.5	2.5	2.49	7.7
1-1.5m	1.72	0.66	0.24	0.05	0	0	0	0	0	0.03	0.37	1.59	3.4	5.58	14.09	8.85	36.59
1.5-2m	0.32	0.04	0	0	0	0	0	0	0	0	0.27	0.77	1.5	4.66	18.39	9.28	35.25
2-2.5m	0.01	0	0	0	0	0	0	0	0	0	0.11	0.13	0.23	1.31	9.16	5.04	15.99
2.5-3m	0	0	0	0	0	0	0	0	0	0	0.05	0.02	0.04	0.21	2.31	1.26	3.89
3-3.5m	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0.32	0.08	0.44
3.5-4m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01
TOTAL	2.96	1.07	0.43	0.1	0.01	0	0	0	0	0.04	0.96	2.78	5.5	12.3	46.76	27.07	100

Table 3.2: Frequency of wave peak periods per incoming wave direction in front of Nouakchott at -123mLAT.

Tp/Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
<2s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-4s	0.01	0.01	0.03	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0.08
4-6s	0.55	0.86	0.4	0.09	0	0	0	0	0	0	0	0	0	0	0.02	0.12	2.05
6-8s	2.37	0.19	0	0	0	0	0	0	0	0.02	0.04	0.08	0.1	0.22	0.7	4.6	8.34
8-10s	0.03	0	0	0	0	0	0	0	0	0.01	0.35	0.98	2.11	4.09	18.07	18.64	44.28
10-12s	0	0	0	0	0	0	0	0	0	0	0.34	0.95	2.16	5.11	20.76	3.68	33.01
12-14s	0	0	0	0	0	0	0	0	0	0	0.17	0.53	0.96	2.19	5.65	0.03	9.53
14-16s	0	0	0	0	0	0	0	0	0	0	0.07	0.23	0.17	0.69	1.56	0	2.72
TOTAL	2.96	1.07	0.43	0.1	0.01	0	0	0	0	0.04	0.96	2.78	5.5	12.3	46.76	27.07	100

Table 3.5: Frequency of wave heights per incoming wave direction in front of Nouakchott at -70mLAT.

Hs/Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
<0.5m	0.03	0.03	0.04	0.02	0	0	0	0	0	0	0	0	0	0	0.06	0.11	0.3
0.5-1m	1.01	0.5	0.22	0.06	0	0	0	0	0	0.01	0.19	0.75	1.11	2.86	5.94	2.41	15.05
1-1.5m	0.7	0.22	0.08	0.01	0	0	0	0	0	0.02	0.28	1.92	5.29	14.65	19.22	3.38	45.76
1.5-2m	0.02	0	0	0	0	0	0	0	0	0	0.21	0.55	1.56	9.17	16.19	1.51	29.21
2-2.5m	0	0	0	0	0	0	0	0	0	0	0.1	0.09	0.18	2.35	5.57	0.35	8.64
2.5-3m	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0.3	0.63	0.02	0.99
3-3.5m	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0	0.03
3.5-4m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1.76	0.75	0.34	0.09	0.01	0	0	0	0	0.03	0.79	3.3	8.17	29.34	47.63	7.78	100

Table 3.6: Frequency of wave peak periods per incoming wave direction in front of Nouakchott at -70mLAT.

Tp/Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
<2s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-4s	0.01	0.02	0.07	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0.14
4-6s	1.21	0.72	0.27	0.06	0	0	0	0	0	0.01	0	0	0	0	0.02	0.31	2.62
6-8s	0.54	0.01	0	0	0	0	0	0	0	0.02	0.04	0.11	0.12	0.34	2.46	5.45	9.09
8-10s	0	0	0	0	0	0	0	0	0	0	0.31	1.15	2.65	6.89	30.41	2.01	43.44
10-12s	0	0	0	0	0	0	0	0	0	0	0.27	1.13	3.17	12.92	13.8	0	31.29
12-14s	0	0	0	0	0	0	0	0	0	0	0.12	0.64	1.78	6.9	0.94	0	10.37
14-16s	0	0	0	0	0	0	0	0	0	0	0.03	0.27	0.44	2.29	0	0	3.04
TOTAL	1.76	0.75	0.34	0.09	0.01	0	0	0	0	0.03	0.79	3.3	8.17	29.34	47.64	7.78	100

Table 3.7: Frequency of wave heights per incoming wave direction in front of Nouakchott at -11mLAT.

Hs/Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
<0.5m	0.35	0.2	0.12	0.02	0	0	0	0	0	0	0	0.11	0.13	0.87	1.19	0.67	3.66
0.5-1m	0.26	0.09	0.02	0	0	0	0	0	0	0	0.04	1.5	9.89	30.75	7.51	1.03	51.09
1-1.5m	0	0	0	0	0	0	0	0	0	0	0.02	0.67	5.15	29.89	4.79	0.06	40.58
1.5-2m	0	0	0	0	0	0	0	0	0	0	0	0.04	0.69	3.28	0.54	0	4.55
2-2.5m	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0.04	0.01	0	0.11
2.5-3m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-3.5m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-4m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.61	0.29	0.14	0.02	0	0	0	0	0	0	0.07	2.32	15.92	64.83	14.03	1.76	100

Table 3.8: Frequency of wave peak periods per incoming wave direction in front of Nouakchott at -11mLAT.

Tp/Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
<2s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-4s	0.46	0.29	0.14	0.02	0	0	0	0	0	0	0	0	0	0	0	0.11	1.02
4-6s	0.15	0	0	0	0	0	0	0	0	0	0.01	0.04	0.03	0.25	3.39	1.64	5.52
6-8s	0	0	0	0	0	0	0	0	0	0	0.05	1.05	3.64	30.65	10.64	0.01	46.03
8-10s	0	0	0	0	0	0	0	0	0	0	0	0.99	8.7	30.86	0	0	40.56
10-12s	0	0	0	0	0	0	0	0	0	0	0	0.22	3.22	3.02	0	0	6.46
12-14s	0	0	0	0	0	0	0	0	0	0	0	0.02	0.31	0.05	0	0	0.38
14-16s	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0.03
TOTAL	0.61	0.29	0.14	0.02	0	0	0	0	0	0	0.07	2.32	15.92	64.83	14.03	1.76	100

3.4 Impact of the future channel on the wave propagation

3.4.1 Model domain and computational model

To simulate properly the local wave conditions around the harbour with the 15.7m-depth drilled channel, the bathymetry had to be changed. The channel used for the model is 150m-wide and flat at the depth of 15.7m. The slope at the two sides of the deep channel has been set at about 15% over its entire length. Therefore, the width of the channel at its outset l is 150m and reaches about 380m at the entrance of the harbour.

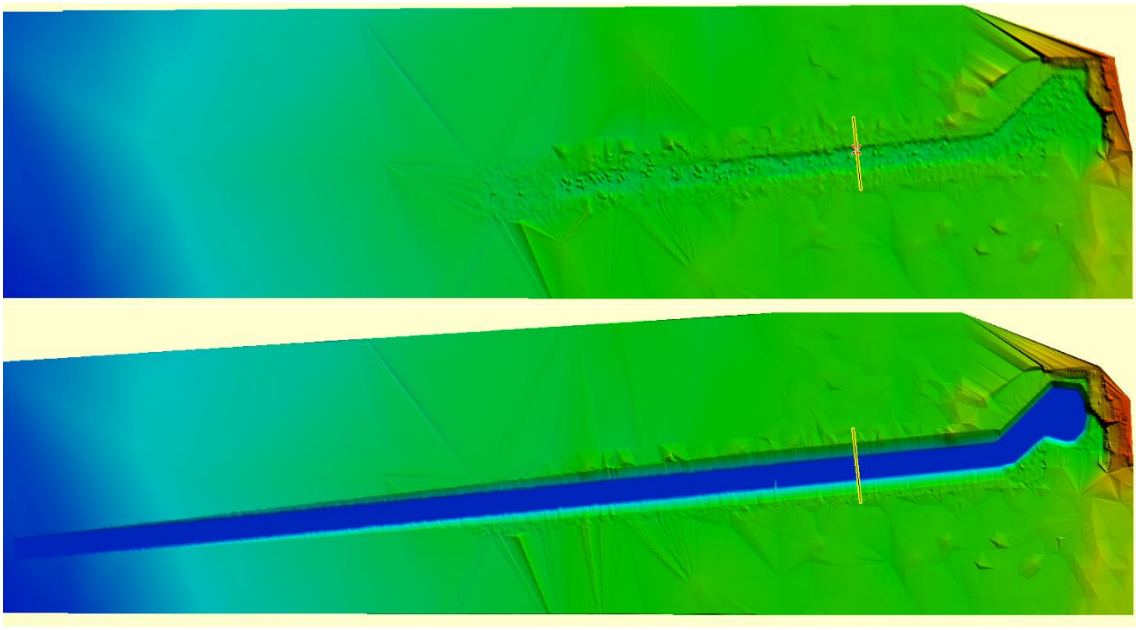

Figure 3.4: Bathymetry around the channel in the existing Nouakchott port (up) and the project case (down).

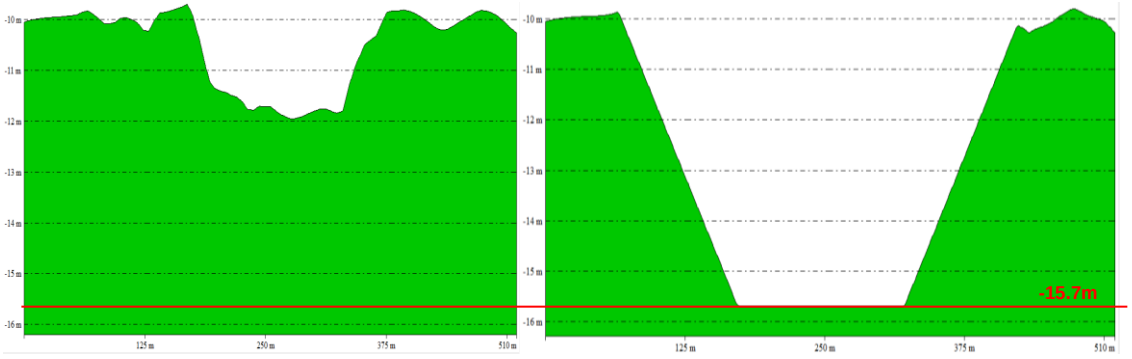

Figure 3.5: Section of the bathymetry around the channel in the existing Nouakchott port (left) and the project case (right).

An unstructured triangular mesh covering the wave model area (domain) was prepared based on the available bathymetry data. To increase accuracy of the results (which leads to better identify the influence of the channel), the resolution was graduated using finer resolutions in the area covering the channel and the areas around. The finest mesh resolution, in the channel (smallest element side lengths) is about 25-30m. The bathymetry and mesh are shown in Figure 4.4 and Figure 4.5.

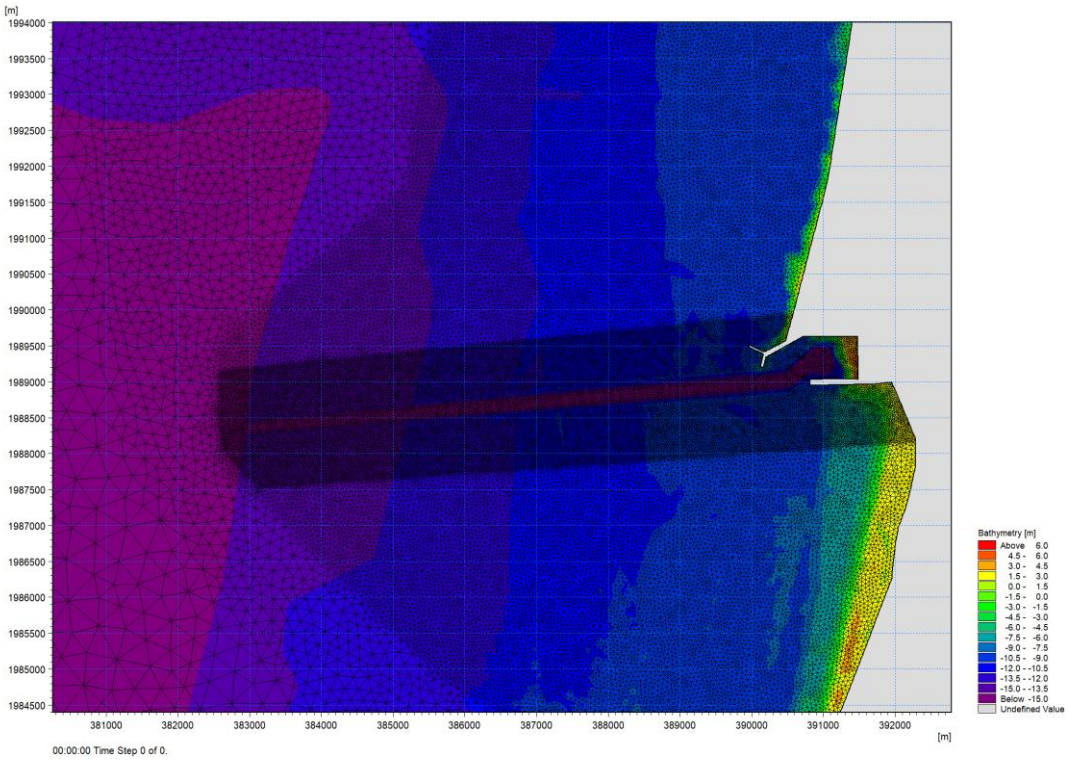

Figure 3.6: Nouakchott's harbour model mesh with the extension of the channel included

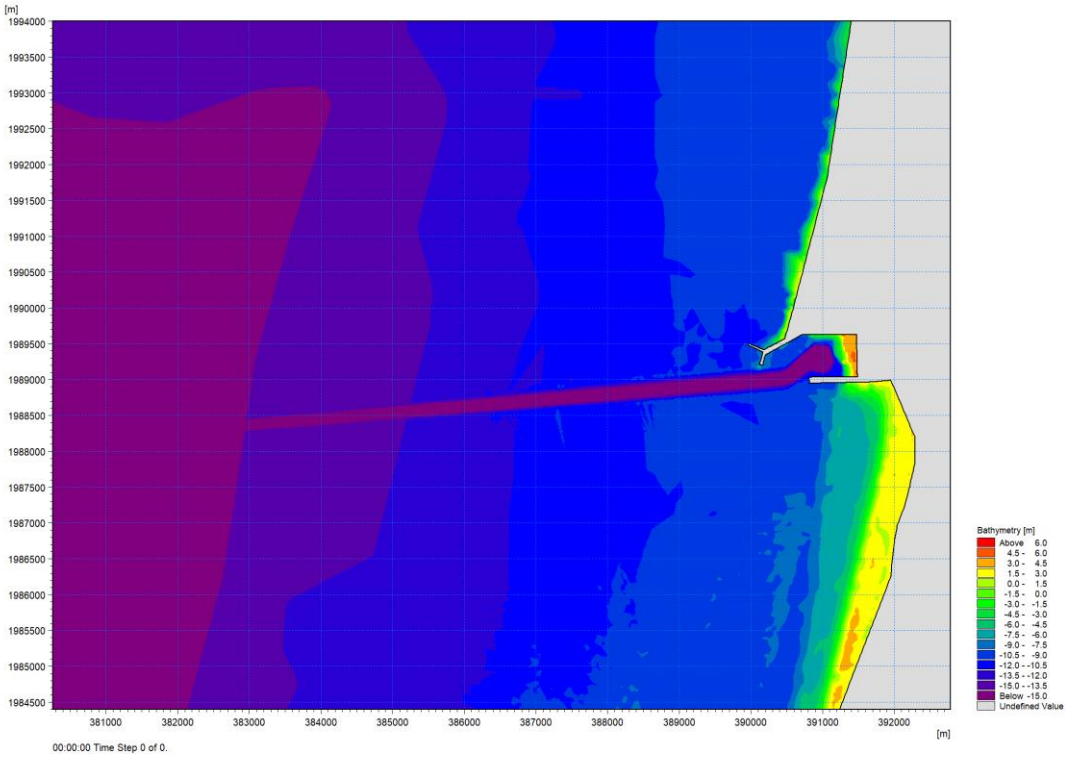

Figure 3.7: Nouakchott's harbour bathymetry area with the extension of the channel included

The deepening of the channel is expected to induce the dredging of about 6 billion of m3 which will be dumped in two areas south of the port. The locations of the dumping zones are shown in Figure 4.8. The bathymetry has been updated to take account at disposal of about 6 billion of m3 spread in these two areas (bathymetry reduced by about 0.75m.

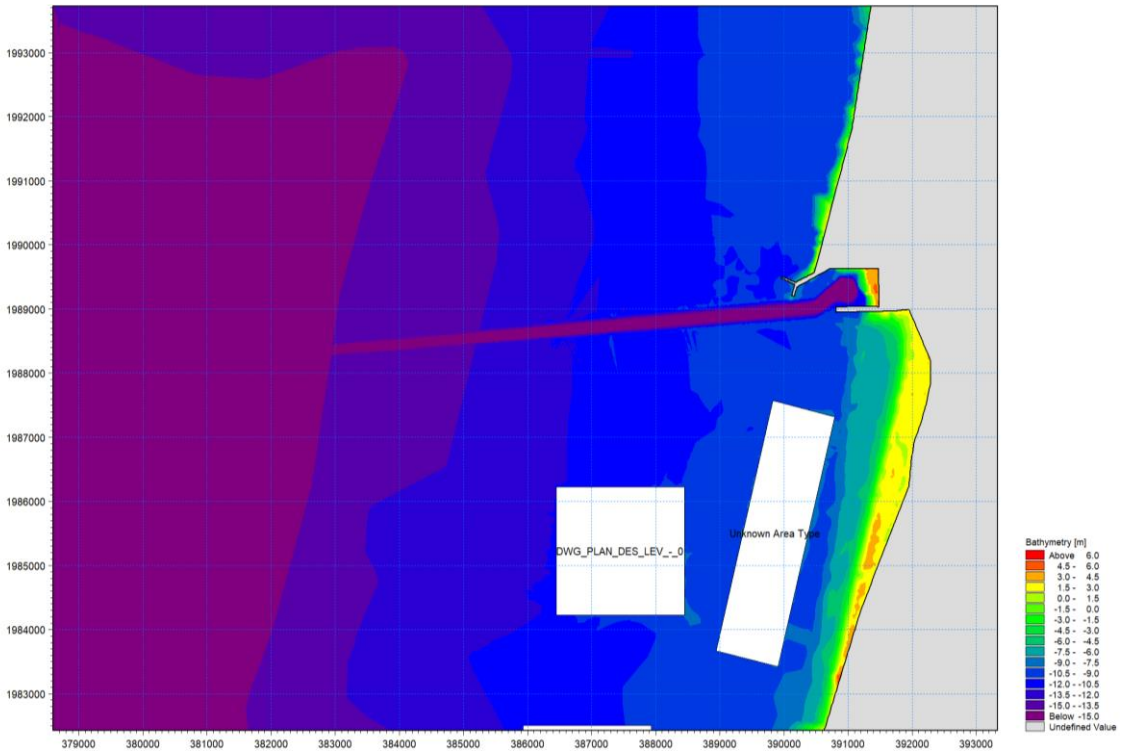

Figure 3.8 Dumping areas near the shoreline

3.4.2 Modelling results

To illustrate the impact induced by the channel on the wave propagation, Figure 3.9 and Figure 3.10 present the difference of Significative wave height Hs (project case – present situation) for a specific timestep. Figure 3.9 correspond to WNW waves. The simulations show that the channel induces an increase of the wave heights where waves reach the area near the channel. It can be attributed to the variation of depth due to reflection on the slope of the channel. Concerning the wave direction parameter, the model indicates a significant variation of the wave direction (Figure 3.10).

The change in wave height and direction is significant inside the harbour and around the breakwater. However, it can be seen on these figures that a wall stretch of coastline is concerned by this change of wave climate.

The processes which induce such changes on the wave propagation are presented in more details in the following section on the wave agitation.

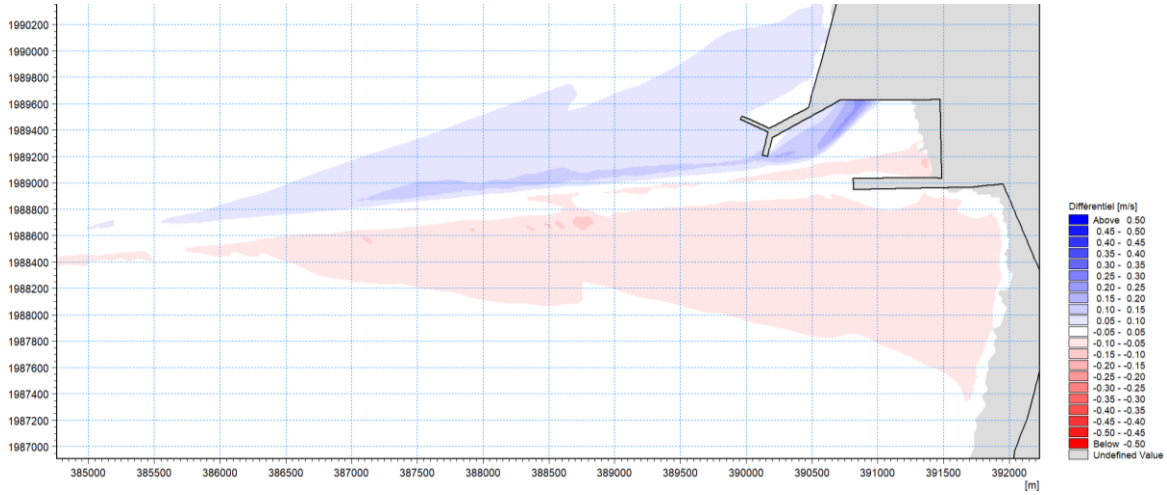

Figure 3.9:: Subtraction of the H_s coming from WNW direction in the current situation from the project case.

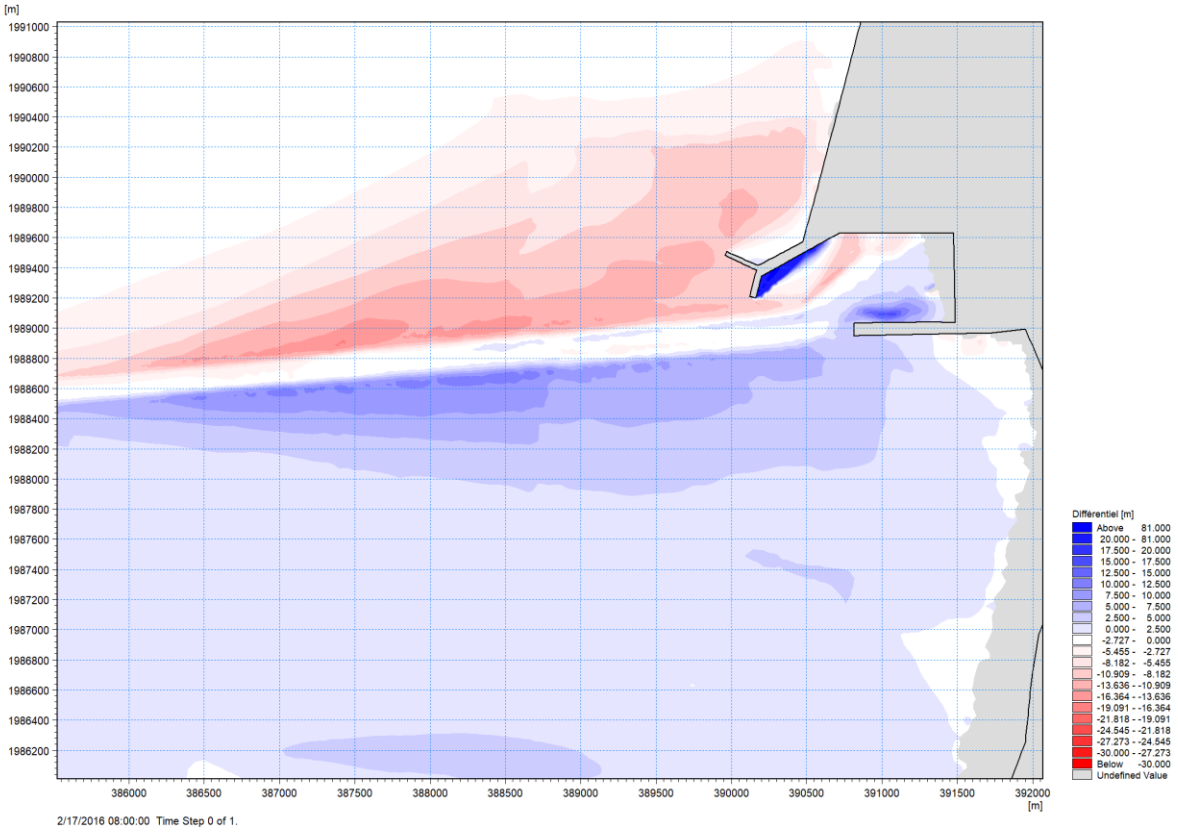

Figure 3.10 Subtraction of the wave direction coming from WNW direction in the current situation from the project case.

4 Wave agitation

In order to investigate the impact of the project on the wave agitation in Nouakchott harbour, the model MIKE 21 BW (described in 4.1), has then been implemented .

4.1 MIKE 21 BW

MIKE 21 BW can be applied to the study of wave dynamics in ports and harbours and coastal areas. It is a time-domain, phase-resolving model capable of reproducing the combined effects of most wave phenomena including refraction, shoaling, diffraction, breaking, partial reflection and transmission, non-linear wave-wave interaction, frequency dispersion, and directional dispersion. The model simulates three-dimensional (3D) natural irregular waves (sea states). The model is a so-called Boussinesq type of wave model.

- features 2D wave generation in relaxation zones;
- features sponge layers for wave damping;
- features porosity for breakwaters etc;
- includes non-linearity as well as frequency dispersion;
- handles wave breaking;
- much faster computation than MIKE 3 Wave FM model.

Wave agitation modelling in the present and future situations, using MIKE 21 BW

4.1.1 Project situation

The project layout and dredging plan are shown on Figure 4.1 and Figure 4.2.



Figure 4.1: Existing Nouakchott port and project case.

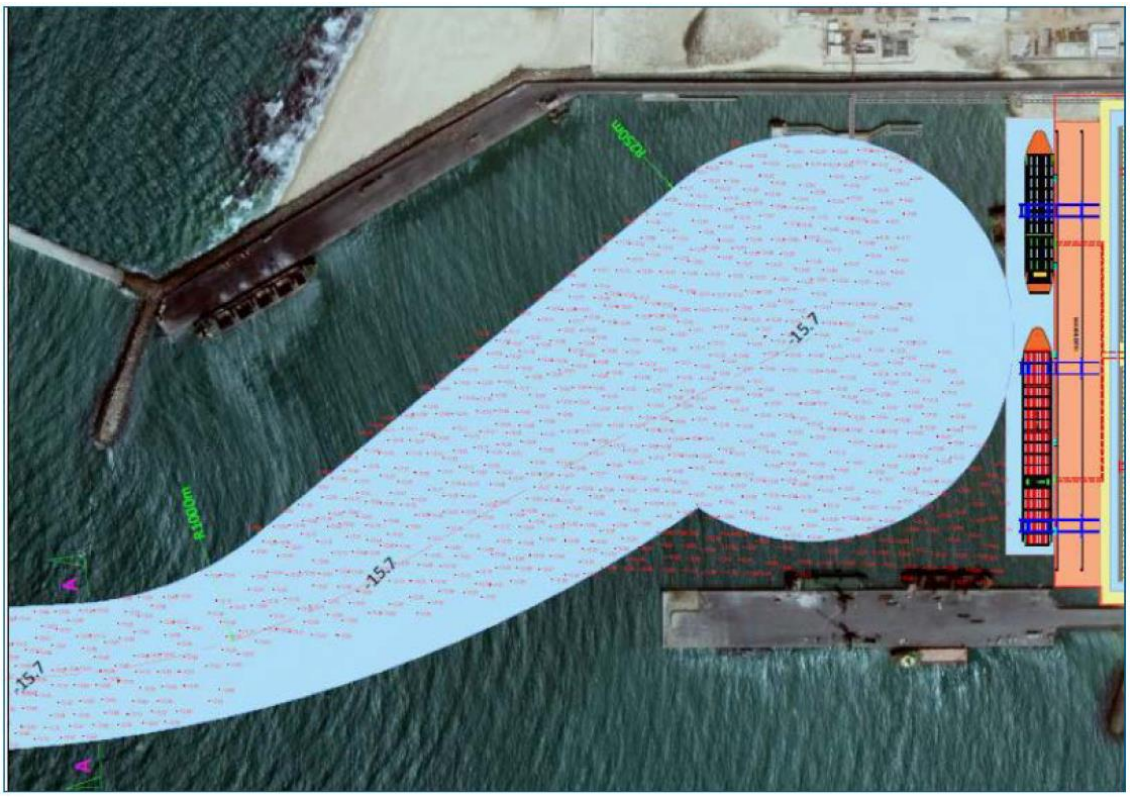

Figure 4.2: Dredging plan in the project case.

4.1.2 Model setup

Bathymetry

The domain extent and bathymetry for the current situation is shown on Figure 4.3.

The model extends over 10 km * 10 km, down to the natural depths around -15.7 m LAT, in order to entirely include the dredged channel in the project situation. Please note that areas North and/or South of the harbour (depending on the modelled incoming wave direction) have been truncated from the computational domain in order to reduce the computation time. The mesh is composed of regular elements of 4 m.

Three configurations of Nouakchott harbour have been modelled using MIKE 21 BW:

1. Current situation;
2. Project situation (as described in Section 4.1.1);
3. Project situation, **with a 100 m extension of the breakwater** which is directed southwards at the entrance of the harbour.

Illustrations of these three cases are shown on Figure 4.4.

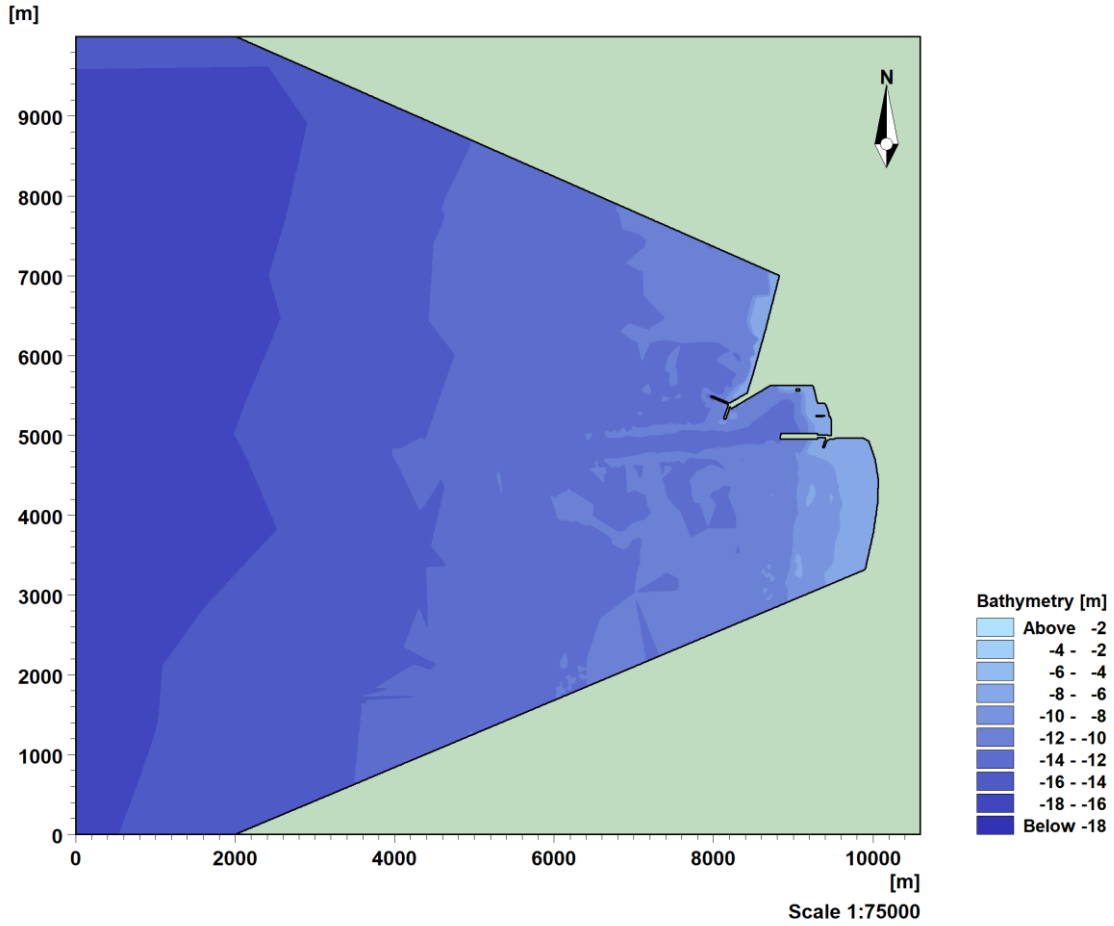

Figure 4.3: MIKE 21 BW model extent and bathymetry for the current situation.

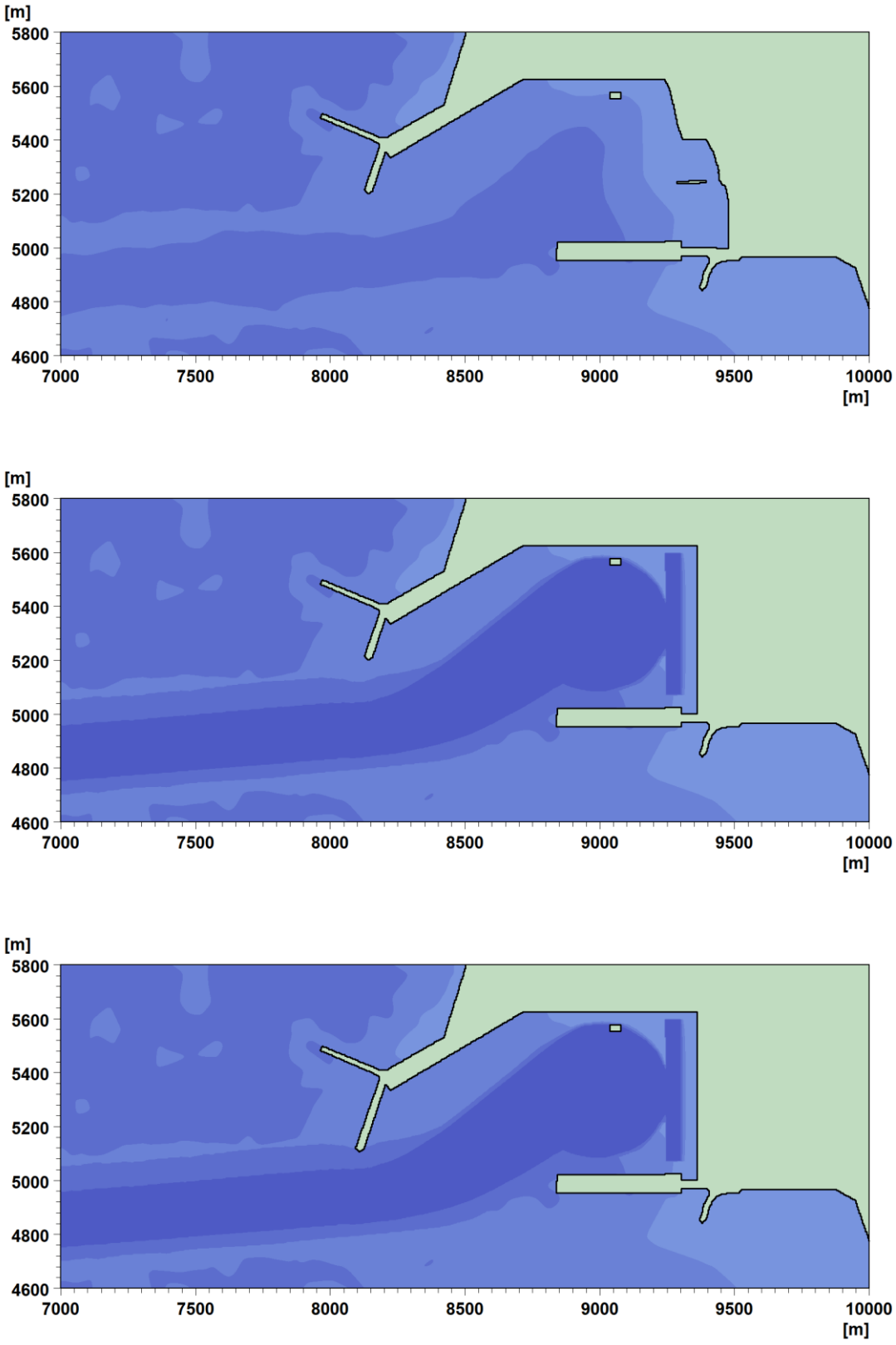

Figure 4.4: Illustration of the three configurations simulated: current situation (upper), project situation (middle), project situation with extension of the breakwater (lower).

Wave generation

Waves are generated in the model along a generation line, which is shown in red on Figure 4.5. They are irregular waves, based on a JONSWAP spectrum with a standard deviation of 30° around the main wave direction. The input waves characteristics simulated are given in Table 4.1.

Table 4.1: Wave conditions modelled with MIKE 21 BW.

Scenario	Wave conditions	Hs (m)	Tp (s)	MWD (°N)	DSD (°)	WL (m LAT)
1	**WNW**	1	8	292.5	30	1.7
2	**WNW**	1	10	292.5	30	1.7
3	**WSW**	1	8	247.5	30	1.7
4	**WSW**	1	10	247.5	30	1.7
5	**W**	1	8	270	30	1.7
6	**W**	1	10	270	30	1.7
7	**W**	1	8	270	30	0.5

Sponge layers

Sponge layers have been applied in the model at the open boundaries as well as at the boundaries used to truncate the model and at the beaches. They are applied in order to dampen the waves reaching these areas and to avoid parasitic reflexions. In the current situation, a sponge layer has been applied to the beach situated inside the port.

Porosity layers

Porosity layers have been applied to the rocky features shown on **Erreur ! Source du renvoi introuvable.**. They have been set in order to apply a reflection coefficient of 0.5 for each of them. The other elements of the harbour have been considered as fully reflective (vertical walls). In the current situation, a porosity layer has been applied to the rocky features located inside the port, North of the beach. In the project situation, a porosity layer has been applied along the whole new quay.

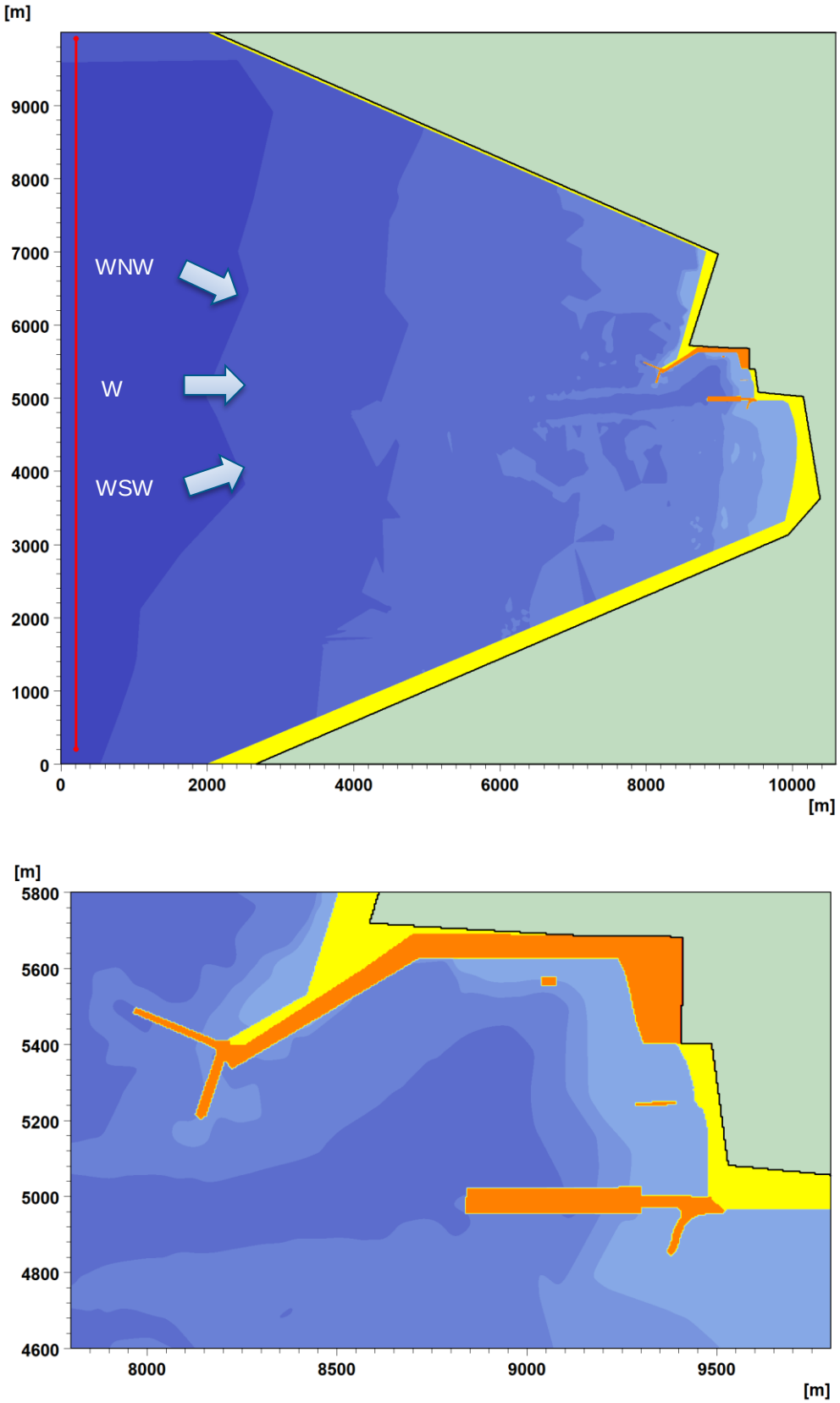

Figure 4.5: Positions of the wave generation line (red), sponge layers (yellow) and porosity layers (orange) for the current situation.

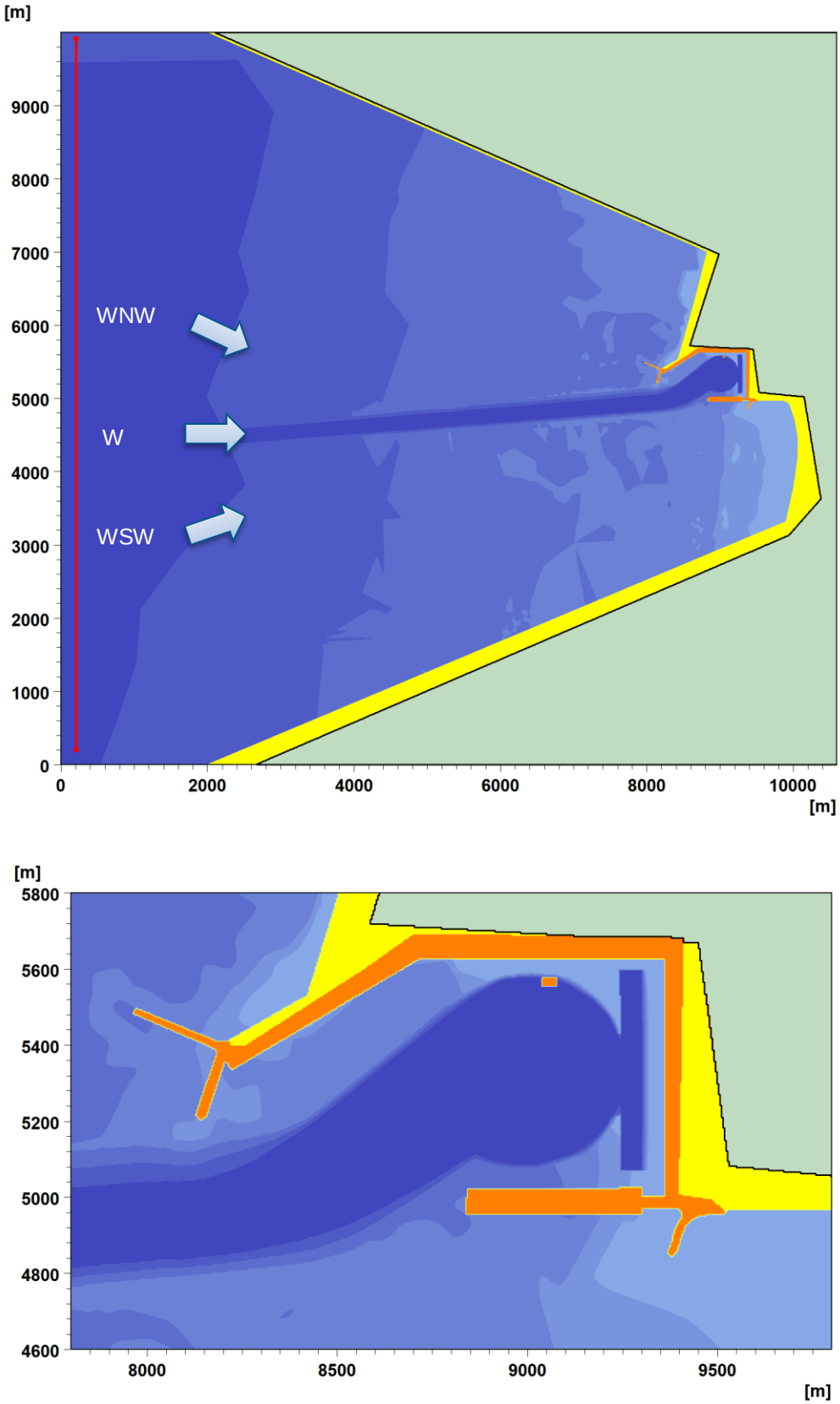

Figure 4.6: Positions of the wave generation line (red), sponge layers (yellow) and porosity layers (orange) for the project situation.

4.1.3 Model results

The key output from the wave agitation modelling is the significant wave height, H_{m0}, in the model area. As the incident wave height at the channel entrance was 1 m, the values can also be regarded as **wave disturbance coefficients**, defined as the wave height relative to the incident wave height.

4.1.3.1 Wave fields

Example of contour plots of the significant wave height (or wave disturbance coefficient) are presented in Figure 4.8 and Figure 4.9 for the wave condition n°5 (T_p = 8 s, MWD = 270°N, WL = 1.7 m).

The maps of the wave attenuation coefficient for the two project situations relatively to the current situation are shown in Figure 4.10 and Figure 4.11. It should be noted that on these plots, the beach in the harbour appears in red because it is dry in the current situation while it will be in the water in the project situation, therefore it should not be understood as a deterioration of the wave conditions at this place, but simply as the extension of the port.

The same results for the other wave conditions simulated are shown in Appendix A.

General impact of a channel on the wave fields

As waves propagate over the channel slopes from shallow water along the channel to the deeper water in the channel, they refract so that the wave direction relative to the channel orientation decreases (refraction occurs as waves propagate faster in deeper water than in shallower water, causing the waves to turn). As the incident wave angle relative to the channel orientation decreases, the refracted wave direction in the channel becomes parallel with the channel. This is the so-called critical angle. Waves with an incident angle smaller than the critical angle are reflected away from the channel slope. This is illustrated on Figure 4.7.

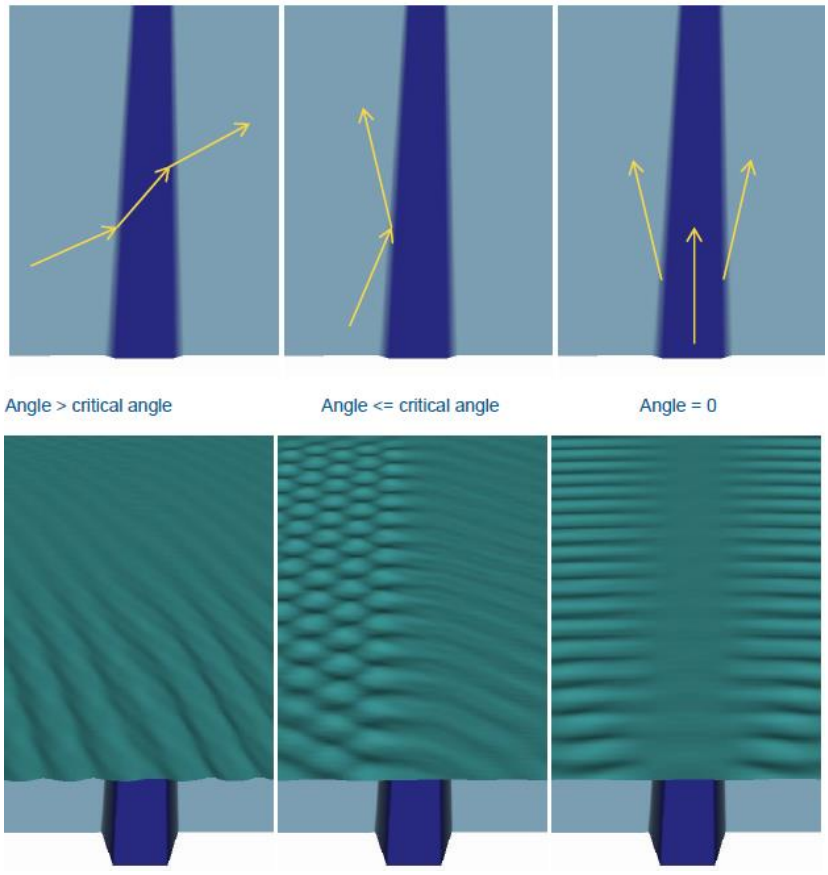

Figure 4.7: Sketch showing the effect of a channel on wave propagation. Depth in channel is 20 m. surrounding seabed is 10 m. Wave period is 15 s.

Impact of the project layout on the wave fields

It is clear from the modelling that the dredged entrance channel plays a large role in the wave propagation towards the port.

Here, it is seen that a large part of the wave energy is reflected at the channel slopes and cause concentration of wave energy along the Northern part of the channel (Figure 4.10 and Figure 4.11).

Moreover, the reflexion of the incoming waves at the channel slopes close to the entrance of the harbour lead to a concentration of wave energy inside the harbour (Figure 4.10), increasing significantly (up to ~ +30% locally) the wave disturbance in the Northern part of the harbour.

The increase of H_{m0} inside the port in the project situation is observed for all wave scenarios with an incoming wave of 270°N and 292.5°N. For the 270°N incoming waves, the increase of H_{m0} is located along the North-West part of the port (berths 1 – 3 : dry bulk on Figure 4.1). For the 292.5°N incoming waves, the increase of H_{m0} is more widespread inside the port and can be seen also along the southern quay of the port (berths 5 – 8 : containers and general cargo on Figure 4.1). The incoming wave direction of 247.5°N on the contrary shows a positive effect of the project in terms of wave disturbance inside the port.

Impact of the project with extension of the breakwater on the wave fields

The overall adverse effect of the project could be mitigated by extending the breakwater directed southward which is located at the channel entrance, as it can be seen from Figure 4.11. The extension of this breakwater prevents the waves reflected away from the channel slopes to enter the harbour.

In all the simulated cases, the extension of the breakwater shows a significative improvement of the wave conditions inside the port compared to the initial project layout. Moreover, in all the simulated cases with an incoming wave direction of 270°N and 247.5°N, the project with extension of the breakwater shows an improvement of the wave conditions inside the port compared to the current situation. For the 292.5°N incoming waves, the project with extension of the breakwater still shows a tendency to increase the wave heights in the NW of the port, between the berths 1 – 3 and the oil berth (Figure 4.1).

Except for the areas mentioned above where the concentration of wave energy induces higher significant wave heights, the channel has a significant impact in decreasing the significant wave heights in the channel (down to ~ - 30%). Moreover, the coastal area behind the channel gets sheltered from the incoming waves by the channel.

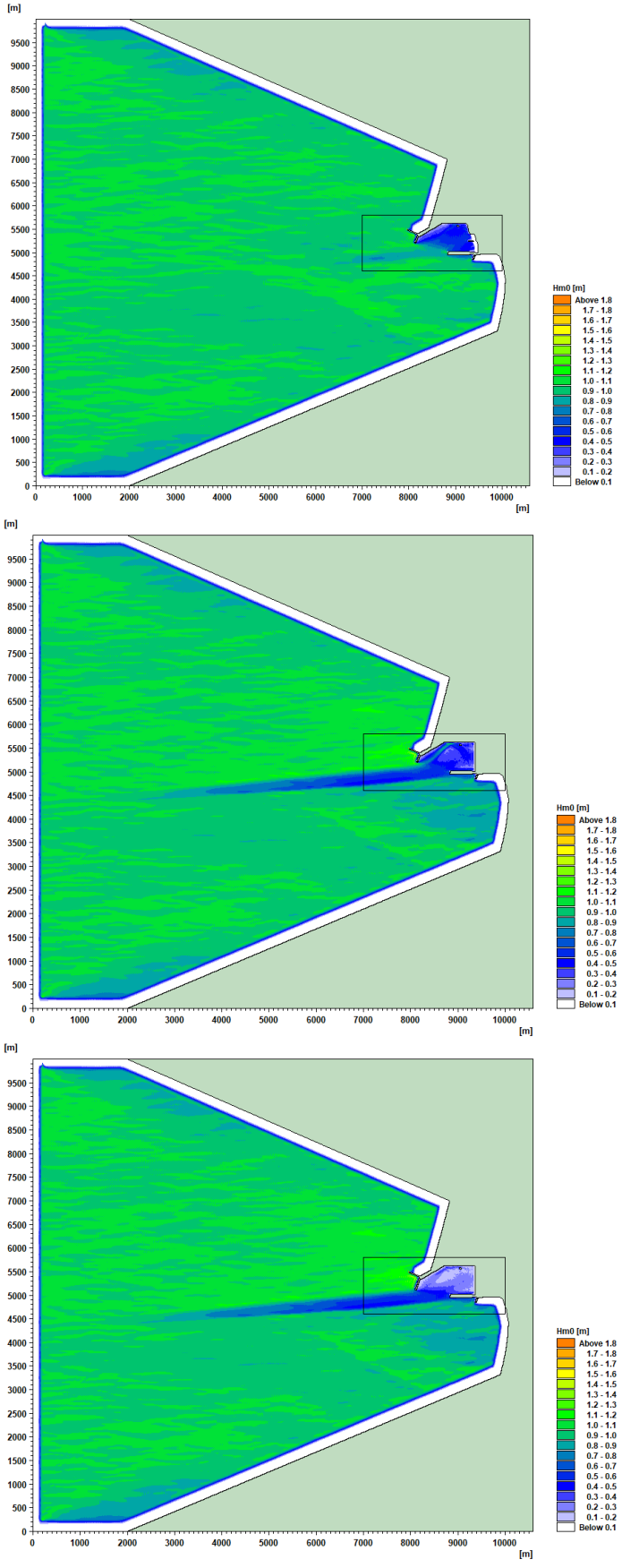

Figure 4.8: H_{m0} in the model area for the current situation, project situation and project situation with extension of the entrance breakwater, for H_{m0} = 1m ,T_p = 8 s, MWD = 270°N.

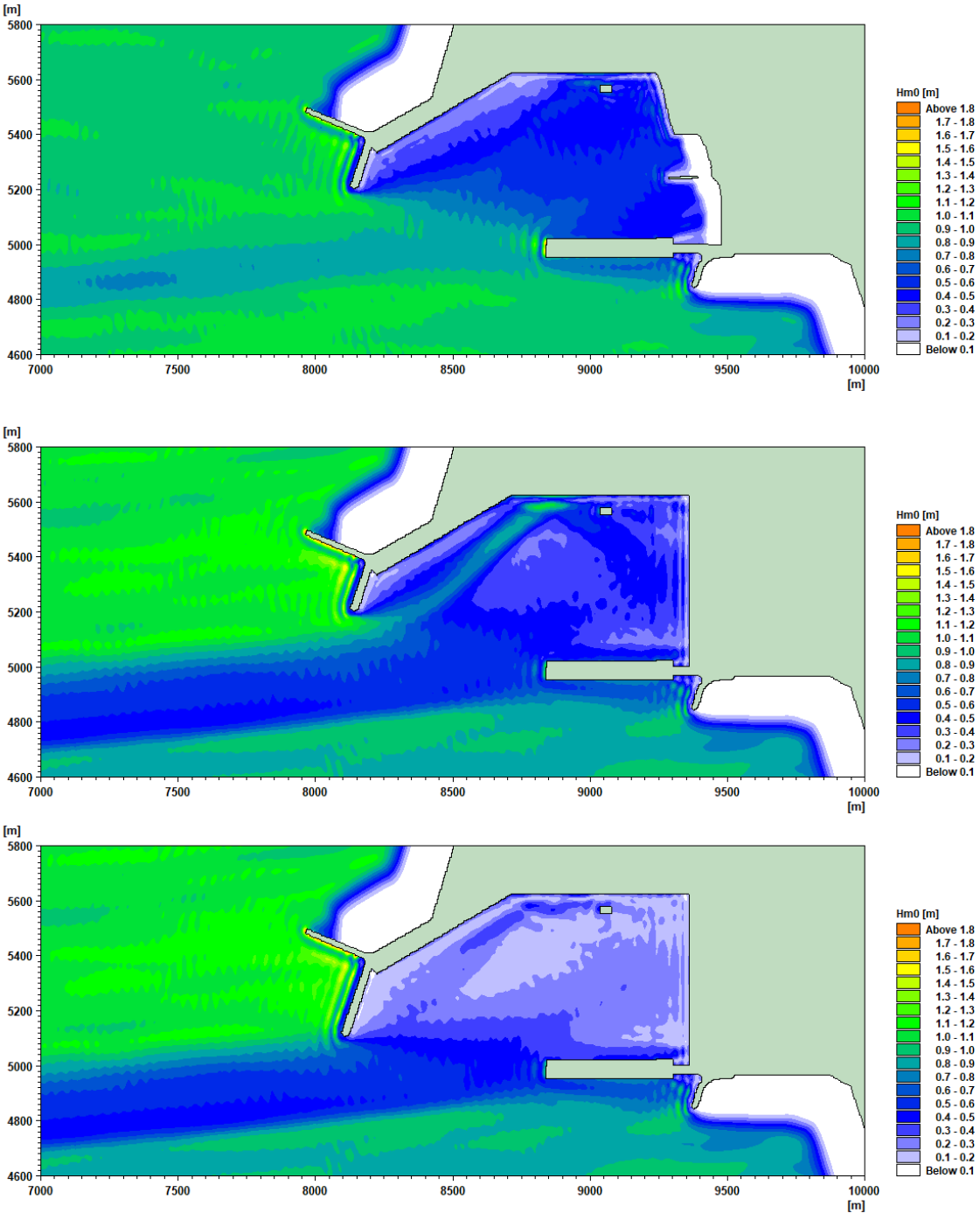

Figure 4.9: H_{m0} in the port for the current situation, project situation and project situation with extension of the entrance breakwater, for H_{m0} = 1m,T_p = 8 s, MWD = 270°N.

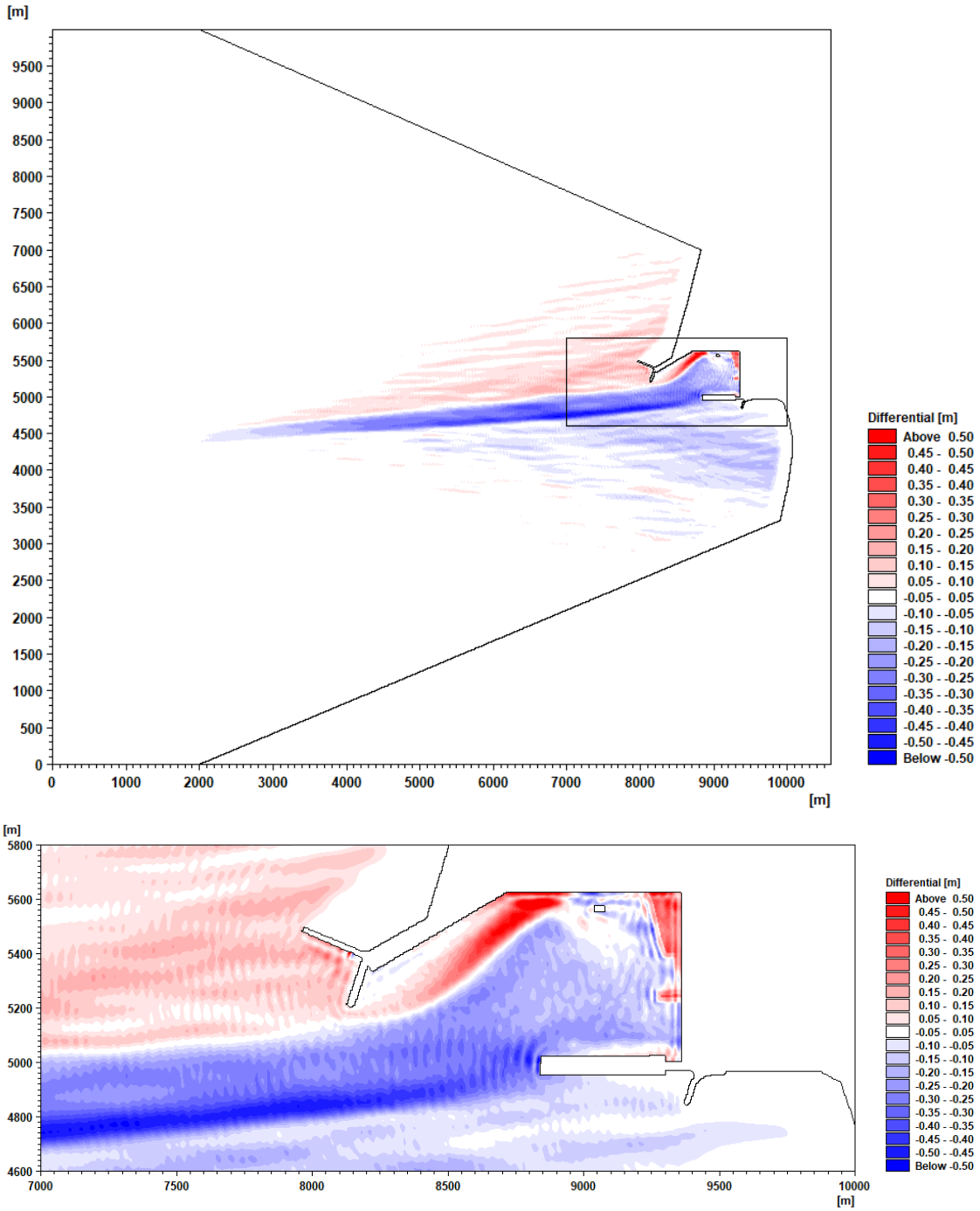

Figure 4.10: Wave attenuation coefficient between the project situation and the current situation. Whole domain (upper) and detail of the port (lower). Red (blue) colour reflects a higher (lower) significant wave height compared with the current situation.

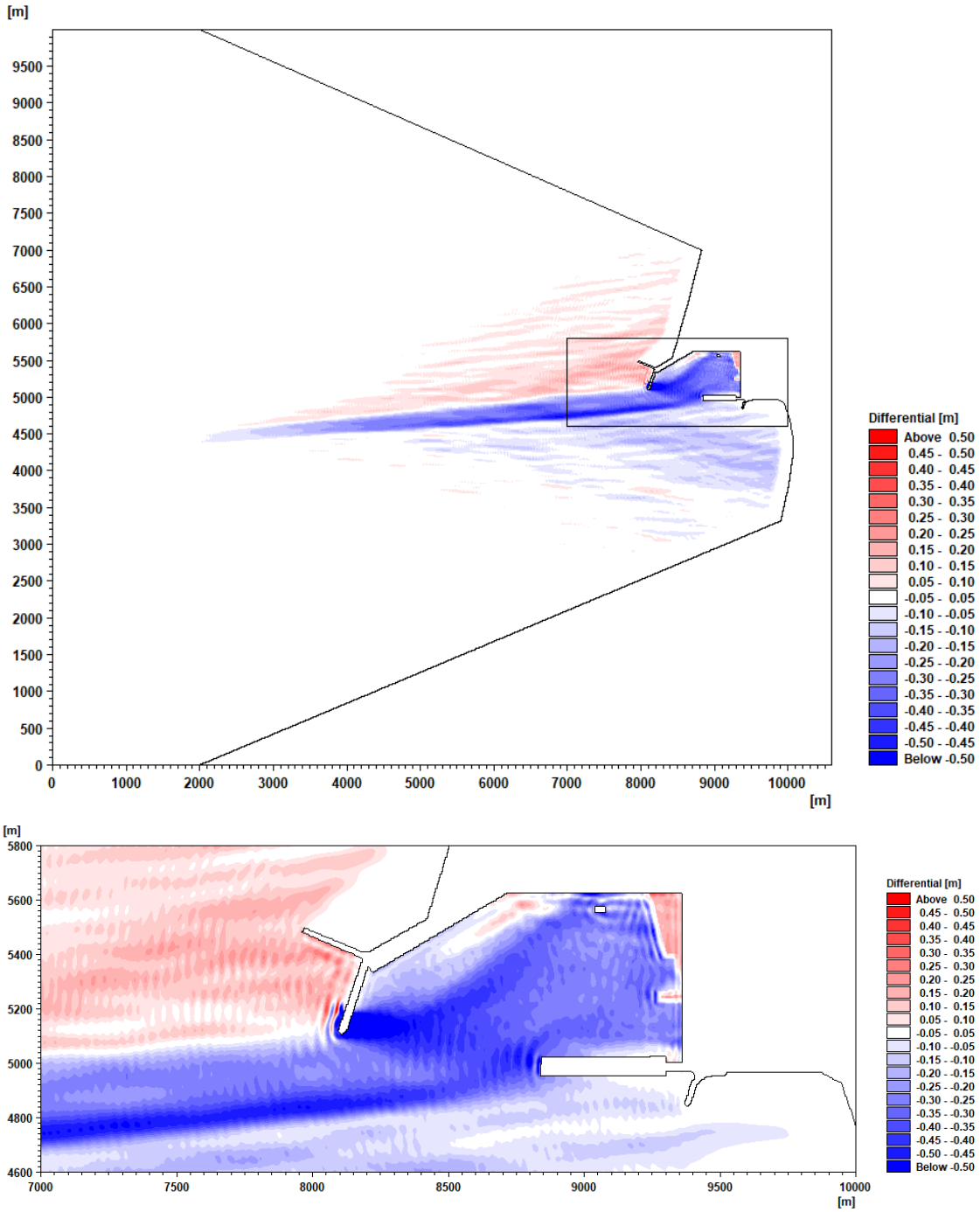

Figure 4.11: Wave attenuation coefficient between the project situation with extension of the breakwater and the current situation. Whole domain (upper) and detail of the port (lower). Red (blue) colour reflects a higher (lower) significant wave height compared with the current situation.

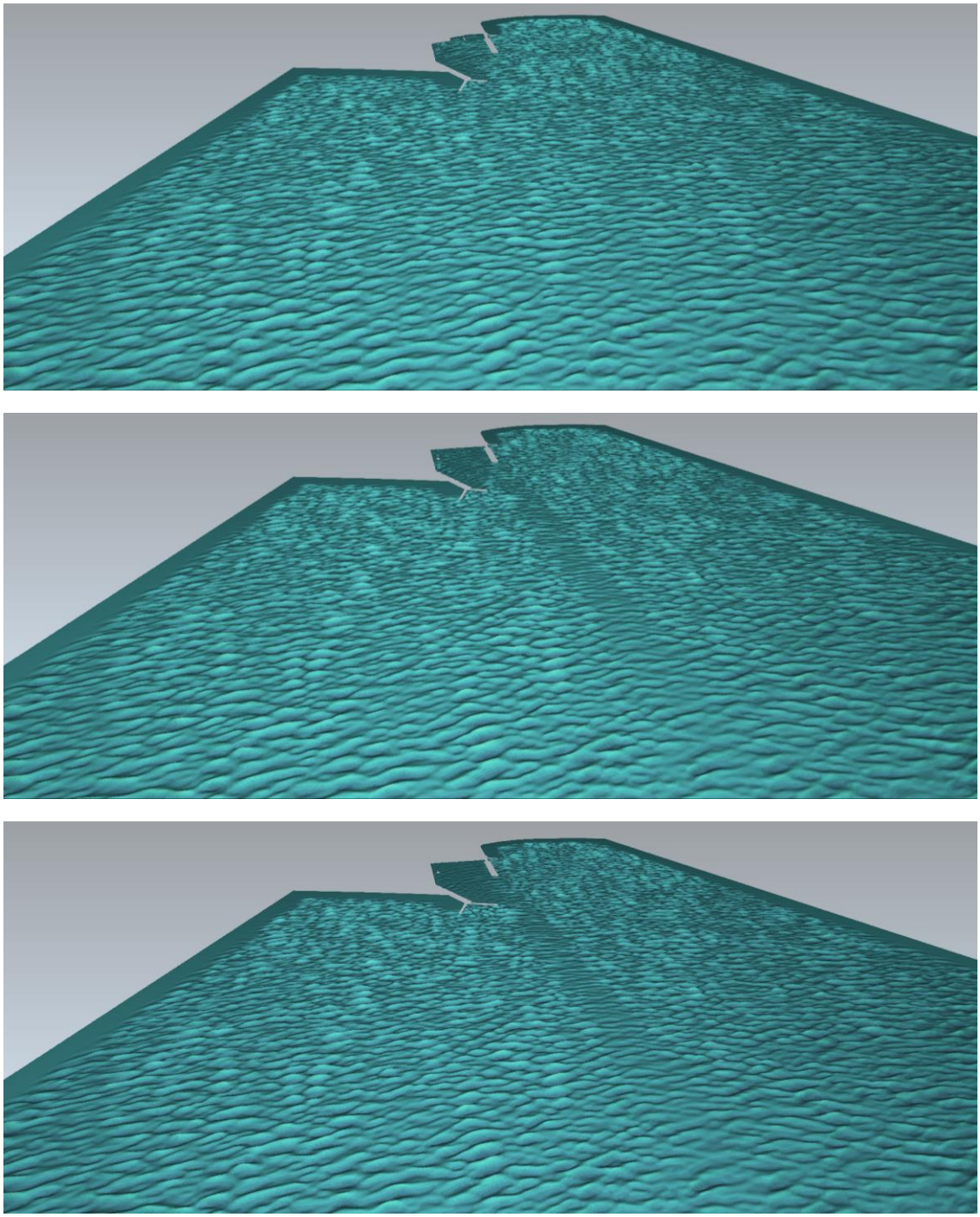

Figure 4.12: Examples of wave patterns around the channel, from top to bottom: current situation, project situation, project situation with extended breakwater. Wave direction: 270°N, T_p = 8 s.

4.1.3.2 Wave disturbance in the port

The wave disturbance inside the port has been investigated for six reference areas corresponding to current and/or future berth locations. The six reference areas are marked in Figure 4.13.

Within each area, the mean value of wave disturbance coefficient was calculated for each incident wave scenario. It should be noted that for areas being influenced by local reflections (and/or partially sheltered), there may be relatively large variations of disturbance coefficient within the area.

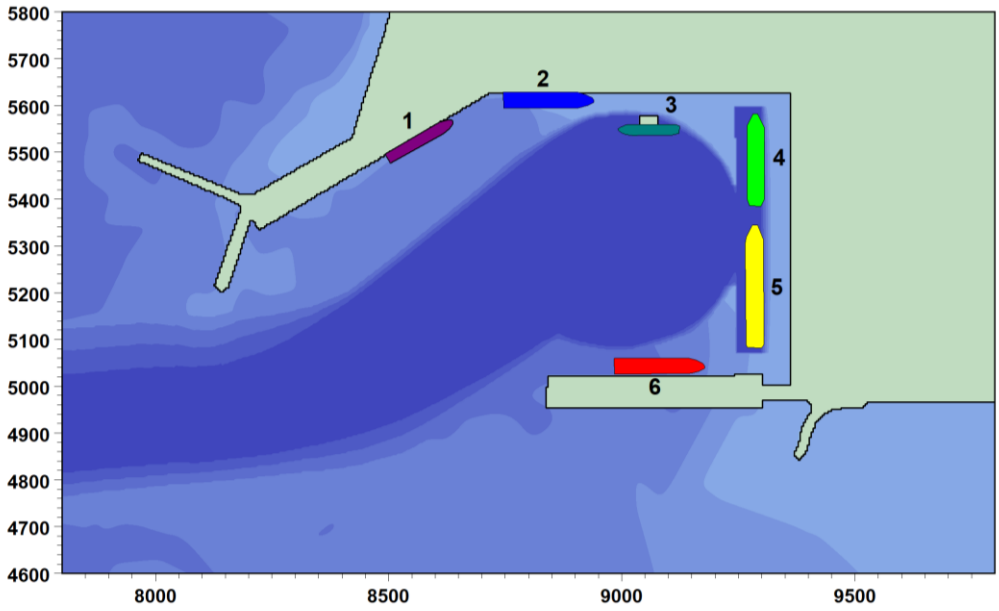

Figure 4.13: Reference areas.

The wave disturbance coefficient calculated within each of the reference areas for the different wave conditions and configurations of the port are given in Table 4.2 to Table 4.7. **"Project 2"** refers to the project layout with the **100m extension of the entrance breakwater**. No wave disturbance coefficient was calculated for area 4 and area 5 in the current situation because these berth areas do not exist yet.

It is seen that on average, the project situation tends to increase the wave disturbance coefficients. This is particularly the case in Area 2 which corresponds to the most critical area of the port in the project situation. In Area 3 and in Area 6 the project layout tends to decrease a bit the wave disturbance coefficient for incoming wave directions of 270°N.

On the opposite, on average the project situation with the extension of the breakwater tends to decrease the wave disturbance coefficients compared to the current situation and to the other project situation. It can be noted that for incoming waves of 292.5°N, the wave disturbance is higher in Area 1 and 2 in the project situation with the breakwater, which corresponds to the observation made in the previous section before, based on the observation of the wave fields. This increase of the wave disturbance is a lot reduced compared to the one observed for similar wave conditions in the project situation.

It can be noted as well that the most critical incoming wave direction with this layout is 247.5°N. In Areas 3, 4, and 5 (depending on the peak period concerning the last one) the extension of the breakwater does not improve the wave disturbance compared to the project situation for this incoming wave direction. In area 6, none of the project layouts improve the current situation for 247.5°N waves. These waves are however relatively rare (see rose plot on Figure 4.14)

The project layout with extension of the breakwater would improve the wave disturbance in Area 3, would offer satisfying wave disturbance coefficient in Area 4 and 5, but it would slightly increase the wave disturbance in Area 1, 2 and 6. Nouakchott port would mostly benefit from an improvement of the wave conditions associated to the much more frequent 292.5°N waves.

Table 4.2: Wave disturbance coefficient in area 1.

Area1			
	Current	Project	Project 2
1: MWD=292.5°N, T_p=8s, WL=1.7m	0.31	0.51	0.33
2: MWD=292.5°N, T_p=10s, WL=1.7m	0.39	0.73	0.45
3: MWD=247.5°N, T_p=8s, WL=1.7m	0.81	0.77	0.71
4: MWD=247.5°N, T_p=10s, WL=1.7m	0.86	0.90	0.72
5: MWD=270°N, T_p=8s, WL=1.7m	0.44	0.48	0.31
6: MWD=270°N, T_p=10s, WL=1.7m	0.51	0.62	0.34
7: MWD=270°N, T_p=8s, WL=0.5m	0.45	0.49	0.32

Table 4.3: Wave disturbance coefficient in area 3.

Area3			
	Current	Project	Project 2
1: MWD=292.5°N, T_p=8s, WL=1.7m	0.53	0.62	0.37
2: MWD=292.5°N, T_p=10s, WL=1.7m	0.55	0.67	0.48
3: MWD=247.5°N, T_p=8s, WL=1.7m	1.19	0.78	0.81
4: MWD=247.5°N, T_p=10s, WL=1.7m	1.16	0.81	0.70
5: MWD=270°N, T_p=8s, WL=1.7m	0.71	0.57	0.31
6: MWD=270°N, T_p=10s, WL=1.7m	0.75	0.58	0.35
7: MWD=270°N, T_p=8s, WL=0.5m	0.70	0.63	0.25

Table 4.4: Wave disturbance coefficient in area 5.

Area5			
	Current	Project	Project 2
1: MWD=292.5°N, T_p=8s, WL=1.7m	-	0.53	0.31
2: MWD=292.5°N, T_p=10s, WL=1.7m	-	0.53	0.34
3: MWD=247.5°N, T_p=8s, WL=1.7m	-	0.62	0.61
4: MWD=247.5°N, T_p=10s, WL=1.7m	-	0.54	0.49
5: MWD=270°N, T_p=8s, WL=1.7m	-	0.48	0.27
6: MWD=270°N, T_p=10s, WL=1.7m	-	0.43	0.25
7: MWD=270°N, T_p=8s, WL=0.5m	-	0.46	0.25

Table 4.5: Wave disturbance coefficient in area 2.

Area2			
	Current	Project	Project 2
1: MWD=292.5°N, T_p=8s, WL=1.7m	0.32	1.16	0.55
2: MWD=292.5°N, T_p=10s, WL=1.7m	0.50	1.14	0.58
3: MWD=247.5°N, T_p=8s, WL=1.7m	1.46	0.96	0.71
4: MWD=247.5°N, T_p=10s, WL=1.7m	1.41	0.96	0.76
5: MWD=270°N, T_p=8s, WL=1.7m	0.49	1.15	0.46
6: MWD=270°N, T_p=10s, WL=1.7m	0.64	1.05	0.44
7: MWD=270°N, T_p=8s, WL=0.5m	0.53	1.11	0.45

Table 4.6: Wave disturbance coefficient in area 4.

Area4			
	Current	Project	Project 2
1: MWD=292.5°N, T_p=8s, WL=1.7m	-	0.43	0.28
2: MWD=292.5°N, T_p=10s, WL=1.7m	-	0.51	0.28
3: MWD=247.5°N, T_p=8s, WL=1.7m	-	0.66	0.67
4: MWD=247.5°N, T_p=10s, WL=1.7m	-	0.65	0.62
5: MWD=270°N, T_p=8s, WL=1.7m	-	0.41	0.25
6: MWD=270°N, T_p=10s, WL=1.7m	-	0.42	0.23
7: MWD=270°N, T_p=8s, WL=0.5m	-	0.39	0.21

Table 4.7: Wave disturbance coefficient in area 6.

Area6			
	Current	Project	Project 2
1: MWD=292.5°N, T_p=8s, WL=1.7m	0.48	0.75	0.55
2: MWD=292.5°N, T_p=10s, WL=1.7m	0.50	0.74	0.54
3: MWD=247.5°N, T_p=8s, WL=1.7m	0.64	0.73	0.71
4: MWD=247.5°N, T_p=10s, WL=1.7m	0.74	0.73	0.71
5: MWD=270°N, T_p=8s, WL=1.7m	0.62	0.61	0.45
6: MWD=270°N, T_p=10s, WL=1.7m	0.60	0.54	0.41
7: MWD=270°N, T_p=8s, WL=0.5m	0.56	0.59	0.43

4.1.3.3 Exceedance of wave disturbance

To provide information for mooring analysis studies and port operability evaluation, we included as additional task in our mission: the production of exceedance curves of wave disturbance.

Methodology

An estimation of the wave statistics at the selected areas has been made, based on:

1. the wave disturbance coefficients calculated for the incident wave scenarios;
2. the long-term wave conditions at the channel entrance coming from the wave propagation modelling.

This estimation was done by:

1. establishing relationships between the incoming wave direction and the wave disturbance coefficient in the port for each area;
2. scaling the wave heights in the port by the incoming wave height at the channel entrance (assuming that the wave processes here are linear, i.e. no wave breaking).

Limitations of the current methodology

As only a few incident wave conditions were modelled, certain assumptions were made to extrapolate the wave disturbance for these few scenarios to wave disturbance for the full long-term time series of wave conditions:

- For wave directions in between the directions actually modelled, linear interpolations were made;
- For wave directions below 247.5°N, the results for 247.5°N were applied;
- For wave directions above 292.5°N, the results for 292.5°N were applied;
- For wave periods, the results for Tp = 8 s were applied.

It should be noted that not all the possible wave scenarios (combinations of wave direction and wave period) are covered by these assumptions. **In particular, the rose plot in Figure 4.14 shows that waves from NW occur 20% of time, therefore at least an additional scenario with an incoming wave direction of 315°N would be required to extrapolate correctly the wave disturbance coefficient for these conditions where waves come from NW.**

Moreover, the scatter plot on Figure 4.14 shows that peak periods can reach 12 to 15 s, therefore modelling additional scenarios with peak period above 10 s would also allow for a better extrapolation of the wave disturbance to the complete long-term time series of waves. Finally, the analysis carried out here only relies on the relation between H_{m0} in the port and the mean wave direction of the incident waves, and not between H_{m0} in the port and the peak period of the incident waves (only T_p = 8 s was considered), whereas this parameter can have a significant impact on the wave disturbance in the port.

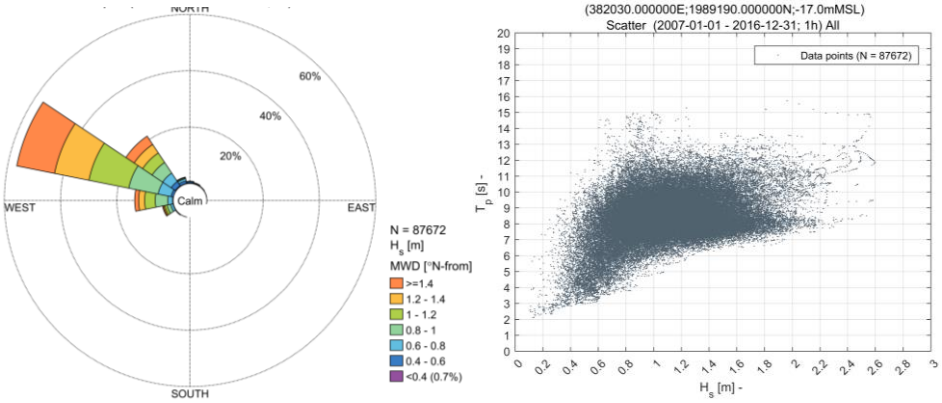

Figure 4.14: Wave statistics at the channel entrance: wave rose of H_{m0} and MWD (left), correlation between H_{m0} and T_p (right).

However, at this stage of the study, the assumptions described above already allow to get a first estimation of the wave statistics in the harbour and to highlight trends.

Results

Figure 4.15 shows the estimated exceedance frequency in % of the mean H_{m0} in the 6 areas.

From this plot, the percentage of time where a certain wave height is exceeded can be read. As an example, it can be seen that in Area 1, H_{m0} = 0.5 m is exceeded 1.2% of time in the current situation, 11% of time in the project situation and 0.16% of time in the project situation with the extension of the breakwater. These percentages correspond respectively to 4.4 days/year, 14 h/year and 40 days/year. However it should be noted that due to the assumptions described above, these values should only be considered as first estimations at this stage of the study.

It is important to note as well that the exceedance analysis does not provide any information about the number of events where a certain wave height is exceeded, but only a total duration of these events. A given exceedance frequency could thus represent both a few events of long duration and a large number of events of short duration.

It is seen that the project situation mostly results in higher significant wave heights inside the harbour (except in Area 3 where the current situation is the most critical one). On the opposite, the project layout with the extension of the breakwater results in the lowest H_{m0} (except only in area 2 and for low H_{m0}).

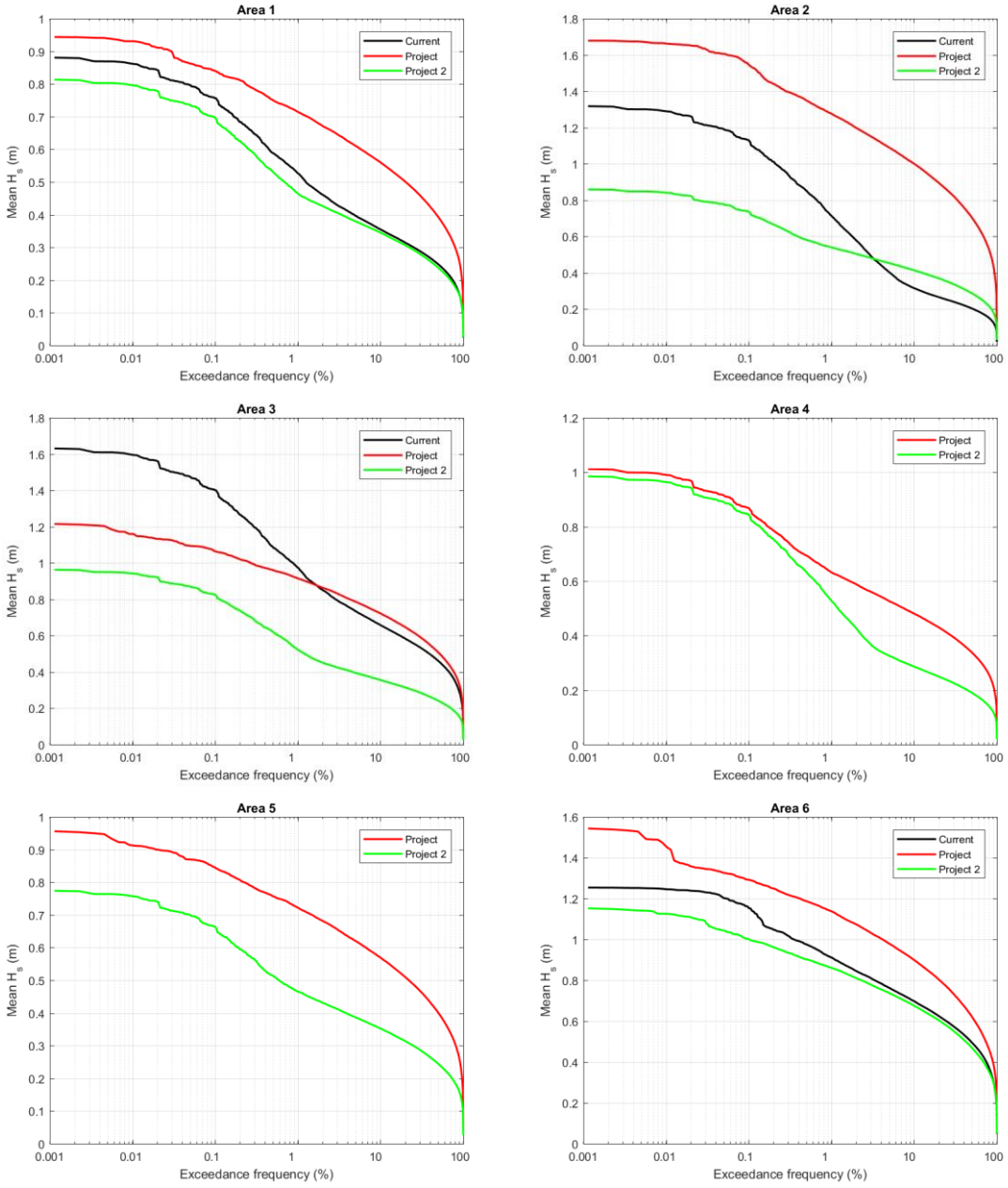

Figure 4.15: Estimation of the exceedance frequency of mean H_{m0} for each selected area in the current situation, in the project situation and in the project situation including the breakwater extension.

5 Turbidity plume dispersion due to dredging operations

Dredging works and dumping activities leads to the generation of sediment plumes, caused by the spillage/release of fines materials from the dredging equipment, and disturbance of the seabed by the mechanical dredging/dumping activities. It is a general requirement by authorities to quantify the possible footprint of the sediment plume excursions and the related impacts to sensitive receptors.

In order to estimate the impact of the dredging operations in term of turbidity plume, and its dispersion, a hydrodynamic and sediment transport numerical modelling (fine sediments) was undertaken.

5.1 General information

The current circulation offshore the Mauritanian coast is characterized by the northward Mauritanian current. Large scale horizontal circulation is schematized Figure 5.1. To the west, the North Equatorial Current (NEC) and the Canary Current (CC) forms the eastern boundary of the North Atlantic subtropical gyre. Near-shore, a strong wind-induced coastal upwelling is active, its extension depending on season, and a density front develops that generates the coastal jet, also named Canary upwelling Current (CanUC). South of the region, the circulation is dominated by the North Equatorial Counter-Current (NECC), which has a large seasonal cycle. It is located near 5°N in winter and reaches 10°N in summer. During this season, it continues north as the Mauritania Current (MC), which flows northward until about 20°N.

The Atlantic North-eastern Tropical Upwelling System is characterized by permanent currents (dark gray), seasonal currents in winter-spring (green), seasonal currents in summer-autumn (blue) and upwelling area (gray shading). Dash line corresponds to currents not evidenced by *in-situ* measurement, but visible in circulation derived from altimetry.

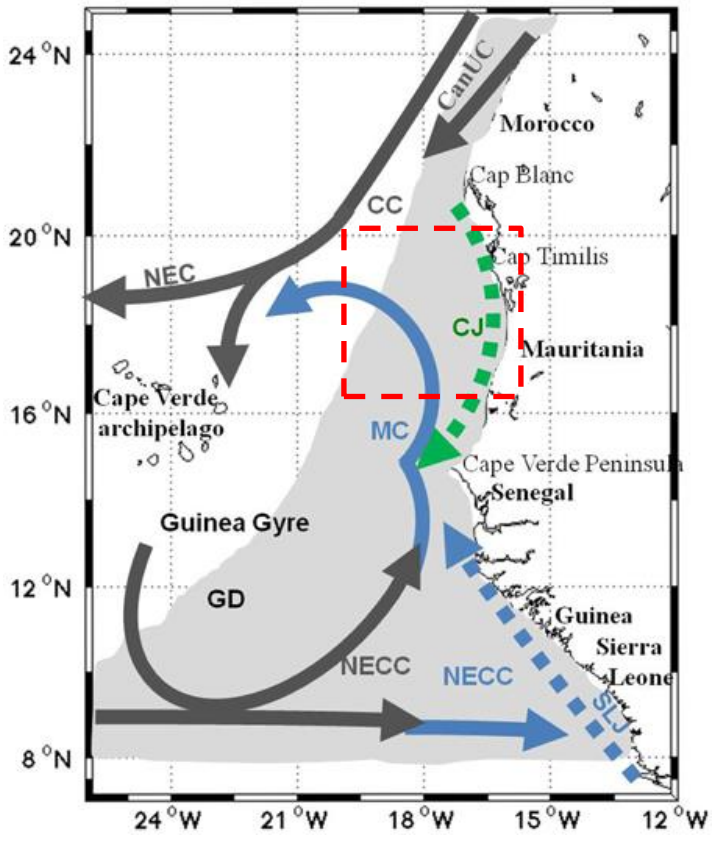

Figure 5.1 Map showing the schematic oceanic circulation pattern along the NW African Margin

To illustrate the upwelling phenomena intensity variation along the year, Figure 5.2 presents the seasonal variation of the surface wind sea surface, the temperature and near surface and the near surface chlorophyll intensity along the Mauritania coast. The sea temperature near Nouakchott appears to vary from 15-17°C in winter-spring, up to 25-27°C in summer-autumn.

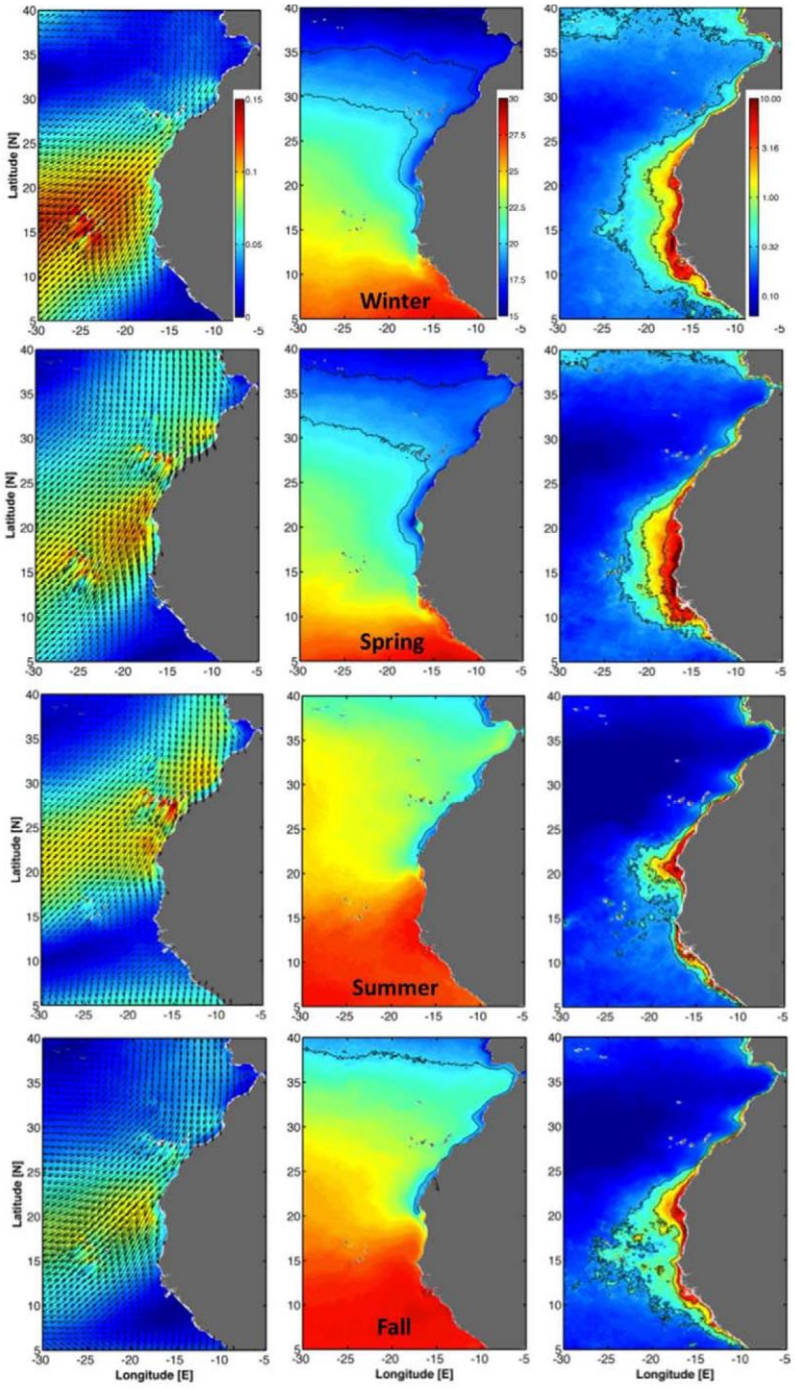

Figure 5.2 Map Distribution of surface wind (left), sea surface temperature (middle) and near surface chlorophyll (right). From top to bottom: winter, spring, summer, autumn)

5.2 Large scale 3D Hydrodynamic model model setup

As presented in the previous section, oceanic currents and winds generate strong wind-induced coastal upwelling along the Mauritanian coast, which can play a significant role on the local current offshore Nouakchott.

A three-dimensional current model, based on the MIKE 3 Flow Model FM module, has been setup to represent the general current climate along and offshore the Mauritanian coast. MIKE 3 Flow Model FM is a modelling system based on a flexible mesh approach. The modelling has been developed for applications within oceanographic, coastal and estuarine environments. This module simulates the water level variations and flows in response to a variety of forcing functions.

The model has been developed to take into account tidal processes, large-scale current influence and wind forcing effects trough 3D density gradient processes.

5.2.1 Model setup

The domain extent and bathymetry are shown on Figure 5.3. The red rectangle (dashed line) present the model extent on Figure 5.1.

It extends approximately over 300 km along the coast, and 280 km offshore, down to a depth of approximately -2900 m LAT. The mesh is composed of flexible triangular elements from 15 km to 4km (with the size reducing from offshore to the coast). The vertical mesh is composed of 6 “sigma” layers down to -120m LAT and 10 “z”-layers from -120m LAT to -3000m LAT (approximately 290m per layer).

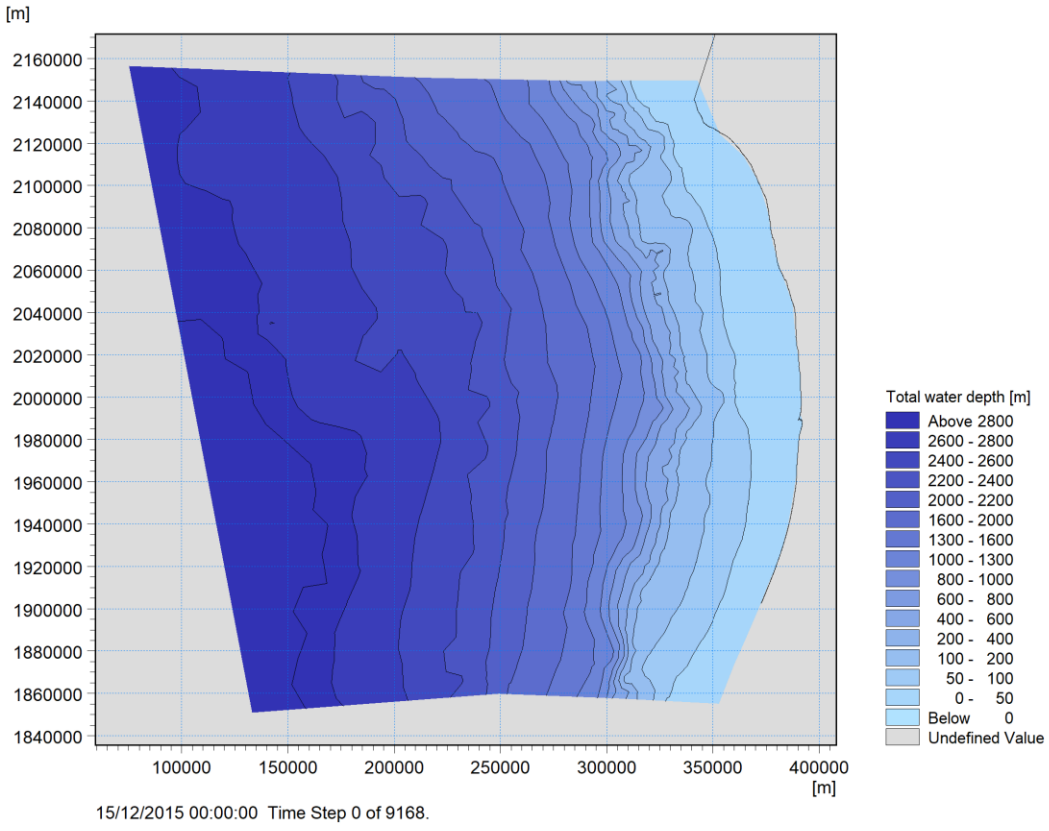

Figure 5.3 Bathymetry of the 3D Hydrodynamic (HD) model

Boundary and initial conditions

Tidal elevations are applied at offshore boundaries North, West and South of the mesh model. Tidal signal is extracted from the MIKE21 Global Tide model (DHI / DTU Space), using 10 astronomical main constituents.

Current, temperature and salinity conditions along the boundary, and initial conditions, were extracted from the HYCOM data.

Parametrization of the hydrodynamic model

Flood and dry areas are taken into account with specific numerical resolutions. Horizontal dispersion is dependent on velocity gradients, according to Smagorinsky (1963) with reference coefficient of 28 m^2/s. Vertical mixing into water column are resolved by a “k-epsilon” turbulence model, that resolves equations of transport, generation and dissipation of kinetic turbulence energy. This model is parametrized with empirical standard coefficients and has been extended to take into account buoyancy effects (Rodi 1980). Bottom friction is parametrized by Nikuradse rugosity ks ~30*z0. The default value of roughness height of 0.05 m is considered

5.2.2 Modelling results

This large-scale model allows to represent the general current climate offshore the Mauritanian coast. The model was run to represent one year (2016) of current climate.

Figure 5.4 presents an example of sea surface current pattern obtained for the winter period. The southward current along the Mauritanian coast, indicated on Figure 5.1 (green arrow, named CJ) is represented. Figure 5.5 presents an example of sea surface current in the summer period showing, on the contrary, the absence of CJ current.

Figure 5.6 and Figure 5.7 show examples of sea temperature profiles, extracted from the 3D HD model along a profile extended from Nouakchott to 120 km offshore. These figures represent respectively an example of sea temperature profile for the winter and summer season, illustrating the coastal upwelling phenomena variation over a 1-year period. As detailed in section 5.1, the upwelling is intense along the Mauritanian coast in winter, leading to sea temperature of about 15 to 17°C in winter-spring. This upwelling phenomenon reduces in summer-autumn, allowing for sea temperature of about 25 to 27°C.

Figure 5.8 presents the variation of sea surface temperature (-5m under surface) over the year 2016 at points three points named by their corresponding water depth, -2800m, -1350m and -25m, and located respectively 240km, 80km and 20km offshore Nouakchott. The nearshore sea surface temperature (point -25 – black line) varies over the year from 15°C in March to May, up to 25°c in August -September.

In the absence of local measured data that would allow to validate the model, one can conclude that, compared to the information in the literature, the model results show good agreements in term of capability to represent the general current climate in this area while

The 3D HD model results are then exploited to analyse the annual current climate near the Nouakchott port are in order to determine two 2 week-periods which are representative of the local hydrodynamic conditions.

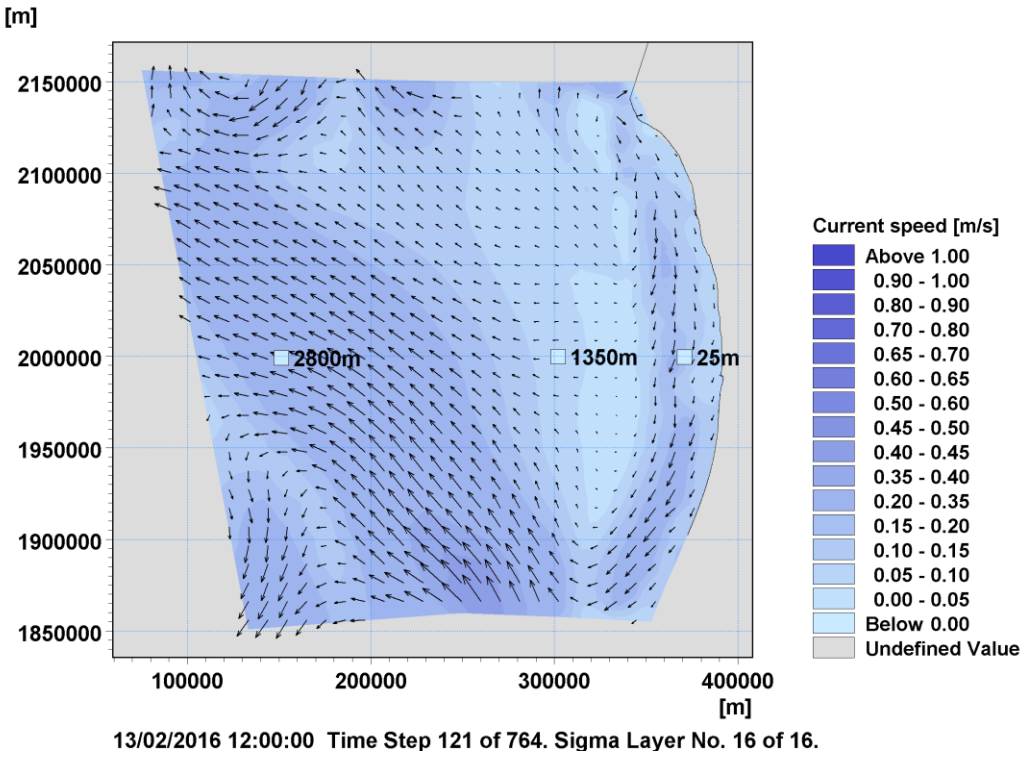

Figure 5.4 Example of surface current pattern showing the southward current along the Mauritanian coast - winter season

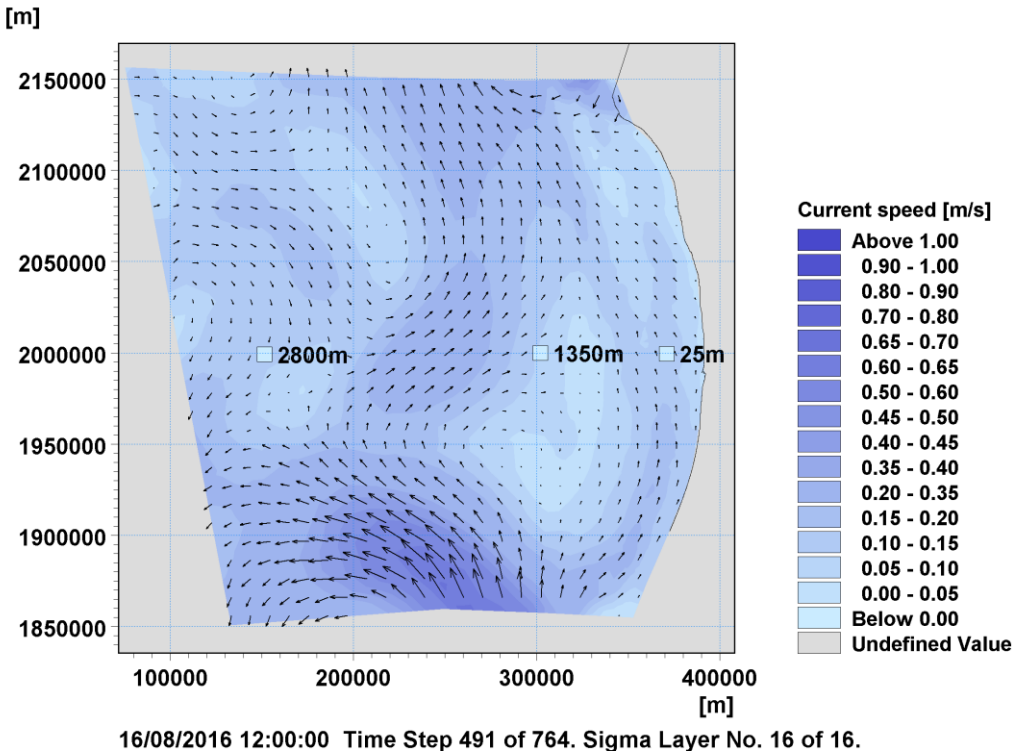

Figure 5.5 Example of surface current pattern along the Mauritanian coast -summer season

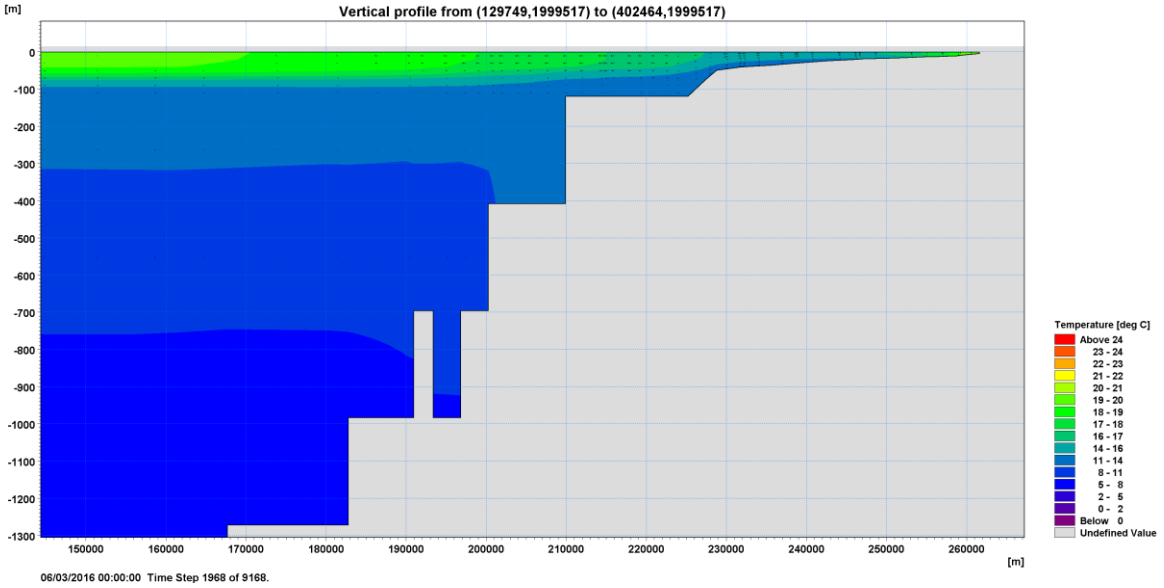

Figure 5.6 Example of sea temperature profile in winter season: profile from Nouakchott to 120km offshore Nouakchott.

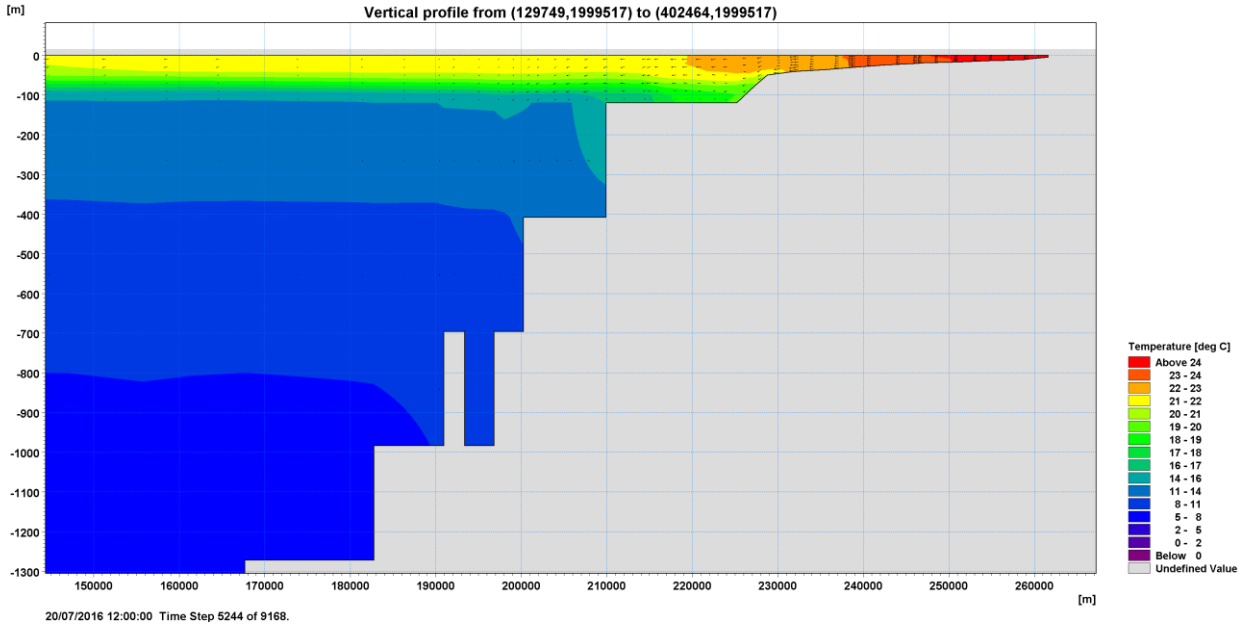

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Figure 5.7 Example of sea temperature profile in summer season: profile from Nouakchott to 120km offshore Nouakchott.

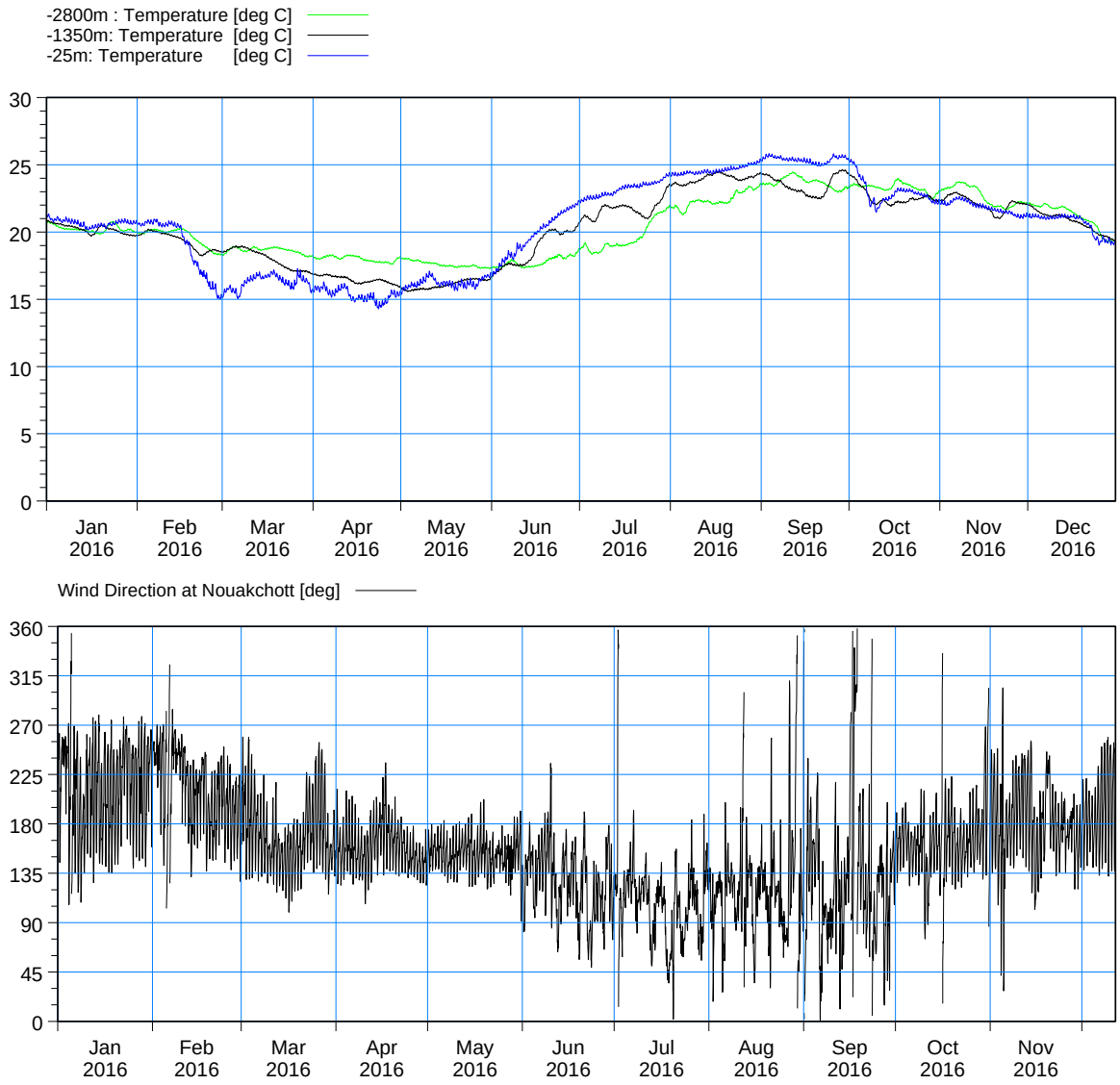


Figure 5.8 Variation of sea surface temperature (-5m under surface) over the year 2016 at points -2800m, -1350m and -25m (top) and associated wind direction at Nouakchott.

5.2.3 Current roses

Figure 5.9 presents the annual sea suface current roses for the points -2800m, -1350m and -25m. Logically, while the offshore current (point -2800m) is characterised by north-westward currents representative of the MC current, the nearshore conditions (point -25m) is characterised by southward currents representative of the CJ current. However, due the seasonal variability of this CJ current, northwards components are noticeable on the corresponding rose.

Figure 5.10 presents the seasonnal sea suface current roses for point -25m only. In spring season, the current is significantly oriented southward. Winter and autumn roses show a similar climate with current speed less intense. On the opposite, in summer, the current is reltaiveley low and is mainly oriented northward

It is therfore decided to consider one “representative” period in spring, with southward currents, and another representive period in summer, with northward currents.

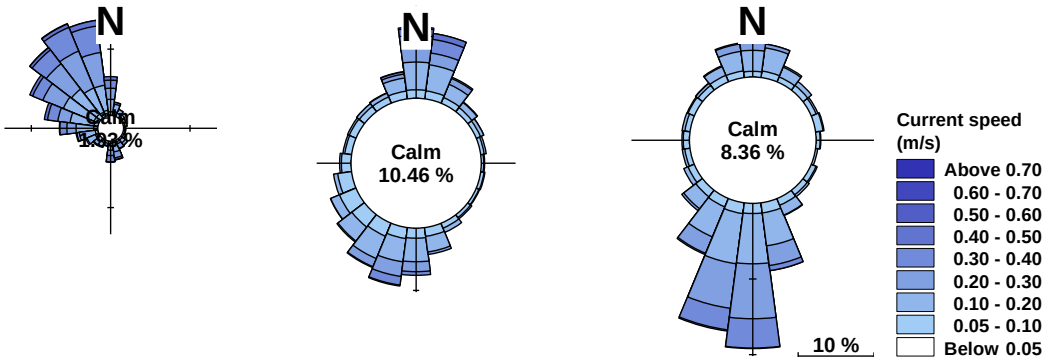


Figure 5.9 Annual sea surface current roses for points -2800m (left), -1350m (middle) and -25m (right)

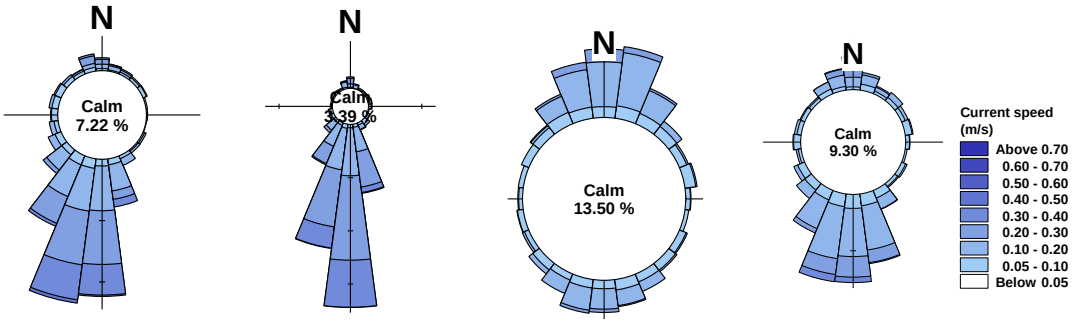


Figure 5.10 Seasonal sea surface current roses for point -25m: winter (left) spring (middle left), summer (middle right), autumn (right)

5.3 Local 2D hydrodynamic model

A 2D local hydrodynamic model was first setup to calculate the hydrodynamic conditions near the port area. It was decided to setup a 2D HD model in order to obtain preliminary information in a reduced period of time. Indeed, the objective of this task is to provide general information on the impact of these marine works, though a high-level approach.

The use of a 2D HD model does not allow to take into account current stratifications and the sediment plume generation and evolution cannot be totally represented. Moreover, the wave effect (induced nearshore currents and sediment resuspension) was not considered at this stage of the study.

A 3D HD local model has been setup in a later stage of the mission, described in section 5.4.

5.3.1 Model setup

The domain extent and bathymetry are shown on Figure 5.11.It extends approximately over 90 km along the coast, and 50 km offshore, down to a depth of approximately -260 m LAT. The mesh is composed of flexible triangular elements from 1 km to 100m (with the size reducing from offshore to the coast). Along the channel, inside the port and along the shore, the element size is reduced to 30m (see Figure 5.12).

Boundary and initial conditions

Tidal elevations and current conditions are applied at offshore boundaries North, West and South of the mesh model. Boundary and initial conditions are excreted from the large-scale 3D HD model.

Parametrization

Flood and dry areas are taken into account with specific numerical resolutions. In the absence of local measured data in the area, defaults values have been considered for all the parameters.

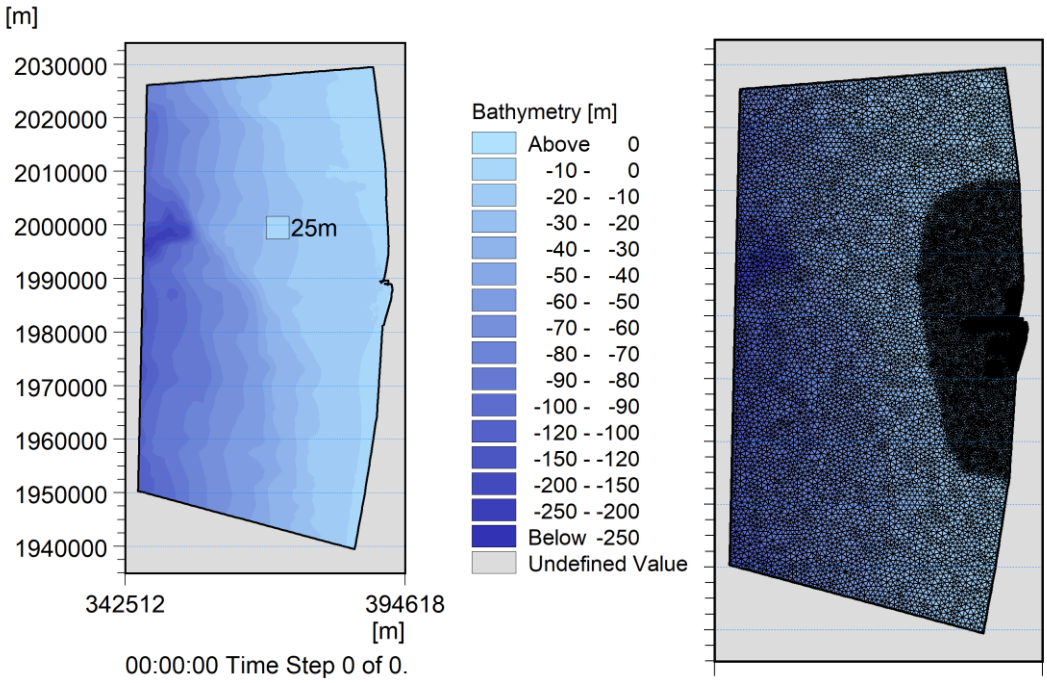


Figure 5.11 Bathymetry and mesh of the 2D Hydrodynamic (HD) local model

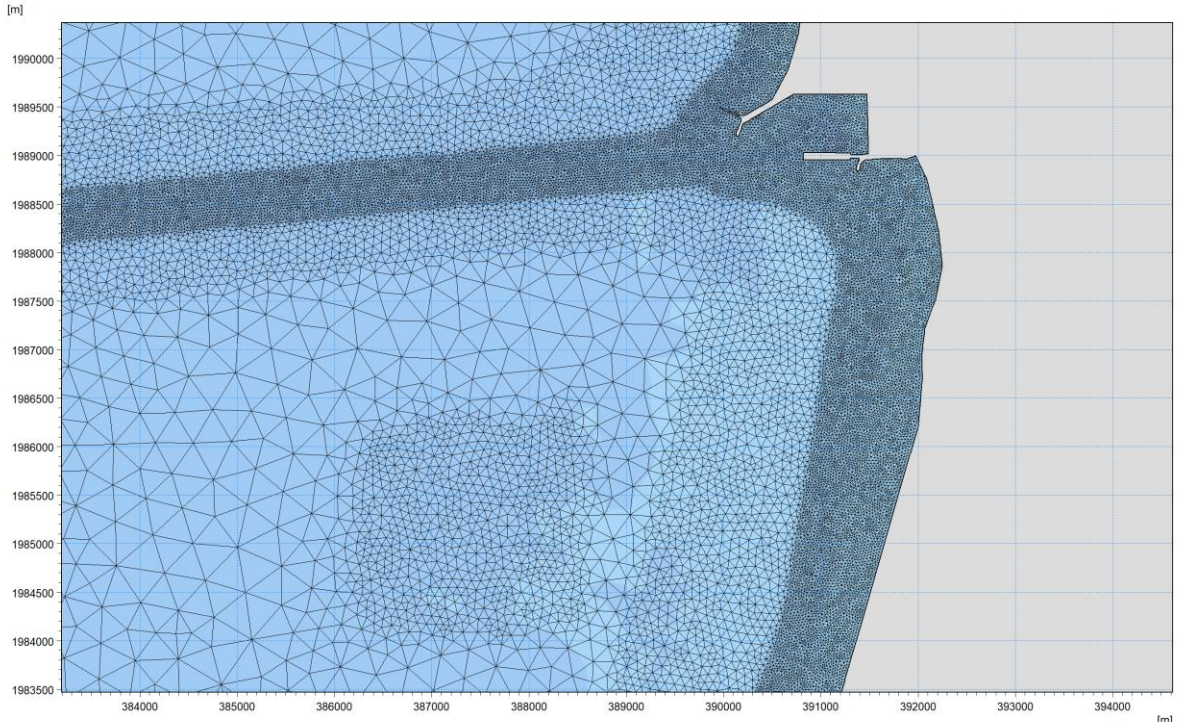


Figure 5.12 Mesh size reduction the channel and port area and along the shore

5.3.2 Hydrodynamic scenarios

The modelling is performed for two 15 days periods:

- **16/03/2016 to 31/03/2016: winter to spring period**
- **16/07/2016 to 31/07/2016: summer period**

For each period, 1 day of model initialisation is considered before the indicated start day. Note that waves are not included in the simulations at this stage.

5.3.3 Model results and comparison 3D vs 2D

A comparison of the results obtained with the large-scale 3D HD model and with the local scale 2D HD model has been performed. The times series of current speed and direction were extracted at the point -25m, located about 20km offshore Nouakchott (see location on Figure 5.11). Figure 5.13 and Figure 5.14present, for the two hydrodynamic scenarios, these times series for different depths (-5m, -12m -20m – from the 3D model) and the depth averaged values (from the 2D model). Current roses are also presented for each depth and the depth averaged values.

Currents are quite weak in this area. The mean depth-averaged current speed over the period is 10 cm/s for the 2D HD model, the maximum depth-averaged current speed is 20 cm/s. The 2D model results show good agreements in term of current direction compared to the 3D model results, especially for the first scenario (winter period). However, the 2D model calculate lower current speed values when looking at the 3D model results. Indeed, according to the 3D model, currents vary in the water column and the surface current can two times higher (up to 40cm/s) than the near bottom current

Moreover, it should be noticed that the 3D model shows a clear change in current direction near the sea bed, compared to the rest of the water column, especially in winter scenario.

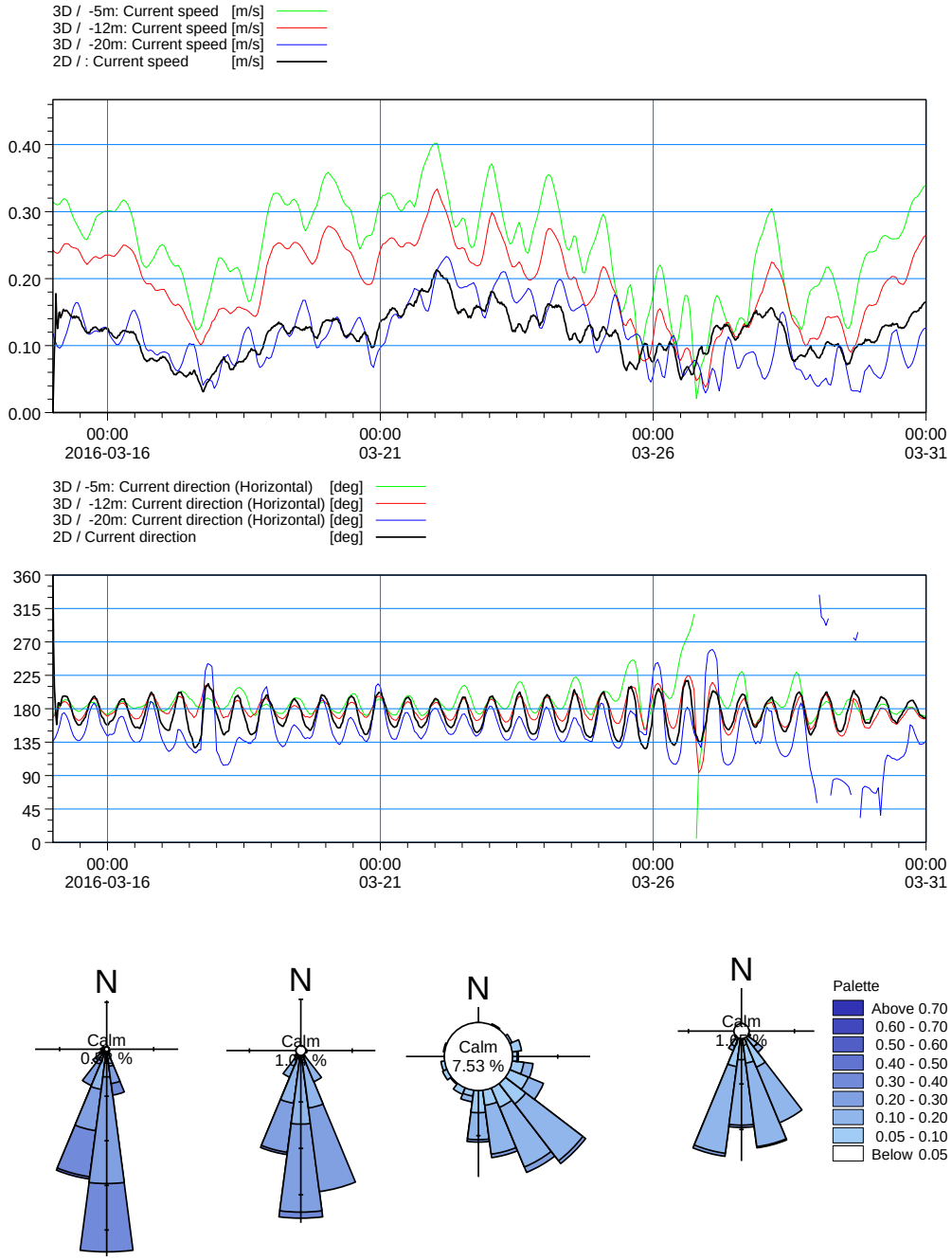


Figure 5.13 Period 16/03/2016 to 31/03/2016: Time series of current speed (top) and current direction (middle) at the point “-25m”, from the 3D model at different depths (-5m, green line, -12m red line and -20m blue line) and from the 2D local model (black line).

Bottom: Current roses from the 3D model (left: -5m, middle left: -12m, middle right: -20m) and from the 2D model (right)

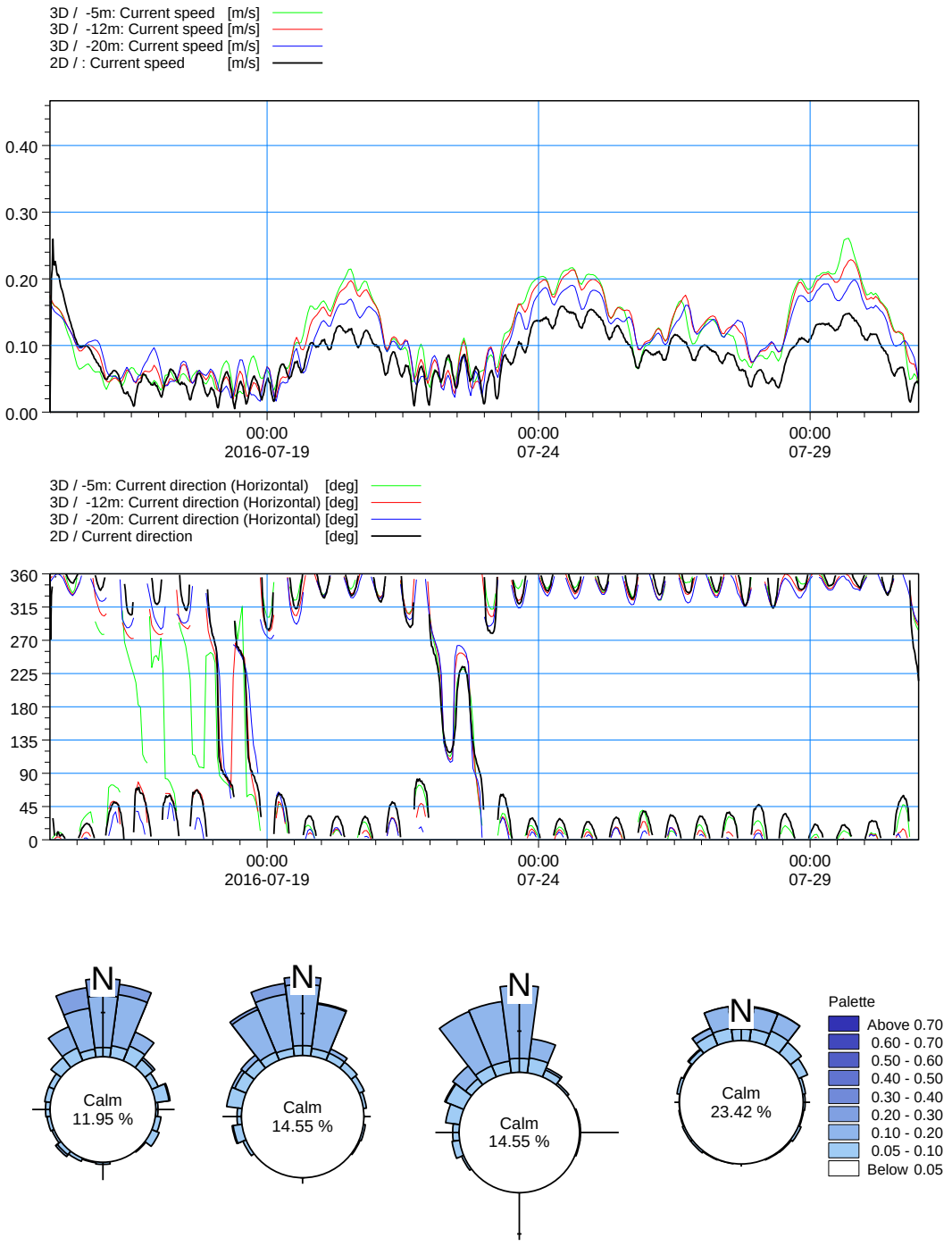


Figure 5.14 Period 16/07/2016 to 31/07/2016: Time series of current speed (top) and current direction (middle) at the point "-25m", from the 3D model at different depths (-5m, green line, -12m red line and -20m blue line) and from the 2D local model (black line).

Bottom: Current roses from the 3D model (left: -5m, middle left: -12m, middle right: -20m) and from the 2D model (right)

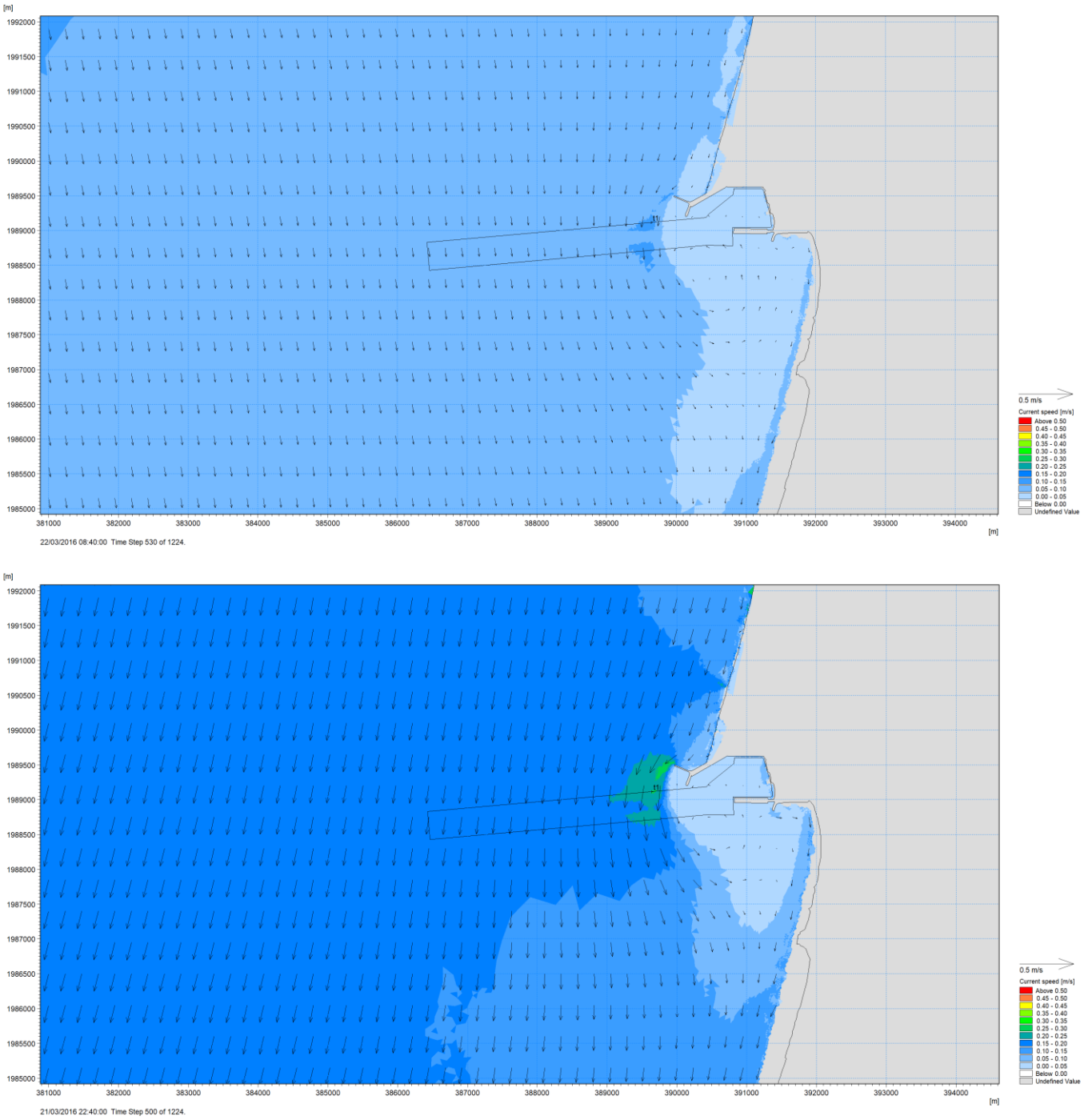


Figure 5.15 Period 16/03/2016 to 31/03/2016: Surface current charts during flood (up) and ebb (bottom), during spring tide. Existing channel layout in black line,

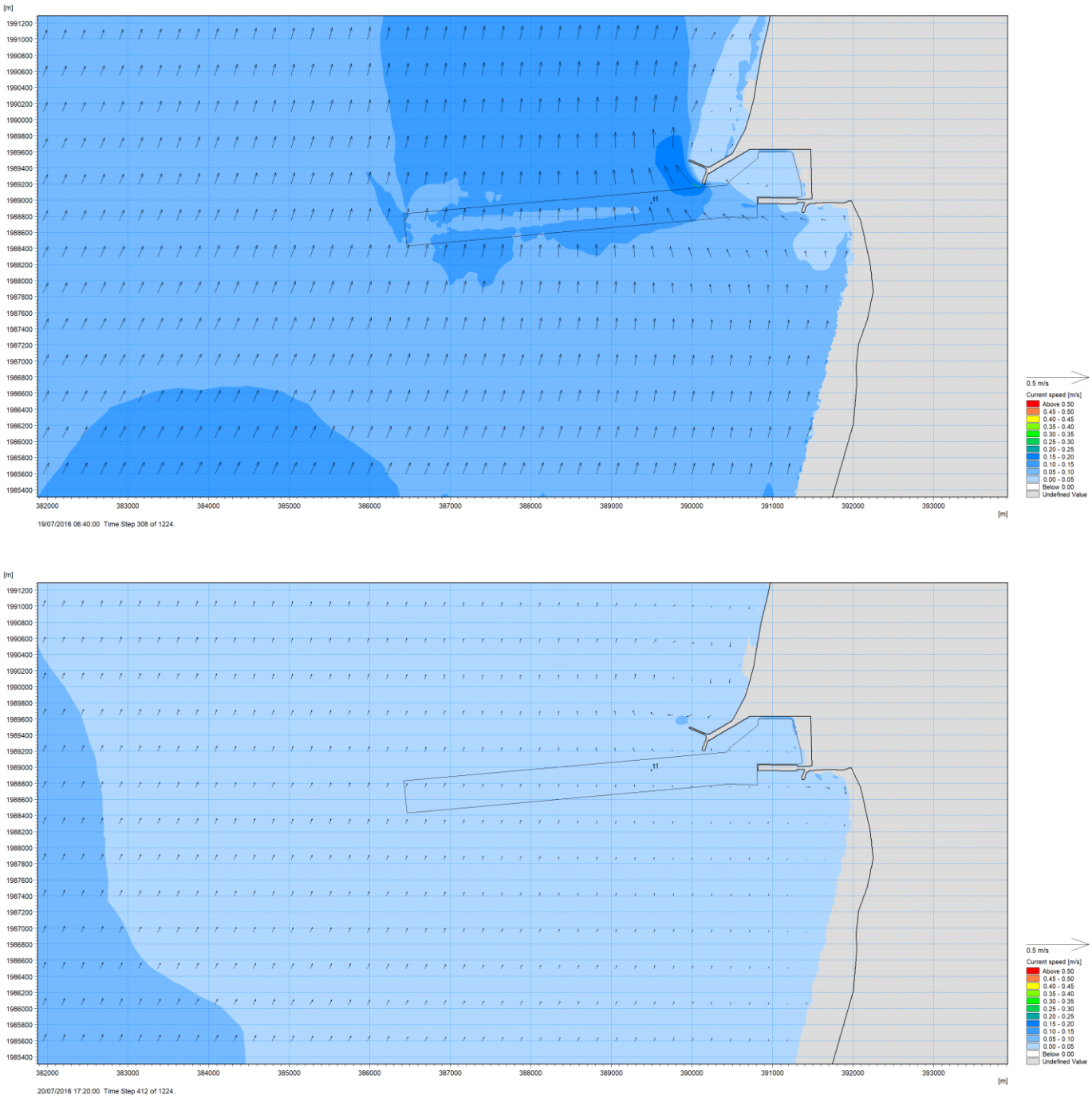


Figure 5.16 Period 16/07/2016 to 31/07/2016: Surface current charts. Existing channel layout in black line,

5.4 Local 3D hydrodynamic model

A three-dimensional HD local model has been then setup to improve the representation of the hydrodynamic and sediment transport phenomenon.

5.4.1 Model setup

Like the local 2D model, the domain extents approximately over 90 km along the coast, and 50 km offshore, down to a depth of approximately -260 m LAT. The mesh is composed of flexible triangular elements from 1 km to 100m (with the size reducing from offshore to the coast). Along the channel, inside the port and along the shore, the element size is reduced to 30m. The vertical mesh is composed of 10 “sigma” layers. The mesh and and bathymetry are shown on Figure 5.11.

Boundary and initial conditions

Tidal elevations and current conditions are applied at offshore boundaries North, West and South of the mesh model. Boundary and initial conditions are excreted from the large-scale 3D HD model.

Parametrization

Flood and dry areas are taken into account with specific numerical resolutions. In the absence of local measured data in the area, defaults values have been considered for all the parameters.

5.4.2 Hydrodynamic scenarios

The modelling is performed for two 15 days periods:

- **16/03/2016 to 31/03/2016: winter to spring period**
- **16/07/2016 to 31/07/2016: summer period**

For each period, 1 day of model initialisation is considered before the indicated start day. Note that waves are not included in the simulations at this stage.

The wind speed and direction, as well as the water levels associated to each period are presented Figure 5.17 and Figure 5.18.

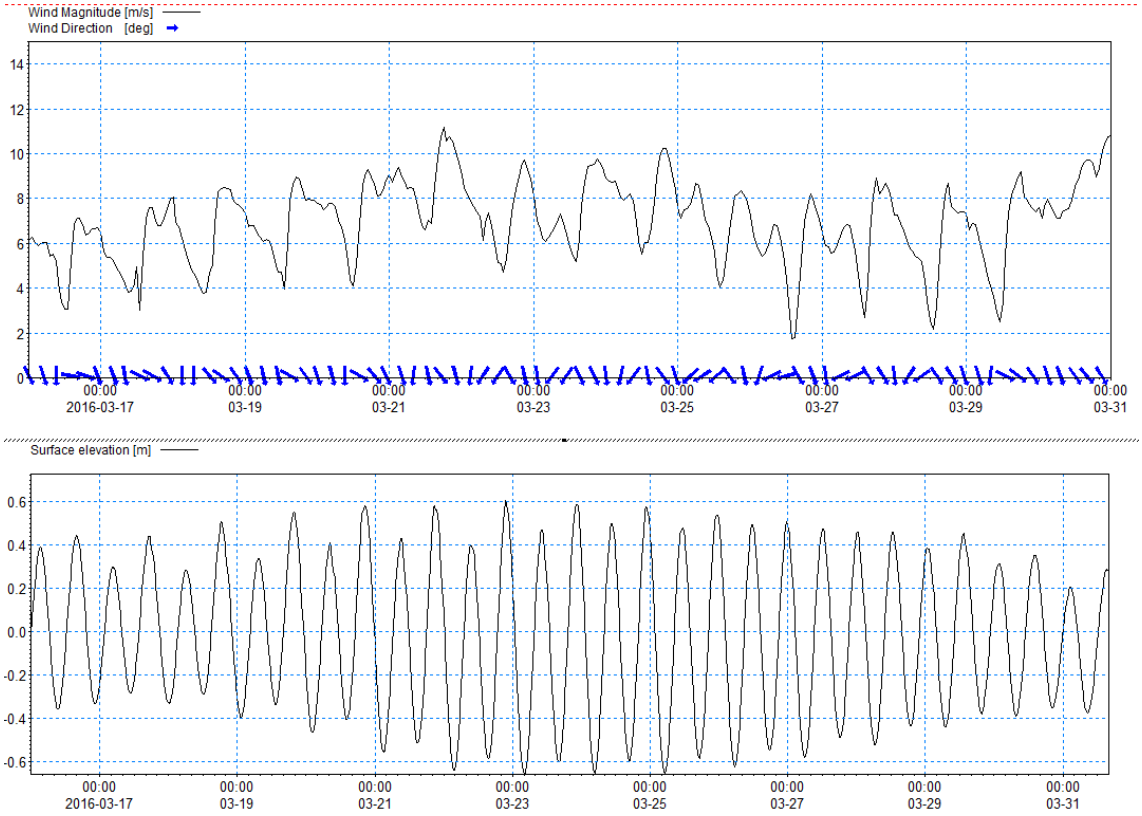


Figure 5.17 Wind speed and direction and water level for the period 16/03/2016 to 31/03/2016

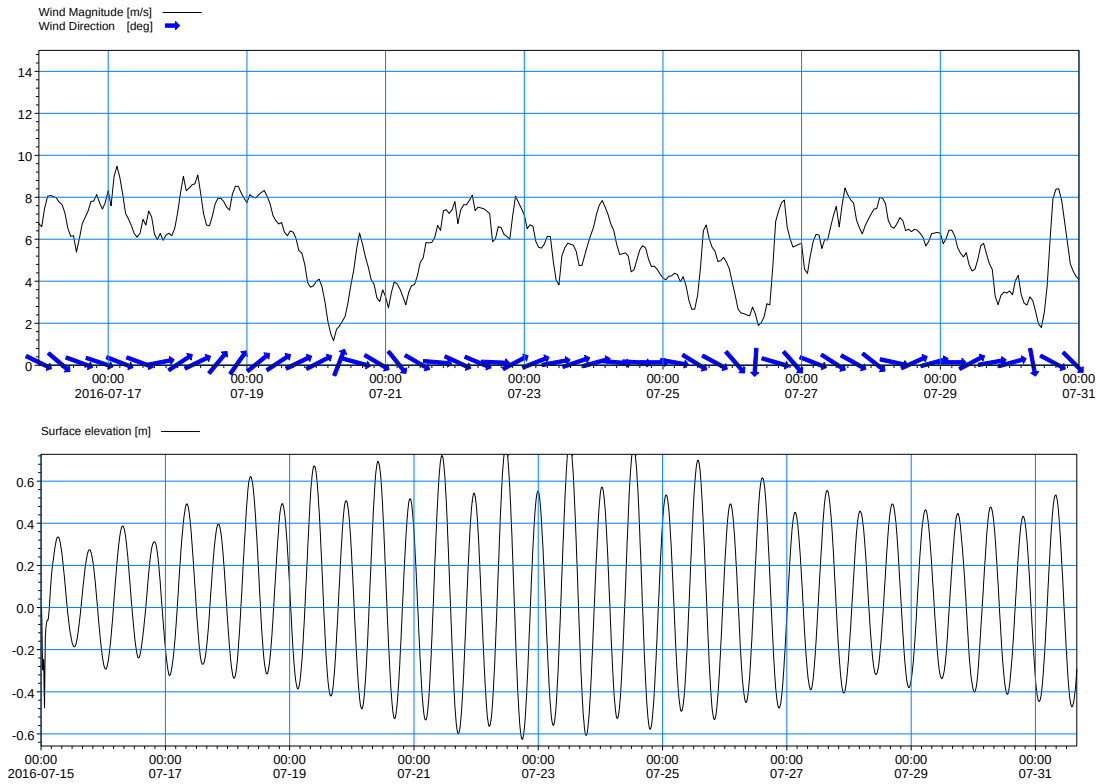


Figure 5.18 Wind speed and direction and water level for the period 16/07/2016 to 31/07/2016

5.4.3 Model results

Model results are presented below. They show a relatively strong variability of the current over the water column, especially in the winter season when the wind is blowing southward.

A comparison of the results obtained with the large-scale 3D HD model and with the local scale 3D HD model has been performed. The times series of current speed and direction were extracted at the point -25m, located about 20km offshore Nouakchott (see location on Figure 5.11).

Figure 5.19 and Figure 5.20 present, for the two hydrodynamic scenarios, these times series for different depths (-5m, -12m -20m) from the two 3D models. Current roses are also presented for each depth for the local 3D model.

It appears that the local model represents stronger and more variable currents at the sea surface compared to the large-scale model. This can be explained by a finest vertical and horizontal resolution. Near bottom currents and middle depth currents from the large-scale model and the local scale model have same order of magnitude. The local 3D model gives higher vertical gradient, thanks to higher vertical resolution.

Wave roses show similar results for the period 15/03-31/03/2016, with a southward current over the upper part of the water column and a south-eastward current near the seabed. For the period 15/07-31/07/16, current roses from the local model show mainly southward currents over the whole water column, while the large-scale model was indicating a predominant northward component.

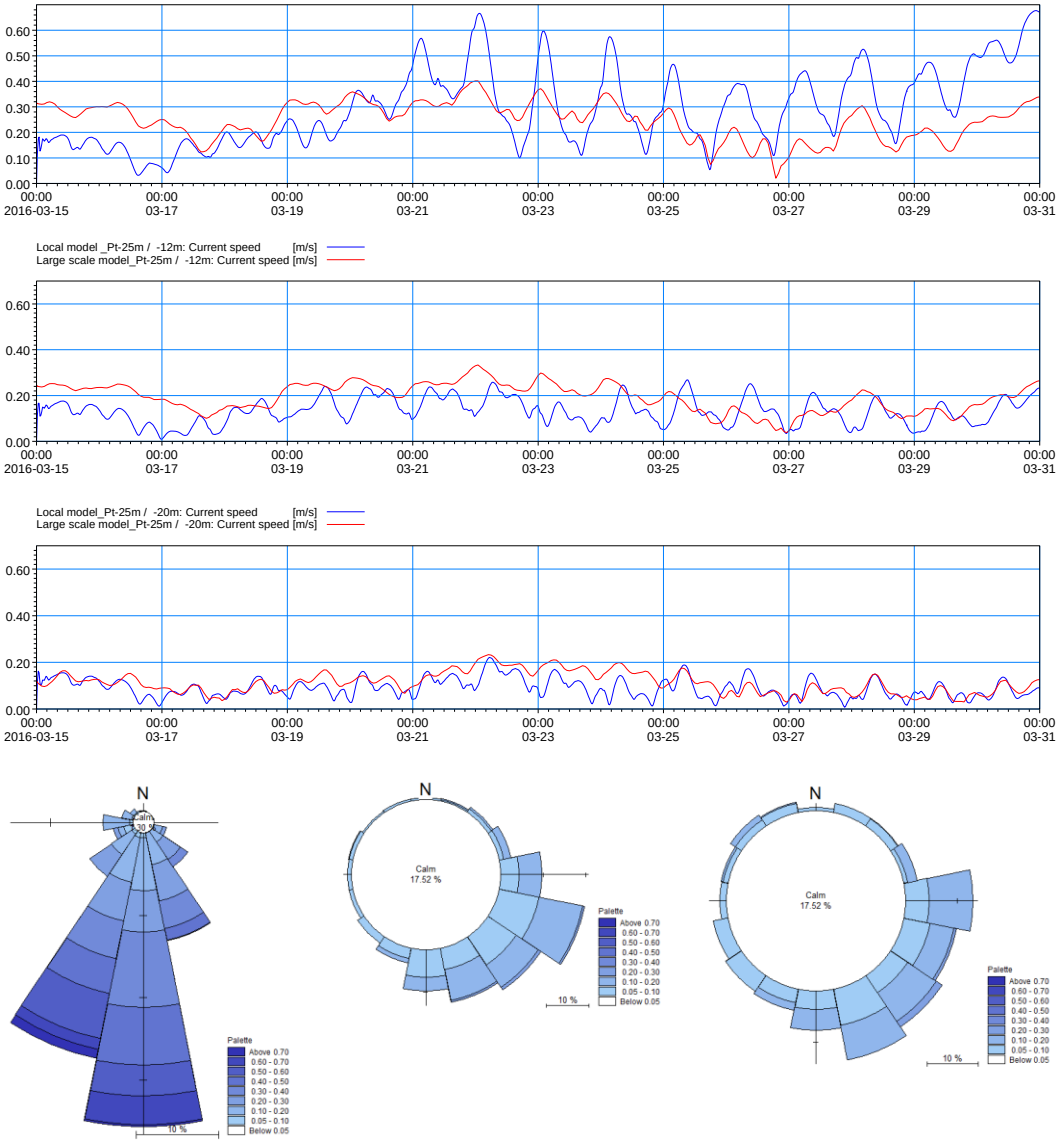


Figure 5.19 Period 16/03/2016 to 31/03/2016: Time series of current speed at the point “-25m”, from the 3D local model (blue lines) and from the 3D large scale model (red lines at different depths (-5m top, -12m middle, -20m bottom).

Bottom: Current roses from the 3D local model (left: -5m, middle left: -12m, middle right: -20m)

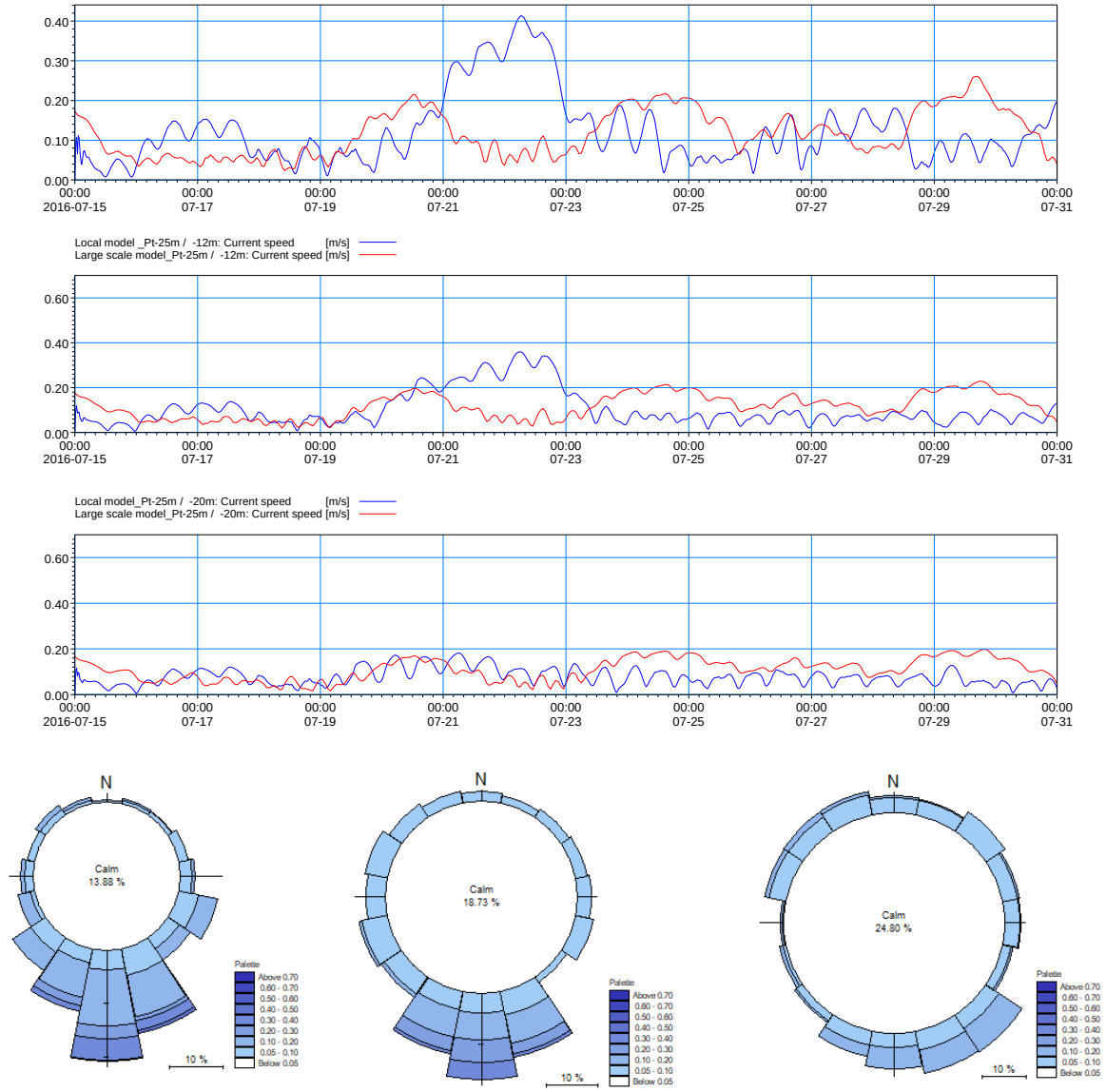


Figure 5.20 Period 16/07/2016 to 31/07/2016: Time series of current speed at the point “-25m”, from the 3D local model (blue lines) and from the 3D large scale model (red lines at different depths (-5m top, -12m middle, -20m bottom).

Bottom: Current roses from the 3D local model (left: -5m, middle left: -12m, middle right: -20m)

21/03 22h40

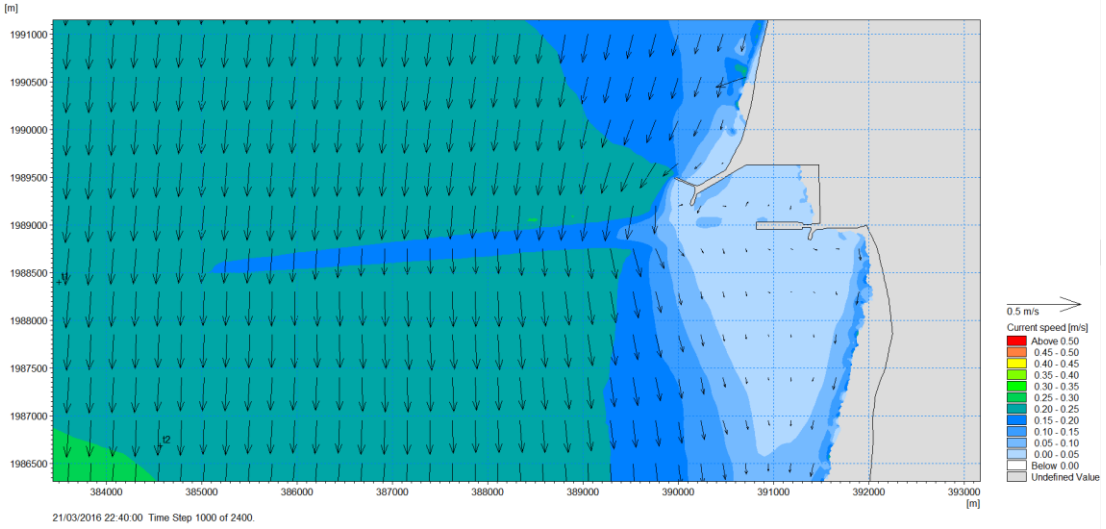


Figure 5.21 depth averaged current

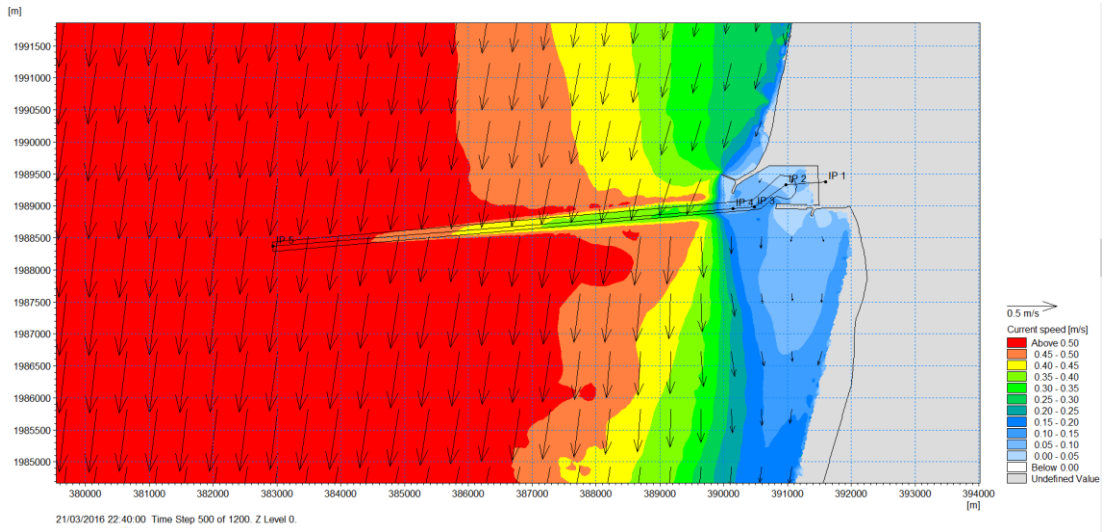


Figure 5.22 surface current

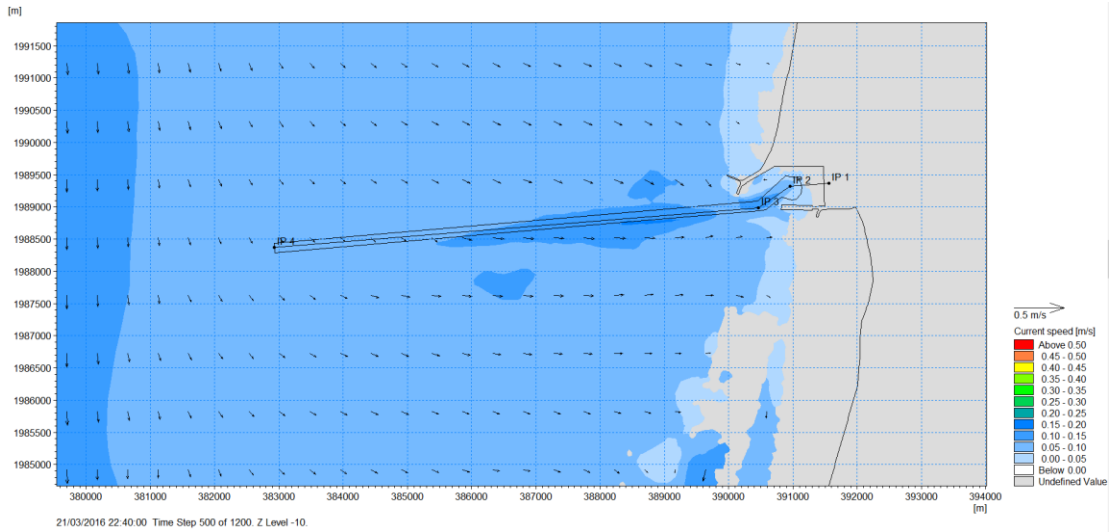


Figure 5.23 sea bottom current

22/03 8h40

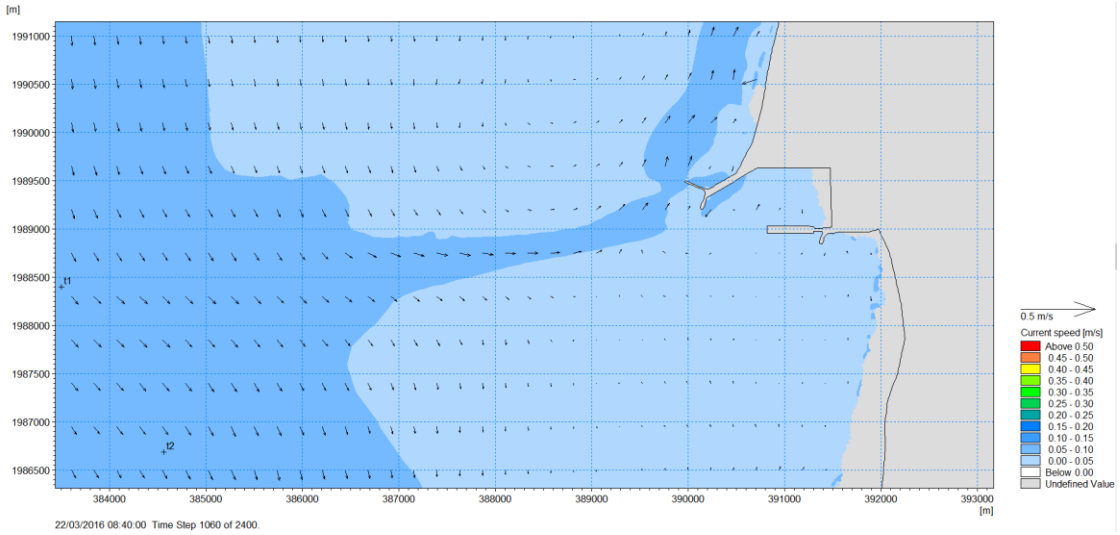


Figure 5.24 depth averaged current

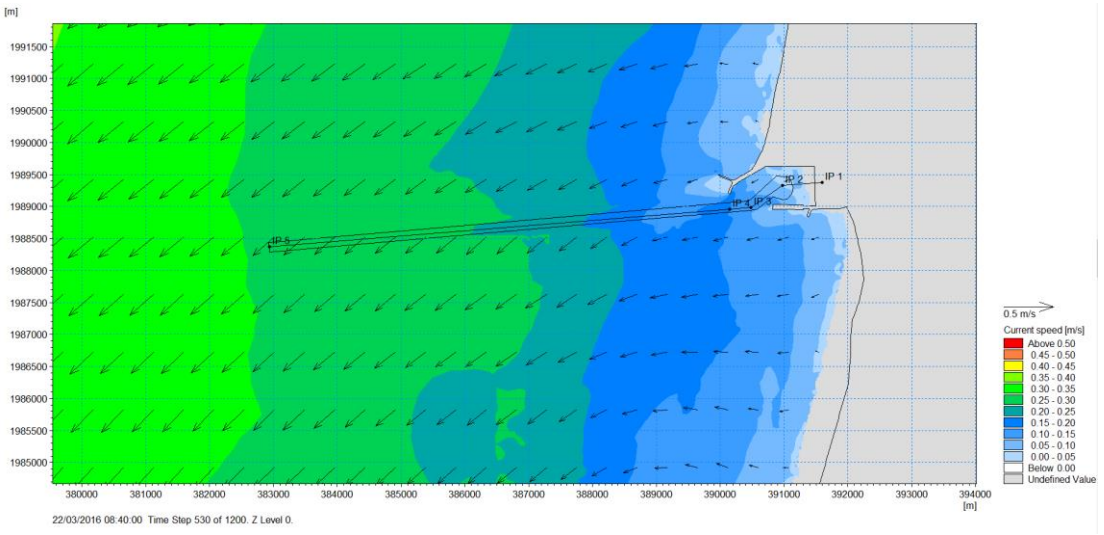


Figure 5.25 surface current

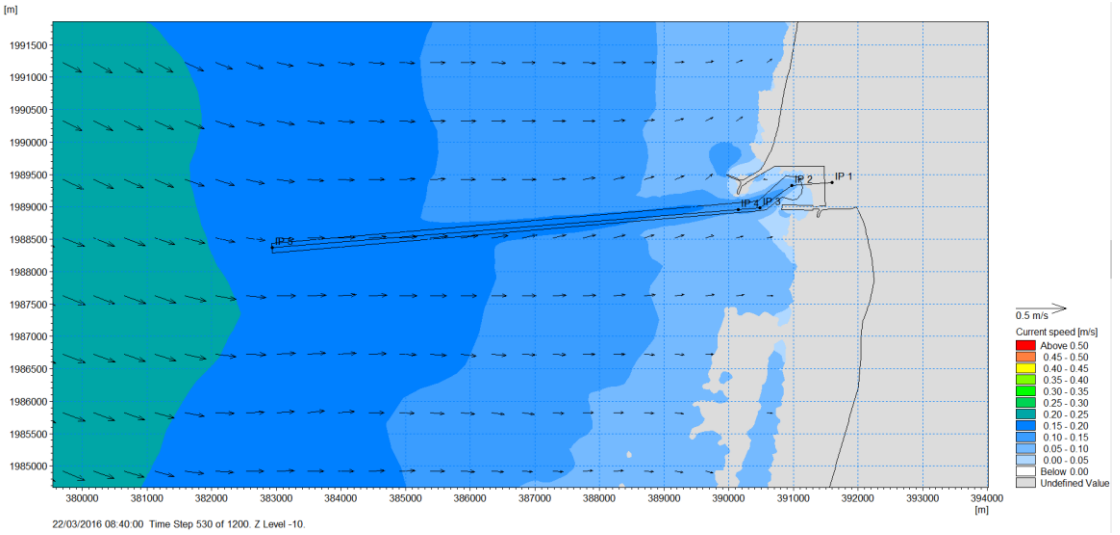


Figure 5.26 sea bottom current

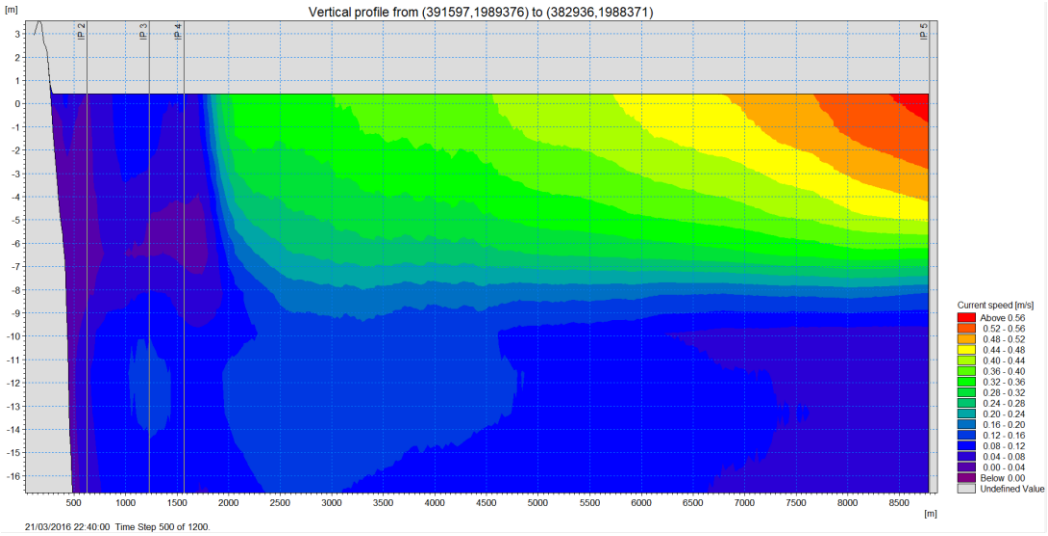


Figure 5.27 current profile along the channel: 21/03/2016 22h40

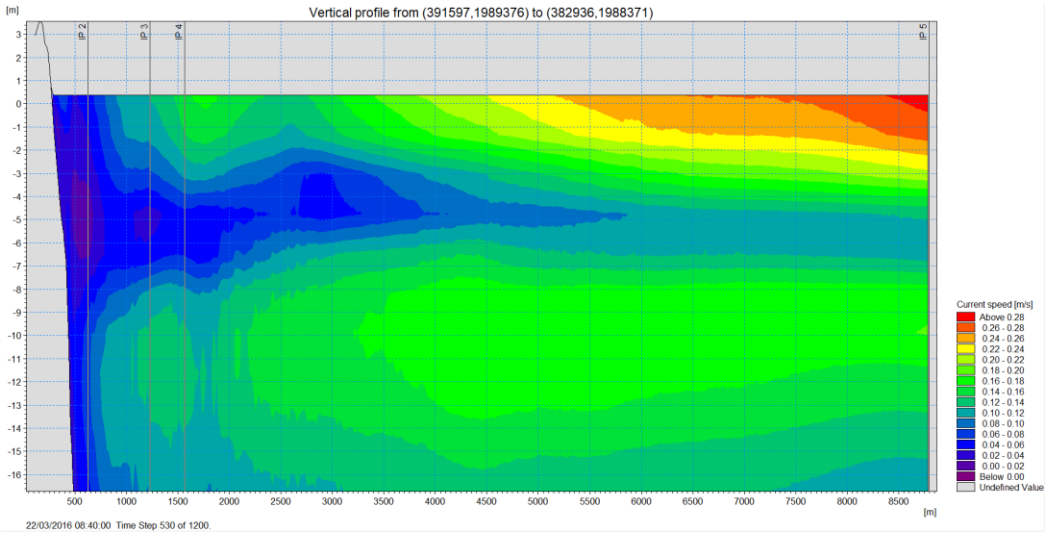
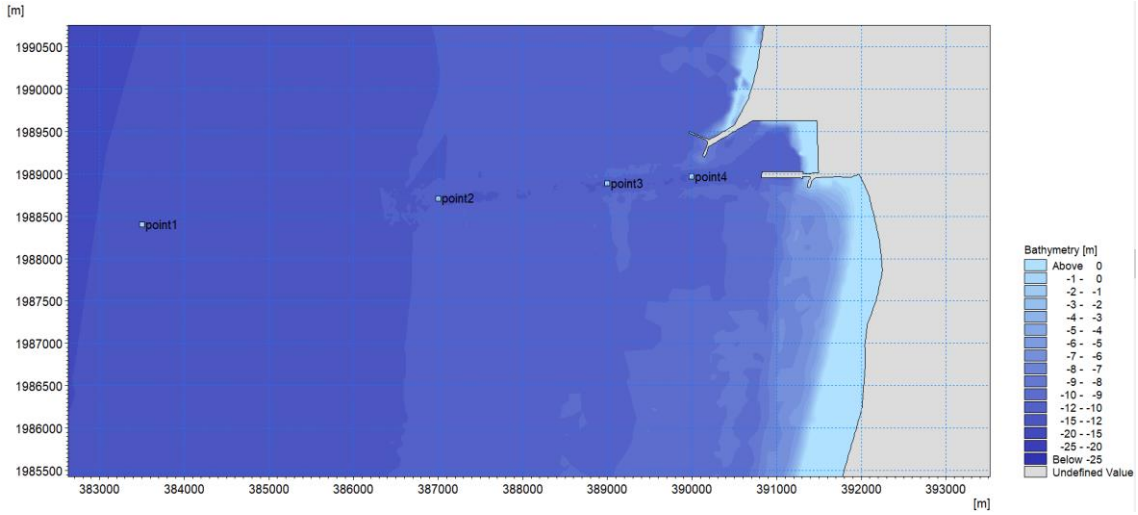


Figure 5.28 current profile along the channel: 22/03/2016 08h40



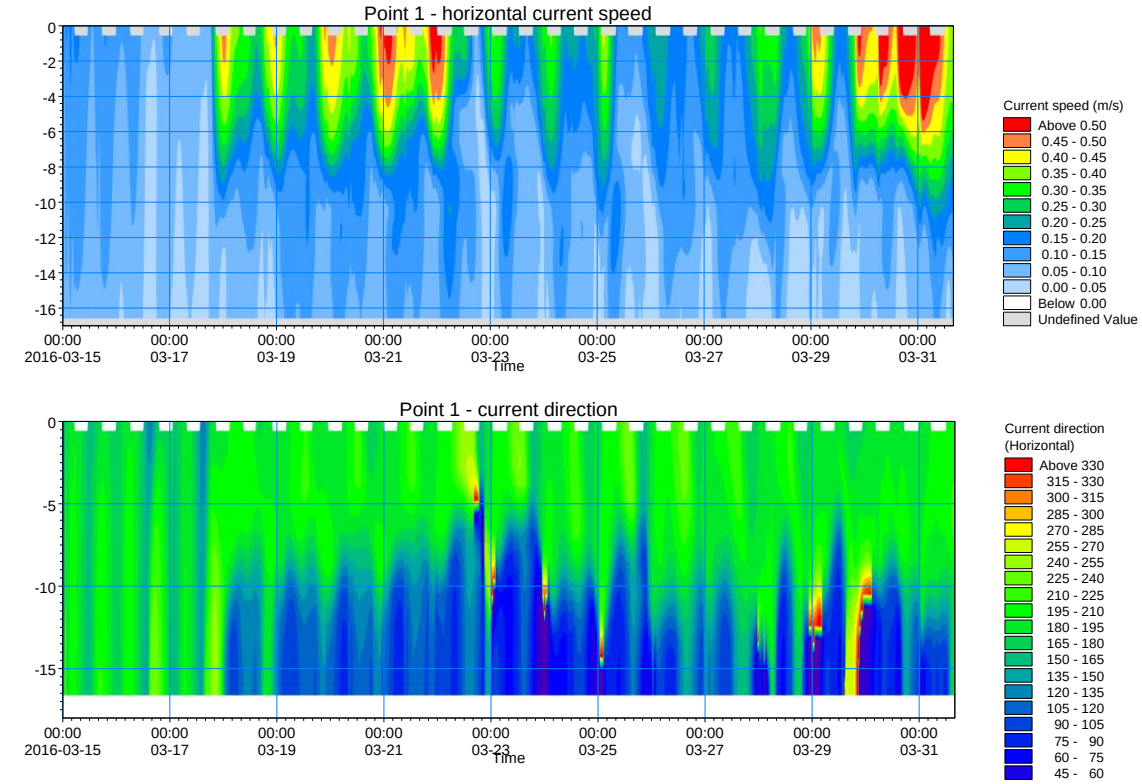


Figure 5.29 current speed and direction (horizontal) over the period 15/03-15/03/2016 at point 1

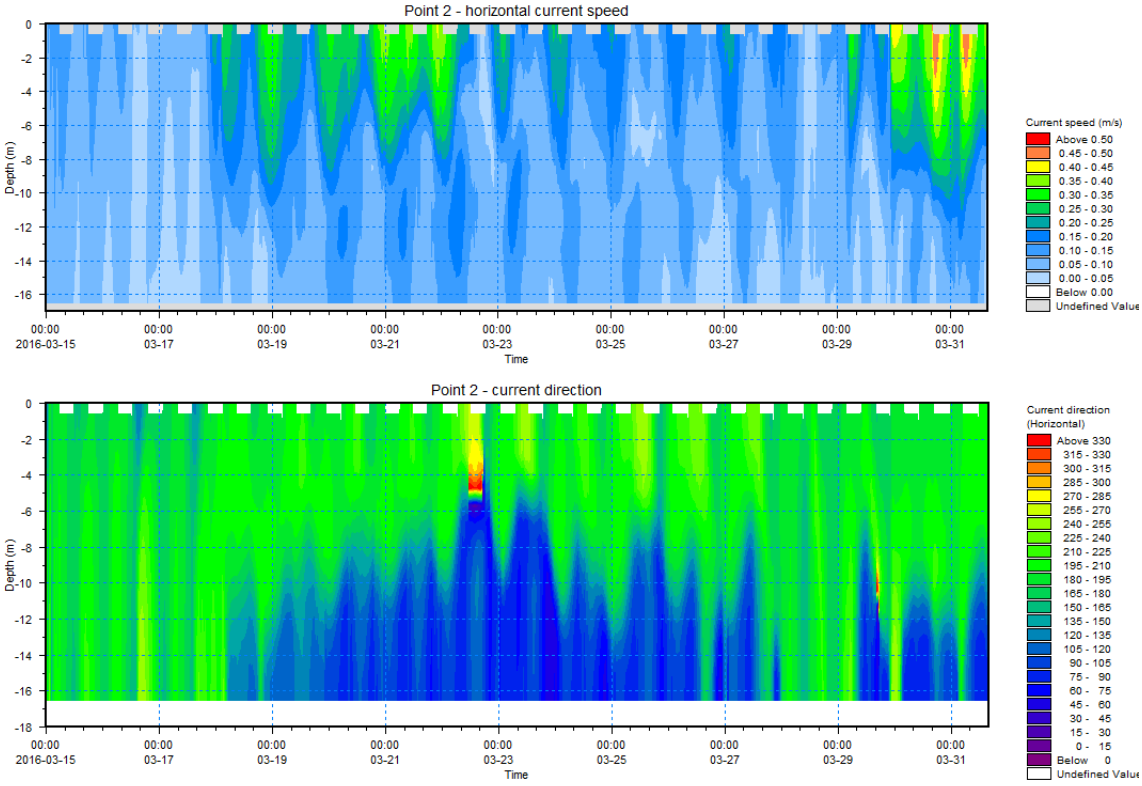


Figure 5.30 current speed and direction (horizontal) over the period 15/03-15/03/2016 at point 2

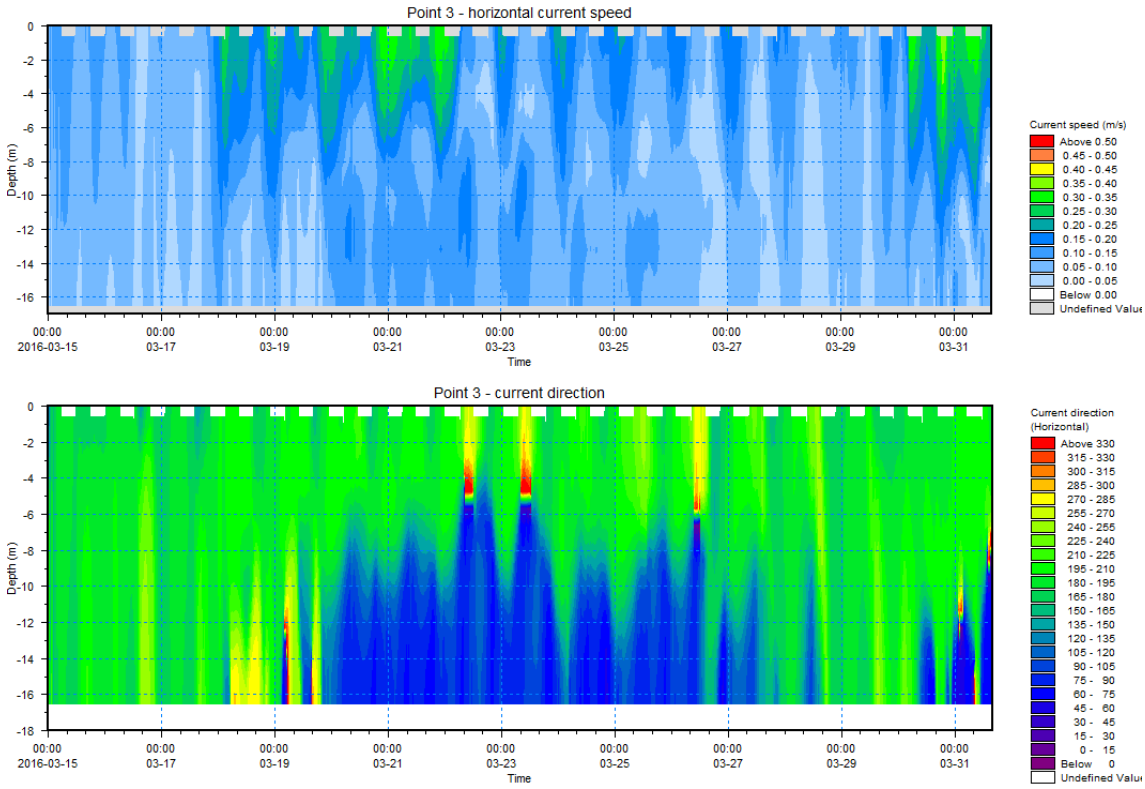


Figure 5.31 current speed and direction (horizontal) over the period 15/03-15/03/2016 at point 3

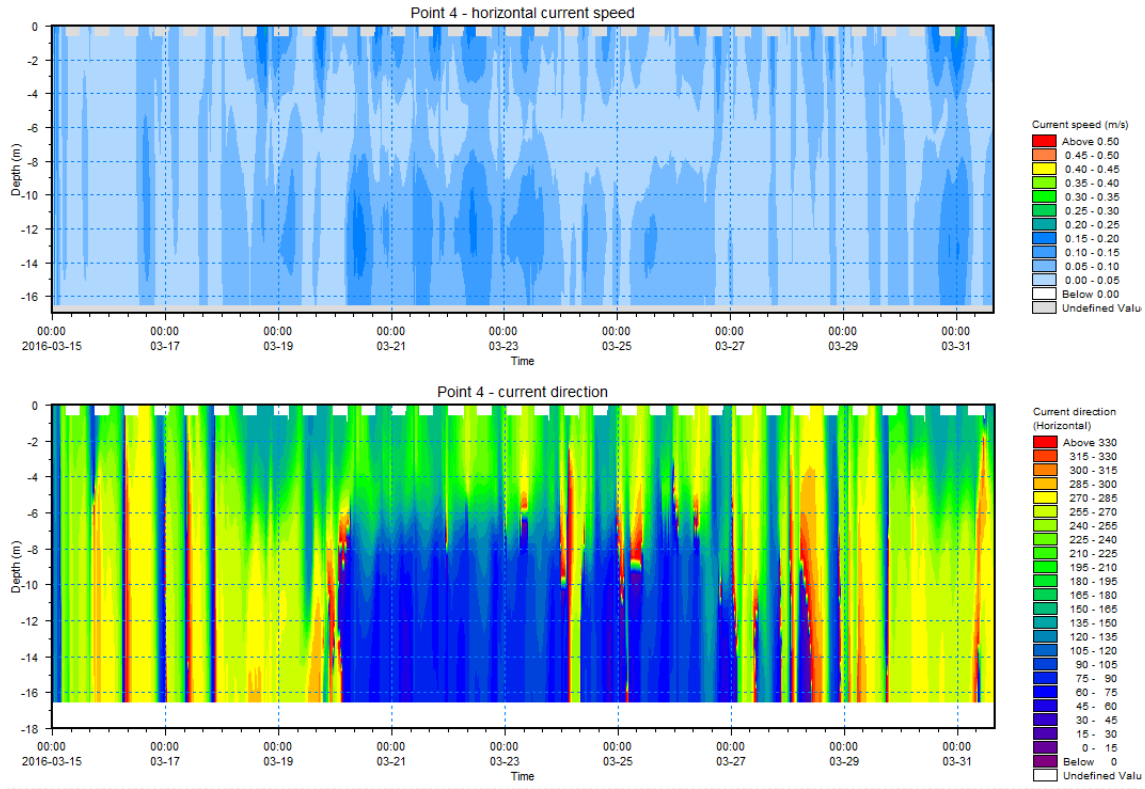


Figure 5.32 current speed and direction (horizontal) over the period 15/03-15/03/2016 at point 4

19/07/2016 6h40

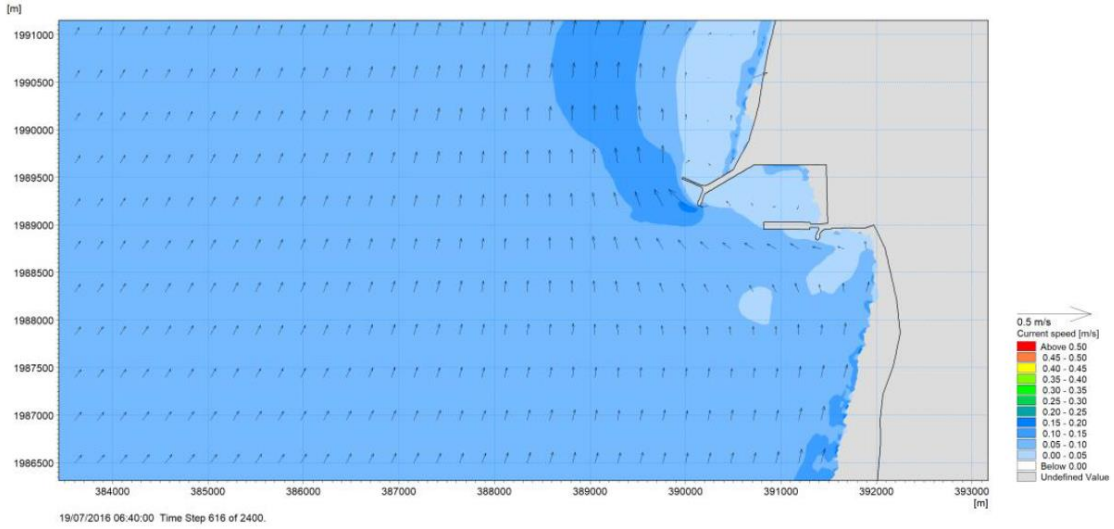


Figure 5.33 depth averaged current

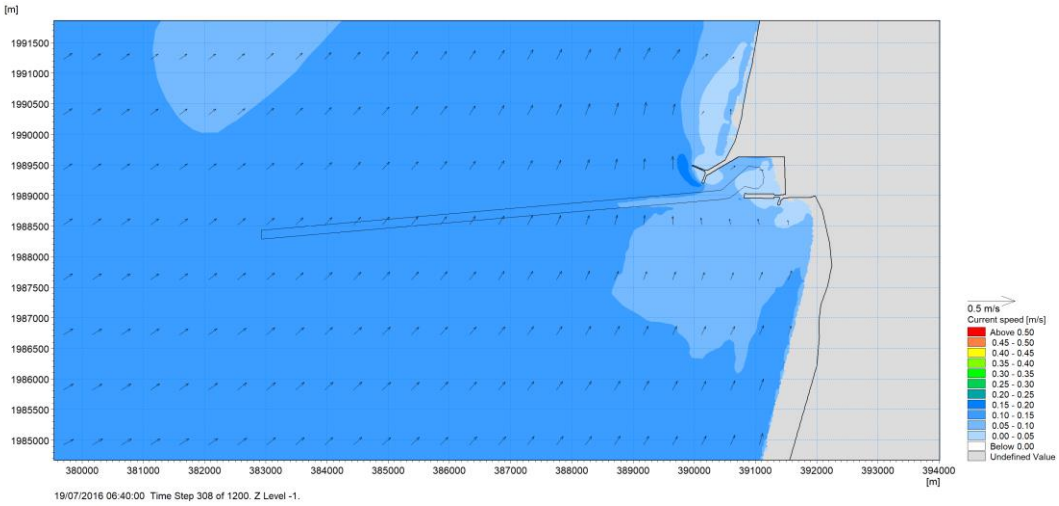


Figure 5.34 surface current

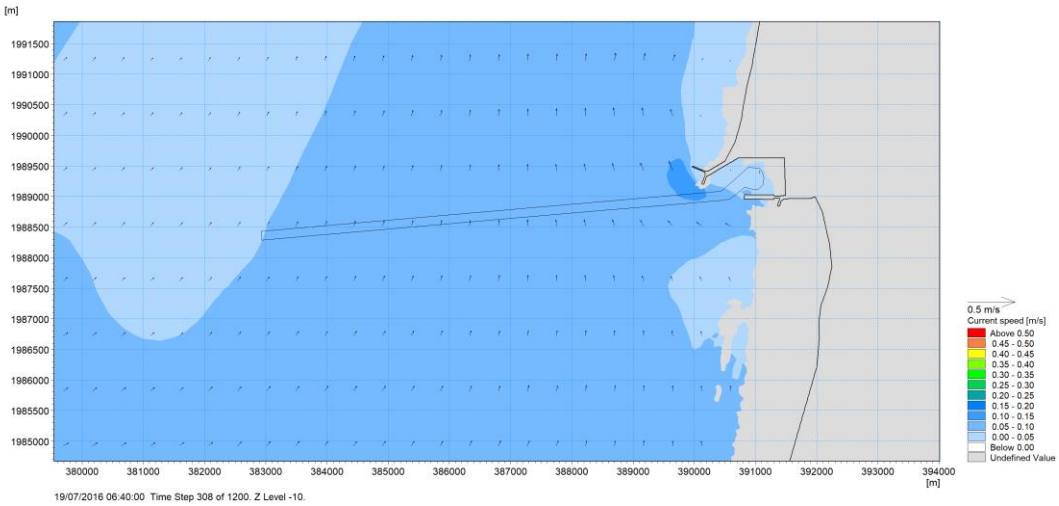


Figure 5.35 sea bottom current

20/07/2016 17h20

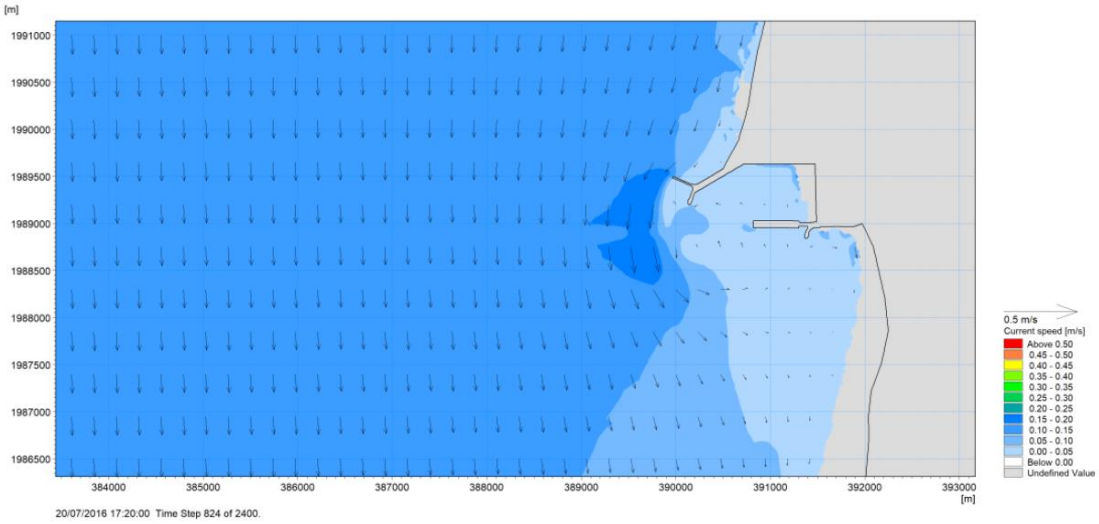


Figure 5.36 depth averaged current

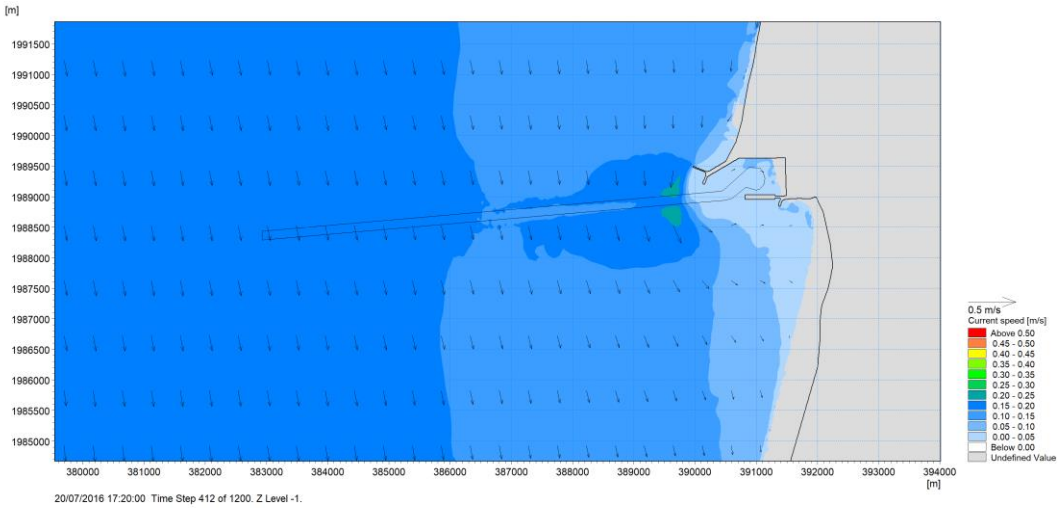


Figure 5.37 surface current

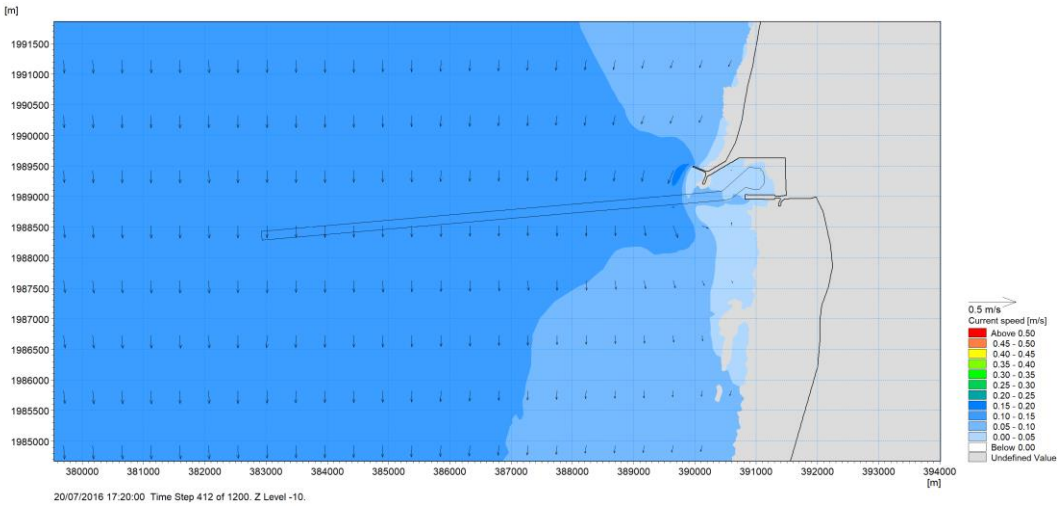


Figure 5.38 sea bottom current

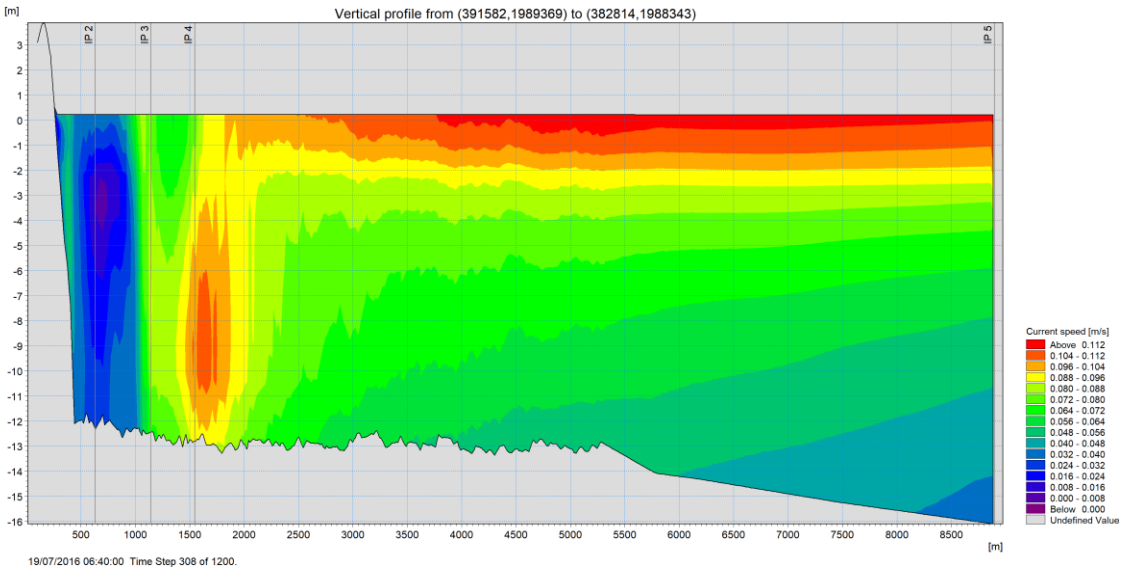
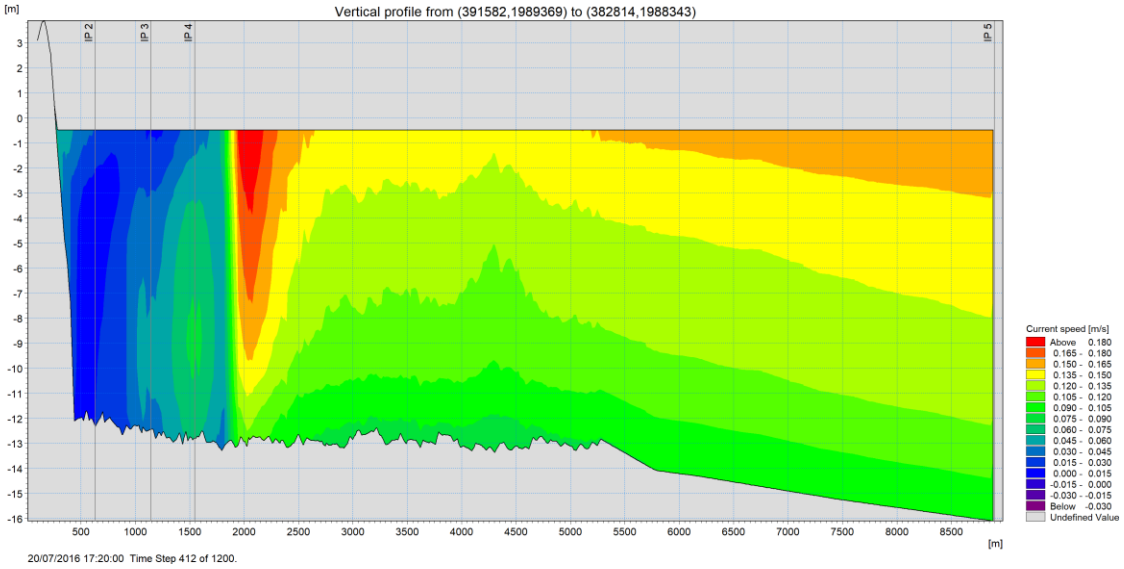


Figure 5.39 current profile along the channel: 19/07/2016 06h40



current profile along the channel: 20/07/2016 17h20

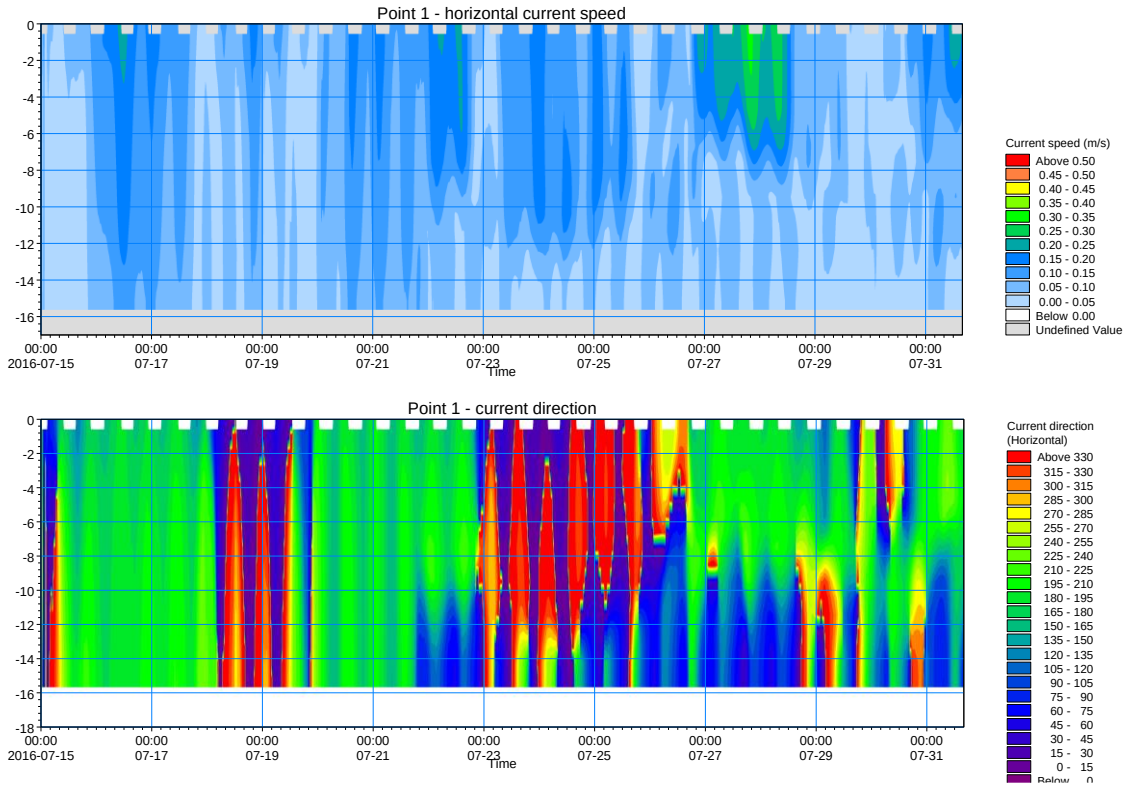


Figure 5.40 current speed and direction (horizontal) over the period 15/07-15/07/2016 at point 1

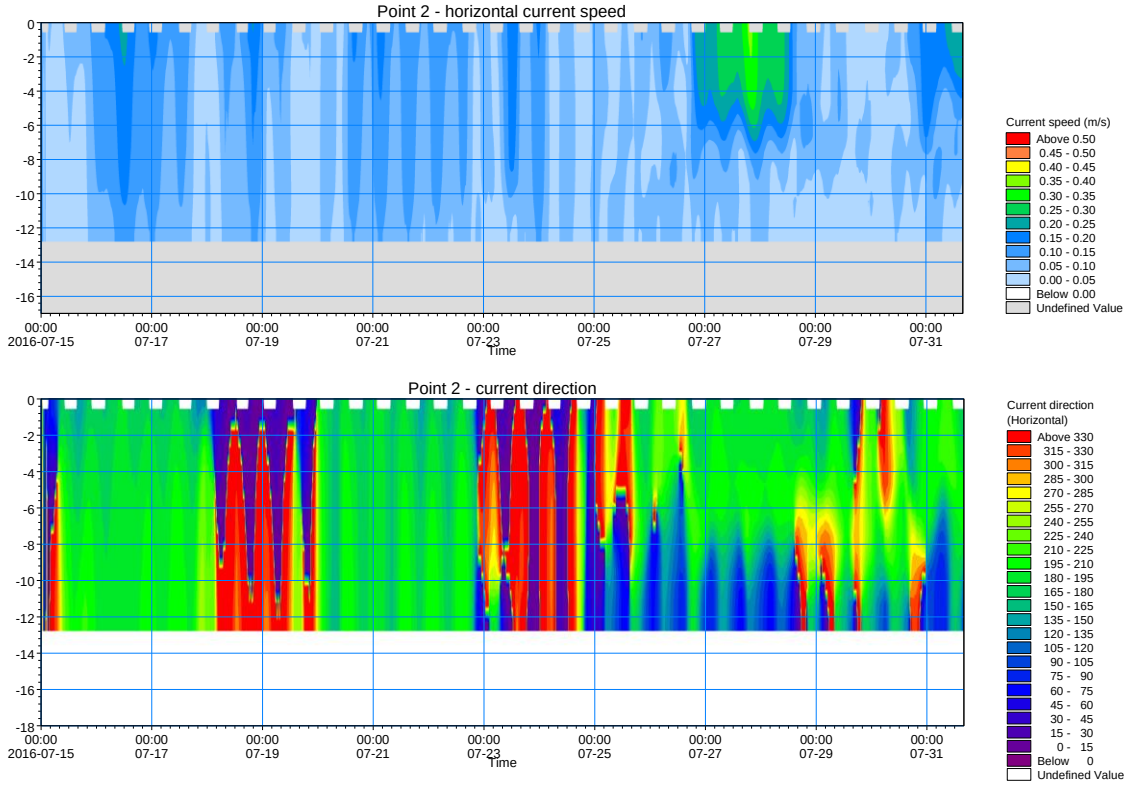


Figure 5.41 current speed and direction (horizontal) over the period 15/07-15/07/2016 at point 2

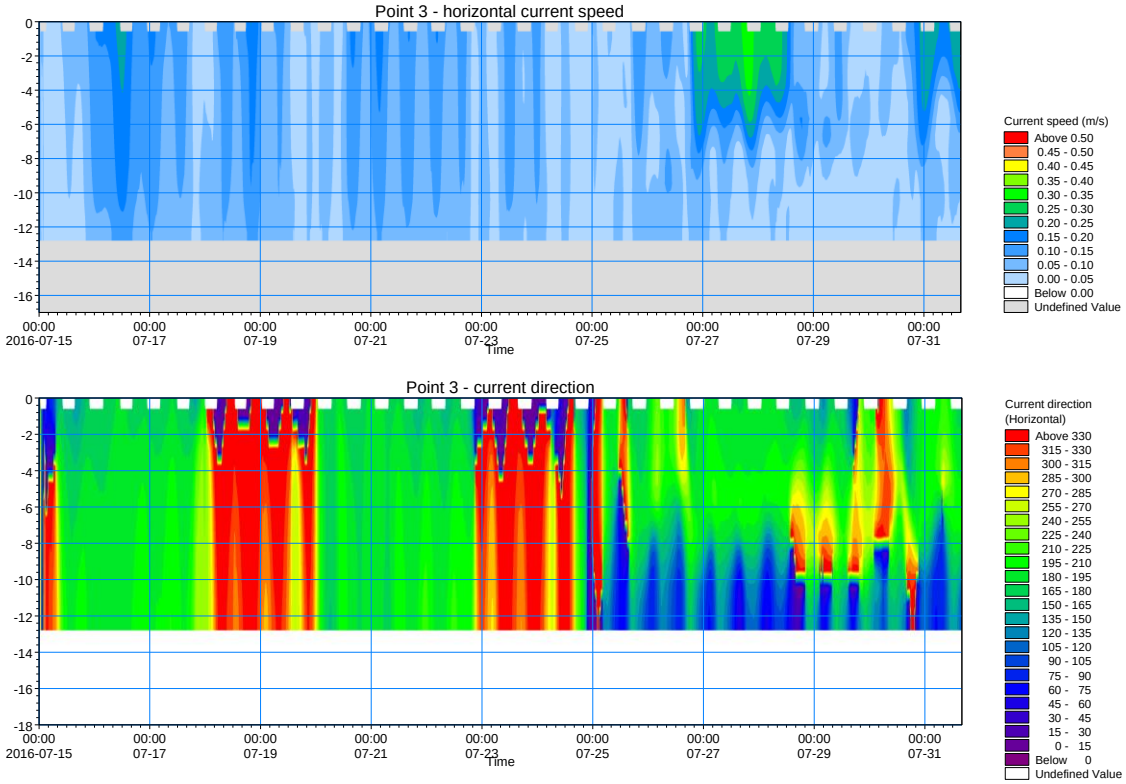


Figure 5.42 current speed and direction (horizontal) over the period 15/07-15/07/2016 at point 3

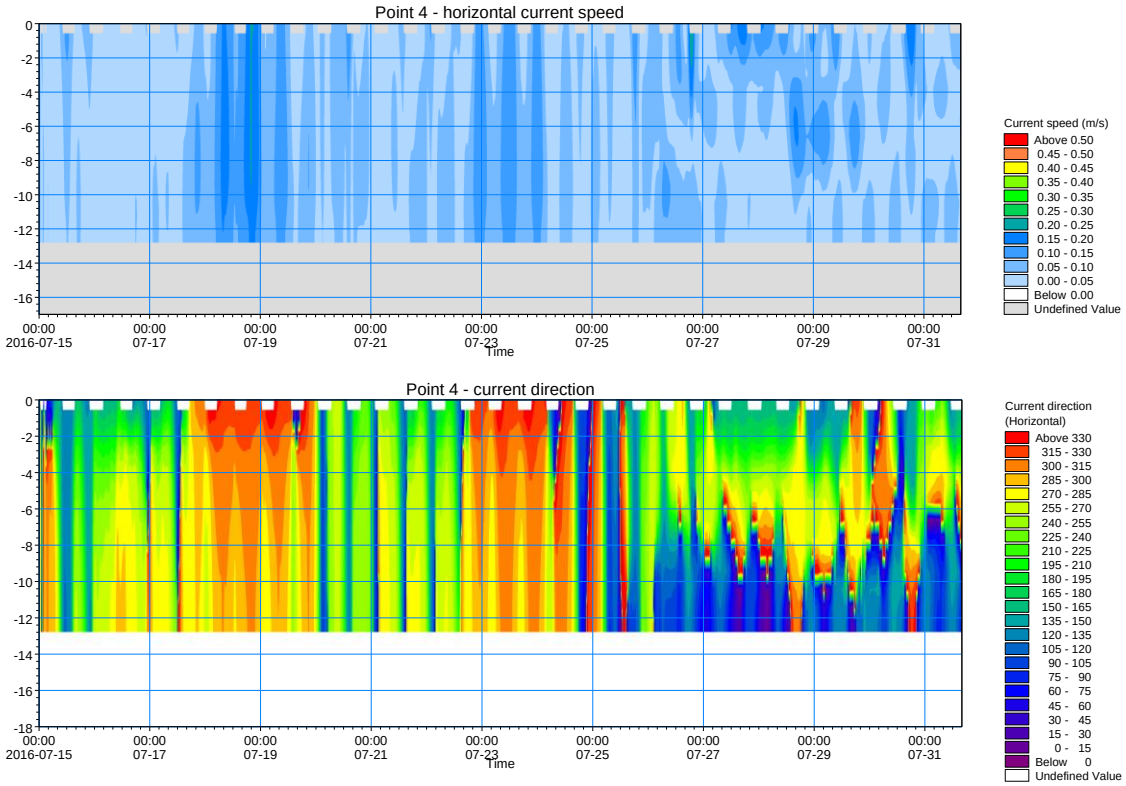


Figure 5.43 current speed and direction (horizontal) over the period 15/07-15/07/2016 at point 4

5.5 Sediment plume Dispersion

The mud transport model

Simulations of plume dispersion were realized with the Mud Transport module (MT) of MIKEbyDHI©. It simulates sediment transport in suspension and processes of erosion-deposition at water-sediment interface.

In the absence of data to calibrate the fine sediment model, the model parameters were defined based on DHI expertise. Critical sheartresses of erosion and deposition are taken with value 0.2 N/m^2, classical value for muddysediment. Bed roughness is k_s =0.1 mm. Settling velocity is set constant to 0.02 mm.

The considered points for dredging operations in the port and along the channel as well as for the disposal operations in areas A and B are located on Figure 5.44. The depths in this area are between -30m LAT and -20m LAT. The sediment disposal is simulated at the central point of this area, thereafter referred as the “offshore disposal point”, and located at a depth of -25m LAT.

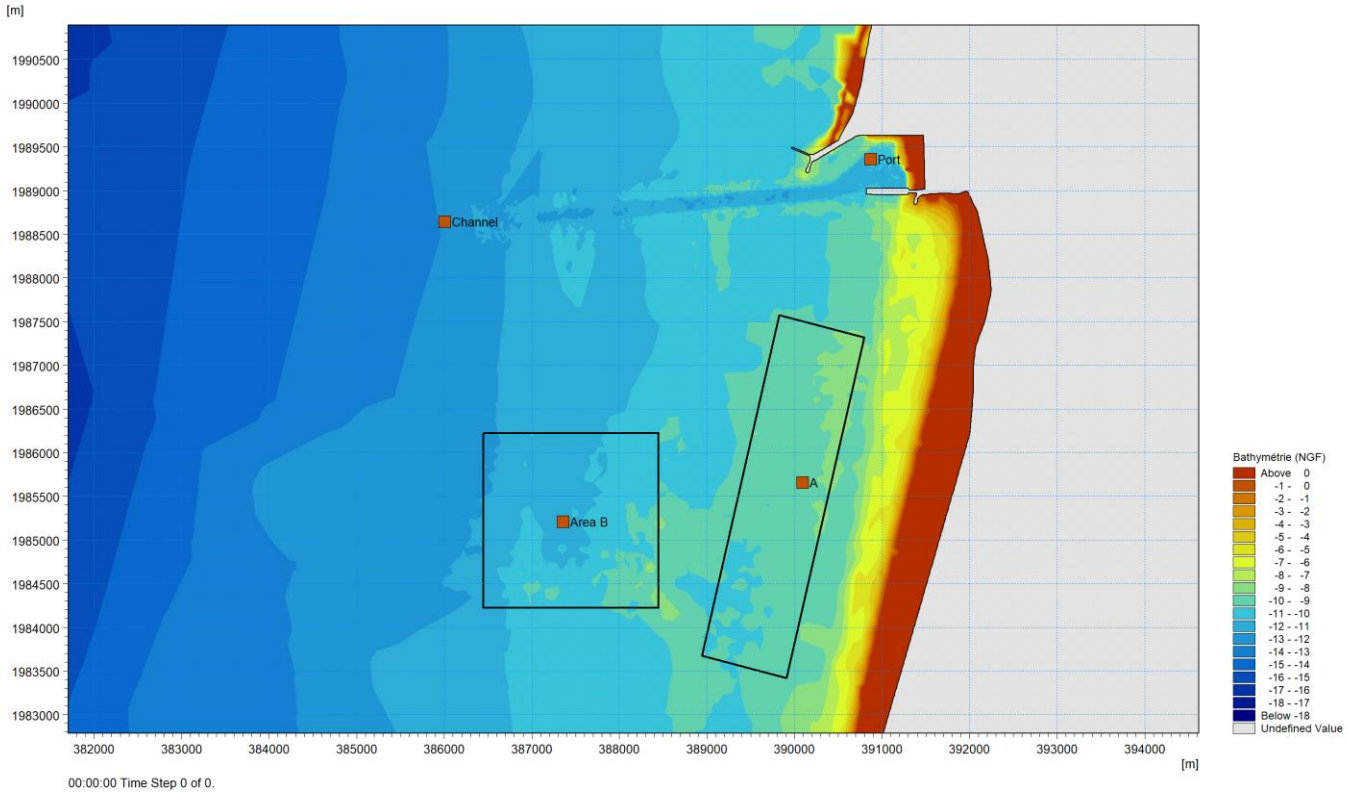


Figure 5.44 Location of the points considered for the modelling for the dredging and offshore operations. Disposal areas A and B are indicated (black box).

5.5.1 Dredging equipment and cycles

As provided by ARISE:

- Method of Dredging: "As of now with the sole bore hole field data (close to the breakwater and the neck of access channel) available it appears to be cemented sands. So, it is envisaged that the dredging contractor may deploy a TSHD to achieve higher rates of production. So the discharge would be bottom discharge."

- Rate of dredging: "7,500-10,000 cum/hr."
    - As a conservative approach, a rate of 10,000cum/hr is considered
- Time of completion: "5 months including mobilization +demobilisation for a total volume of 6-million cum".
- Location of dredging: "Initially, port basin, access channel shall be deepened and extended. The location of disposal shall be Zone-A and Zone-B as indicated in the bathymetric survey".
    - For this 15-day periods of modelling, zone A is associated dumping of materials dredged on the port and zone B to materials dredged in the channel.

Regarding the TSHD operation cycles, it has been assumed the following:

- Duration of one cycle: 180 minutes (3 hours);
- For each cycle:
    - duration of the dredging operations: 60 minutes (1 hour);
    - dumping operations: 1 minute.

A 24/7 operation is assumed; therefore 8 cycles are considered per day.

The in-situ sediment along the channel is composed of 44% of fines (see section 2.3, sample ST06). Its density inside the dredger is considered to be 1700 kg/m^3.

Regarding the in-situ sediment in the port, two samples were analysed. Sample ST01, with less than 3% of fines and sample ST02 mainly composed by fines. An average value of 50% of fines is considered as a first approach. The in-situ density is considered to be 1700 kg/m^3.

The modelling was performed at first using the 2D hydro-sedimentary model. Simulations were performed for the two 15-day periods (15/03/1 -31/0/2016 and 15/07/2016-31/07/2016). At a later stage of the mission, simulations were then performed using a 3D hydro-sediment model.

In the model, the operation cycles are continuously repeated all over the 15-day simulation periods to have a conservative approach.

The modelling focuses on the plume dispersion in the offshore disposal area. The natural turbidity here has not been considered in the modelling. The measured turbidity is however very low.

5.5.2 Modelling approach

The sediment load and discharges are implemented in the model at the dredging and Disposal Points (A & B) using timeseries with a timestep of 1 min, in order to correctly describe the TSHD discharges.

Assuming spill rates of 3% during the dredging operations and of 10% during the disposal, sediment conditions give a fine sediment flux of approximately:

- Sediments from the port:
    - 70 kg/s during the dredging operations in the port
    - 4417 kg/s during the discharges in zone A

- Sediments from the channel:
    - 62 kg/s during the dredging operations in the port
    - 3887 kg/s during the discharges in zone B

5.5.3 2D Modelling results

Period: 15/03/2016 to 31/03/2016

The extent and concentration of the mean and maximum (over the 15-day period simulated) depth-averaged turbidity plumes induced by the disposal operations are shown on Figure 5.45 and Figure 5.46 and for both dredging and disposal scenarios: inside the port and area A for one scenario, along the channel and area B for the second scenario, Figure 5.47 shows the bed thickness change (deposition) over the 15-day period.

The turbidity plume is mainly located south of the dredging operation area and of the disposal areas, due to the currents which mainly drive the plume. To be noted that the plume from the dredging operations inside the port does not extent too much outside the basins, due to calm conditions.

- On average, the extent of the 5mg/L threshold contour is 4km southward;
- Considering the maximum value, the extent of the 50mg/L threshold contour is about 2km in southward;
- For the bed thickness variation, the 5mm threshold contour is about 3.5 to 4km south of the dredging and disposal sites.

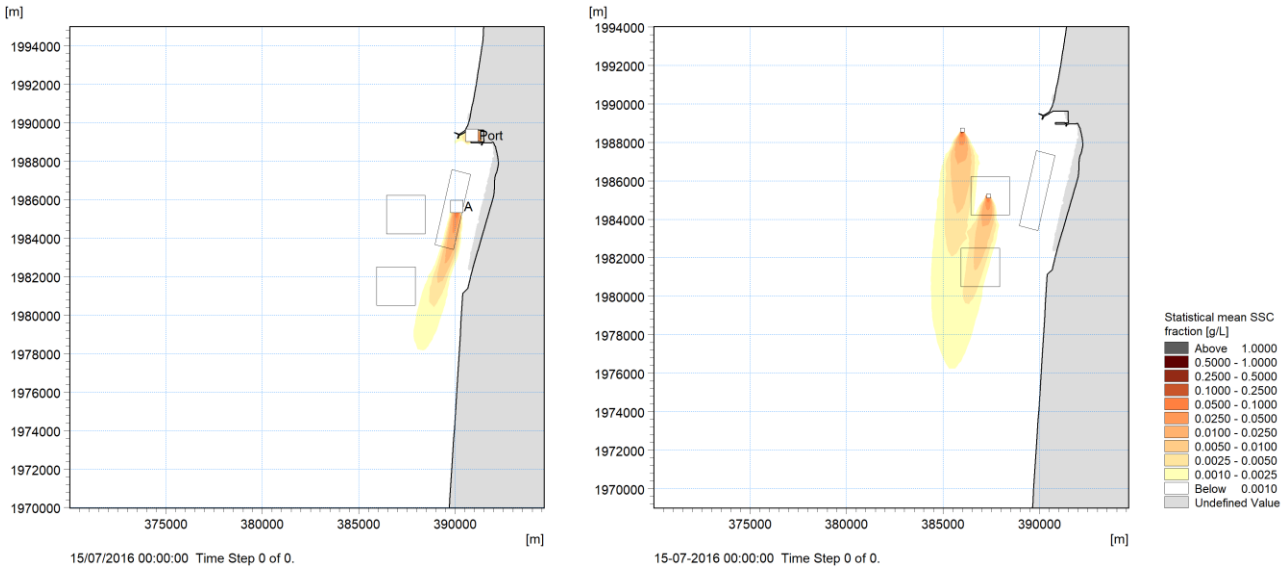


Figure 5.45 Mean depth-averaged turbidity plume over the 15-day simulation period (period 15/03/2016 to 31/03/2016) – dredging in the port and deposition in area A (left) – dredging in the channel and deposit in area B (right)

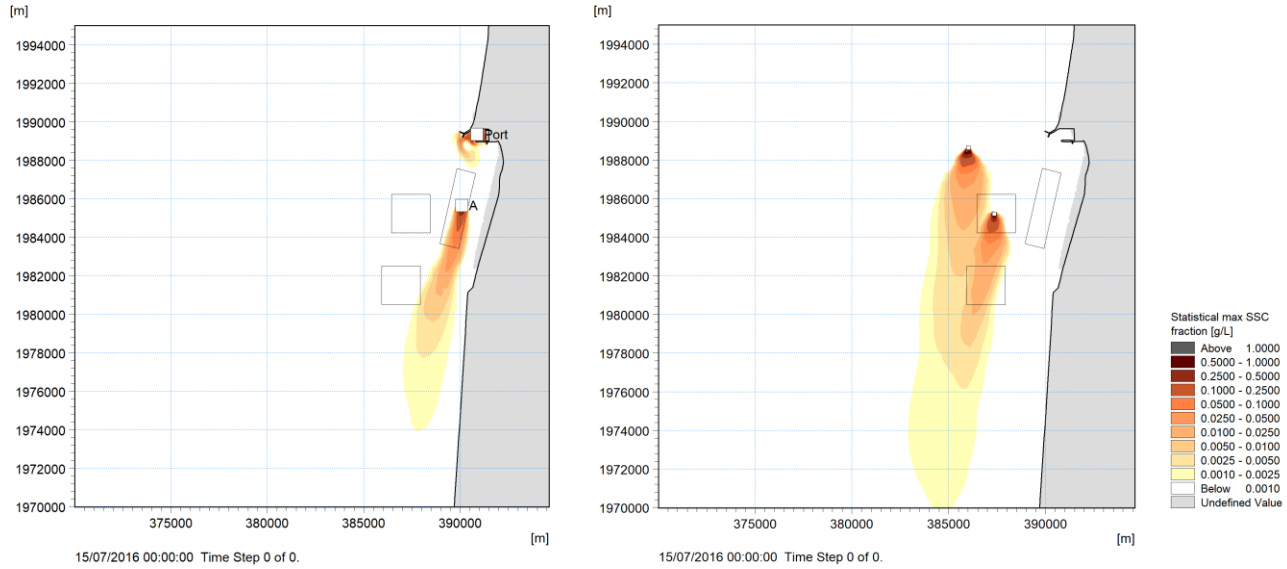


Figure 5.46 Maximum depth-averaged turbidity plume over the 15-day simulation period (period 15/03/2016 to 31/03/2016) – dredging in the port and deposit in area A (left) – dredging in the channel and deposit in area B (right)

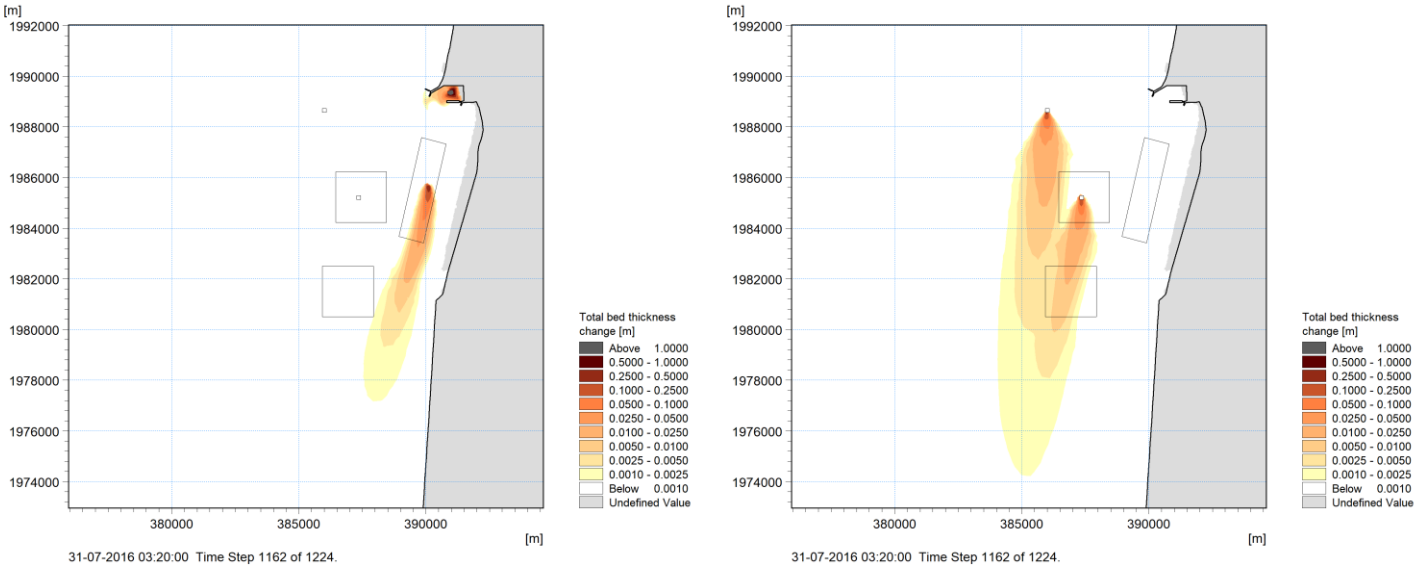


Figure 5.47 Total bed thickness change over the 15-day simulation period (period 15/03/2016 to 31/03/2016) – dredging in the port and deposit in area A (left) – dredging in the channel and deposit in area B (right)

Period: 15/07/2016 to 31/07/2016

The extent and concentration of the mean and maximum (over the 15-day period simulated) depth-averaged turbidity plumes induced by the disposal operations are shown on Figure 5.48 and Figure 5.49 for both dredging and disposal scenarios: inside the port and area A for one scenario, along the channel and area B for the second scenario.

The turbidity plume is mainly located North and south of the dredging operation area and of the disposal areas, due to the currents which mainly drive the plume. To be noted that the plume from the dredging operations inside the port does not extent too much outside the basins, due to calm conditions.

- On average, the north ward and southward extent of the 5mg/L threshold contour is 1km in both directions;
- Considering the maximum value, the northward and southward extent of the 50mg/L threshold contour is about 1km in both directions
- For the bed thickness variation, the 5mm threshold contour is about 2km north and south of the dredging and disposal sites.

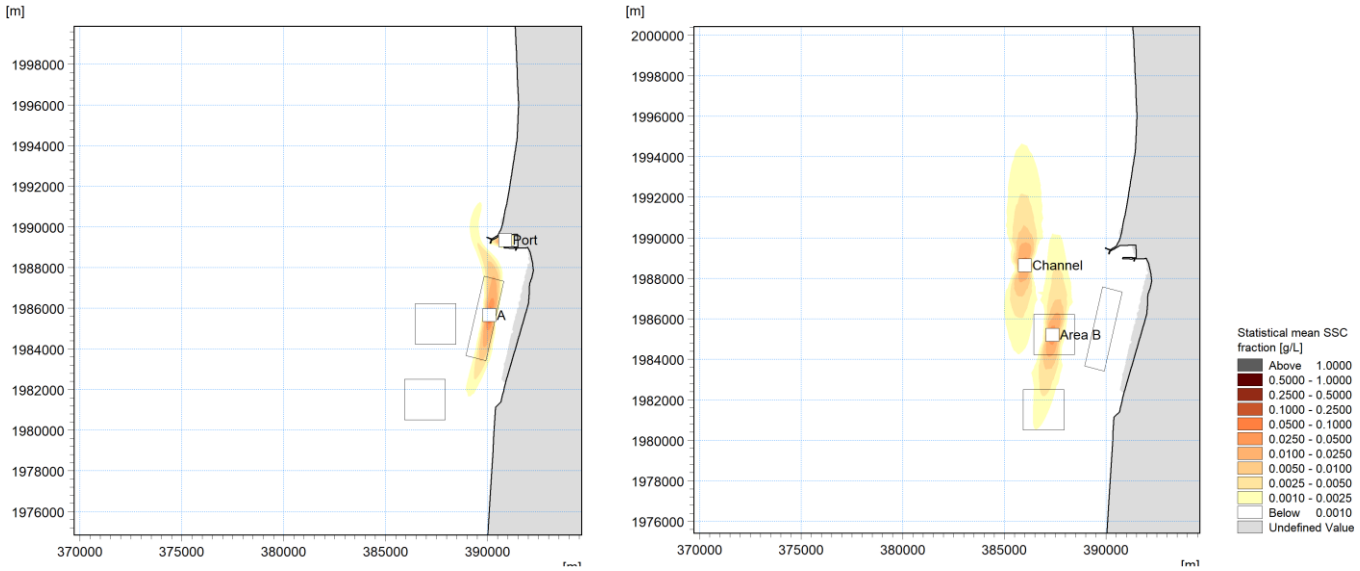


Figure 5.48 Mean depth-averaged turbidity plume over the 15-day simulation period (period 15/07/2016 to 31/07/2016) – dredging in the port and deposit in area A (left) – dredging in the channel and deposit in area B (right)

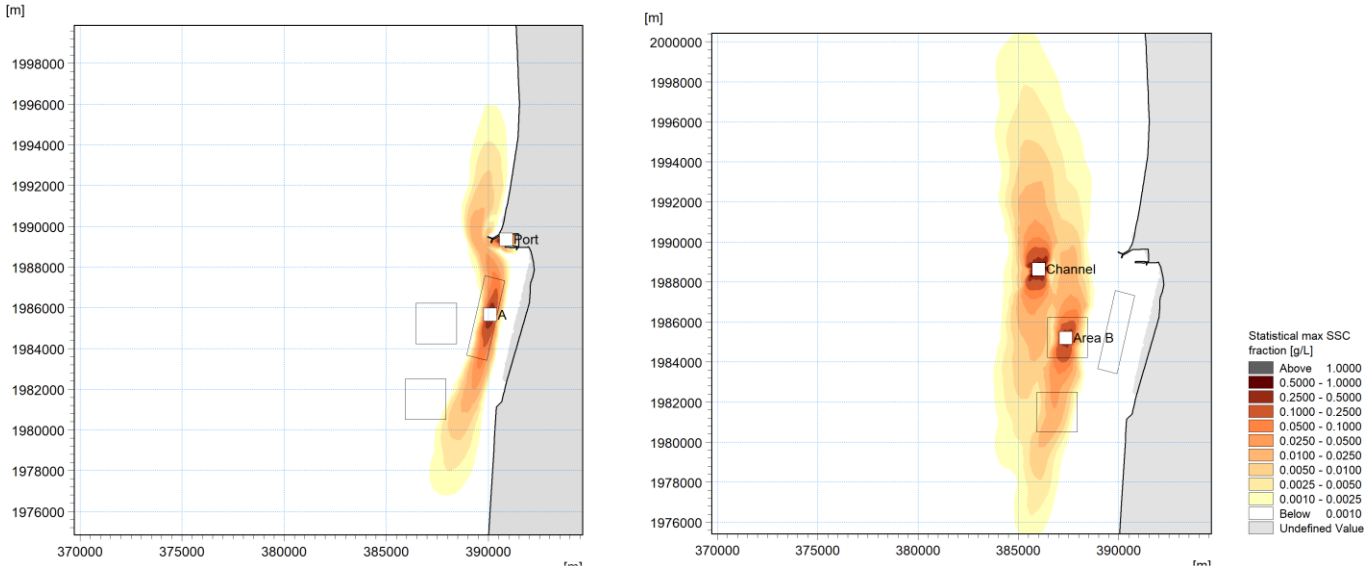


Figure 5.49 Maximum depth-averaged turbidity plume over the 15-day simulation period (period 15/07/2016 to 31/07/2016) – dredging in the port and deposit in area A (left) – dredging in the channel and deposit in area B (right)

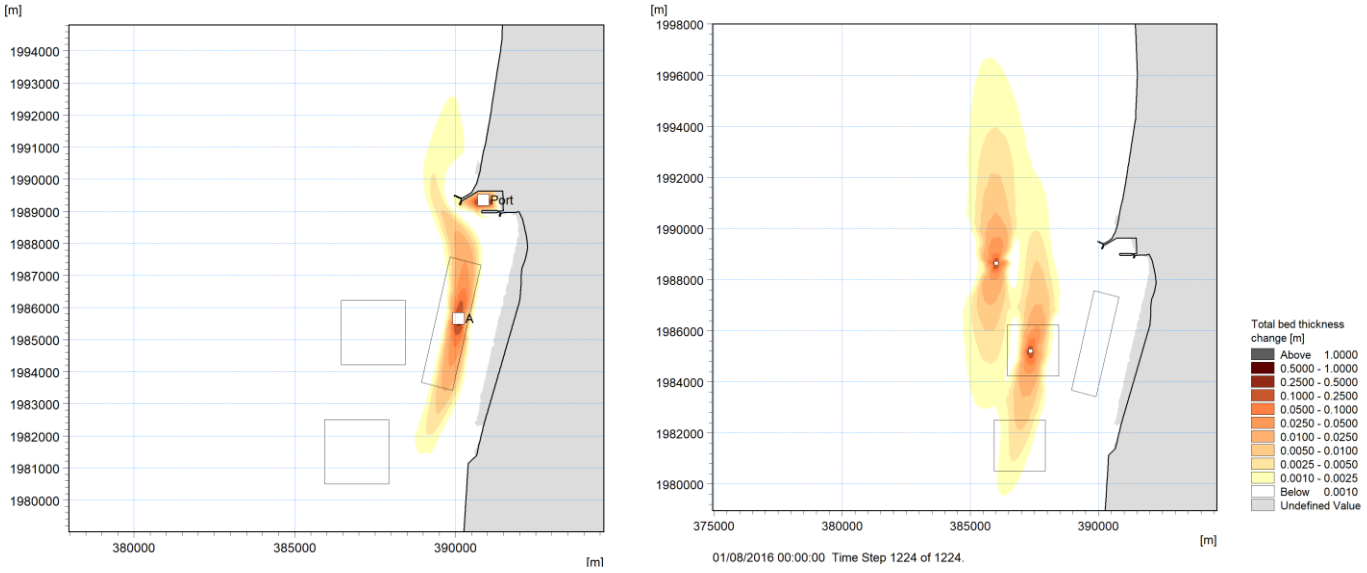


Figure 5.50 Total bed thickness change over the 15-day simulation period (period 15/07/2016 to 31/07/2016) – dredging in the port and deposit in area A (left) – dredging in the channel and deposit in area B (right)

5.5.4 3D Hydro sediment modelling results

Sediment plume modelling was performed, in a later stage, using a 3D hydro-sediment model. Same scenarios were reproduced. Results are detailed hereinafter.

For each meteorological and dredging scenario, are presented:

- The total bed thickness change (after the 15-day period simulated);
- The extent and concentration of the mean and maximum (over the 15-day period simulated) turbidity plumes induced by the dredging and disposal operations, near the bottom layer, and averaged over the water column.

Compared with the 2D modelling results, the order of magnitude of the sediment plume extent is similar (2 to 4 km), mainly dispersed southward of the dredging and disposal areas. The plume is spreader than with the 2D models thanks to a better representation of the distribution of sediment sources in the water column and the associated current speed structures.

Moreover, the 3D modelling provides a better representation of the sediment concentration near the bottom layer. Indeed, most of the sediments spill will be generated near the bottom, due to the dredging methods, and will then be spread around in the water.

In addition, a more accurate current modelling details how dredging operations in the port can potentially generate a plume extending beyond this facility boundaries.

To provide additional information to better estimate the potential impact of the dredging operations on the environment, the percentage of time exposure is provided in the following figures. The percentage is provided compared to the total duration of the 15-day duration, for different thresholds of suspended sediment concentration (SSC): 5mg/l, 10mg/L, 25mg/l and 50mg/L.

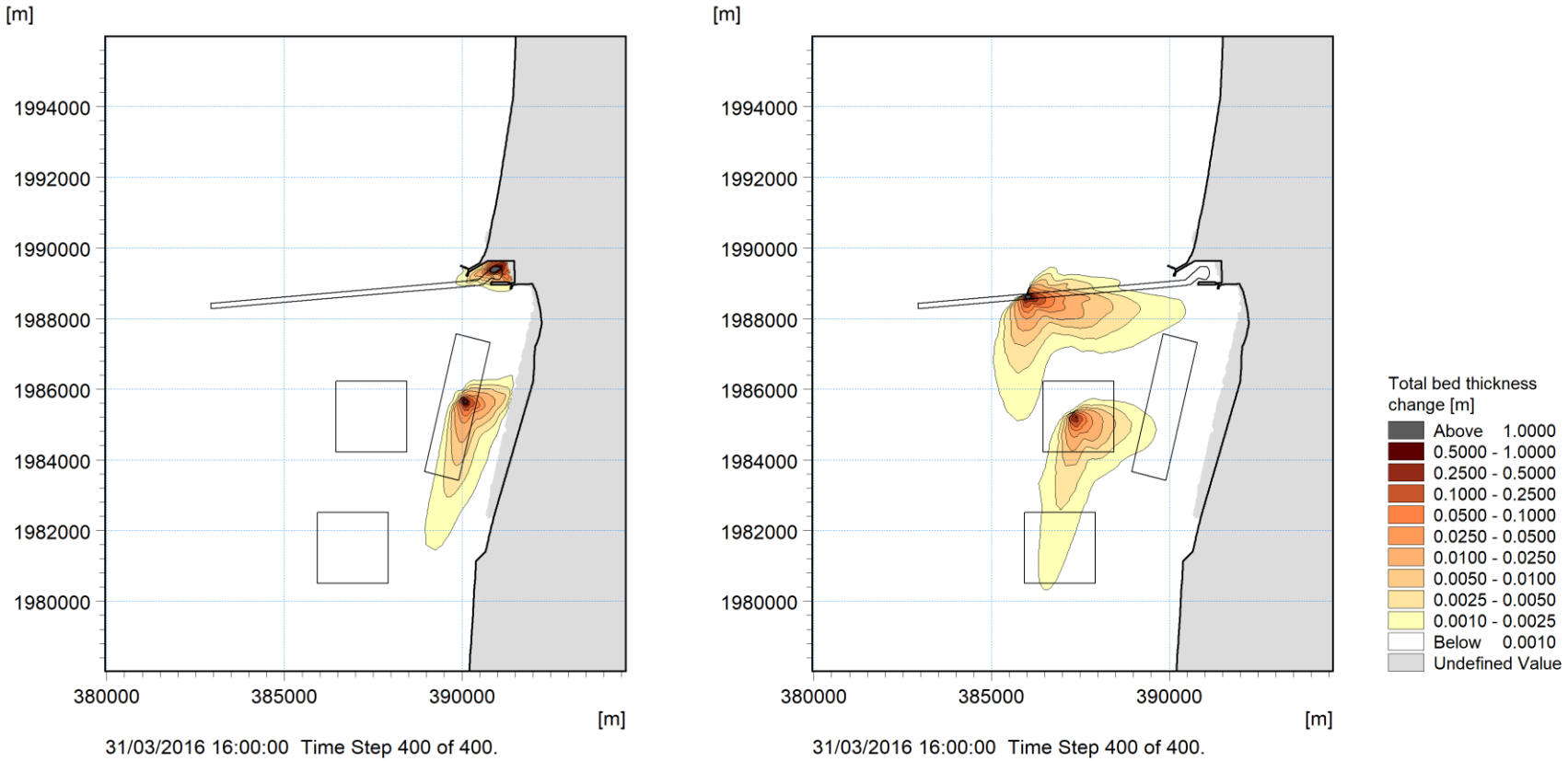


Figure 5.51 Total bed thickness change over the 15-day simulation period (period 15/03/2016 to 31/03/2016) – dredging in the port and deposition in area A (left) – dredging in the channel and deposition in area B (right)

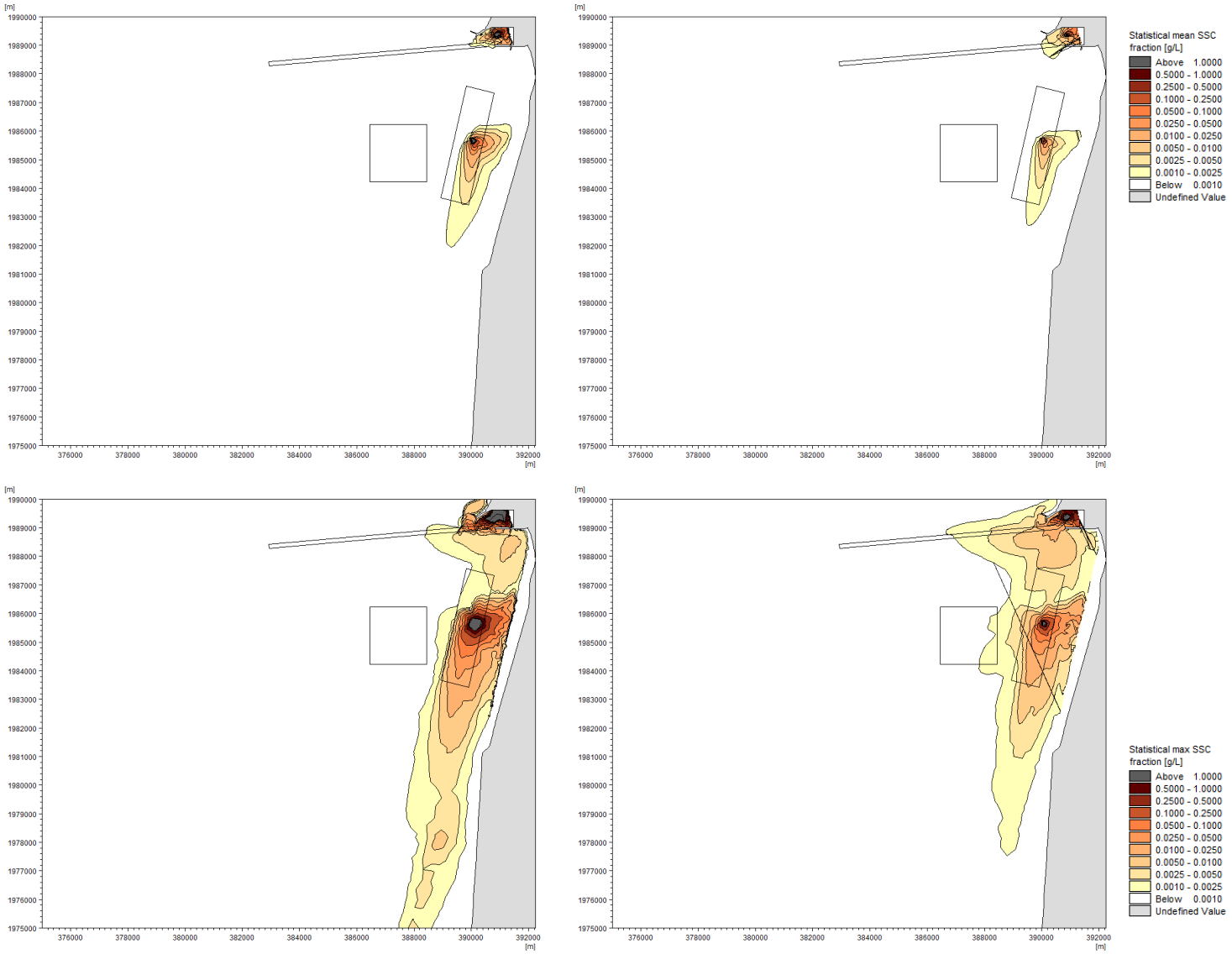


Figure 5.52 Mean (top) and maximal (bottom) turbidity plume over the 15-day simulation period (period 15/03/2016 to 31/03/2016) – dredging in the port and deposition in area A. **Left:** bottom layer – **Right;** depth averaged

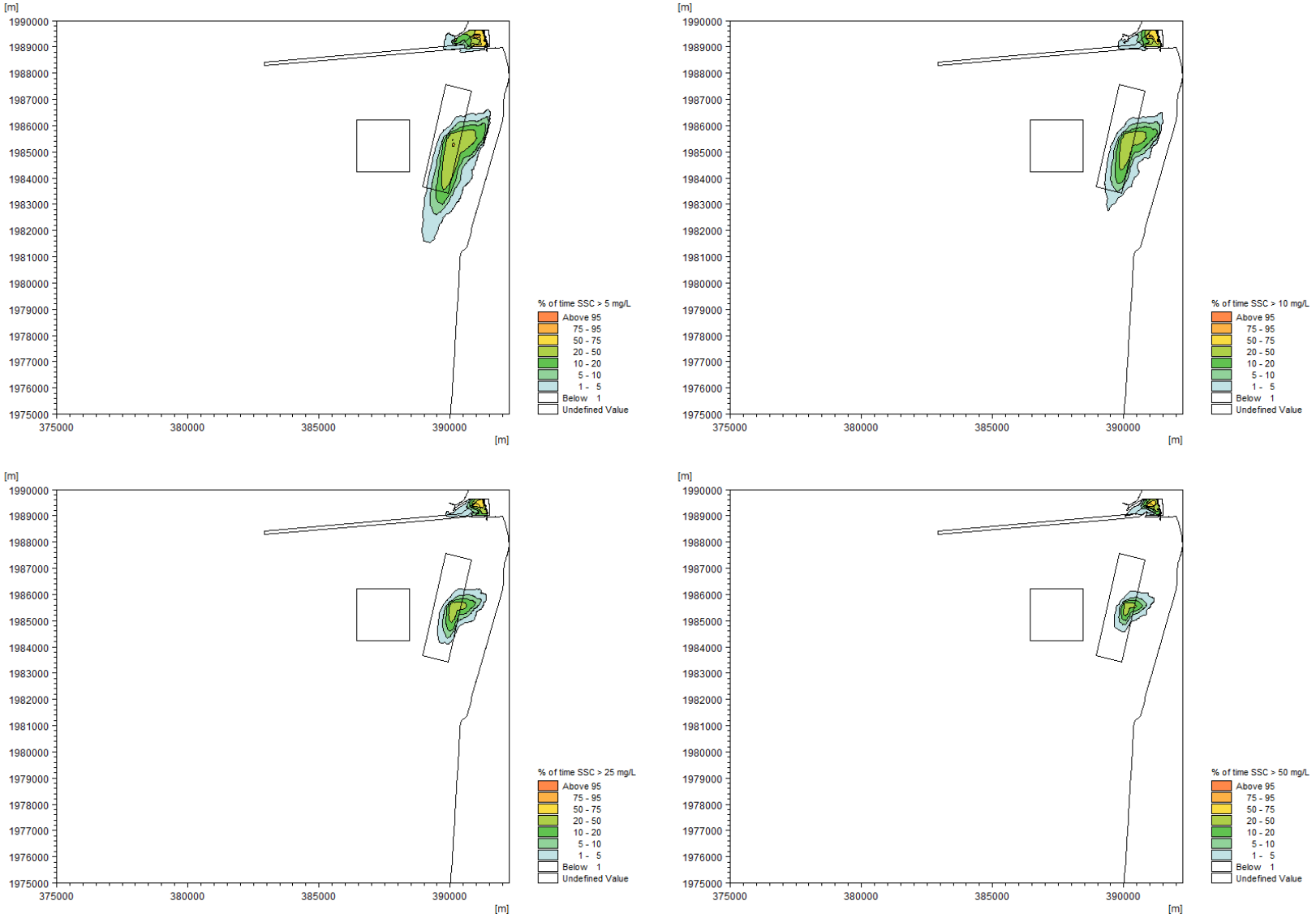


Figure 5.53 Bottom layer: exposure (% of the total duration) over the 15-day duration (period 15/03/2016 to 31/03/2016) – dredging in the port and deposit in area A. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

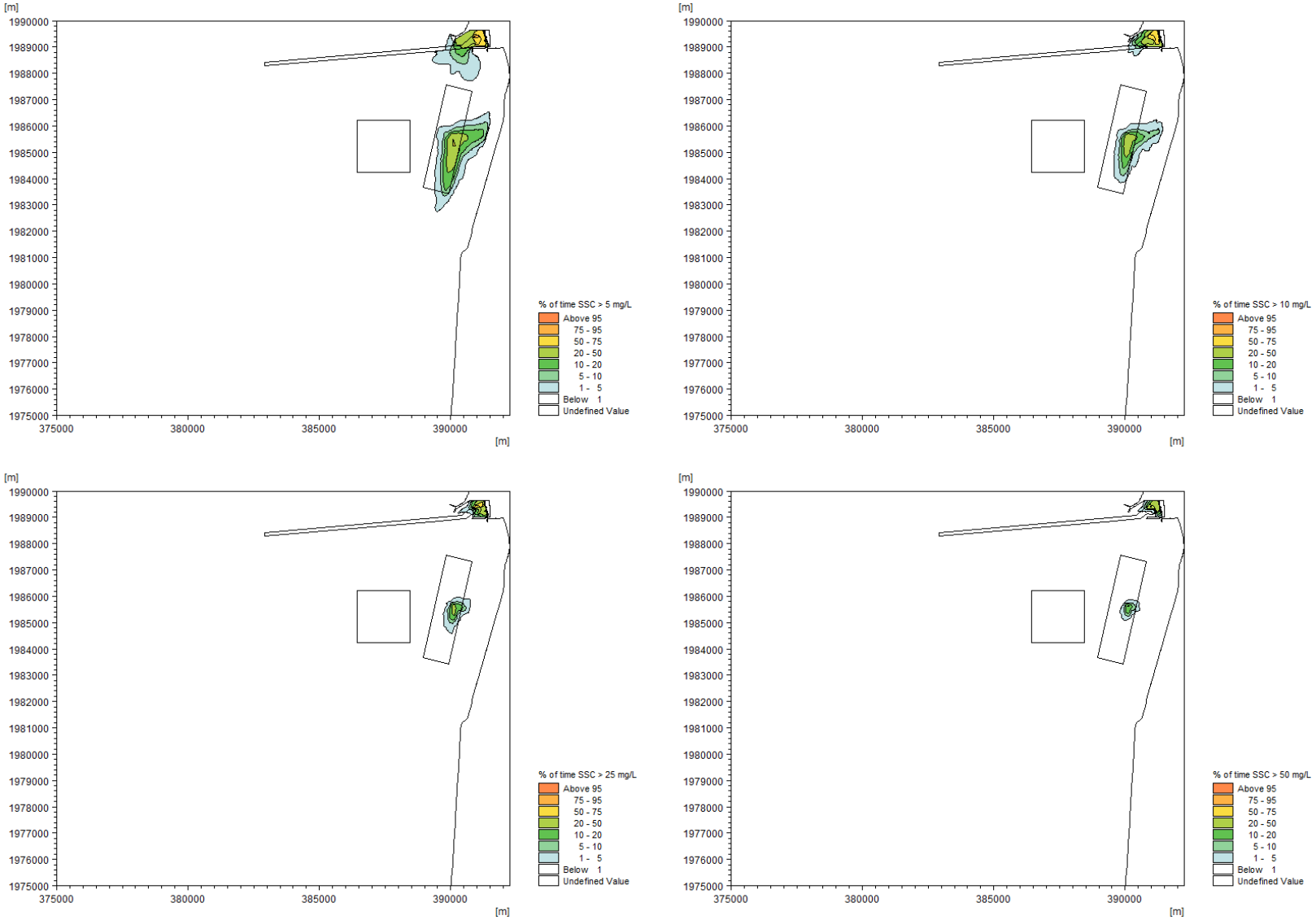


Figure 5.54 Depth averaged: exposure (% of the total duration) over the 15-day duration (period 15/03/2016 to 31/03/2016) – dredging in the port and deposit in area A. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

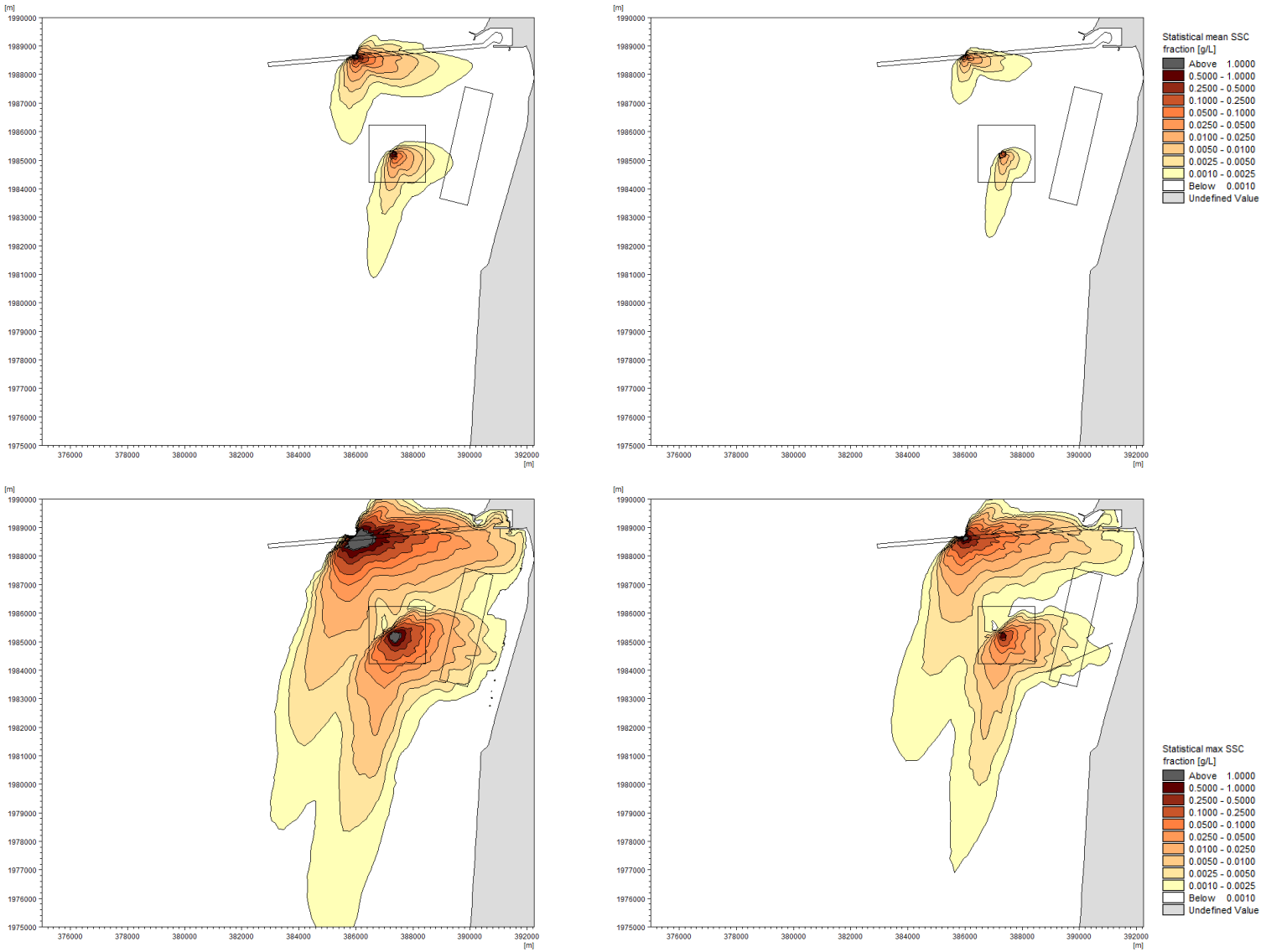


Figure 5.55 Mean (top) and maximal (bottom) turbidity plume over the 15-day simulation period (period 15/03/2016 to 31/3/2016) – dredging along channel and deposit in area B. **Left**: bottom layer – **Right**; depth averaged

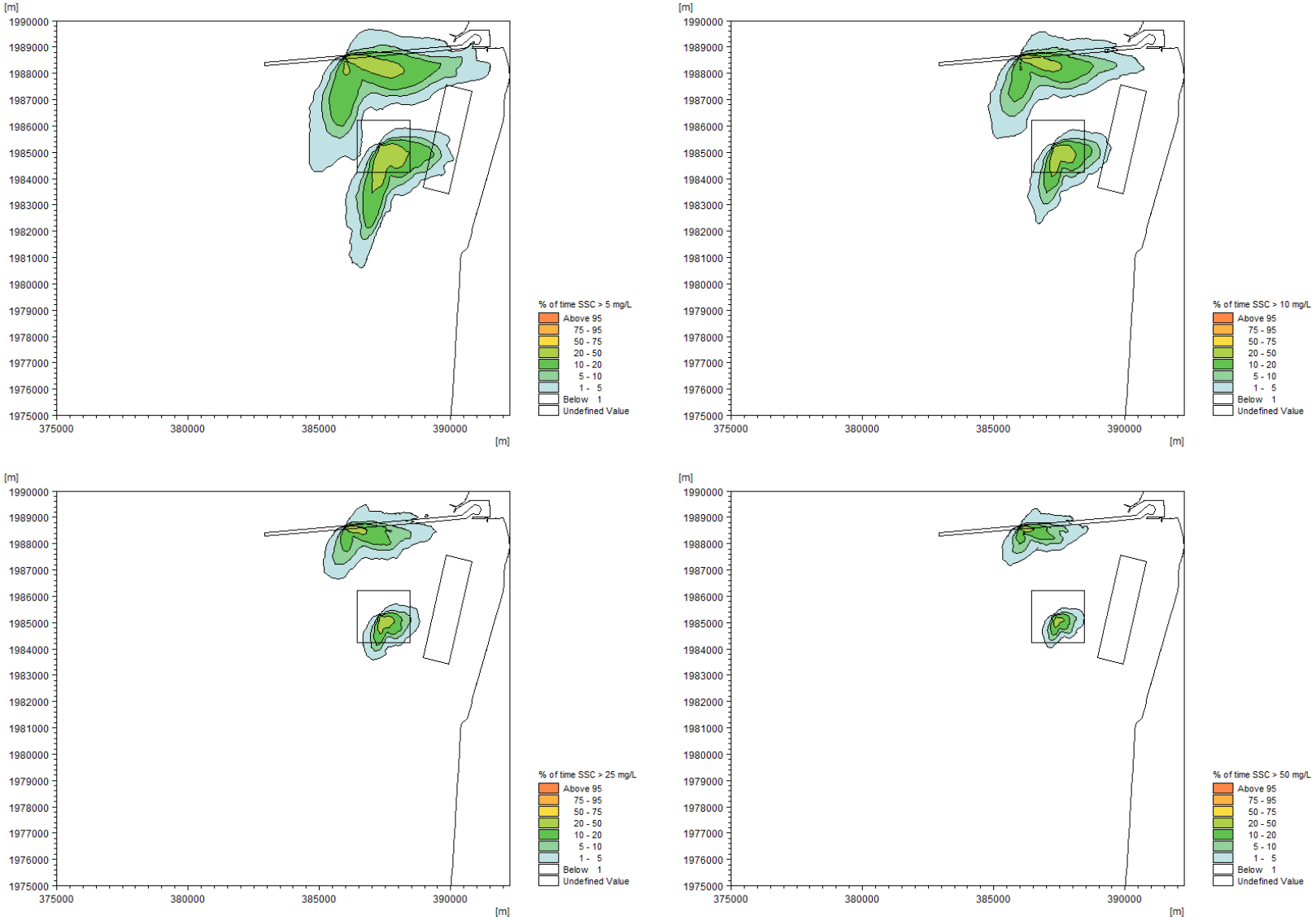


Figure 5.56 Bottom layer: exposure (% of the total duration) over the 15-day duration (period 15/03/2016 to 31/03/2016) – dredging along channel and deposit in area B. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

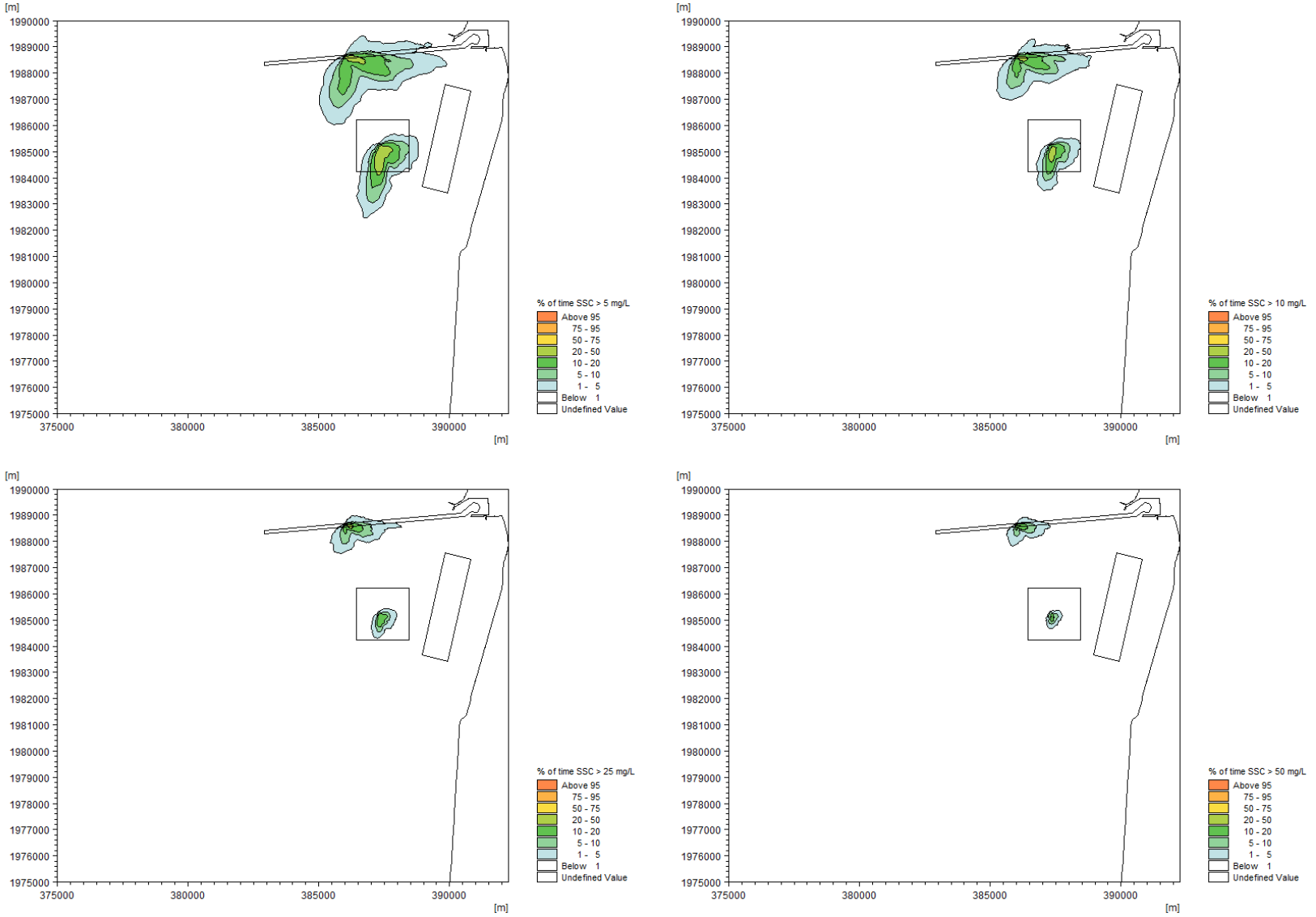


Figure 5.57 Depth averaged: exposure (% of the total duration) over the 15-day duration (period 15/03/2016 to 31/02/2016) – dredging along channel and deposit in area B. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

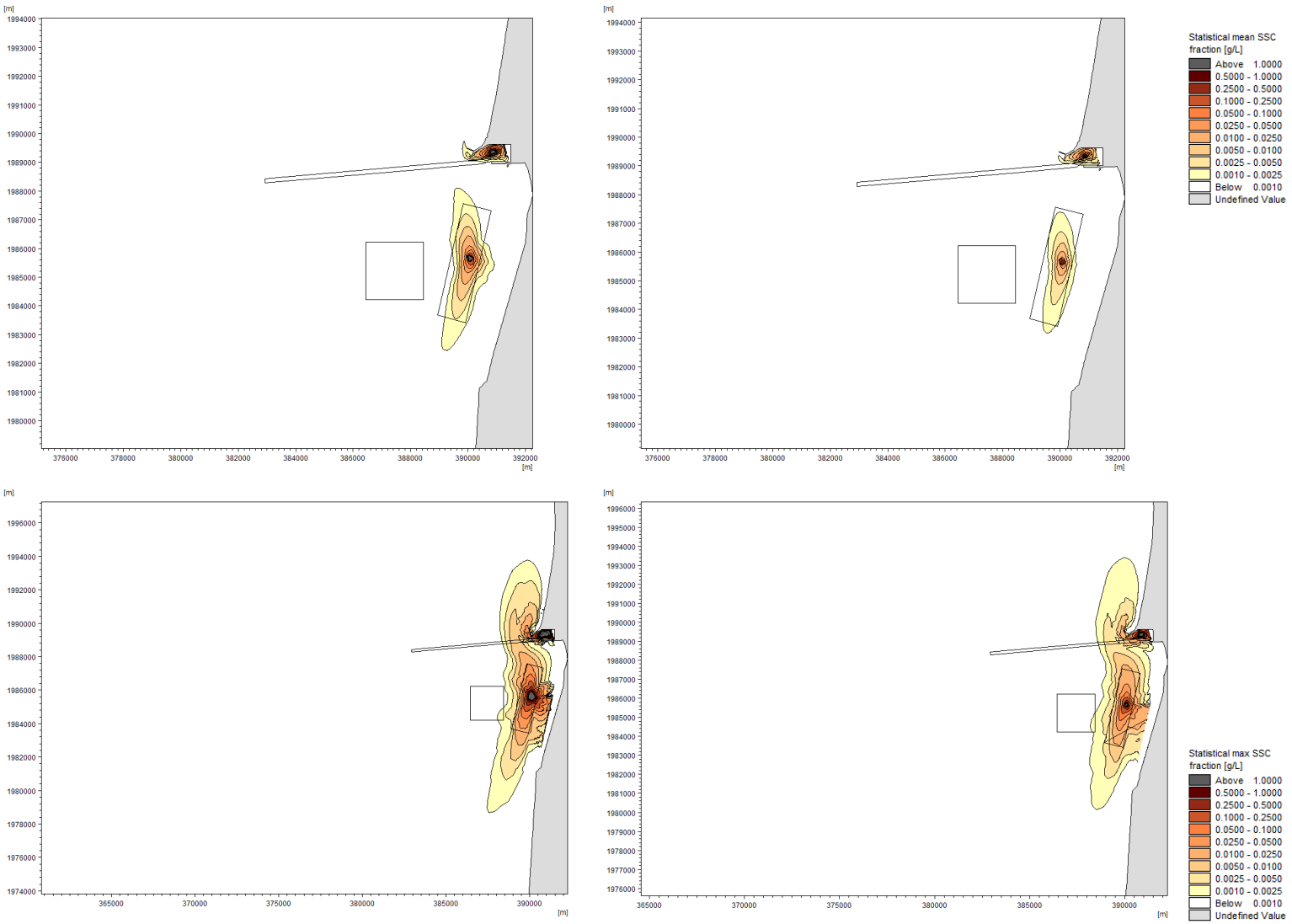


Figure 5.58 Mean (top) and maximal (bottom) turbidity plume over the 15-day simulation period (period 15/03/2016 to 31/03/2016) – dredging in the port and deposit in area A. **Left:** bottom layer – **Right;** depth averaged

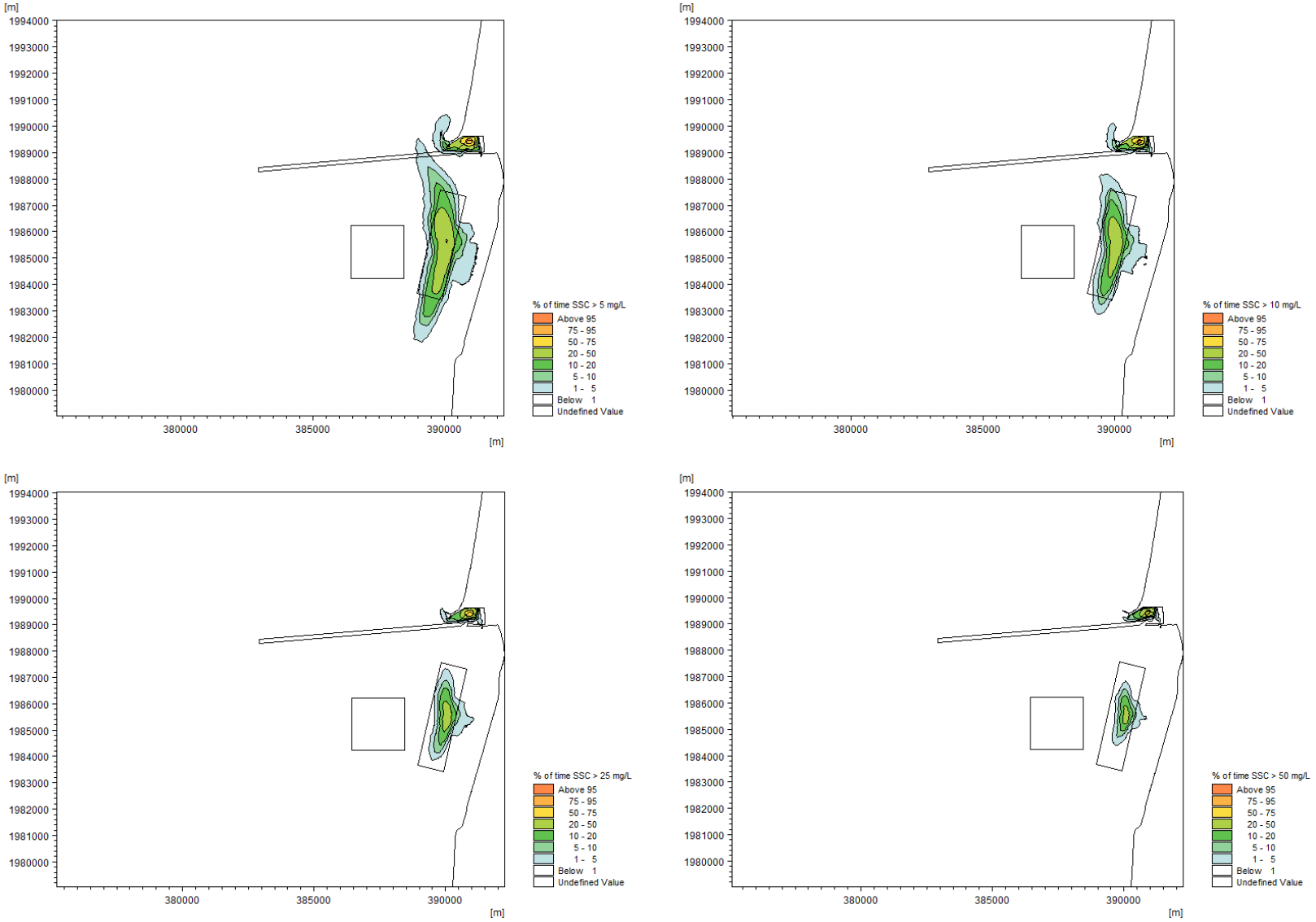


Figure 5.59 Bottom layer: exposure (% of the total duration) over the 15-day duration (period 15/03/2016 to 31/03/2016) – dredging in the port and deposit in area A. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

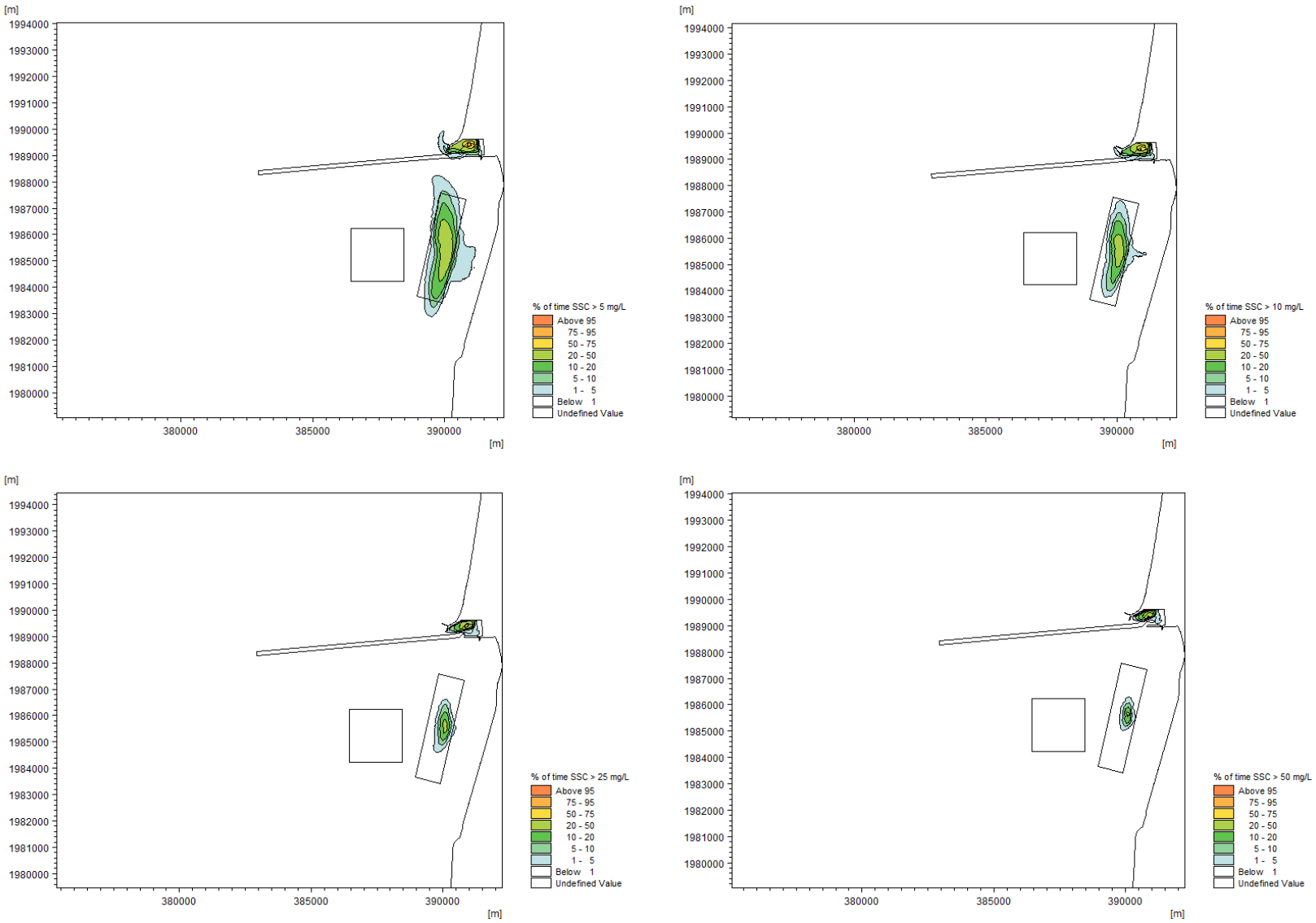


Figure 5.60 Depth averaged: exposure (% of the total duration) over the 15-day duration (period 15/03/2016 to 31/03/2016) – dredging in the port and deposit in area A. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

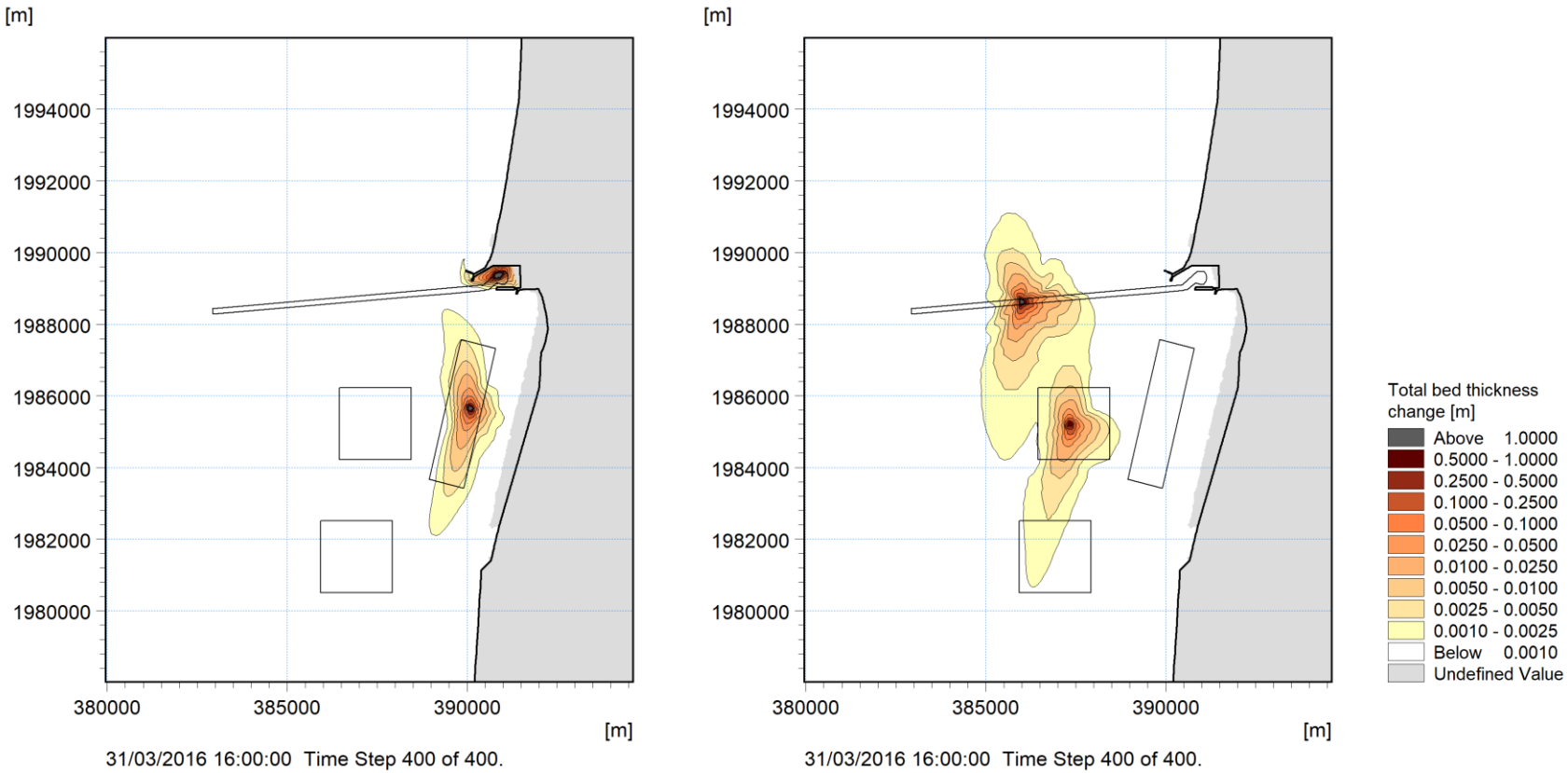


Figure 5.61 Total bed thickness change over the 15-day simulation period (period 15/07/2016 to 31/07/2016) – dredging in the port and deposit in area A (left) – dredging in the channel and deposit in area B (right)

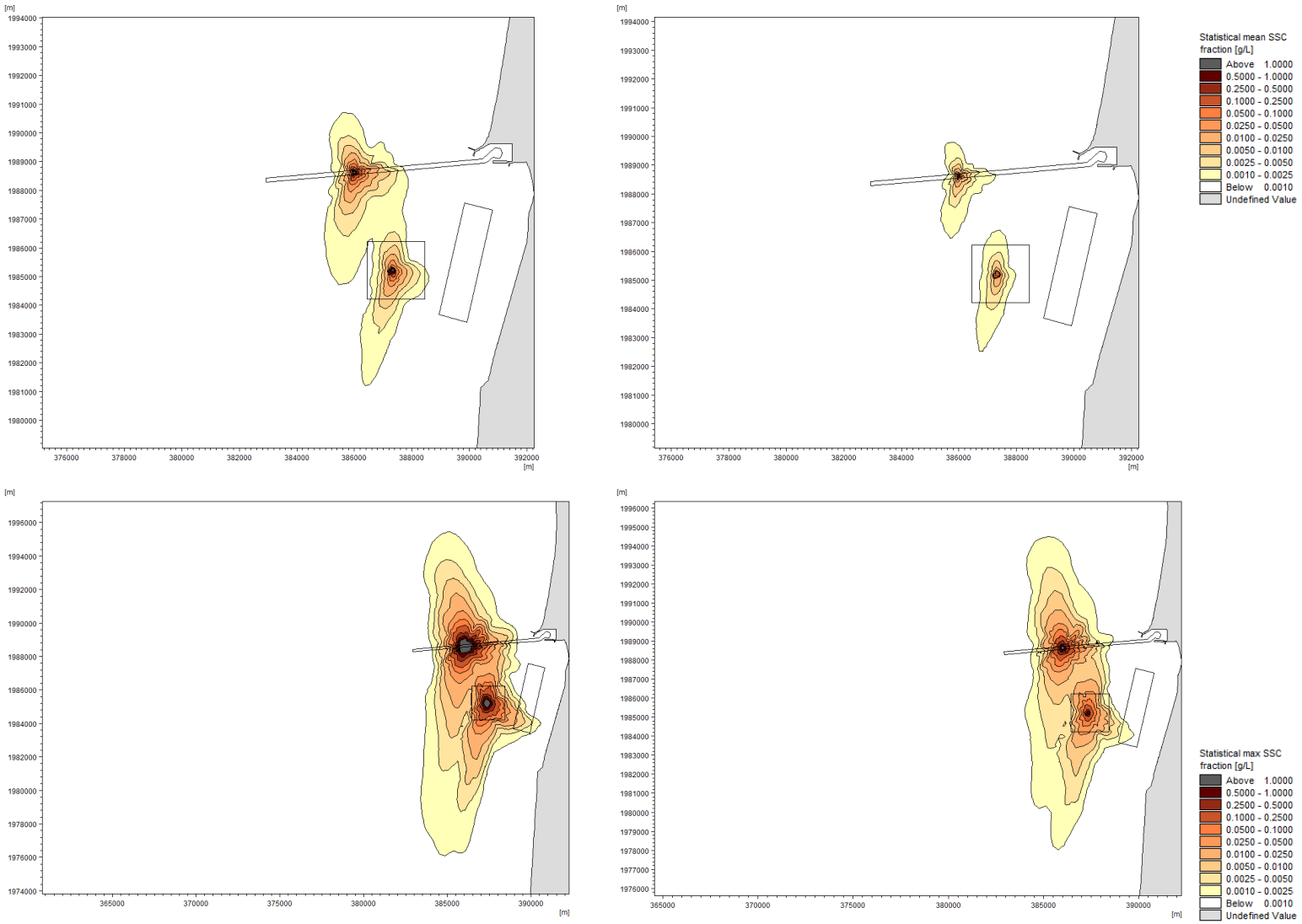


Figure 5.62 Mean (top) and maximal (bottom) turbidity plume over the 15-day simulation period (period 15/07/2016 to 31/07/2016) – dredging along channel and deposit in area B. **Left**: bottom layer – **Right**; depth averaged

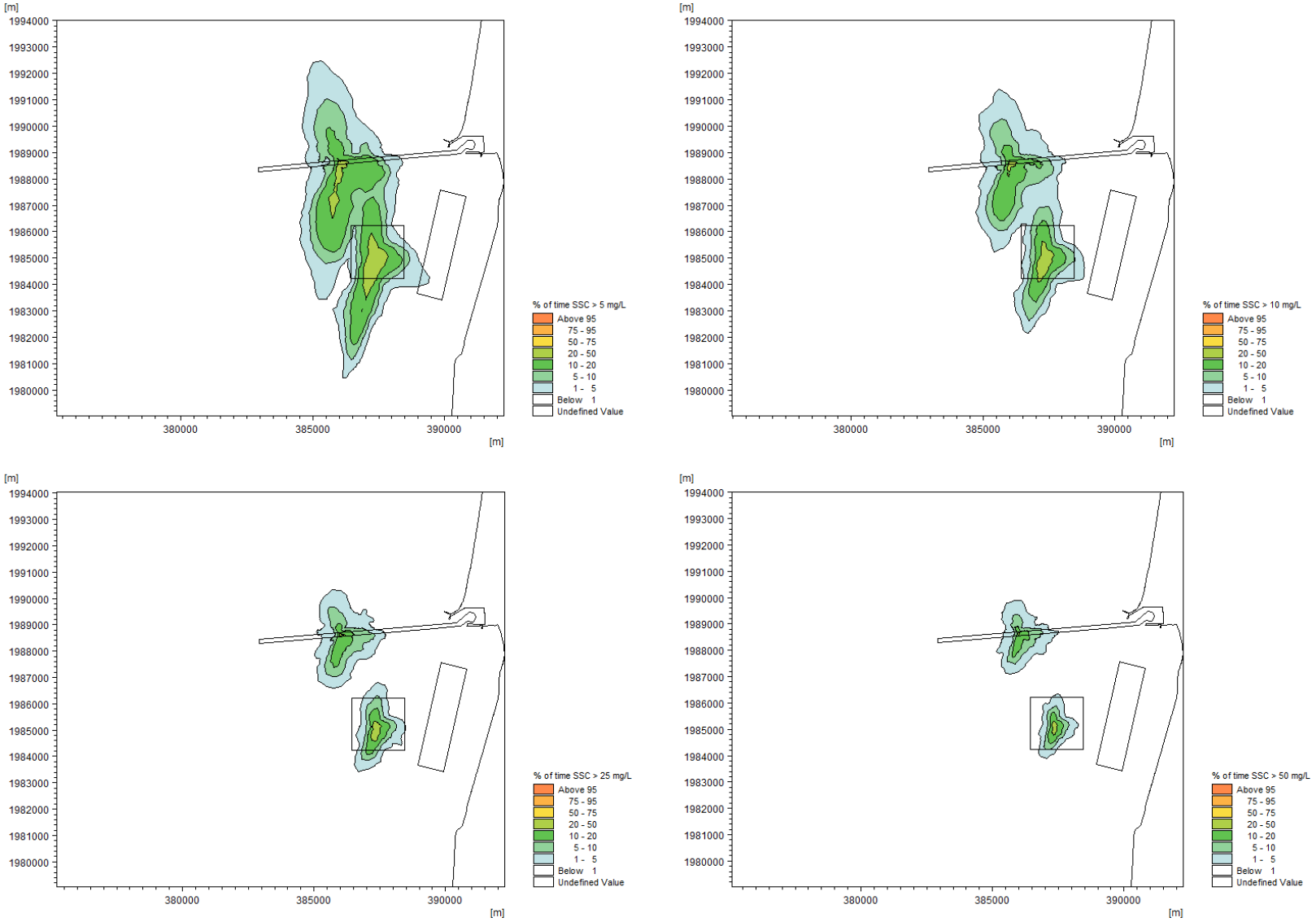


Figure 5.63 Bottom layer: exposure (% of the total duration) over the 15-day duration (period 15/07/2016 to 31/07/2016) – dredging along channel and deposit in area B. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

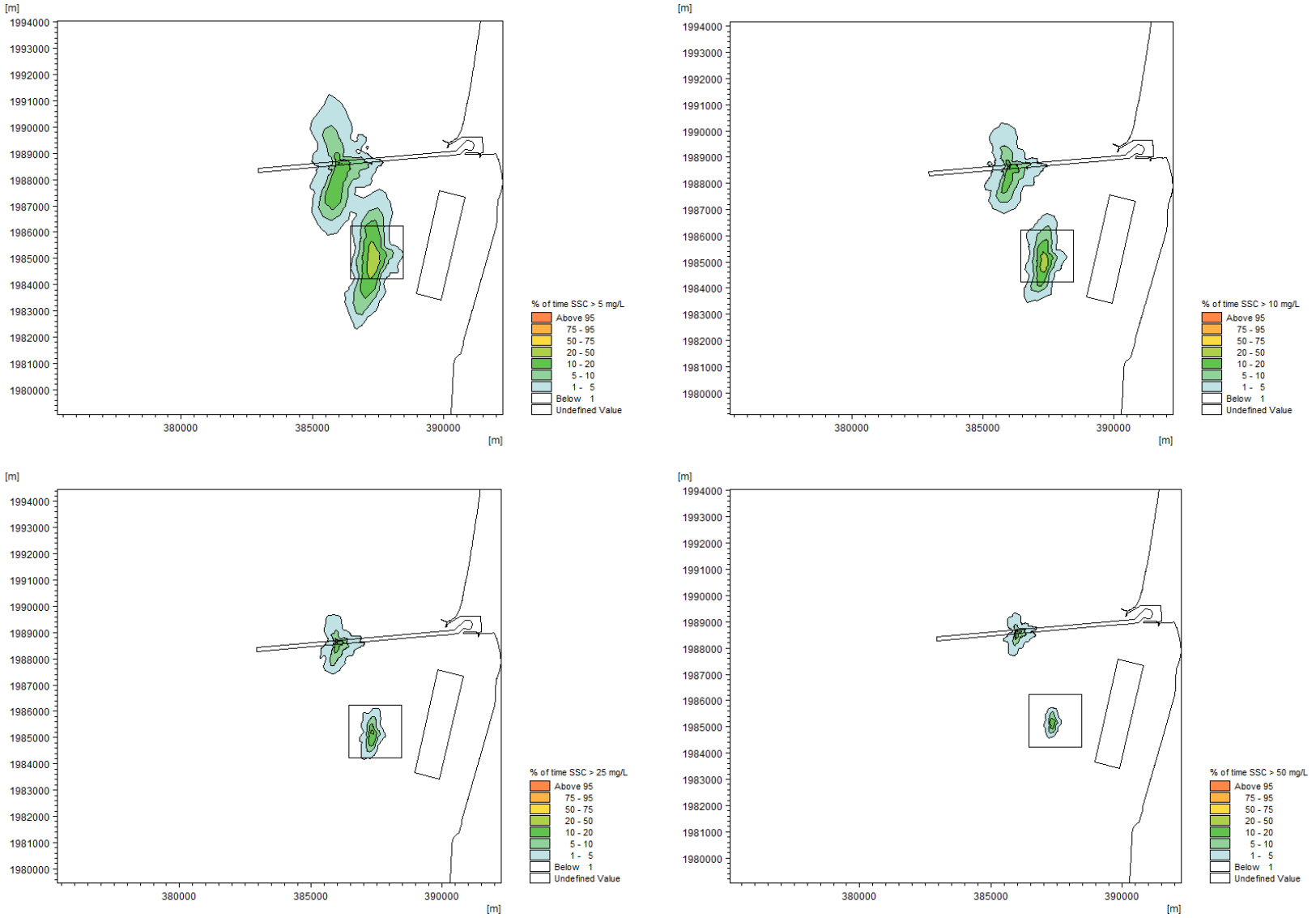


Figure 5.64 Depth averaged: exposure (% of the total duration) over the 15-day duration (period 15/03/2016 to 31/02/2016) – dredging along channel and deposit in area B. Exposure relative to the SSC thresholds of 5mg/l, 10mg/l, 25mg/l and 50mg/l

6 Hydro-sediment study

The aim of this study is to analyse the impact of the project (new quay and potential deepening of the entrance channel or existing turning basin) on sedimentation inside the existing port and shoreline stability near the port.

The work includes analysis of thte shoreline retreat, supported by mathematical modelling of waves, currents, sediment transport and coastal morphodynamics.

6.1 Site characterisation

At first, a site characterisation has been undertaken. It was based on available data and documents. This step is necessary to insure an adequate calibration and validation of the hydro-sediment model.

6.1.1 Evolution of the shoreline

First works for the Port de l'Amitié development started in 1979, completed in 1986. The second phase of development was engaged in 2031 with the construction of the southern jetty.

The construction of the Port on the Nouakchott coast has led to a rapid coastline evolution that has resulted in:

- a strong accretion of the coast north of the port;
- a significant erosion south of the facilities, that has required the implementation of protective measures, which include:
    - construction of a groyne south of the port and a protective seawall
    - construction of a detached breakwater about 2km south of the port in 2012.

In addition, the northern jetty was completed by an additional extent in order to reduce the sediment input from the north.

The following picture present the shoreline position in 1991, illustrating the beach erosion issue that the part of the shoreline is facing, and the maritime structures (jetty and groyne).

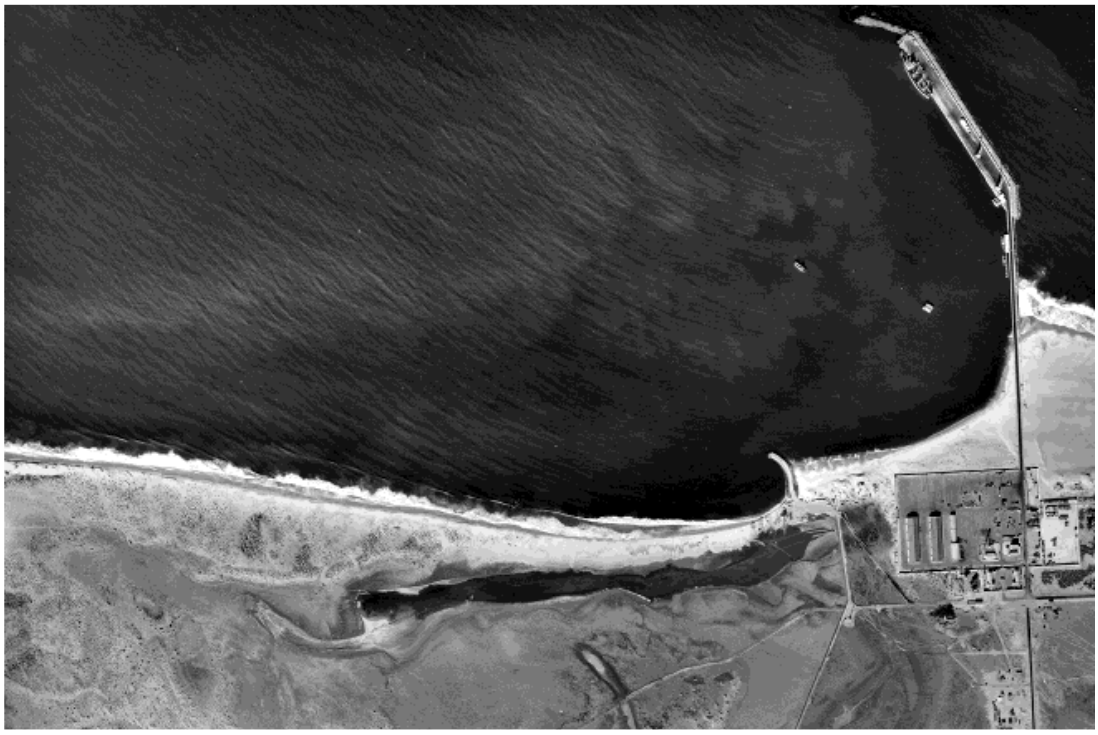


Figure 6.1: Aerial view of the port of Nouakchott in 1991.

The beach evolution of Nouakchott has been the subject of some studies including /1/and /8/. The following figure is extracted from /8/. It illustrates the shoreline mobility for the period 2004 to 2010, with a rate of accretion of about 14m/year north of the harbour and 20m/year south of the harbour

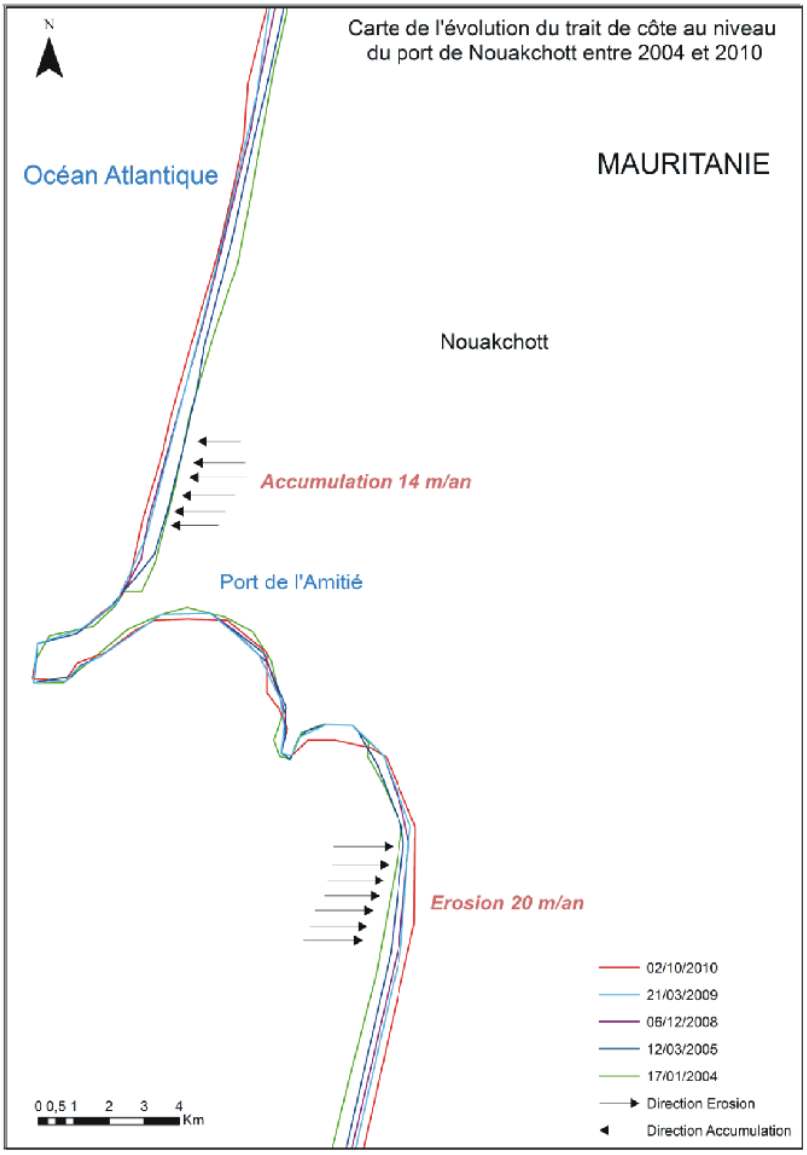


Figure 6.2: Shoreline mobility during the period 2004-2010.

To update the shoreline evolution understanding, data from previous studies have been completed by the analysis of more recent aerial views. Results of this analysis are illustrated on Figure 6.3 where shoreline position from 1980, 1998, 2003, 2009, 2012, 2016 and 2018 are compared. The addition of the recent shoreline position confirms the past trend of evolution, with a continuation of accretion north of the harbour an erosion south of it.

However, it has to be noted that after the contrition of the breakwater about 2km south of the harbour, the erosion has been significantly reduced between this structure and the harbour. In return, the hot spot for intense erosion has been reported south of the breakwater.

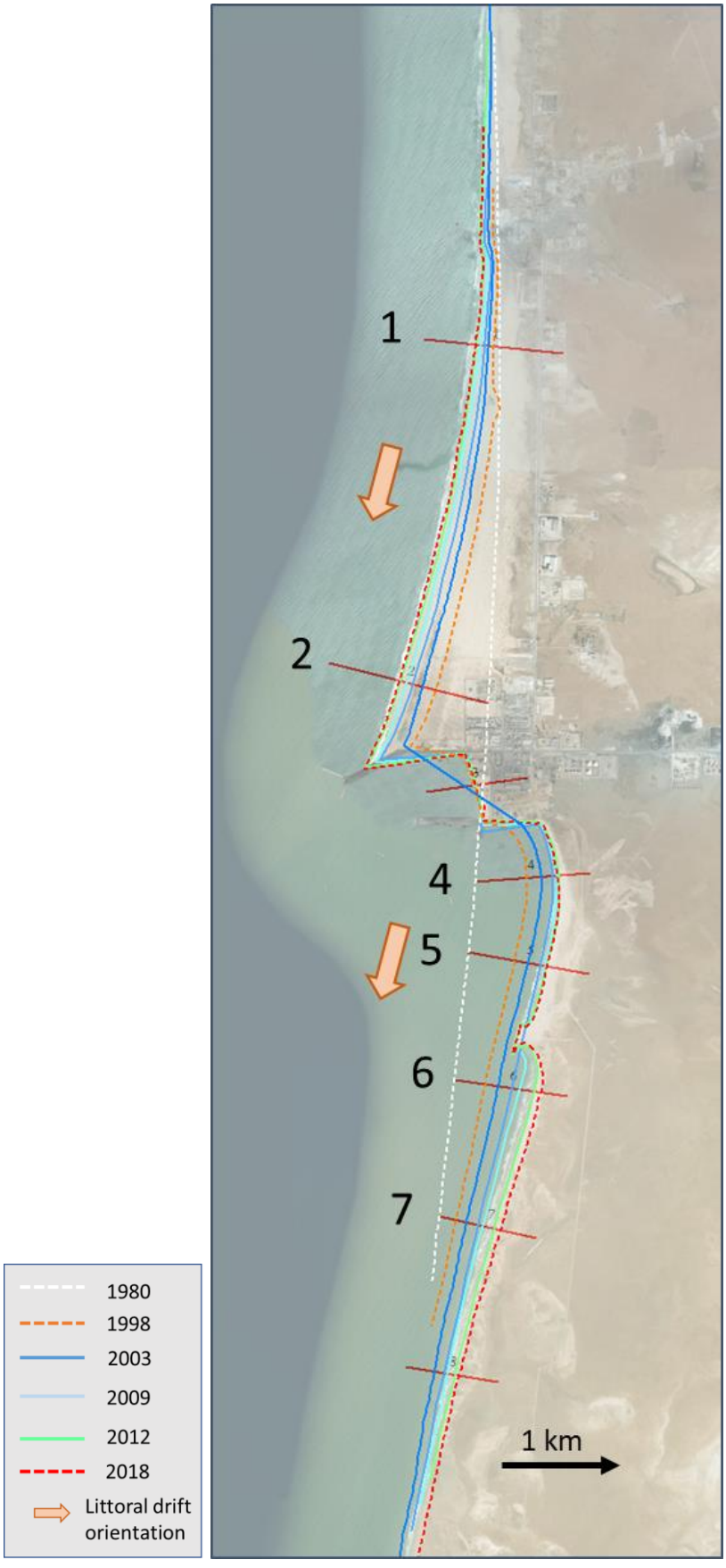


Figure 6.3: Shoreline mobility during the period 1980-2018.

To confirm this observation, the evolution of the shoreline position, relative to the position in 1980, has been reported for 6 profiles, illustrated Figure 6.4.

- Profiles 1 and 2 located north of the harbour
- Profiles 4 and 5: located between the harbour and the breakwater
- Profiles 6 and 7: located south of the breakwater

The following graph shows the results of this analysis.

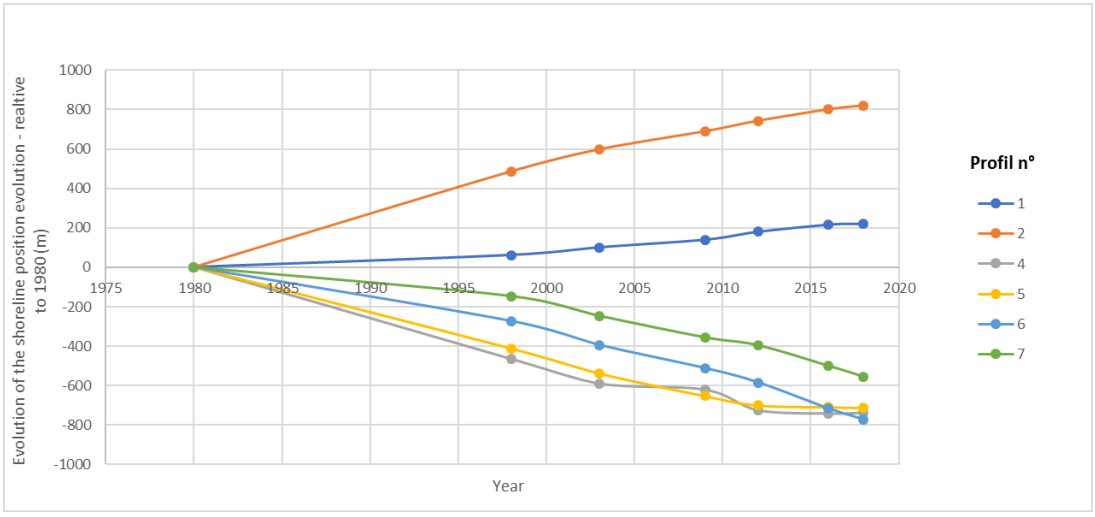


Figure 6.4: Shoreline position evolution, relative to 1980, for 6 profiles along the coast.

For the period 1980-2018, we note the following:

- The accretion trend is retirement stable, with a slight reduction of intensity in the recent year, for profiles 1 and 2: 800m of accretion for profile 1 and 200m of accretion for profile 2
- A significant erosion for profiles 4 and 5 (about 750m) which has been stabilized over the 2 last years (2016-2018)
- A significant erosion for profiles 6 (about 800m) and 7 (about 700m), with a slight increase of intensity over the 2 last years.

A recent shoreline position survey was undertaken by Magma group in March 2019. The measured shoreline position is compared with the 2018 position extracted from aerial views. Results are presented on the following figure. As expected, a tendency of accretion can be noticed north of the port. South of the port, the shoreline position in 2018 and 2019 appear relatively similar.



Figure 6.5: Comparison of shoreline positions in 2018 (from aerial view) and 03-2019 (field survey)

6.1.2 Sediment analysis

The sediments diameter was provided thanks to the particle size analysis performed on the sediment's samples carried out by Magma Group. The particle size analysis has been carried out on 19 sediments samples, along the Nouakchott beach.

The list of samples with the coordinates of the locations and the sample location plan are given below:

Table 6.1: Program of tests and coordinates of sampling.

Profile	Sample ID	X(m)	Y(m)	Z(m)	PSA
Profil 1	P1-1	391367.385	1993461.222	3.109	1
	P1-2	391361.513	1993461.590	2.421	1
	P1-3	391379.766	1993460.763	3.594	1
Profil 2	P2-1	390704.340	1990468.159	3.328	1
	P2-2	390696.208	1990469.386	2.522	1
Profil 3	P3-1	391374.024	1989271.869	3.770	1
	P3-2	391357.350	1989272.061	2.605	1
Profil 4	P4-1	391896.715	1988991.289	2.541	1
	P4-2	391892.444	1988985.861	1.992	1
Profil 5	P5-1	391987.232	1987680.604	2.820	1
	P5-2	391980.742	1987680.871	2.253	1
	P5-3	392034.781	1987657.926	3.131	1
Profil 6	P6-1	391920.667	1986519.705	2.979	1
	P6-2	391905.271	1986520.883	1.752	1
Profil 7	P7-1	391579.566	1985280.437	3.416	1
	P7-2	391560.037	1985284.097	1.776	1
	P7-3	391621.848	1985274.066	3.212	1
Profil 8	P8-1	391193.600	1983943.585	3.413	1
	P8-2	391187.201	1983944.739	2.748	1
	Total				19



Figure 6.6: Sampling location.

The data provided by these sediment measurements has enabled to calculate the mean grain diameter at the 6 locations that was relevant for the sediment transport model (profile 3 and 4 were therefore excluded). For each profile, 2 or 3 sediments samples were taken at the low longshore, the high longshore and the top of the dune (2 samples corresponding at measures taken at the low and high longshore). The results are shown below:

Table 6.2: Coordinates and mean grain diameter at all profiles.

Profiles		X	Y	Z	D50
P1	P1-1	391367.4	1993461	3.109	0.45
	P1-2	391361.5	1993462	2.421	0.315
	P1-3	391379.8	1993461	3.594	0.3
P2	P2-1	390704.3	1990468	3.328	0.385
	P2-2	390696.2	1990469	2.522	0.3
P3	P5-1	391987.2	1987681	2.82	0.31
	P5-2	391980.7	1987681	2.253	0.29
	P5-3	392034.8	1987658	3.131	0.31
P4	P6-1	391920.7	1986520	2.979	0.34
	P6-2	391905.3	1986521	1.752	0.285
P5	P7-1	391579.6	1985280	3.416	0.5
	P7-2	391560	1985284	1.776	0.32
	P7-3	391621.8	1985274	3.212	0.3
P6	P8-1	391193.6	1983944	3.413	0.28
	P8-2	391187.2	1983945	2.748	0.336

Alongside with the measures taken by Magma, the diameter of the sediments was measured in the late 90s (/1/) at various locations around the harbour. It consisted in sampling 26 sand samples chosen at 3 distinct areas of the beach:

- The accretion zone north of the port;
- Inside the port ;
- The erosion zone south of the port;

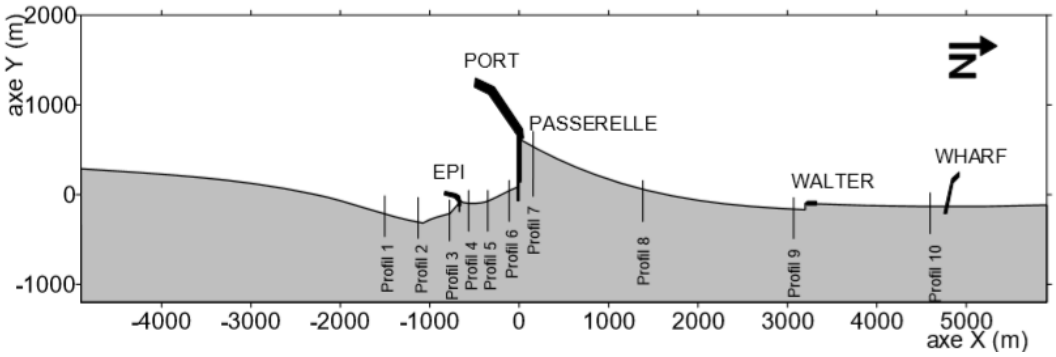
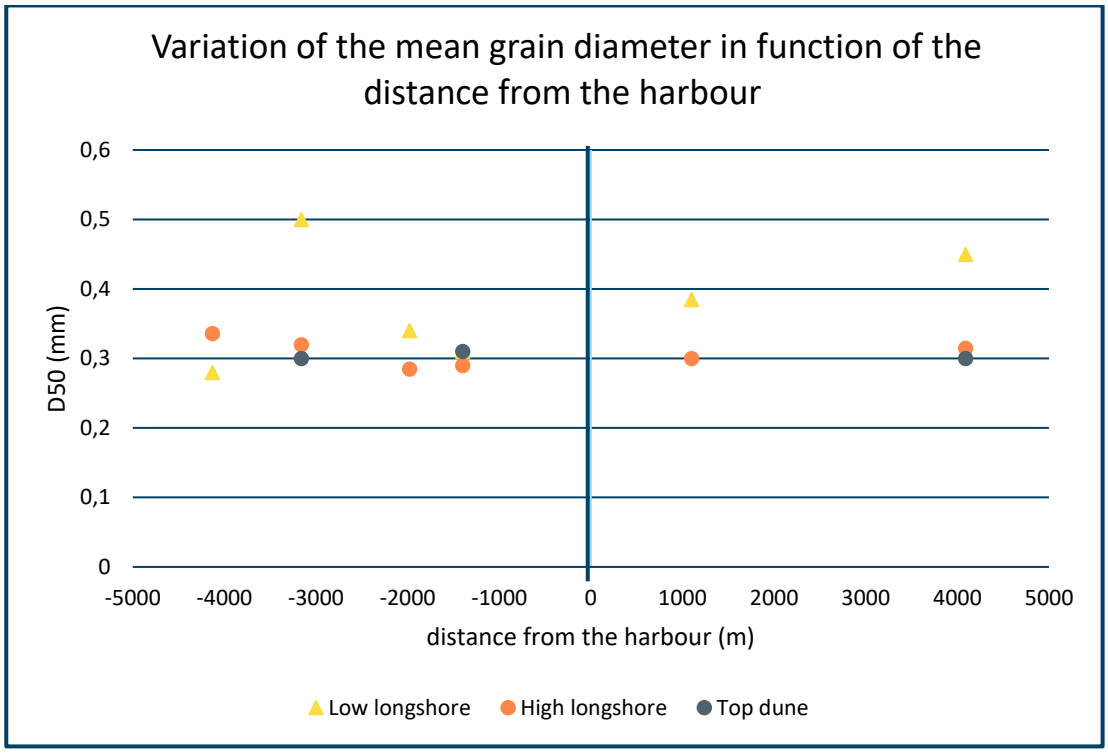


Figure 6.7: Localisation of sampling profiles.

The comparison of the mean grain diameter of the two sampling profiles is displayed below.



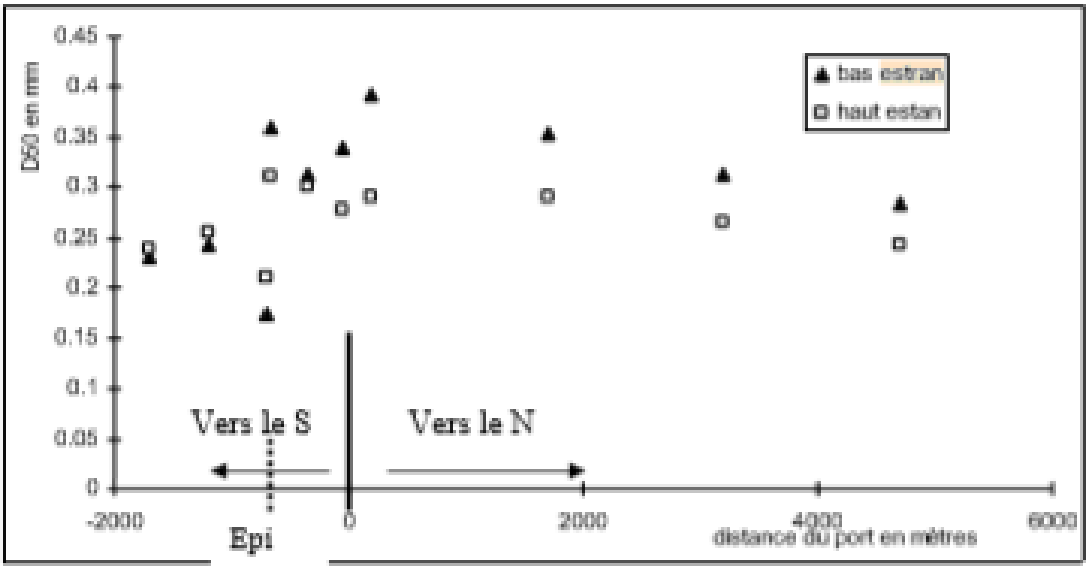


Figure 6.8: Comparison of the variation of the mean grain diameter in function of the distance from the harbour using data from Magma (upward) and analysis from the thesis (downward).

The mean grain diameter is very similar from one study to the other. The samples are between 0.15 and 0.40 mm and most of them situated at around 0.2 to 0.3mm.

6.2 Numerical model, Littoral processes FM

Littoral processes FM is a numerical model capable of simulating littoral drift and coastline evolution in areas with non-cohesive sediment and quasi-uniform beaches in which the flow and transport can be assumed to be primarily in the longshore direction. A technical description of the model can be obtained at http://manuals.mikepoweredbydhi.help/2017/LITPACK.htm.

The model can be used for studies regarding sediment budgets, morphological baseline and the impact of coastal works. It combines a technically strong deterministic sediment transport model .

6.2.1 Longshore Sediment Transport and shoreline evolution

When waves approach the shore under an angle then currents are generated by the hydrodynamic forces associated with wave breaking. These wave-driven currents cause sediment transport along the beach.

As detailed in the previous section and explained by previous studies /11/, along the present project site, the net annual transport is directed towards south. The derived near-shore wave statistics were used to estimate the annual longshore transport (littoral drift).

The net annual sediment transport, or littoral drift, is defined as the sum of the annual northward- and southward transport.

The sediment transport model LITDRIFT, which is a module in the Littoral Processes FM suite of models, calculates the transformation and breaking of waves through the surf zone. The simulated wave fields are used to calculate longshore currents and the resulting sediment transport. The model is a so-called line model which means that depth contours are assumed to be parallel. This assumption is justified along the present project site.

Beach cross-sections along the shoreline was derived from the bathymetric and recent survey data. Along these cross-sections, the annual sediment transport rates were calculated, using the available sediment data and the derived inshore wave climate. The

The simulation of the coastline evolution has been made by the model LITLINE, which is a module in the Littoral Processes FM suite of models. LITLINE calculates the erosion and accretion along the coastline on the basis of the variation in the longshore sediment transport. The sediment transport depends on the wave climate, the coastal profile and the beach sediments, but most important for the coastline modelling is the variation with the orientation of the coastline.

Model domain

The sediment transport model LITDRIFT was applied along 6 cross-shore profiles, as shown in respectively Figure 5.8.



Figure 6.9: Position of the 6 cross-shore profiles considered for LITDRIFT modelling

The cross-shore beach profiles used in the model were obtained by extraction from the bathymetric topographic data.

However, for the two profiles north of the port, the data used for the bathymetry were considered “outdated”: as the shoreline has moved towards the sea due to the beach accretion. Consequently, the interpolation of these data gave a slope of the bathymetry which was too high to represent the real beach slope. Therefore, for these two profiles, it has been decided to use the cross-shore profile detailed in /1/. This beach profile was measured near the Wharf, so located north of profile 1. It is assumed to be representative of the beach cross shore profiles along the northern part (north of the port) of the shoreline.

South of the harbor, the extraction of the cross-shore profiles from the interpolated bathymetric data resented realistic slopes and these profiles were used for the sediment transport modelling.

The cross-shore beach profiles are displayed below:

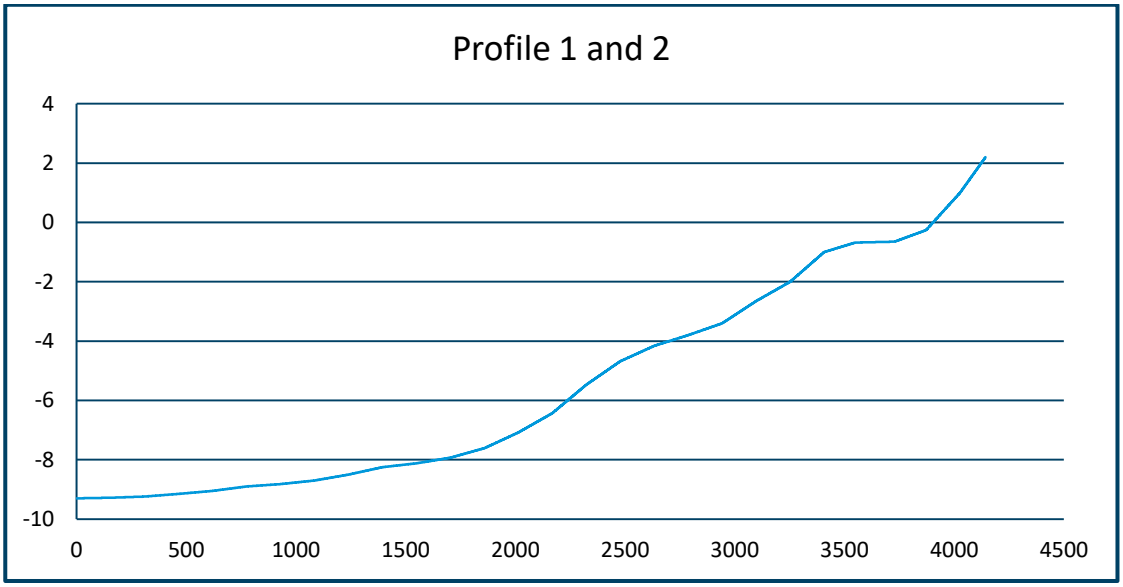


Figure 5.9: Representative cross-shore profile considered for profiles 1 and 2

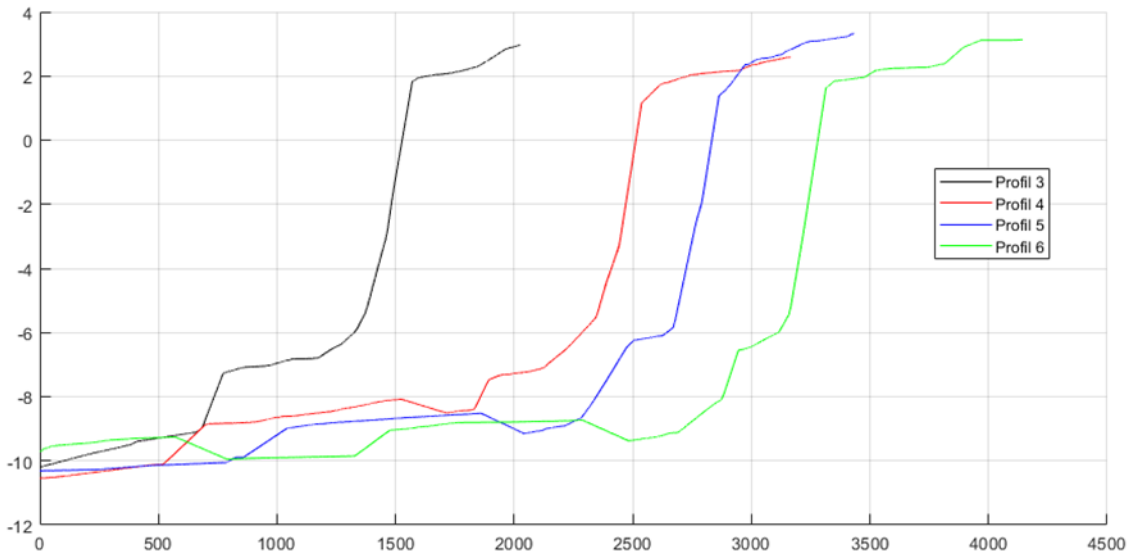


Figure 6.10: Cross-shore profiles obtained for profiles 3 to 6

Waves

Timeseries of waves were extracted from the hindcast MIKE 21 SW simulations carried out previously in the current situation and in the project case. It contains the root-mean-square heights, peak period, mean water direction of the waves and Rouse number values at the edge of the six profile lines.

The wave roses at the edge of the six cross-shore profiles are shown below in Table 6.3 and Table 6.4.

Table 6.3: Wave roses for profiles P1 to P3, in the current situation and in the project situation.

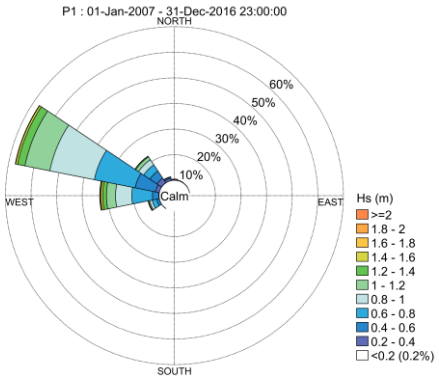
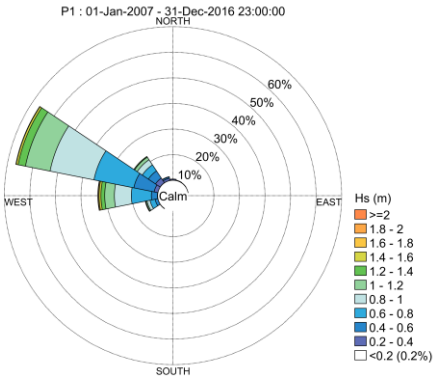
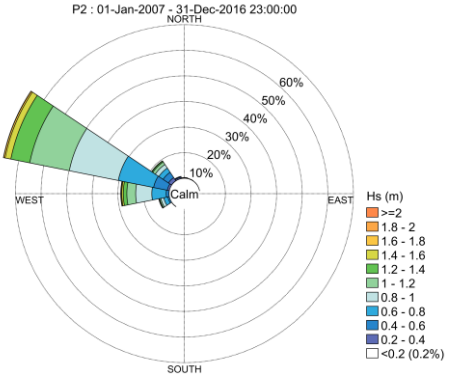
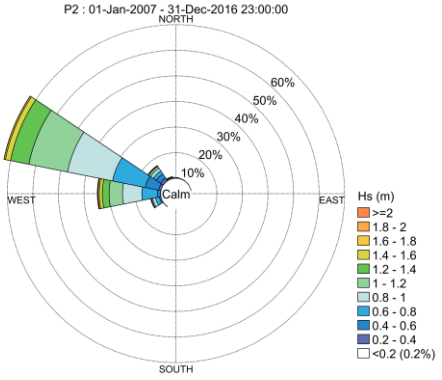
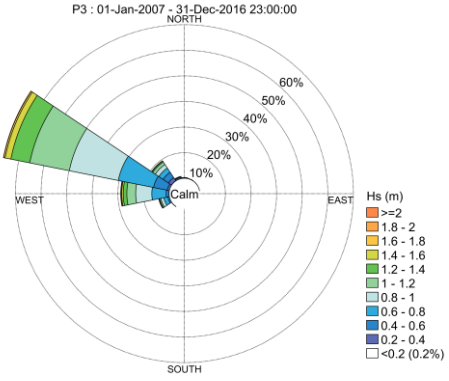
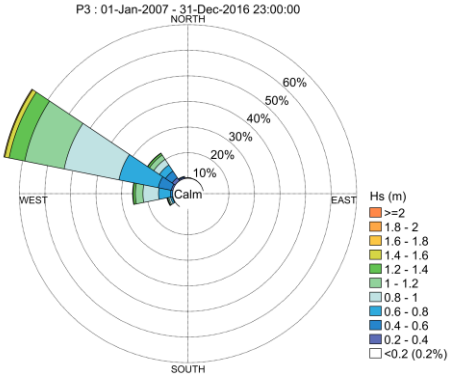
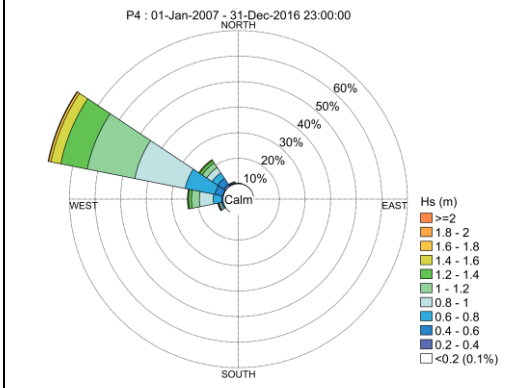
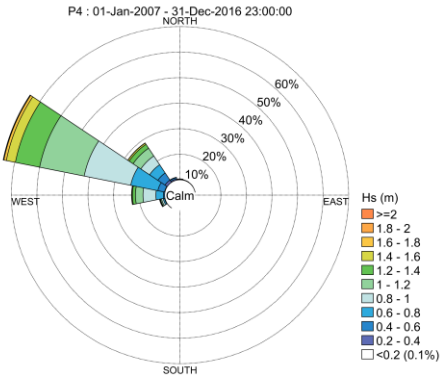
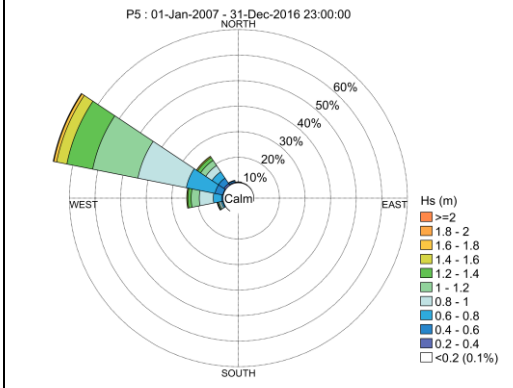
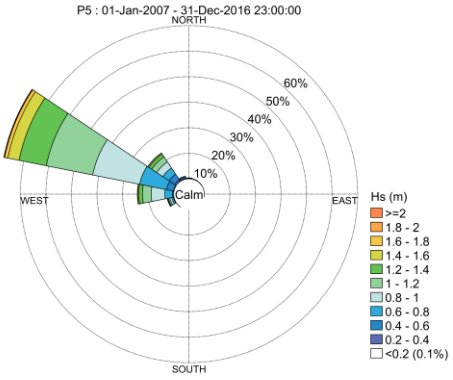
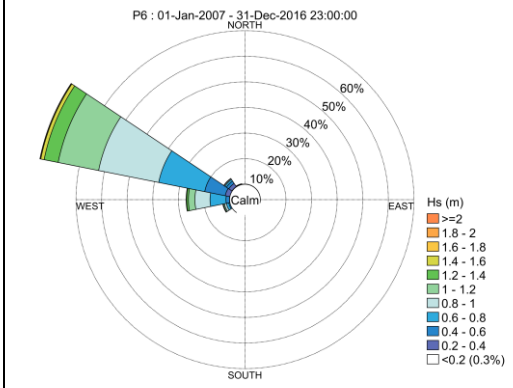
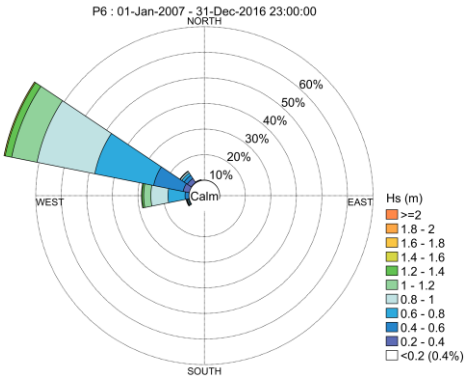
Points	Wave roses (current situation)	Wave roses (project situation)
P1		
P2		
P3		

Table 6.4: Wave roses for profiles P4 to P6, in the current situation and in the project situation.

Points	Wave roses (current situation)	Wave roses (project)
P4		
P5		
P6		

The angle between the approaching waves and the shoreline normal orientation is one of the key parameters for longshore sediment transport. The next figure allows comparing the main wave direction along the studied shoreline orientation and the shore normal direction, resulting in an average southward littoral drift.

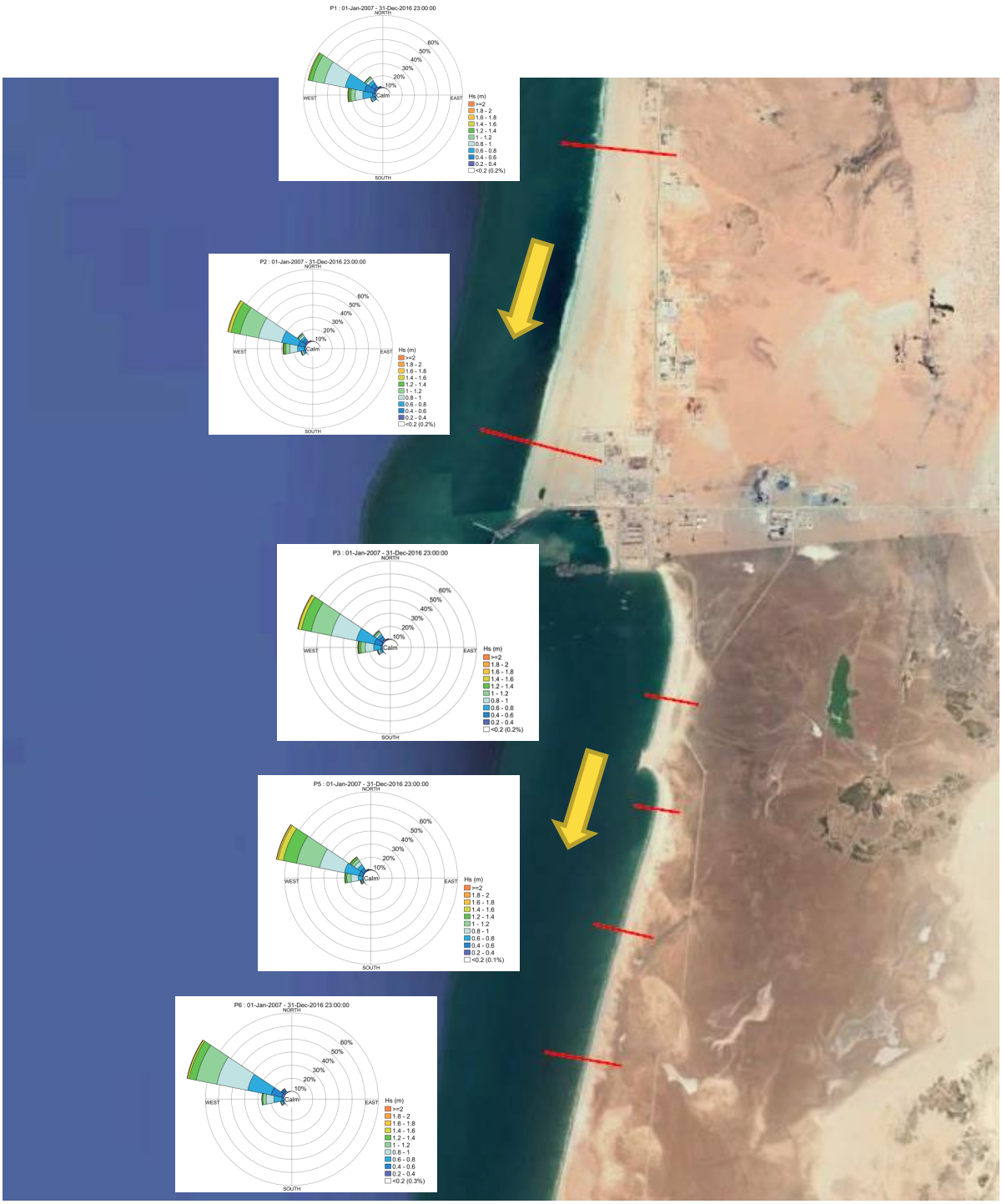


Figure 6.11: Illustration of main wave direction variation along the shoreline, relative to the shoreline orientation

Sediment diameter

The sediment analysis has shown (see part 5.1.2) has shown that the mean grain diameter obtained with the 2 campaigns of measurements is estimated most of the time around 0.2 to 0.3 mm.

6.2.2 Estimation of the littoral drift

The littoral drift model (LITDRIFT) was applied to estimate the sediment transport. The Battjes and Janssen formulation (1978) was used for the wave breaking calculation and a bed roughness value of 0.0004 m was considered. The critical Shields parameter was set at the value of 0.045. The sediment was considered as graded sand with a relative density of 2.65, the bed porosity was taken as 0.4.

For each of the six cross-shore profiles studied, waves and water levels were described as varying in time: the 10-year continuous period (2007-2016) – see section 3) was considered.

For the calibration of the model it is necessary to have an estimate of the amounts of sediment acting along the beach. This can only be done in the form of order of magnitudes.

The observed shoreline movements are transformed into changes in sediment volume using geometric consideration. The response of a coastal profile to deposition/erosion may conceptually be either of the two sketched in Figure 6.12. The profile may either move with the shoreline without changing shape, i.e. the profile response is a translation (left panel of the figure). Alternatively, the response may be assumed to largest at the beach and the profile may be fixed at the depth of closure, i.e. a hinged response (right panel of the figure).

The change in volume associated with a shoreline change is calculated by the relation:

$$\Delta V = \eta * h_{act} * \Delta s * \Delta L$$

where η is a shape factor which depends on the assumed type of profile response. η=1 for a translation of the profile and η=0.5 for a hinged response. h_{act} is the active height of the beach, Δs is the horizontal change in shoreline position and ΔL is an alongshore length over which the shoreline change occurs.

It has been decided to assume a transitional response in this study because long term trends are identified in the observed shoreline movements. The transitional response is in such a case more realistic whereas the hinged response is more realistic for shoreline showing no clear long-term trend.



Figure 6.12: Conceptual calculation of change in profile volume for a given change in shoreline position. Left: Translation of coastal profile, shape factor = 1. Right: Hinged response, shape factor = 0.5.

Figure 6.13 shows the calculated annual transport rates across the beach profile. **A negative value indicates transport towards south**. It was found that the sediment transport mainly occurs in a narrow zone of approximately 40 0m from the waterline, where the water depth is approximately 3m. The annual sediment transport is directed towards south.

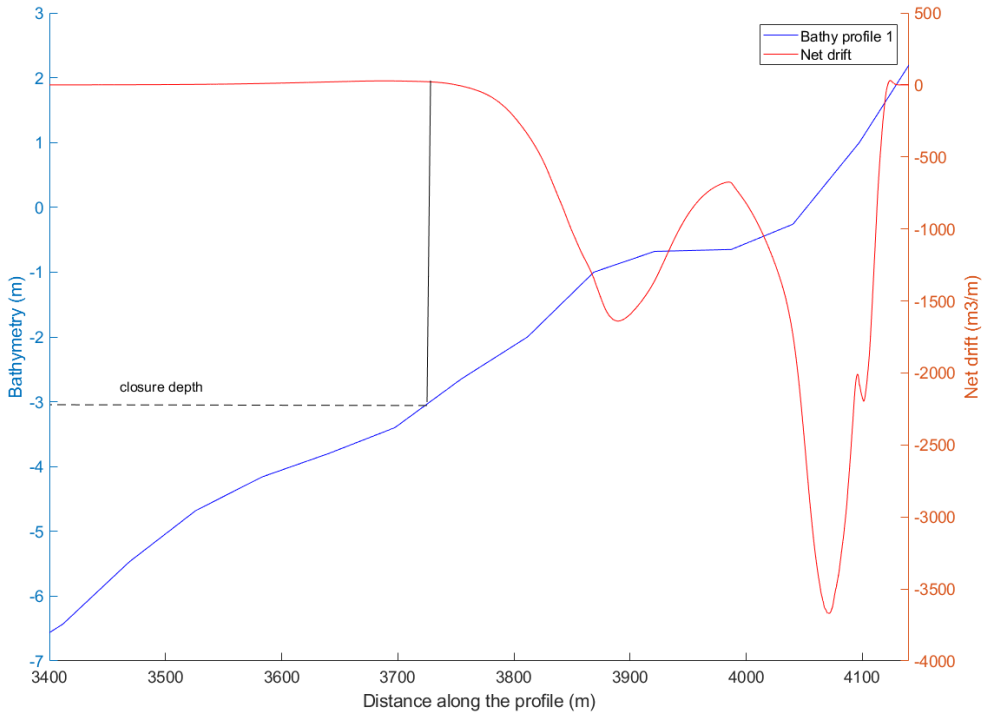


Figure 6.13: Line series of net littoral drift (blue line) and the cross-shore section at P1 (black line)

Based on modelling results, the closure depth is estimated to approximately -3 to -4 m CD both south and north of the port. The dry part of the beach has a berm which extends up to 2m CD. The active height of the coastal profiles is therefore estimated to 5 to 6 m. For example, a seaward shoreline movement of 10 m occurring along a 100 m section of the coast corresponds therefore to an accreting volume of 6,000m^3.

To be noted that previous studies have considered a 10 to 12m active height, mainly based on the observed beach slope variation along the profile (/11/).

The volume change for each of the observed shoreline movements (2006, 2009, 2012 and 2016) were calculated, for the different active heights. Those values were then compared to the accumulated sediment transport calculated from the LITDRIFT modelling for the period 2007 and 2016.



Figure 6.14: Satellite image of the shoreline accretion north of the port.

The areas represented in orange, blue and green correspond to the accumulated sediment surface respectively between 2006 and 2009, 2009 and 2012, and between 2012 and 2016.

From the measurement, the averaged southward littoral drift can vary from 300 000 m^3/year to 500 000m^3/year for an active depth of 5m to 6m, and up to 800 000 m^3/year to 1 000 000 m^3/year, for an active depth of 10m. Therefore, the result is highly dependent on the active height. Previous studies indicate a southward littoral drift of 700 000m^3 to 1 000 000m^3 per years (/11/)

The model estimates a lower rate of about 260 000m^3/year (see Figure 6.15).

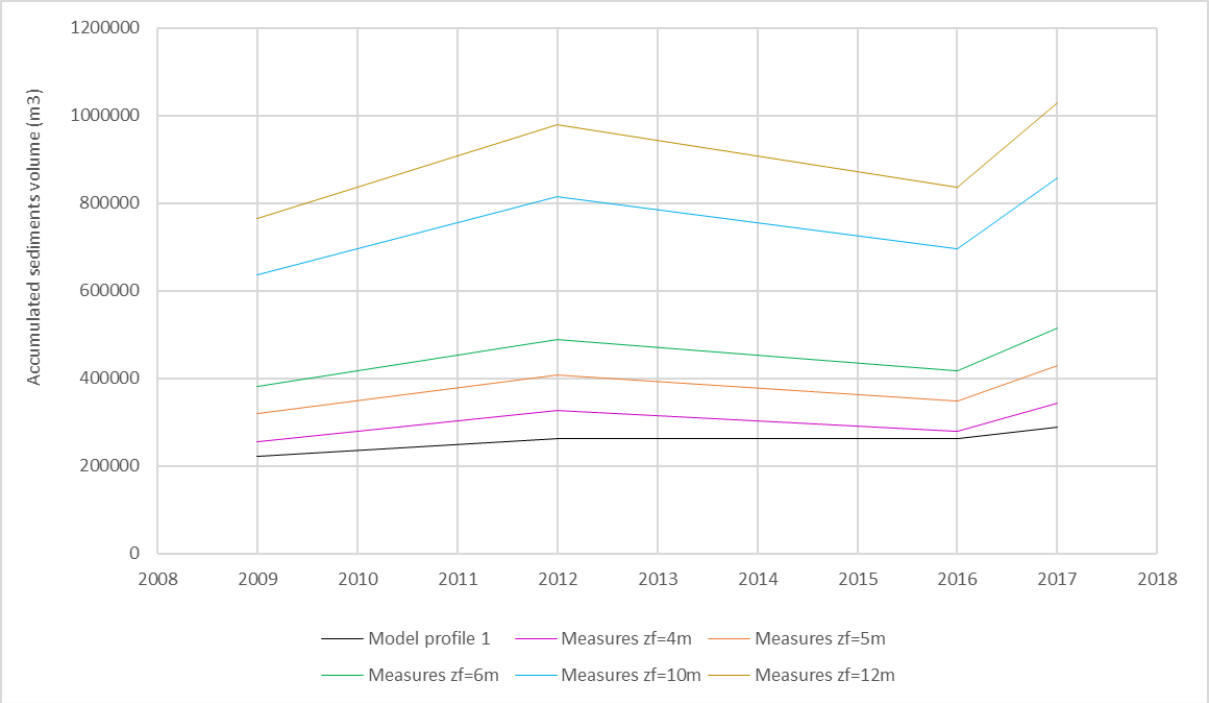


Figure 6.16: Comparison of sediments accumulation volumes per year, deduced from measurement and calculated (black line)

While the littoral drift variation is well represented by the model, it seems to tend to underpredict the littoral drift intensity. As main factor for the littoral drift generation, a correct wave representation is essential to accurately calculated the sediment transport. In the absence of recent local wave measurement, the hindcast wave model has not been validated yet and one cannot conclude if the low calculated littoral drift, compared to observation is due to the representation of the wave climate. Other parameters could be of consideration, such as the wind induced sand transport, or the representation of the local sea wind generation (Seabreeze effect). In order to account for this potential underprediction of the littoral drift intensity, the shoreline evolution model (LITLINE) will be calibrated accordingly.

Sensitivity to changes in shoreline orientation

As highlighted previously, the longshore transport is highly sensitive to the orientation of the shoreline normal. A change in the shoreline normal will affect the angle between the approaching waves and the shoreline normal, which is one of the key parameters for longshore sediment transport. This is illustrated in, in which a coastline is shown for two different shoreline orientations. Waves are in both cases approaching the shoreline from east. The beach in the left panel has a shoreline normal towards south-east which causes longshore transport towards south (indicated by the blue arrow). The shoreline normal in the right panel is oriented towards north-east, which causes transport towards north (indicated by the blue arrow).

Changes to shoreline orientation occur naturally in response to seasonal variations in the wave climate and in response to long term trends in erosion/deposition. The shoreline orientation will in particular change if changes to the upstream sediment supply changes. e.g. if sediment is blocked at a point along the shoreline, then the downstream shoreline will turn up against the predominant waves such that the

longshore transport on the downstream beach is also zero. Estimates of the equilibrium orientation of a shoreline may be calculated by use of numerical models, in which the annual longshore transport is calculated for different orientations of a shoreline. The calculated longshore transport is then shown as function of the shoreline orientation thus forming a so-called Q-α curve.

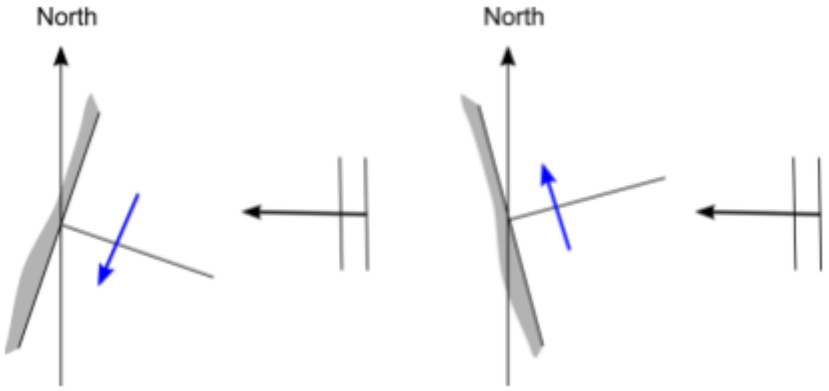


Figure 6.17: Illustration which shows that changes in shoreline orientation will affect the longshore transport. The direction of the longshore transport is indicated by the blue arrow and the waves are in both cases approaching from East as indicate with the black wave annotation.

For example, the shoreline normal orientation for profile P1 is about 275°N while it is about 283°N for profile P2 for a rather similar wave direction (see Figure 6.18). This results in a reduction of the southward littoral drift orientation. Figure 6.19 presents the accumulated littoral drift calculated for the period 2007-2016 for the two profiles P1 and P2. It illustrates the above described littoral drift intensity reduction due to the shoreline orientation variation.

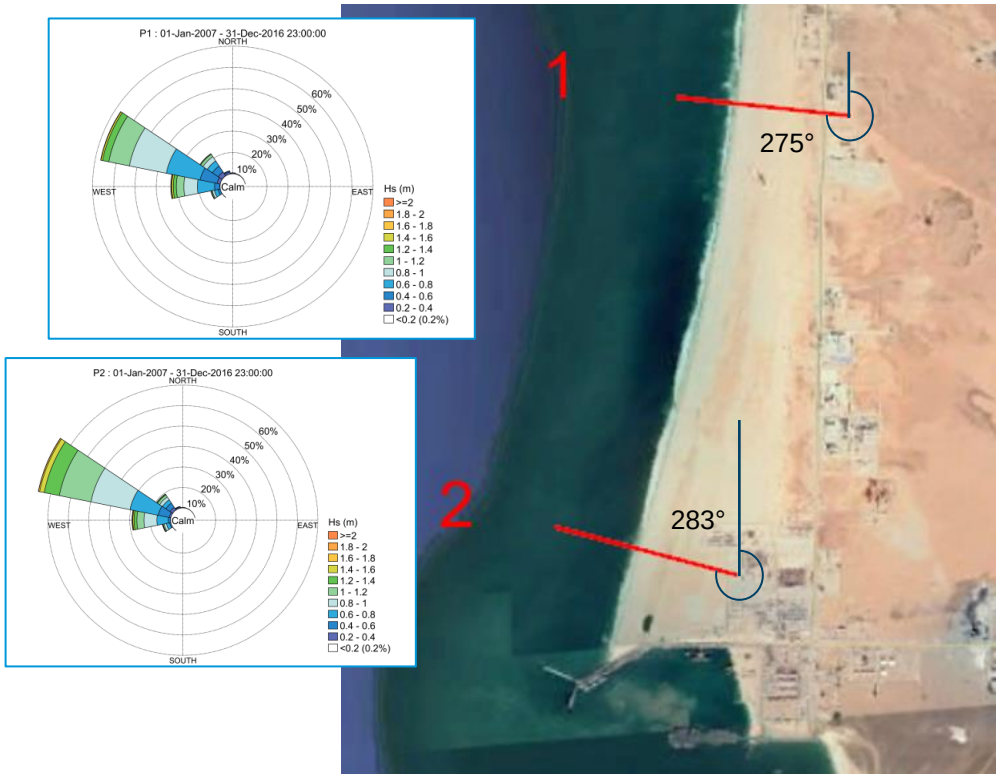


Figure 6.18: Orientation of profile1 and profile 2

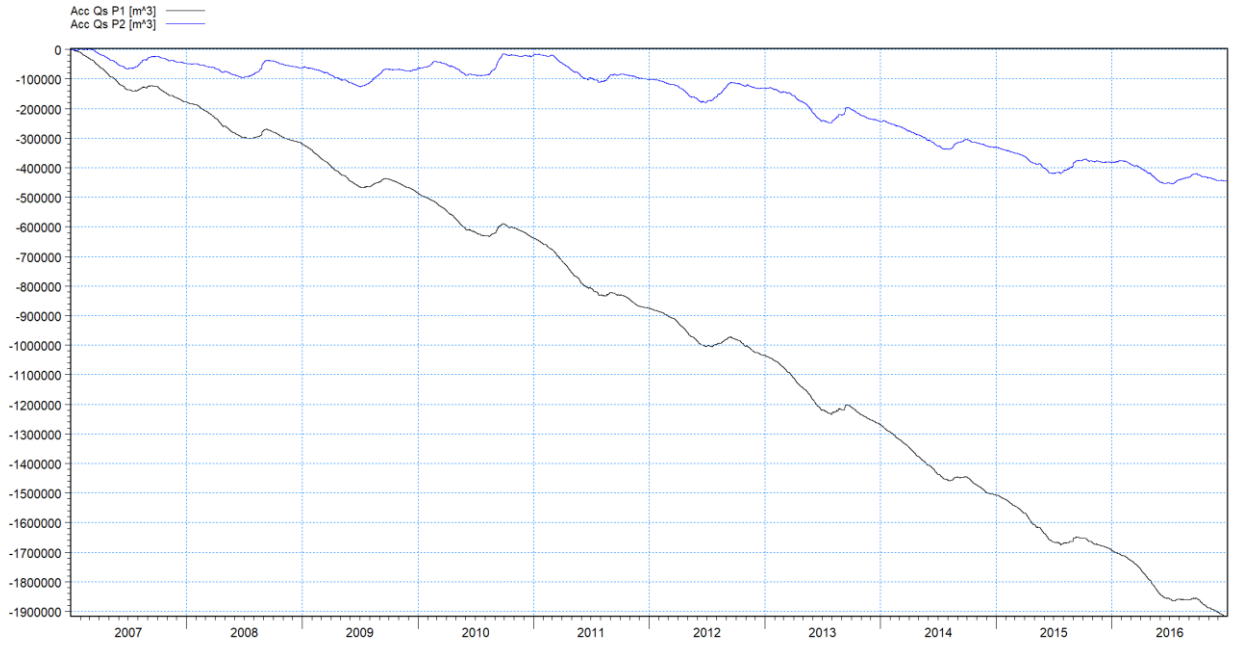


Figure 6.19: Sediment transport capacity in function of time for profile 1 and 2 (Q(t) curves)

The influence of the shoreline orientation was therefore evaluated. To this end, additional simulations were run in which various shoreline orientation were considered. Results are presented in the figure below for profiles 1 and 2.

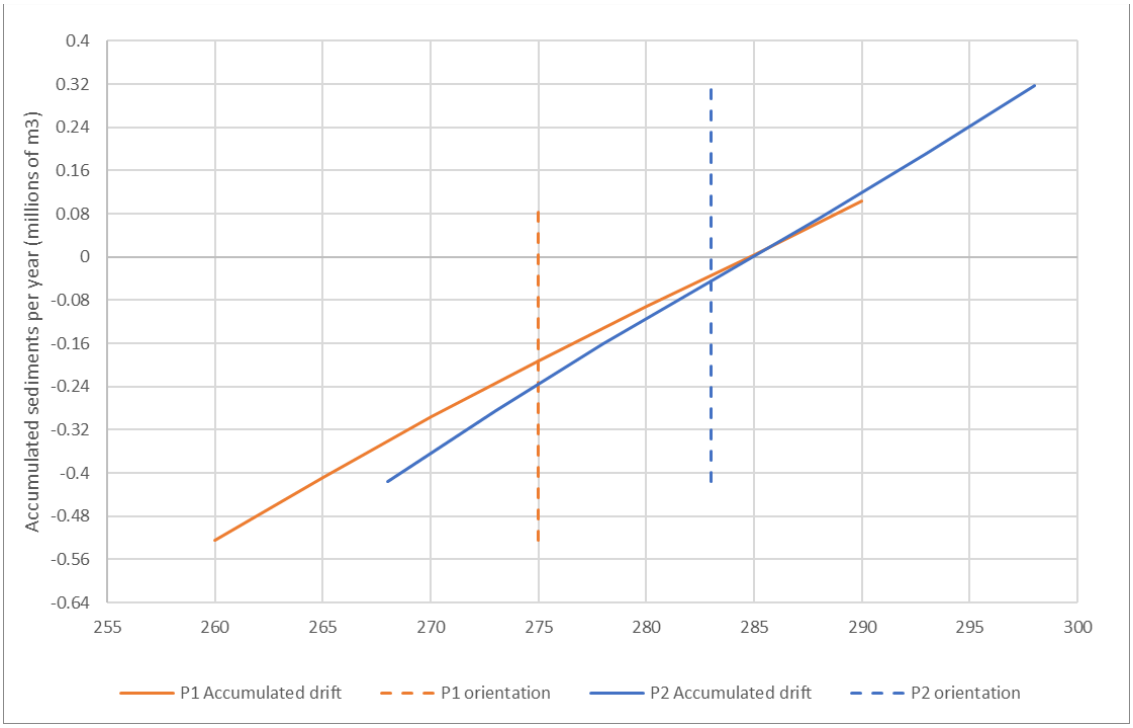


Figure 6.20: Mean sediment transport capacity per year in function of the shoreline orientation (Q-α curve).

To be noted that for a shoreline orientation of 265°N to 270°N, representative of the shoreline orientation north of the Wharf, the calculated littoral drift is about 400 000m^3.

Annual and monthly variation of the littoral drift

The annual variation of the northward and southward components of the littoral drift are presented on the figure below. It shows a relatively regular rate of transport over the years with a relatively limited variability over the years.

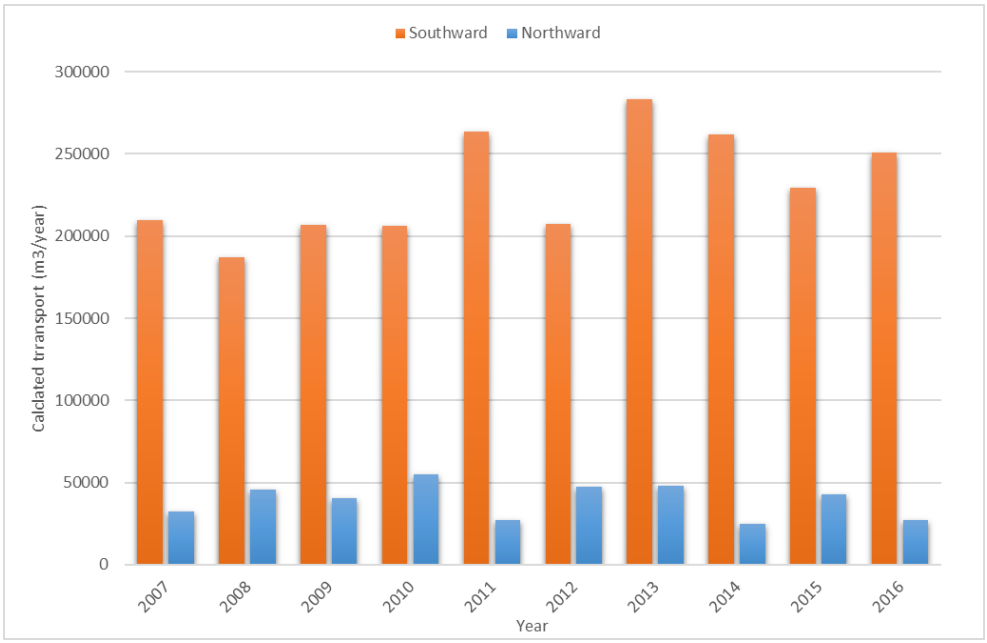


Figure 6.21: Annual variability of the littoral drift.

The monthly variations of the littoral drift are presented on the figure below. It shows a maximum of southward transport in spring and net reduction in summer. The littoral drift is oriented northward during the in August and September.

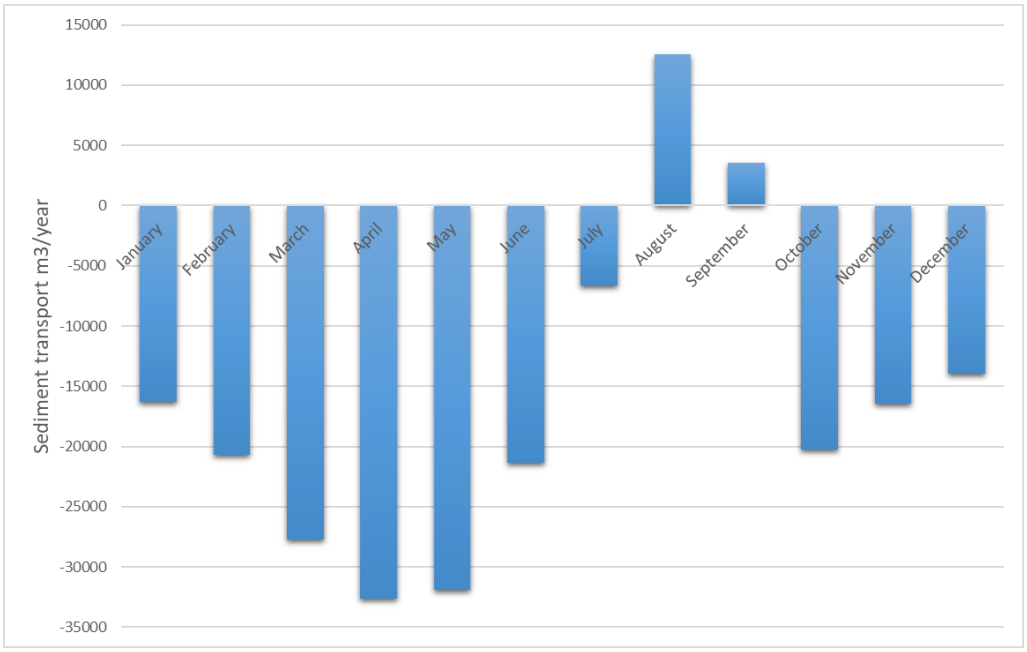


Figure 6.22: Monthly variability of the littoral drift (calculated over the period 2007-2016)

Impact of the northern jetty

North of the port, the length of the groyne is around 500 meters. Thus, the tip of the structure extends beyond the area where the sediments are drifting along the shoreline and consequently, the jetty blocks most of the littoral transport and the bypass area near the offshore edge is limited. based on the available information, no dredging operation for the channel depth maintenance is required. This is therefore in agreement with the above comment

Further analyses is however required to link the potential bypass of sediment and the shoreline accretion north of the port.

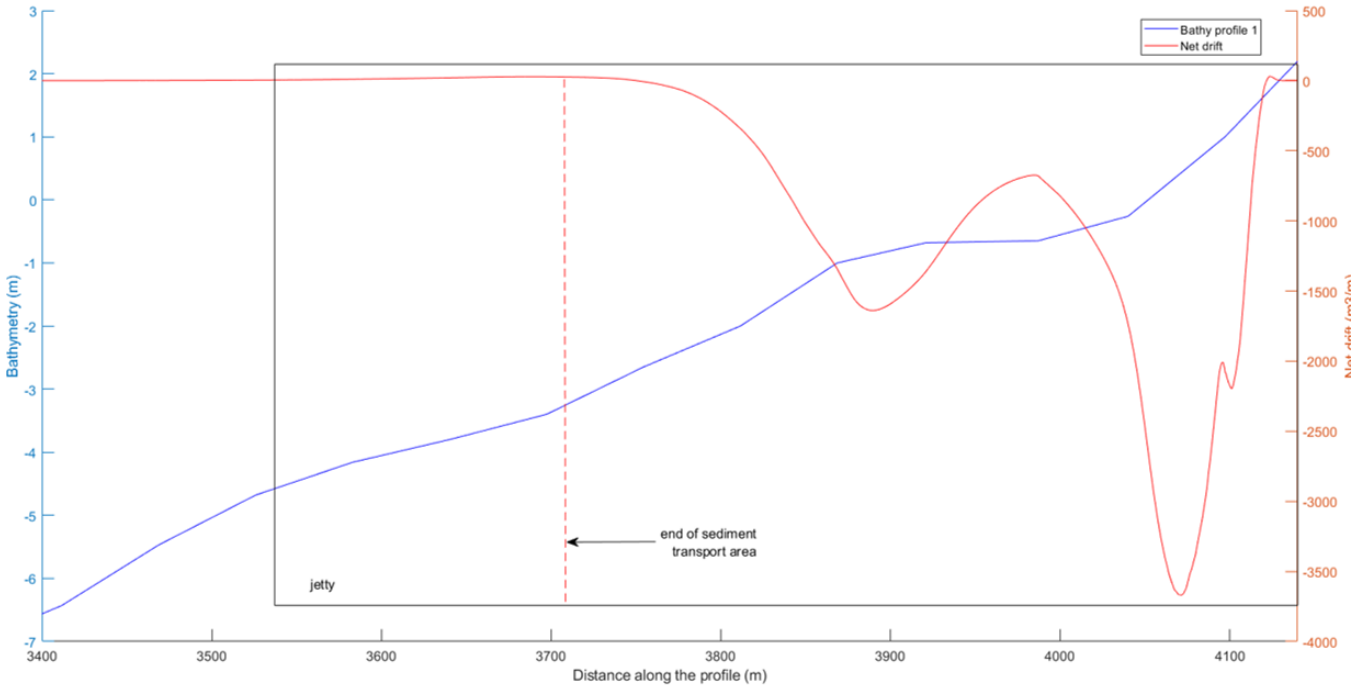


Figure 6.23: Comparison of the groyne extend compared to seaward extend of the calculated littoral drift

Littoral drift south of the port

In the same way as beforehand, coastlines in 2006, 2009, 2012 and 2016 south of the port have been digitalized and sediments accumulating volumes per year were estimated and then compared with the model.



Figure 6.24: Satellite image of the coastline situated south of the port.

The areas represented in red, green and blue correspond to the accumulated sediment surface respectively between 2006 and 2009, 2009 and 2012, and between 2012 and 2016.

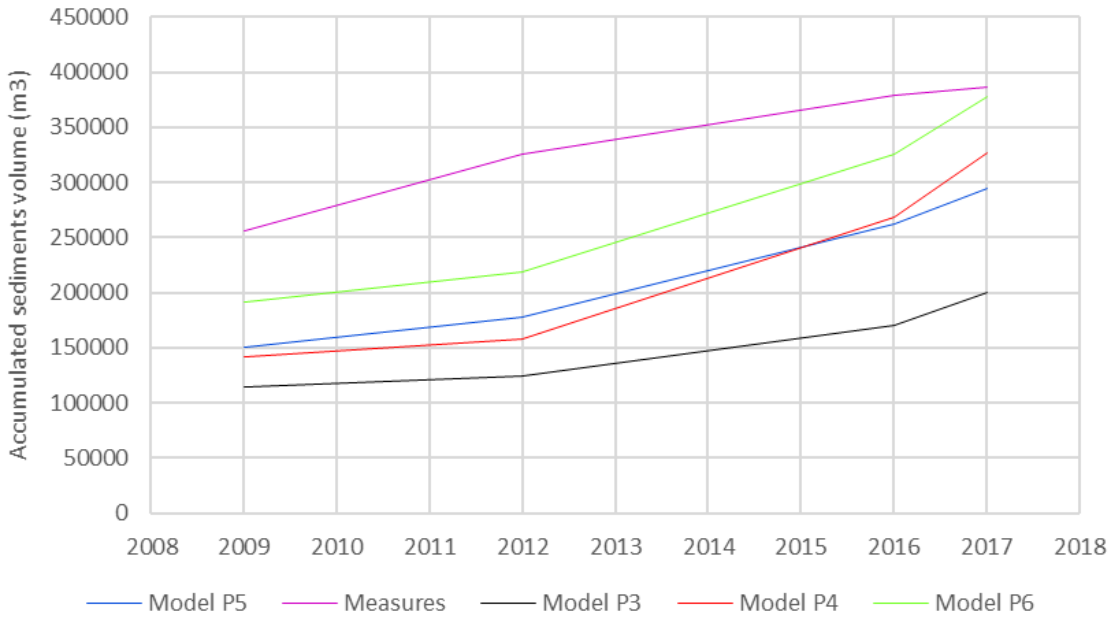


Figure 6.25: Comparison of sediments accumulation volumes per year, deduced from measurement (pink line) and calculated

For the shoreline evolution model, Profile 4 is then chosen as representative of the cross-shore profile along the beach south of the port.

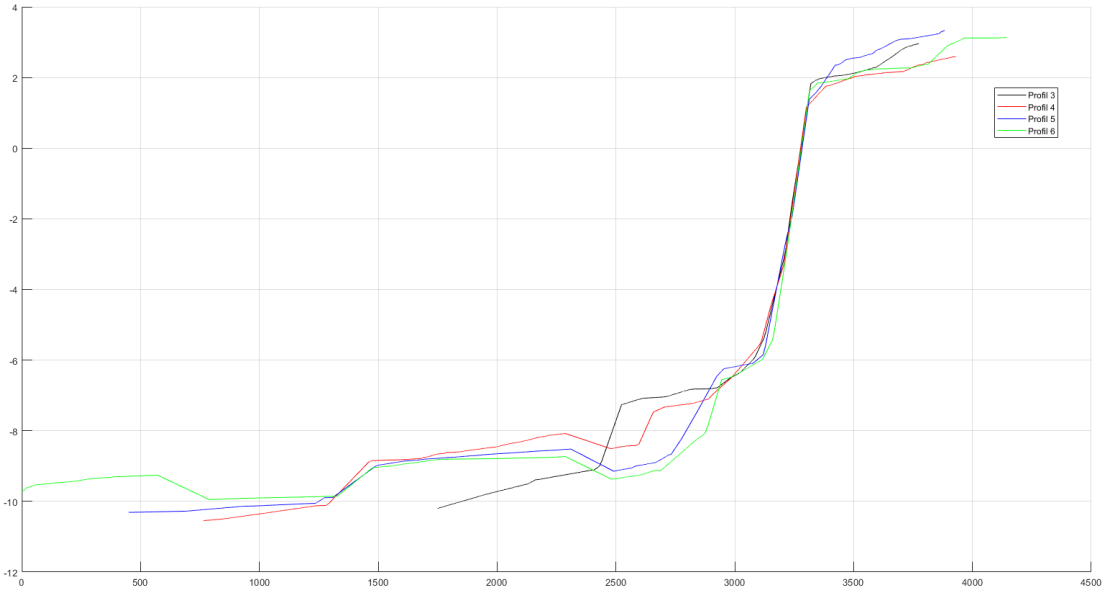


Figure 6.26: Superposition of the 4 profiles south of the port

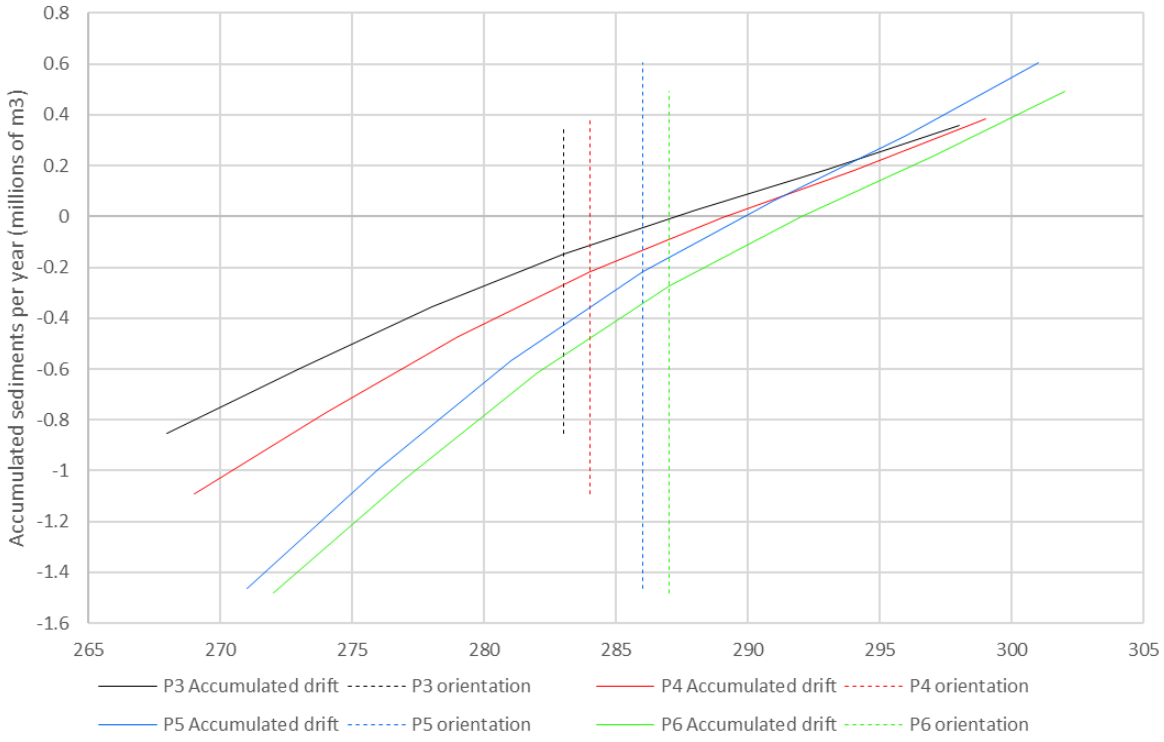


Figure 6.27: Mean sediment transport capacity per year in function of the coastline orientation (Q-α curve)
The time span taken for the simulation was 10 years (between 2007 and 2016)

6.3 Coastline evolution modelling – south of the port

In order to evaluate the potential impact of the port extension project, the modelling of the shoreline evolution south of the port was carried out with the dedicated Littoral Processes FM model called LITLINE The model was calibrated and attested to compute and evaluate the shoreline evolution in the long run.

6.3.1 The morphological model – LITLINE

LITLINE calculates the coastline position from wave climate time series included among input parameters. Sediment fluxes are computed as tables for each study area profiles in function of the water level and waves characteristics (period, height and direction). Several structures types can be considered in the model set up such as jetties, groynes or break-waters. Sources and leaks sediments can also be included in the model. More information about LITLINE model are available on the website: https://www.mikepoweredbydhi.com/products/litpack

Model settings

As for LITDRIFT, waves conditions are extracted from wave propagation simulation with the model MIKE 21 SW. The time series are interpolated along the study areas to get wave conditions in each coastline point.

The shoreline is discretised with a spatial resolution of 25m. The shoreline used for the calibration of the model south of the port is stretching over 8500 meters. This area fits the sediment erosions area after the construction of the harbour. Calculation parameters such as the bed roughness or the wave model are identical to those used for the sediment transport study with LITDRIFT.

6.3.2 Calibration and validation: existing case

As for LITDRIFT, morphological model calibration is realised from historical data of coastline position. The wave hindcast data covering the period 2007-2016, the model calibration was performed for the periods:

- 2008-2011: before the construction f the southern breakwater;
- 2012-2015: in the presence of the southern breakwater.

A model validation was then performed considering the periods 2006-2011 and 2012-2019. As per details in section 6.2.2, the inter-annual variation of the littoral drift is limited. Therefore, the wave data time series for the extended periods of validation were constructed based on the hindcast data. The wave climate is interpolated for each shoreline node to acquire a distribution of waves heights, periods, direction etc… along the study area.

Figure 6.28 to Figure 6.31 present the model calibration and validation results. They show a relatively good capability of the calibrated model to represent the shoreline evolution over several years,

To be noted that near the southern breakwater and the northern jetty, the capacity of this one-line model is limited to correctly represent the shadowing areas effect induced by this Maritimes structures. Therefore, differences between observed shoreline and predicted shoreline are logically obtained. However, the general impact of the structures on the shoreline impact is correctly represented:

- Between the port and the breakwater: a relative stability of the beach;
- South of the breakwater: an increase of the existing erosion rate.

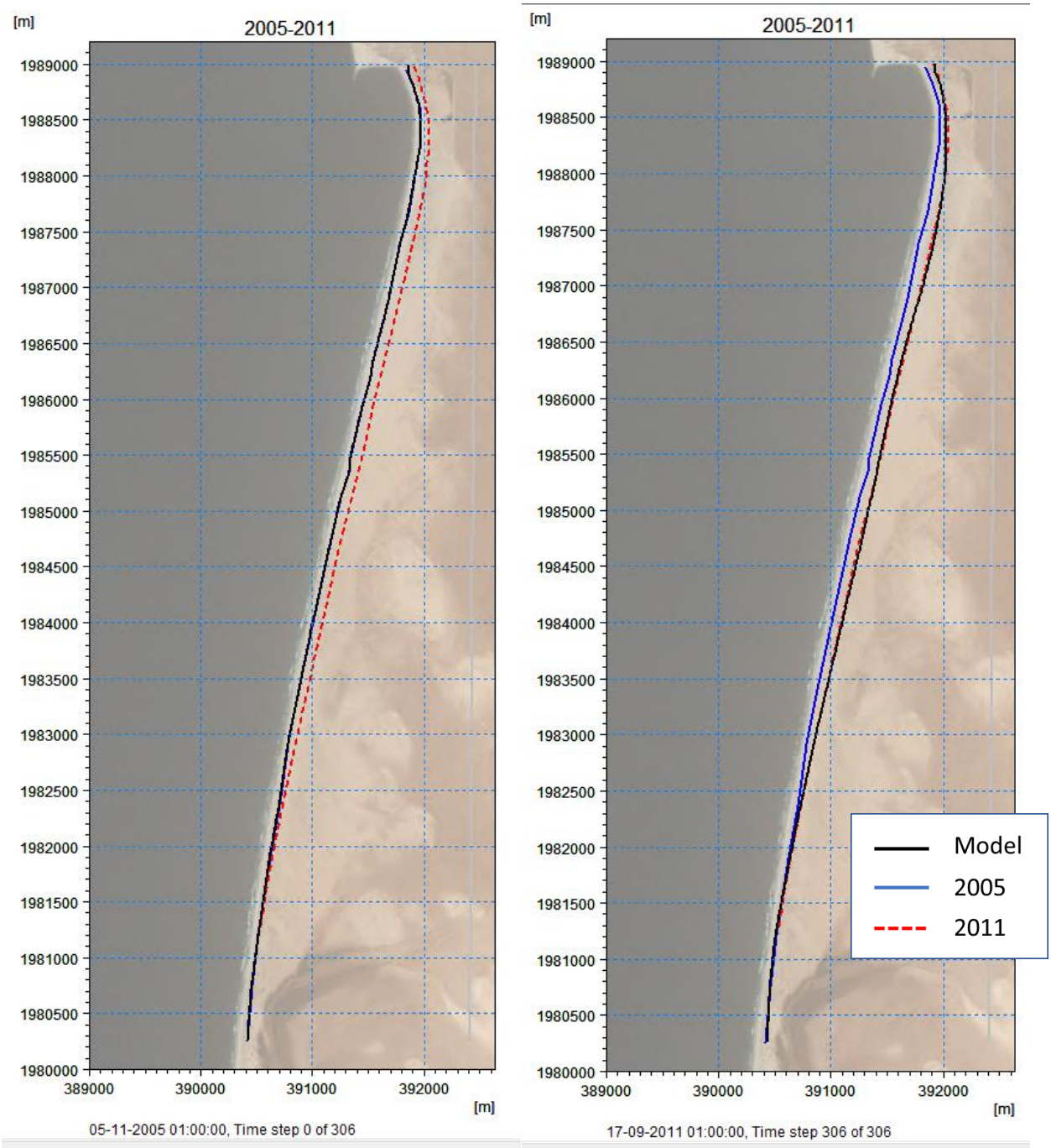


Figure 6.28: Model validation – period 2005-2011: initial (left) and final position of the modelled shoreline (right) for the period 2005-2011. Measured shoreline position in 2005 (blue line) and 2011 (red dots)

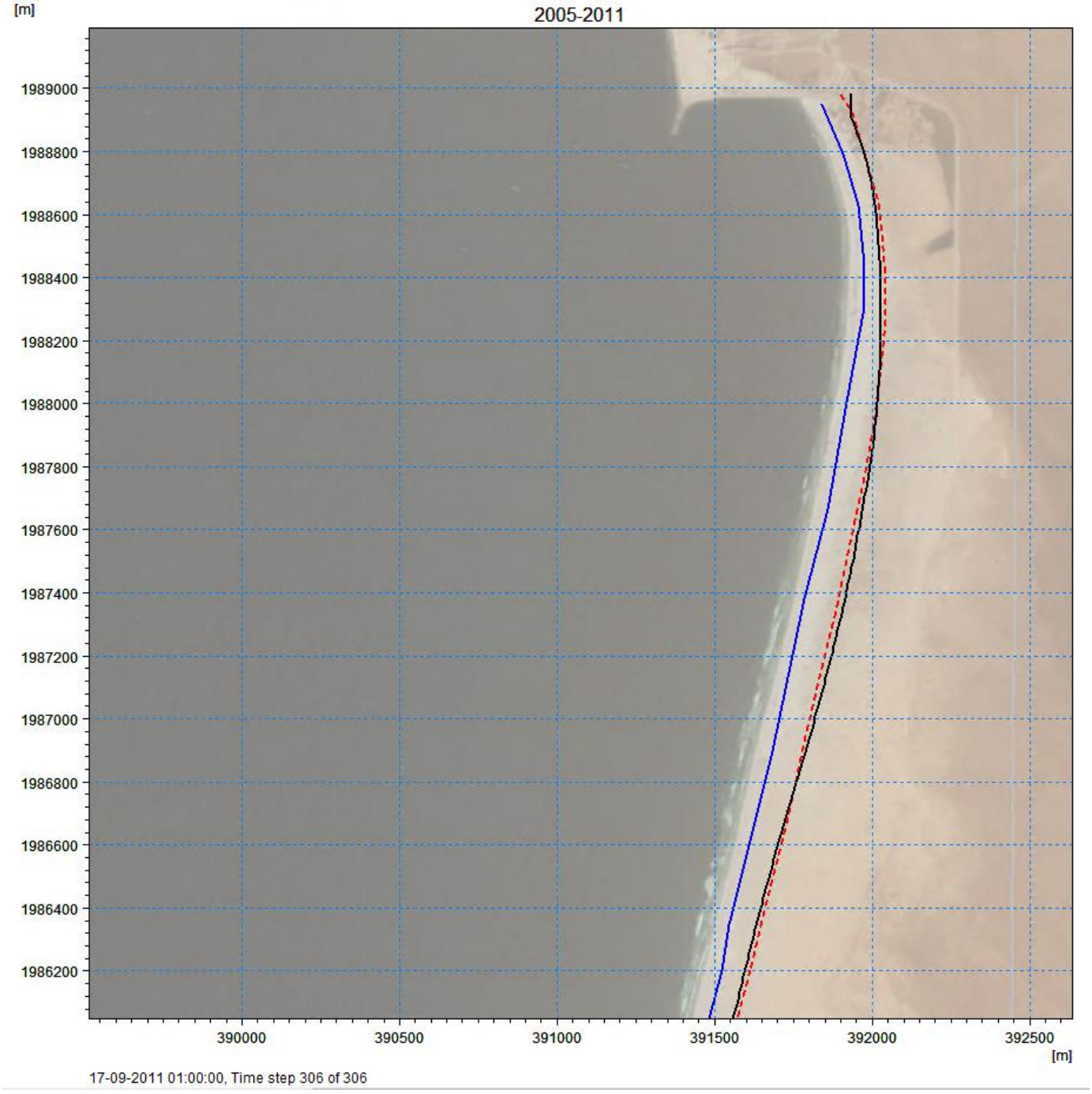


Figure 6.29: Model validation – period 2005-2011 – zoom near the port area: final position of the modelled shoreline. Measured shoreline position in 2005 (blue line) and 2011 (red dots)

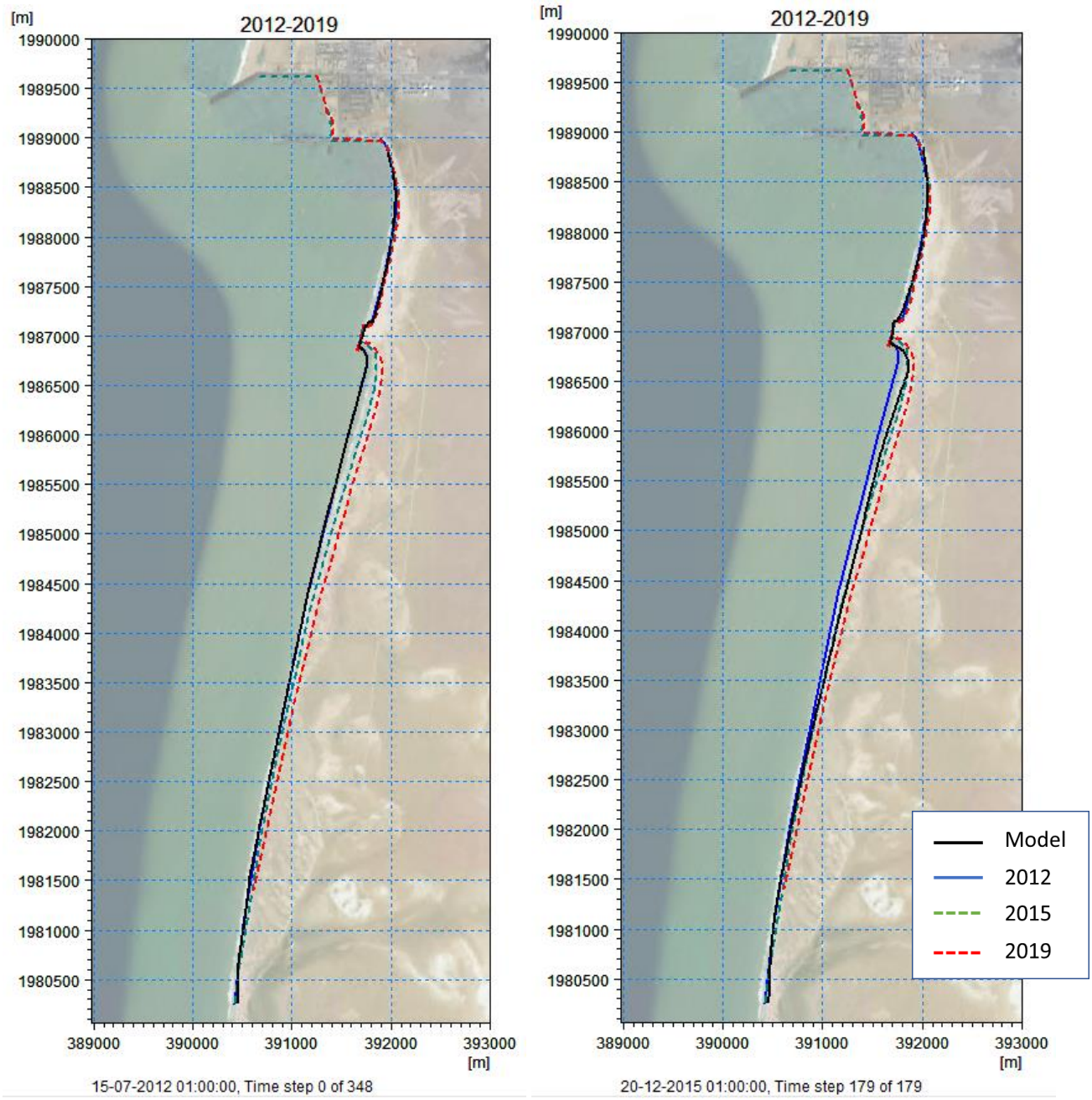


Figure 6.30: Model validation – period 2012-2019: initial (left) and intermediate position (2015 - right) of the modelled shoreline position. Measured shoreline position in 2012 (blue line), 2015 (green dots) and 2019 (red dots)

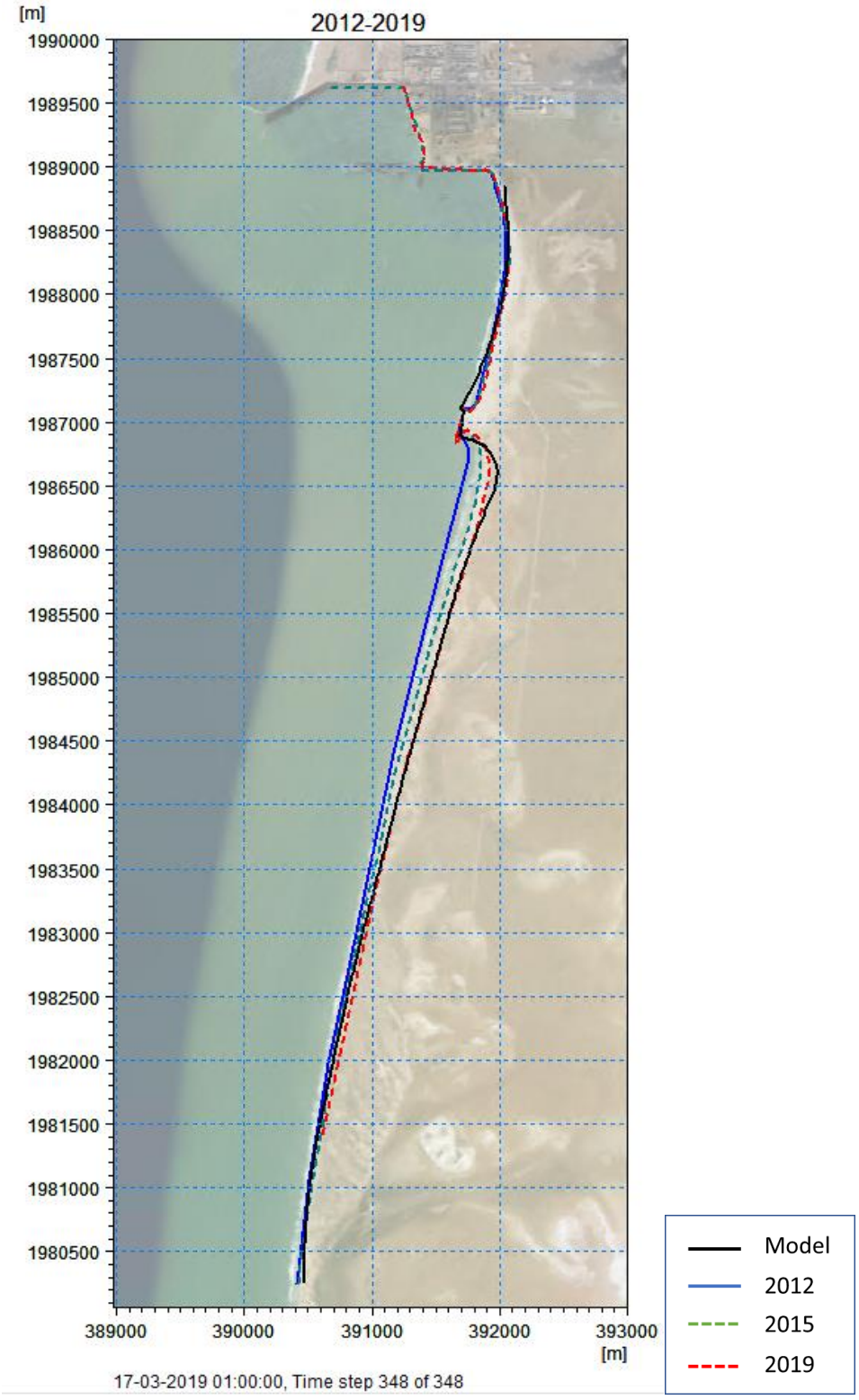


Figure 6.31: Model validation – period 2012-2019: final position (2019) of the modelled shoreline position. Measured shoreline position in 2012 (blue line), 2015 (green dots) and 2019 (red dots)

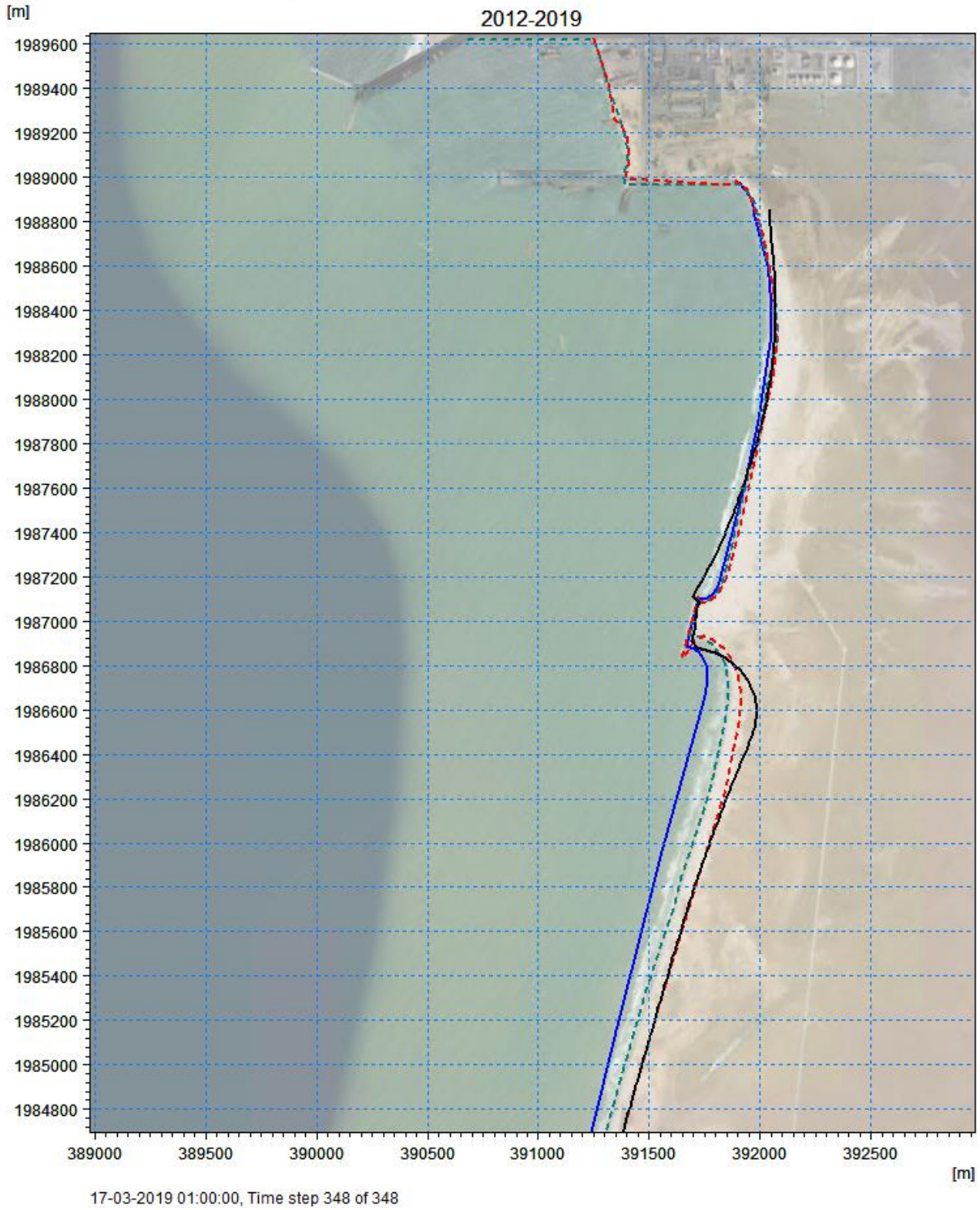


Figure 6.32: Model validation – zoom on the area near the port– period 2012-2019: final position (2019) of the modelled shoreline position. Measured shoreline position in 2012 (blue line), 2015 (green dots) and 2019 (red dots)

6.3.3 Project impact on the shoreline evolution

To evaluate the impact of the project on the shoreline evolution, the model was run for a 10-year period (say 2019-2028), considering the 2019 initial shoreline position. The hindcast wave data were considered as input. For the project case, the hindcast wave data integrates the influence of the bathymetry change (channel depth) on the wave propagation.

The modelling results of the shoreline evolution model are presented in Figure 6.34 to Figure 6.36. Erosion is predicted south of the breakwater while the erosion north of the breakwater is limited.

The model predicts an erosion just south of the port but as explained, the capacity of this one-line model to represent properly the shadowing effect (especially the wave diffraction effect) is limited. Therefore, the result for this specific area should be considered with caution.

The graphs below present the shoreline evolution compared to the initial position in 2019. The beach erosion south of the breakwater is about 150 to 200m (erosion rate of 15 to 20m/an), while, on average, the beach between the port and the breakwater is relatively stable.

The difference of shoreline position, for the final position (2028), between the project case and the present case indicates a maximum of -16m at the alongshore position 4000m. This indicates that the erosion in the project case, is increased by -a maximum of 16m after 10 years, compared to the present case. Further south (position 5350m), the erosion rate is reduced by about 1.4m/an compared to the present case. It can be noted that south of the breakwater (position 2000m to 2800m), the erosion rate is reduced by up to 0.5m/year.

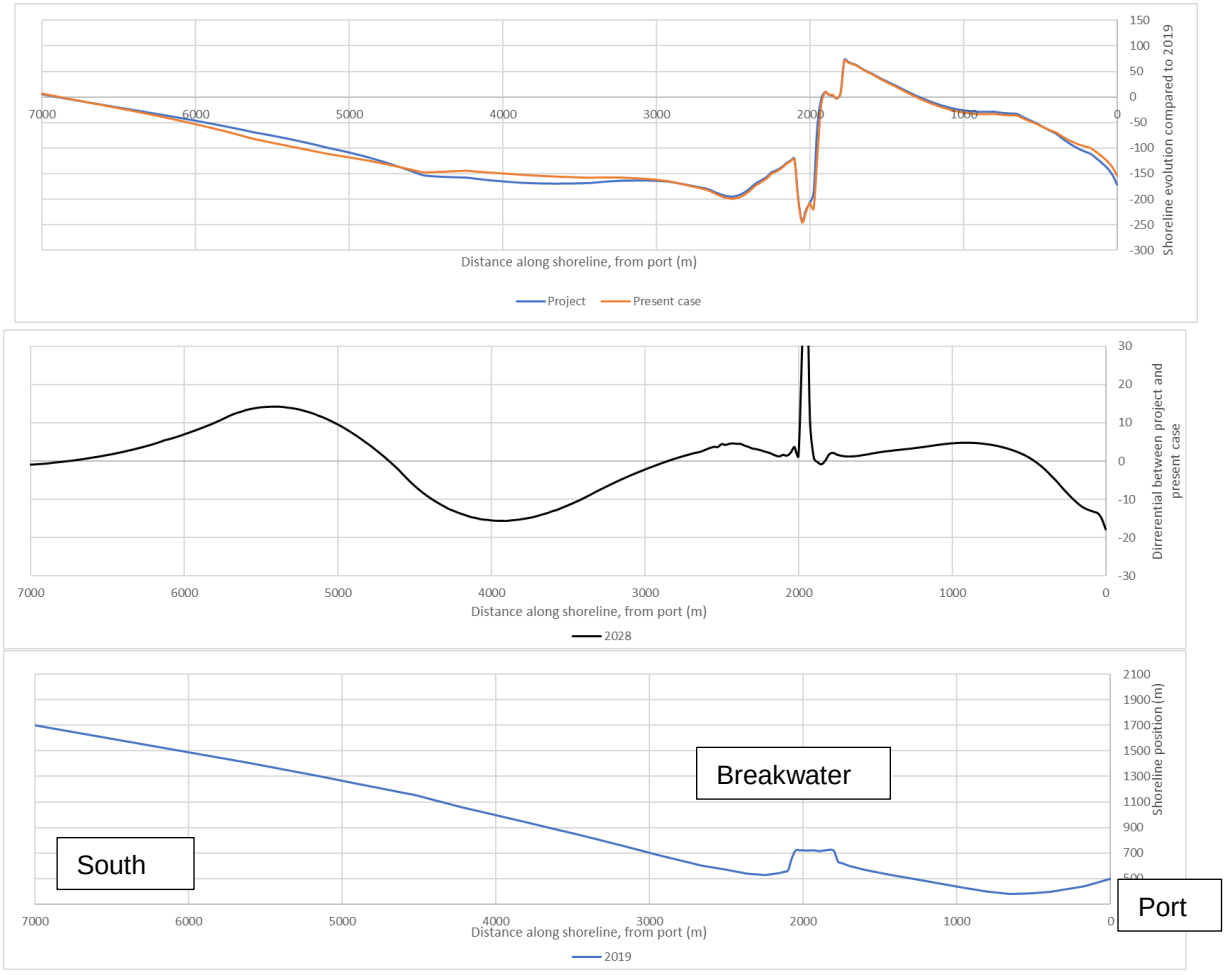


Figure 6.33: Comparison of beach evolution for project and present case

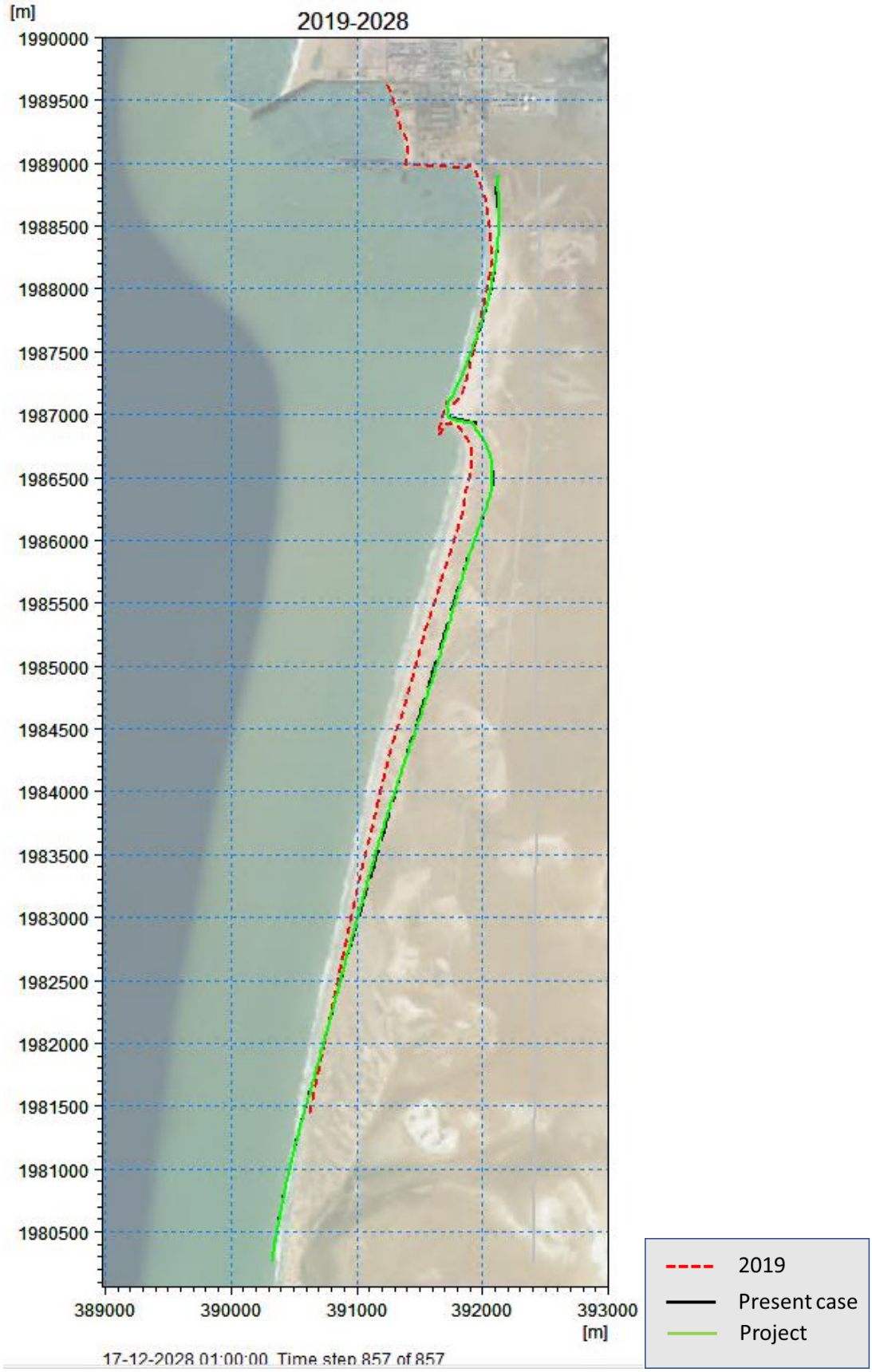


Figure 6.34: 10 year shoreline evolution simulation: comparison of shoreline evolution for the project case (green line) and the present case (dashed black) –: initial position 2019 (dashed red)

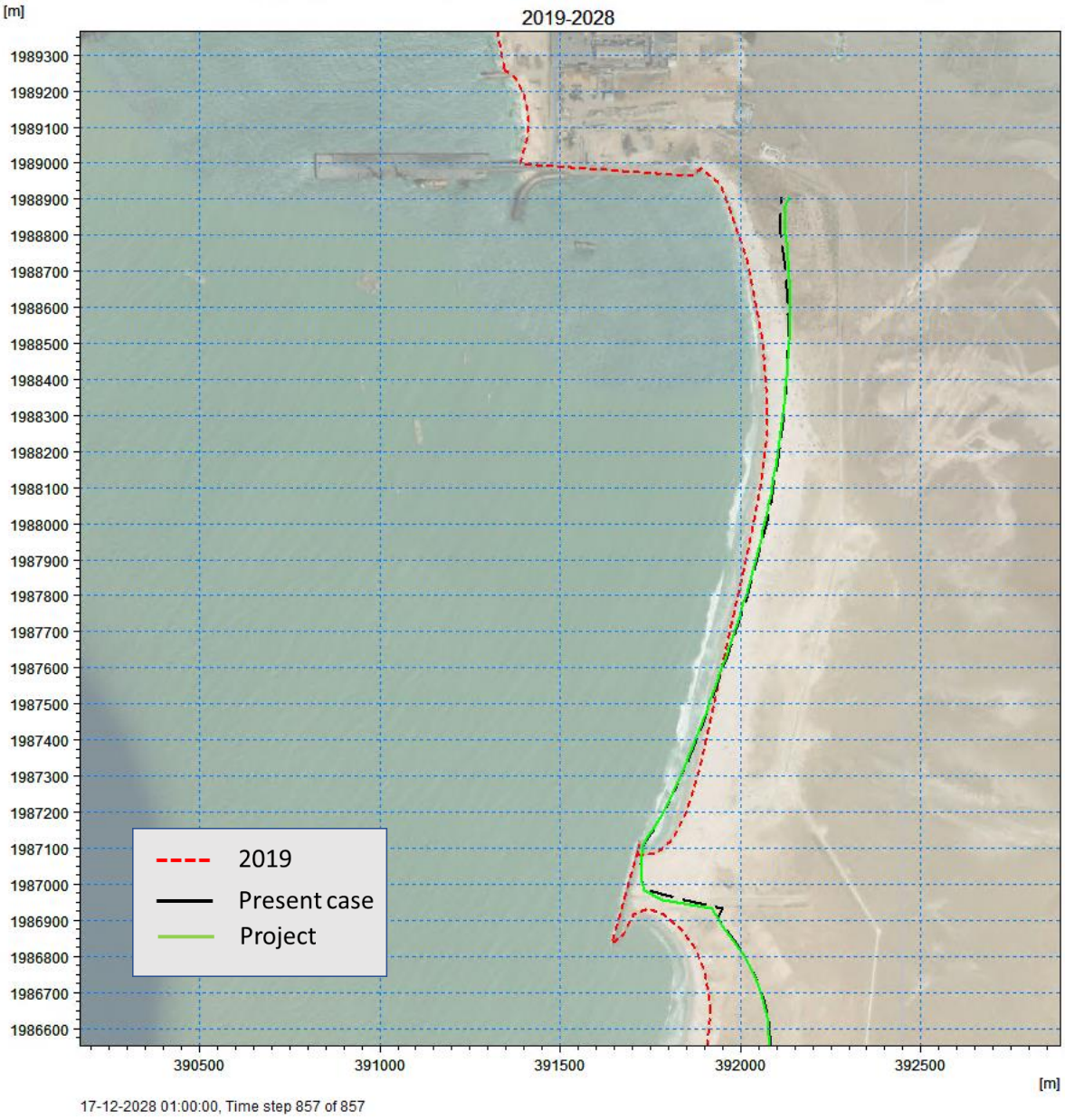


Figure 6.35: 10-year shoreline evolution simulation- zoom near the port- comparison of shoreline evolution for the project case (green line) and the present case (dashed black) –: initial position 2019 (dashed red)

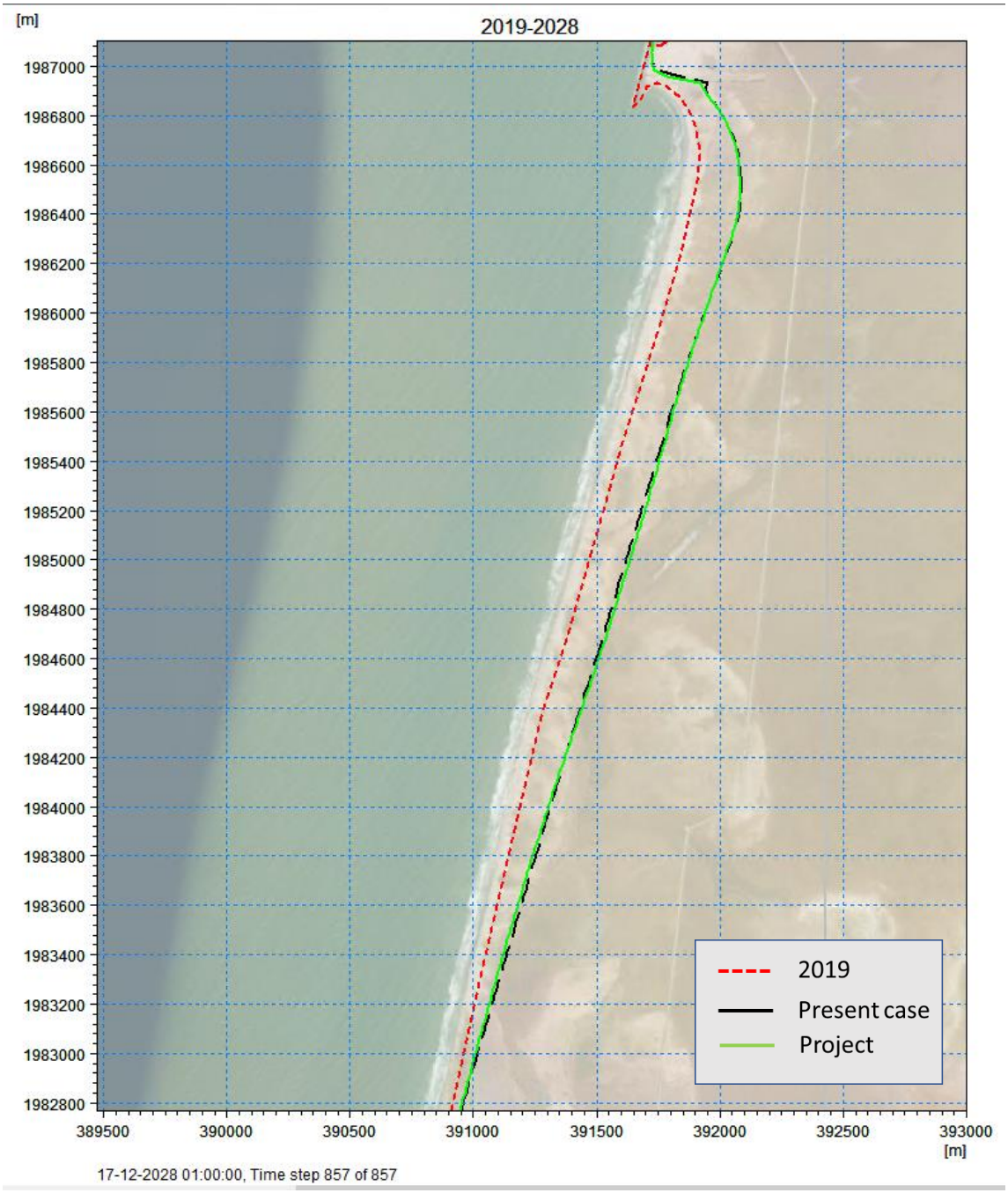


Figure 6.36: 10-year shoreline evolution simulation- zoom south of the breakwater - comparison of shoreline evolution for the project case (green line) and the present case (dashed black) –: initial position 2019 (dashed red)

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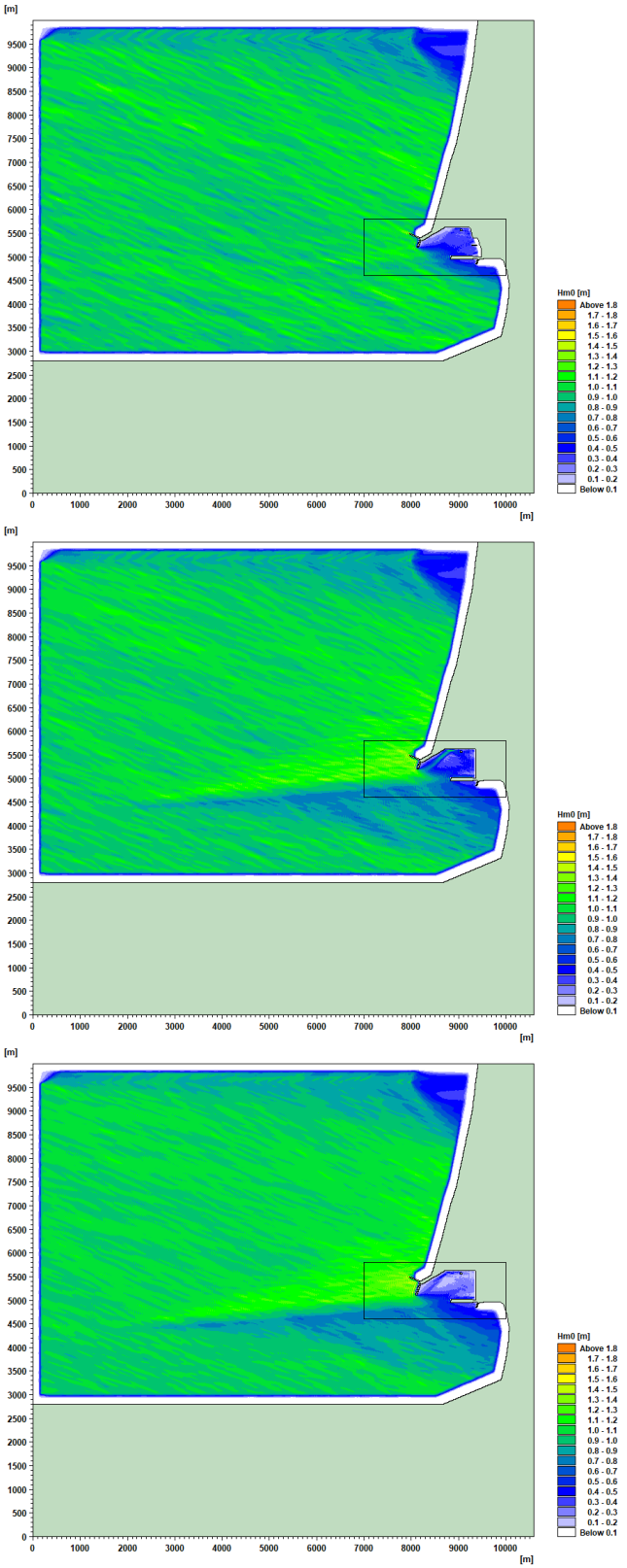
APPENDICES

APPENDIX A – Wave Disturbance Modelling Results

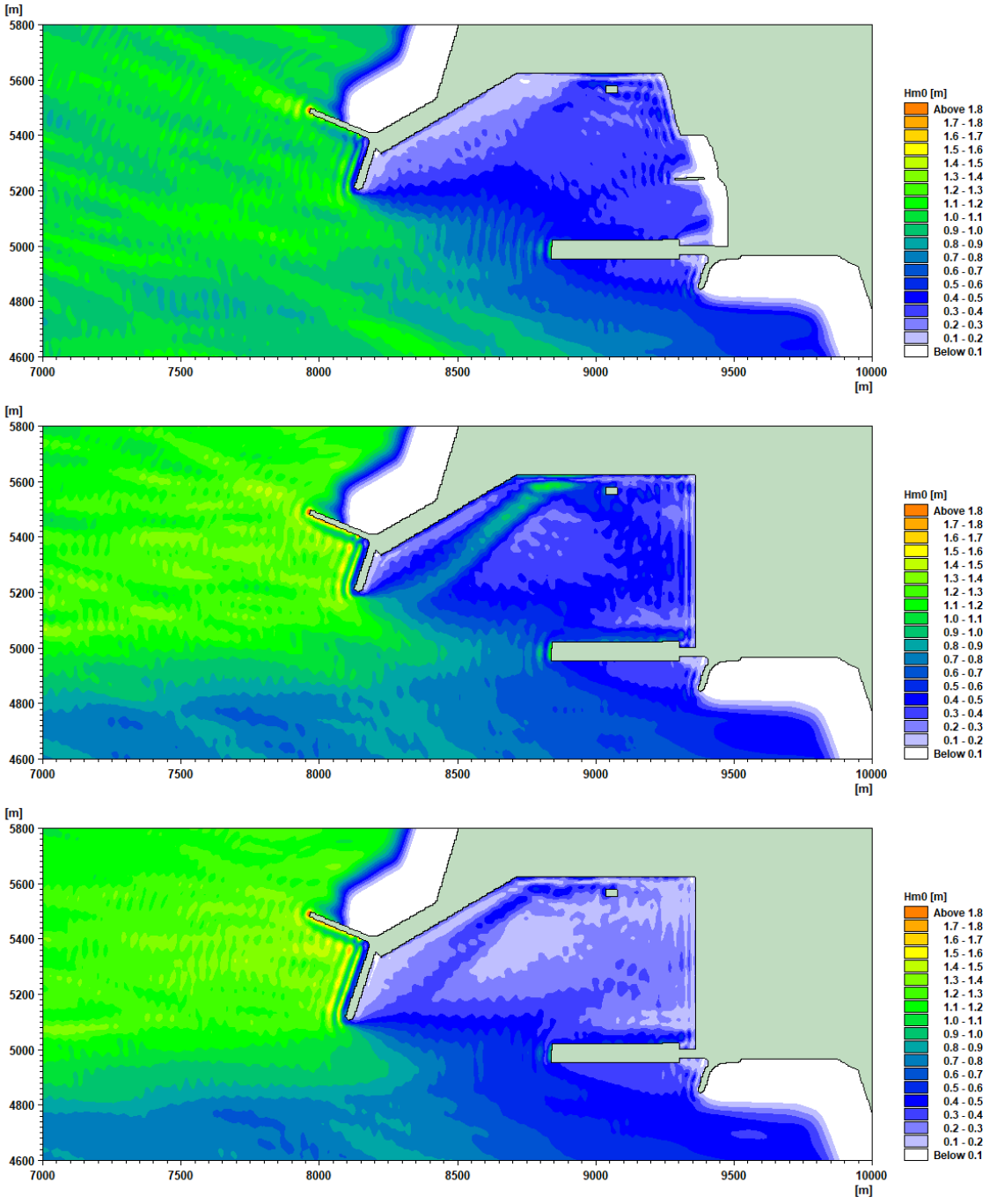
A Wave Disturbance Modelling Results

A.1 Wave Condition N°1 : Tp = 8 s ; MWD = 292.5°N ; WL = 1.7 m LAT

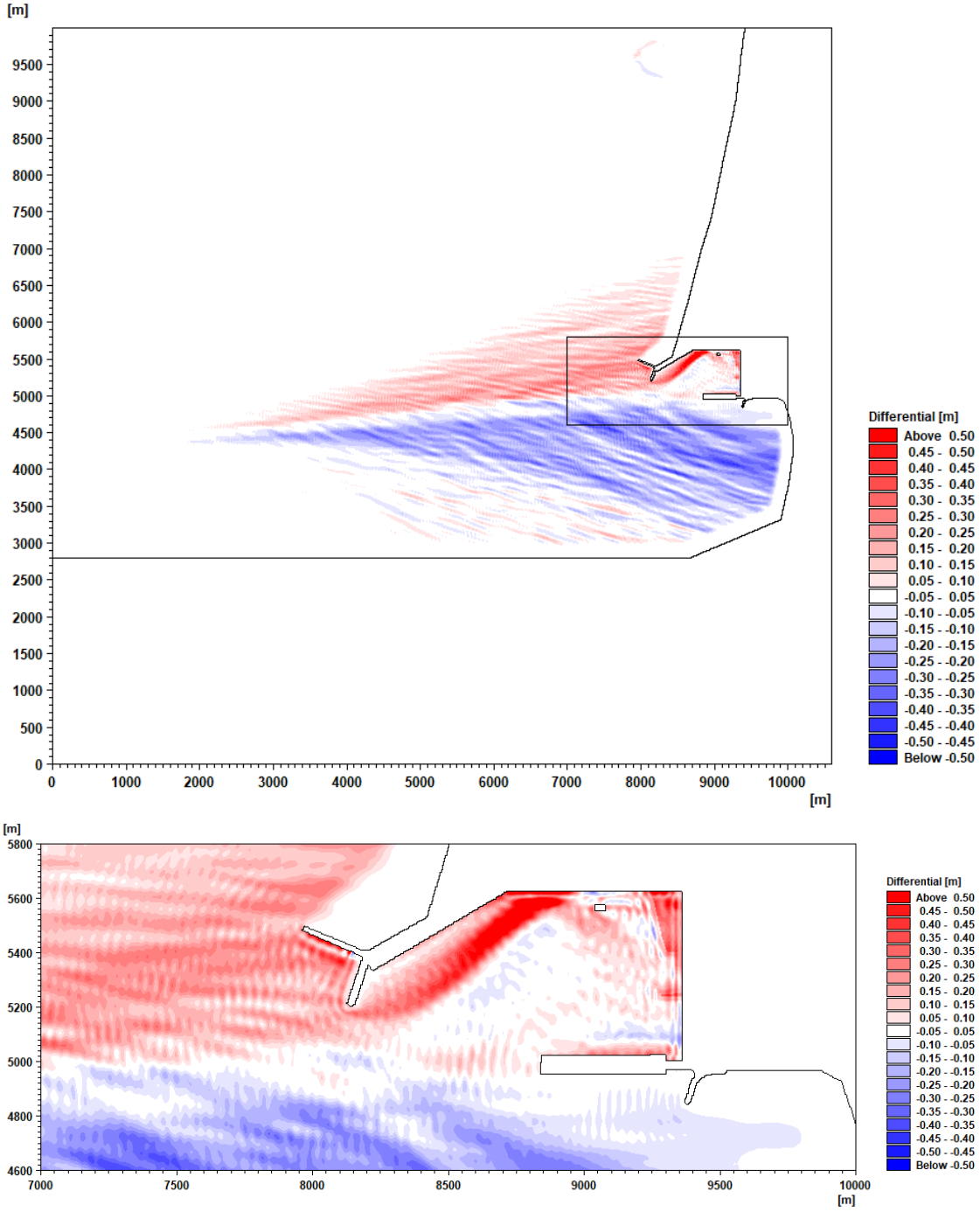
A.1.1 H_{m0} in the model domain



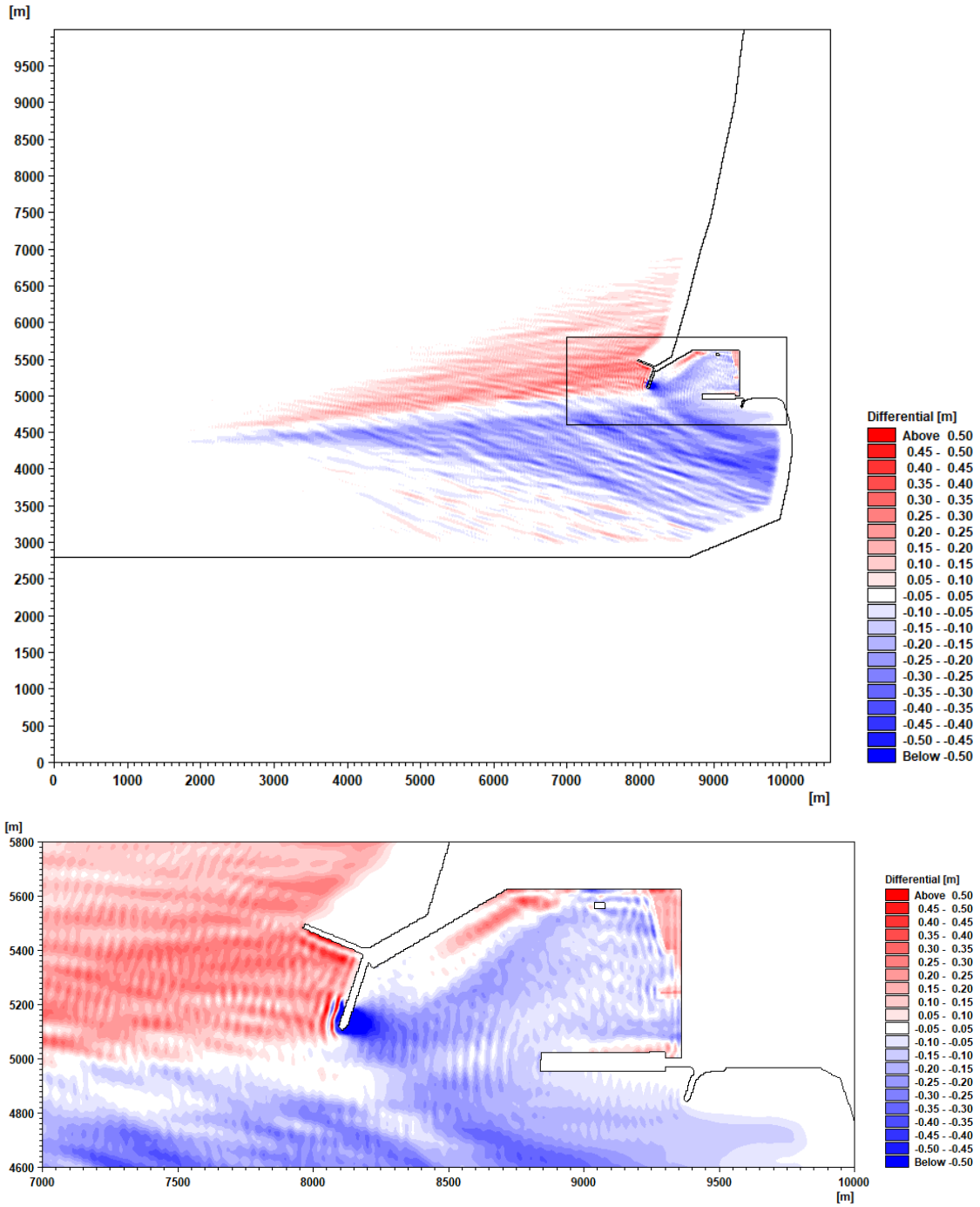
A.1.2 H_{m0} in the port



A.1.3 Wave attenuation coefficient in the project situation

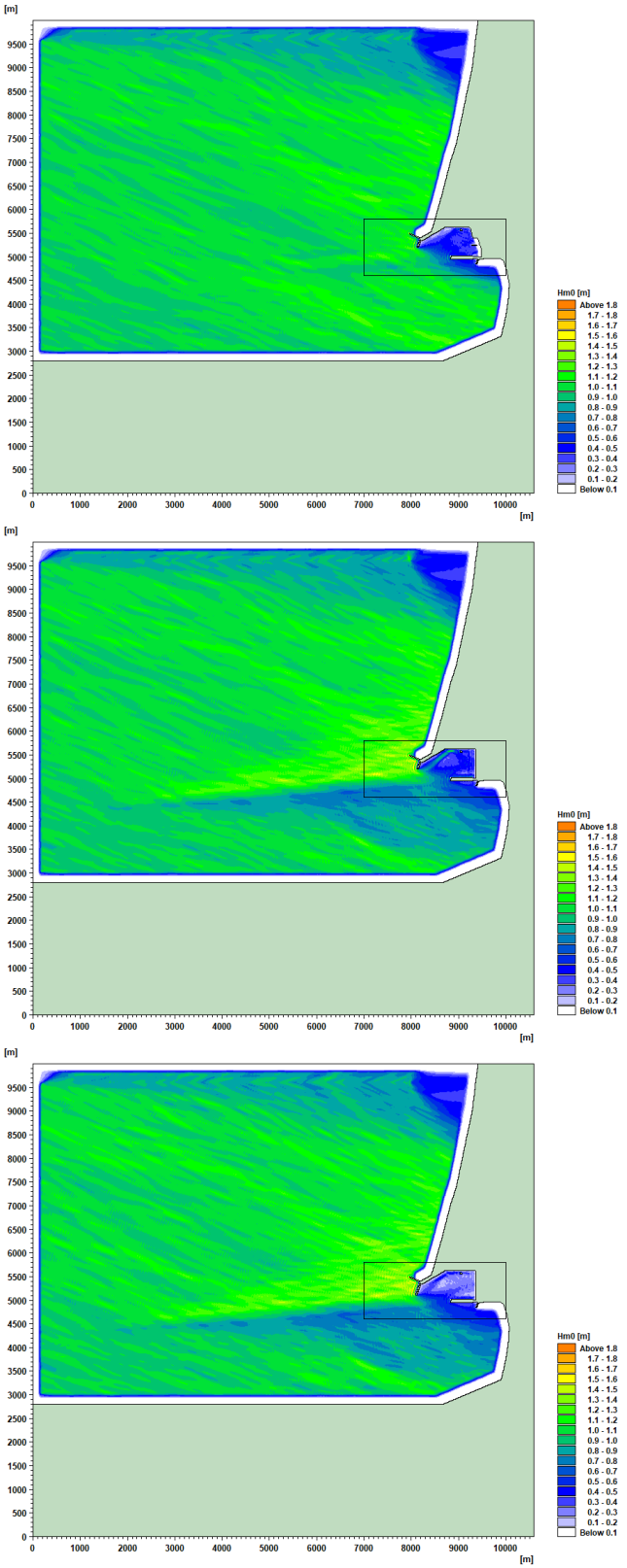


A.1.4 Wave attenuation coefficient in the project situation with extension of the entrance breakwater



A.2 Wave Condition N°2 : Tp = 10 s ; MWD = 292.5°N ; WL = 1.7 m LAT

A.2.1.1 H_{m0} in the model domain



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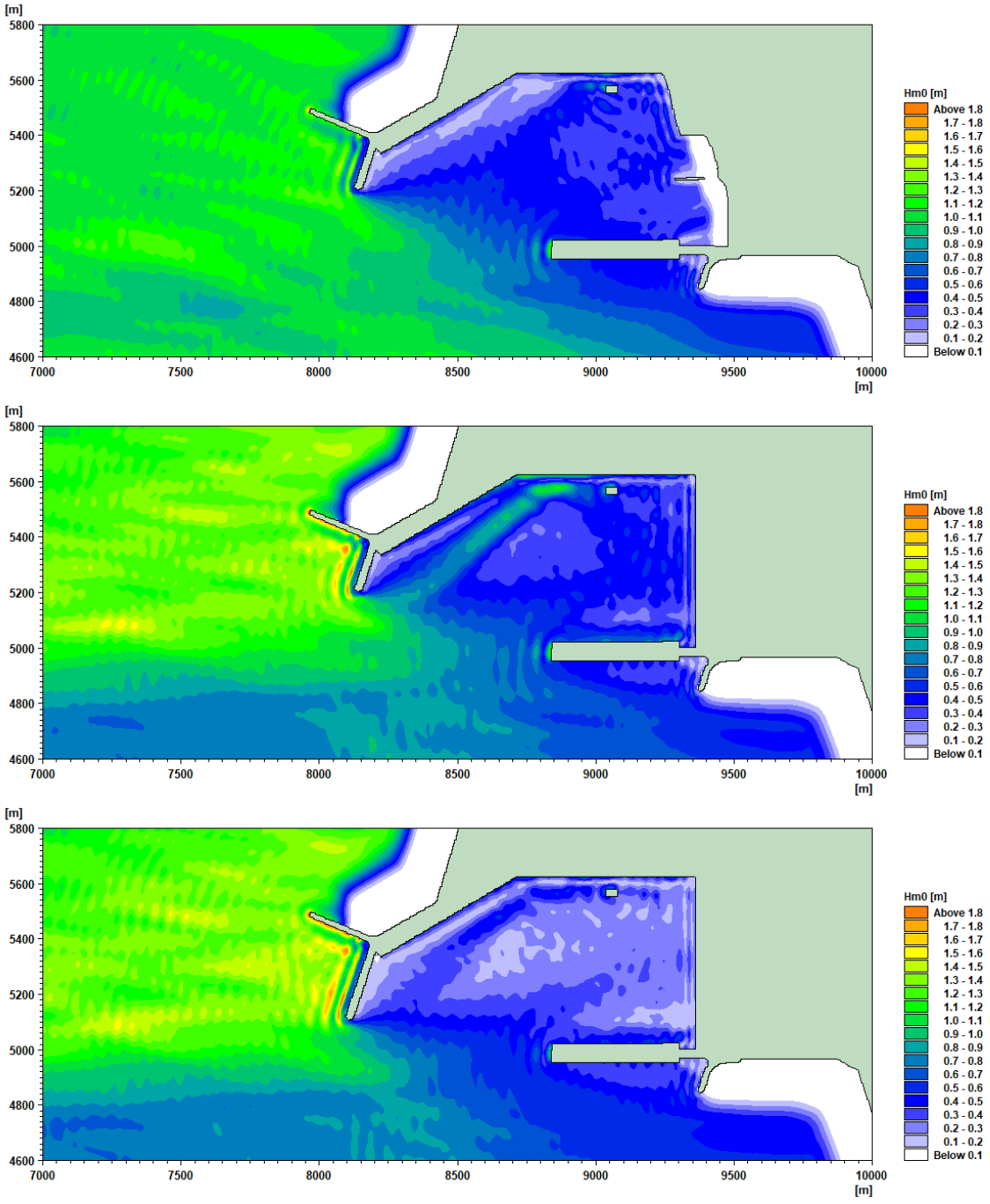
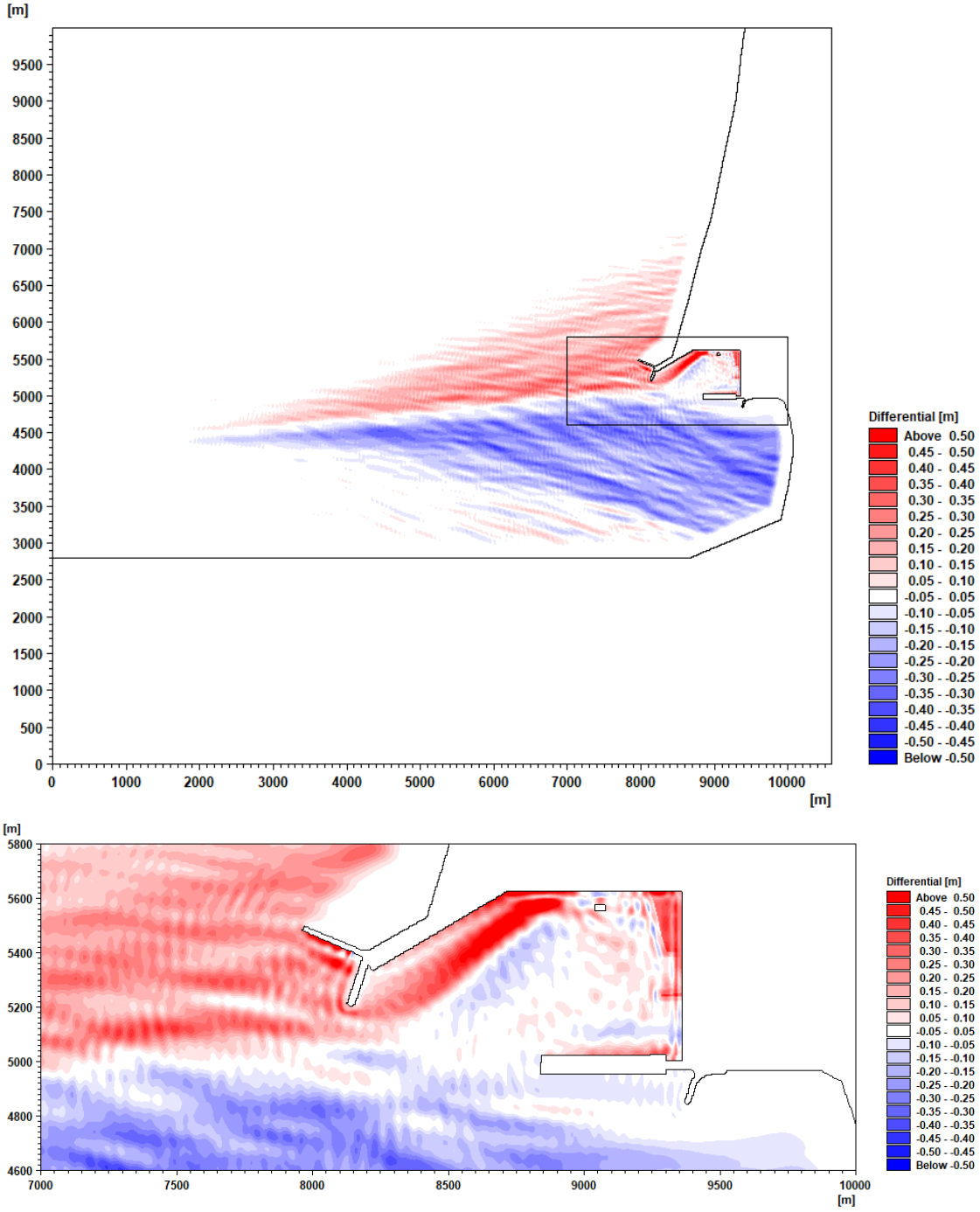
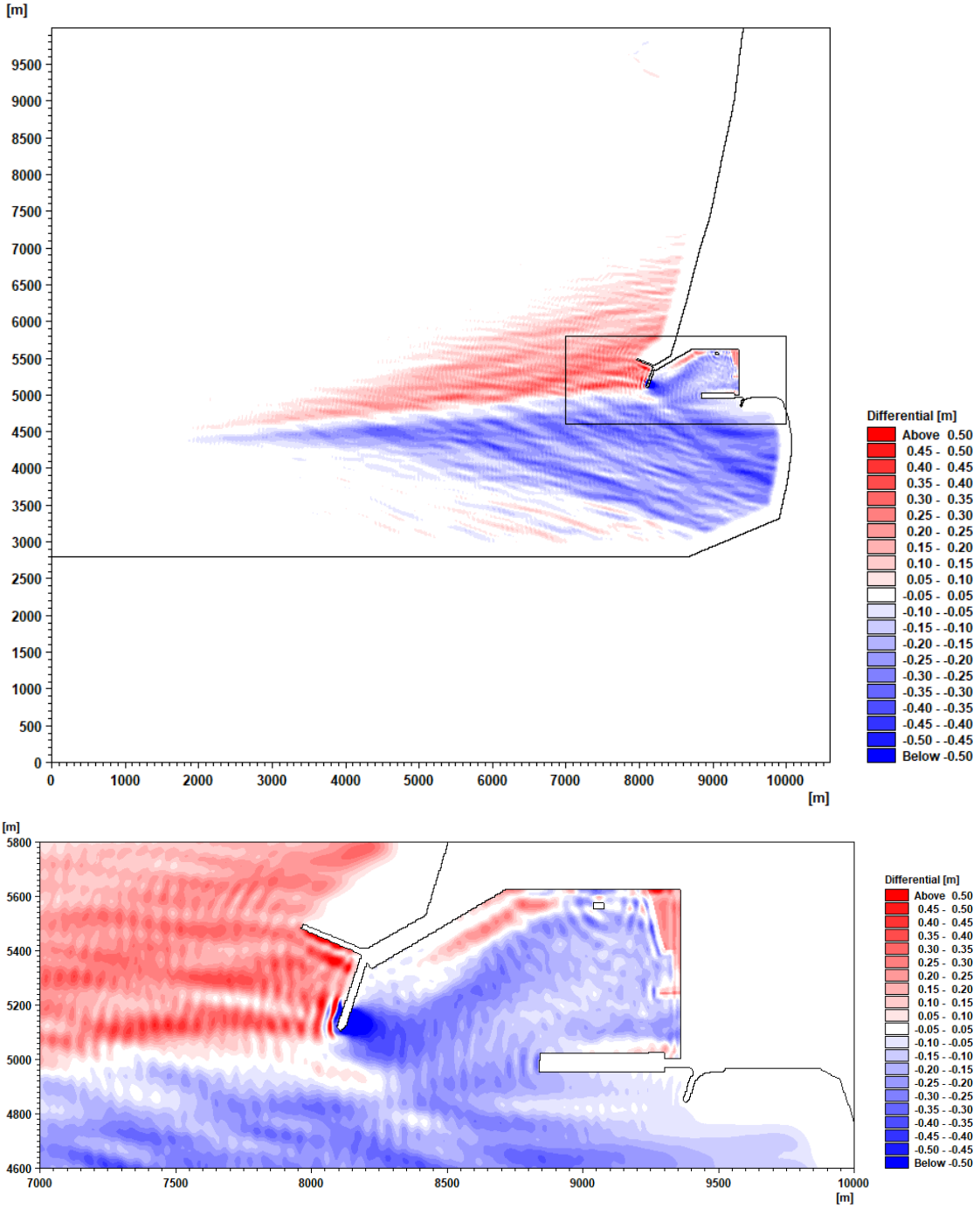


A.2.1.3 Wave attenuation coefficient in the project situation

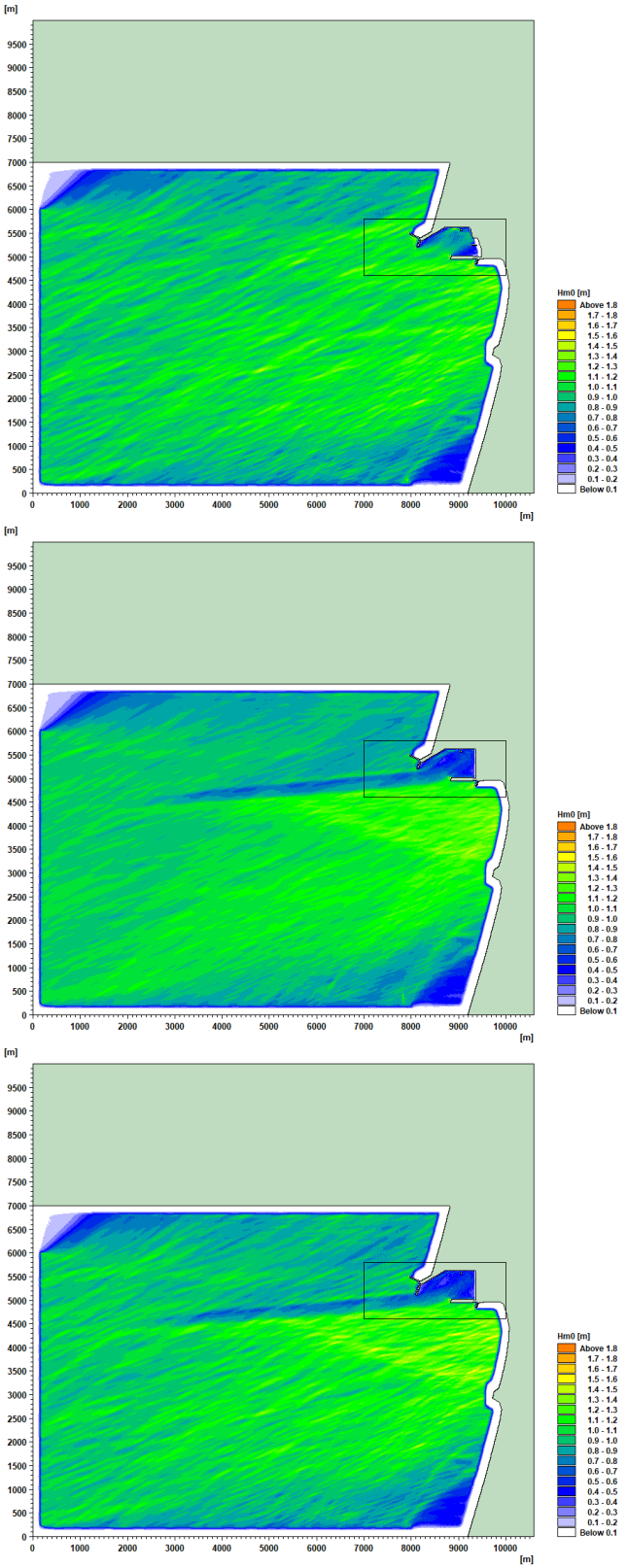


A.2.1.4 Wave attenuation coefficient in the project situation with extension of the entrance breakwater

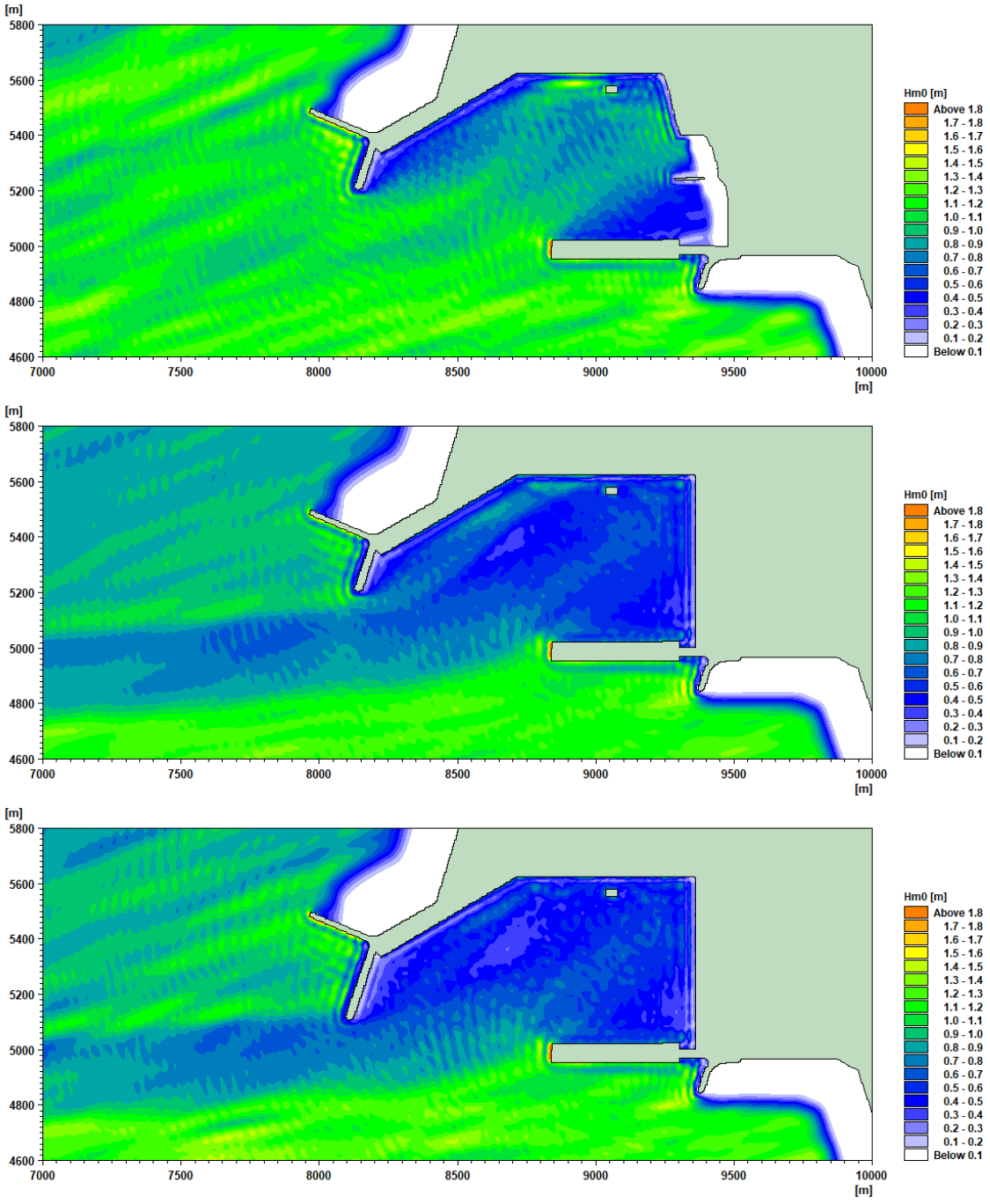


A.3 Wave Condition N°3 : Tp = 8 s ; MWD = 247.5°N ; WL = 1.7 m LAT

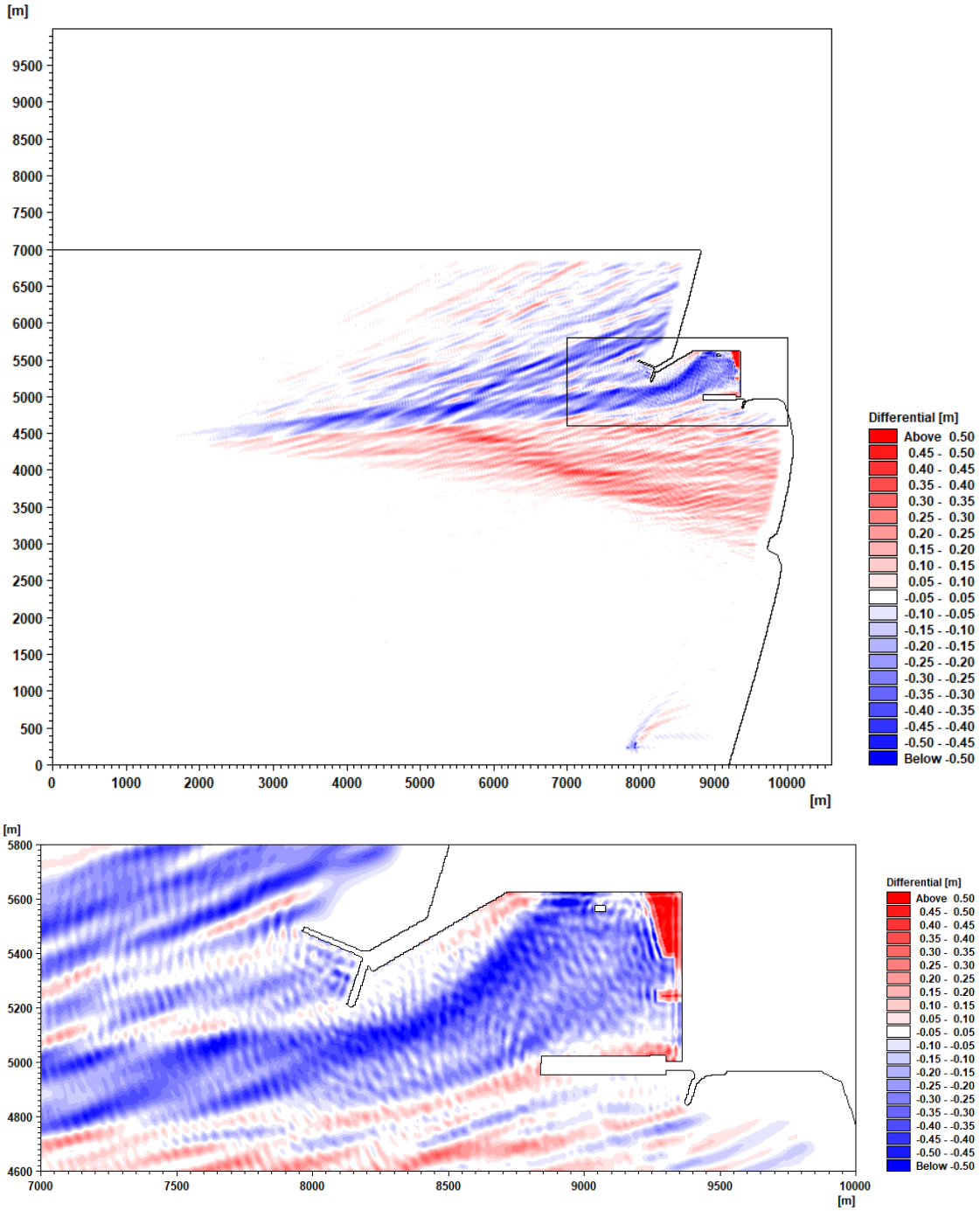
A.3.1.1 H_{m0} in the model domain



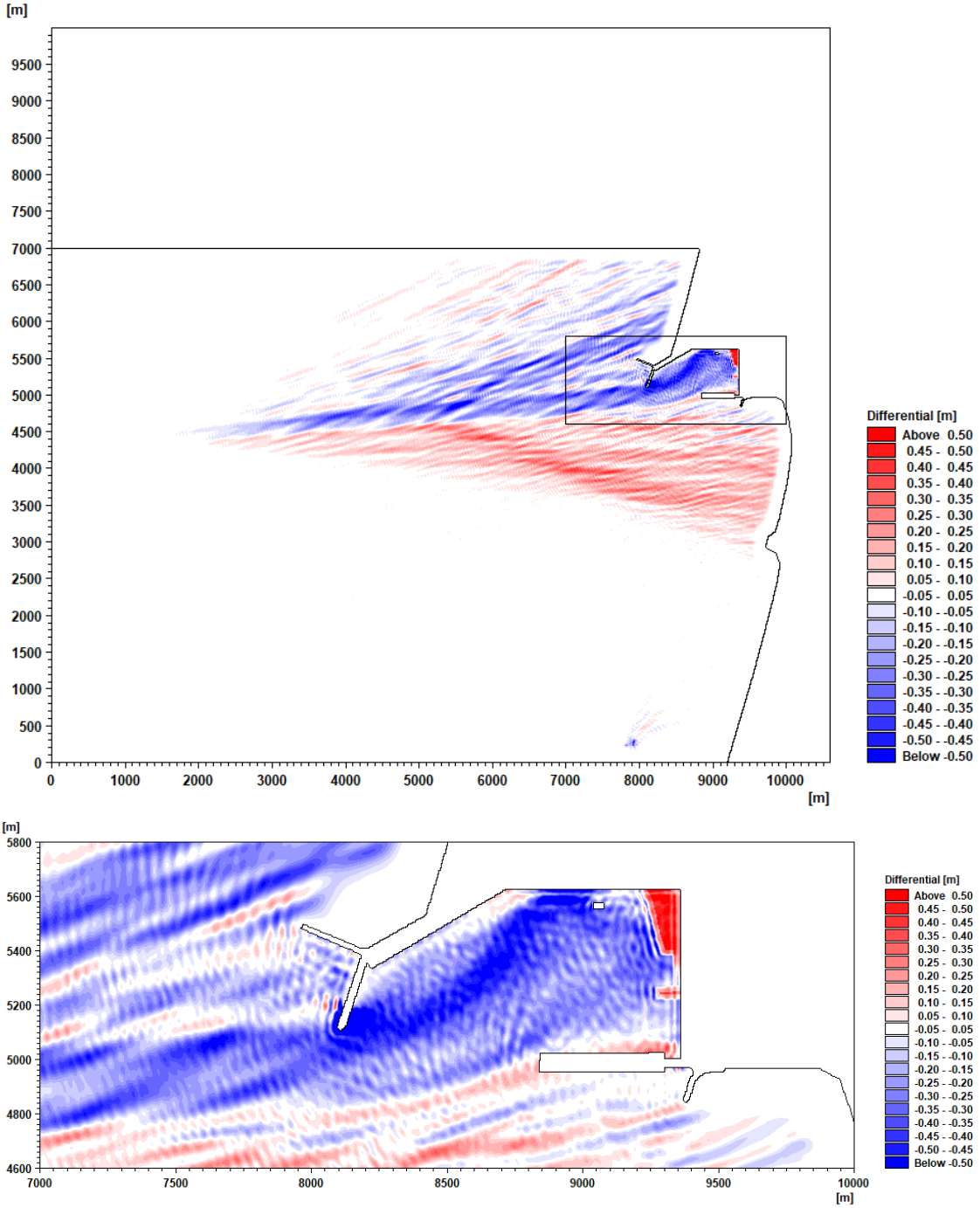
A.3.1.2 H_{m0} in the port



A.3.1.3 Wave attenuation coefficient in the project situation

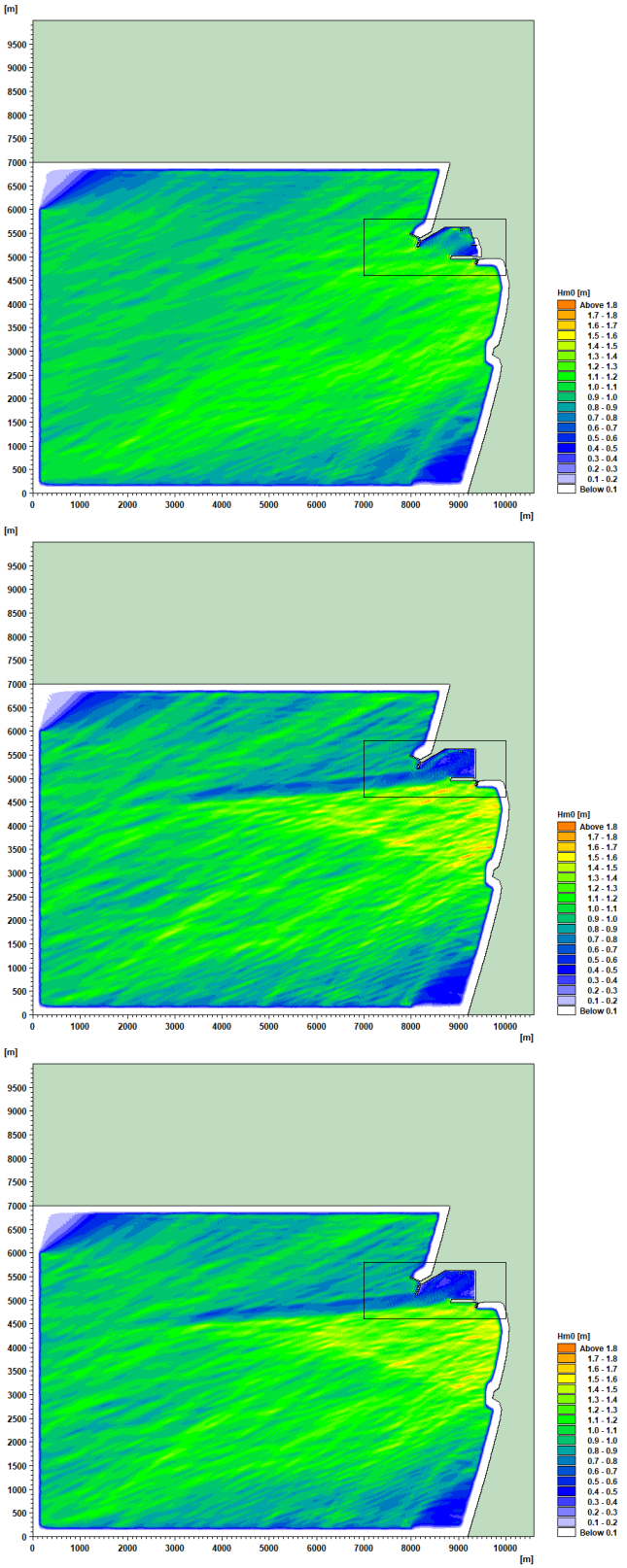


A.3.1.4 Wave attenuation coefficient in the project situation with extension of the entrance breakwater

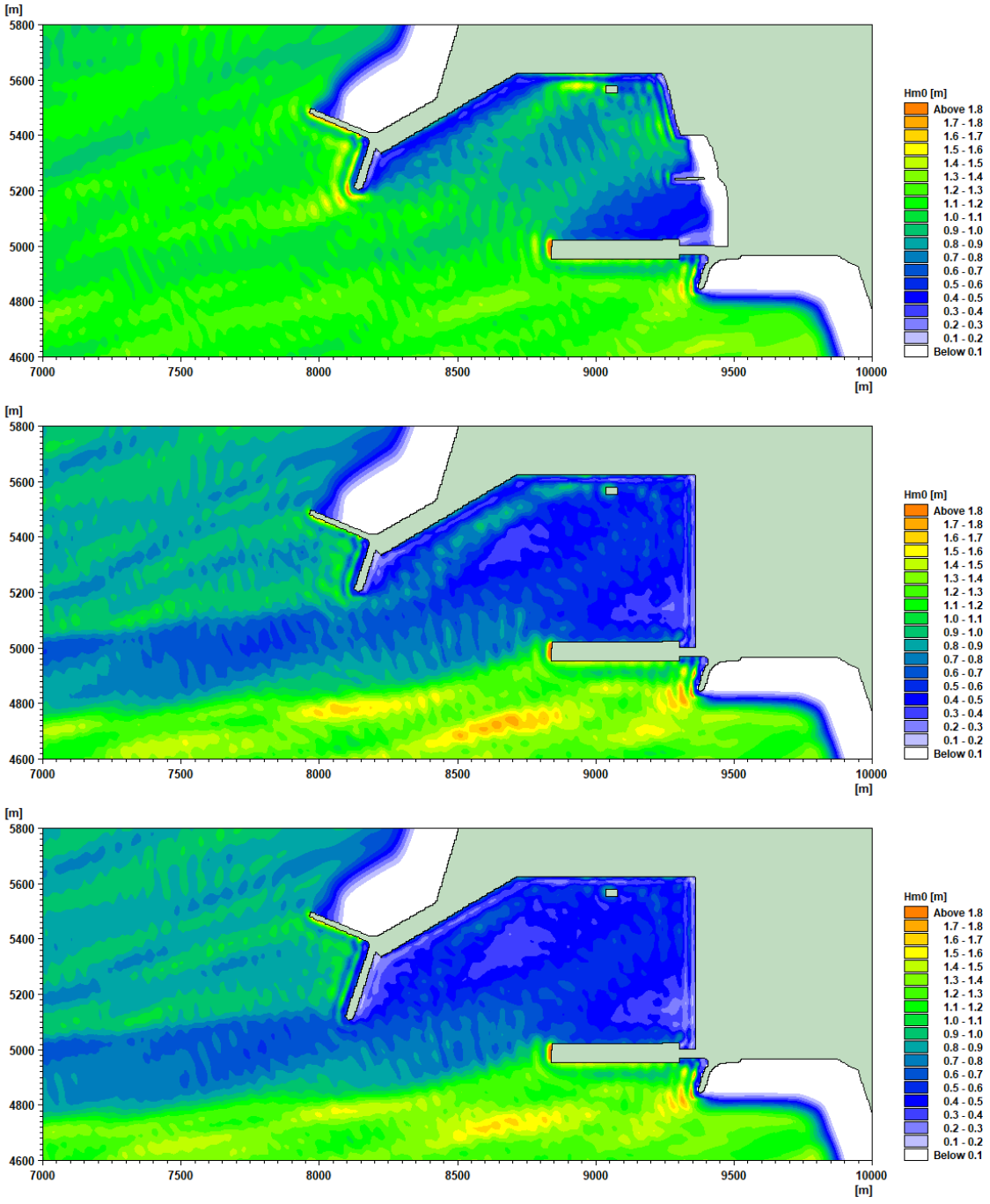


A.4 Wave Condition N°4 : Tp = 10 s ; MWD = 247.5°N ; WL = 1.7 m LAT

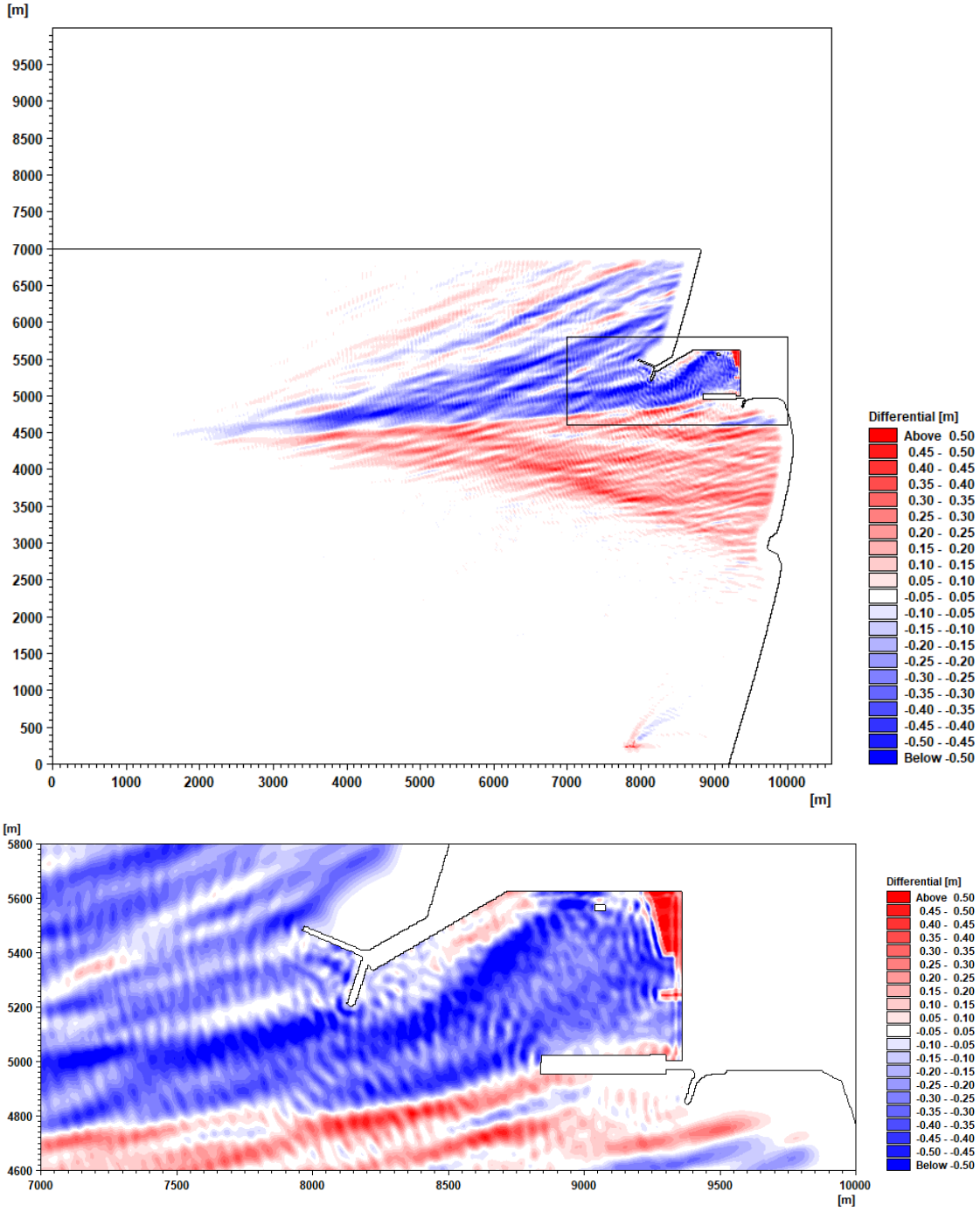
A.4.1.1 H_{m0} in the model domain



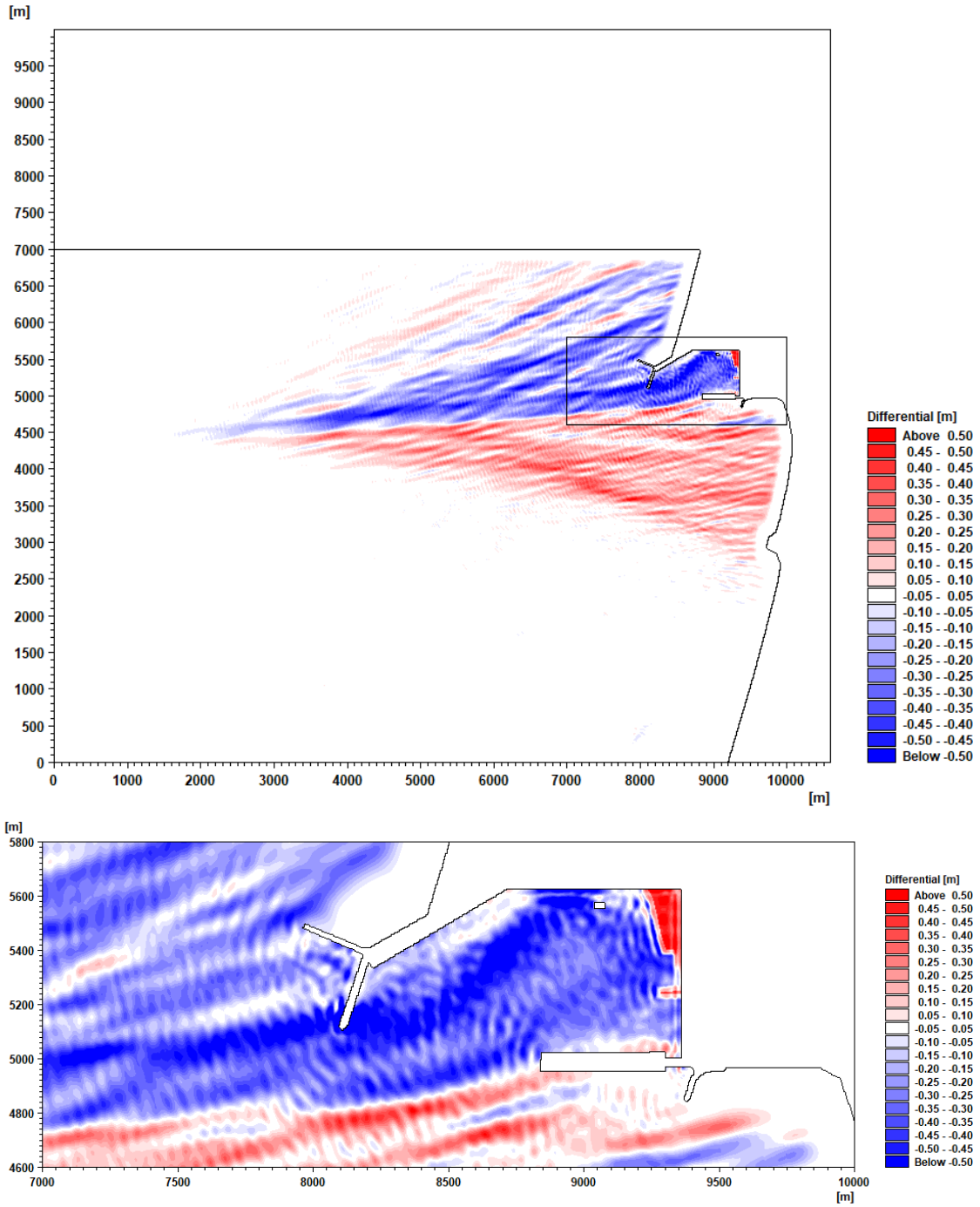
A.4.1.2 H_{m0} in the port



A.4.1.3 Wave attenuation coefficient in the project situation

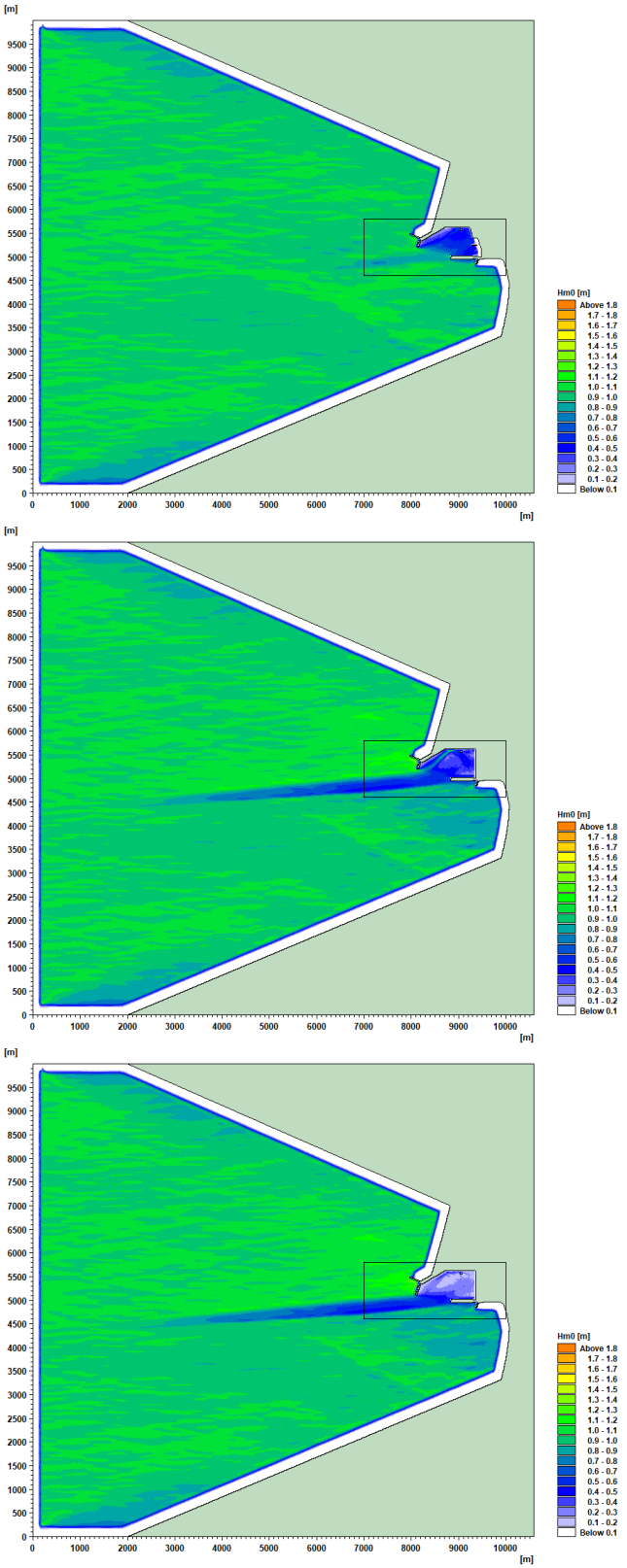


A.4.1.4 Wave attenuation coefficient in the project situation with extension of the entrance breakwater



A.5 Wave Condition N°5 : Tp = 8 s ; MWD = 270°N ; WL = 1.7 m LAT

A.5.1.1 H_{m0} in the model domain



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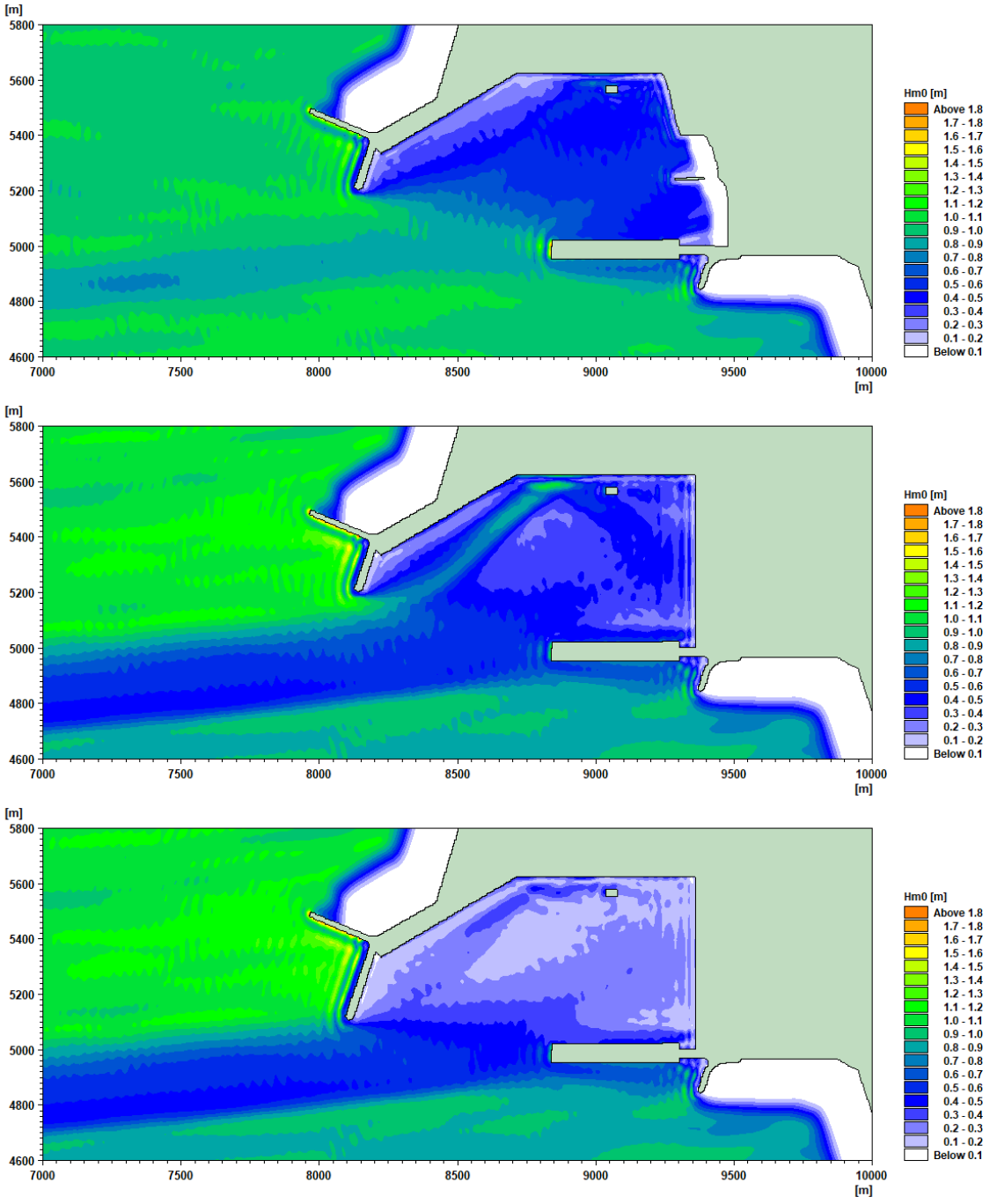
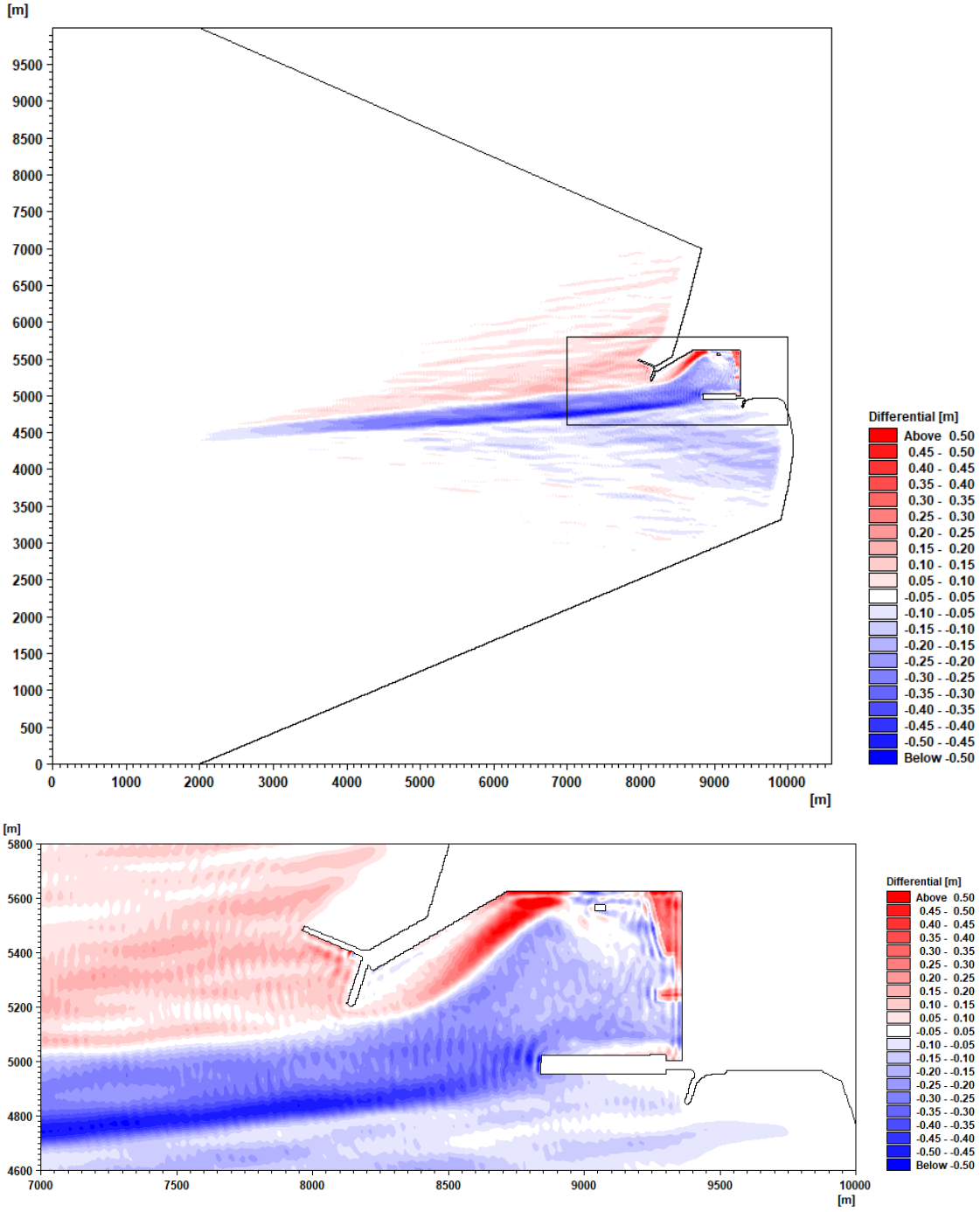
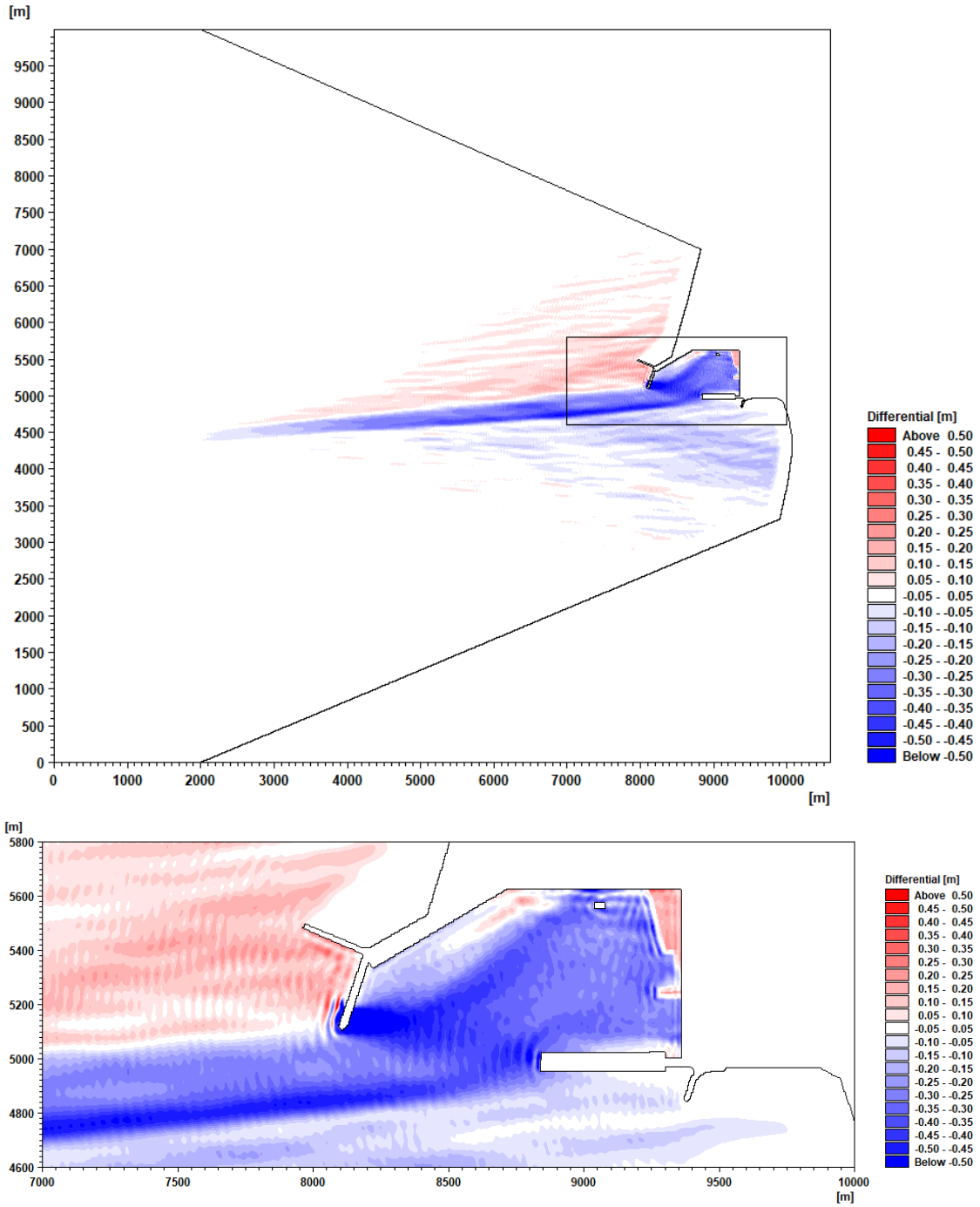


A.5.1.3 Wave attenuation coefficient in the project situation

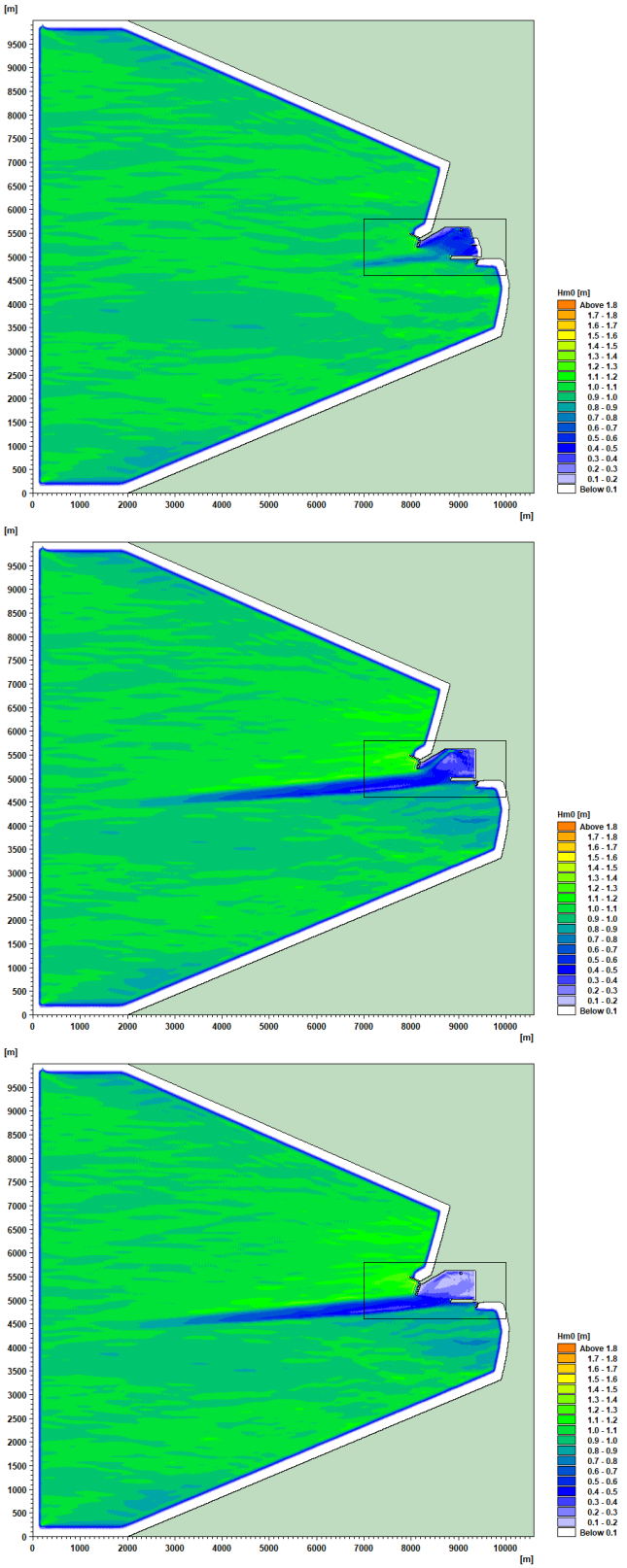


A.5.1.4 Wave attenuation coefficient in the project situation with extension of the entrance breakwater



A.6 Wave Condition N°6 : Tp = 10 s ; MWD = 270°N ; WL = 1.7 m LAT

A.6.1.1 H_{m0} in the model domain



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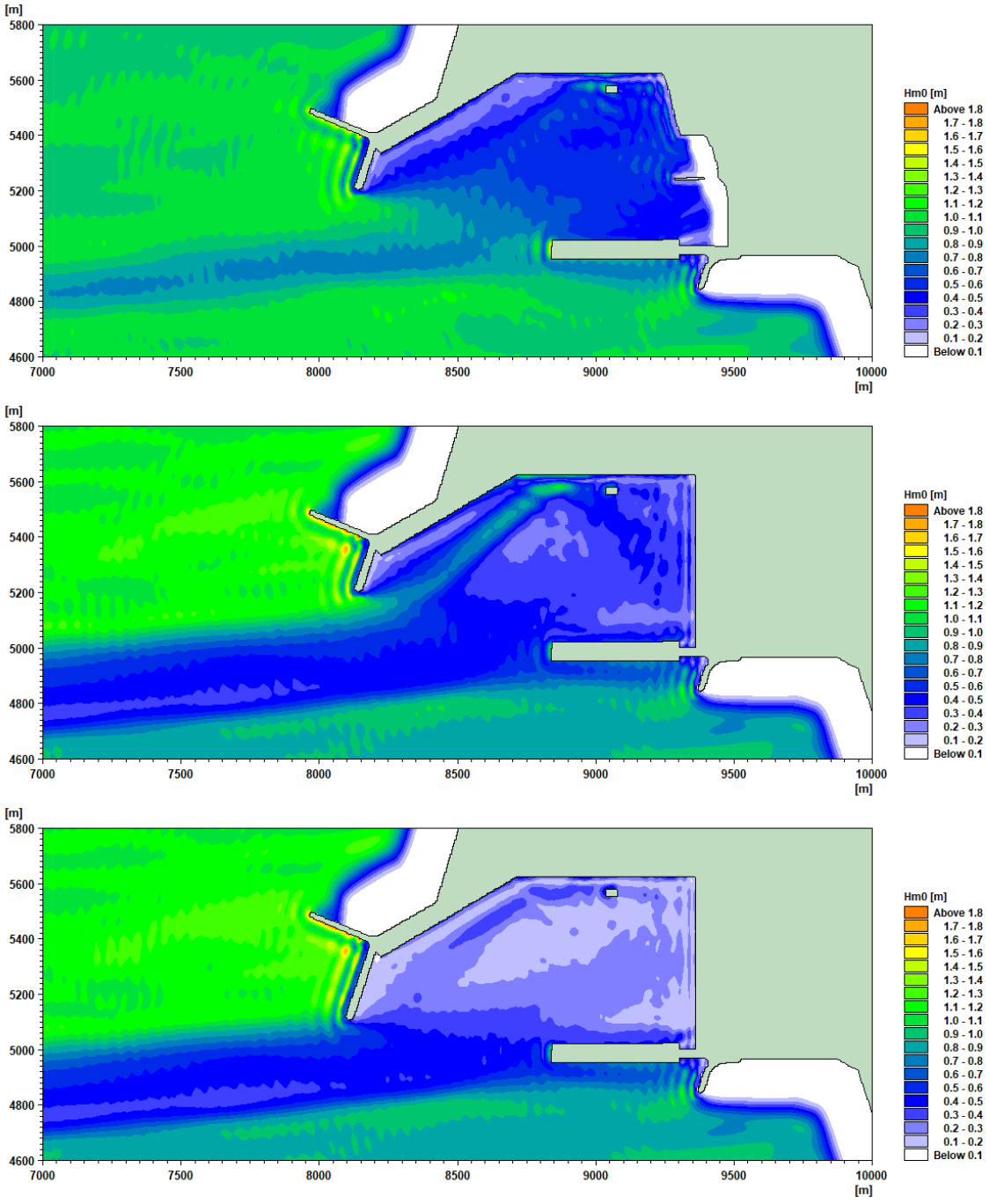
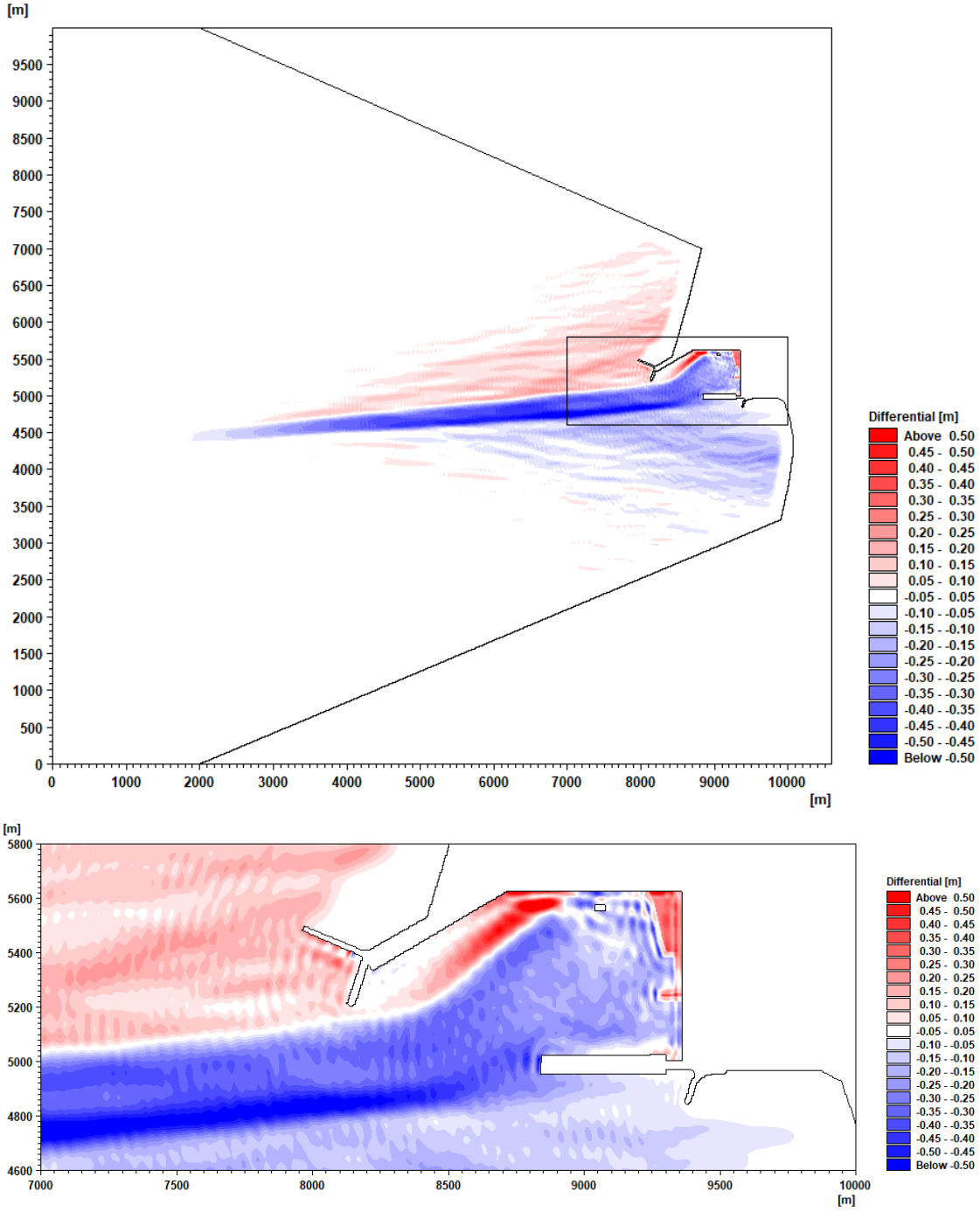
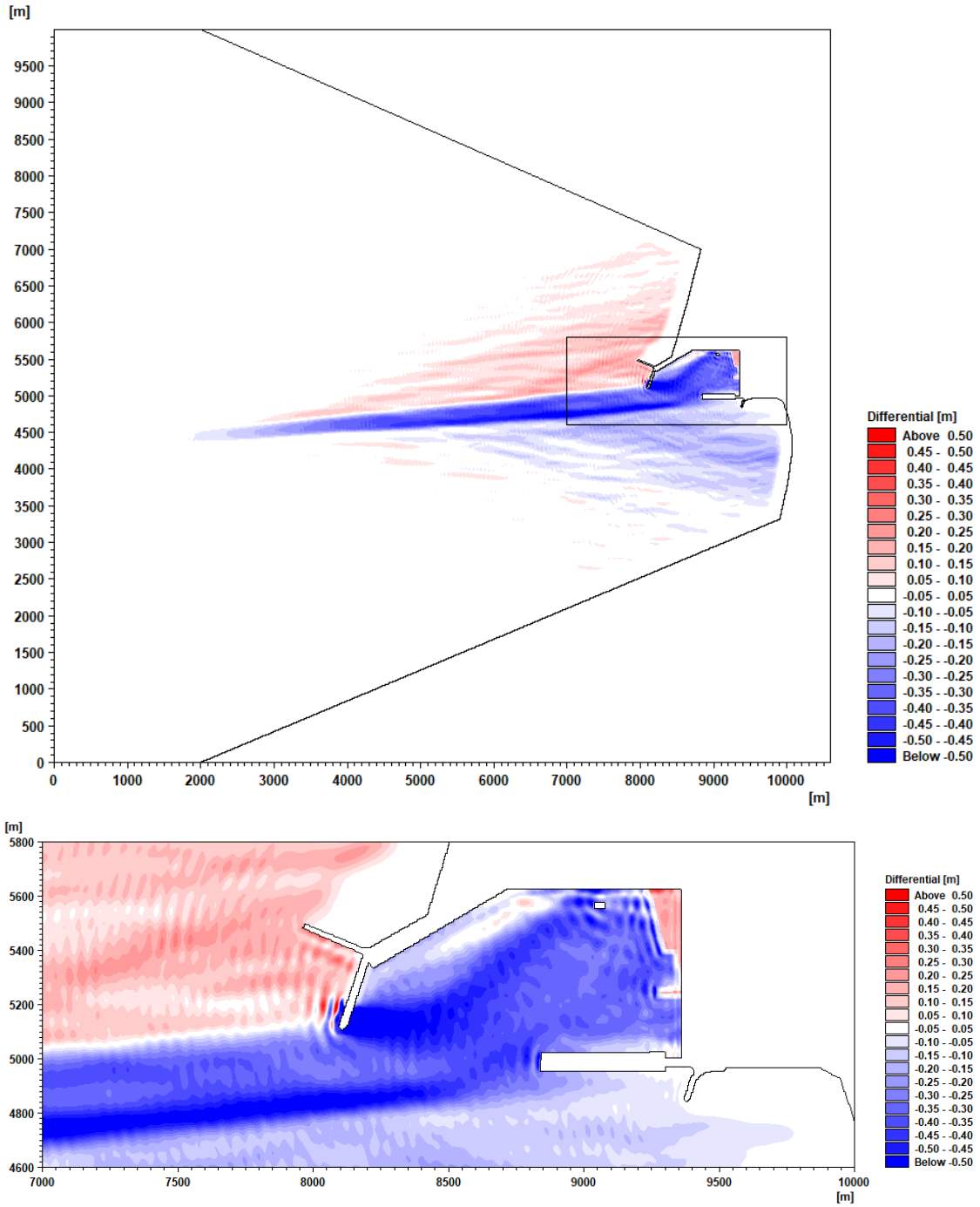


A.6.1.3 Wave attenuation coefficient in the project situation

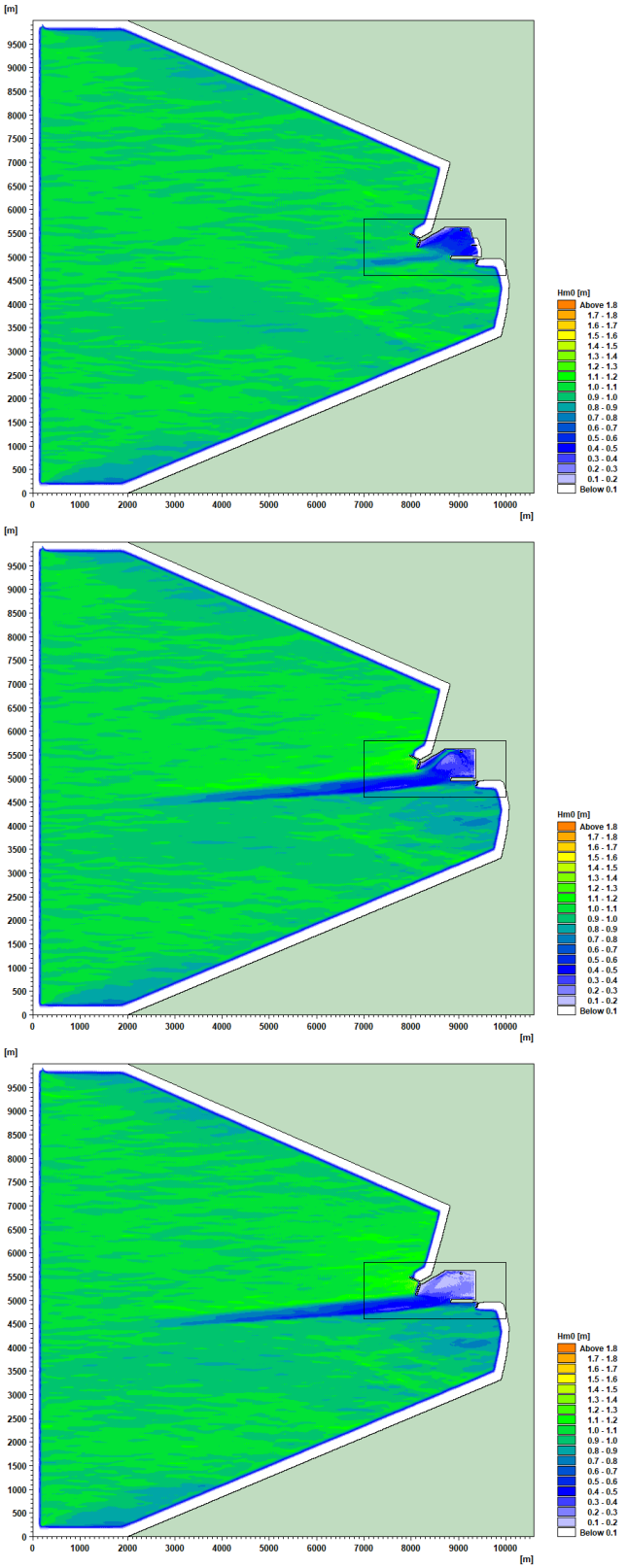


A.6.1.4 Wave attenuation coefficient in the project situation with extension of the entrance breakwater

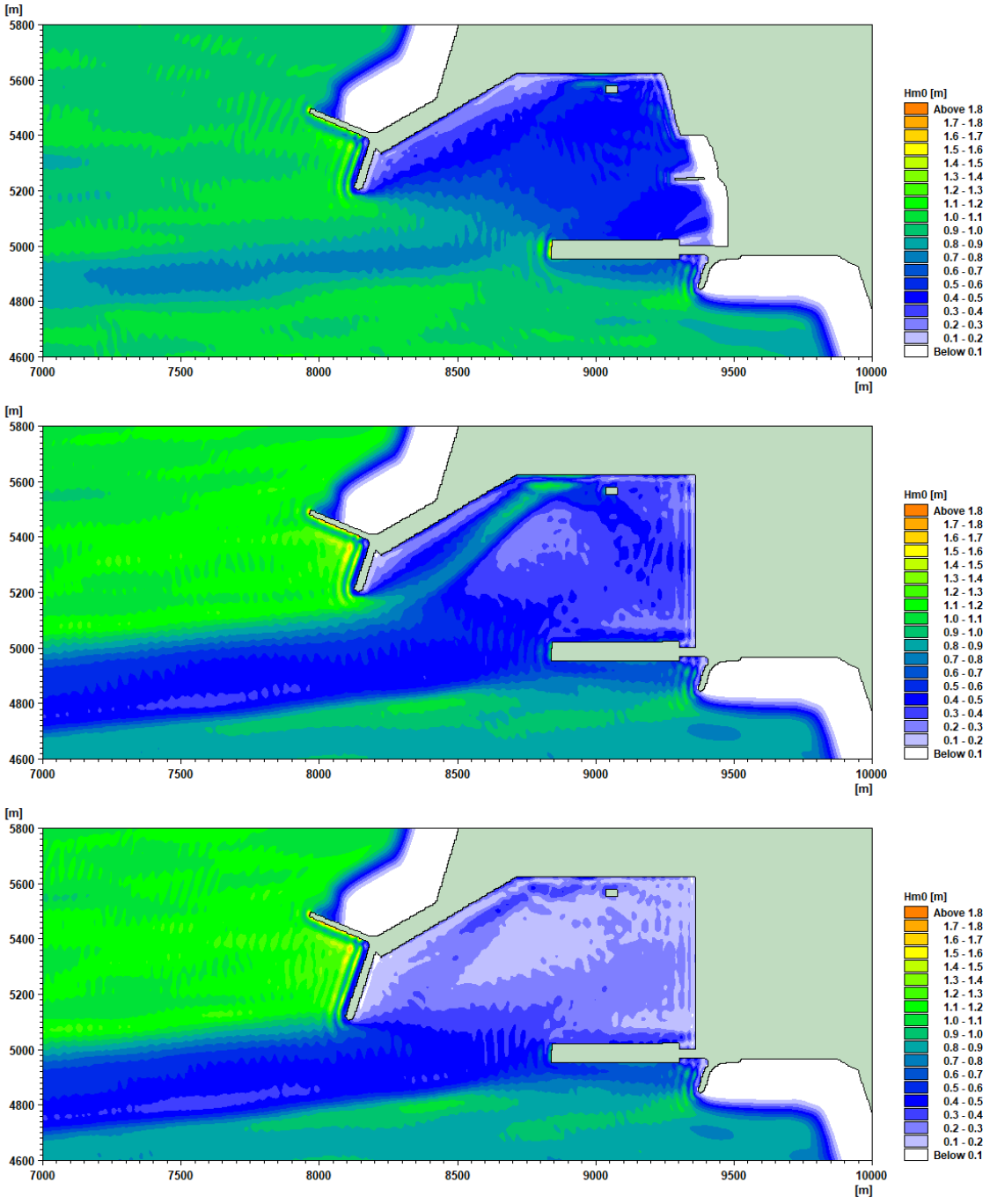


A.7 Wave Condition N°7 : Tp = 8 s ; MWD = 270°N ; WL = 0.5 m LAT

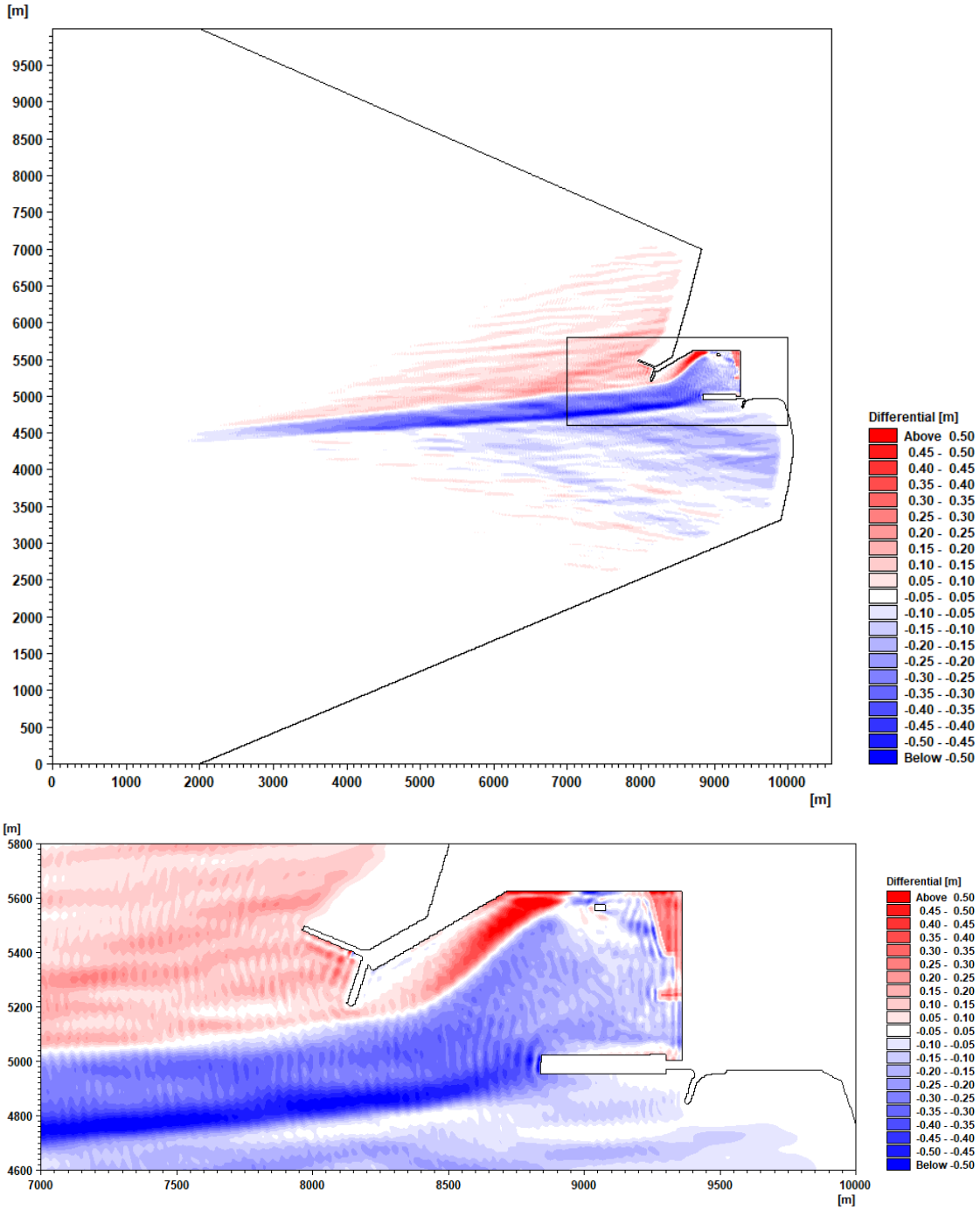
A.7.1.1 H_{m0} in the model domain



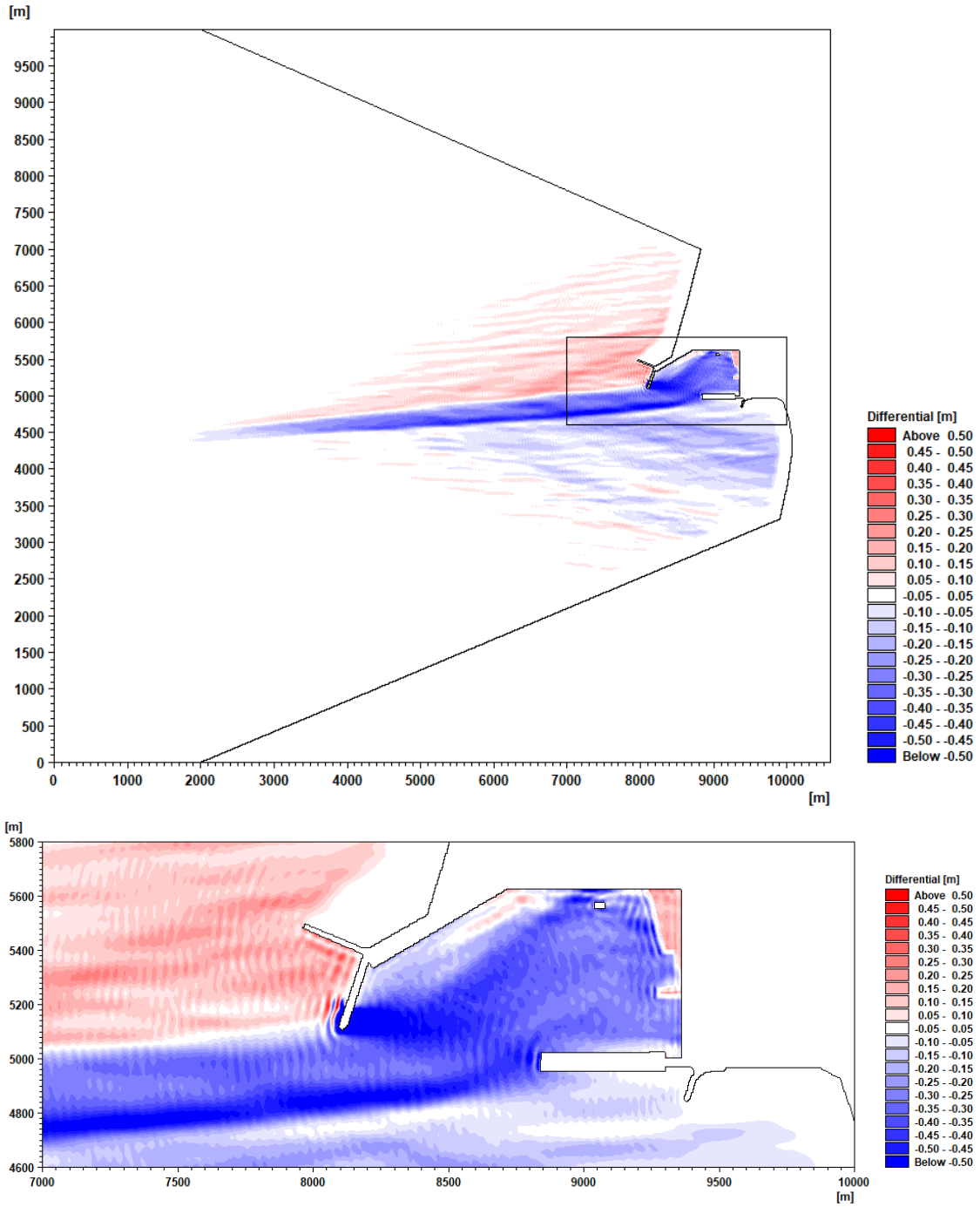
A.7.1.2 H_{m0} in the port



A.7.1.3 Wave attenuation coefficient in the project situation



A.7.1.4 Wave attenuation coefficient in the project situation with extension of the entrance breakwater



Appendix 6

Stakeholder Engagement Plan

REPORT

Stakeholder Engagement Plan

Nouakchott Container Terminal

Client: ARISE

Reference: BG3959IBRP1905070922
Status: 02/Final
Date: 07 May 2019

ARISE

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Enhancing Society Together

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Document title:	Stakeholder Engagement Plan
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Project name:	ESIA Nouakchott Port
Project number:	BG3959-101-100
Author(s):	Stuart Lednor
Drafted by:	Stuart Lednor
Checked by:	
Date / initials:	
Approved by:	
Date / initials:	

Classification
Project related

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Appendix 3 Grievance Redress Mechanism
Appendix 4 Template for Stakeholder Engagement Minutes of Meetings and Attendance Sheets
Appendix 5 Stakeholders and stakeholder meetings database
Appendix 6 Minutes of Public Consultation Meeting held on 25 April 2019

1 Introduction

ARISE Mauritania S.A. (**ARISE**), a company held by ARISE Mauritius (parent company of GSEZ) and Meridiam, is planning to construct and operate a new container and hydrocarbon terminal in the Port of Nouakchott, Mauritania (hereafter referred to as '**the Project**' or '**Nouakchott Container Terminal**' or '**NCT**').

This document is the **Stakeholder Engagement Plan (SEP)** for this Project.

This SEP presents the approach to planning and managing stakeholder engagement activities during project implementation, beginning during the Construction and Operation Phase of the Project. This is a live document that will be periodically updated as the Project progresses. It will be ARISE's responsibility to update and supervise implementation of the SEP as part of the Project's Environmental and Social Management Plan (ESMP). The current document presents Version 1 of the SEP and was prepared on behalf of ARISE by Royal HaskoningDHV in March 2019.

This SEP sets out the process for undertaking engagement and consultation with stakeholders. Consultation with stakeholders is essential to building a longer term 'social licence to operate' to facilitate the successful implementation of the Project. Stakeholders include local communities and people directly affected by the Project (Project Affected Communities; PACs and Project Affected People; PAPs) and other stakeholders not directly affected by the Project but that have an interest in it. These could include national and local authorities, neighbouring projects, and/ or non-governmental organisations (IFC, 2012).

The SEP aims to establish the process and tools to:

- Identify stakeholders and map their perceptions about the Project and identify and record key issues and concerns that stakeholders have about the Project.
- Keep stakeholders informed about the Project, explaining its nature and potential impacts, and opportunities for engagement throughout the project lifecycle, based on the principles of free, prior and informed consultation and in a culturally-sensitive manner.
- Avoid any misunderstandings about the Project and properly manage expectations.
- Build positive stakeholder relationships and lay the foundations for ongoing stakeholder participation.
- Implement a viable grievance mechanism.
- Maintain a record of all consultations and grievances using a Stakeholder Database and Grievance Mechanism Database.

2 Project Background

This section provides a short description about the Project. For more information please refer to the Environmental and Social Impact Assessment (ESIA), Chapter 3.

2.1 Project Location

The Project will be located within the boundaries of the existing Port of Nouakchott ('**the port**' also called in French '**Port Autonome de Nouakchott dit Port de l'Amitié**' or '**PANPA**'), approximately 15km south-west of Nouakchott city.

The port is located in the administrative region (Wilaya) of Nouakchott-Sud, subdivided further to be located in the sub-regional department (Moughataa) of El Mina.

The port is located within a designated economic industrial zone, where several hydrocarbon storage facilities, cement factories, grain and flour factories amongst others are located. Despite being an economic hub for the region/country, no noticeable permanent residential areas are located in the site vicinity.

2.2 Project Components

The Project will be developed in different phases. At present only Phase 1 (as described below) is under consideration.

The following key components will be constructed and/or operated as part of Phase 1 of the Project.

- Main berth of size 570 m x 56.56 m wide accommodating container and general cargo berth;
- Container yard of size 600 x 120m (7.20 ha) to accommodate containers, reefer containers and hazardous cargo containers;
- Capital dredging of the navigation channel and port basin and disposal of dredged material into identified potential disposal sites;
- Extension of the existing breakwater to reduce the wave agitation into the port basin;
- Provision of hydrocarbon pipeline from berth to the existing junction point and demolition of the existing oil jetty and oil pipeline going from the oil jetty to the junction point;
- Provision of power supply network via a new substation and a 5kV distribution line along the 5 km right of way of the existing power line; and
- Construction of other utilities and facilities for port operations.

Figure 2-1 shows the location of the at a high level the footprint of all project components, namely the new container and hydrocarbon terminal, the channel to be dredged, the potential dredge spoil disposal sites and the electrical substation.

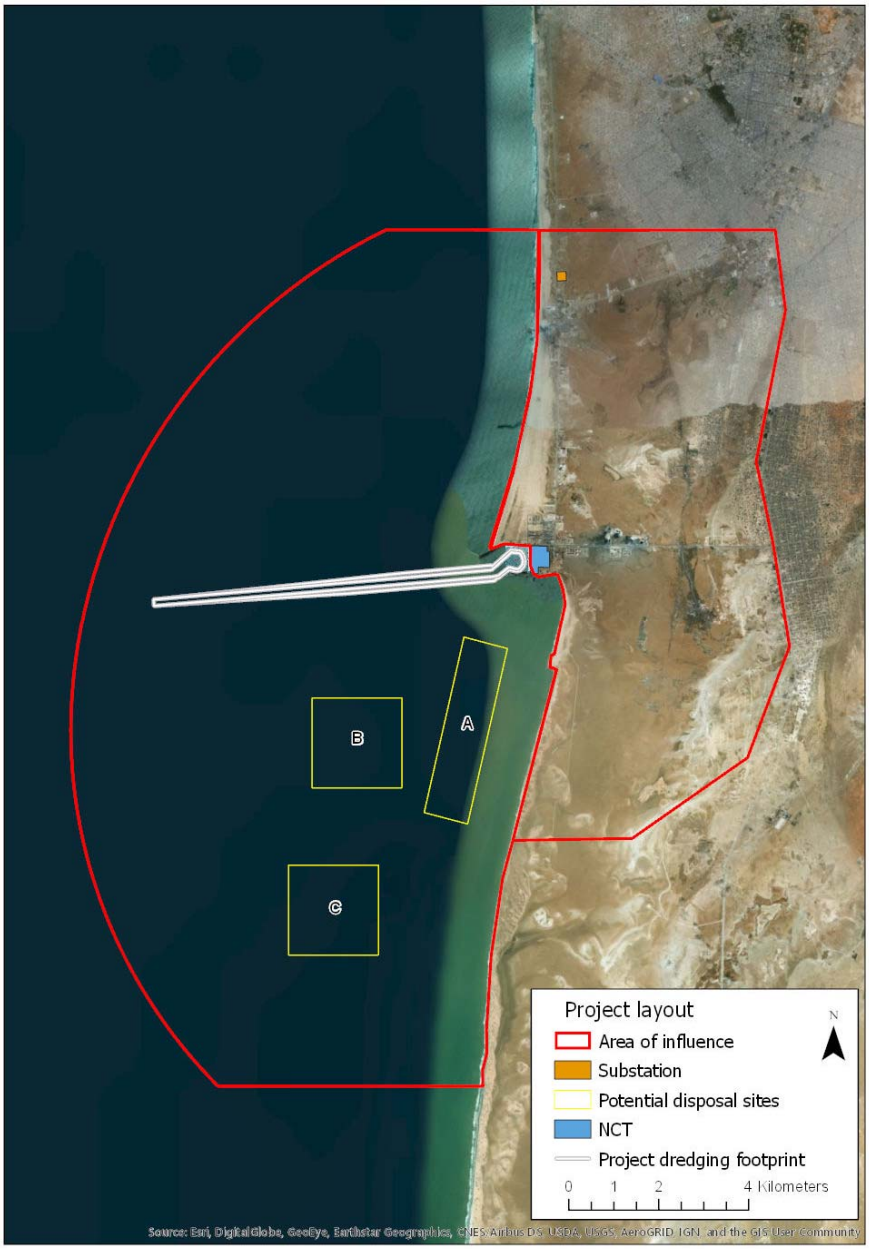


Figure 2-1: Location of the key project components

2.3 Project Activities

Project construction activities entails the construction works associated with the Project components mentioned in the above section. Project operation activities entail operations of the new multipurpose (container and hydrocarbon) terminal, including the new quay and the new container yard, as well as the occupation and use of some existing storage areas (which will be completely redeveloped as additional container yards in Phase 2).

3 Regulations and Requirements

3.1 Mauritanian Legislation

Several laws, ordinances and other texts applicable to stakeholder consultation may be applied during the Project phase, namely:

- Framework Law on the Environment No. 2000-045, adopted in July 2000, aims to establish the general principles that should underpin the national policy on environmental protection and serve as a basis to harmonise ecological imperatives with sustainable economic and social development requirements.
- Decree 2004 - 094 of 04 November 2004 on Impact Assessment, amended and supplemented by Decree 2007 - 105. The decree is issued pursuant to the provisions of the Environmental Code with regard to the implementation of Environmental Impact Assessments (EIA). In Article 2, it defines the EIA as a document to assess, appraise and measure the direct, indirect and cumulative environmental effects of a project in the short, medium and long term.

The national stakeholder disclosure process is led by the government and involves an enquiry and follow-up on the ESIA process. After the ESIA is published, the government leads the process of consultation hearings and addressing responses from stakeholders. This takes places at various levels of government (local municipality to national level). The disclosure of information and announcements is required to 30 days before the meetings can take place. The final report is not published, but follow-up by the public is allowed and comments are to be considered in the development of the Project cycle.

3.2 IFC's Policies

3.2.1 IFC's Policy on Environmental and Social Sustainability

The IFC sets out requirements for undertaking stakeholder engagement throughout the Project lifecycle in IFC Performance Standard 1 - Assessment and Management of Environmental and Social Risks and Impacts (IFC, 2012). Further guidance is available in Good Practice Manual: Doing Better Business through Effective Public Consultation (IFC, 1998) and Stakeholder Engagement: A Good Practice Handbook for Companies doing Business in Emerging Markets (IFC, 2007). A summary of IFC Performance Standard 1 engagement requirements is presented in Figure 3-1.

Figure 3-1: Stakeholder engagement requirements of IFC Performance Standard 1

Issues	Key requirements
Stakeholder analysis and planning	Identify Project affected stakeholders, including vulnerable groups6 Develop and implement a Stakeholder Engagement Plan
Disclosure of information	Provide stakeholders with access to information on: • Purpose, nature and scale of the Project • Duration of proposed Project activities • Any risks, potential impacts and mitigation measures • Proposed stakeholder engagement process • Grievance Mechanism
Consultation	Consultation will be in line with the degree of potential project impacts and will: • Begin early and continue throughout the Project lifecycle

Issues	Key requirements
	• Be based on prior disclosure and dissemination of information • Focus on those directly affected • Be free of outside interference and external manipulation • Enable meaningful participation • Be documented
External communications	Implement and maintain a procedure for external communications that: • Registers communication • Screens and assesses issues raised • Tracks and documents responses • Adjusts the management programme
Grievance Mechanism for Project Affected Communities	Establish a Grievance Mechanism to receive and facilitate resolution of Affected Communities' concerns and grievances about the Project. The Grievance Mechanism should: • Resolve concerns promptly • Use a transparent and culturally appropriate consultative process
Ongoing reporting to affected communities	Provide periodic progress updates, specifically with regard to issues or grievances communities have raised • Communicate any updates to the management programme • Report to the community with frequency that is proportionate to the concerns of affected communities but not less than annually

3.2.2 IFC's Access to Information Policy

As mentioned in the ESIA Project has been categorized as Category A as per IFC's Policy on Environmental and Social Sustainability (i.e. project "with potential significant adverse environmental or social impacts that are diverse, irreversible or unprecedented").

In terms of disclosure this means that, in line with IFC's Access to Information Policy, the Draft Final ESIA needs to be disclosed to the general public for a minimum period of sixty (60) days.

3.3 ARISE Corporate Stakeholder Engagement Policy

The ARISE Environmental Sustainability includes the requirement of reviewing the policy to align with Company and key stakeholder expectations. This policy is shown in Figure 3-2.



ARISE

Environmental Sustainability Policy

ARISE is committed to managing our business to minimize the environmental risks for Air, Water, Land and Biodiversity related to our Business and the communities in a safe environment.

Our goals:

Deliver a world-class Environmentally Friendly and Sustainable Management programme at our Infrastructure Projects, through effective risk management as far as practically possible to minimize the impact on Air, Land and Water.

To achieve these goals, we will:

- Select and manage land responsibly through relevant risks and impacts assessments to our existing and new facilities.
- Increase the efficiency of all resources used including fuel, energy, water and land.
- Reduce any impacts arising from our business activities on the environment and biodiversity through process innovation, and waste elimination, reduction, reuse and recycling.
- Conduct periodic environmental footprint reviews for our business.
- Encourage and support our suppliers to improve the sustainability of their business.
- Create a learning organisation where colleagues including contractors can share their successes and failures to drive continual improvement.

For the management and implementation of this and all policies, we will:

- Conduct our business with integrity and in compliance with the relevant laws of countries where we operate and in accordance with recognised international and national standards, guidelines and processes.
- Ensure all levels of our management accountable for applying the policy in their business decisions.
- Ensure all employees, business partners, contractors, suppliers and visitors understand this Policy and their own responsibilities and accountabilities and receive appropriate training and support for delivering successfully.
- Establish strategies and management systems to create and prioritise SMART objectives and execute improvement plans that are aligned with our business goals and address our significant risks, impacts and opportunities.
- Ensure effective communication to all employees, contractors, visitors and other interested parties through meaningful and accurate information regarding our Environmental and Sustainability performance standards to demonstrate continual progress towards commitments made in our Policies.
- Periodical review of this Policy to align with our business and our key stakeholder expectations.

Gagan Gupta
Président – ARISE

Bhavin Vyas
Directeur E&S ARISE

Version – 01
15-02-2019

Figure 3-2: ARISE Environmental Sustainability Policy

4 Stakeholder Identification and Analysis

4.1 Stakeholder Identification

Table 4-1 provides a summary of the key stakeholder groups identified to date based on data collection and interviews conducted during the ESAI process.

Table 4-1: Stakeholder groups and interest in the Project

Stakeholder Group	Stakeholder Entity	Interest in Project
National Authorities	Ministère de l'environnement et du développement durable (MEDD)	Environmental and sustainability protection
	Direction du Contrôle Environnemental (DCE)	Part of MEDD, has a mandate to give guidance on (national) EIA process
	Port Autonome de Nouakchott dit Port de l'Amitié (PANPA)	Responsible for operating, maintaining, and developing the port
	Ministère des Pêches et de l'Economie Maritime	Environmental and social impacts
	Ministère du Pétrole, de l'énergie et des Mines	Environmental and social impacts; Project affects oil jetty and pipeline
Local Authorities	Wayila, Nouakchott-Sud	Environmental and Social impacts
Port Employees (including Shipping Operators, Container Handlers, Dockers Associations)	APM Terminals	Social impacts
	Securim SRMOP	Social impacts
	CMA-CGM	Social impacts
	OPM	Social impacts
	Maurilog	Social impacts
	SOGECO	Social impacts
Local Fishermen Associations	Société Mauritanienne pour la Pêche et la Navigation (SMPN)	Social impacts
	Société Mauritanienne de Commercialisation de Poissons (SMCP)	Social impacts
	Fédération Libre de la Pêche Artisanale (FLPA)	Social impacts
Local Industry located in the vicinity of the Project and/or directly affected by the Project	Oil Terminal	Economic impacts and interests
	Cement Factory	Economic impacts and interests
	Les Grandes Moulin de Mauritanie	Economic impacts and interests
NGOs	Institut Mauritanien de Recherche Océanographique et de Pêche (IMROP)	Environmental impacts
	Fédération Nationale de la Pêche Artisanale (FNPA)	Social impacts
	Fondation Internationale du Banc d'Arguin (FIBA)	Environmental impacts
	IUCN Mauritania	Environmental impacts
Project Proponent	ARISE Head Office	Economic interests
	ARISE Shareholders	Economic interests
	ARISE Financial Partners (e.g. Meridiam)	Economic interests
	ARISE Employees (including contractors)	Social impact; Economic interests

4.2 Stakeholder Analysis

The objective of the stakeholder analysis is to categorise the identified stakeholders and determine which ones:

- Are directly and/or indirectly affected by the project (or Project's operations);
- Have interests in the project or present companies that determine them as stakeholders; and
- Have the potential to influence projects outcomes or Project's operations.

Stakeholder interest is defined as the extent to which the interests of a stakeholder are affected by the Project, either due to the Project's direct impact on them or because of political, financial, social, cultural, scientific or technical interests in the Project. These interests can either be positively or negatively affected leading to either an improvement or deteriorations in a stakeholder's baseline conditions.

Stakeholder influence refers to the power that a stakeholder has over the Project's outcomes. Influence can be direct or indirect. Indirect influence derives, for example, from a stakeholder's ability to influence others or their access to important information. Formal influence may derive from their ability to directly affect decision making through, for example, the issue of government approval and permitting decisions.

A common approach for the identification of the importance of stakeholders is to map the stakeholder's impact on the Project against the extent to which the Project may impact the stakeholder. A matrix is illustrated below in Figure 4-1.

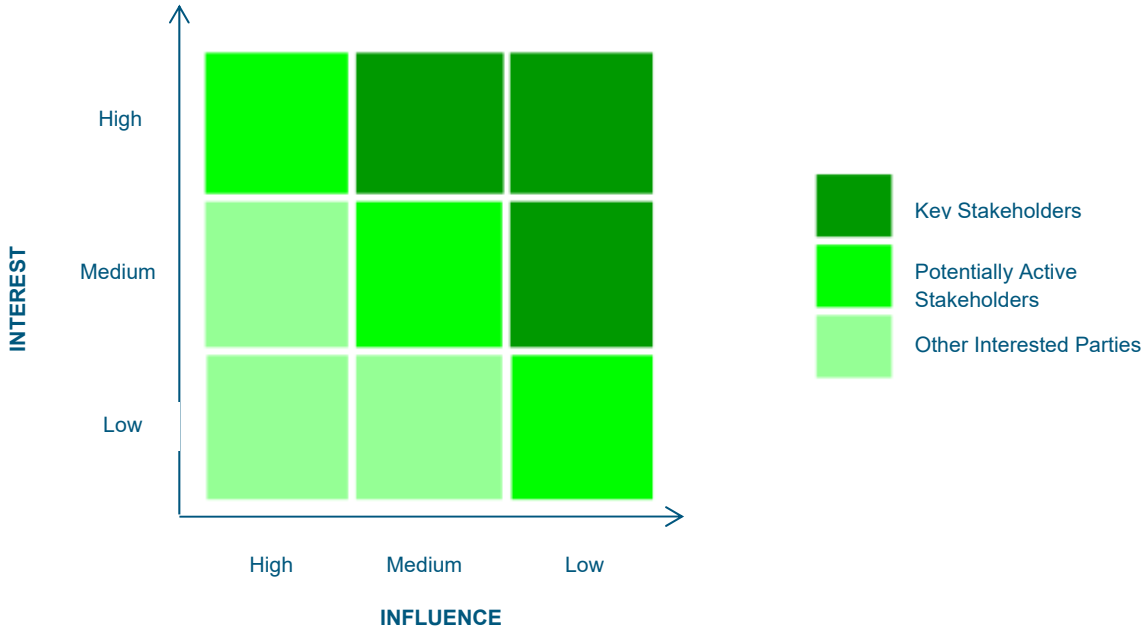


Figure 4-1: Illustrative indication of how potential impact of project / stakeholder relationship exists

The matrix outlines three levels of stakeholders. Table 4-2 outlines the engagement approach and corresponding objective of stakeholder consultation.

Table 4-2: Engagement approach and objective per stakeholder category

Stakeholder category	Engagement approach	Engagement objective	Strategy / main actions
Key stakeholders	Participation	To arrive at a mutually satisfactory way forward through dialogue; building a strong relationship with the relevant stakeholders and including them in the processes of analysis and decision-making.	• Maximum feedback importance • Personal, frequent contact • Priority for information sharing
Potentially active stakeholders	Consultation	A flow of information between the Project and the public to obtain stakeholder input and feedback; this provides opportunities for the public to express views and issues.	• Maintain regular contact • Closely monitor level of interest and involvement • Prioritise information sharing as needed
Other interested parties	Information	A one-way flow of information from the Project to the public. In international best practice this is sometimes termed “disclosure” and is not considered a sufficient approach to real stakeholder involvement. However, it’s essential in conjunction with consultation.	• Maintain briefed and informed • Occasional contact • Discreet monitoring

Higher levels of disclosure and consultation correspond to the provision of more detailed project information and more in-depth discussion in relation to project impacts. Lower levels of disclosure and consultation represent more limited project information and discussion and are generally less technical and less specific in nature.

Stakeholders that have both high influence and high impact will be continuously engaged and kept fully informed throughout the Project. Those with high influence include both ‘decision-makers’ and ‘opinion leaders’ and are thus considered ‘Key Stakeholders’. Stakeholders that have low influence but high interest will also be kept well informed and involved in a process of informed consultation and participation, so that their views are taken into account in project decision making, and are therefore considered ‘Potentially Active Stakeholders’.

4.2.1 Key stakeholders

Table 4-3 lists out the potential key stakeholders. Key stakeholders have a high level of interest and influence in the project, particularly regarding approvals, and those who are likely to experience direct impacts.

Table 4-3: List of potential key stakeholders

Stakeholder	Justification
Port Autonome de Nouakchott dit Port de l’Amitié (PANPA)	• Control and operate the port, thus could restrict or limit Project activity
Local Fishermen Associations (SMPN, SMCP and FLPA)	• The Project may cause resentment amongst fishers, if their activities are limited or reduced due to Project activities, particularly when crossing the port entrance channel and any impact of fish stocks
Ministère des Pêches et de l'Economie Maritime	• A negative impact on the fishing industry may result in pressure from the Ministry towards the Project

Stakeholder	Justification
Ministère de l'environnement et du développement durable	• A negative impact on the environment may result in pressure from the MEDD towards the Project
Direction du Contrôle Environnemental (DCE)	• A negative impact on the environment may result in pressure from the DCE towards the Project
Ministère du Pétrole, de l'énergie et des Mines	• A negative impact as a result of the Project may impact hydrocarbon imports into the country; the Ministry may be able to influence Project direction as a result
ARISE Employees	• Project personnel and employees have an interest in preserving their jobs, and good health and safety conditions.

4.2.1.1 Potentially active stakeholders

Table 4-4 lists out the potentially active stakeholders. These are stakeholders who are likely to voice their opinions and/or concerns about the project and who may experience indirect impacts.

Table 4-4: List of potentially active stakeholders

Stakeholder	Justification
Port Employees	• If employees feel they may be impacted (for example, less work during construction) then they may disrupt Project activities
Financial Partners	• If the Project does not comply with the necessary legislation and requirements, Project finance will likely be delayed
Local Industry located in the vicinity of the Project and directly affected by the Project	• Whilst not directly impacted, industries located within the Port vicinity could see increased competition (for resources and trade), increase traffic volume on the roads, resulting in an indirect impact
NGOs	• NGOs have the ability to resist or support Project activity, particularly those actively participating in social and environmental development.

4.2.2 Other interested parties

Table 4-5 lists out the potential other interested parties. These are stakeholders who are likely to voice their opinions and/or concerns about the project but are unlikely to experience any impacts from the project.

Table 4-5: List of other interested parties

Stakeholder	Justification
ARISE Head Office	• The Project Head Office has both a business and thus financial interest in the performance and compliance of the Project
ARISE shareholders	• Shareholders have a financial interest in the performance and compliance of the Project.

4.2.3 Disadvantaged or Vulnerable People

The IFC Performance Standards defines **disadvantaged or vulnerable people** as stemming "*from an individual's or group's race, color, sex, language, religion, political or other opinion, national or social origin, property, birth, or other status. The client should also consider factors such as gender, age,*

ethnicity, culture, literacy, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources"

If disadvantaged or vulnerable groups are identified, it is important that the Project is able to identify the limitations that the identified groups may have in accessing Project information and participating in the consultation process. Care should be taken that Project information is available in relevant and required languages, transport be provided if needed (or consultation meetings held in convenient locations), and additional measures considered that allow for an encompassing engagement process.

5 Previous Stakeholder Engagement Activities

ARISE and the Project's ESIA team (Royal HaskoningDHV and EnviroConseil) have undertaken/ are undertaking engagement with stakeholders as part of the NCT ESIA process. An overview of the engagement activities related to this process is presented below.

According to IFC Performance Standards, the first stage of engagement during the ESIA process is intended to provide the community a chance to express its opinion regarding the main issues related to the impact assessment, to ensure that no issue has been missed. This first stage took place during the ESIA Scoping Study which took place on 22 November 2018 at the same time as the official public consultation held for the National EIA.



Figure 5-1: November 2018 consultation meeting

Additional stakeholder engagement activities were then conducted during the ESIA baseline data collection which took place in January 2019.

The second stage of engagement during the ESIA process focuses on disclosing and consulting on the results of the ESIA process. The specific objectives of this stage of engagement are to 1) provide feedback to the stakeholders on the draft impact assessment and associated management/mitigation measures (disclosure); and 2) gather stakeholder input on the initial impact assessment and identified mitigation and enhancement measures (consultation). This second stage of engagement was initiated with the organisation of a public consultation meeting to which all key stakeholders were invited. The meeting took place on 25 April 2018.



Figure 5-2: April 2019 consultation meeting

An overview of the engagement activities conducted so far is outlined in Table 5-1.

Table 5-1: Previous stakeholder engagement activities

Stakeholder Group	Purpose	Communication Tools/Techniques	Date occurred	Information Discussed	Responsibility
FLPA fishing union	Gather baseline data regarding fishing grounds and access	Focus group meetings	19th November, 2018	• High level understanding of local fishing regulations • High level discussion regarding fishing rights and access • Discussion of potential mitigation measures and previous impact of offshore petrochemical exploration. *NB. A high level summary of this meeting is included in* **Appendix 1**	ARISE RHDHV EnviroConseil
National Authorities Port Employees Local Fishermen Associations NGOs	Project information disclosure	Formal meeting; Round table discussion	22nd November, 2018	• The siting of the oil jetty inside the harbour; preference was for it to be located outside to reduce pollution inside the harbour; • Whether the effect of ocean swell had been considered in the design; • Concerns on the effects of coastal erosion brought on by Project activities; and • Establishing visible markers of the boundaries of restricted shipping lanes and permitted crossing points. *NB. Minutes of this meeting are included in* **Appendix 2**	ARISE RHDHV EnviroConseil
Port Management (DG level)	Project information disclosure Introduction Financial Partner	Formal meeting	4th December, 2018	• Introduction partners • Project development • Requirements of Financial Partner	ARISE RHDHV
EPC Contractor	Inform Financial Partner on scope of works of Contractor	Project Discussion	5th December, 2018	• Detailed scope of construction works • Capabilities of Contractor	ARISE RHDHV
Shipping / Container Handling (SMPN)	Project information disclosure, gather baseline information	Focus group meetings	24th January, 2019	• Project information; • Dredging being limited to just the turning circle; • The siting of the oil jetty inside the harbour; preference was for it to be located outside to reduce pollution inside the harbour; • Activities impeding on existing work inside the port • Dredging could stabilise existing port infrastructure *NB. A high level summary of this meeting is included in* **Appendix 1**	ARISE RHDHV EnviroConseil
Shipping / Container	Project information disclosure,	Focus group meetings	24th January,	• Concern over access roads within the Port being impacted or	ARISE

Stakeholder Group	Purpose	Communication Tools/Techniques	Date occurred	Information Discussed	Responsibility
Handling (APM Terminals)	gather baseline information		2019	closed during construction - access to berths is critical for operations • High levels of coordination would be needed to ensure dredging activities does not impede on access and shipping activities • Project would create fierce competition for current operators within the Port, but overall good for the economy • APM Terminals will start their own construction Project, it is hoped that this won't be impeded. *NB. A high level summary of this meeting is included in* **Appendix 1**	RHDHV
Dockers Association (Securim SRMOP)	Project information disclosure, gather baseline information	Focus group meetings	24th January, 2019	• Main concern was with regards to the use of the workers represented by SRMOP. Any need during port construction of their unskilled workers would be well seen by Port Authority and Government. The association also represents a hundred or so specialized workers such as crane operators. • Raised concerns about increased health and safety risks brought about by the Project, namely due to increased road traffic and risk of accidents, as well as increased air pollution due to marine and road traffic. *NB. A high level summary of this meeting is included in* **Appendix 1**	ARISE RHDHV
Local Business (Les Grandes Moulins de Mauritanie)	Project information disclosure, gather baseline information	Focus group meetings	25th January, 2019	• Did not foresee any problems with the Port expansion Project. • Increased capacity and flexibility of the Port will be beneficial to business in general. • GMM is planning an expansion of their storage facilities adjacent to their current operation; this increased traffic may have short term impacts on the road network. *NB. A high level summary of this meeting is included in* **Appendix 1**	ARISE RHDHV
Shipping / Container Handling (CMA-CGM and OPM)	Project information disclosure, gather baseline information	Focus group meetings	29th January, 2019	• Did not foresee any issues as long as Project activities do not interfere with their operations • Query over the dredging being limited to only the turning circle, and not the whole of the Port • Dredging may influence water circulation and thus erosion inside the port.	ARISE RHDHV

Stakeholder Group	Purpose	Communication Tools/Techniques	Date occurred	Information Discussed	Responsibility
				• The current breakwater is not sufficient for the port • Query regarding the commercial impact, and having commercial exclusivity during operations *NB. A high level summary of this meeting is included in* **Appendix 1**	
Local Authorities (Wayila Nouakchott Sud)	Project information disclosure, gather baseline information	Focus group meetings	30th January, 2019	• Waste management is a large problem in Nouakchott, and is largely unnoticed. There is only one waste management facility • Concern about high demand for resources (aggregate) and associated increase in traffic • Coastal erosion and dune restoration is a large ongoing concern • Proposed resettlement of informal settlement within the industrial zone, 5km north of the port. • Baseline health information; facilities, and common diseases • Baseline education information *NB. A high level summary of this meeting is included in* **Appendix 1**	ARISE RHDHV
NGO (IUCN Mauritania)	Project information disclosure, gather baseline information	Focus group meetings	30th January, 2019	• General positive and negative impacts from the Project • Negative impacts mentioned include coastal erosion, and disturbance of migration routes and breeding areas *NB. A high level summary of this meeting is included in* **Appendix 1**	ARISE RHDHV EnviroConseil
Fishing / Container Handling (SMCP)	Project information disclosure, gather baseline information	Focus group meetings	30th January, 2019	• Project could lead to a positive impact on Nouakchott fishing industry *NB. A high level summary of this meeting is included in* **Appendix 1**	ARISE RHDHV EnviroConseil
All relevant stakeholders	Draft ESIA disclosure	Formal meeting in plenary session	25 April 2019	*Minutes of this meeting are included in* **Appendix 6**	ARISE Meridiam RHDHV EnviroConseil

6 Planned Future Stakeholder Engagement Activities

6.1 Disclosure of the Draft Final ESIA

As explained in section 3.2.2, in line with IFC's Access to Information Policy, the Draft Final ESIA will be disclosed to the general public for a minimum period of sixty (60) days.

A Non-Technical Summary (NTS) translated into French and Arabic will be added to the disclosure documentation.

At the start of the disclosure period the disclosure documentation will be posted on ARISE website and one hard-copy made available at ARISE office or another office where the public have access. Feedback forms will accompany the disclosure documentation and written guidance will be given in English and French on how comments can either be placed at the Company's office (ARISE MAURITANIA, Port Autonome de Nouakchott – BP 7303 Nouakchott – Mauritanie) or email address (mauritanie@AriseNet.com). It is recommended to have ARISE CLO contact details mentioned as he will be the point of contact for this process and in charge of collecting all comments.

The stakeholders identified in the SEP will be informed about the disclosure documentation by e-mail or letter.

At the end of the disclosure period a Final ESIA report will be issued taking into considerations the comments received during this period.

6.2 Stakeholder Engagement Approach during Project Construction and Operation

The objective of the consultation during the construction and operation phases is to maintain positive connections between the Project and its human surroundings. Increasing transparency and promoting trust throughout the different stages of the project life-time aims at strengthening stakeholder engagement processes built in the stage previous to the Project commencement. People will have the opportunity to specify their concern and potential complaints due to the activities or impacts, and to discuss the community and development actions that the Project is planning to implement in the future.

The Project shall maintain and operate a phone line at minimum to allow stakeholders to contact the Project and raise concerns and questions. This channel of communication shall be active during both construction and operation phases, and responses shall be communicated within a reasonable response time.

The proposed stakeholder engagement approach and purpose that is to be used during the Construction phase is outlined in Table 6-1.

Table 6-1: Proposed engagement approach and purpose during the Project construction

Stakeholder Group	Purpose	Communication Tools/Techniques	Date occurred or Timeframe/Frequency	Information Discussed	Responsibility
National and Local Authorities	• To inform authorities of the proposed construction details, schedule and any anticipated delays. To work effectively towards operational licenses. • To obtain any relevant stakeholder feedback, including complaints, received by email, letter or phone by MEDD.	• One-to-one meeting • Formal letter/ email • Meeting note form	• At the start of construction, and then periodic reporting (frequency to be agreed with authorities) of any changes until end of construction	• Construction schedule • Certain key method statements for dredging and piling • Safety studies	ARISE Contractor
Local Fishermen Associations	• To provide more detailed baseline data regarding catch size, variations, species. • To obtain any relevant stakeholder feedback or grievances that may have ARISEn since the Scoping phase	• One-to-one meeting • Focus group meetings • Public information boards • Website	• At the start of construction, and then periodic engagement tailored to specific needs of stakeholder/ Project until end of construction	• Relevant construction milestones, in particular reference to marine activities • Potential environmental and social impacts • Any relevant monitoring results • Grievances raised and resolved	ARISE Contractor
Port Employees	• To provide accessible information about the project so that stakeholders are well informed at all times • Share environmental performance results and demonstrate transparency • Communicate emergency response procedures to minimise risks to the Port Employees	• Public consultations • Focus group meetings • Public information boards • Website	• At the start of construction, and then periodic engagement tailored to specific needs of stakeholder/ Project until end of construction	• Relevant construction milestones, in particular reference to marine/port activities • Potential environmental and social impacts • Any relevant monitoring results • Grievances raised and resolved	ARISE Contractor
Businesses, NGOs	• To provide accessible information about the project so that stakeholders are well informed at all times • Share environmental performance results and demonstrate	• Public consultations • Via Steering Committee • Media • Public information boards • Website	• At the start of construction, and then periodic engagement tailored to specific needs of stakeholder/ Project until end of	• Relevant construction milestones • Potential environmental and social impacts • Any relevant monitoring results • Grievances raised and resolved • Updates if any to Emergency	ARISE Contractor

Stakeholder Group	Purpose	Communication Tools/Techniques	Date occurred or Timeframe/Frequency	Information Discussed	Responsibility
	transparency • Communicate emergency response procedures to minimise risks to the public		construction	Response Plans and Procedures	
Project Employees	• Ensuring that any engagement between the construction workforce and external stakeholders follows ARISE's and the EPC contractors principles and messages • Enforcing and monitoring construction management procedures that prevent impacts on local stakeholders	• Meetings • Tool box talks • Incident reporting • Notice on internal bulletin boards	• Monthly, until end of construction	• Emergency Response Plans and Procedures • Labour standards • Security workforce protocols • Grievance Procedure	ARISE Contractor

7 Resources and Responsibilities

Table 7-1 sets out key roles and responsibilities to manage stakeholder engagement during the Construction phase of the Project. Roles and responsibilities are likely to evolve as the Project progresses.

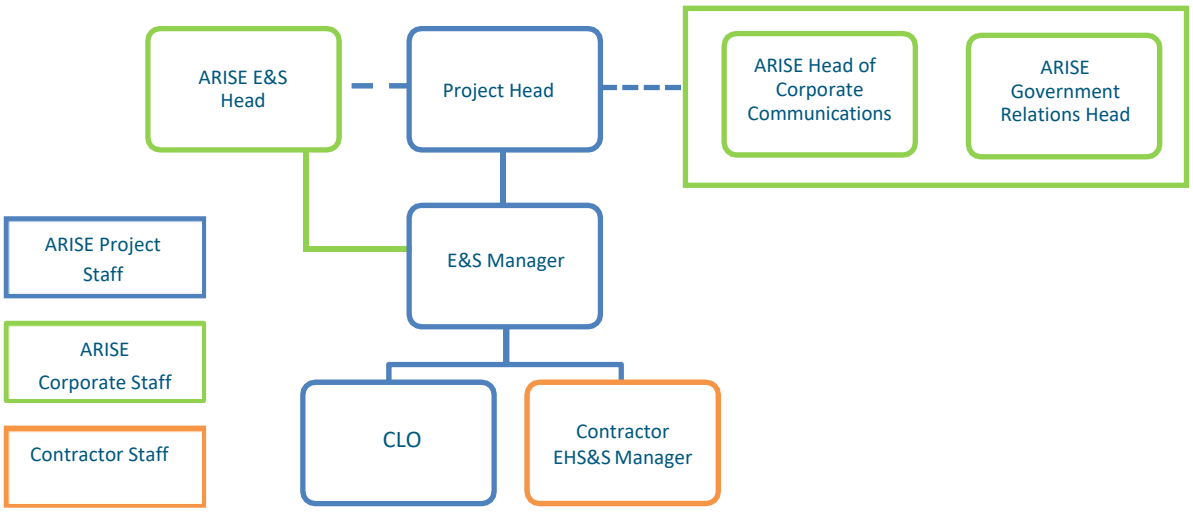
Table 7-1 Key roles and responsibilities for Stakeholder Engagement during the Construction phase

Position / Title	Role	Responsibilities
ARISE Project Head	Responsible for overall Project delivery	• Ensuring that the stakeholder engagement strategy is communicated internally and that the staff, resources and systems are in place to enable the strategy and this SEP (including Grievance Mechanism) to be implemented. • Ensure coordination and consistency across all stakeholder facing activities by all parties. • Ensure relevant ARISE staff are briefed in a timely and consistent way about the SEP. • Reviews weekly monitoring report from Environment and Social Manager on SEP activities and outcomes and, where necessary, reports issues of concern to ARISE Environment and Social Corporate Head, ARISE Government Relations, and/ or ARISE Head of Corporate Communications. • Participates in quarterly SEP monitoring and evaluation review meeting.
ARISE Government Relations	Point of liaison between ARISE and Government stakeholders	• Advises on any government-focused aspects of stakeholder engagement. • Participates in consultations with government stakeholders where required. • Participates in quarterly SEP monitoring and evaluation review meeting.
ARISE Head of Corporate Communications	Leads ARISE communications strategy	• Sign-off on any media communications. • Sign-off on any publicly disclosed project information. • Periodic review of SEP to ensure it aligns with ARISE wider corporate communications strategy. • Participates in quarterly SEP monitoring and evaluation review meeting. • Work closely with ARISE stakeholder team.
ARISE Head of Corporate Environment & Social	Leads the development of and oversees implementation of ARISE environmental, health and safety and social governance framework	• Periodic review of SEP to ensure it aligns with ARISE corporate social standards. • Provides senior guidance and advice on stakeholder engagement strategy as needed. • Participates in quarterly SEP monitoring and evaluation review meeting.
ARISE Environment and Social Manager	The ARISE Environment and Social Manager will act as liaison between ARISE and local communities and manage the implementation and monitoring of the SEP and Grievance Mechanism	• The Environment and Social Manager will work supported by Community Liaison Officer (assigned specifically to the Project) and act as a focal point for communications between local populations and the Project. • Liaising on a weekly basis with the EPC Contractor - General Manager on the construction schedule and milestones, focusing on potential forthcoming disturbances and restrictions that may potentially affect stakeholders. • Planning, implementing and conducting day-to-day ongoing management of stakeholder engagement including periodic update of the SEP. • Monitor grievance management and assist in resolution of grievances where required. • Communicate the Grievance Mechanism and oversee training to community representatives, ARISE management, staff and contractors, as appropriate. • Receive daily reports on stakeholder engagement from Contractor

Position / Title	Role	Responsibilities
		EHS&S Manager & ARISE CLO. • Provide weekly reports to the Project Head regarding engagement and grievances. • Lead quarterly SEP monitoring and evaluation review meeting.
ARISE Community Liaison Officer (CLO)	The CLO reports to the Environment and Social Manager and acts as liaisons between ARISE and local communities and stakeholders	• Day-to-day point of contact between the Project and local communities and stakeholders. • Record grievances received by stakeholders and follow Grievance Mechanism procedure to allow their resolution. • Keep affected populations updated on project activities through use of formal and informal consultation methods. • Organisation and administration of consultation events including managing logistics, recording attendance and taking minutes of meetings. • Report feedback received from stakeholders to the Environment and Social Manager and Project Head. • Provides daily report to ARISE Environment and Social Manager on stakeholder issues.
Contractor EHS&S Manager	Manages the contracted activities and reports to ARISE on progress. Once appointed, the contractor will take over day-to- day responsibilities for implementation of the SEP and Grievance Mechanism	• Facilitate coordination and consistency across all stakeholder facing activities by working with all parties (including construction staff and ARISE) to carry out coordinated engagement activities and deliver consistent information and messages. • Implementing and monitoring the use of stakeholder engagement procedures by contractor staff and sub-contractors. • Document all stakeholder engagement activities in the Stakeholder Database. • Providing weekly report on stakeholder issues to the ARISE Environment and Social Manager. • Participate in quarterly SEP monitoring and evaluation review meeting. • Notify and involve ARISE Environment and Social Manager where necessary to address stakeholder issues of concern.

Table 7-1 shows an overview of the expected Project team organisational structure

Figure 7-1: Stakeholder Engagement Organisational Chart



8 Grievance Mechanism

8.1 Introduction

This section describes the process by which people affected by the project can bring their grievance to the Project, in a culturally appropriate manner for consideration and redress. Every person impacted by the Project will be able to use this mechanism in accordance with the procedure described below, preserving the right to take legal action through Mauritanian law enforcement authorities. The process has three levels:

- Provision for the establishment of a grievance redress committee that is representative of all stakeholders;
- Registration of grievance by the Project;
- Processing of grievance by the Project until a decision is made to close a claim or complaint based on actions undertaken by the Project; and
- Amicable arbitration in case the submitter is not satisfied with the result of grievance processing by the Project, involving a committee independent of the Project.

In the interest of all parties concerned, the grievance redress mechanisms are designed with the objective of solving disputes at the earliest possible time. World Bank OP. 4.12 emphasises that the project affected people (PAPs) should be heard and as such, they must be fairly and fully represented. Further, the mechanism should implicitly discourage referring matters to the court system for resolution.

The Grievance Mechanism provides a structured way of receiving and resolving grievances. The Grievance Mechanism is provided in **Appendix 3** to this document. The mechanism will be used for the duration of the project lifecycle. Grievances will be monitored to provide signals of any escalating concerns or disputes.

8.2 Grievance Mechanism Database

The purpose of the Grievance Mechanism Database (GMD) is to collect, manage and monitor data on grievances in line with good international industry practice (GIIP). Updating the database will also be the responsibility of ARISE Environment and Social Manager and the Contractor EHS&S Manager, with assistance from the Community Liaison Officer, as necessary. The GMD will be web-based and accessible to ARISE personnel with appropriate security clearance.

The GMD will comprise of the following elements:

- **User dashboard:** the dashboard will be the first screen visible to the user once they have logged in and will display key information from the database relevant to the user and their role.
- **Grievance Entry/ Review:** This form will allow the entry and review of the grievance record, starting from the original Grievance Report Form (see Appendix B to Grievance Mechanism) and proceeding through grievance communication and resolution. The user will be able to upload files related to the grievances (e.g. photos and videos from grievance investigation, letter, etc.) which can be downloaded when required.
- **Analytics and Reporting:** The user dashboard will show a snapshot of the data in the system relevant to the user, on occasion it will be necessary to analyse and report on data in the system in more detail. The user will be able to download the data using a filter and the information will be displayed through a web interface or through reports which can be downloaded.
- **Communication Log:** the communication log will show a tabled log of all communications recorded in the GMD. It can be tailored to only show the record selected in the table as each record will be related to a grievance.

The GMD will also allow the user to generate a number of types of reports in order to ensure compliance with the needs of the lenders and other project sponsors. The reporting function will allow the user to download weekly/ monthly or annual reports outlining the status of the grievance process for the Project.

9 Monitoring and Reporting

9.1 Management of Engagement Activities and Documentation

Transparent documentation of engagement activities will enable ARISE to track stakeholders' perceptions and concerns regarding the development of the Project, facilitate the identification of additional stakeholders and stakeholder groups, and track the effectiveness of engagement activities.

9.2 Record of Engagement Activities

Attendance will be taken for all consultation meetings and minutes will be written up following the meeting. Meeting minutes will be taken to record all stakeholder comments or concerns received during meetings and key points from consultations will be recorded in the Stakeholder Database. If unscheduled meetings are held between stakeholders and ARISE or the Contractor that lead to substantive matters and discussions, then the meeting should still be recorded in the database. A template for recording minutes is presented in **Appendix 4**.

The purpose of recording meetings in the Stakeholder Database is to allow ARISE and other interested parties (with appropriate permission) to monitor and evaluate the level and efficiency of stakeholder engagement activities undertaken for the Project and will assist with decision making when observing the level of recurrence of issues and concerns stakeholders have raised during a certain period of time.

9.3 Monitoring of Stakeholders Engagement and Satisfaction

The ARISE Environment and Social Manager and the Contractor EHS&S Manager will be required to record all stakeholder engagement activities undertaken during the Pre- Construction and Construction phases to ensure that all engagement and communications are fully documented; to track actions and commitments; and which can also potentially link with or support the grievance mechanism.

The system will accurately record and track, at a minimum:

- Stakeholder contact details for all stakeholders (including key contact person(s) within organisations such as Ministries, government offices or departments, NGOs, etc.);
- Stakeholder analysis results (e.g. impact, influence) and other profile information (key concerns, etc.);
- Consultation conducted with each stakeholder (or stakeholder group);
- Description of key point of discussion or activities to be undertaken;
- Categorisation of issues raised (e.g. access to information, resettlement and compensation; water and waste management, air quality, noise and vibration, ESIA process, employment);
- Any follow-up actions required to address concerns and issues recorded and their status (e.g. pending or delivered).

Any comments raised by stakeholders during engagement which may constitute a complaint or grievance should be addressed in line with the requirements of the Grievance Mechanism Database (see Section 10.2). It is the responsibility of the ARISE Environment and Social Manager and the Contractor EHS&S Manager to ensure that any commitments made to stakeholders can be tracked and are delivered upon.

Stakeholders will continue to be identified through the Project lifecycle, including during construction, operation, and beyond. Accordingly, the database will be continuously updated. The Project Stakeholder Database is contained in **Appendix 5**.

9.4 Audit of Stakeholder Satisfaction

In order to monitor properly that the Stakeholder Engagement Plan is adequate and properly implemented, a set of stakeholder satisfaction indicators should be set up before the end of Phase 2 of the Stakeholder Engagement program. During construction and operations of the Project these indicators should be regularly audited (twice a year for instance).

9.5 Report to Stakeholders

A report on environmental and social performances, actions and initiatives should be drafted yearly and disclosed digitally on the Project and Financial Partner's website.

9.6 Stakeholder Engagement Plan Update

This document is a 'living' document that will need to be updated regularly as the Project progresses. The document can be updated at any point as new information emerges or project milestones change. However, as a minimum, the document should be reviewed:

- Quarterly during pre-construction and construction.
- When on-going stakeholder engagement provides new information or requires a change in strategy or approach.
- When key Project milestones change.
- On completion of key stages in the Project.
- Following changes in applicable national legislation and/ or regulatory requirements for the Project.
- Following changes in applicable international standards (IFC Performance standards);
- Following changes in corporate policies or commitments.
- Following project decision gates.

9.7 Health, Safety, Environment, and Social (HSES) Update

The Project has a HSES (Health, Safety, Environment, and Social) unit. This unit will also be in charge of the consultation (monitoring) and disclosure actions upon completion of the ESIA and for post-ESIA engagement activities.

Appendix 1
Meeting Notes of Stakeholder Meetings

Meeting Note Form

This form should be used to record details of informal meetings

Place: Port de Peche	**Date/time:** 19th November, 2018
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor, Henk Blok
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Ibrahim Sarr	Director General	FLPA	+222 46 06 81 92
Babana Yahya	Consultant	EnviroConseil	

Summary / Observations	This was the first time the Project had met with Mr Sarr.
Details of stakeholder comments/ requests and responses given	
Comments	- All fishing activity is from the Port de Pêche (Fishing Port) – approximately 12 km north of the Port; - The government limits access for fishing at specified access points, approximately every 25 km; - An exclusion zone exists around the port, as well as specific military zones; - Fishing activity does take place to the south of the Port, as well as to the north; - The fishermen all recognise the exclusion zone around the port, including the entry channel; - The exclusion zone is not marked, and a fine (approximately USD 250) is in place for those who breach the exclusion zone; - The government have provided all fishermen with GPS coordinates of the exclusion zone, but few have GPS devices; - Marker buoys would be a useful addition to assist the fishing community; - Dredge zone A would be preferable for the fishing community, as it is the least preferred fishing zone.
Company Information	FLPA is a fishing organisation that represents fishermen at high level meetings. New regulations, decrees, and matters that affect fishermen are then discussed at round table meetings, then the information is disseminated to the respective fishing associations
Additional Stakeholder Engagement	This was not discussed.
Actions	No follow up actions are required.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: Hotel Azalai	**Date/time:** 23rd January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Hamoud Lemobott	Director General	Société Maritanienne pour la Pêche et la Navigation (SMPN)	+222 46 48 00 93

Summary / Observations	This was the second time that the Project had met with Mr. Lemobott; he was present at the national EIA disclosure meeting.
Details of stakeholder comments/ requests and responses given	
Comments	Mr Lemobott highlighted his concern due to the siting and location of the hydrocarbon jetty inside the Port. His preference would be for the hydrocarbon jetty to be located outside, and in the event of an oil spill or fire, there would be limited to no interruption to the activities and operations within the Port, and better for overall security and safety of the Port. Mr Lemobott highlighted three key areas of concern during the construction phase of the Project: • That work activities will impede on existing work through blocking or limiting of internal circulation; • That the new facility will result in the closure of other existing societies already present at the Port; • That dredging work could destabilize existing port infrastructure resulting in potential collapses of damage limiting their use. Mr Lemobott raised a concern over the dredging being limited to only the turning circle, and not the whole of the inside of the Port. He believes that allow larger boats to come into deeper berths, will limit and ultimately reduce the market for small boats that are able to dock at shallower berths.
Company Information	SMPN is a shipping and freight forwarding company, providing services to Nouadhibou (Mauritania), and Senegal and Mali. They operate a small boat, carrying container transport between Nouakchott and Nouadhibou. There are approximately 100 workers who work for SMPN, with three quarters living in Nouakchott, the rest in Nouadhibou. The majority of the workers in Nouakchott live in close proximity to the Port.

Actions	No follow up actions are required.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: APM Terminals Office	**Date/time:** 24th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Sidat Moustapha	Managing Director	APM Terminals Mauritania S.A.	T +222 45 25 40 98 M +222 44 00 12 34

Summary / Observations	This was Mr Moustapha's first meeting with the Project. An overview of the Project was explained for this reason. The meeting was well received.
Details of stakeholder comments/ requests and responses given	
Comments	Mr Moustapha raised his concern regarding the access road through the port to the berths 4-7, and the possible consequences and impacts this might have on operations in general if this access is limited during construction period. He was informed that this was not the case. He also raised concern with regards to the dredging activity, and that coordination between the Port Authority, Project, and operators would be vital for this to reduce any delays or limitations in access. He also mentioned that dredging takes place regularly around the world, so with good coordination this shouldn't be a problem. The Project would create fierce competition for operators inside the Port, but overall would be good for the Port's business and the economy of Nouakchott and Mauritania in general as more business will be attracted to the Port. APM Terminals is due to start their own project (probably end of February), involving the paving of their laydown yards with interlocking blocks. It is not foreseen that either project will directly impact each other. Mr. Moustapha mentioned that from February to April, the area of Nouakchott was being affected by storms that made it difficult to impossible to berth.
Company Information	APM Terminals handles the containers for 2 ships per week (shipping is operated by Maersk) and which stay in average for 2 days each. There are approximately 110 staff members in total, who work in shifts each day of the week. Buses are provided by the company to assist with commuting, but staff also use their own cars. Most companies within the Port have their own canteens for workers to use. There is a infirmary being constructed just outside the Port entrance, that will be available for public use (with two ambulances). APM Terminals have contributed towards this infirmary.

Additional Stakeholder Engagement	Mr Moustapha recommended that the Project setup a website as an easy and convenient way to share Project information and updates. He mentioned that most if not all workers within the Port are already aware of the Project.
Actions	No follow up actions are required.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: Port Authority Office	**Date/time:** 24th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Isselmou Sidoumou	President du Groupement	Securim SRMOP	T +222 45 25 92 92 M +222 36 30 92 92

Summary / Observations	This was the second time that the Project had met with Mr. Simoudou; he was present at the national EIA disclosure meeting.
Details of stakeholder comments/ requests and responses given	
Comments	Mr Sidoumou's main concern was with regards to the use of the workers represented by SRMOP. Indeed, there is an estimated 2500 unskilled workers registered with the association and there is not enough work at the port to keep all of them busy. Any need during port construction of such unskilled workers would be well seen by Port Authority and Government. The association also represents a hundred or so specialized workers such as crane operators. He highlighted that the workers in his organisation all have access badges, security clearance, and are familiar with the Port area, and so would be suitable for future employment, particularly for unskilled workers. The association also provides transport for the workers from the association's office to work site. Mr Sidoumou raised concerns about increased health and safety risks brought about by the Project, namely due to increased road traffic and risk of accidents, as well as increased air pollution due to marine and road traffic.
Company Information	SMROP is a Dockers Association that represents over 2500 workers, mainly unskilled, as well as additional casual workers. The workers live all around Nouakchott area, and use buses, taxis, cars to get to work.
Additional Stakeholder Engagement	Mr Sidoumou suggested using a Project WhatsApp number and Facebook page to share information and updates from the Project, as most people have access to and use these platforms.
Actions	No follow up actions are required.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: Les Grandes Moulin de Mauritanie Office	**Date/time:** 25th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Frank Le Bris	Director General	Les Grandes Moulin de Mauritanie (GMM)	+ 222 44 44 50 30

Summary / Observations	This was Mr Le Bris' first meeting and meeting with the Project. An overview of the Project was explained for this reason. The meeting was well received.
Details of stakeholder comments/ requests and responses given	
Comments	Mr Le Bris did not foresee any negative impact or problems with Project on his business operation, or workforce. Increased capacity and flexibility of the Port will be beneficial to business in general. GMM is planning an expansion of their storage facilities adjacent to their current operation; this increased traffic may have short term impacts on the road network.
Company Information	GMM operates both a flour mill and pasta factory. There are approximately 200 workers, most of whom largely live in close vicinity to the mill. GMM uses company buses to transport workers to and from their homes, which is apparently normal for businesses in the region. The nearest health centre is currently in the city centre.
Additional Stakeholder Engagement	This was not discussed.
Actions	No follow up actions are required.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: Port Authority Office	**Date/time:** 28th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Aurélien Gorre	Commerical Area Manager, Africa	CMA CGM	+ 33 (0)4 88 91 59 70
Christophe Jourdan	General Manager	CMA CGM	+ 222 45 25 20 16 / 26 + 222 41 42 70 00
Thomas FROMET DE ROSNAY		OPM	+222 34848889

Summary / Observations	This was CMA CGM's first meeting and meeting with the Project. An overview of the Project was explained for this reason. The meeting was well received.
Details of stakeholder comments/ requests and responses given	
Comments	Neither CMA CGM could foresee any problems with the Port expansion project, as long as the activities did not directly interfere with their operations. A query was made regarding only dredging in the turning circle, and why dredging was not planned for the whole port, as this would allow access for larger ships on all berths. Also regarding the dredging, concerns were raised as the effect that of deepening the turning circle, and the impact on flow/circulation of sediment within the port. It was also emphasised how inadequate the current breakwater is as ships cannot load or offload containers and bulk in berths 1-3 even when docked when swell is present. A question was raised by Mr Jourdan about the commercial impact that the Project will have, particularly regarding commercial exclusivity during operations. Reference was made to previous impact studies for proposed expansion, with no project execution materializing.
Company Information	CMA CGM operates with approximately 90 people working at the Port.
Additional Stakeholder Engagement	The representatives were not aware if the workers were aware of the Project, as information had not previously been shared widely.
Actions	No follow up actions are required.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: Port de Peche	**Date/time:** 28th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor, Audrey van Mastrigt
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Ibrahim Sarr	Director General	FLPA	+222 46 06 81 92
Babana Yahya	Consultant	EnviroConseil	

Summary / Observations	The session consisted of a visit and catch survey of the fish market, followed by focus group discussion. This was the third time the Project had engaged with Mr Sarr, and so detailed discussions were able to take place as he was familiar with the Project.
Details of stakeholder comments/ requests and responses given	
Comments	There is a terrestrial exclusion zone for access to fishing along the coast, which extends 5km north of the Port, to 28km to the south of the Port. Furthermore there is a marine security zone around the Port where small boats are forbidden to enter (this is in line with IMO SOLAS chapter XI-2 (July 1, 2014) 'The International Ship and Port Facility (ISPS) Code'). A fine is in place if any fishing boat breaches the security zone, including crossing the access channel; the fine ranges from approximately €250 - €4800. There are no clear demarcations of the security zone thus it is not always clear for the fisherman where they can and cannot pass. Artisanal fishing boats are defined as boats that are less than 12m in length, which consist of a crew of 4-8 people. Larger boats are used; up to 26m in length with crews of up to 30 men use purse seine nets, often assisted by smaller boats. There are between 3000-5000 boats in Nouakchott, and approximately 800 Senegalese fishermen. The fishing industry in Mauritania employs over 100,000 people both directly and indirectly. Of this, 45% of the fishing industry is centred in Nouadibou, and the remaining 55% along the coast of Mauritania. Port development could bring about additional infrastructure and facilities benefiting the fishing industry; currently the primary industry is in Nouadibou, such as processing plants. This will be beneficial to the local industry in Nouakchott. However, more marine traffic and larger hydrocarbon vessels bring a higher risk of collision and potential pollution. This would be detrimental to the fishing industry. Compensation measures are in place if this happened. A quota system is used to monitor and limit fish catches. Each boat has a certain quota per year, and a license is needed to exceed the quota limit. Fish catches are weighed and recorded by the Garde Cote who are based in the Port de Pêche. For information on fish stocks the following websites were suggested: - www.imrop.mr

	- www.peches.gov.mr The following fish species were seen on the market and the beach: - Squid - Sardinelle - Mackerel - Thiof/ Mérou/ white grouper/*Epinephelus aeneus* - Dorade - Gambas and shrimp in freezer - Red scorpion fish? - Bream species - Puffer fish - Rascasse - Rouget barbu - Langouste - Sargo - Crabs - Octopus
Company Information	FLPA is a fishing organisation that represents fishermen at high level meetings. New regulations, decrees, and matters that affect fishermen are then discussed at round table meetings, then the information is disseminated to the respective fishing associations
Additional Stakeholder Engagement	This was not discussed.
Actions	No follow up actions are required.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: IUCN Office	**Date/time:** 30th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Audrey Mastrigt, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Name Unknown	Director General	IUCN	+ 222 45 25 12 76

Summary / Observations	This was IUCN's first meeting regarding the Project. The meeting was well received.
Details of stakeholder comments/ requests and responses given	
Comments	The meeting was well received, and it was appreciated that the Project is acknowledging the importance of conservation and biodiversity. The Project will have a positive impact on the economy of Mauritania, but negative impacts could occur during construction, and therefore it is important to consider environmental protection. An example was given that turtle migration had previously been affected by petroleum exploration. The main negative impact of concern would be changes in the current and circulation of the coastal waters, and the impact that this could have on coastal erosion. A second impact could potentially be on disturbance of breeding and migration of marine species, which takes place throughout the year for different species. As far as he was aware, the coastal waters consist of sand, and more rocks and coral are present in the south towards Senegal. The representative will provide the Project with studies on marine and terrestrial fauna for the local area surrounding the Port.
Company Information	This was not discussed.
Additional Stakeholder Engagement	This was not discussed.
Actions	The Project will wait for additional studies and data to be sent to Ghyslain Pothier.

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: Azalai Hotel	**Date/time:** 30th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Audrey Mastrigt, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
Mr. Mohamed Boukhary	Director General	Société Mauritanien Commercial de Poisson (SMCP)	+222 22364707

Summary / Observations	This was SMCP's first meeting regarding the Project. The meeting was well received. SMCP are perhaps low risk stakeholders; the representative didn't foresee any negative impact, and a detailed discussion took place about the general business climate for the local fishing industry.
Details of stakeholder comments/ requests and responses given	
Comments	The Port expansion could lead to a positive impact on the local fishing industry, with potential expansion on supporting infrastructure, making Nouakchott more competitive with Nouadhibou as a fishing centre.
Company Information	SMCP has a monopoly on the export of fish from Nouakchott. Fish is exported as far as Senegal and Morocco, with 900 containers passing through Nouakchott related to the fishing industry. In Mauritania, Nouadhibou is the largest fishing centre, where large boats in excess of 80m can be received. A smaller dedicated fishing Port has recently been constructed in Tanit, where produce is sent to Nouakchott for export. There are approximately 130 workers for SMCP, with 20 being based in Nouakchott, the remainder in Nouadhibou.
Additional Stakeholder Engagement	This was not discussed.
Actions	

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Meeting Note Form

This form should be used to record details of informal meetings

Place: Wilaya, Nouakchott Sud	**Date/time:** 30th January, 2019
Subject: Focus group meeting	**Note Taker:** Ghyslain Pothier, Stuart Lednor
Attachments: *Attach attendance sheets, photos etc if taken*	

Attendees			
Name	**Occupation**	**Village / Organisation**	**Tel.**
M. Achmed	Regional Director, Education	Wilaya, Nouakchott Sud	
Dr. Ayri	Regional Director, Health	Wilaya, Nouakchott Sud	
Mme Amélio	Regional Director, New Projects	Wilaya, Nouakchott Sud	
Mr. Saydhou Bha	Regional Director, Environment	Wilaya, Nouakchott Sud	
Hilaire Courau		ARISE	
Bertrand Fournier Montgieux		Meridiam	

Summary / Observations	This was the Project's first meeting with the Wilaya, and the meeting was well received and the Wilaya delegation appreciated the opportunity to be informed about the Project. An overview of the Project was given, and each Department member voiced their concerns. Overall, the meeting and discussion focused largely on the problems and risks associated with international companies operating in Nouakchott, rather than specific concerns and queries regarding the Project. It did prove useful in baseline information.
Details of stakeholder comments/ requests and responses given	
Comments	**General information** The people we met are delegates of central government Ministries within the Wilaya. They represent their respective Ministry and coordinate actions related to their specific mandate (Environment, Health, Education and Urban Planning). **Environmental** The regional director was interested in the potential environmental impacts as these don't get enough recognition. It is therefore important to conduct a good impact study, and listen and discuss with stakeholders, as the population does not necessarily know about the impacts that large projects like this can have. Pollution and rubbish is a large problem in Nouakchott, and this largely goes unnoticed. There is only one waste management facility in Nouakchott, which poses a big problem for the environment and the population's health. There is also a municipal incinerator where medical waste is incinerated.

	There will be a high demand for resources (such as aggregate) during construction, and this will lead to more traffic. This increases the risk of accidents and pollution. A major concern and current environmental programme is coastal erosion and dune restoration. This involves the planting of trees and bushes to rehabilitate and stabilise the dunes. Two of the most important sources of dune destabilisation include illegal salt exploitation and vehicle movement on the dunes. **New Projects / Infrastructure** There are planned improvements for electricity, water, and sanitation Projects in the local area. There is also a planned (resettlement) development of the population living in the industrial area (approximately 5 km north of the project) to for a site at PK11, to the east of the city. The reasons for this relocation are two folds: 1) the Wilaya wants to keep the area strictly industrial in terms of zoning; 2) people living in the industrial area are living in unhealthy conditions and frequent fires within the community puts them at risk. The coastal road between Nouakchott and the Port is due to be updated in the near future. **Health** According to Dr. Ayri's statistics, the Wilaya counts 513200 inhabitants and it is the most highly populated Wilaya of Mauritania. The project is located within the community of El Mina which counts 159 957 inhabitants. A new health centre is currently being built adjacent to the Port, opposite the Port Authority office. This will be available for both community members, as well as serving the Port workers. The main illnesses affecting the community are 1) respiratory illness, 2) fever, 3) malaria. For children, the main illnesses are 1) diarrhoea, 2) respiratory, 3) malaria. There are currently several teaching hospitals and health centres within Nouakchott providing healthcare. Within the Wilaya, there is one Hospital, 9 health centres and 8 health posts. In El Mina, there are 3 Health Centre and 4 Health Posts. **Education** The above mentioned diseases have impacts on attendance rates at schools. There are little facilities within the schools, with regards to classroom equipment and sanitary facilities. Ages for elementary school range from 6-15 years, and secondary schools, 15-22 years. In addition to this, there are approximately 12,000 students studying at baccalaureate level, and 10,000 at tertiary level.
Company Information	The Wilaya of Nouakchott Sud is responsible for the local governance of the area. The Regional Directors report to both the local Wilaya as well as a representative within the Ministerial Department
Additional Stakeholder Engagement	This was not discussed.
Actions	

Minutes prepared by:

NAME : Stuart Lednor **TITLE: Consultant (RHDHV)**

Appendix 2
Minutes of Public Consultation Meeting held on 22 November 2018

mauritanie@AriseNet.com
+222 4600 5800

Localisation:	Salle de conférence du Port de Nouaktchott	**Date:**	22 Novembre 2018 à 10h30
Nom du projet:	Construction d'un nouveau parc à conteneur	**Préparé par:**	Ghyslain Pothier
Re:		**Approuvé par:**	Mohit Agrawal

Étaient presents:

Nom	**Agence/Compagnie**	**Nom**	**Agence/Compagnie**
Voir la liste des présences attachées			

Une copie du Procès-verbal est transmise aux participants et à:

Mohit Agrawal	Responsable du projet	**Henk Blok**	**Consultant**
Stuart Lednor	Consultant		

Art.	**Aspects discutés**	**Action par**
1.0	**INTRODUCTION**	
	• Monsieur Ould Beyirouk, Directeur Technique du port de Nouakchott, procède au mot de bienvenu et à un bref récapitulatif du projet qui est en gestation depuis 2009 et dont la réalisation revêt une grande importance pour l'évolution du port et du point de vue économique pour la nation. Il insiste sur le fait que le projet s'inscrit en droite ligne avec le plan de développement envisagé par le Port et qu'il s'agira de son premier terminal de conteneurs.	
	• M. Cheikh Tourad, Directeur du Contrôle Environnemental représentant le Ministère de l'Environnement et du Développement Durable (MEDD) de la Mauritanie, rappel les dispositions réglementaires en vigueur en ce qui concerne la réalisation d'EIE et du processus qui lui est associé. Ce processus est important car le MEDD n'autorise que les projets qui sont techniquement solides, financièrement viables et dont les impacts environnementaux sont acceptables. Il s'avère donc primordial de s'appesantir sur les aspects négatifs et proposer des mesures d'atténuation appropriées. Il encourage enfin la société ARISE à travailler en étroite collaboration avec les services compétentes du MEDD afin d'assurer un suivi environnemental efficace du projet.	
2.0	**PRÉSENTATION DU PROJET PAR ARISE**	
	• M. Pothier, Responsable Environnement, Social et Gouvernance chez ARISE, procède à la présentation du projet en effectuant : o Une mise en contexte ; o La présentation du promoteur et de son consultant ; o La description du projet et de ses composantes ; o La description des principales composantes environnementales ; o Le sommaire des principaux impacts relevés pour les milieux physique, biologique et social ; o L'énumération des mesures d'atténuation proposées ; o Le sommaire des impacts résiduels anticipés ; o L'annonce des étapes à venir.	
3.0	**PÉRIODE DE QUESTIONS ET DE DISCUSSION**	

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Art.	Aspects discutés	Action par
	• M. Hamoud Ismail de la Société Mauritanienne de Pêche et de Navigation, a demandé des précisions sur ce qui suit : ○ La date du début des travaux et leur durée ? ▪ *M. Pothier précise que la date exacte du début des travaux dépendra de la fin du processus environnemental et de la finalisation du design technique, mais qu'ARISE souhaite initier les travaux au cours du premier trimestre 2019. Les travaux devraient prendre de 18 à 24 mois à compter de la date de démarrage.* ○ Les activités sur les infrastructures existantes seront-elles affectées ? ▪ *M. Pothier précise qu'il n'est pas prévu que les travaux de la nouvelle plateforme affecteront les activités existantes. Néanmoins, tel que mentionné durant la présentation, un lien de communication continu sera maintenu avec l'ensemble des usagers du port pour les tenir au courant des activités de construction.* ○ Y aura-t-il un monopole pour ce qui concerne la manutention ? ▪ *M. Ould Beyrouk mentionne qu'ARISE gèrera le nouveau parc à conteneur mais pas les activités sur les infrastructures existantes qui resteront opérationnelles.* ○ Le TC et le poste d'hydrocarbure vont certainement augmenter la congestion du port qui est déjà à son sommet. Il y a risque de délocalisation des navires vers Dakar ce qui engendrera des frais supplémentaires sur le fret donc répercussion immanquable sur le consommateur. ▪ *M. Ould Beyrouk mentionne que le parc à conteneur aura ses propres postes à quai augmentant donc la capacité des installations à recevoir des bateaux.* ○ Il est proposé de relocaliser le poste pétrolier à l'extérieur du bassin actuel pour réduire les risques de pollutions accidentelles. ▪ *M. Ould Beyrouk mentionne que pour le moment, il n'est pas envisagé une localisation de ce poste à l'extérieur du bassin.* ▪ *M. Pothier ajoute qu'au niveau de la nouvelle installation, les points de jonction entre les pipelines et les tuyaux du bateau seront situés dans une fosse étanche. Le bassin agit également comme aire de confinement pour maintenir les hydrocarbures à l'intérieur du port facilitant ainsi leur récupération.*	
	• Un opérateur du Port de Nouakchott demande : ○ Si la dimension météorologique a été prise en compte pour développer ce projet et ainsi réduire l'effet de la houle dans le port ? ▪ *M. Pothier explique que le choix même d'une construction sur pieux réduira les effets de la houle au sein du bassin en agissant comme diffuseur de l'énergie des vagues qui viendront mourir sous la plateforme plutôt que de se réverbérer sur une surface pleine. Comme c'est le cas actuellement.* ○ Si le dragage à l'intérieur du bassin pourrait avoir un effet sur les infrastructures existantes ? ▪ *M. Ould Beyrouk explique que les travaux de dragages prévus ne s'approcheront pas suffisamment près des infrastructures existantes pour qu'ils aient une influence sur celles-ci.*	
	• M. Taghi, DC du PANPA fait les observations suivantes : ○ La localisation du poste pétrolier dans le cadre de ce projet n'est pas judicieuse car, selon lui, il s'agit d'un des endroits du port le plus exposé à la houle. ▪ *Voir l'explication de M. Pothier à ce sujet ci-dessus.* ▪ *M. Ould Yahya mentionne également qu'avec la possibilité d'accueillir des bateaux de 30 000 T à 50 000 T, une réserve d'au moins un mois sera disponible au lieu de 7 à 10 jours. Avec une bonne planification des livraisons, cela permettra d'éviter*	

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Art.	Aspects discutés	Action par
	les pénuries même si les conditions météos rendent le port inaccessible pour quelques jours. ○ Il serait approprié d'installer des brise-vents pour atténuer l'effet des vagues et stabiliser l'enceinte du port. ▪ *M. Ould Beyrouk précise qu'il est prévu prolonger le brise-lame existant pour réduire les effets directs de la houle.* ○ Il faut préciser la relation entre le port et la nouvelle société. ▪ *M. Ould Beyrouk mentionne que cette relation est fixée par une convention.*	
	• M. Ahmedou, responsable de la sûreté du PANPA se demande et observe : ○ Quelles sont les garanties prises par l'État en accordant une concession d'exploitation de longue durée à un investisseur privé ? ▪ *M. Ould Beyrouk mentionne que les garanties sont définies dans la convention signée avec le promoteur.* ○ Le PANPA a des problèmes environnementaux au nord et au sud respectivement en raison de l'engraissement et de l'érosion. Nous n'avons pas vu de simulation de la situation dans dix ans et la prise en compte de la dimension du réchauffement climatique. ▪ *M. Ould Beyrouk mentionne que le projet du promoteur se situant entièrement à l'intérieur du port existant, il ne contribuera pas à ces phénomènes d'où l'absence de telles simulations.* ○ Où va-t-on stocker les 50 000 Tm d'hydrocarbures sachant que les cuves de Nouakchott font à peine 15 000 Tm ? ▪ *M. Pothier mentionne que le mandat actuel d'ARISE se limite à la construction du nouveau parc à conteneur, à la relocalisation du poste pétrolier et à l'installation de nouveaux pipelines jusqu'à un point de jonction situé dans l'espace anciennement occupé par les Chinois. Pour tout aspect concernant le parc à carburant, il faut se référer à la Direction des Hydrocarbures. ARISE pourra, si requis, mettre son expertise dans la construction d'une éventuelle extension du parc existant ; expertise acquise lors de la construction d'un dépôt pétrolier à Libreville au Gabon.*	
	• Me Sidi Ahmed, Coordonnateur adjoint du WACA, souligne que leur préoccupation se porte sur le littoral et qu'ils sont disposés à accompagner la DPC pour le suivi environnemental du projet.	
	• Le représentant de la FNP/SS mentionne que les pêcheurs sont préoccupés par les divers impacts négatifs mentionnés et leur durée et si ces nouvelles activités n'entraîneront pas des restrictions supplémentaires du plan d'eau aux environs du port. ▪ *M. Pothier mentionne que la grande majorité des impacts négatifs relevés seront générés au niveau du port lui-même et qu'ils peuvent être atténués de façon efficace par les mesures d'atténuation proposées. Il mentionne également que les activités d'ARISE n'entraîneront aucune restriction supplémentaire des plans d'eau environnant le port.*	
	• Le représentant de la FLPA (M. Sarr), énumère les demandes suivantes faites par les pêcheurs traditionnaux : ○ Obtenir l'accès au port ou à ses abords lors de mauvais temps. ○ Mettre en place un balisage visible des limites des zones interdites et du point de passage autorisé au niveau du chenal d'accès. ○ Les pêcheurs sont inquiets pour la sécurité de la ressource en cas de déversement de contaminant. ▪ *M. Ahmedou, Responsable de la Sûreté du PANPA, explique qu'en raison des exigences internationaux, notamment celles associées à la norme ISPS, il n'est pas autorisé de laisser s'approcher du port d'autres bateaux que ceux dûment*	

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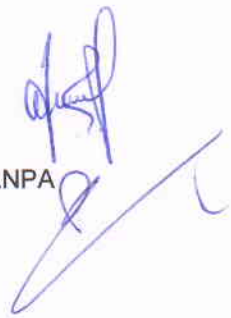
Art.	Aspects discutés	Action par
	prévus à cet effet, soit les navires commerciaux.	
4.0	**MOTS DE LA FIN**	
	• M. Ould Beyrouk remercie tous les participants et réitère l'importance de ce projet pour le port de Nouakchott.	
	• M. Cheikh Tourad, remercie également les participants, le promoteur, l'administration portuaire pour leur contribution à cette consultation publique et souligne la qualité des échanges survenues. Il insiste sur l'importance de telles rencontre qui permettent une meilleure compréhension du projet et la prise en compte des avis et préoccupations des diverses parties prenantes. Il clos la séance.	
	Fin de la rencontre : 12h15	

Approuvé par:

- Cheikh Tourad Mohamed Saad Bouh Directeur DCE/MEDD
-
- Mohamed Fayçal OULD BEYROUK ,Directeur Technique PANPA



ARISE

ENVIROCONSEIL

DATE: 22/11/2018

Consultation Publique du Nouveau Terminal à Conteneurs et à Hydrocarbures

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ARISE

ENVIROCONSEIL

DATE: 22/11/2018

Consultation Publique du Nouveau Terminal à Conteneurs et à Hydrocarbures

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Appendix 3
Grievance Redress Mechanism

Grievance Mechanism

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Appendices

APPENDIX A – GRIEVANCE SUBMISSION FORM

APPENDIX B – GRIEVANCE REPORT FORM

1 INTRODUCTION

1.1 Objective

The purpose of the Grievance Mechanism is to ensure a legitimate, accessible and consistent mechanism for receiving, investigating, consulting on, responding to and resolving formal complaints or concerns that may arise as a direct result of the Project.

The Grievance Mechanism will be implemented in a timely and transparent manner. This procedure provides measures so that the impacts of the Project on stakeholders and Project Affected People (PAPs) can be monitored and, if needed, operations or policies can be adjusted to reduce adverse impacts.

All staff members who are in direct contact with the local community should familiarise themselves with this document. It is of particular relevance to:

- The Contractor who will liaise directly with PAPs on a daily basis during the Construction Phase.
- The ARISE E&S Team (composed of the ARISE E&S Manager and ARISE Community Liaison Officer [CLO]), who will have an open dialogue with the Contractor and monitor all grievances raised on a weekly basis (Section 6.7).

The Grievance Mechanism presented in this document is available to all project affected stakeholders.

It should be noted that workers' grievances will be handled in a separate Workers' Grievance Procedure. This Grievance Mechanism Procedure is also not for incident reporting but may manage grievances arising from incidents. Incident reporting is managed as part of a separate Project Health and Safety Reporting System.

1.2 Grievance Mechanism Principles

The Grievance Mechanism is based on the following principles from the IFC Performance Standards (2012) as shown in Table 1.1

Table 1.1 Grievance mechanism principles

Responsibility	Task
Accessibility	• Accessible to all affected stakeholders. Factors that affect accessibility to the mechanism include: location, access to technology, language barriers, literacy.
Regular communication	• Grievance Mechanism should be publicised to all stakeholders. • Information will be provided in a format and language readily understandable to the local population.
Transparency	• Process will be transparent, readily understandable and appropriate for all affected stakeholders, in particular vulnerable populations. • Indicate at the outset who is expected to use this procedure. • Assure potential users that there will be neither costs nor retribution associated with logging a grievance.
Efficiency	• Publicly communicate and adhere to a timeframe in which all recorded complaints will receive a response. • Grievant will be made aware of when they can expect to be contacted and/ or receive a response to their complaint.
Fairness	• Measures will be put in place to ensure fairness of process for affected parties. • If a resolution cannot be reached, an independent third party will mediate between the Contractor/ ARISE and the grievant.

Responsibility	Task
Written records	• All grievances will be formally recorded/ documented in the Stakeholder Consultation and Grievance Mechanism System (SCGMS)..

2 GRIEVANCE POLICY

ARISE values stakeholder engagement at all levels and recognises that one of the pillars of sustainable development is achieving and maintaining a project's social license to operate. Engagement with the communities in which we operate is a long-term commitment, requiring equitable and transparent means of communication. This engagement is a mainstay of ARISE's aspirations for continuous improvement, facilitating the identification, monitoring and mitigation of the social and environmental impacts of projects.

To that end, and as an integral part of the Project's Stakeholder Engagement Plan (SEP), ARISE has developed a Grievance Mechanism based on Good International Industry Practice (GIIP), including IFC Performance Standards, and examples across various industries and from traditional or customary means for resolving grievances.

All operators working for ARISE will appropriately implement and manage grievances through this Grievance Mechanism, and ensure that all stakeholders have access to this mechanism and are not discriminated against in relation to raising a grievance. **Stakeholders should be reassured that if they raise a grievance against the Project they will be protected from retribution of any kind.**

3 ROLES AND RESPONSIBILITIES

3.1 Overview

During the Construction Phase, the implementation and day-to-day management of the Grievance Mechanism will be the responsibility of the Contractor. The Contractor will appoint an appropriate member of staff who will be responsible for receiving, coordinating, classifying and processing grievances as they are lodged, in accordance with the process and procedures outlined in this document.

The ARISE E&S Team, headed by the ARISE E&S Manager, will be responsible for supervising the implementation of the Grievance Mechanism throughout the life of the Project. Should the Contractor require assistance or clarifications regarding the resolution of grievances they should contact the ARISE E&S Manager directly.

Community representatives will also be involved in the management of grievances, helping to ensure that the mechanism is understood by all community members, providing support to community members to log grievances as necessary, and providing support for conflict resolution in case of appeals.

Upon the appointment of the Contractor, the ARISE E&S Team will initiate the engagement process between the Contractor and community representatives that will have a role in the implementation of the Grievance Mechanism. If these community representatives have not already been identified prior to the Contractor's appointment the ARISE E&S Team and Contractor will work together to identify them. They should be unbiased and trusted community members that can assist in the mediation and resolution of grievances.

3.2 Roles and Responsibilities

Grievance management roles and responsibilities, as well as monitoring and reporting responsibilities, are presented in Table 3.1.The responsibilities outlined for each role are not prescriptive and it is anticipated that the responsibilities will evolve as the Project progresses.

In addition to the roles outlined below, a select group of managers and staff may be given the authority to implement steps and actions when required to resolve certain issues directly with a grievant, without the need for referral. The types of issues that can be resolved directly will be agreed in advance with the ARISE E&S Team and ARISE Project Head. The delegation of authorisation to selected staff to resolve grievances directly will be the responsibility of the Contractor (General Manager).

Table 3.1 Grievance Management Roles and Responsibilities

Title	Role	Responsibilities	Reporting
CONTRACTOR			
Contractor General Manager	Manages the contracted activity, and reports to ARISE on progress. Manages Contractor CLO team.	• Responsible for overseeing the implementation and management of the Grievance Mechanism and Stakeholder Consultation and Grievance Management System (SCGMS). • Works with the CLO to distribute resolution of actions to relevant departments and personnel. • Advises on resolution of significant issues and involves ARISE E&S Team and ARISE Project Head as necessary. • Reviews daily report on grievances from Contractor CLOs.	• Weekly report to ARISE E&S Manager. • Contribution to annual Grievance Monitoring Report.
Contractor CLOs	The Contractor CLO will be responsible for the day-to-day liaison between the Contractor and local communities and will manage the implementation of the Grievance Mechanism.	• Communicate the Grievance Mechanism to communities on an ongoing basis. • For any complaints or concerns raised verbally (by phone or in person), explain the Grievance Mechanism process to the grievant and request that they complete a Grievance Submission Form for Local Communities (Appendix A) (with assistance if needed). • Upon receipt of a grievance, complete the ARISE/ Contractor Grievance Report Form. • Manage all communications with grievant. • Ensure Grievance Submission Forms for Local Communities are available with village representatives and at agreed locations. • Collect Grievance Submission Forms on a weekly basis from Village Representatives. • Review of Grievance Submission Forms received to ensure they have been correctly completed. • Investigate grievances to ensure they are valid, with support from Village Representatives, the Steering Committee and the Hakem, as necessary. • Feedback to Contractor General Manager and ARISE E&S Manager, recommendations about improving Grievance Mechanism or problems encountered implementing the procedure to allow for improvement.	• Daily reporting to the Contractor General Manager and ARISE E&S Manager on grievances raised that day and status of existing grievances. • Contribute to preparation of weekly report.

Title	Role	Responsibilities	Reporting
ARISE			
ARISE E&S Manager	Supervises Contractor and provide assistance to the Contractor and ARISE CLOs to resolve grievances, when necessary.	• Provide training to Contractor General Manager and Contractor CLOs on the implementation and management of the Grievance Mechanism. • Initiate the engagement between the Contractor and the Steering Committee, Hakem and village chiefs. • Oversee initial communication of the Grievance Mechanism to communities and training to Village Representatives, Steering Committee and Hakem on the Grievance Mechanism and ethics of the process. • Oversee and assist the appointment of village representatives and the Steering Committee ensuring there is sufficient representation of disadvantaged and vulnerable groups (ensure woman, minority ethnic groups, landless and migrants are sufficiently represented). • Oversee the implementation of the Grievance Mechanism and follow up with the Contractor on a monthly basis to ensure that there are no outstanding grievances and check if assistance from ARISE is required. • Involve ARISE Project Head or other ARISE management team in resolution of complex grievances where necessary.	• Review of Contractor's daily reports and Weekly Monitoring Report on Grievance Mechanism implementation. • Quarterly reporting to the ARISE Project Head. • Contributes to the preparation of annual Grievance Monitoring Report.
ARISE Community Liaison Officers	Will act as liaison between ARISE and affected communities and manage grievances that are the responsibility of ARISE.	• Assist in the process to select village representatives and the Steering Committee. • Assist in the initial engagement between the Contractor, Steering Committee, Hakem and village chiefs. • For grievances that are the responsibility of ARISE: o Manage all communications with grievant o Investigate and resolve claims in line with the Grievance Mechanism Procedure.	• Weekly reporting to ARISE E&S Manager.
ARISE Project Head	The Project Head reports to the CEO and manages the Contractor and the ARISE E&S Team.	• Oversee that the necessary staff, resources and systems are in place to allow effective internal communication of the Grievance Mechanism and to enable the Grievance Mechanism to be implemented. • Provide on-going advice and support to the ARISE E&S Manager and advise CLOs, operational teams or Contractor, where relevant, to develop a grievance resolution proposal.	• Reviews the quarterly Grievance Monitoring Report. • Reviews the annual Grievance Monitoring Report

Title	Role	Responsibilities	Reporting
		• Work alongside the ARISE E&S Manager, corporate management and sustainability and communications teams to develop resolutions for grievances that pose a significant risk to ARISE's reputation and/ or that attract broad media coverage. • Oversee resolutions for grievances that require a change in operational practices or policies by working with the operations team and providing necessary training or appropriate information to facilitate a change in operational practices or policies. • Implement and monitor the use of ARISE's internal corporate requirements for environmental and social management by contractors and sub-contractors.	
ARISE Social, Health, Safety and Environment Manager	Provide assistance and direction to the ARISE E&S Manager, and monitor the implementation of the Grievance Mechanism in line with overall ARISE procedures and policies.	• Oversee the implementation of the Grievance Mechanism in line with ARISE policies and procedures and work alongside project management, corporate management and sustainability and communications teams to develop resolutions for grievances that pose a significant risk to ARISE's reputation and attract broad media coverage.	• Reviews the Quarterly Grievance Monitoring Report. • Reviews the annual Grievance Monitoring Report
Local Community			
Village Representatives	Two village representatives per village (a male and female) will be elected by their respective communities. Village representatives will act as local points of contact to assist PAPs in understanding Grievance Mechanism and submitting grievances.	• Support the implementation of the Grievance Mechanism by communicating it to PAPs so that it is understood and used appropriately. • Distribute the Grievance Submission Forms for Local Communities to PAPs. • Assist illiterate members of their community to complete the Grievance Submission Forms. • Review of Grievance Submission Forms received to ensure they have been correctly completed and submit to the Contractor within 48 hours of the grievance being lodged by the grievant. • Assist in communicating to the grievant when their grievance has been resolved or rejected and who they should contact should they wish to appeal the response to their grievance. • Provide feedback to the Contractor on the procedure.	• Attend project meetings (when invited) • Feedback on community's perception and use of the Grievance Mechanism to ARISE/ Contractor (when requested).
Steering Committee	The Steering Committee comprises two village representatives from each	• Represent the community's view at consultation events relating to the Project. • Act as mediators in the case of an appeal and provide third party facilitation, when required.	• Attend project meetings (when invited). • Contribute to annual review of

Title	Role	Responsibilities	Reporting
	village (one would normally be the village chief and the second an appointed community member[1]), and government representatives. The Steering Committee assists in resolution of grievances that cannot be resolved directly between a grievant and ARISE/ Contractor.	• Participate in review of the Grievance Mechanism (on trimester basis during first year and annually thereafter during the Construction Phase) to assess its effectiveness and recommend changes where relevant.	Grievance Mechanism. • Feedback as required on Grievance Mechanism to ARISE CLO.
Hakem	Spokesperson for local community. Liaises between PAPs and ARISE/ Contractor.	• For any grievances raised directly to the Hakem, explain the Grievance Mechanism process to the grievant and request that they complete a Grievance Submission Form (with assistance if needed). • Assist ARISE/ Contractor in the investigation of grievances and provide advice on resolving grievances where requested. • Act as mediator in the case of an appeal and provide third party facilitation, when required.	• Attend project meetings (when invited). • Contribute to annual review of Grievance Mechanism. • Feedback as required on Grievance Mechanism to ARISE CLO.

[1] The process for selecting the community representative to accompany the village chief, represent the village and be part of the Steering Committee will be determined in consultation with PAPs. Appointed community members will not necessarily be part of the village administration personnel or a respected noble of the village, and as appropriate, a community representative representing disadvantaged and vulnerable groups should be appointed (e.g. migrants, woman head of household, ethnic minority, landless).

3.3 Training

The ARISE E&S Team will hold an induction on how to implement and manage the Grievance Mechanism to Contractor staff prior to the start of the Construction Phase.

All management and staff in direct contact with communities will be trained on how to actively listen for and register grievances. Training will also be provided on grievance management ethics.

Community members involved in the implementation of the Grievance Mechanism (Village Representatives, Steering Committee members and the Hakem) will be trained by ARISE on the procedure and protocol for filing a grievance.

4 COMMUNICATING THE GRIEVANCE MECHANISM

4.1 Overview

Stakeholders will be informed about the Grievance Mechanism by the ARISE E&S Team ARISE E&S Team and the Contractor through consultation activities, such as public meetings, letters/ leaflets and newspaper and radio adverts, as well as through ad-hoc day-to-day engagements between CLOs and PAPs. Special consideration will be given to vulnerable and harder to reach groups.

The ARISE E&S Team will undertake the initial engagement with the local community to disclose the Grievance Mechanism. Ongoing communication of the Grievance Mechanism to PAPs will then be handed over to the Contractor once appointed. The Village Representatives will also be involved in communicating the Grievance Mechanism to their local villages.

4.2 Key Messages

When communicating the Grievance Mechanism to project affected stakeholders, as a minimum the responsible party should communicate the following:

- Who is eligible to use the mechanism.
- What can be classified as a grievance (provide examples).
- How and where to file a grievance.
- Steps for resolving grievances including grievance investigation process.
- Different types of responses typically provided to the grievant, including timing of responses.
- How the mechanism works in comparison to third party mediation or litigation.

5 TYPES OF GRIEVANCES

5.1 Grievances Managed through the Grievance Mechanism

A number of commonly anticipated grievances may be raised by project affected stakeholders throughout the project lifecycle including but are not limited to:

- Flaws in the consultation process
- Noise and pollution
- Roads and traffic
- Loss of access to resources e.g. fishing grounds
- Access to job benefits (e.g. no or insufficient jobs created for local communities)
- Security forces
- Influx and in migration of workers

The types of grievances outlined above will be dealt with through the Grievance Mechanism and ARISE/ Contractor will be required to follow the procedure and process outlined in the Grievance Mechanism for their resolution.

5.2 Grievances Managed through the Compensation Plan

The Compensation Plan will deal with grievances that are caused by project activity and that relate to:

- Accidental damage to buildings, structures, equipment, machinery, land, livestock, and water resources.
- Accidental clearance of vegetation or structures outside of the project boundary.
- Road traffic accidents that impact livestock, land, buildings or structures.
- Damage to land or sea from spillages.

These grievances will be logged in the SCGMS; however, they will be handled following the procedure outlined in the Compensation Plan.

6 GRIEVANCE MECHANISM PROCEDURE

The Grievance Mechanism involves a number of steps moving from grievance submission and investigation throughout to grievance resolution. The Grievance Mechanism process is described in detail in Section 6.1 to Section 6.8 and presented graphically in Figure 6-1**.**

The Grievance Mechanism process may be updated as the Project progresses based on feedback from PAPs and project staff, and Plate 2 will be updated as necessary.

Figure 6-1: Grievance mechanism process



6.1 STEP 1: Submitting a Grievance

Stakeholders are able to lodge grievances in writing using the Grievance Submission Form for Local Communities (see Appendix A). If a stakeholder is unable to submit a written grievance, they can submit a grievance verbally and the CLO, appointed personnel, Hakem or village representative will record the grievance on their behalf.

A Grievance Submission Form must be submitted for the resolution process to begin.

Grievance Submission Forms will be made available at designated points around the Project Area (e.g. at security gates, carried in selected project vehicles), and in relevant villages with village representatives or at other readily accessible points.

Stakeholders will be able to lodge a grievance at the project construction site office or by email, telephone or letter. Grievances may also be lodged with village representatives or the Hakem who will pass the grievance on to the Contractor.

Provisions should be made for stakeholders who wish to communicate their grievances verbally, are unable to write, wish to remain anonymous or feel uncomfortable approaching a village representative or otherwise, to access the Grievance Mechanism and lodge a grievance (e.g. grievance call line, submission boxes in remote areas or churches).

Village representatives and the Hakem will be trained in the protocol for completing the Grievance Submission Form and can assist stakeholders wishing to make a grievance but shall not negotiate on the Contractor/ ARISE's behalf. The village representatives will **assist illiterate stakeholders** in completing the Grievance Submission Form.

Village representatives and/ or authorised staff are responsible for submitting the Grievance Submission Form to the Contractor within **24 hours.**

6.2 STEP 2: Recording Grievances

Upon receiving a Grievance Submission Form, the Contractor CLO will begin filling out a new Grievance Report Form (Appendix B), which will be used to log the grievance in the Grievance Log. All grievances should be logged within **24 hours** of being submitted. The Grievance Log is the SCGMS which will be used for logging, tracking all grievances and monitoring the implementation of the Grievance Mechanism.

6.3 STEP 3: Acknowledgement

The grievant will receive acknowledgement that their grievance has been received and logged within **48 hours** of the grievance being recorded in the SCGMS.

A copy of the Grievance Report Form and letter of acknowledgement will be generated and provided to the grievant (if possible), stating the date the grievance was received, and when ARISE/ the Contractor are likely to provide a formal response to the grievant.

If it is not possible to physically deliver the copy of the Grievance Report Form and letter of acknowledgement to the grievant, then the grievant will be informed verbally (most likely a telephone call to the grievant) and a record of this communication will be made in the SCGMS. The grievant will also be informed that a copy of the Grievance Report Form and acknowledgement letter will be kept on record and provided to him/ her, when requested.

6.4 STEP 4: Analysis, Investigation, Consultation and Developing a Resolution

The Contractor CLO will assess the significance of the grievance and categorise it in accordance with the following categories:

- **Low Priority**: a local, isolated or one-off complaint.

- **Medium Priority**: widespread and/ or ongoing complaint, e.g. noise, vibration and dust during construction.
- **Critical Priority**: potential for significant breach of ARISE policies (including national permits and international conventions that ARISE is committed to complying with) and/ or negative media attention.

This categorisation will be updated and refined over the life of the Project.

Table 6.1 outlines the timeframe and types of response for different categories of grievances. The Contractor will aim to close the grievance within the response timeframes outlined in Table 6.1, or within at least 30 days of receiving a grievance, as far as possible.

When developing a response to a grievance the Contractor CLO should consult with relevant parties (this could include management team members, ARISE staff, village elders, witnesses, the Hakem, and/ or the Steering Committee) to obtain guidance and further information in order to develop a well-informed proposal for resolution. The grievant may also be approached by the Contractor CLO and/ or the ARISE E&S Manager or ARISE-Airport CLOs to provide more details during the investigation or to discuss potential next steps. Furthermore, it is advisable that the source of a grievance is assessed where possible (e.g. a river which may have been polluted; a damaged plantation).

Any consultation with stakeholders during the investigation of a grievance should be noted in the SCGMS. If the grievance is complex and requires a more lengthy investigation then the grievant should be notified in writing and verbally with reasons for the delay.

Once enough information has been gathered and the root of the grievance is identified, clear, time-bound and measurable steps to resolve the grievance should be proposed to the grievant verbally and in writing. The proposed resolution must be recorded in the SCGMS using the Grievance Report Form.

Table 6.1 Grievance categorisation and response

Grievance Priority	Description	Response Timeframe	Type of Response
Low Priority	Local, isolated or one-off complaint.	Grievance response within **14 days**	Contractor CLO to coordinate internal response to grievance.
Medium Priority	Widespread and/ or ongoing complaint, i.e. noise, vibration and dust during construction.	Grievance response within **7 days**	Contractor CLO to involve Contractor General Manager and ARISE E&S Manager and relevant team to investigate complaint.

Grievance Priority	Description	Response Timeframe	Type of Response
Critical Priority	Potential for significant breach of ARISE/ Contractor policies and/ or negative media attention.	Grievance response within **3 days**	Contractor CLO will refer grievance to Contractor General Manager who will liaise internally with management to organise priority team to investigate the complaint as a matter of urgency. General Manager to involve ARISE Project Head and ARISE E&S Manager, if necessary. ARISE Project Head may decide to halt activities for the investigation and to allow time for mitigation to be determined.

6.4.1 Escalation of Grievances

The escalation metrics outlined in Table 6.2 will be followed in the event that the targeted response timeframes are not met.

Table 6.2 Escalation of Grievances

Grievance Priority	Escalation Chain	Updated Response Time Frame
Low Priority	14 days: Notify Contractor General Manager	4 days
	18 days: Notify ARISE CLO	3 days
	21 days: Notify ARISE E&S Manager	2 day
	23 days: Notify ARISE Project Head	1 day
	24 days: Notify ARISE Social, Health, Safety and Environment Manager	Same day
Medium Priority	7 days: Notify Contractor General Manager	3 days
	10 days: Notify ARISE E&S Manager	2 days
	12 days: Notify ARISE Project Head	1 days
	13 days: Notify ARISE Social, Health, Safety and Environment Manager	Same day
Critical Priority	3 days: Notify ARISE Project Head	1 day

Grievance Priority	Escalation Chain	Updated Response Time Frame
	4 days: Notify ARISE Social, Health, Safety and Environment Manager	Same day

6.5 STEP 5: Providing a Response and Agreement on Next Steps

The Contractor CLO will communicate the outcome of the investigation to the grievant and request feedback on the resolution. This initial response will include a summary of what actions are planned to resolve the grievance and when they are likely to be implemented, or an explanatory note clarifying why action is not required. The response will be in writing, although a verbal response will also be provided where appropriate.

The grievant will be asked to give their feedback on the proposed course of action within **five** working days. If the grievant is in agreement with the next steps, they will co-sign with the Contractor/ ARISE in Section 3 of the Grievance Report Form (Appendix B) to acknowledge agreement on the proposed actions for resolution.

Agreement should be recorded in the SCGMS and the actions delegated to appropriate personnel by the General Manager. Although the resolution of the grievance cannot be time bound, the appropriate steps and actions to resolve the grievance should be completed in a thorough and prompt manner.

6.5.1 What to do if Proposed Resolution is Rejected by Grievant

Any rejection by the grievant should immediately be reported to the ARISE-Airport Project Head. If the category of the grievance is critical it should be immediately reported to ARISE Head –Airports.

If the grievant does not agree with the proposed actions then the case may be put before the Steering Committee or a designated appropriate third party in order to find an alternative resolution. ARISE/ Contractor must inform the grievant that their case is being put forward to the Steering Committee prior to this occurring. If the grievant is not happy with their grievance being put forward to the Steering Committee they may suggest an alternative third party to seek guidance regarding grievance resolution. This will be dealt with on a case-by-case basis.

ARISE/ Contractor will engage with the Steering Committee or selected third party within **48 hours** of the grievant rejecting the proposed resolution. All background information on the grievance will be provided in order to allow the Steering Committee or other third party to have a full understanding of the grievance. The Steering Committee or other third party will be responsible for reviewing the proposed resolution put forward by ARISE/ Contractor and will deliberate internally regarding what is the best course of action for grievance resolution. The proposed resolutions will be put forward to ARISE/ Contractor for discussion. Once ARISE/ Contractor and the Steering Committee agree on the proposed resolution it will be put forward to the grievant.

A meeting between ARISE/ Contractor, the grievant and the Steering Committee will be held within **5 days** of the grievant receiving the revised proposed resolutions to discuss and agree a way forward. During the meeting, the grievant will be invited to provide feedback to ARISE/ Contractor. Grievant

All actions will be logged in the Grievance Report Form (Appendix B) and the SCGMS. If no steps can be agreed, then litigation may be sought.

6.5.2 Rejecting a Grievance

Decision to reject a grievance must be approved by the ARISE E&S Manager.

If evidence or a lack of evidence demonstrates the grievance is unfounded, a letter of rejection including the rationale behind the decision will be provided to the stakeholder. The grievance may only be resubmitted for appeal once, must be resubmitted within 30 days, and must address the comments provided by the Contractor in the rejection letter. If the grievance is rejected again after being resubmitted for appeal, it may not be raised again unless there is new substantiating evidence.

If a grievance is rejected, consideration should be given as to whether this grievance is arising from a misperception due to a lack of information. Should this be the case, the Contractor, ARISE E&S Team and village representatives will provide relevant information to the individual, and efforts should be made to share this with the broader community to prevent similar grievances arising in the future.

6.6 STEP 6: Resolution and Follow Up

When corrective actions are agreed upon between the Contractor and the grievant, relevant personnel assigned to the case will be responsible for ensuring that they are implemented.

It is the responsibility of the Contractor CLO to inform the grievant on the progress of implemented corrective actions. If the grievant is satisfied with the steps that have been taken they must sign-off Section 4 of the Grievance Report Form (Appendix B) to signify the closing of the case. If the completed actions have not resolved the issue to the satisfaction of the grievant, the grievant and ARISE must identify where the shortcoming was and/ or propose further steps. The date of the follow up and whether or not the grievance was resolved, and any further action shall be noted in the SCGMS.

6.7 Monitoring

The Contractor CLO will provide daily reports to the Contractor General Manager on any grievances raised that day and status of existing grievances using the form provided in Appendix B. A copy of the daily report will also be sent to the ARISE E&S Manager for information. A weekly Grievance Monitoring Report summarising grievances that have occurred and actions taken, as well as trends, will be submitted to the ARISE E&S Manager.

Active monitoring by the Contractor/ ARISE of the outcome/ resolution of individual grievances may be required depending on the severity of the grievance; however, this will be agreed between general management on a case by case basis.

All staff involved in grievance management will have access to the Grievance Log, which can be used to track existing grievances.

6.8 Review, Feedback and Reporting

Weekly reporting on the grievance mechanism will be made to the ARISE-Airport Project Head.

A regular system for reviewing and providing feedback to management and other stakeholders, such as a bi-annual Steering Committee meeting, should be implemented. Additionally, to ensure continuous improvement, the Grievance Mechanism should be adjusted where needed based on feedback from stakeholders and staff involved in the Grievance Mechanism implementation. Any changes should be communicated to all relevant parties.

7 GRIEVANCE CONTACT INFORMATION

The contact details for ARISE where stakeholders can lodge a grievance are shown in Table 7.1. The contact details will be updated once the Contractor is appointed.

Table 7.1 Contact details

Detail	Contact
Contact name	**Hilaire Courau**
Telephone number	**+222 4300 5820**
Email	**mauritanie@AriseNet.com and hilaire.courau@AriseNet.com**

Appendix A
Grievance Submission Form for local communities

Grievance Submission Form for local communities

Please use this form to report any concerns that you have about the Nouakchott Port Project. Please provide information about any impacts or damage that have occurred, or ways that you would like us to improve.

1. Your Information

We would like to know your name and contact information so that we can speak to you about the grievance, and to provide you with information about how we will respond to make improvements. If you would like to submit this complaint anonymously please leave this section blank.

Name (Last, First): _____

Gender: ☐ Male ☐ Female

Village: _____

Address: _____

Occupation: _____

Phone Number: _____

2. Your complaint

Please describe the concern or complaint that you have, providing as much information as possible about any impacts or damage, including when and where they occurred.

_____

_____

_____

_____

_____

_____

_____

_____

3. Proposed Solution

Please provide suggestions on how you would like us to resolve your grievance.

_____

_____

_____

_____

_____

_____

_____

3. Recorder's Information

If someone completed this form on behalf of the grievant please provide your information

Name (Last, First): _____ **Phone Number:** _____

Appendix B
Grievance Report Form for ARISE / Contractor

Grievance Report Form for ARISE / Contractor

Grievance Number: _____
Submission Date: _____

Status of Report
Grievance Number: _____
☐ Open ☐ Closed
Report completed by: _____ _____ _____
Please Print Name Position Date
Acknowledgement that grievance has been received sent to Grievant within 48 hours:
☐ Yes ☐ No **Date**_____

1st Response Date: _____
2nd Response Date (for appeals) _____

Date resolution actions completed and grievance closed _____

Part 1 – Details of Grievant

(To be completed based on information provided in Grievance Submission Form**).**

Name (Last, First): _____
Gender: ☐ Male ☐ Female
Village:_____
Address: _____
Occupation: _____
Phone Number: _____

Previous Grievances

Has a written report been previously submitted to ARISE by grievant? ☐ Yes ☐ No
If yes, give grievance record number: _____

Recorder's Information (details of third party submitting grievance on behalf of grievant if relevant)
Name (Last, First):_____ **Phone Number:** _____

Part 2 – Details of Grievance

a. Description of grievance as provided by grievant (to be completed based on information provided in Grievance Submission Form).

_____
_____
_____
_____

b. Grievance type (list all): _____

Does grievance relate to a claim for compensation due to accidental damage or temporary disturbance to economic activity?

☐ Yes Follow process outlined in the Compensation Plan to address grievance.

☐ No Complete remainder of Grievance Report Form.

Part 3 - Analysis and Investigation

a. Significance of grievance ☐ **Low Priority** ☐ **Medium Priority** ☐ **Critical Priority**

Explanation (provide justification for rating e.g. is this a one of or recurring incident, does it involve risks to company reputation or breach of policies or regulations):

_____
_____
_____
_____

b. Response timeframe:____days

c. Witnesses associated with case (list all)

TABLE 1	
Name	**Number**

d. Details of staff involved in investigating and responding to grievance (list all)

TABLE 2				
Name	**Position/ Department**	**Company**	**Email / Tel.**	**Date engaged**

e. Details of external stakeholders consulted in relation to grievance (list all).

TABLE 3					
Name	**Title**	**Company / Village**	**Contact Tel.**	**Date engaged**	**Meeting Notes Reference***

**Upload meeting minutes to the SCGMS and give the reference here.*

f. Description of findings from initial investigation:

_____
_____
_____
_____

g. Based on initial investigation is grievance valid?

☐ Yes Go to Part 4

☐ No Give reasons and go to Part 5

Reasons for rejection of grievance_____
_____
_____
_____

Part 4 – Resolution Proposal

a. Resolution Proposal Provided by Grievant

Suggestions from grievant on how they would like grievance to be resolved (based on information given in submission form).

_____
_____
_____
_____

b. Resolution Proposal Provided by Contractor/ ARISE

Proposed resolution from Contractor/ ARISE (include details of all actions to be taken by named staff or third parties to resolve grievance, timeframe for implementation, and any recommended changes to operational practices or policies). *Include details of any consultations held to develop resolution proposal in Table 2 and Table 3 above.*

TABLE 4						
Response # (first, second, third etc**)**	**Action(s)**	**Change to Policies or Practices needed?**	**Timeframe**	**Responsible Party (**name and company of individual**)**	**Monitoring requirements**	**Status** • Proposed • Agreed • Rejected • Under implementation • Complete

Part 5 – First Response & Follow-Up

For **valid grievances** the response should communicate the outcome of the investigation and proposed resolution to the grievant and request feedback on the proposed resolution.

For **non-valid grievances** a letter of rejection including the rationale behind the decision should be sent to the grievant.

a. Date first response given to grievant _____

b. How was the response provided to grievant (tick all that apply)

☐ Phone

☐ In person

☐ Letter (attach copy)

☐ Email (attach copy)

c. Grievant feedback on first proposed response (to be received within five days)

☐ Grievant agrees with proposed response: Go to Part 8a.

☐ Grievant rejects proposed response. Go to Part 6.

Part 6 - Grievance Appeal

For appeals against a grievance deemed non-valid complete section 6A and B.

For appeals against a proposed resolution to a grievance complete section 6C to G.

a. If a grievance is deemed not to be valid and is therefore rejected the grievant may submit an appeal for their grievance to be reconsidered. The appeal should be submitted within 30 days of them receiving the initial response. Reasons for appeal (including new evidence) must be provided and recorded below. This section should be completed by **ARISE/ Contractor** based on information and evidence provided by the grievant.

Additional or new evidence. *Please list and attach any additional documents relevant to the grievance.*

_____
_____
_____
_____

b. Review of appeal by ARISE/ Contractor

Considering new evidence detailed in part 6 (a), is grievance valid?

☐ Yes Grievance remains open. Complete Part 4, Part 7 and Part 8.

☐ No Give reasons and go to Part 7.

Reasons for rejection of grievance_____

_____
_____
_____

c. Reasons given by grievant for rejection of first proposed response:

_____
_____
_____
_____

d. Alternative solutions to resolve grievance proposed by grievant or ARISE/ Contractor:

_____
_____
_____
_____

e. Alternative solution proposed accepted by both parties?

☐ Yes Add new actions to Table 3 (Part 4) and go to Part 7.

☐ No Complete remainder of this section.

f. Third party consultation

If a grievant has rejected the proposed response to their grievance and no alternative resolution can be agreed between ARISE/ Contractor and the grievant, the issue must be referred to a third party. The details of any third parties consulted should be recorded in Table 3 (Part 3). The third parties' proposed resolutions should be recorded below.

Proposed resolution given by Steering Committee or designated third party *Please list and attach any additional documents relevant to the grievance and minutes of meetings with third parties.*

_____
_____
_____
_____

g. Alternative solution proposed by third party accepted by ARISE/ Contractor and grievant?

☐ Yes Add new actions to Table 4 (Part 4) and go to Part 7.

☐ No Give reasons and go to Part 7.

Reasons for rejection of third party proposal

_____
_____
_____
_____

Part 7 – Second Response & Follow-Up

For **valid grievances**:

- Where a revised resolution is being proposed: the response should communicate the revised proposed resolution to the grievant and request feedback on the proposed resolution.
- Where no revised resolution is being proposed: the response should communicate that no revised resolution has been found and the grievant can pursue to litigation if they choose.

For **non-valid grievances** a letter should be sent to the grievant that explains why the decision to reject the grievance is being upheld despite any new evidence that was provided.

a. Date second response given to grievant _____

b. How was the response provided to grievant (tick all that apply)

☐ Phone

☐ In person

☐ Letter (attach copy)

☐ Email (attach copy)

c. Grievant feedback on second proposed response (to be received within five days)

☐ Grievant agrees with proposed response: Go to Part 8a.

☐ Grievant rejects proposed response. Go to Part 8b.

Part 8 – Grievance Acknowledgement

a. Grievant Acknowledgement of Acceptance

I,_____, (full name of grievant) hereby acknowledge that I have read or heard and understand the response to my grievance given by_____(full name of staff providing response) on_____(date response was given).

Signature of Grievant*: _____
**If the grievant cannot sign use finger print*

b. No Resolution

If no resolution for the grievance can be agreed between the grievant and ARISE/Contractor, the grievant may pursue to litigation or further third party mediation. The outcome of this process, if pursued, should be recorded here and the grievance record updated once any additional actions have been implemented and the grievance is considered closed.

Details of results of litigation process including any actions assigned to ARISE/ Contractor: *Update Table 4 with actions as required.*

_____
_____
_____

Part 9 – Grievance Close

Has action been properly implemented according to the above specifications?

☐ Yes ☐ No _____ Signature of Grievant

Date

If the response to this question is no, the grievance remains open and supplementary consultation and actions should be undertaken and recorded in Tables 2, 3 and 4.

Date Closed: _____ _____

Signature of Contractor personnel

Appendix 4
Template for Stakeholder Engagement Minutes of Meetings and Attendance Sheets

Procès Verbal

Projet	
Sujet	

Rapporteur	
Date/heures de réunion	
Lieu	

Personne présentes	La liste nominative des personnes présentes est annexée au présent document

Short introduction

Stakeholders attending the meeting:

- administration ;
- administration ;
- administration ;
- GSEZ;
- Contractor
- Consultants ;
- NGO representatives ;
- Representatives of the populations (district chiefs, village chiefs, …)
- ….
- ….

Objectives of the meeting

Process of the meeting:

- Any comments done before the presentation itself
- Break time
- Questions and answers

Stakeholder signatures

Meeting Note Form

This form should be used to record details of informal meetings

Place:		**Date/time:**	
Subject:		**Note Taker:**	
Attachments: *Attach attendance sheets, photos etc if taken*			

Attendees			
Name	**Occupation**	**Village**	**Tel.**

Summary / Observations		
Details of stakeholder comments/ requests and responses given	Comment or request	Response
Actions	Action	Responsibility (name / job title / company)

Minutes prepared by:

NAME : **TITLE:** **SIGNATURE:**

Feuille de Présence

Village:

Date:

No	NOM, Prénom	Activité	Homme/Femme	Age	Téléphone	Signature
1						
2						
3						
4						
5						
6						
7						
8						

Register of Attendees	
Purpose of the meeting:	**Date:**
Consultation with:	**Location:**

No.	Name	Company	Designation	Contact		Signature
				Tel	Email	
1						
2						
3						
4						
5						
6						

Appendix 5
Stakeholders and stakeholder meetings database

Stakeholder Details			Consultation / Correspondence Record											Additional Comments		
Stakeholder Group	Stakeholder Organisation / Entity	Stakeholder Individuals	Status (Completed/ Planned/ Cancelled)	Status Notes	Date	Time	Location	Type	Project Attendance	Points of discussion (or activities to be undertaken)	Date of Engagement	Information Disclosure (tools, materials, activities)	Issues Raised	Responsibility	Timeline	Status (open/ closed)
National Government Local Fisher Group Port Employees NGO	Port de l'Amitié, Nouakchott (PANPA) Ministère de l'environnement et du développement durable (MEDD) Fédération Libre de la Pêche Artisanale (FLPA) Société Mauritanienne de Pêche et de Navigation Remaining groups unknown	Ould Beyirouk Cheikh Tourad M. Sarr Hamoud Ismail Remaining individuals unknown	Completed		22nd November, 2018	10.30	Salle de conférence du Port de Nouaktchott	Public Consultation	ARISE RHDHV EnviroConseil	Project Overview Potential impacts Mitigation measures	22-11-2018	Powerpoint	• The siting of the oil jetty inside the harbour; an alternative was for it to be located outside to reduce pollution inside the harbour; • Whether the effect of oceanswell had been considered in the design; • Concerns on the affects of coastal erosion brought on by Project activities; and • Establishing visible markers of the boundaries of restricted shipping lanes and permitted crossing points			
Local Fisher Group	Fédération Libre de la Pêche Artisanale (FLPA)	Ibrahim Sarr	Completed		19th November, 2018	16.00	Nouakchott	Focus Group Meeting	ARISE RHDHV EnviroConseil	Project Overview Potential impacts Mitigation measures	19-11-2018	n/a	• All fishing activity is from the Port de Peche (Fishing Port) – approximately 12 km north of the Port; • The government limits access for fishing at specified access points, approximately every 25 km; • An exclusion zone exists around the port, as well as specific military zones; • Fishing activity does take place to the south of the Port, as well as to the north; • The fisherman all recognise the exclusion zone around the port, including the entry channel; • The exclusion zone is not marked, and a fine (approximately USD 250) is in place for those who breach the exclusion zone; • The government have provided all fishermen with GPS coordinates of the exclusion zone, but few have GPS devices. • Marker buoys would be a useful addition to assist the fishing community; • Disposal zone A would be preferable for the fishing community, as it is the least preferred fishing zone			
Shipping / Container Handling	Société Mauritanienne de Pêche et de Navigation	Hummud Lemubott	Completed		22-1-2019	17.00	Hotel Azalai	Focus Group Meeting	ARISE RHDHV EnviroConseil	Potential impacts, benefits, concerns. Future stakeholder enagement methods	22-1-2019	n/a	• Concern was raised about the siting of the hydrocarbon jetty inside the Port, and high risk of shutdown in the event of a spill or leak • Concern over dredging being limited to only the turning circle and not all berths • Three main areas of concern were mentioned: 1) That work activities will impede on existing work through blocking or limiting of internal circulation; 2) That the new facility will result in the closure of other existing societies already present at the Port; 3) That dredging work could destabilize existing port infrastructure resulting in potential collapses of damage limiting their use.			
Shipping / Container Handling	APM Termials	Sidat Moustapha	Completed		24-1-2019	11.00	APM Terminal Office	Focus Group Meeting	ARISE RHDHV	Potential impacts, benefits, concerns. Future stakeholder enagement methods	24-1-2019	n/a	• Concern over access roads within the Port being impacted or closed during construction - access to berths is critical for operations • High levels of coordination would be needed to ensure dredging activities does not impede on access and shipping activities • Project would create fierce competition for current operators within the Port, but overall good for the economy • APM Terminals will start their own construction Project, it is hoped that this won't be impeded.			
Docker Assocation	Securim SRMOP	Isselmou Sidoumou	Completed		24-1-2019	12.00	PANPA Office	Focus Group Meeting	ARISE RHDHV	Potential impacts, benefits, concerns. Future stakeholder enagement methods	24-1-2019	n/a	• Main concern was with regards to the use of the workers represented by SRMOP. Any need during port construction of their unskilled workers would be well seen by Port Authority and Government. The association also represents a hundred or so specialized workers such as crane operators. • Raised concerns about increased health and safety risks brought about by the Project, namely due to increased road traffic and risk of accidents, as well as increased air pollution due to marine and road traffic.			
Local Business	Les Grande Moulins de Mauritanie	Frank Le Bris	Completed		25-1-2019	16.00	GMM Office	Focus Group Meeting	ARISE RHDHV	Project Overview Potential impacts Potential benefits	25-1-2019	n/a	• Did not foresee any problems with the Port expansion Project. • Increased capacity and flexibility of the Port will be beneficial to business in general. • GMM is planning an expansion of their storage facilities adjacent to their current operation; this increased traffic may have short term impacts on the road network.			
Shipping / Container Handling	CMA-CGM OPM	Christophe Jourdan (CMA-CGM) Aurélien Gorre (CMA-CGM) Thomas Fromet de Rosnay (OPM)	Completed		28-1-2019	12.00	PANPA Office	Focus Group Meeting	ARISE RHDHV	Project Overview Potential impacts Potential benefits	28-1-2019	n/a	• Did not foresee any issues aslong as Project activities do not interfere with their operations • Query over the dredging being limited to only the turning circle, and not the whole of the Port • Dredging may influence water circulation and thus erosion inside the port. • The current breakwater is not sufficient for the port Query regarding the commercial impact, and having commercial exclusivity during operations			
Local Fisher Group	Fédération Libre de la Pêche Artisanale (FLPA)	Ibrahim Sarr	Completed		28-1-2019		Port de Peche	Fish market survey; Focus group meeting	ARISE RHDHV EnviroConseil	Project Overview Potential impacts Potential benefits	28-1-2019	n/a	• Details on the exclusion zone around the Port • Definition of artisinal fishing boats, and number of fishermen in the industry • Compensation measures if fishing industry is distrupted • Existence of a quota system for fishermen • Fish species that are caught (and fish market survey)			

Local Authorities	Wayila, Nouakchott Sud	M. Achmed Dr. Ayri Mme Amélio Mr. Saydhou Bha	Completed		30-1-2019	11.30	Wayila Office	Focus Group Meeting	ARISE RHDHV EnviroConseil	Project Overview Potential impacts Potential benefits	30-1-2019		• Waste management is a large problem in Nouakchott, and is largely unnoticed. There is only one waste management facility • Concern about high demand for resources (aggregate) and associated increase in traffic • Coastal erosion and dune restoration is a large ongoing concern • Proposed resettlement of informal settlement within the industrial zone, 5km north of the port. • Baseline health information; facilties, and common diseases • Baseline education information			
NGO	IUCN		Completed		30-1-2019	16.30	IUCN Office	Focus Group Meeting	ARISE RHDHV EnviroConseil	Project Overview Potential impacts Potential benefits	30-1-2019	Information about the project was requested prior to the meeting	• General positive and negative impacts from the Project • Negative impacts mentioned include coastal erosion, and disturbance of migration routes and breeding areas			
Fishing / Container Handling	Société Mauritanien Commercial de Poisson (SMCP)	Mohamed Boukhary	Completed		30-1-2019	19.30	Hotel Azalai	Focus Group Meeting	ARISE RHDHV EnviroConseil	Project Overview Potential impacts Potential benefits	30-1-2019		• Project could lead to a positive impact on Nouakchott fishing industry			

Stakeholder Information								Stakeholder Analysis					Additional Comments		
Stakeholder Group	Stakeholder Organisation / Entity	Name	Title	Telephone	Address	Email	Website	Interest	Influence	Level of Engagement	Date of	Topics of Interest	Recommended engagement methods	Background notes	When to engage
National Government	Port de l'Amitié, Nouakchott (PANPA)	Ould Beyirouk	Directeur Technique du port de Nouakchott					High	High	Information disclosure	22-11-2018	All			
National Government	Ministère de l'environnement et du développement durable (MEDD)	Cheikh Tourad	Directeur du Contrôle Environnemental					High	High	Information disclosure	22-11-2018	All			
Local Fisher Association	Fédération Libre de la Pêche Artisanale (FLPA)	Ibrahim Sarr	Representative	+222 46 06 81 92				High	High	Information disclosure; Focus group meetings	22-11-2018	All; Fishing access; marker bouys			
Shipping / Container Handling	Société Mauritanienne de Pêche et de Navigation	Hamoud Ismail	Representative					High	High	Information disclosure	22-11-2018	All			
Shipping / Container Handling	Société Mauritanienne de Pêche et de Navigation	Hummud Lemubott	Director General	+222 46480093				High	High	Focus Group meeting	22-1-2019	All; Hydrocarbon terminal; dredging			
Shipping / Container Handling	APM Termials	Sidat Moustapha	Managing Director	+222 45 25 40 98 +222 44 00 12 34	Port Autonome De Nouakchott PO Box 5767 Nouakchott	sidat.mohamed.moustapha@apmterminals.com		High	High	Focus Group meeting	24-1-2019	Project details; dredging; access; concurrent projects; company details	Website, information board, regular information disclosure		
Docker Assocation	Securim SRMOP	Isselmou Sidoumou	President du Groupement	+222 45 25 92 92 +222 36 30 92 92	ZRA 418 Boite Postale 5131 Nouakchott	isidoumou@gmail.com		Medium	Medium	Focus Group meeting	24-1-2019	Project details; dredging; access; concurrent projects;association details	WhatsApp number; Facebook group; office at Port		
Local Enterprise	Les Grande Moulins de Mauritanie	Frank Le Bris	Director General	+222 44 44 50 30	BP 4407 Zone Industrial du Wharf Nouakchott	frank.lebris@gmoulin.com		Low	Low	Focus Group meeting	25-1-2019	Project overview; potential impacts; potential benefits; company details			
Shipping / Container Handling	CMA CGM	Christophe Jourdan	General Manager	+222 45 25 20 16 / 26 +222 41 42 70 00	Immeuble du stade Olympique	nkt.cjourdan@cma-cgm.com		High	High	Focus Group meeting	28-1-2019	Project overview; potential impacts; potential benefits; company details			
Shipping / Container Handling	CMA CGM	Aurélien Gorre	Commerical Area Manager, Africa	+33 4 88 91 59 70	4, Quai d'Arenc 13235 Marseille cedex 02 France	ho.agorre@cma-cgm.com		High	High	Focus Group meeting	28-1-2019	Project overview; potential impacts; potential benefits; company details			
Shipping / Container Handling	OPM	Thomas Fromet de Rosnay		+222 34848889				High	High	Focus Group meeting	28-1-2019	Project overview; potential impacts; potential benefits; company details			
NGO	IUCN		Director General	+ 222 45 25 12 76	PO Box 4167 Nouakchott	uicnmauritanie@iucn.org		Medium	Medium	Focus Group meeting	30-1-2019	Project overview; potential impacts; potential benefits			
Fishing / Container Handling	Société Mauritanien Commercial de Poisson (SMCP)	Mohamed Boukhary	Director General	+222 22364707				Low	Low	Focus Group meeting	30-1-2019	Project overview; potential impacts; potential benefits; company details			
Local Authorities	Wayila, Nouakchott Sud	M. Achmed	Regional Director, Education					Medium	Medium	Focus Group meeting	30-1-2019	Project overview; potential impacts; potential benefits			
Local Authorities	Wayila, Nouakchott Sud	Dr. Ayri	Regional Director, Health					Medium	Medium	Focus Group meeting	30-1-2019	Project overview; potential impacts; potential benefits			
Local Authorities	Wayila, Nouakchott Sud	Mme Amélio	Regional Director, New Projects					Medium	Medium	Focus Group meeting	30-1-2019	Project overview; potential impacts; potential benefits			
Local Authorities	Wayila, Nouakchott Sud	Mr. Saydhou Bha	Regional Director, Environment					Medium	Medium	Focus Group meeting	30-1-2019	Project overview; potential impacts; potential benefits			

Project related

Appendix 6
Minutes of Public Consultation Meeting held on 25 April 2019

PROCES VERBAL DE LA CONSULTATION PUBLIQUE	
SUJET	Présentation des résultats de l'EIES conforme aux exigences de la Société Internationale Financière (SFI) du Nouveau Port à Conteneurs et à Hydrocarbures de Nouakchott
LIEU	Hotel Azalaï, Salle IMRAG, Nouakchott, Mauritanie
DATE	25 Avril 2019, 10h00

LISTE DE PRESENCE	
Ministère de l'Environnement et du Développement Durable	Institut Mauritanien des Recherches Océanographiques et des Pêches
Ministère de l'Economie et des Finances	Coopération Allemande GIZ / GOPA
Ministère du Pétrole, de l'Energie et des Mines	Société Mauritanienne de Pêche et de Navigation
Ministère des Pêches	Société d'Acconage et de Manutention en Mauritanie
Ministère de l'Equipement et des Transports	Les Grands Moulins de la Mauritanie
Wilaya de Nouakchott Sud	CMA-CGM Mauritanie
Autorités Portuaires	MERIDIAM
Marché au Poisson de Nouakchott	ARISE Mauritania
Fédération Libre de la Pêche Artisanale	AFCONS
Fédération Nationale de la Pêche	EnviroConseil
Fédération Nationale de la Pêche Artisanale	Royal HaskoningDHV
Fédération des Services et Professions Libérales	EGIS
Société Mauritanienne des Hydrocarbures	Société Civile (Expert Environnement, Almoustakbal, Technicien de Froid, Ingénieur Biomédical, RoyaPost, Consignataire,)
Parc Nationale du Banc d'Arguin	

Une copie du Procès-verbal est transmise aux participants et à:

ART.	ASPECTS DISCUTÉS	ACTION PAR
1.0	**Introduction:**	
	M. Hilaire Courau de Arise remercie les invités et participants pour leur présence. Il introduit la diffusion d'une courte vidéo de présentation du groupe Arise. Suite à cette diffusion, M. Courau présente les porteurs du projet que sont Arise et Meridiam puis résume l'historique du projet. Enfin, il explique brièvement la différence entre l'étude d'impact environnementale (EIE) nationale et l'étude d'impact environnementale et sociale (EIES) dont les résultats sont présentés dans le cadre de la présente consultation, ainsi que les raisons pour lesquelles Arise Mauritania a dû procéder à chacune de ces études.	
2.0	**Le projet**	
	M. Rayann Elzein de la société Royal HaskoningDHV débute son allocution par une présentation des divers consultants et entreprises qui contribuent ou vont contribuer au projet. Il poursuit avec une présentation des composantes du projet et de leurs caractéristiques techniques à l'aide de différents plans et photos illustrant l'organisation future du site. Enfin, il termine avec le dévoilement d'un calendrier des grandes étapes à venir jusqu'à l'achèvement des travaux de construction du nouveau terminal.	
3.0	**Méthodologie et résultats de l'EIES**	
	M. Balthazar Schlumberger débute son allocution avec une description des grandes étapes ayant permis la réalisation de l'étude d'impact, le contexte de la présente consultation publique et les suites qui y seront données. Il aborde ensuite les grandes lignes de la méthodologie suivie et explique le processus de consultation suivi à ce jour. Il présente également la liste des principales préoccupations et attentes ayant été formulées par les parties prenantes au cours des différentes rencontres organisées pour les besoins de la réalisation des études d'impacts.	
	Il aborde ensuite le résumé de l'état des lieux, des principaux impacts du projet sur les milieux terrestre, maritime et social et les mesures d'atténuation proposées par Arise Mauritania pour prévenir ou minimiser ces impacts. Une emphase est placée sur les aspects nouveaux relevés dans le cadre des activités de l'EIES. Il complète le sommaire des résultats de l'étude d'impacts en présentant l'évaluation des impacts cumulatifs et des impacts positifs anticipés.	
4.0	**Questions et réponses**	
	Hadrami Mohamed MBareck, Directeur des Hydrocarbures, Ministère de l'Énergie, du Pétrole et des Mines	
	M. MBareck se félicite du développement de cette nouvelle infrastructure pour le pays et plus particulièrement pour le Ministère car elle résoudra les problèmes d'approvisionnement en pétrole et de congestion au niveau du port.	
	Question 1 : Qu'est-ce que l'administration portuaire et Arise proposent comme solution aux problèmes causés par la météo au niveau des activités du port ? **Réponse 1** : Il est prévu une prolongation du brise-lame existant afin d'améliorer la protection des navires vis-à-vis des affres de la météo. La longueur exacte de l'allongement du brise-lame fait actuellement l'objet d'une étude technique. De plus, le type de quai sélectionné est basé sur des études qui confirment l'avantage d'un quai sur pieux qui permet de dissiper l'effet des vagues plutôt que de les réfléchir vers l'intérieur du port. **Question 2** : Comment Arise fixera la priorité entre les navires de conteneurs et ceux d'hydrocarbure ? Il considère que les navires d'hydrocarbures devraient avoir la priorité sur les autres navires arrivant au port. **Réponse 2 :** Les études de simulation ont montré que le taux d'occupation en phase 1 ne devrait pas dépasser 30% ce qui est sous les niveaux standards d'occupation internationaux. Avec un tel taux, les navires devraient avoir un temps d'attente maximum de 6h, mais généralement moins. De plus, une	

ART.	ASPECTS DISCUTÉS	ACTION PAR
	coordination fine, qui relève de l'autorité portuaire, devra effectivement être réalisée, comme elle l'est actuellement.	
	M. Mohamed Faycal Ould Beirouk, Directeur Technique du Port de Nouakchott	
	M. Beirouk fait l'historique du projet et mentionne qu'il s'insère dans le plan directeur du port de Nouakchott. D'autres opérateurs ont fait des propositions depuis 2012 mais seul le projet d'Arise répondait aux attentes du gouvernement et de l'autorité portuaire. La proposition d'aménagement n'aura pas d'effet sur le relief côtier et utilisera des zones de clappages déjà entérinées par les agences gouvernementales. Il souligne que le port n'est pas une zone de pêche pour des raisons de sécurité. Il réitère que la prolongation du brise-lame va améliorer les conditions dans le bassin et que le réaménagement du terminal pétrolier va améliorer l'approvisionnement en hydrocarbures tout en réduisant ses coûts. Il souligne également l'importance de bien prendre en compte dans l'EIES les impacts qui pourraient être générés lors du transfert des anciens pipelines vers les nouveaux (déversement, émission atmosphérique, etc.). Enfin, il mentionne que le poste d'accostage existant pour les pétroliers restera en fonction tant que les nouvelles installations ne seront pas opérationnelles. De plus, ce poste d'accostage pourrait être conservé, même après le transfert des activités pétrolières, à moins qu'il gêne les mouvements des navires.	
	M. Cheik Abdelkhader, Expert en environnement	
	M. Abdelkhader mentionne que c'est bien de présenter les impacts positifs, mais qu'il aurait aimé entendre parler des impacts négatifs. Il aurait également voulu entendre parler du PGES ainsi que de la réhabilitation du site. **Réponse :** Les impacts négatifs ont été largement évoqués au cours de la présentation. Il s'agissait de l'ensemble des diapositives précédant la diapositive sur les impacts positifs. Pour le PGES, l'ensemble des mesures d'atténuation proposées par Arise Mauritania et présentées dans ces diverses diapositives constitueront le PGES. S'agissant de la réhabilitation du site, ce point mérite effectivement d'être pris en compte dans le cadre de la version finale de l'EIES.	
	M. Cheikh Tijani, Conseiller juridique du Wali Nouakchott-Sud	
	M. Tijani souligne son appréciation du projet pour ce qu'il apportera tant au niveau national que local, ainsi que la qualité de la présentation. Il demande ce qu'on entend par habitation informelle et demande ce qui est prévu comme compensation pour les impacts sociaux ? Il demande plus généralement ce qu'Arise Mauritania entend faire pour les populations environnantes du projet. **Réponse :** Les habitations informelles sont les groupes de résidences qui se trouvent dans le secteur du Wharf en zone industrielle. Seule la construction de la nouvelle ligne électrique (6 km) souterraine aura des répercussions mineures sur ces résidents associées à une élévation temporaire du bruit et des émissions de poussières. Il n'y aura pas de relocalisation associée à ces travaux.	
	M. Mohamed Mahfoud, Chercheur à l'IMROP	
	M. Mahfoud mentionne que le secteur côtier fait l'objet de puissants courants et que les changements climatiques ont un effet marqué sur l'amplitude des vagues. Il mentionne qu'il faudrait mieux définir les impacts sur le benthos et qu'il aurait été intéressant de voir davantage de chiffres en ce qui concerne les emplois.	
	Question 1 : Est-ce qu'on a envisagé des mesures pour prendre en compte les changements climatiques ? **Réponse 1** : Lors du design des infrastructures, la plateforme du quai est conçue en fonction des plus hautes marées et une sécurité de 20 à 50 cm est ajoutée pour anticiper une éventuelle élévation de la mer, conformément aux standards internationaux aujourd'hui en vigueur. **Question 2** : Est-ce que le quai répondra aux exigences de construction afin de réduire l'érosion ?	

ART.	ASPECTS DISCUTÉS	ACTION PAR
	Réponse 2 : La nouvelle plateforme sera entièrement construite à l'intérieure du port existant ce qui permettra de minimiser le niveau d'érosion du projet..	
	M. Dia Mamadou, Chercheur à l'IMROP	
	M. Mamadou souligne que les communautés benthiques ne sont pas les mêmes partout en Mauritanie. Il souhaite qu'on évite de parler de « perte potentielle » pour la faune benthique (corail, éponges, etc.) en rapport avec les travaux de dragage car il y aura des pertes. Il souhaite enfin savoir en quoi consistent les études complémentaires que nous avons annoncées. **Réponse :** Les études complémentaires comprennent : Étude hydrosédimentaire 3 et Impacts du dragage du chenal sur l'agitation des vagues. Concernant la faune benthique, des études doivent permettre de quantifier et de qualifier cette faune de manière à adapter les mesures de compensation qui s'imposent et qui seront intégrées dans un plan de gestion des opérations de dragage.	
	M. Sid'Amed Bouh, Conseiller du Ministre de l'Économie et des Finance, Chargé du Secteur Privé.	
	L'expression du besoin de ce projet était dans le portefeuille du gouvernement depuis longtemps mais les critères de sélection et de compétitivité pour un éventuel partenaire ont retardé le processus jusqu'à ce qu'ARISE ait postulé pour ce projet. Une relation de confiance s'est établie entre le gouvernement mauritanien et le groupe ARISE après des démarches transparentes respectant les processus réglementaires en vigueur. Tous les aspects de la concession ont été négociés et notamment les modalités de partage avec le gouvernement des revenus tirés de l'exploitation du port et le montant du bonus à verser par ARISE au début de l'exécution du contrat – ce dernier ayant d'ailleurs déjà été versé. La réalisation de cette EIES complémentaire considérant des critères internationaux vient renforcer la relation de confiance car celle validée au niveau national était bien suffisante pour permettre le début des travaux. Le ministère des finances est heureux de participer à sa restitution et d'exprimer sa satisfaction. En réaction à la question posée sur l'existence d'habitations informelles au niveau du wharf, M. Bouh indique que le gouvernement travaille sur leur relocalisation. La position de ARISE de prendre cette présence en compte est tout à fait justifiée. **Questions** : Est-ce que tout le personnel (local et expatrié) bénéficie d'une assurance maladie contre les accidents de travail. Par ailleurs, la société s'engage-t-elle à obtenir des permis de travail pour tous les employés expatriés ? **Réponses :** Il est confirmé que les employés d'Arise bénéficient d'une assurance conforme aux exigences nationales et que les expatriés seront tous munis d'un permis de travail valide, comme c'est déjà le cas de tous les expatriés déjà en poste.	
	M. Ibrahim Gaye, Représentant de la Fédération Libre de la Pêche Artisanale (FLPA)	
	M. Gaye conçoit que le port de Nouakchott soit interdit à la pêche mais souhaite la mise en place de marquage (bouées ou autres) des limites de la zone d'exclusion pour faciliter son repérage par les pêcheurs. Il souhaite également que soit considéré une provision pour compensation des pêcheurs en cas de déversements d'hydrocarbures pouvant affecter les zones de pêches. **Réponse** : La société Arise Mauritania s'engage à étudier les solutions envisageables avec les autorités portuaires pour répondre aux mieux aux préoccupations des pêcheurs en matière de circulation autour de la zone d'exclusion portuaire et son balisage. Il est aussi précisé que la diminution des activités de cabotage entre Nouadhibou et Nouakchott va réduire les risques de collision avec les embarcations de pêcheurs.	
	M. Cheikh Tourad, Directeur du Contrôle Environnemental, Ministère de l'Environnement et du Développement Durable.	
	M. Tourad souligne que le processus national a bel et bien été complété et qu'il n'y a pas de références juridiques nationales pour une étude complémentaire. Il confirme toutefois que les normes internationales qui sont appliquées dans la cadre de l'EIES seront utilisées par le Ministère comme référence pour la réalisation des suivis.	

ART.	ASPECTS DISCUTÉS	ACTION PAR
	Il mentionne qu'un opérateur qui s'était positionné pour ce même projet s'est vu refuser sa validation en raison de l'importance des impacts qu'il aurait causé sur l'environnement. La proposition d'Arise, quoique générant des impacts, occasionne peu de perturbation sur les composantes environnementales.	
	M. Hamoud Ismail, Société Mauritanienne de Pêche et de Navigation (SMPN)	
	Question 1 : A-t-il été envisagé de déplacer le terminal pétrolier à l'extérieur de l'enceinte du port pour éviter que des accidents liés à la manipulation de produits pétroliers impactent le reste des activités au port. **Réponse 1 :** La création d'un nouveau terminal pétrolier à l'extérieur du port risquerait d'engendrer plus d'impact en raison de la nécessité de créer une nouvelle installation portuaire (empiètement sur la côte, nouvelle zone d'érosion). Les bateaux pétroliers viennent déjà au port, ils seront seulement plus gros. La présence de ce terminal dans l'enceinte du port lui offre un certain confinement en cas de déversement, facilitant la récupération des hydrocarbures. **Question 2 :** Est-ce que le dragage prévu dans l'enceinte du port ne risque pas de déstabiliser les infrastructures existantes ? **Réponse 2 :** En ce qui concerne l'effet du dragage sur les infrastructures existantes, leur présence a été prise en compte dans l'évaluation des zones et profondeurs à draguer. Seul l'ancienne jetée pétrolière pourrait être menacée par le dragage. Le sort de cette jetée devra être décidé en concertation avec l'autorité portuaire. Enfin, Monsieur Ismail recommande que toutes les sociétés travaillant au port depuis des années soient au mieux associées à ce projet de nouveau terminal.	
	M. Taled Taki, Directeur de la Capitainerie	
	M. Taki se félicite de l'arrivée de ce projet car il augmentera l'activité au port ainsi que sa compétitivité. Il mentionne que le chenal d'approche a été conçu pour des navires de moyennes tailles (150 m de largeur) et qu'avec de plus gros navires il faudra sans doute l'élargir. Il souhaiterait également qu'on envisage une prolongation du brise-lame sur 200m au lieu de 100m. **Réponse** : Selon les études théoriques menés à ce jour, une largeur de 125m serait suffisante pour les nouveaux navires envisagés. Des études pratiques seront menées pour confirmer ces premiers résultats. En ce qui a trait au brise-lame, des études sont en cours afin de déterminer sa longueur optimale pour protéger au mieux le port sans impliquer la modification du tracé du chenal d'approche.	
	M. Mohamed Mahmoud Babana, Inspecteur Général, Ministère des Pêches	
	M. Babana mentionne que l'évaluation et l'intervention en cas de déversement est strictement réglementée en Mauritanie et que l'État s'est doté d'un plan d'intervention national qui est mis en pratique si celui de l'Autorité portuaire ne suffit pas à contenir un déversement. Il souligne que le principal risque n'est pas la présence des installations de déchargement d'hydrocarbures au sein du port mais plutôt les activités de transport des hydrocarbures par cabotage entre Nouadhibou et Nouakchott, donc très près des côtes. Le projet d'Arise vient éliminer ce risque en permettant au pétrolier de venir directement à Nouakchott.	
	M. Oumar Bellal, Société Mauritanienne des Hydrocarbures	
	Question : Qu'est-ce que l'EIES apporte de plus que l'étude nationale ? Qui valide cette étude ? **Réponse :** L'EIES est réalisée pour répondre aux exigences de la Banque Mondiale qui sont adoptées par la grande majorité des établissements de financement internationaux dont Meridiam et ses investisseurs. La première des exigences de la Banque Mondiale est que le projet respecte et applique les exigences nationales en ce qui a trait aux évaluations environnementales. De plus, ces exigences nécessitent parfois de couvrir davantage certains aspects et d'aborder des thématiques non exigées au niveau national (ex. impacts cumulatifs, services rendu par les écosystèmes, consultations publiques élargies, etc.). Il n'existe pas d'organe ou d'institution unique en charge de valider cette étude. Dans la pratique, celle-ci doit être revue et approuvée par chaque bailleur de fonds international participant au financement du projet considéré.	

ART.	ASPECTS DISCUTÉS	ACTION PAR
	M. Ahmed Zein, Consultant expert de la Coopération Allemande GIZ	
	M. Zein se demande également à qui s'adresse cette étude d'impact complémentaire et qui doit la valider. (voir réponses aux questions de M. Bellal). Il aurait souhaité voir le tracé des nouveaux pipelines prévus et leur connectivité avec les installations existantes. Il aurait également voulu voir le tracé de la nouvelle ligne électrique et connaître la nature des discussions avec la Société d'État à ce sujet. Il conseille l'utilisation des études existantes pour les secteurs comme base aux études réalisées et d'impliquer les agences et organismes indépendants (ex. WACA, Banque Mondiale).	
	M. Sarr, Conseiller en Ressource Humaine	
	M. Sarr souhaite savoir ce qui est prévu pour la formation continue des employés et la formation en vue des besoins futurs. Il demande également ce qui est prévu pour assurer l'entretien des équipements. **Réponses :** Arise Mauritania bénéficie de l'expérience dans le secteur portier de sa filiale au Gabon (nommée GSEZ) dans la mise en place de structures efficaces de formation des employés et entend répliquer cette expérience en Mauritanie en l'adaptant au contexte national. Arise assurera la maintenance de base de ses équipements sur place grâce à la mise en place d'une équipe de maintenance et d'infrastructures à cet effet.	
	M. Fadel, SAMMA	
	M. Fadel s'inquiète de savoir quels sont les impacts du projet sur les Sociétés de manutention au port ? **Réponse :** la création du nouveau terminal va créer des opportunités de travail dans la manutention, avec des augmentations de volumes des marchandises échangées. De plus, la création du nouveau terminal par une société d'envergure internationale comme Arise va permettre de renforcer la sécurité de la manutention, tant pour le personnel que pour les équipements.	
	Mot de clôture	
	M. Mohit Agrawal, DG du projet pour Arise, remercie les participants pour leur contribution et invite les participants à poursuivre les discussions autour de rafraichissements. Mentionnons que 15 fiches de commentaires ont été récupérées à la fin de la session. Ces commentaires seront pris en compte lors de la finalisation du rapport final de cette EIES.	
	Fin de la rencontre : 13h00	

PREPARATION	REVISION	APPROBATION
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ARISE Mauritania

DATE: 25/04/2019

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Appendix 7

ESMP Matrix for the Construction Phase and for the Operation Phase

CONSTRUCTION

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
C1	Air Quality and Climate	Impairment of air quality by exhaust emissions from vehicles, vessels and equipment engines	Minor	• Maintain and operate all vehicles, vessels and equipment engines in accordance with manufacturers recommendations; • Select location of stationary generators to facilitate dispersion of the exhaust gases; • Where available use as much as possible good quality (low sulphur) fuel; • Develop and implement a Traffic Management Plan (TMP) for the hauling operations to minimise local traffic congestion as a result of truck movements.	Minor	EPC Contractor	Construction	• Log of routine maintenance • Record of any maintenance needed to address visible emissions or localized air quality incident • Opportunistic visual observation of vehicles or engines showing excess emissions	ARISE	Daily visual inspections, monthly review of monitoring logs and records
C2		Dust emission from land preparation, concrete batching and material hauling	Minor	• Cover loose materials and keep top layers moist; • Stockpiled soil is not to be compacted but should be covered to limit wind exposure;; • Use binder material for erosion and dust control for long term exposed surfaces; • Use dust suppression measures (e.g. wetting the ground) when necessary to reduce dust and erosion from wind; • Regular cleaning of equipment, drains and roads to avoid excessive build-up of dirt; • Use load covers for the transportation of materials that release dust emissions; and During dusty conditions use a speed limits on-site of 15 kph on unhardened roads and surfaces	Negligible	EPC Contractor	Construction	• Visual inspection and photographic record	ARISE EPC Contractor	Daily visual inspections Monthly monitoring of dust fallout
C3	Noise and Vibration	Nuisance noise from construction activities	Minor	• Maintain and operate all vehicles and equipment's in accordance with manufacturer's recommendations; • Avoid dropping materials from height, where practicable; • Avoid metal-to-metal contact on equipment; • Develop a noise control plan for relevant work practices and activities and discuss this with construction staff during health & safety briefings; • Ensure periods of respite are provided in the case of unavoidable maximum noise level events and provide adequate Personal Protective Equipment (PPE) to workers; • Impose vehicle speed limits for heavy goods vehicle traffic travelling on access roads close to receptors; • Develop and implement a noise monitoring plan to measure out of door noise levels at relevant receptors (e.g. administration building, workers camp, etc.); if noise levels exceed WHO Guidelines for Community Noise (World Health Organisation, 1999) of 70 LAeq, implement temporary noise barriers or other appropriate noise reduction measures; • Inform all potentially impacted port workers of project activities that have the potential to be with high noise	Minor	EPC Contractor	Information to potentially impacted residents/businesses before construction starts Construction	• Community liaison	ARISE	As required / monthly

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
				level as well as providing the contact details of the community liaison officer.						
C4	Soil and Groundwater Quality	Soil and groundwater contamination from accidental spills of hazardous material and improper disposal of waste and wastewater	Moderate	• Implement effective site drainage to direct surface water flow away from work/storage areas. This shall include cut-off drains to divert surface runoff from exposed soils or construction areas; • Install oil water separators and grease traps at refuelling facilities, workshops, parking areas, fuel storage and maintain as appropriate; • Bund areas where hazardous substances are stored (e.g., fuel storage area, waste storage areas); • Remove all water accumulation within bunds using manually controlled positive lift pumps not gravity drains and ensure it passes through the oil water separator prior to be released to the environment; • Check and maintain regularly all plants and equipment to minimize the risk of fuel or lubricant leakages; • Train relevant staff in safe storage and handling practices as well as on rapid spill response and clean-up techniques. Set-up and apply procedures regarding dealing with contaminated soils; and • Develop and implement a Waste Management Plan for the Construction Phase to ensure that waste is collected and disposed of correctly. All waste materials must be properly segregated, and temporarily stored in a manner commensurate with the hazard posed by the waste and then disposed of in a proper waste facility that is appropriate to the waste type.	Minor	EPC Contractor	Waste Management Plan before construction starts Construction	Visual inspection and photographic record	ARISE	Daily visual inspection
C5		Soil and groundwater contamination from oil jetty and hydrocarbon pipelines removal operation	Moderate	• Residual fuel should be removed from all associated pipelines and managed as hazardous waste; • All pipelines should be dismantled and/or capped-off and clearly labelled; • If pipes are to be left in-situ (for example, subsurface sections), recommended closure methods should include cleaning and removing contents, inerting, and filling with sand and cement slurry, hydrophobic foams, or foamed concrete.	Minor	EPC Contractor	Construction	Visual inspection and photographic record	ARISE	Daily visual inspection
C6	Coastal Geomorphology, Coastal Processes and Sediment Transport	Impact on suspended sediment concentrations and sedimentation due to dredging and disposal activities	Moderate	Depending on the dredge method selected (most probably TSHD), measures should be applied, such as: • limiting the overflow during dredging activities (this will limit the overflow of fines and therefore reduce the dispersion of fines); and • selection of appropriate dredge method (mechanical dredging will result in less suspended sediment at the disposal site) and rate of dredging (slower rates of dredging could reduce the plume density).		Dredging contractor	Design and construction	Monitoring of turbidity and or sedimentation levels	Dredging contractor	Daily

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
				• Changing dredging schedules based on tide, wind, and background/natural turbidity and or season to minimize effects due to increases in turbidity levels						
C7	Marine Water and Sediment Quality	Impact of dredging and disposal on physical water and sediment quality parameters	Minor	• Adapt the rate of removal of material, as slower dredging speeds may reduce impacts; • Limit the speed of the cutter head to reduce the amount of material entering the water column; • Change dredging schedules based on tide, wind, and background/natural turbidity to minimize effects due to increases in turbidity levels; • Avoid "overflow" dredging by transporting the dredge to the disposal zone once the hopper is at capacity. •	Minor	Dredging contractor	Construction	Monitoring of turbidity	Dredging contractor ARISE	To be established in a dredging management plan. Depending on frequency of maintenance dredging
C8		Impact of dredging and disposal on chemical water and sediment quality parameters	Negligible	NA	Negligible	NA				
C9		Increased levels of pollutants in marine water in case of discharge of untreated waste water	Moderate	• Adopt treatment system design specifications for all effluents intended for discharge that allow compliance with specified discharge limits; as national limits don't exist, Indicative values for treated sanitary sewage discharges given in Table 1.3.1 of the IFC General EHS Guidelines (IFC, 2007) will be used as discharge limits to comply with; • Sanitary/domestic wastewater collected in septic tanks shall be commingled with other sanitary wastewater streams and treated prior to discharge or pumped out and directed to an existing authorized treatment plant off-site.	Minor	Port Authority	Construction	Routine monitoring and visual inspections	Port Authority	Monthly
C10	Protected Area Designations	Impact of Project activity on protected areas	Negligible	NA	NA	NA	NA	NA	NA	NA
C11	Terrestrial Ecology	Impact on terrestrial ecology from activities inside the port	Negligible	NA	NA	NA	NA	NA	NA	NA
C12	Marine and Coastal Ecology	Loss of habitat and increase suspended sediment as a result of dredging and disposal	Moderate	• Develop and implement a Dredging Management Plan. This plan should be tailored to the project and should: • define the dredging methodology;		ARISE/ dredging contractor	Before construction Construction	Identification of hard substrate species present and overall distribution	Arise Dredging contractor	Baseline Daily

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
				• identify and assess dredged materials disposal options and sites; • characterize the chemical and physical composition and behaviour of the sediments to be dredged; • characterize the environmental baseline where the port, harbour, and/or terminal (and disposal area) will be located; • define the area of influence with identification, • assessment and modelling of sensitive ecological receptors (usually through sediment plume propagation modelling); • define mitigation measures to address adverse impacts (for example on aquatic habitat, biodiversity, and water quality), and relevant environmental monitoring parameters and indicators.		Dredging contractor		Monitoring of turbidity and or sedimentation levels Monitoring of benthic fauna in impact area	Dredging contractor	Monthly
C13		Impact on marine ecology due to increased underwater noise and vibrations	Minor	• Employ a Marine Megafauna Observer (MMO) to monitor for turtles and marine mammals. Observations for no less than 30 minutes should be undertaken prior to commencement. • Dredging and piling (vibrohammer) should stop when megafauna species are in close proximity • Use a soft start/slow ram up during piling and dredging activities	Minor	Dredging contractor and EPC contractor	Construction	Log/detailed report by MMO	Dredging and EPC contractor	Daily during dredging and piling activities
C14		Increased traffic and use of dredge vessels	Minor	• When using a suction dredger only start the pumps once the draghead is close to the seabed. If issues arise consider using a tickler chains or turtle deflectors on the drag head to reduce the likelihood of a turtle getting drawn into the draghead	Negligible	Dredging contractor	Construction	Visual inspection	Dredging contractor	During dredging activities
C15		Impact of suspended sediments on fishing success	Negligible	• None required	Negligible	NA		NA		
C16		Impact on avifauna due to increased disturbance and noise	Minor	• Excessive noise should be avoided or minimized during construction and operation of ports to prevent harmful exposure terrestrial and marine environmental receptors, including wildlife. • Further mitigation measures are described under C3 noise and vibration.	Minor	EPC Contractor	Construction	See C3.	See C3	See c3
C17	Ecosystem Services	Impact of construction and operation activities on commercial fishing (provisioning ecosystem service)	Negligible	NA	Negligible					
C18		Impact of dredging activities on coastal protection (supporting ecosystem service)	Negligible		Negligible					
C19	Visual Amenities	Impact of project activities and components on landscape and visual environment	Negligible	NA	Negligible					

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
C20	Community Health, Safety, and Security	Increased risk of road traffic safety incidents	Moderate	• To reduce the risk of traffic accidents the EPC Contractor will develop and implement a **Traffic Management Plan** including design of access points, signage, speed limits, training and fitness of drivers, maintenance of vehicles, use of traffic marshals, procedures for transport of oversized loads, maintenance of log of traffic related incidents, sensitisation of road users and people living or working close to the road and establish a monitoring mechanism to ensure effectiveness of the plan; • Avoid night driving where possible and, where necessary, implement reduced speeds for night driving; • Use as much as possible buses for the commuting of project workers; and • Establish a grievance mechanism that allows communities to communicate concerns and have them addressed in a timely and effective manner.	Minor	EPC Contractor ARISE	Traffic Management Plan, pre-construction Construction	Check compliance of plan and log of traffic incidents	ARISE	Weekly Grievance Mechanism updated as required
C21		Increased risk of vessel traffic safety incidents	Moderate	• Clearly demarcate marine (e.g. markers and buoys with lights etc.) worksites; • Equip vessels involved in dredging and other construction-related activities with navigation equipment and suitable aids (such as buoys and lights) to minimise interference with other vessels and to maintain high visibility at all times; • Ensure that all service and construction vessels are equipped with a functioning radar and communication equipment, and that the radar system is continuously monitored; • Maintain ongoing engagement with fishing groups (as well as other relevant stakeholders) and communicate specific project information such as exclusion zones well in advance of activities; and • Notices should be issued to users of the marine environment to ensure awareness of the activities.	Minor	EPC Contractor Dredging Contractor Port Authority ARISE	Pre-construction Construction	Routine monitoring and maintenance Visual inspection Community liaison	ARISE	Weekly As required
C22		Impact on community health from construction activities	Minor	• Develop and implement a programme to raise awareness, with special attention to incoming expat workers, on HIV/AIDS (and other sexually transmitted diseases), which includes voluntary testing, provision of condoms, and education.	Minor	EPC Contractor	Pre-construction Construction	Check on awareness on STD with labour force and prevalence of STD	ARISE / Health post statistics	Monthly check
C23	Economics and Livelihood	Impact on fishing grounds and fishing access	Minor	• Implement the identified measures to mitigate the risk of increase vessel traffic incidents C21 • Establish a grievance mechanism that allow fishermen to communicate concerns and have them addressed in a timely and effective manner.	Minor	EPC Contractor ARISE/Port Authority	Design Construction	Routine monitoring and maintenance Visual inspection Community liaison	ARISE	Weekly As required
C24		Hindrance of port operations	Minor	• Measures will be developed by the EPC Contractor and ARISE to reduce hindrance of construction activities on current port operations. These measures will include regular engagement and coordination meetings with the Port Authority and relevant port operators to inform them about construction schedule and activities and collect their feedback and potential grievances. In	Minor	EPC Contractor Port Authority ARISE	Design Pre-construction Construction	Regular announcements regarding activity Update of Grievance Mechanism	ARISE	As required

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
				particular the Port Authority will coordinate with ARISE and the Dredging Contractor to ensure that dredging activities hindrance to vessel movement is as low as possible.						
C25		Employment Opportunities	Positive	• Develop and implement a **Local Employment and Content Plan** to maximise the employment of local labour and Mauritanian nationals. This plan should include provisions for equal opportunity (non-discrimination by gender, ethnicity, religion, and age) and for "equal pay for work of equal value". The plan should also facilitate identification and selection of qualified local and Mauritanian companies to provide needed supplies and services. This plan should include provisions for advance notice to local companies, along with selection criteria including health and safety, to allow them to prepare for upcoming opportunities • Set-up a fair, inclusive and transparent recruitment process for the workforce needs and ensure that this is clearly communicated to all potential work force in advance of the construction phase, in order to manage expectations and opportunistic influx. • Disseminate information about local employment and contracting opportunities equitably by using accessible communication channels such as local government bulletins, notice boards, registration with district employment departments, and advertisements in local newspapers; • Set-up a local hiring office for use by all contractors to advertise positions, receive applications, and provide guidance to applicants. • Develop and implement training programmes to develop local workforce and supplier capacity; • Deliver to all project staff on-the-job training associated with their role, with associated certification for employees to use in future employment; • Disclose Project employment and procurement information frequently and regularly through transparent communication on hiring policies amongst local communities, which aid in managing expectations and demonstrating to local communities that Arise is providing training and employment opportunities to their full ability.	Positive	ARISE	Pre-construction Construction	Compliance with Local Employment Content Plan Check, negotiate and record opportunities for Mauritanian companies Record origin of employees	ARISE	Continuous
C26	Cultural Heritage	Impact of influx of expat workers on cultural heritage	Minor	• Develop training and awareness material to educate Project staff and contractors in the identification and understanding of cultural sensitivities.	Minor	ARISE EPC Contractor	Pre-construction	Compliance with schedule	ARISE	During construction
C27	Labour and Working Conditions	Potential issues related to labour related grievances, discrimination, equal opportunities, supply chain,	Moderate	• Adopt and implement a **Human Resources Policy** and all relevant accompanying Procedures, Plans and manuals, in line with the applicable provisions in the Labour Act of Mauritania (Decree 2004-017) and the requirements of IFC Performance Standard 2;	Minor	ARISE EPC Contractor	Pre-construction Construction	Approval of human resources and procedures and compliance check	ARISE	Pre-construction and weekly audits

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
		risk of child labour and forced labour		• Develop a fair, inclusive and transparent recruitment process for the construction workforce, and ensure that this is clearly communicated to all potential workforce in advance of the construction phase, in order to manage expectations and opportunistic influx; no hiring of short-term labour to be made at the site gate; • Prohibit forced labour and child labour – including verification procedures to check employees' age and safeguards that workers are not recruited so as to accrue unacceptable debt or limit access to essential documents; • Recognise trade unions where workers request this in line with national legislation and international standards, no activity to discourage workers from forming unions, and policy towards other forms of collective organisation; • Respect for any collective bargaining agreements; • Adhere with the principles of non-discrimination at work; • Provide reasonable terms and working conditions for employees including avoidance of excessive working hours, payment of at least the national minimum wage and seeking to provide a wage which will provide sufficient disposable; • Establish an effective worker's grievance mechanism, so that labour potential conflicts can be dealt with in an early and proper way; and • Implement independent labour audits during the construction phase to check compliance of the Construction Contractors with the above measures						
C28		Risk of health & safety incidents amongst labour force	Major	• Require that the Construction Contractors comply with Arise's OHS policy and develop and implement a project specific Occupational Health and Safety ('OHS') Plan and accompanying Procedures. All Contractors' plans shall be reviewed for adequacy prior to start of construction activities. • Conduct daily worker induction including detailed H&S training, including awareness raising regarding disease vectors, for all staff and conduct daily H&S toolbox talks with the entire workforce prior to commencement of construction activities; • Provide specific H&S training programmes for workers assigned to tasks associated with particular H&S risks i.e. working at heights, hot work, drivers, machine operators, those working in areas with elevated dust and noise levels. Provide first aid training for key staff and include issuing of first aid certificates; • Ensure Personal Protective Equipment (PPE) is worn at all times during construction, where required. This will depend on the type of work being conducted but will		EPC Contractor Dredging Contractor ARISE	Pre-construction Construction	Daily and weekly incident reports. Visual observation of work areas for non-compliant behaviors or activity.	ARISE	Daily compliances checks, H&S talks

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
				include hard hats, safety boots, hearing protection, eye protection, and lifejackets or buoyancy aids; • Make readily available first aid kits and defibrillators at several locations on site; • Provide safe access arrangements suitable for the size and type of vessels calling at port facilities, such as guard rails and/or properly secured safety nets between ships and the adjacent quay; • Provide dock premises with adequate and suitable rescue and lifesaving equipment and means to escape from danger, e.g. handholds on the quayside at water level, ladders on quay walls and life-saving appliances; • Install warning signs in place, including those for the electrical and me²chanical equipment safety warning, and chemical hazard warning; • Provide appropriate road signs and markings and separate people from areas of vehicle traffic and make vehicle passageways one-way, to the extent practical; • Vehicles should be safe, provided with suitable visibility aids, regularly maintained, repaired and inspected and all drivers should be fit and competent to operate all the vehicles they use at work; • Develop and implement an **Emergency Preparedness and Response Plan**; and • Provide HIV/AIDS awareness and prevention training which will include voluntary testing, the provision of condoms, and education of the workforce.						

OPERATIONS

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
O1	Air Quality and Climate	Impairment of air quality by exhaust emissions from vehicles, vessels and equipment engines	Moderate	• Maintain and operate vehicles, own vessels and equipment engines in accordance with manufacturers recommendations; • Where practicable in terms of technology and national policy, upgrade land vehicle and equipment fleets with low emission vehicles, including use of alternative energy sources and fuels/fuel mixtures (e.g. electricity or compressed natural gas, etc.); at this stage, Arise plans to procure major equipment (ship to shore container cranes (STS) and rubber tyred gantry (RTG) cranes) fully electrical; • Encourage reduced engine idling during on- and off-loading activities; • For vessel operated by Arise (if any), ensure combustion emissions (including NOx, SOx, and PM) are within the limits established by international regulations (MARPOL 73/78, Annex VI, Chapter III of MARPOL 73/78) and use low-sulphur fuels if available in Mauritania; • Conduct a study to assess the feasibility for NCT to offer cold ironing (shore-based power) to vessels berthing at NCT; • Discuss in a working group with Port Authority and other operators the possibility to use reduced ship propulsion power in port access areas, when practical and without affecting the safety of vessel navigation; and • Explore ways to encourage the behaviour of shipping companies berthing at NCT towards a better environmental performance.	Minor	ARISE Port Authority	Design Operations	Routine maintenance and checks	ARISE	Daily / as required
O2		Volatile organic compound (VOC) emissions from fuel storage tanks and fuel transfer activities	Moderate	• Install vapor recovery systems for fuel storage, loading/offloading, and fuelling activities (see MARPOL 73/78, Annex VI, Regulation 15) ; • Adopt management practices such as limiting or eliminating loading/unloading activities during poor air quality conditions; • Implement fuel tank and piping leak detection and repair programs for on-site equipment.	Minor	ARISE	Design Operations	Routine maintenance and checks	ARISE	Daily / as required
O3	Noise and Vibration	Nuisance noise level from operation activities	Minor	• See mitigations measures noise and vibration C3 • Replace as much as possible forklifts and reach-stackers with gantry cranes with rubber tires; • Substitute where possible diesel engines with electric power.	Minor	ARISE Port Authority	Design Operations	Visual inspection	ARISE	As required
O4	Soil and Groundwater Quality	Soil and groundwater contamination from accidental spills of hazardous material and improper disposal of waste and wastewater	Moderate	• Install, maintain and monitor oil water separators and grease traps at refuelling facilities, workshops, parking areas, fuel storage and containment; • Install secondary containment of areas where hazardous substances are stored (e.g. fuel, waste areas);	Minor	ARISE	Design Operations	Routine inspection	ARISE	Monthly, or as required after rain or coastal flooding

#	Aspect	Potential impact	Significance (pre-mitigation)	Mitigation or enhancement measures	Significance (post-mitigation)	Responsible for implementation measures	Timing for implementation	Monitoring	Responsible for monitoring	Timing/ Frequency monitoring
				• Equip fuel dispensing equipment with "breakaway" hose connections that provide emergency shutdown of flow should the fuelling connection be broken by movement. • Training of relevant staff in safe storage and handling practices, and rapid spill response and clean-up techniques; • Set-up and apply procedures regarding dealing with contaminated soils; • Develop and implement a Waste Management Plan for the operation of the NCT.						
O5		Soil and groundwater contamination from accidental spills from hydrocarbon pipelines	Moderate	• Conduct a spill risk assessment for the facilities and design, drilling, process, and utility systems to reduce the risk of major uncontained spills; • Ensure adequate corrosion allowance for the lifetime of the facilities or installation of corrosion control and prevention systems in all pipelines; • Install shutdown valves to allow early shutdown or isolation in the event of a spill; • Develop automatic shutdown actions through an emergency shutdown system for significant spill scenarios so that the facility may be rapidly brought into a safe condition; • Install secondary containment and leak detection systems at all hydrocarbon pipelines, • Develop corrosion maintenance (e.g. regular pigging to clean the pipeline) and monitoring programs to ensure the integrity of pipelines; • Ensure adequate personnel training in oil spill prevention, containment, and response; • Ensure spill response and containment equipment is deployed or available for a response; and • If the spill reached the marine environment, implement the Port Oil Spill Contingency Plan	Minor	ARISE	Design Operations	Routine inspection	ARISE	Monthly, or as required after rain or coastal flooding
O7	Coastal Geomorphology, Coastal Processes and Sediment Transport	Impacts on coastal processes during operation	Minor/Moderate	• Potential use of dredged materials to counter shoreline erosion through beach nourishment; this will be studied in the DMP as part of the selection of beneficial use of dredged material; • Design, siting considerations and other coastal protection measures (e.g., beach nourishment, sand bypassing, groynes, seawalls, coastal revegetation, etc.) to minimize adverse impacts from the project on coastal erosion.	Minor	ARISE	Design and construction	Bi-annual beach monitoring for 5 years	ARISE	
O8	Marine Water and Sediment Quality	Water contamination from an oil spill incident in or reaching marine water	Moderate	• Adhere to the existing National Oil Spill Contingency Plan (Plan POLMAR) and the Port Oil Spill Contingency Plan (PIU) • Update, together with the Port Authority the Port Oil Spill Contingency Plan to take into account any possible changes to risks or potential scales of impact as a result of the proposed port extension and ensure	Minor	ARISE and port authority	Operation	Log of oil spill accidents Regular training sessions Visual observations	ARISE	As required

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				that equipment and trained staff are available for its implementation; the updated plan should amongst others: • Outline responsibilities for managing spills, releases, and other pollution incidents, including reporting and alerting mechanisms to ensure any spillage is reported promptly to the Port Authority; • Include provision of specialized oil spill response equipment (e.g., containment booms, recovery devices, and oil recovery or dispersant application vessels, etc.); and • Include regular training schedules and simulated spill incident and response exercises for response personnel in spill alert and reporting procedures, the deployment of spill control equipment, and the emergency care/treatment of people and animals impacted by the spill. • Implement measures described in C5 to mitigate the risk of accidental spills on land of hazardous material (including oil from the hydrocarbon pipelines) and improper disposal of waste.						
O9		Increased levels of pollutants in marine water in case of discharge of untreated waste water	Moderate	• Implement the measures mentioned in C5 to mitigate the impact of water pollution in case of discharge of untreated waste water from land-based activities; and • Provision, in collaboration with the Port Authority and other port operators, collection, storage, and transfer and/or treatment services, and facilities of sufficient capacity and type for all wastewater generated by vessels at the terminal in accordance with MARPOL and national regulations. • Oily waste and wastewater should be collected in barges, vehicles, or central collection systems and storage tanks. The capacity of oily waste collection should be established based on applicable MARPOL provisions. • Sewage from ships should be collected and treated on-site or off-site according to the recommendations provided in the IFC General EHS Guidelines.	Minor	ARISE, Port Authorities and port operators	Operation	Visual observation	ARISE	Regularly during operation
O10	Protected Area Designations	Decrease of shipping activities in designated protected area Banc D'Arguin protected areas	Positive	NA						
O11	Terrestrial Ecology	Impact on terrestrial ecology from activities inside the port	Negligible	NA						
O12	Marine and Coastal Ecology	Impact of maintenance dredging and disposal on marine species	Minor	See C12						

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O13		Increased use of the area by vessels using the new port increasing the risk of collisions with marine mammals and marine turtles	Minor	• speed limits should be adhered to whilst entering the port	Minor	ARISE/port authority	Operation	Compliance and log/report of incidents	Arise/Port Authority	
		Increased use of the area increasing the risk of pollution incidents	Moderate	See O8	Minor					
O14	Ecosystem Services	Impact of construction and operation activities on commercial fishing (provisioning ecosystem service)	Negligible	NA	Negligible					
		Impact of dredging activities on coastal protection (supporting ecosystem service)	Negligible	NA	Negligible					
O15	Visual Amenities	Impact of project activities and components on landscape and visual environment	Negligible	NA	Negligible					
O16	Community Health, Safety, and Security	Increased risk of road traffic safety incidents	Minor	• Establish a grievance mechanism that allow communities to communicate concerns and have them addressed in a timely and effective manner; and • Consider offering road safety training to main container trucking companies and applying an incentive scheme for companies that can demonstrate good maintenance of their vehicles and low accident statistics.	Minor	ARISE	Operations	Community engagement Updating Grievance Mechanism	ARISE	As required
O17		Increased risk of vessel traffic safety incidents	Negligible	NA	Negligible					
O18	Economics and Livelihood	Impact on fishing grounds and fishing access	Moderate	• Discuss the status of the marine security zone with the Port Authority; discussions should be oriented towards not extending the security zone but instead installing buoys on each side of the access channel just out of the security zone to indicate to fishermen where to cross; • Ensure that, where possible, safety exclusion zones are clearly demarcated, noted and/or monitored, to enable vessels to be aware when they are close to the safety zones.		ARISE Port Authority	Operations	Visual inspection	ARISE	Monthly / as required
O19		Enhanced national economic growth thanks to the operation of the new terminal	Positive	NA	Positive					

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O19		Employment opportunities	Positive	• Implement measures described in C25	Positive					
O20	Cultural Heritage	Impact of influx of expat workers on historic and cultural heritage	Negligible	NA						
O21	Labour and Working Conditions	Impact on labour conditions from operation phase	Moderate	• Implement measures described in C27	Minor	ARISE	Pre-construction Operation	Approval of human resources and procedures and compliance check	ARISE	Pre-construction and weekly audits
O22		Impact on occupational health and safety during routine operation activities	Moderate	• Implement measures described in C28	Minor	ARISE	Operation	Daily and weekly incident reports. Visual observation of work areas for non-compliant behaviors or activity.	ARISE	Daily compliances checks, H&S talks
O23		Impact on occupational health and safety from fire and explosion accident on hydrocarbon berth and pipelines	Moderate	• Conduct a quantitative risk assessment (QRA) for the fuel unloading activities and section of pipeline crossing the container terminal; • Install a combination of automatic and manual fire alarm systems that can be heard across the project site; • Install active fire protection systems strategically located to enable rapid and effective response. The fire suppression equipment should meet internationally recognized technical specifications for the type and amount of flammable and combustible materials at the site; • Implement safety procedures for unloading of product to transport systems (e.g. ship tankers), including use of failsafe control valves and emergency shutdown equipment; • Prepare, as part of the Emergency Preparedness and Response Plan, a fire response plan supported by the necessary resources to implement the plan; coordinate with Port Authority firefighting team (if any) and with the fire brigades of Nouakchott; and • Provision of fire safety training and response as part of workforce health and safety induction / training, including training in the use fire suppression equipment and evacuation, with advanced fire safety training provided to a designated firefighting team.	Minor	ARISE	Design Operation	Control and auditing of H&S plan	ARISE	Before operation starts, continuous monitoring on compliance, Weekly H&S talks