REPUBLIC OF COTE D'IVOIRE
AUTONOMOUS PORT OF ABIDJAN

REPUBLIC OF COTE D'IVOIRE

DETAILED DESIGN STUDY OF ABIDJAN PORT CEREAL BERTH CONSTRUCTION PROJECT

FINAL REPORT

MARCH 2018

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ECOH CORPORATION
ORIENTAL CONSULTANTS GLOBAL CO., LTD
THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN

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1. General Description of Detailed Design for the Project

1.1 Outline of Project under Loan from JICA (STEP: Japan Tied, 1 package, without PQ)

(1) Objective

The objective of the Project is to increase the cargo-handling capacity of the Abidjan Port, by constructing new cereal berth and storage space, thereby responding to the increasing cargo demand and contributing to the economic development in Republic of Cote d'Ivoire and the West Africa Region.

This Detailed Design Study was executed for preparation of the draft Bidding Documents and submission of the documents to the Government of Republic of Cote d'Ivoire. .

(2) Location

Abidjan Port

(3) Executing Agency

The Autonomous Port of Abidjan (hereinafter referred to as "PAA")

(4) Project Components

1) Construction of -14m New West Quay (450m)
2) Construction of -13m New North Quay (250m)
3) Dredging work to secure -14m depth for New West Quay and -13m depth for New North Quay
4) Reclamation of terminal yard (9.5 ha)
5) Construction of -10m New South Quay for Tug and pilot boats (310m)
6) Construction of retaining wall and revetment for the access road (approx. 50m) and a mooring bollard
7) Drainage facilities, water supply, lighting and electrical supply including yard lighting with its connection (including transformer)
8) Construction of a building of the Watch-tower for Harbor Master (5F tower with approx. 1,400 m^2 office space)

1.2 Outline of Detailed Design Study

1.2.1 Confirmation on Detailed Design of the Port Facilities

The Detailed Design Study was conducted properly reflecting the results of technical discussions between JICA and PAA signed on July 14, 2017. Additionally, the result of discussion on March, 2018 was taken into consideration.

(1) Basic conditions for Detailed Design of Quay Structure

The following conditions on the main quay structure are agreed with JICA and PAA, and they were basically applied to the Detailed Design Study.

1) Dredging Depth

Quay	Water depth of wharf structure	Dredging water depth in front of wharf
450m (-14m New West Quay)	-14m	-14m
250m (-13m New North Quay)	-13m	-13m

2) Dimensions of steel pipe sheet piles to be applied

Quay	Diameter (mm)	Thickness (mm)
450m (-14m New West Quay)	900	17
250m (-13m New North Quay)	900	17

3) Junction of steel pipe sheet pile: LT65

4) Tie rod elevation: ±0.00m above the Chart Datum

5) Type of structure for New South Quay (tugboats' and pilot boats' berths)
- Application of steel piles composed of Hat-type sheet pile and H-section pile, which is named Hat-H pile

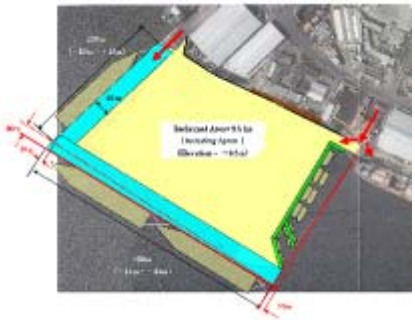
(2) Layout of Cereal Berths

The new cereal berth layout was originally proposed in the JICA Preparatory Survey, and the final layout was determined through discussions with PAA as shown in Table 1.2.1-1. Modification of the layout was made considering avoidance of obstruction by a large cargo vessel to smooth and safe traffic of smaller boats.

The Detailed Design Study had been carried out on the basis of the final layout shown right in the Table 1.2.1-1.

In the Preparatory Survey, several options of warehouse layouts were proposed; but PAA determined to provide an area for concessionaires to design free layout of warehouses. Based on this layout concept, the Detailed Design Study did not discuss provision of warehouses and open space excluding apron pavement along the quays in the new reclaimed area.

Table 1.2.1-1 Modification of Layout of Berths

Layout Proposed in Preparatory Survey	Layout agreed with PAA
	

Source: JICA Study Team

1.2.2 Additional Surveys for the Study

In the stage of the Preparatory Survey, topographic surveys, bathymetric surveys, geotechnical investigations, analysis of seabed material and water quality surveys were conducted for obtaining minimum necessary information for judging the feasibility.

Additional surveys and geotechnical investigations listed below were executed for further detailed information of the Detailed Design Study.

- Bathymetric survey for additional dredging
- Underwater survey of the existing seawalls and concrete blocks of the North and West Quays
- Analysis of seabed material and seawater
- Geotechnical investigation for the New South Quay and a watch tower for harbor master

1.2.3 Preparation of Draft Bidding Documents

JICA Study Team shall prepare draft Bidding Documents based on the JICA Guideline in French version, on which CCAG is based. Technical documents such as Specifications and Bill of Quantities will be prepared, fundamentally applying requirements in Eurocode and local codes with possible efforts except specifications stipulated in Japan Industrial Standards for steel material composing the quay structures.

1.2.4 Preparation of Environmental and Social Impact Assessment (ESIA) for PAA

JICA Study Team recruited the local consultant for preparation of the application documents, the ESIA report, to ANDE. The documents also needs conformity with the stipulations of JICA Guideline for ESIA. JICA Guideline requires completion of Environmental Monitoring Form (EMF) and preparation of Environmental Management Plan (EMP) with Environmental Monitoring Plan (EMoP) to be applied at the construction stage.

The draft ESIA report is prepared in consultation with PAA and ANDE; however, the critical issues on dredging and dumping of dredged material have not been finally agreed between PAA and ANDE.

Under the above situation, the Detailed Design Report is submitted to PAA without solution for the issues, because they are characterized as the internal issues to be solved/agreed among the governmental authorities in Republic of Republic of Cote d'Ivoire.

2. Review and Verification of the Study Results during Preparatory Survey for the Project

2.1 Design Codes/Standards

Steel material such as steel pipe sheet piles applied to the quay structure will be purchased from Japanese manufacturers under the Japan's Loan with the Special Terms of Economic Partnership (STEP) scheme. In the course of several times of discussions between the JICA Preparatory Survey Team and PAA, both parties agreed on application of the Japanese Standards for Port Facilities to design the quays for the Cereal Berth Construction Project, conditioning that reports on calculation for design of quays based on Eurocode should be also attached to the Detailed Design Report.

Buildings are designed on the basis of Eurocode and local codes considering building materials are expected to be purchased locally and/or from EU.

Specifications for this construction project are expected to follow those of Eurocode except steel material such as steel pipe steel piles, steel sheet piles including Hat-H, etc.

2.2 Design of Quay Structure, and Dredging and Improvement of Subsoil

2.2.1 Design of Quay Structure

(1) Input Data and Design Criteria

The input data applied to the design of quays in the Preparatory Survey stage were obtained from the site surveys and geotechnical investigations. In designing the quay structure, input data such as tide information, surcharge loads, design elevation of the quay top, rates of steel corrosion, etc. were given by PAA.

For implementation of detailed design of the quays, the Study Team proposed additional surveys and investigations to supplement data and information as stated in sub-section 1.2.2, which were conducted in the present detailed design stage. The scope of the additional surveys and geotechnical investigation were confirmed between JICA Study team and PAA.

All the input data and criteria collected in and applied to the Preparatory Survey and Detailed Design Study stated above are reflected to design conditions of the quay structure stated in Sections 3.3.

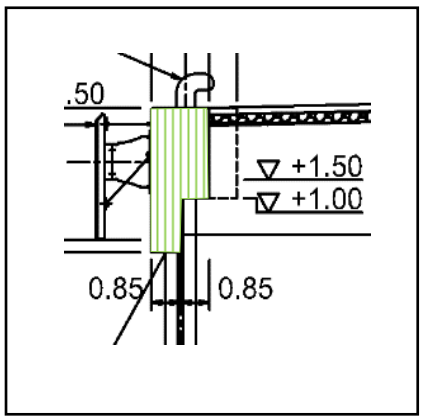
(2) Design of Quay Structure

Preparatory Survey Report was prepared with many times of technical discussions on quay structure between JICA Team and PAA; however, the technical discussions continued till the date of 14th July 2017. Further to the occasions of the discussions, the technical discussions were made in the detailed design stage for finalizing the design elements of structure.

After the above steps, JICA Study Team dispatched to PAA for the inceptive discussion for the Detailed Design Study in July and August 2017. Due to PAA's expression about wrong process for officially approving TOR of the Detailed Design Study, presentation of the Inception Report could not be made.

Inception Report was presented on September 20, 2017, and practical discussion on quay structure was commenced with PAA for the Detailed Design Study from the date.

Regarding the quay structure in the project, JICA Study Team was given the following concrete comments from PAA on November 20, 2017 to the reports submitted by JICA Study Team on October 16, 2017 for clarification to PAA about quay structure and its stability.



a) Dimension of SPSP for -14m New West Quay: ϕ 900mm, t17mm
b) Calculation notes for -14m New West Quay, -13m New North Quay and -10m New South Quay submitted to PAA: acceptable with the instruction a)
c) Capping concrete: to be modified as shown right for

minimization of capping concrete
d) Apron width along the -14m and -13m quays: 25m with interlocking concrete blocks
e) Gradient of aprons: 2%

Additionally, the comments from PAA on March, 2018

f) Dimension of SPSP for -13m New North Quay: ϕ 900mm, t17mm

The above instructions required modification of the design of quay structure proposed in the Preparatory Survey. Design of the new quays in the detailed design stage was made with reflection of the above instructions on the basis of Japanese Technical Standards.

Therefore, structure of the quays proposed in the Preparatory Survey has been modified in the Detailed Design Report to conform to the instructions from PAA as stated above.

Since basic structure for -13m, 14m and -10m quays are accepted by PAA as above b), basic structure with using SPSP for -13m and -14m quays, and Hat-H for -10m was designed as mentioned in Sub-chapter 3.3.

2.2.2 Dredging and Reclamation including Improvement of Sand Replacement

It is not too much to say that dredging and reclamation including sand improvement fully depend on subsoil characteristics at the site to be developed. In the previous Preparatory Survey, the area, depths, volumes and other specifications of the dredging and reclamation were technically discussed and examined based on the geotechnical investigations conducted by PAA and JICA Survey Team. The following are technical concepts and conclusions for dredging and reclamation in the Preparatory Survey:

- Peat layer recognized as unsuitable material in civil engineering exists most likely at all site area in the range of the thickness between 4m to 25m. The layer tends to appear thinner at north and existing shoreline/quay/revetment sides but thicker at new west and south quay corner area
- Based on examination for application of two (2) soil improvement methods for new quay base such as vertical drain and PVD methods in order to minimize the dredging and reclamation volumes, it was acknowledged that the both applications were not really effective, more costly and longer construction period in actual implementation. Therefore sand preplacement was resultantly recommended instead of the application of such methods.
- Considering the above, the Study Team concluded that all the peat and surface soft layers are to be dredged under reclamation and new quay walls and to be reclaimed and backfilled by fine graded sand material to be taken from the sand extraction area designated by PAA. The dredged unsuitable materials would not be reused for reclamation and would be disposed at the damping area specified by PAA taking environmental laws and regulations into account

In this Detailed Design Study, it is reasonably accepted to basically follow the said technical concepts and conclusions in the Preparatory Survey based on due review and verification of the subsoil conditions and the seabed configuration obtained from additional bathymetric survey as also referred to Sub-chapter 3.1.2. It is therefore recognized that the following considerations should be duly taken into this Detailed Design Study:

a) Identification of more accurate areas and volumes of dredging and reclamation including sand replacement, which should be technically and economically reasonable in view of actual implementation
b) Provision of necessary basin areas for maneuvering and operations of the future target vessels
c) Clarification of environmental requirements for implementation of dredging and reclamation works including sand replacement

The above a) and b) are further discussed in Sub-chapter 3.3.3 and c) is explicated in Chapter 4

accordingly.

2.3 Watch Tower for Harbor Master

In the Preparatory Survey, only following scale concept of the building was proposed without any design sketch:

a) 3 floors for pilot officers with area of 325 m^2
b) Top floor: pilots' operation room
c) Second floor: set at elevation of the floor of 11~12m above a ground level as a canteen & toilet
d) Ground floor: Pilots' office
e) Height of the building: 21m
f) Construction cost: 800,000 Euro

Under the situation, the building had to be newly designed for fitting the above concept for meeting the requirements of Eurocode. In the detailed design stage, the architect office recruited by JICA Study Team made a series of discussions with PAA, presenting several types of building sketches.

Through discussions with PAA, it was clarified that requirements of PAA for the building were for creating a new office for pilots with demolishing a small building in the area of buildings for Division of Maritime Operation Security and Environment.

As a result, the final design concept determined by PAA exceeds the above scale concept and estimated cost at f) as above.

JICA Study Team determined to proceed to completion of the detailed design of the building with satisfaction of PAA.

It is understood that adjustment of design and cost for the building might be required in finalizing the Bidding Documents.

3. Detailed Design of Port Facilities

3.1 Site Investigations

3.1.1 Topographic and bathymetric survey

(1) General

During JICA Preparatory Survey, the topographic and bathymetric surveys were carried out for certain areas in order to determine the areas of dredging and reclamation and also to ascertain the location of the existing seawall and quay structures at the project site. However the coverage especially of the bathymetric survey was resultantly not enough for the said examination, so the additional bathymetric survey was conducted in this Detailed Design Study.

The survey intervals were specified as five (5) meters mesh. During the survey period, tide observation was conducted to collect the tide data for correction of the depths measured in the survey. The datum of the elevation was set as Chart Datum Level (CDL). The geodetic system and the map projection applied were respectfully WGS84 and UTM (Universal Transverse Mercator) meshed into 30N.

Figure 3.1.1-1 shows the existing plan covering whole project site as combined with reflection of the results of the topographic and bathymetric surveys previously carried out and the additional bathymetric survey. The particular features found based on the outcome are described as follows.

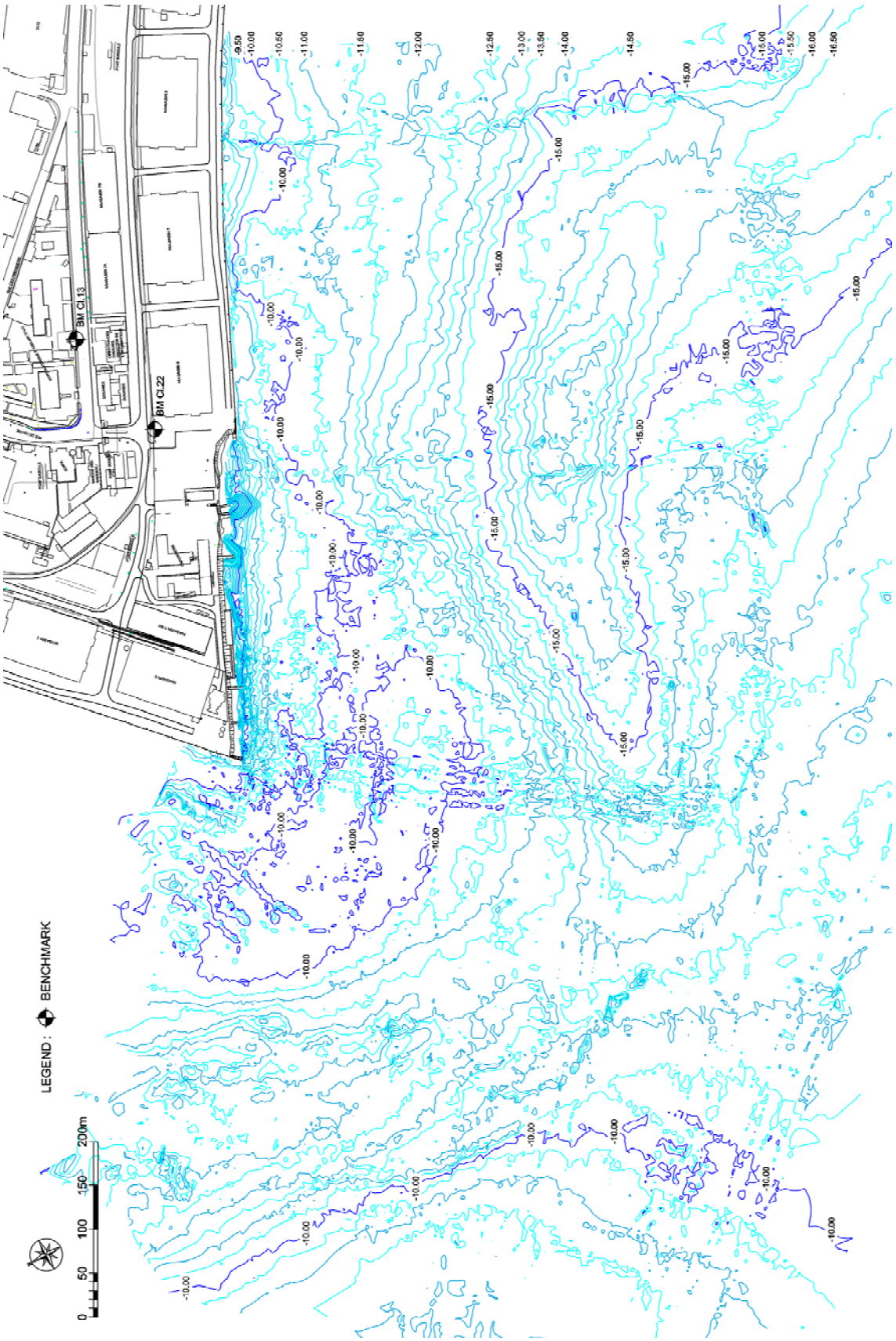
(2) Topography

According to the topographic survey previously conducted in application of using aerial photographs as shown in Figure 3.1.1-1, the area probably reclaimed during French administration is almost flat within the range of 3.2 to 3.8 meters above CDL. The elevation of the shoreline and existing quays adjacent to the site to be developed is most likely within the rage between 3.2 and 3.5 meters above CDL. The hinterland of the site are quite congested with occupation by various port related industries and activities such as factory, mills, strorage, transportation infrastructure and the like. In addition, there are two benchmarks officially established by PAA as CI 22 and CI 13, which are respectively located at the entrances of PAA annex building and at the Gate No. 6A as presented in the Figure.

(3) Bathymetry

As seen in the Figure 3.1.1-1, the features of the seabed configuration around the site area are typically summarized as follows:

- In general, the depth of the area is most likely more than ten (10) meters below CDL even though the contour lines are unevenly complicated but is good condition to construct new quays as well as to minimize dredging volumes except for the shoreline of existing quays and revetment that is shallower than ten (10) meters
- Mass sedimentation appears around the corner of the north quay, which may be caused by tidal current or other marine phenomenon
- The area more than 15 m below CDL which may be arisen from spot dredging is confirmed about 300 meters away from the existing revetment and west quay
- The north and west offshore side areas have a sort of deeper trench channel which seems to be naturally made by current stream during tidal change and/or artificially dredged for facilitation of inlet bay system



Source: JICA Survey Team

Figure 3.1.1-1 Existing Plan based on Combined Topographic and Bathymetric Surveys

3.1.2 Geotechnical Investigations

(1) General

As referred to the final report of JICA Preparatory Survey, there are two (2) geotechnical investigations were previously carried out in 2015 and 2016 by the JICA Survey. To identify more accurate areas and volumes of dredging and reclamation including sand replacement, additional geotechnical investigation was further required to be conducted in this Detailed Design Study. The summary of geotechnical investigations are presented in Table 3.1.2-1.

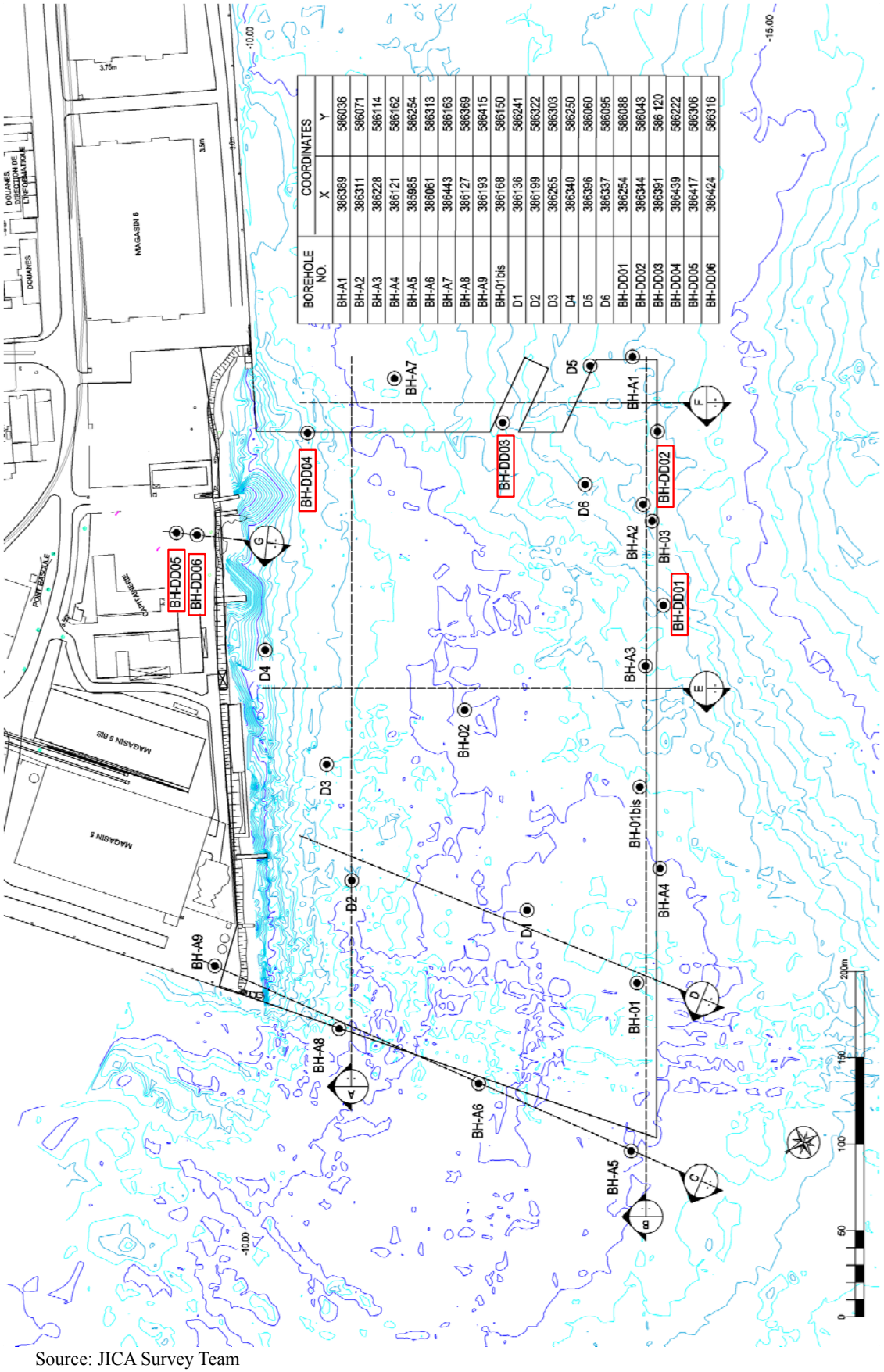
Table 3.1.2-1 Summary of Geotechnical Investigations Conducted at the Site

Conducted by	Conducted in	Borehole No.	Conducted Sampling and Test
JICA (Preparatory Survey)	2015/2016	BH-01 to BH-03 and BH-01bis, BH-A1 to BH-A9	Sampling (disturbed), Standard Penetration Test (SPT), Specific Gravity, Natural Water Content, Grain Size Analysis and Liquid & Plastic Limit
	2016	D1 to D6	Sampling (disturbed), detective boring
JICA (Detailed Design Study)	2017	BH-DD01 to BH-DD06	Sampling (disturbed), Standard Penetration Test (SPT), Specific Gravity, Natural Water Content, Grain Size Analysis and Liquid & Plastic Limit

Source: Final Report on the Preparatory Survey for the Improvement of Grain Terminal of Abidjan Port, JICA Survey Team

(2) Subsoil Characteristics

Figures 3.1.2-1 and 3.1.2-2 to 3.1.2-4 respectively show location map of the boreholes and subsoil profiles at the site.

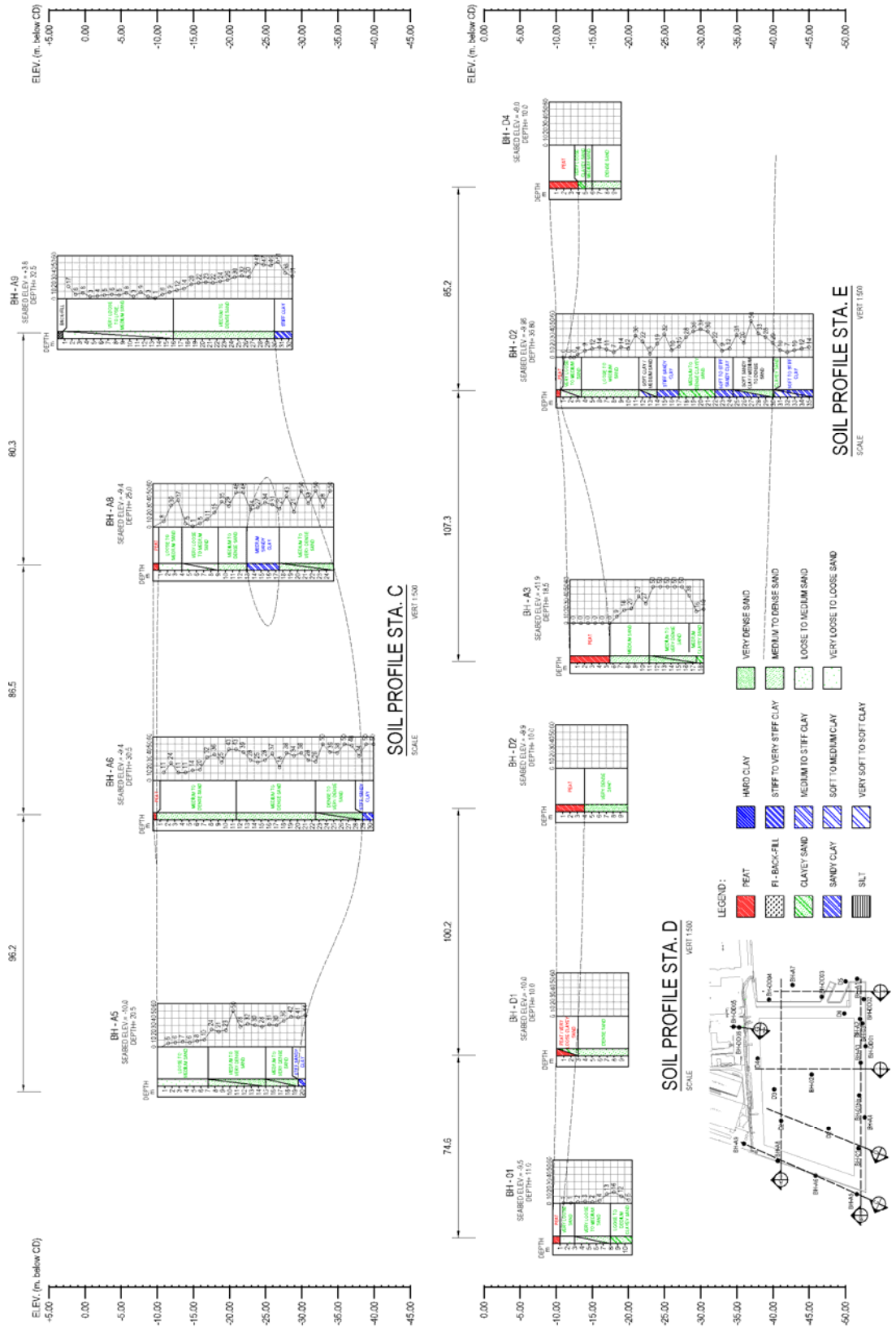


Source: JICA Survey Team

Figure 3.1.2-1 Location Map of Boreholes at Site

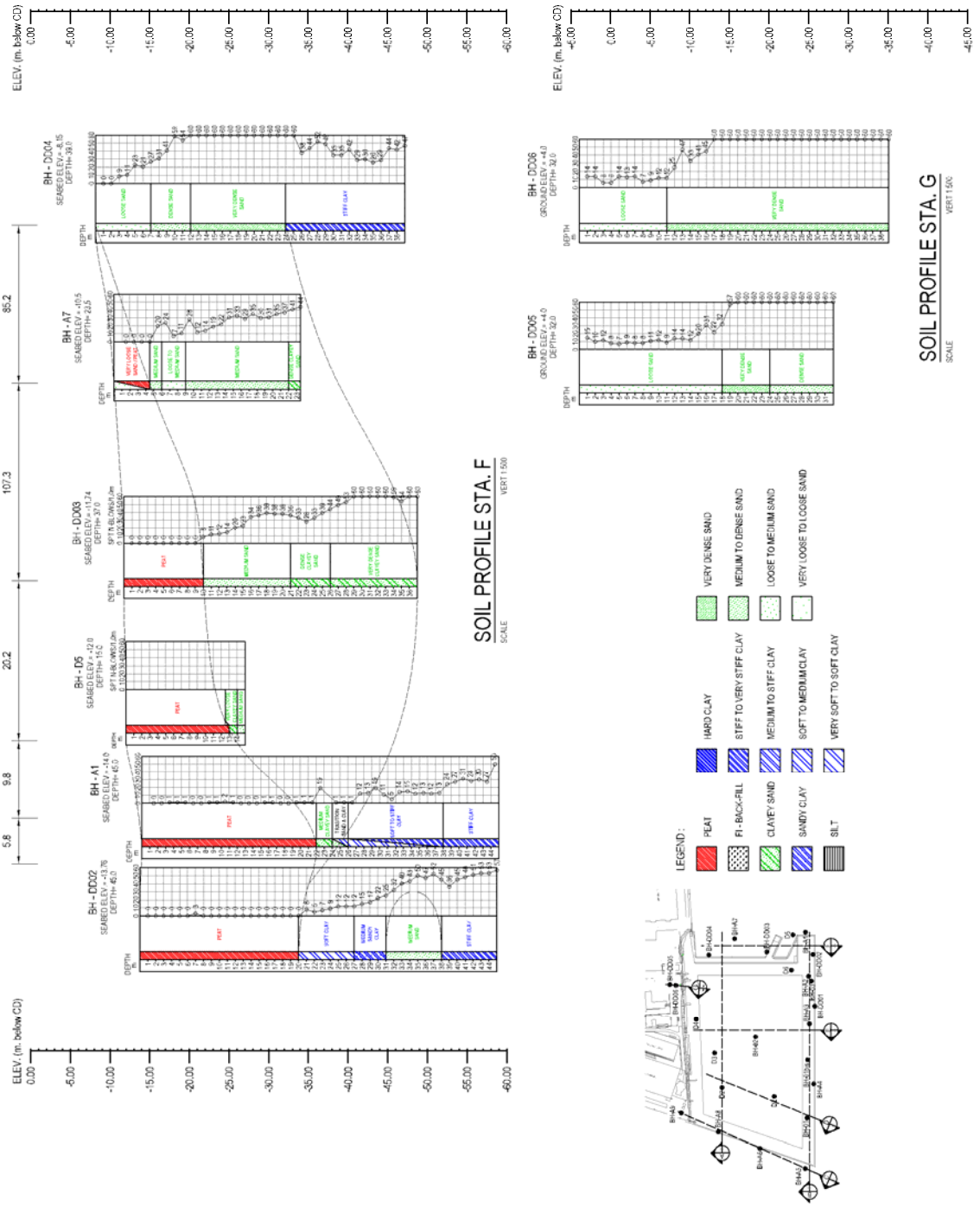
Source: JICA Survey Team

Figure 3.1.2-2 Subsoil Profile at Site (1 of 3)



Source: JICA Survey Team

Figure 3.1.2-3 Subsoil Profile at Site (2 of 3)



Source: JICA Survey Team

Figure 3.1.2-4 Subsoil Profile at Site (3 of 3)

As seen in figures presented, it is commonly characterized that the types of the subsoils of the site generally consist of four (4) layers; **peat**, **sand, clayey silt** and **clay**. There are no rock and stone layers confirmed in any boreholes. The appearance of each layer is not simply uniformed, and the thicknesses and soil properties vary even for same soil type.

Also there are some intermediate soil layers only presented in specific boreholes such as silty/sand clay in BHs-A4, -A8 and -01bis. Further details of soil properties of the above three (3) types are highlighted below (but BHs-D1, -D2, -D3 and -D4 are not considered in the following due to detective boring):

Peat Layer: this soil covers mostly overall at the seabed surface in the thickness approximately between 0.5 and 22.0 m. The appearance of the thicker layer is more dominant from the east (land) to the west (offshore) and from the north to south sides. The borehole that has the thickest layer was BH-A1. The soil type is fractionated as "Very Soft" and the soil layer consists of clay, sand, shell debris, organic decomposition material odor. The layer represents N-value= 0-4 (averaged) and ρ_t=2.2-2.8 t/m^3 (specific gravity), w=88-164 % (moisture content), LL=110-145 % (liquid limit) and PL=57-74 % (plastic index) appeared at BHs-01, -03, -A1, -A2, -A3, -A6, -A7, -A8, -DD01, -DD02, and -DD03.

Sand Layer: this soil appears totally in all the boreholes as the most dominant soil type under the sediment or directly from the seabed in the thickness approximately between 2.0 and 20.0 m at the range of the elevation from 10.0 to 50.0 m more below CDL except for land boreholes. This soil is fragmented into the following four (4) groups from the aspect of density; "Very Loose to Loose" having N-value= 0-10 (averaged) and ρ_t=2.5-2.8 t/m^3 (specific gravity) in BHs-01, -02, -A5, -A6, -A7, -A8, and -A9, -DD04, -DD05 and -DD06, "Loose to Medium Dense" presenting N-value= 11-30 (averaged) and ρ_t=2.7-2.8 t/m^3 (specific gravity) in BHs-01, -02, -03, -A4, -A8, -DD03, -DD04, -DD05 and -DD06, "Medium Dense to Very Dense" indicating N-value= 31-50 (averaged) and ρ_t=2.6-2.9 t/m^3 (specific gravity) in BHs-02, -03, -01bis, -A2, -A3, -A4, -A5, -A6, -A7, -A8, -A9, -DD01, -DD02, -DD03, -DD04, -DD05 and –DD06, and "Dense to Very Dense" with the parameters of N-value > 50 (averaged) and ρ_t=2.7-2.8 t/m^3 (specific gravity) in BHs-A3, -DD03, -DD04, -DD05 and –DD06.

Clayey Silt Layer: this soil appears specifically in BH-A2 under the sediment (peat layer) in the thickness approximately of 2.0 m at the range of the elevation from 21.0 to 23.0 m more below CDL. This parameter of the soil is N-value= 0-4 (averaged) and ρ_t=2.4 t/m^3 (specific gravity).

Clay Layer: this soil appears mostly in some boreholes basically under the layer of peat or sand in the thickness approximately between 1.0 and 15.0 m at the range of the elevation from 25 to 60 m below CDL. This soil is fragmented into the following three (3) groups from the aspect of stiffness; "Soft to Stiff" having N-value= 3-15 (averaged), ρ_t=2.4-2.7 g/cm^3, w=88-91 % (moisture content), LL=65 % (liquid limit) and PL=32 % (plastic index) in BHs-02, -01bis, -A1, -A2 and -DD02, "Stiff to Very Stiff" presenting N-value= 16-30 (averaged), ρ_t=2.2-2.7 t/m^3, w=17-36 % (moisture content), LL=40-62 % (liquid limit) and PL=20-30 % (plastic index) in BHs-03, -01bis, -A1, -A2, -A4, -A8, and -DD02, and "Hard" indicating N-value > 30 (averaged), ρ_t=2.4-2.9 t/m^3 w=18-47 % (moisture content), LL=75-78 % (liquid limit) and PL=37-38 % (plastic index) in BH-03, -A1, -A2, -A4, -A5, -A6, -A9, -DD01, -DD02, -DD03 and -DD04.

3.1.3 Underwater Survey for Existing Port Facilities

(1) General

Underwater survey for existing port facilities were carried out by JICA Study in August 2017 in order to confirm the status and identify objects, shapes, dimensions (width, height, length) and their conditions of the structures existing at the both edges of the existing north and west quays.

The structures are sort of edge quay wall structures of the said existing quays constructed during French administration. The particulars resulted from the survey are summarized in the following.

(2) Structure at the end of existing north quay

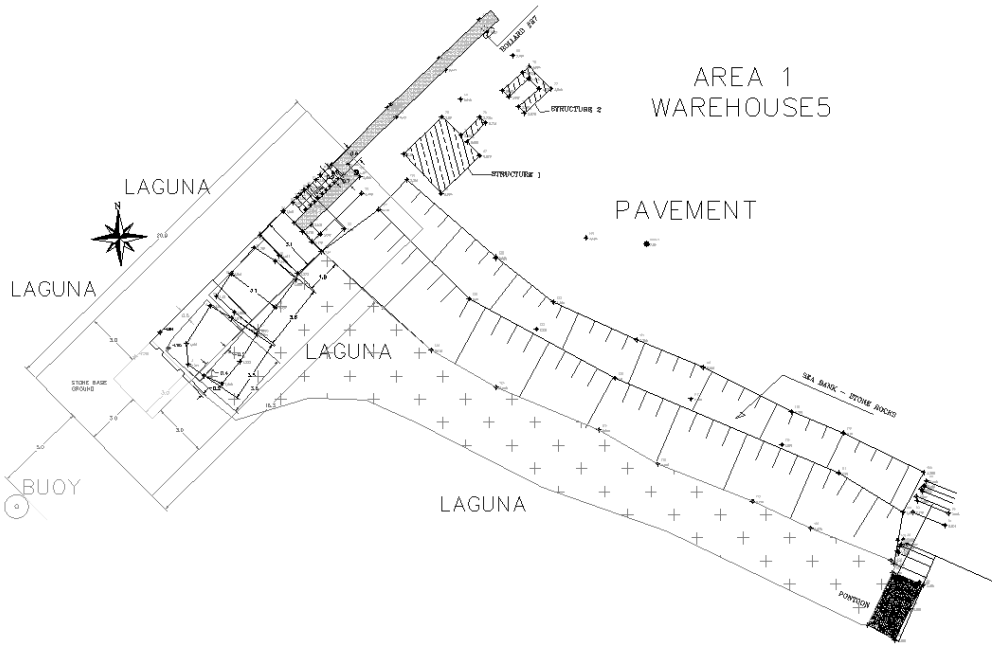
Figures 3.1.3-1 and 3.1.3-2 respectively show a general plan and a typical section of the existing structure at the edge of the existing north quay. As presented in the figures, the alignment of the concrete blocks layered is basically straight except for top layer of the blocks. The width of the blocks is about three (3) meters and the length of the whole structure combined above the seabed is approximately fourteen (14) meters. The structure consists of four (4) layers of the concrete blocks above rubble stone foundation of two (2) meters thickness. The elevation of the existing quay is 3.5 m above Chart Datum Level (CDL) and that of the top layer is about 1.5 m from CDL. There is a terraced access concreted between the quay and the top layer of the blocks.

The top layer has totally three (3) blocks composed of 1 pc of Length 2 m×Width 3m×Height 3m and 2 pcs of L3 m×W3m×H3m with 0.6-0.7 m gap between the blocks. In case of second and third layers, the total numbers of the blocks in each layer are same as the top layer but the dimension of the blocks are individually different. The second layer has three (3) types of block such as L2.5 m×W3m×H3m, L3 m×W3m×H3m and L4 m×W3m×H3m and the third layer also has three (3) types of block such as L2.5 m×W3m×H3m, L3 m×W3m×H3m and L4.5 m×W3m×H3m. At the bottom layer above rubble foundation, there are four (4) blocks consisting of 1pc of L2.5 m×W3m×H3m and 3 pcs of L3 m×W3m×H3m. The rubble foundation is almost two (2) meters longer from the tip fourth (4) block of the bottom layer and the surface elevation of the foundation is 10.5m below CDL.

Upon the observation of the structure, it is generally stable and durable to be utilized as seawall at the transitional part between the reclamation and the existing quay. It seems that the blocks at the top layer require to be rectified with same face line of the existing quay and/or infilling concrete not to retain the gaps and clearances to secure more stability uniformly.

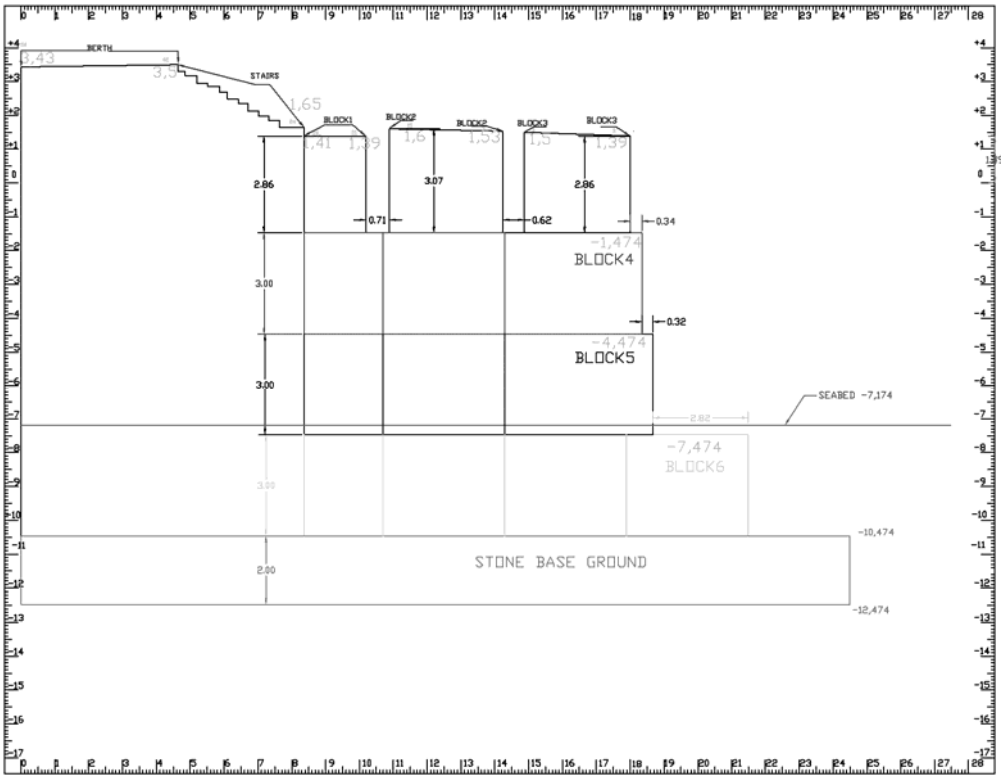
(3) Structure at the end of existing west quay

Figures 3.1.3-3 and 3.1.3-4 respectively show a general plan and a typical section of the existing structure at the edge of the existing west quay. As presented in the figures, the alignment of the concrete blocks layered is straight toward the north quay.



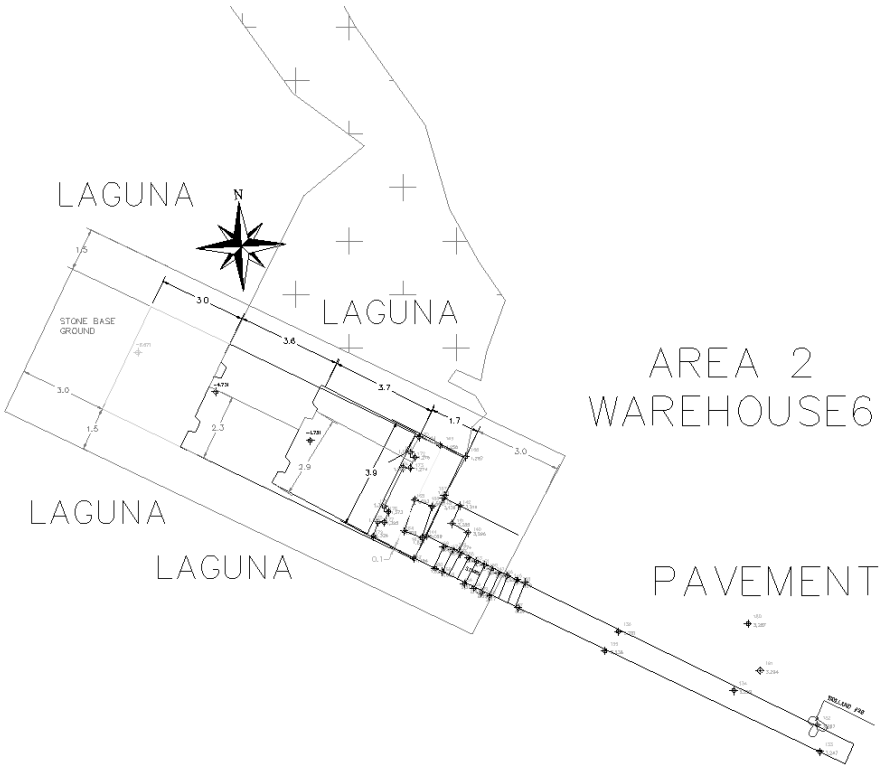
Source: JICA Survey Team

Figure 3.1.3-1 General Plan of Existing Structure adjacent to North Quay



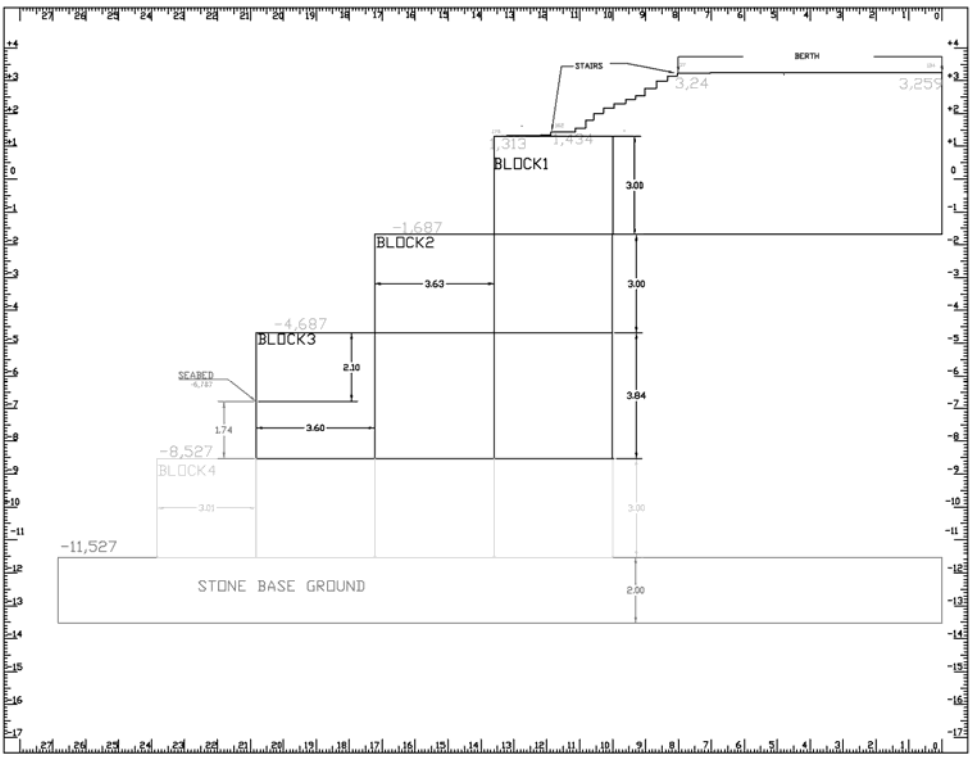
Source: JICA Survey Team

Figure 3.1.3-2 Typical Section of Existing Structure based on Actual Measurement (North Quay)



Source: JICA Survey Team

Figure 3.1.3-3 General Plan of Existing Structure adjacent to West Quay



Source: JICA Survey Team

Figure 3.1.3-4 Typical Section of Existing Structure based on Actual Measurement (West Quay)

The width of the blocks is about four (4) meters and the length of the whole structure combined above seabed is approximately ten (10) meters. Likewise, the structure consists of four (4) layers of the concrete blocks above rubble stone foundation of two (2) meters thickness. The elevation of the existing west quay is 3.2 m above CDL and that of the top layer is about 1.3 m from CDL. There is also a terraced access concreted between the quay and the top layer of the blocks.

The top layer has only one (1) block with dimension of L3.5 m×W4m×H 3m. The second layer has two pieces of the same blocks of L3.6 m×W4m×H 3m. The third layer is comprised of 3pcs of the blocks of L3.6 m×W4m×H 3.8m. The bottom layer has 3pcs of L3.6 m×W4m×H 3m and 1 pc of L3 m×W4m×H 3m. The rubble foundation is almost four (4) meters longer from the tip of the fourth (4) block of the bottom layer and the elevation of the surface of the foundation is 11.5 m below CDL.

Upon the observation of the structure, it is also generally stable and durable to be utilized as seawall at the transitional part between the reclamation and the existing quay.

3.2 Layout of facilities

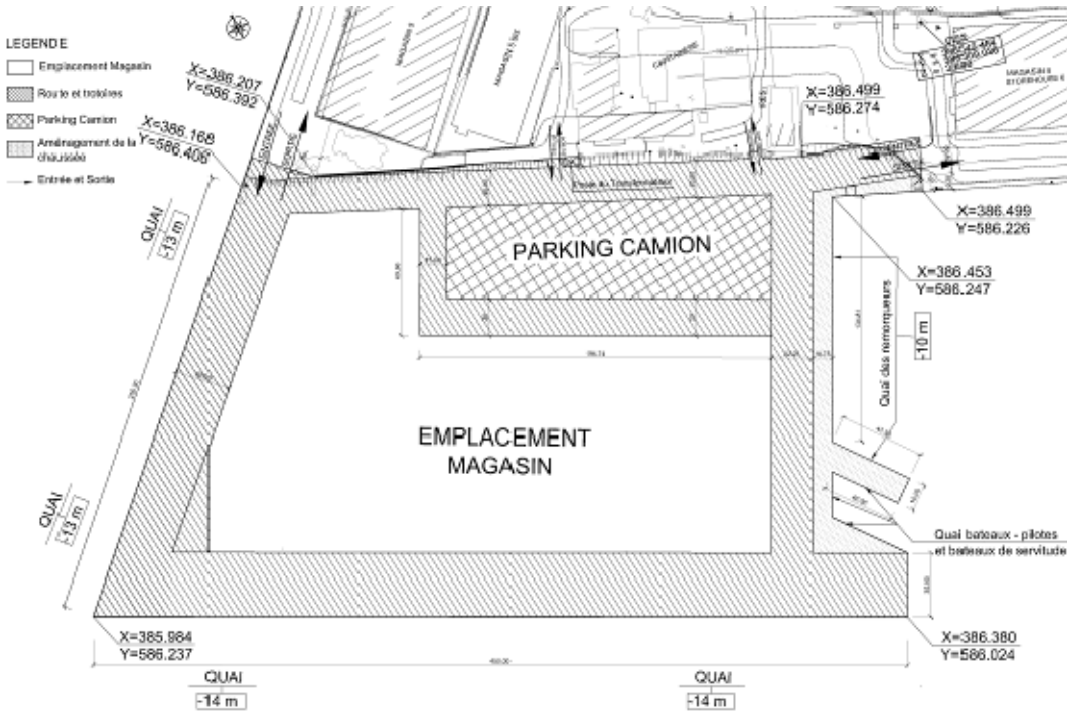
In accordance with the Preparatory Survey for the Project of the Cereal Berth Construction in Abidjan Port conducted from 2015 to 2017 by JICA, the berth has 9.5 ha in space with -14m depth quay having 450m in length, -13m depth quay having 250m in length and tugboat and pilot boat berth having 310m in length. The berth location has been decided at the water area in front of the existing mooring space for tugboats, pilot boats and small service boats due to following reasons.

1) Possible to construct the terminal without any outage for the existing cereal berths.
2) Possible to access smoothly from the existing cereal berths of the north quay and the west quay due to the location is between the both quays.
3) Possible to secure enough space and depth for vessels approaching to the berth.

However, the followings shall be taken into account.

1) Necessary in temporary relocation of the tugboats, pilot boats and small service boats during construction period.
2) Watching building of the harbor master for port operation shall be incorporated into the project due to obstruct the view from the harbor master by the terminal.

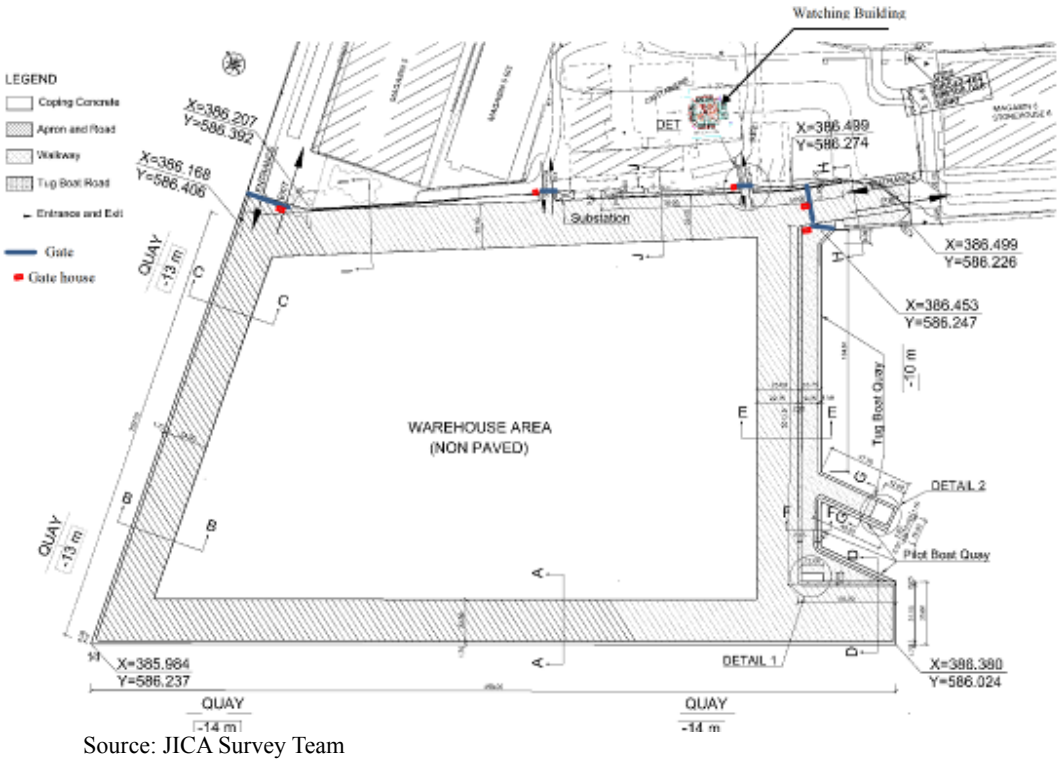
Finally, the berth layout for cereal quays and new tugboat and pilot quay was proposed as the Figure 3.2-1.



Source: JICA Survey Team

Figure 3.2-1 Proposed Terminal Layout

In discussion with PAA, the apron and road pavement of the 450m quay, 250m quay and terminal road shall be 25m in width respectively in order to secure the construction space of the facilities for the concessioner. Moreover, the parking area shall be deleted due to the trucks shall be planned and constructed by the concessioner. The watch tower for harbor master is also decided the location near by the harbor master office. Therefore, the final berth facility layout was decided as Figure 3.2-2.



Source: JICA Survey Team

Figure 3.2-2 Terminal Facility Layout

3.3 Port Structure and Related Facilities

3.3.1 Design Conditions

1) Concrete and Reinforcing Steel Characteristics

Characteristics of Concrete

1	Grade of Concrete		A	C	D	E	F	G	H	I
2	Work Items		Drainage, Sewerage, Fence and Other RC Concrete	Plain Concrete (Precast Concrete Block and Retaining Wall)	Plain Concrete (Interlocking Concrete Block)	Lean Concrete	Building	Precast Concrete Block (borders and pavement)	RC Coping and Beams, RC Base	Under water Concrete (exemptin g Plain precast concrete block)
3	Minimum 28 day Cylinder MPa	Design Strength MPa	25	20	35*	10	25	30	27	30

Source: JICA Survey Team

- High-strength steels for reinforced concrete reinforcement: fe = 400 Mpa
- Cracking will be considered to be very detrimental to docking works, as being detrimental to other structures
- Concrete metered to 350 kg/m3 CLK or CHF for reinforced concrete and quay beam: fc 28 = 25 Mpa
- Concrete metered at 400 kg/m3 CLK or CHF for reinforced concrete and quay beam at the top: fc 28= 27 Mpa
- Concrete metered to 350 kg/m3 CPA for reinforced concrete structure in platform: fc 28 = 25 Mpa
- Minimum coating for reinforced concrete: 6 cm for docking works, 4 cm for other structures
- Reinforcement Bars (Steel Grade)
  i) Plain and Round Steel Bars: The round and plain reinforcements shall be of grade Fe E22 or Fe E24 as specified in Chapter II of Title I of Paper 4 (Fascicle 4) of CCTG.
  ii) High Adherence Bars: The high adherence reinforcements used shall be of grade Fe E40 or Fe E50 and shall be chosen from among those specified in Chapter III of Title I from Paper 4 (Fascicle 4) of the GTCC, which require identification using the identification form published by ministerial decision.

2) Steel Pipe Sheet Pile and Steel Sheet Pile for Quay

- Steel Pipe Sheet Pile (SPSP) and Steel Pipe Pile (SPP)

The chemical composition of steel sheet pipe piles shall conform to the requirements of steel grade JIS A5530 Grade SKY490 or approved equivalent and shall have the following minimum properties.

i) Tensile strength: 490N/mm^2 min.
ii) Yield strength: 315N/mm^2 min.
iii) Elongation: 18%
iv) Tensile strength of arc welded portion: 490N/mm^2 min.

- Steel Sheet Pile (SSP)

The Steel sheet piles shall be Hat-type with continuous interlock and shall have the following minimum properties.

i) Minimum tensile strength: 490N/mm^2 min. (SYW390)
ii) Minimum yield strength: 390N/mm^2 min. (SYW390)
iii) Elongation: 16% min. (SKY490)

- Synthesis Steel Sheet Pile

Steel sheet piles shall be synthesis steel sheet pile which is composed of Steel sheet pile and

H-shaped with continuous interlock and hall have the following minimum properties.

i) Minimum tensile strength	Sheet pile: 450N/mm^2 (SYW295) H-shaped: 490N/mm^2 (SM490YA)
ii) Minimum yield strength	Sheet pile: 295N/mm^2 (SYW295) H-shaped: 365N/mm^2 (SM490YA)
iii) Elongation	Sheet pile: 18% (SYW295) H-shaped: 15% (SM490YA)

- Anchor Tie Fittings and Waling

All materials shall conform to JIS standards or other equivalent standards and hall have the following minimum properties.

Material	Grade	Tensile Strength N/mm^2	Yield Point N/mm^2	Elongation %
Waling	SS400	400	245	17
Plate	SS400	400	245	17
Tie rod	HT740	740	540	17
Tie rod	HT690	690	440	19

3) Nature of soils

Reconnaissance surveys were carried out in front of the quay/ berth/ reclamation area, the characteristics of the soil in place are given by the ground ratio and sub-soil strata presented in Section 3.1.2 Geotechnical investigation.

4) Water level

- Plus Haute Eau / Highest water: PHE= + 1.70 Hydro PAA
- Plus Basse Eau / Lowest water: PBE = + 0.30 Hydro PAA

5) Overloads on the (median) ground

- 4 T/m^2 over 30m for the first thirty (30) meters along the quay
- 2 T/m^2 beyond
- 3 T/m^2 on the apron within the thirty (30) meter from quay corner
- 1.5 T/m^2 on the apron for the Tug and Pilot-boat Berth

6) Energy/power to be reclaimed by defense: 53 tm

7) Mooring load: 100 tons

8) Ship/Vessels features/Characteristics

- Project vessel: Cereal Bulk Vessel
- DWT weight = 60,000 tons
- Length = 195m, Width= 32m,
- Draft/draught= 11m for 80% load for-13m Quay, =12.5 m for full load for -14m Quay
- Typical Docking/Berthing Speed: Vk = 0.12 m/s
- Calculated Berthing Speed: Vd = 0.12 m/s

9) Earthquake (None)

Maximum wind for calculation of lighting masts and lighting columns: 120 km/h

10) Load on the Road Pavement

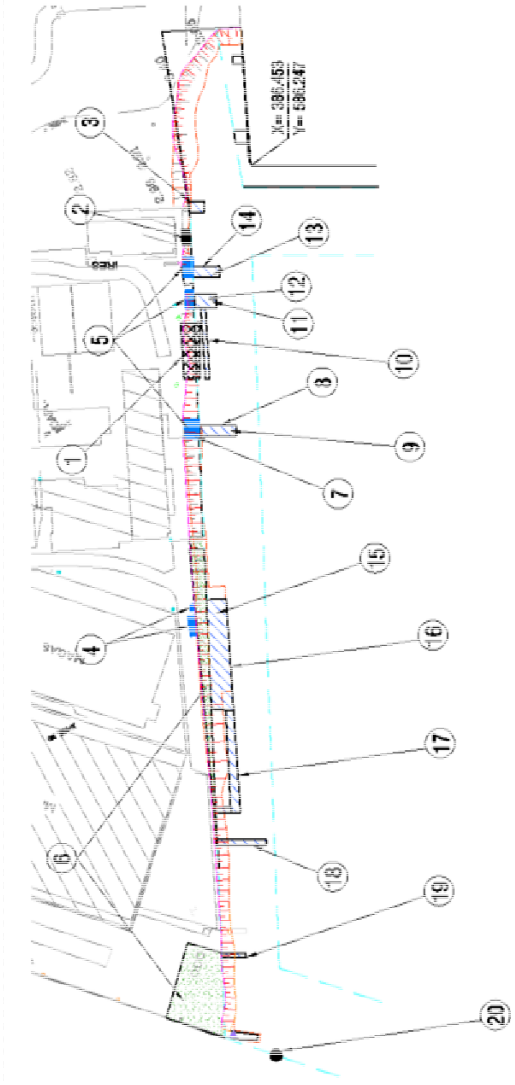
- Design CBR of Sub-Grade: 7%
- Wheel load: 85.75 kN/Trailer: 49 kN/truck
- Number of passing during design life (25years): 1,500,000

3.3.2 Demolition and Relocation of Port Facilities

The work consists of clearing shrubs, a number of trees (inventory to be prepared), and removal of moveable items, rubbish etc. Details are described in Specifications Article 3.1.

Based on site investigations and coordination meetings with PAA and private companies who have the ownership of the items to be affected by the construction of the new cereal berth, the items and their location map of the demolitions, removals, relocation and alternations for the items specified are is shown in Figure 3.3.2-1. As een in the Figure, time tiems owned by PAA are to be included in the BOQ as original pay item. However, the items owned by the private comppanies will be demolished, removed, relocated and/or altered by the private compnaies in application of provisional sum in this BOQ.

The works consist of recovery and handover to PAA or private companies of salvageable items, demolition of building, and disposal of waste materials to approved sites. Disposal of concrete and masonry includes sorting, compacting and levelling at the designated disposal area.



No.	Description	Unit	Qty	Structure	Removal /Disposal	Demolition /Disposal	Alteration	Relocation	To be left	BOQ Item	Property	Remark
①	Open Rest House	m2	100	RC. Deck on RC Piles		✔	✔			Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
②	Oil Tank with Distributer	unit	1	Steel tank on land				✔		Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
③	Mooring Anchor	nr	1	Concrete with small buoy	✔					Demolition and Removing Works 2	PAA	Instruction to replace by PAA
④	Oil Tank with Distributer	nr	1	Steel tank under ground			✔		✔	Provisional Sum for Security Company	Security Company	Works bone by Security Company
⑤	Concrete Pavement	LS	1	Heavy duty concrete pavement					✔	Not in BOQ	BOLUDA	Remain unchanged
⑥	Site Clearance	m2	1,000	Remove obstructions and cleaning	✔	✔				Site Clearance	PAA	Disposal tow trees, debris and Remove obstructions
⑦	Electrical Panel	unit	1	Steel Box Panel				✔		Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
⑧	Tug-boat Jetty	m2	30	RC. Deck on RC Piles		✔				Demolition and Removing Works	PAA	Concrete Debris less than 10kg disposed into reclamation area
⑨	Electrical Panel	unit	1	Steel Box Panel				✔		Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
⑩	Pontoon for small boats	m2	60	Steel pontoon	✔					Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
⑪	Derrick Crane	unit	1	Manual steel beam crane				✔		Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
⑫	Concrete Deck	m2	40	Concrete Base		✔	✔			Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
⑬	Electrical Panel	unit	1	Steel Box Panel				✔		Provisional Sum for BOLUDA	BOLUDA	Works bone by BOLUDA
⑭	Tug-boat Jetty	m2	35	RC. Deck on RC Piles		✔				Demolition and Removing Works 1	PAA	Concrete Debris less than 10kg disposed into reclamation area
⑮	Tide gauge	unit	1	Mechanical Tide Gauge in RC Pipe				✔		Demolition and Removing Works 3	PAA	Instruction to replace by PAA
⑯	Pilot (small) boat Jetty	m2	220	RC. Deck on RC Piles		✔				Demolition and Removing Works 1	PAA	Concrete Debris less than 10kg disposed into reclamation area
⑰	Pilot (small) boat Jetty	m2	68	RC. Deck on RC Piles		✔				Demolition and Removing Works 1	PAA	Ditto
⑱	Speed boat Jetty	m2	28	RC. Deck on RC Piles		✔				Demolition and Removing Works 1	PAA	Ditto
⑲	Small boat Jetty (Not used)	m2	10	RC. Deck on RC Piles		✔				Demolition and Removing Works 1	PAA	Ditto
⑳	Mooring Buoy	nr	1	Mooring Buoy with Sinker				✔		Demolition and Removing Works 2	PAA	Instruction to replace by PAA

Source: JICA Survey Team

Figure 3.3.2-1 Summary of Demolitions, Removals, Relocation and Alternations

3.3.3 Dredging and Reclamation including Soil Improvement

(1) General

This sub-section describes the general design requirements for the dredging and reclamation works for the new cereal berth at Abidjan port. The general requirements consist of many primary factors, such as dredging and slope, reclamation level, and the quantities both for dredging and reclamation.

Dredging and reclamation are important activities for the new cereal berth. In order to ensure that dredging and reclamation are carried out in an effective, efficient, economical, and environmentally compatible manner, the following essential factors have been considered in the planning and design aspects. The construction method and planning of the works including types of plants to be assumedly used for the works are described in Clause 3.5 in this report. The relevant drawings are shown on Drawings B-001 to B-018. Specification Articles 3.2 and 3.3 apply to all these works.

(2) Dredging

1) Configuration of area to be dredged

a) Dredged area

The proposed site of the new cereal terminal was selected at both ends of the north and west quays of Abidjan port, where there is sufficient approach channel and the basin areas for vessel maneuvering. The limits of the areas to be dredged are shown on Figure 3.3.3-1. As seen in the drawing, the areas are divided into four (4) areas such as an area under -14 m new west quay to replace existing unsuitable materials by suitable materials, an area under reclamation for prevention of anticipated settlement may be caused by peat and other soft materials covering surface of the area and areas in front of new quays as basin for maneuvering of the target vessels.

b) Dredged depth

The depth of the dredging area under the new west quay varies from 17.5 to 41 m below CDL in order to replace the peat and associated soft layers with fine graded sand for securing reduction of passive soil pressure and structural stability.

The area under reclamation is to be totally deepened up to 14 m below CDL. The depths of the basin areas are determined 13 m in front of the new north quay and 14 m in front of new west quay respectively below CDL.

c) Dredging slopes

Based on examination of actual subsoil conditions resulted from several geotechnical investigations and waves, current and tide conditions with reference to relevant standard[1] and code[2], the dredged slopes are accordingly designed as shown in Table 3.3.3-1.

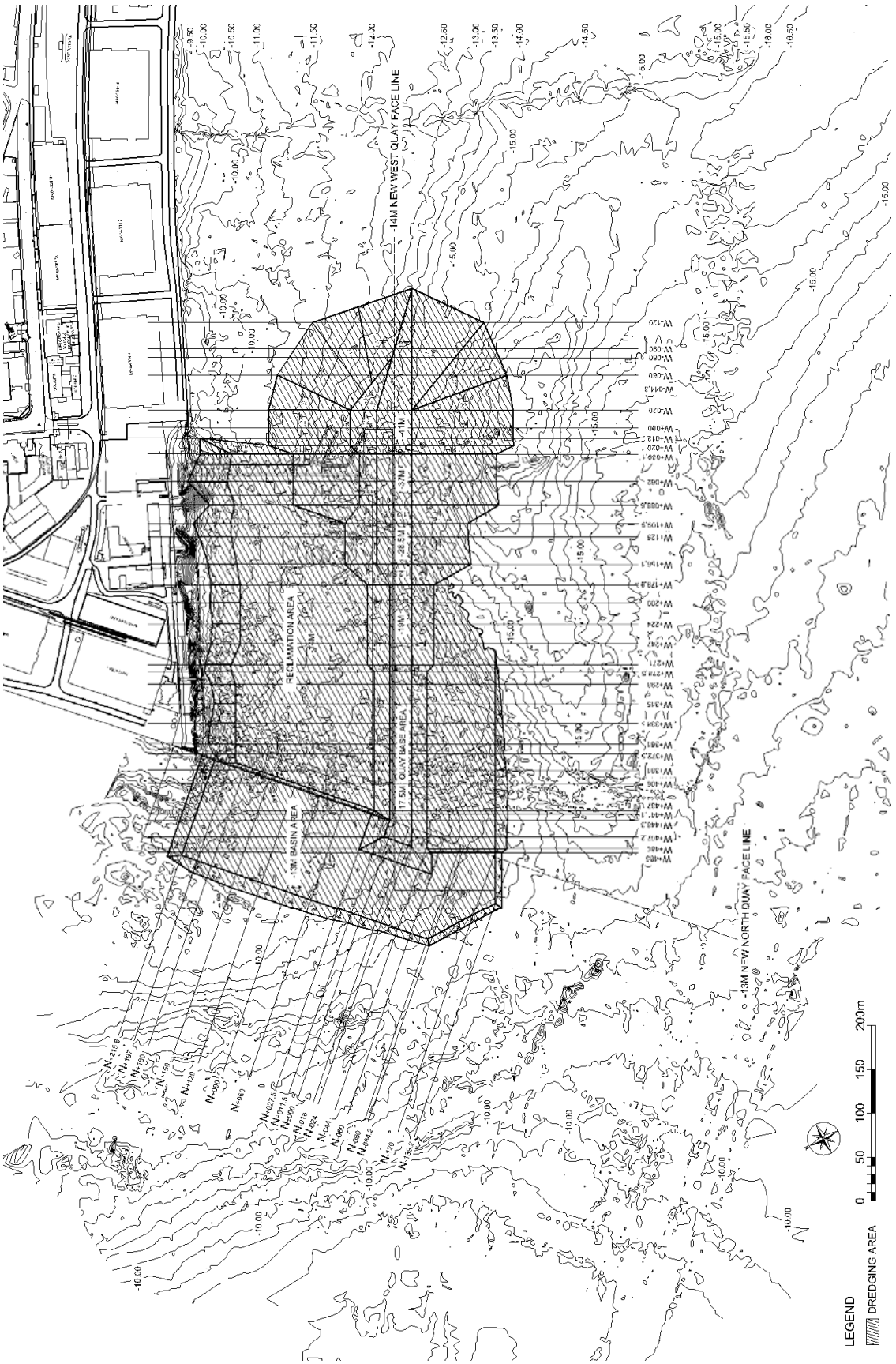
Table 3.3.3-1 Dredging Slopes

Typical Soil Layer		Area to be Dredged			
		for/under 14 m Quay	under Reclamation	for -13m Basin	for -14 m Basin
Sand	in active water (N<10)	1:5.0	1:5.0	1:5.0	1:5.0
	in still water (N>10)	1:2.5	-	-	-
Soft Materials	in active water	1:5.0	-	-	-
	in still water	1:5.0	1:5.0	-	-

Source: JICA Survey Team

[1] OCDI (2009) Technical Standard and Commentaries for Port and Harbour Facilities in Japan

[2] BSI (2016) BS 6349-5 Maritime works: Code of Practice for Dredging and Land Reclamation



Source: JICA Survey Team

Figure 3.3.3-1 Dredging Plan

2) Materials to be dredged

It was determined that the materials to be dredged are soft materials in particular of peat and its associated soft layers. The materials are totally covering on the seabed from the north to west generally with the thickness of 0.5 – 7.0 m below the existing seabed. The thickness of the layer tends to be less or nothing if the location shifts to the north quay side. Remarkably, there is a spot where peat layer is around 21m thickness at BH-A1 (as refer to Sub-section 3.1.1, (2)). The thicker layer exists under -14 m new west quay to be constructed, it is therefore required to dredge for replacement of such materials by suitable materials.

3) Dredging volume

The dredging volume summarized in the BOQ is totally estimated as 1.32 million m^3 based on the quantity computation in application of the latest bathymetric survey. The volumes indicated include those of reclamation area, of basin areas of -13 m and -14 m quays, and of -14 m quay base area.

4) Disposal of dredged materials

All dredged materials are to be disposed to the disposal area designated by PAA, which is located around thirteen (13) km south east from the site passing through Vridi Canal. The dumping of the materials should be carefully complied with relevant environmental laws and regulations required. The disposal area with its coordinates is shown on Drawing A-010.

(3) Reclamation

1) Configuration of area to be reclaimed

a) Reclamation area

As shown in Figures 3.3.3-2 and 3.3.3-3, the total reclamation area required for construction of the new cereal berth is approximately 11 ha including service road and the areas for the backfilling in front of -10 m new east quay and for the sand replacement under -14 m new west quay.

b) Reclamation elevation

The reclamation elevation for the terminal area are not uniformed in varying surface elevations to be 0.56 m below subgrade level taking account of finish elevations of surface drainage and yard pavement preparation. The top elevations of the backfilling and the sand replacement under water are respectively 10 m and 14 m below CDL.

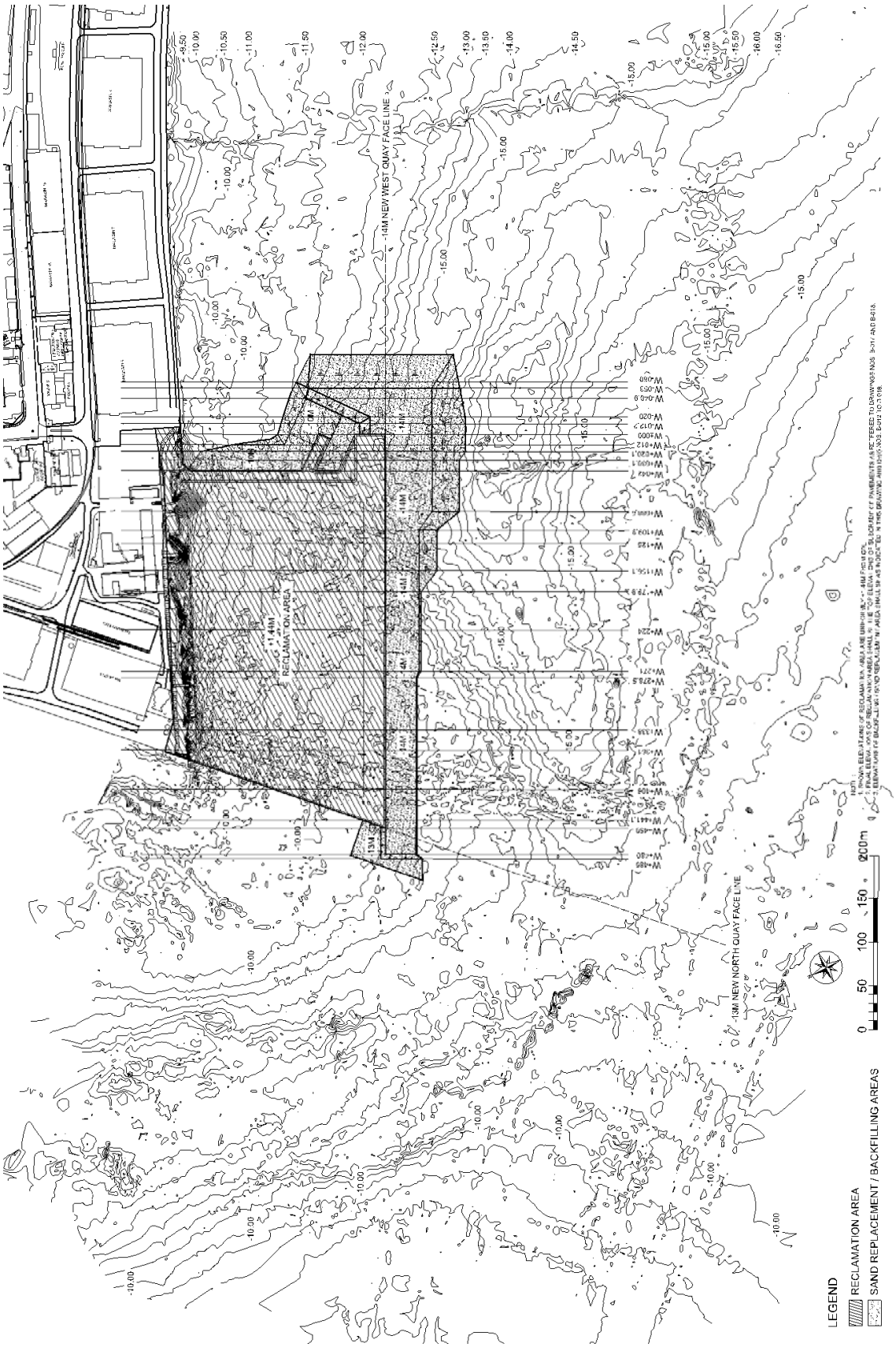
2) Materials to be reclaimed

Materials to be used for reclamation are sourced from sand extraction area designated by PAA which is located about nine (9) km west from the offshore site passing through Vridi Canal as shown on Drawing A-011. According to PAA, the designated area is depositional of sand originated by littoral drift from the west to east coast and the both constructions of the new container terminal and the fish port expansion in Abidjan port used same materials for reclamation, sand replacement and other purposed suitable materials. Two (2) sand samplings at the extraction area were conducted in August in this JICA Study. As the result of the analysis in accordance with NF ISO 13320-1: Particle Size Analysis by Laser Diffraction Method, Figure 3.3.3-4 shows the cumulative passing percentage by weight of the samples.

As per the figure shown, the materials sampled at the extraction area are mostly fine graded sand soil which is clearly of non-plasticity. The analysis is less than 5% by weight passing the #200 (0.074 mm) sieve which is lower than the requirements that should be less than 10 % by weight passing the #200 (0.074 mm) sieve, and is resultantly within the acceptable gradation pattern. Therefore the materials at the extraction area are usable for the reclamation.

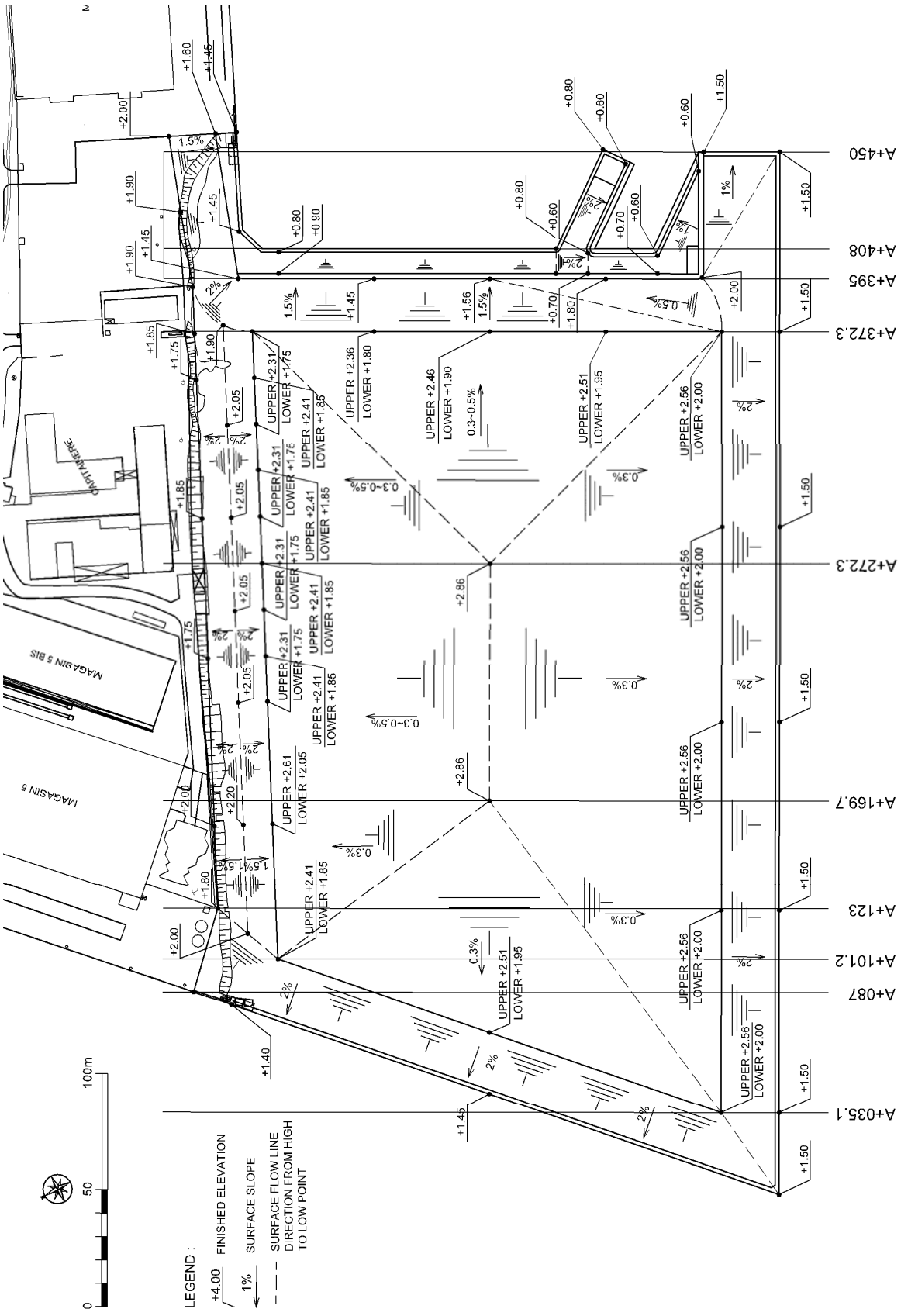
3) Reclamation volumes

The total reclamation volume is estimated as 2.19 million m^3 based on the quantity computation in application of the latest bathymetric survey. The volumes indicated include those of reclamation, and of backfilling (sand replacement) of -14 m quay base area.



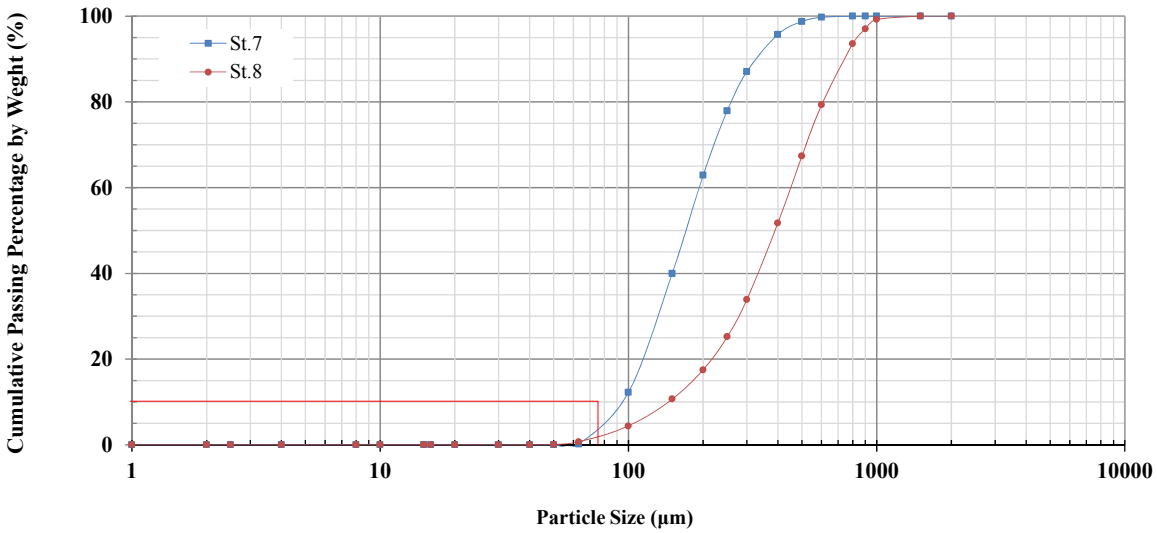
Source: JICA Survey Team

Figure 3.3.3-2 Reclamation Plan (below +1.44 m)



Source: JICA Survey Team

Figure 3.3.3-3 Reclamation Plan (above +1.44 m up to top level of subgrade)



Source: JICA Survey Team

Figure 3.3.3-4 Cumulative Passing Percentage by Weight for Samples at Sand Extraction Area

3.3.4 Wharves

3.3.4.1 General

The structural design for the wharves is complying with the "Technical Standards and Commentaries for Port and Harbor Facilities in Japan" as STEP loan requirement.

In accordance with the discussion with PAA and the Survey Team for the Preparatory Survey for the Project of the Grain Terminal Construction in Abidjan Port conducted from 2015 to 2017 by JICA, the basic structural design for each quays which is described in the terminal layout in the Figure 3.2-2 (Terminal Facility Layout) , are decided as follows.

- -14 m New West Quay

Quay length: 450 m, Quay height: CDL+3.5 m, Using SPSP wall having 900 mm diameter and 17 mm in thick with LT type joint, Tie-rod position: CDL±0.0 m

- -13 m New North Quay

Quay length: 250 m, Quay height: CDL +3.5 m ,Using SPSP wall having 900 mm diameter and 17 mm in thick with LT type joint, Tie-rod position: CDL±0.0 m

- -10 m New South Quay for Tug Boat

Quay length: 189 m, Quay height: CDL+2.8 m , Using Hat-H sheet pile wall having 900 mm in width sheet pile, Tie-rod position: CDL±0.0 m

- -10 m New South Quay for Pilot Boat

Quay length: 113 m, quay height: CDL +2.0 m, Using Hat-H sheet pile wall having 900 mm in width sheet pile, Tie-rod position: CDL±0.0 m

3.3.4.2 Specific Design Conditions

1) Existing sub-soil conditions and soil replacement

Existing sub-soil conditions under seabed for each planned quay is as following tables, in order to execute the economical design for the Steel Pipe Sheet Pile Wall mentioned above basic design, the soft soil of seabed surface and soft clay shall be required to replace to the suitable sand.

a) -14 m NWQ (150m in length of quay base from the east end)

In accordance with the results of geotechnical investigation conducted in 2016 and 2017, the

most unsuitable sub-soil located from the east end of -14 m quay base to 150 m area in length shall be required the sand replacement for the structure. The replacement shall be done from seabed surface to CDL -41 m (-14 m ~-41 m), CDL-37 m (-14 m ~ -37 m) and CDL-28.5 m (-14 m ~ -28.5 m).

Table 3.3.4.2-1 Sub-soil -14m NWQ (L=150m: BH-A1~BH-DD01)

Elevation (m)	Sub-soil strata	Sub-soil parameter
CDL -14m ~ -36.0m (CDL -14m ~ -37.0m in BH-A2) (CDL -14m ~ -28.5m in BH-03)	Very soft peat / clay	C=6.1 kN/m^2, N=1
CDL -36.0m ~ -38.0m	Medium dense clayey sand	Φ=34.5°, N= 19
CDL -38.0m ~ -41.0m	Very soft sandy clay	C=6.1 kN/m^2, N=1
CDL -41.0m ~ -52.0m	Medium stiff clay	C=79.3kN/m^2 , N=13
CDL-44m ~ -50m	Stiff clay	C=171kN/m^2, N=28

Source: JICA Study Team

b) -14m NWQ (300 m in length of quay base from the west end)

In accordance with the results of geotechnical investigation conducted in 2015 and 2016, the unsuitable sub-soil located from the west end of -14 m quay base to the remaining 300m area shall be required the sand replacement from seabed surface to CDL -17.5m (-14m ~17.5m) and CDL -19m (-14m ~ -19m) .

Table 3.3.4.2-2 Sub-soil for -14m NWQ (L=300m: BH-A5~BH-A3)

Elevation (m)	Sub-soil strata	Sub-soil parameter
CDL -14m ~ -19m in BH-01bis (CDL -10m ~ -17.5m in BH-A3)	Soft sand (Soft peat)	Φ=20°, N= 3 (C=0.0kN/m^2, N=0)
CDL -19m ~ -24.0m	Medium dense sand	Φ=25°, N= 13
CDL -24.0m ~ -26.5m	Dense sand	Φ=40°, N= 50
CDL -26.5m ~ -32.0m	Stiff clay	C=110kN/m^2, N=15

Source: JICA Study Team

c) -13m NNQ (L=250m)

In accordance with the results of geotechnical investigation conducted in 2016, the unsuitable sub-soil located -13 m quay base area shall not be required the sand replacement.

Table 3.3.4.2-3 Sub-soil -13m NNQ (BH-A5 ~ BH-A8)

Elevation (m)	Sub-soil strata	Sub-soil parameter
CDL -13m ~ -17m	Loose sand	Φ=26.8°, N=7
CDL -17m ~ - 25m	Medium dense sand	Φ=38.2°, N=27
CDL -25m ~ -29.5m	Dense sand	Φ=41.8° N=36
CDL -29.5m ~ -30.5m	Stiff clay	C=268kN/m^2, N=44

Source: JICA Study Team

d) -10 m NSQ for Tug Boat (L=189m)

In accordance with the results of geotechnical investigation conducted in 2017, the unsuitable sub-soil located -13 m quay base area shall be required the sand replacement from CDL -10 m to CDL -14.5 m.

Table 3.3.4.2-4 Sub-soil -10m NSQ for Tug Boat (BH-A7)

Elevation (m)	Sub-soil strata	Sub-soil parameter
CDL -10m ~ -15m	Soft Peat	C=6.1 kN/m^2, N=1
CDL -15m ~ - 17m	Medium dense sand	Φ=36°, N= 22
CDL -17m ~ -19.5m	Soft sand	Φ=28.4°, N= 9
CDL -19.5m ~ -23m	Medium dense sand	Φ=32.3°, N= 15
CDL -23m ~ -32.5m	Dense sand	Φ=39.5°, N= 30

Source: JICA Study Team

e) -10 m NSQ for Pilot Boat (L=113m)

In accordance with the results of geotechnical investigation conducted in 2017, the unsuitable sub-soil located -10 m quay base area shall be required the sand replacement from CDL-14 m to CDL-36 m which is replaced together with -14 m quay base. Results of Sub-soil conditions was used BH-A1 same as -14m quay base.

With discussion between the PAA and the Study Team, the parameter of the replaced sand shall be followed the previous fishing port project in Abidjan Port due to using same sandy material of the source of extraction of which is as follows:

Replaced sand and reclaimed material: Φ=33°, N value = 10 (after filling work)

2) Water Level

Extreme water level at the project location of Abidjan Port is provided by PAA as follows:

High Water Level (HWL)	:	CDL+1.70 m
Mean Water Level (MWL)	:	CDL+1.10 m
Mean Law Water Level (MLWL)	:	CDL+0.30 m
Chart Datum Level (CDL)	:	CDL±0.00 m
Residual Water Level	:	CDL+1.23 m

3) Loading Conditions and Operational Conditions

The operational conditions for the berth structures are given by PAA, as follows.

a) Design life for Quay Structure: 50 years

b) Overloads on the (median) ground
- 40 kN/m^2 on the apron of -13 m and -14 m quay
- 20 kN/m^2 behind the apron
- 30 kN/m^2 on the apron for the thirty (30) meter from quay corner
- 15 kN/m^2 on the apron for the tug and pilot boat quay

c) Ship/Vessels features/Characteristics
- Bulk Carrier for -13 m NNQ
  50,000DWT, Loa=211.4 m, Beam=32.7 m, Draft=12.4 m, Berthing speed=0.12 m/s
  Tractive force (Bollard pull) = 1,000kN
  Design ship in future: 60,000DWT partially loaded
- Bulk Carrier for -14 m NWQ
  60,000DWT, Loa=223.0 m, Beam=34.4 m, Draft=13.2 m, Berthing speed=0.12 m/s
  Tractive force (Bollard pull) = 1,000kN
  Design ship in future: 80,000DWT partially loaded
- Tug Boat for -10 m NSQ
  5,000HP, Loa=44.9 m, B=12.6 m, Draft=5.8 m, Berthing speed=0.20 m/s
  Tractive force (Bollard pull) = 150kN
- Pilot and Small Boat for -10 m NSQ
  Loa=14.0m, Beam=5.0 m, Draft=0.5 m, Berthing speed=0.30 m/s

Tractive force (Bollard pull) = 50kN

d) Corrosion Ratio of SPSP (adopting Eurocode)
- Splash Zone: 0 mm/year (Covered by the Concrete by CDL -0.5 m)
- Seawater Zone: 0.07 mm/ year, (thickness increasing 3.5 mm for 50 years)
- Behind the wall (land): 0.048 mm/year (thickness increasing 2.4 mm for 50 years)

For the design, SPSP shall be increasing 3.5 mm in thick for the corrosion at all the zones.

3.3.4.3 Results of Wharves Structural Calculation and Typical Section

1) -14m NWQ (150m from the east end)
Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4.3-1.

Berthing Force (Bollard Pull): 1000kN

Front wall: φ= 900.0 mm x t=17.0 mm: (L-T) type [L-65x65x8]

	Ordinary Conditions
Stress Intensity (N/mm^2)	172.3 ≦ 185.0 OK
Driving depth (CDL: m)	-24.052
Adopted depth (m) Length of Pile (m)	-24.500 26.5m (including pile-head and toe damage allowance) +1.5m~-25.0m

Tie-rod: High Tensile Steel -740: φ=80 mm

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	186.3 ≦ 216.0 OK	201.3 ≦ 324.0 OK
Minimum length of Tie-rod (m)	13.814	13.899
tie-rod length Adopted for construction (m)	More than 14m 22.150 m (considering construction method)	

Waling Works for Front wall: 2x [380×100×10.5×16.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	105.1 ≦ 140.0 OK	113.6 ≦ 210.0 OK

Waling Works for Anchorage Tie -back Wall: 2x [380×100×13.0×20.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	235.0 ≦ 140.0 OK	133.4 ≦ 210.0 OK

Anchorage Tie-back Wall: SP -45H

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity(N/mm^2)	201.1 ≦ 235.0 OK	220.7 ≦ 352.5 OK
Displacement amount (cm)	2.875 ≦ 5.000 OK	3.254 ≦ 7.000 OK
Driving depth (CDL: m)	-8.408	-8.540
Adopted depth (m) Length of Pile (m)	-9.000 9.5m (+0.5m~-9.0m)	

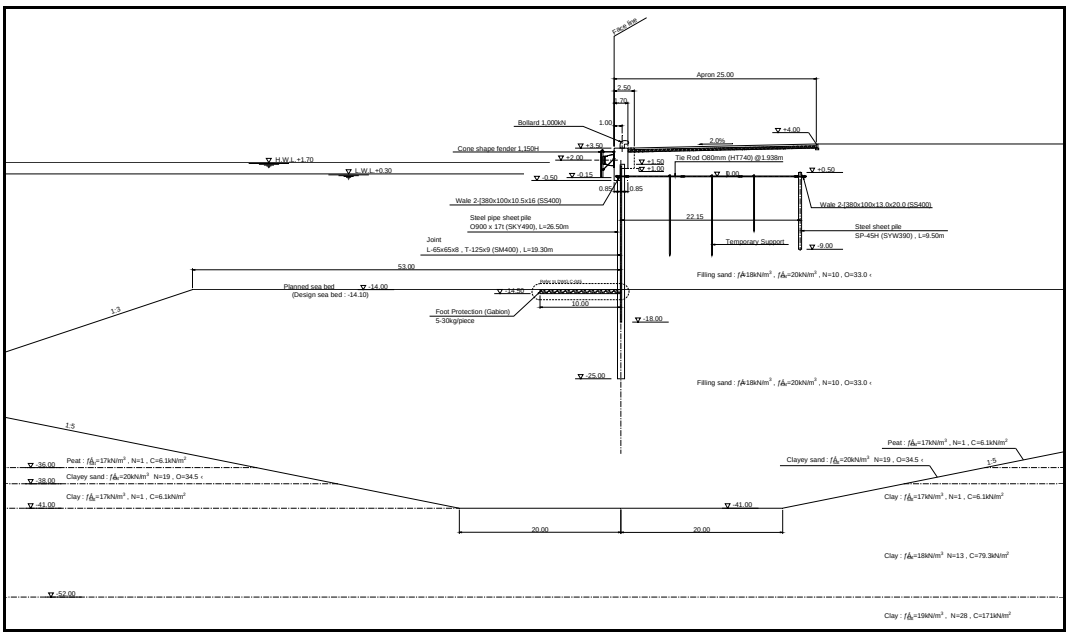


Figure 3.3.4.3-1 Typical Section of -14m NWQ (L=150m)

Results of Circular Arc Analysis for -14 m NWQ (L=150 m) is shown in Figure 3.3.4.3-1(2).

Minimum case of safety factor is 1.301> 1.3 (OK)

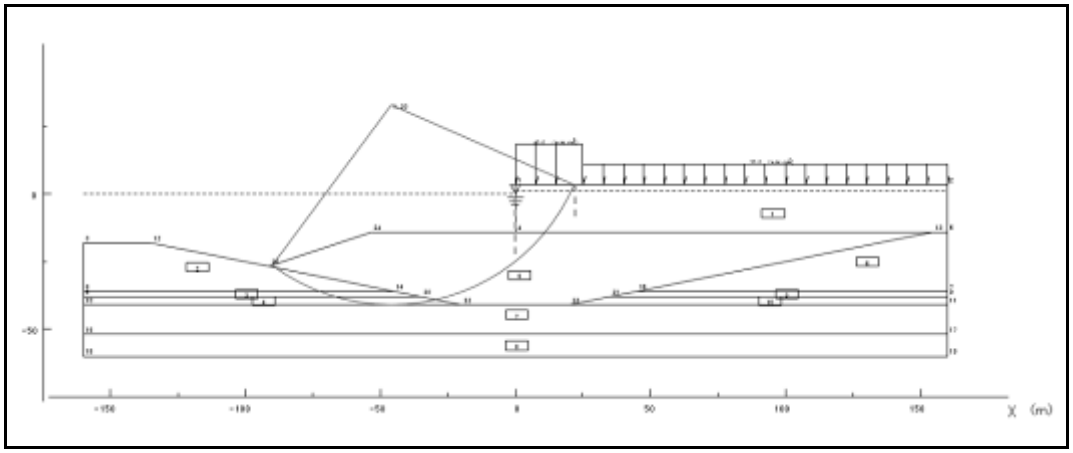


Figure 3.3.4.3-1(2) Results of Circular Arc Analysis for -14m NWQ (L=150m)

2) -14 m NWQ (300 m from the west end)

Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4.3-2.

Berthing Force (Bollard Pull): 1000kN

Front wall: φ= 900.0 mm x t=17.0 mm: (L-T) type [L-65x65x8]

	Ordinary Conditions
Stress Intensity (N/mm²)	180.6 ≦ 185.0 OK
Driving depth (CDL: m)	-25.771
Adopted depth (m) Length of Pile (m)	-26.000 28m (including pile-head and toe damage allowance) +1.5m~-26.5m

Tie-rod: High Tensile Steel -740 : φ=80 mm

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm²)	190.1 ≦ 216.0 OK	205.1 ≦ 324.0 OK
Minimum length of Tie-rod (m)	13.837	13.919
tie-rod length Adopted for construction (m)	More than 14m 22.150 m (considering construction method)	

Waling Works for Front wall: 2x [380×100×10.5×16.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm²)	107.2 ≦ 140.0 OK	115.7 ≦ 210.0 OK

Waling Works for Anchorage Tie -back Wall: 2x [380×100×13.0×20.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm²)	126.0 ≦ 140.0 OK	135.9 ≦ 210.0 OK

Anchorage Tie-back Wall: SP -45H

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity(N/mm²)	206.0 ≦ 235.0 OK	225.7 ≦ 352.5 OK
Displacement amount (cm)	2.968 ≦ 5.000 OK	3.352 ≦ 7.000 OK
Driving depth (CDL: m)	-8.441	-8.571
Adopted depth (m) Length of Pile (m)	-9.000 9.5m (+0.5m~-9.0m)	

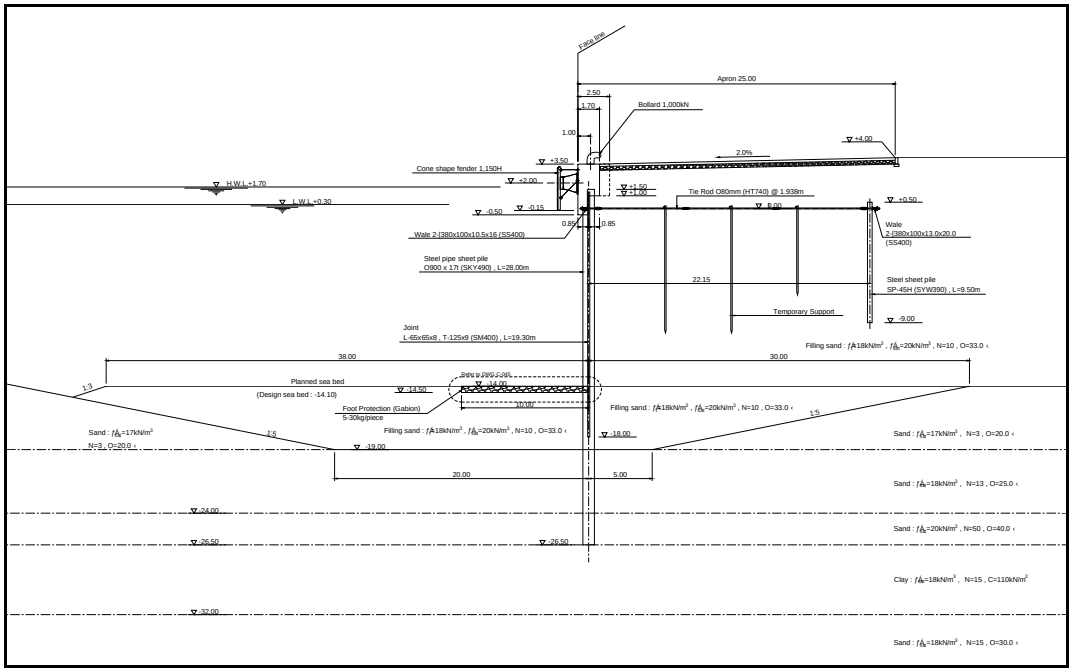


Figure 3.3.4.3-2 Typical Section of -14m NWQ (L=300m)

Results of Circular Arc Analysis for -14m NWQ (L=300m) is shown in Figure 3.3.4.3-2(2).

Minimum case of safety factor is 1.504 > 1.3 (OK)

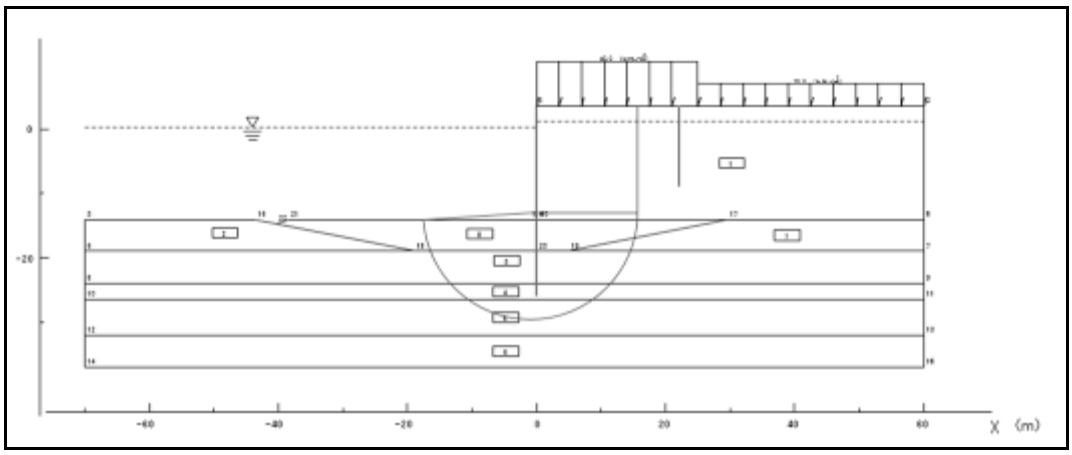


Figure 3.3.4.3-2(2) Results of Circular Arc Analysis for -14m NWQ (L=300m)

3) -13m Quay (250m New North Quay)

Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4.3-3.

Berthing Force (Bollard Pull): 1000kN

Front wall : φ= 900.0 mm x t=17.0 mm: (L-T) type [L-65x65x8]

	Ordinary Conditions
Stress Intensity (N/mm^2)	170.3 ≦ 185.0 OK
Driving depth (CDL: m)	-23.563
Adopted depth (m) Length of Pile (m)	-24.000 25.5m (including pile-head and toe damage allowance) +1.5m~-24.0m

Tie-rod: High Tensile Steel -690: φ=85 mm

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	163.0 ≦ 176.0 OK	176.2 ≦ 264.0 OK
Minimum length of Tie-rod (m)	13.206	13.288
tie-rod length Adopted for construction (m)	More than 14m 22.150 m (considering construction method)	

Waling Works for Front wall: 2 x [380×100×10.5×16.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	104.6 ≦ 140.0 OK	113.1 ≦ 210.0 OK

Waling Works for Anchorage Tie -back Wall: 2 x [380×100×13.0×20.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	122.9 ≦ 140.0 OK	132.8 ≦ 210.0 OK

Anchorage Tie-back Wall: SP -45H

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity(N/mm²)	199.9 ≦ 235.0 OK	219.5 ≦ 352.5 OK
Displacement amount (cm)	2.852 ≦ 5.000 OK	3.230 ≦ 7.000 OK
Driving depth (CDL: m)	-8.400	-8.531
Adopted depth (m)	-9.000	
Length of Pile (m)	9.5m (+0.5m~-9.0m)	

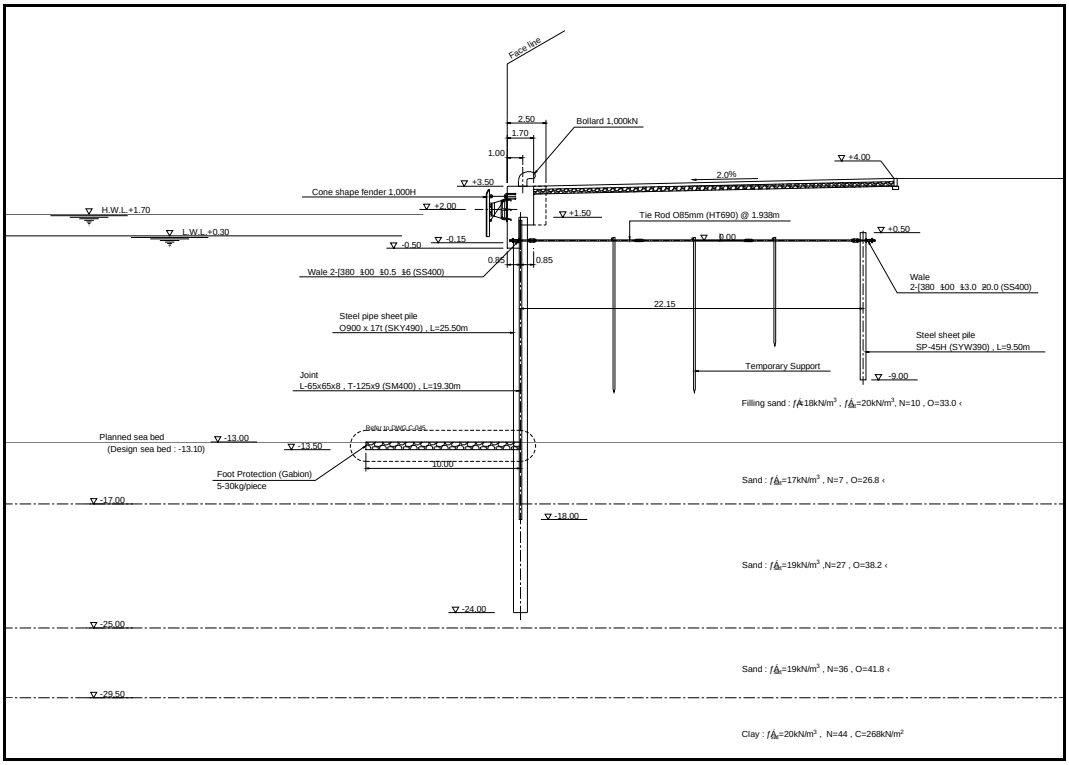


Figure 3.3.4.3-3 Typical Section of -13m NNQ

Results of Circular Arc Analysis for -13m Quay is shown in Figure 3.3.4.3-3(2).

Minimum case of safety factor is 1.583 > 1.3 (OK)

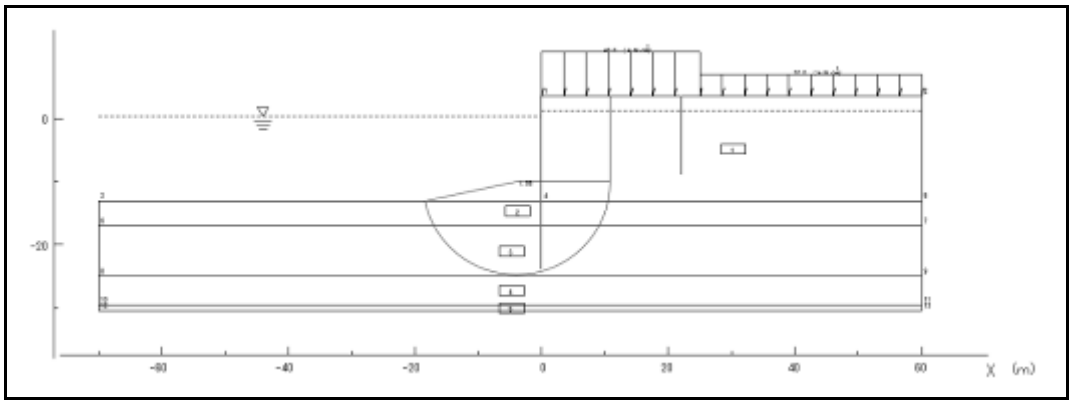


Figure 3.3.4.3-3(2) Results of Circular Arc Analysis for -13m NNQ

4) -10m NSQ for Tug Boat (L=189m)

Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4.3-4.

Berthing Force (Bollard Pull): 150kN

Front wall : Hat Sheet Pile = 25H, + H Beam =H450x200x12x25x13

	Ordinary Conditions
Stress Intensity (N/mm^2)	189.5 ≦ 210.0 OK
Driving depth (CDL: m)	-17.770
Adopted depth (m) Length of Pile (m)	-18.000 20.50m (+1.5m~-19.00m)

Tie-rod: High Tensile Steel -740 :φ=70 mm

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	191.1 ≦ 216.0 OK	202.3 ≦ 324.0 OK
Minimum length of Tie-rod (m)	10.507	10.553
tie-rod length Adopted for construction (m)	More than 11m 25.00 m (considering construction conditions)	

Waling Works for Front wall: 2x [380×100×13.0×20.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	132.6 ≦ 140.0 OK	140.4 ≦ 210.0 OK

Waling Works for Anchorage Tie -back Wall: 2x [380×100×13.0×20.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	132.6 ≦ 140.0 OK	140.4 ≦ 210.0 OK

Anchorage Tie-back Wall: SP -25H

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity(N/mm^2)	146.1 ≦ 180.0 OK	156.4 ≦ 270.0 OK
Displacement amount (cm)	1.504 ≦ 5.000 OK	1.648 ≦ 7.000 OK
Driving depth (CDL: m)	-6.609	-6.684
Adopted depth (m) Length of Pile (m)	-7.000 7.5m (+0.5m~-7.0m)	

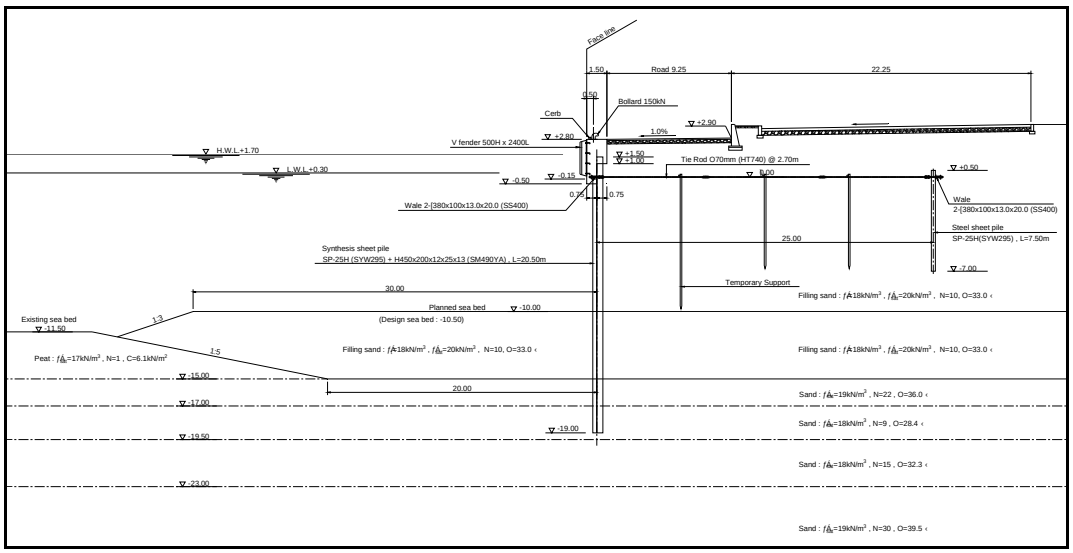


Figure 3.3.4.3-4 Typical Section of -10m NSQ for Tug Boat

Results of Circular Arc Analysis for -10m NSQ for Tug Boat is shown in Figure 3.3.4.3-4(2).

Minimum case of safety factor is 1.382 > 1.3 (OK)

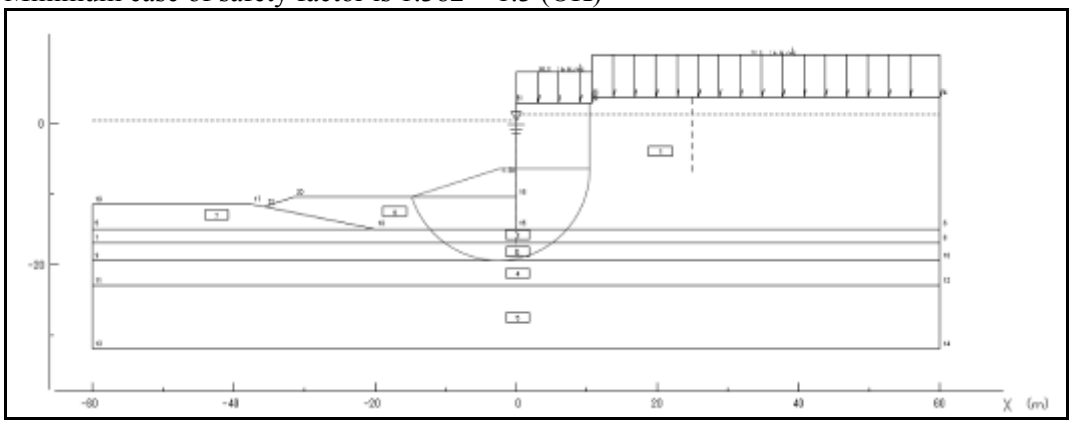


Figure 3.3.4.3-4(2) Results of Circular Arc Analysis for -10m NSQ for Tug Boat

5) -10 m NSQ for Tug and Pilot Boat (W-wall part)

The design procedure complies with the Steel Sheet Pile Cellular Structure Design Manual provided by Workshop Committee of Prefabricated Cellular Structure. Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4.3-7.

Design Structure : Wall: Hat Sheet Pile = 25H, + H Beam 450x200x12x25x13, L= 19.5m
: Tie-rod :High Tensile Steel -740 : φ=70 mm
: Waling Works: 2 x [380×100×13.0×20.0
: Wall Span: 12.551m

Results of Design Calculation

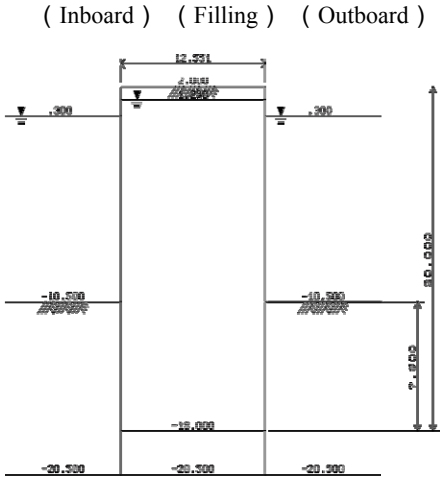


Figure 3.3.4.3-5 Construction plan, Soil property plan

a) Shear deformation of cell

Fs : Safety factor of shear deformation
ΣMr : Resisting moment (kN･m/m)
ΣM_0 : Deformation moment (kN･m/m)

			Sea bottom	Cell bottom
Deformation moment		(ΣM_o)	3392.50	1634.18
Resisting moment	Resisting moment of the filling	Mf (kN･m/m)	4121.48	3177.32
	Resisting moment due to friction force of joints	Ms (kN･m/m)	0.00	0.00
	Mt = Mf + Ms	(kN･m/m)	4121.48	3177.32
	Height of cell wall	H (m)	12.500	12.500
	Embedded length	D (m)	7.500	7.500
	Factor of embedding	α	0.000	1.000
	C = 1 + α x D / H		1.000	1.600
	Resisting moment ΣMr = C･Mt	(kN･m/m)	4121.48	5083.72
Safety factor Fs = ΣMr / ΣM_0			1.215	3.111
Required safety factor			1.200	1.200
Verification			OK	OK

b) Displacement mode of cell and stability check

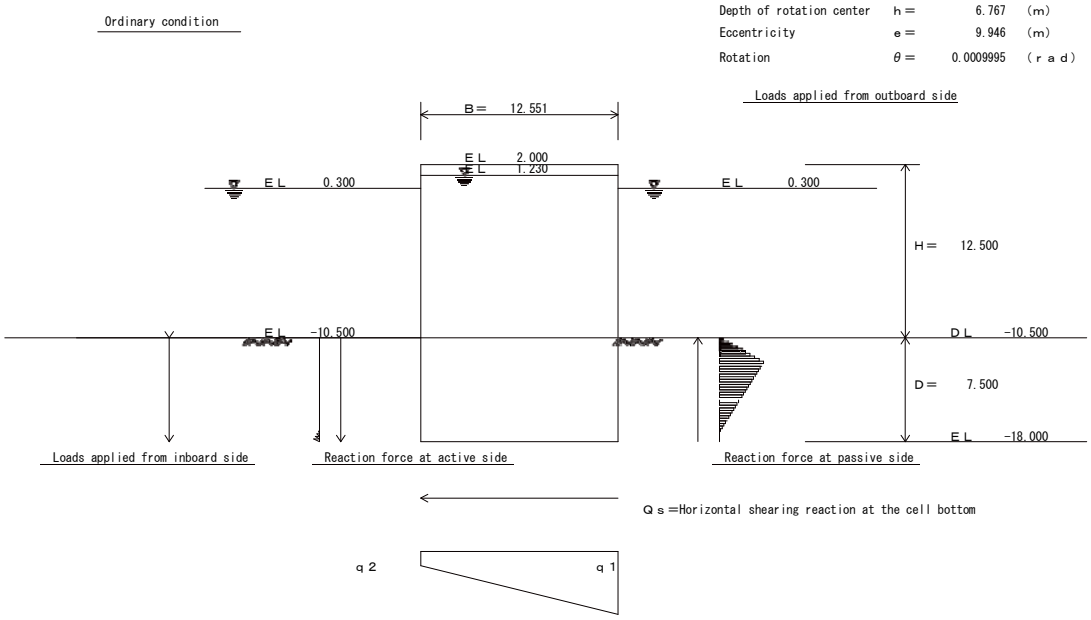


Figure 3.3.4.3-6 Displacement mode of cell

➢ Ground bearing capacity check

			Ordinary
Reaction	q1 (kN/m2)		324.27
	q2 (kN/m2)		73.37
Allowable bearing capacity	Equivalent width of wall B (m)		12.551
	Embedded length of cell D (m)		7.500
	Submerged weight of soil cell bottom γ1 (kN/m^3)		10.00
	Average submerged weight of soil in zone D γ2 (kN/m^3)		10.00
	Shape factor β		0.500
	Friction angle of soil at cell bottom φ(deg)		33.000
	Bearing capacity factor Nr		15.000
	Bearing capacity factor Nq		18.182
	Calculated Values	βγ1 BNr	941.347
		γ2 DNq	1363.636
		γ2 D	75.000
	Safety factor F		2.500
	Allowable bearing capacity qa kN/m2)		996.99
Safety factor	Safety factor for bearing capacity qa/q1		3.075
	Required safety factor		1.000
	Verification		OK

➢ Stability against sliding

			Ordinary
External force	Horizontal shear force at cell bottom Hs(kN/m)		61.62
Resistance force against sliding	Level of cell bottom		-18.000
	Angle of internal friction φ (deg)		33.000
	Cohesion c (kN/㎡)		0.00
	Distributed length of vert. reac.force at cell bottom		12.551
	Vertical subgrade reaction force at cell bottom V(KN/m)		2495.47
	Resistance force	Friction Resistane V tan φ(kN/m)	1620.58
		Cohesive resistance bc (kN/m)	0.00
		Total shear resistance Rs	1620.58
Safety factor	Safety factor Rs/Hs		26.300
	Required safety factor		1.200
	Verification		OK

➢ Displacement

	Ordinary
Top level of cell EL1 (m)	2.000
Design bed level EL2 (m)	-10.500
Cell height H＝EL1－EL2 (m)	12.500
Center of cell depth from DL h (m)	6.767
Rotation angle of cell θ (rad)	0.000999
Cell top Displacement δ＝（H＋h）θ (m)	0.019257
Allowable displacement δa＝0.015H (m)	0.188
Safety factor Fs＝δa／δ	9.737
Required safety factor	1.000
Verification	OK

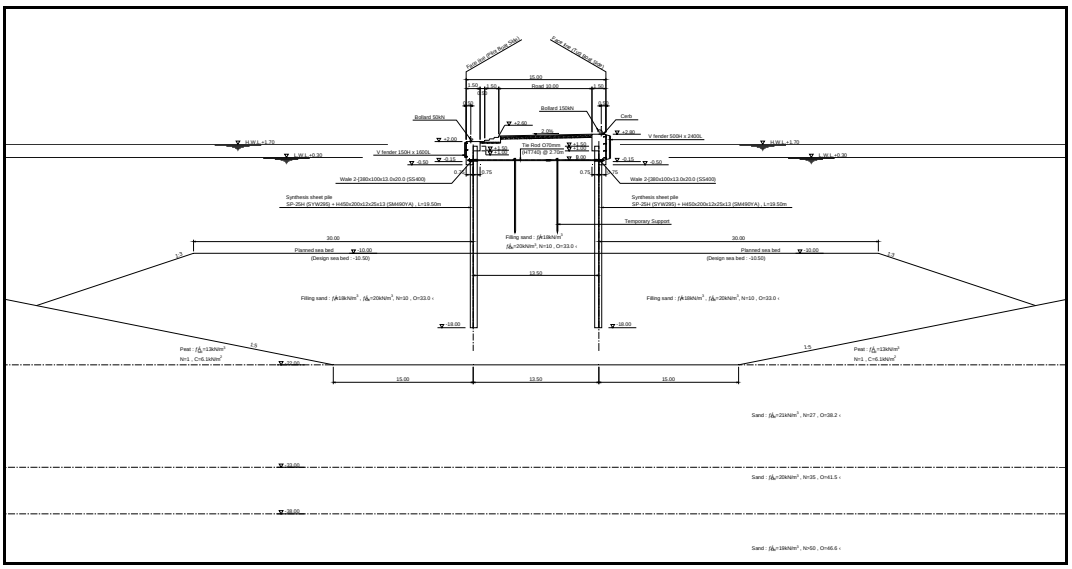


Figure 3.3.4.3-7 Typical Section of -10m NSQ (W-wall part)

6) **-10 m NSQ for Pilot Boat No.1**

Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4-8.

Berthing Force (Bollard Pull): 50kN

Front wall: Hat Sheet Pile=25H, +H Beam=H550x250x16x28x13

	Ordinary Conditions
Stress Intensity (N/mm²)	176.5 ≦ 210.0 OK
Driving depth (CDL: m)	-18.688
Adopted depth (m) Length of Pile (m)	-19.000 20.5m (+1.5m~-19m)

Tie-rod: High Tensile Steel - 740 : φ=75mm

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm²)	192.5 ≦ 216.0 OK	199.0 ≦ 324.0 OK
Minimum length of Tie-rod (m)	16.270	16.332
tie-rod length Adopted for construction (m)	More than 17m 25.00 m (considering construction conditions)	

Waling Works for Front wall: 2 x [380×100×10.5×16.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm²)	131.7 ≦ 140.0 OK	136.2 ≦ 210.0 OK

Waling Works for Anchorage Tie-back Wall: 2 x H 340×250×9.0×14.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm²)	125.2 ≦ 140.0 OK	129.4 ≦ 210.0 OK

Anchorage Tie-back Wall: φ= 900.0 mm x t=13.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity(N/mm²)	158.6 ≦ 185.0 OK	165.0 ≦ 277.5 OK
Displacement amount (cm)	3.169 ≦ 5.000 OK	3.341 ≦ 7.000 OK
Driving depth (CDL: m)	-13.828	-13.925
Adopted depth (m) Length of Pile (m)	-14.000 15.50m (+1.5m~-14.0m)	

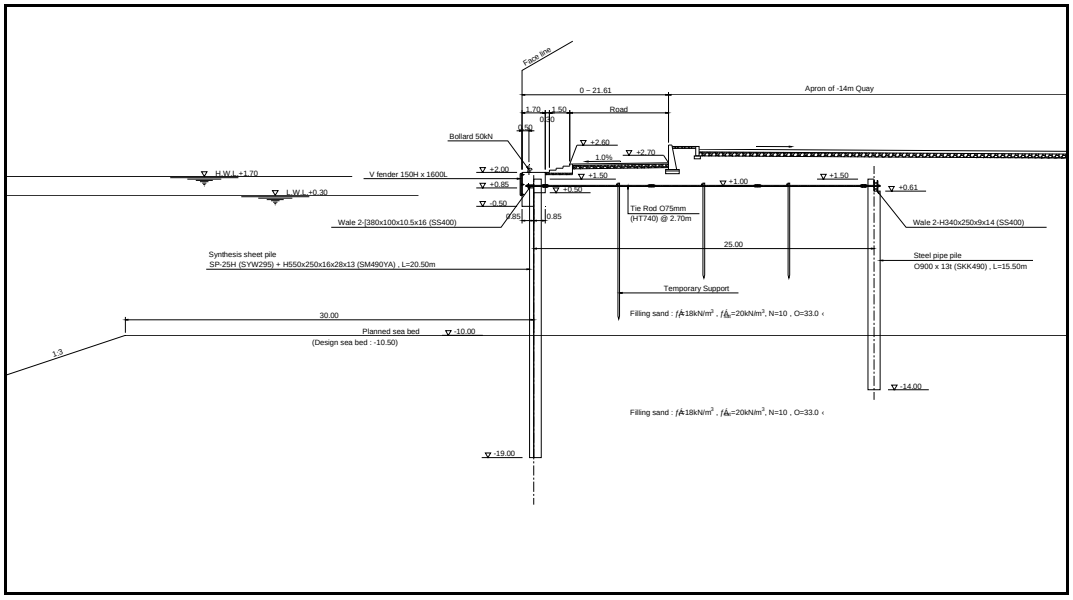


Figure 3.3.4.3-8 Typical Section of -10m NSQ for Pilot Boat No.1

Results of Circular Arc Analysis for -10m NSQ for Pilot Boat is shown in Figure 3.3.4.3-8(2).
Minimum case of safety factor is 1.399 > 1.3 (OK)

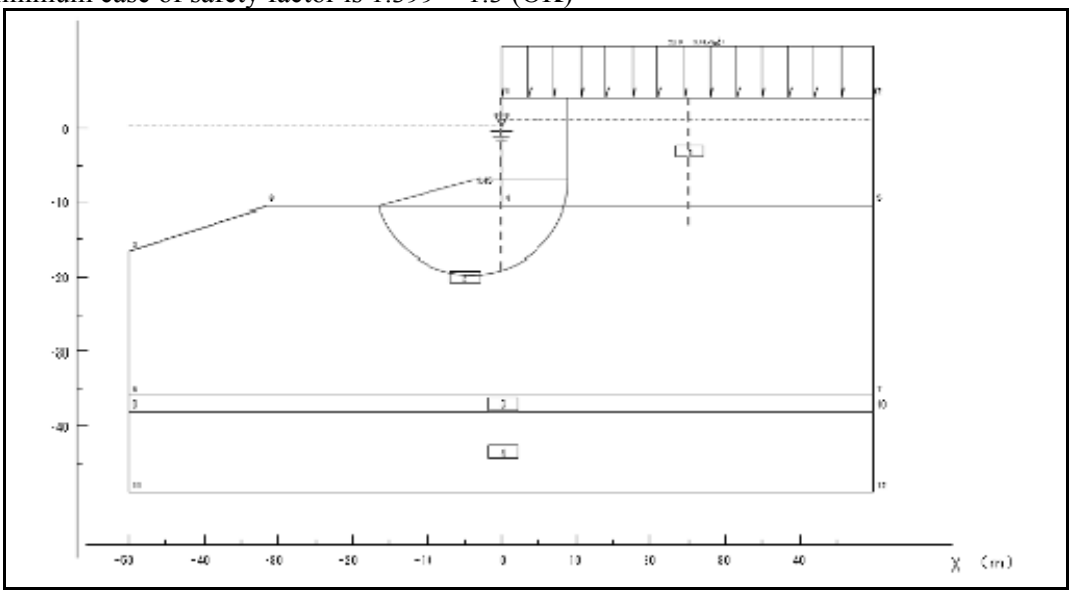


Figure 3.3.4.3-8(2) Results of Circular Arc Analysis for -10m NSQ for Pilot Boat No.1

7) **-10 m NSQ for Pilot Boat No.2**

Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4.3-9.

: Berthing Force (Bollard Pull): 50kN

Front wall: Hat Sheet Pile=25H, +H Beam=H450x200x12x25x13

	Ordinary Conditions
Stress Intensity (N/mm^2)	185.6 ≦ 210.0 OK
Driving depth (CDL: m)	-17.845
Adopted depth (m) Length of Pile (m)	-18.000 19.5m (+1.5m~-18m)

Tie-rod: High Tensile Steel - 740 : φ=70mm

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	178.2 ≦ 216.0 OK	185.7 ≦ 324.0 OK
Minimum length of Tie-rod (m)	10.448	10.482
tie-rod length Adopted for construction (m)	More than 11m 25.00 m (considering construction conditions)	

Waling Works for Front wall: 2 x [380×100×13.0×20.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	123.7 ≦ 140.0 OK	128.9 ≦ 210.0 OK

Waling Works for Anchorage Tie-back Wall: 2 x [380×100×13.0×20.0

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity (N/mm^2)	123.7 ≦ 140.0 OK	128.9 ≦ 210.0 OK

Anchorage Tie-back Wall: SP-25H

	Ordinary Case	Berthing Case (Bollard Pull)
Stress Intensity(N/mm^2)	134.3 ≦ 180.0 OK	141.1 ≦ 270.0 OK
Displacement amount (cm)	1.344 ≦ 5.000 OK	1.436 ≦ 7.000 OK
Driving depth (CDL: m)	-6.516	-6.570
Adopted depth (m) Length of Pile (m)	-7.000 7.5m (+0.5m~-7.0m)	

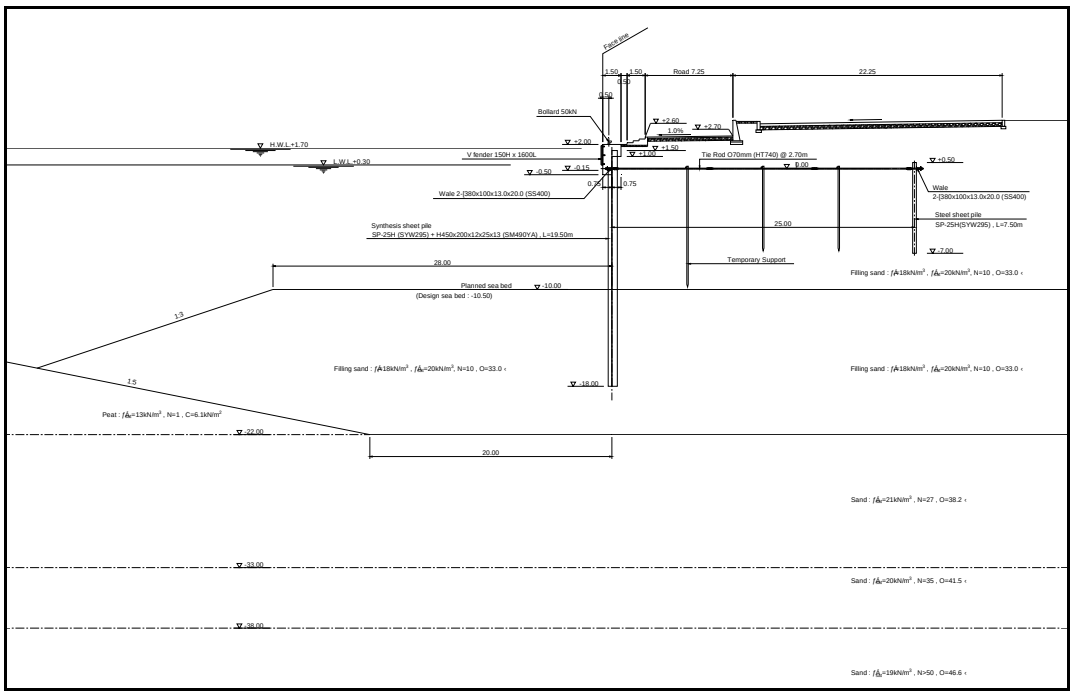


Figure 3.3.4.3-9 Typical Section of -10m NSQ for Pilot Boat No.2

Results of Circular Arc Analysis for -10m NSQ for Pilot boat is shown in Figure 3.3.4.3-9(2)
Minimum case of safety factor is 1.399 > 1.3 (OK)

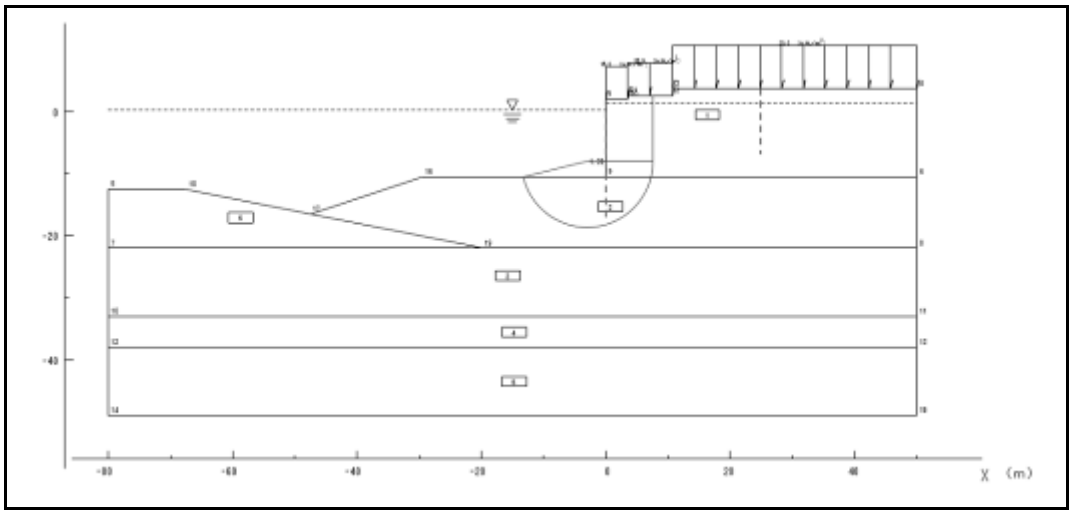


Figure 3.3.4.3-9(2) Results of Circular Arc Analysis for -10m NSQ for Pilot Boat No.2

3.3.4.4 Results of Fender Calculation and Typical Drawing

1) -13 m NNQ and -14 m NWQ Fenders

a) Design Conditions

- Vessel parameters

Vessel Type	DT (ton)	Loa (m)	Lpp (m)	B (m)	D (m)	d (m)	v (m/s)	Design Quay
80,000DWT Bulk Carrier	87,000	242.8	230.9	37.4	20.3	13.2	0.12	-14m (future)
60,000DWT Bulk Carrier	70,440	223.0	211.5	34.4	18.5	13.2	0.12	-14m
	66,000	223.0	211.5	34.4	18.5	12.4	0.12	-13m
50,000DWT Bulk Carrier	58,700	211.4	200.1	32.7	17.4	12.4	0.12	-13m/-14m

Where, DWT: Dead weight tonnage, DT: Design displacement tonnage, Loa: Overall length
Lpp : Length between perpendiculars, B : Beam, D : Depth, d : Design Draft, v: Berthing speed

- Tidal Range and Structure Elevation

					-13m NNQ	-14m NWQ
HWL	: +1.70 m	Fender Top (covered)	:	+3.30 m	+3.30 m
LWL	: +0.30 m	Fender Bottom (covered)	:	+0.25 m	-0.12 m

- Berthing and other criteria requirement

a) Horizontal berthing angle of vessel : 6 degrees for 30,000DWT and above vessels
10 degrees for below 30,000DWT vessels

b) Design temperature range : 24.3 ºC to 29.6 ºC

c) Abnormal factor of berthing energy : 1.25

b) Calculation Results of Berthing Energy

Vessel Type	DT (ton)	Ce	Cm	Cc	Cs	v (m/s)	Energy (kN-m)	C_{ab}	Abnormal Energy (kN-m)
80,000DWT Bulk Carrier	87,000	0.564	1.744	0.9	1.0	0.12	554.7	1.25	693.4
60,000DWT Bulk Carrier	70,440	0.555	1.842	0.9	1.0	0.12	466.8	1.25	583.5
	66,000	0.555	1.793	0.9	1.0	0.12	425.3	1.25	531.6
50,000DWT Bulk Carrier	58,700	0.552	1.844	0.9	1.0	0.12	387.5	1.25	484.4

C_{ab} = Abnormal Factor

-
- Min. Required Energy Absorption, $E_{req.,}$ ($E_{req.} = E_{ab(max)} / TCF_{EA}$)

Vessel Type	Abnormal Berthing Energy (kN-m)	Total Correction Factor	Required Energy Absorption For Fenders (kN-m)
80,000DWT Bulk Carrier	693.4	0.882	786.2
60,000DWT Bulk Carrier	583.5	0.882	661.6
	531.6	0.877	606.2
50,000DWT Bulk Carrier	484.4	0.877	552.3

c) Recommended Fender System

Based on the above results of Required Energy Absorption, the reaction force of the Fenders of the several manufacture's catalogues is evaluated as 606.2kN in maximum for -13 m NNQ and 786.2kN in maximum for -14 m NWQ. The calculation sheets for the required energy absorption of each fender are presented in Appendix 1.

The Fender pitch for -13 m NNQ and -14 m NWQ is evaluated as 15 m interval and the fender type is recommended as Cone Type Cell Fender with chain supported, the reference design is shown in the Figure 3.3.4.4-1 for -13 m NNQ and Figure 3.3.4.4-2 for -14 m NWQ.

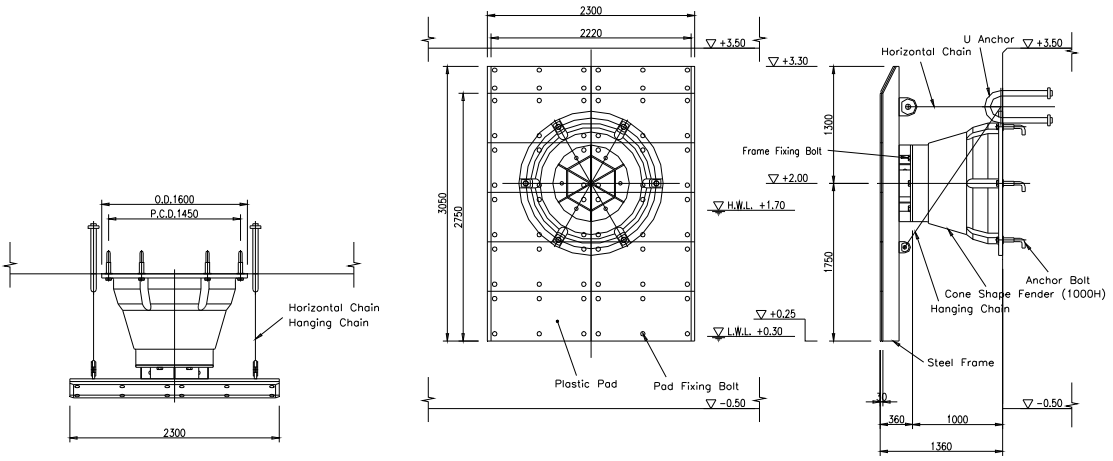


Figure 3.3.4.4-1 Fender Reference Design for -13m NNQ

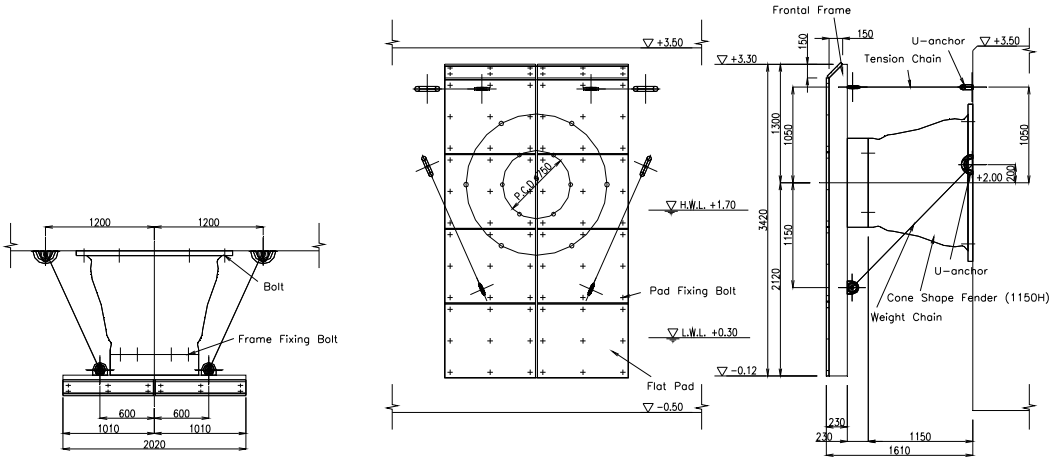


Figure 3.3.4.4-2 Reference Design for -14m NWQ

2) -10 m Quay Fenders for Tugboat and Pilot-boat

Calculation sheet for Fender system of Tugboat and Pilot-boat is presented in Appendix 1. The fender type is recommended as V type Rubber Fender and the reference design is shown in the Figure 3.3.4.4-3 for Tugboat at 5m interval and Figure 3.3.4.4-4 for Pilot-boat at 2 m interval.

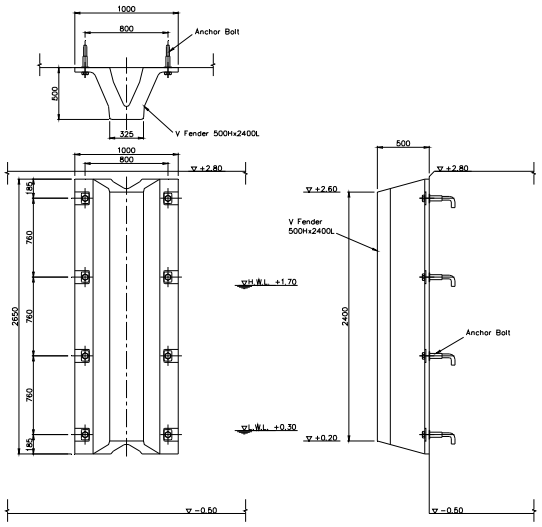


Figure 3.3.4.4-3 Reference Design for -10m NSQ for Tug Boat

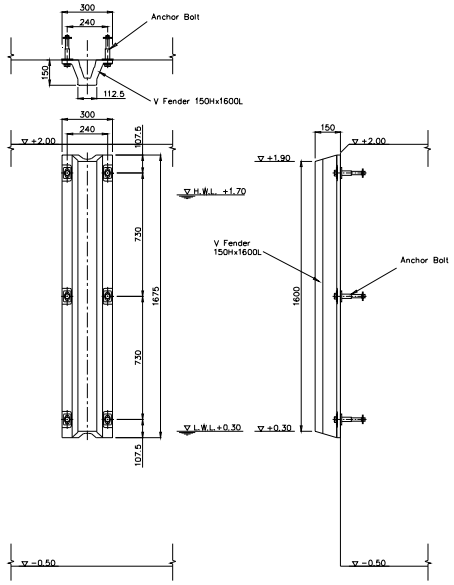


Figure 3.3.4.4-4 Reference Design for -10m NSQ for Pilot Boat

3.3.4.5 Revetment for Connection of Existing Quay

The Connection between the Existing Quay and Revetment, and between the Existing Quay and the New Quay was designed same as Existing Quay Structure (Concrete block wall). Therefore, the structural calculation and its drawing is omitted in this report. Only new revetment (steel sheet pile type) between the Existing West Quay and the -10 m NSQ is presented the calculation results and its typical Section drawing as follows.

Results of the structural calculation are as follows and typical section of the structure is shown in Figure 3.3.4.5-1.

Hat Sheet Pile=25H, +H Beam=H450x200x12x25x13

	Ordinary Case	Allowable Stress	Result
Stress Intensity (N/mm^2)	87.9	180.0	OK
Displacement amount (cm)	2.694	5.000	OK
Adopted depth (m)	-10.500	--	--
Length of Pile (m)	12.00	--	--

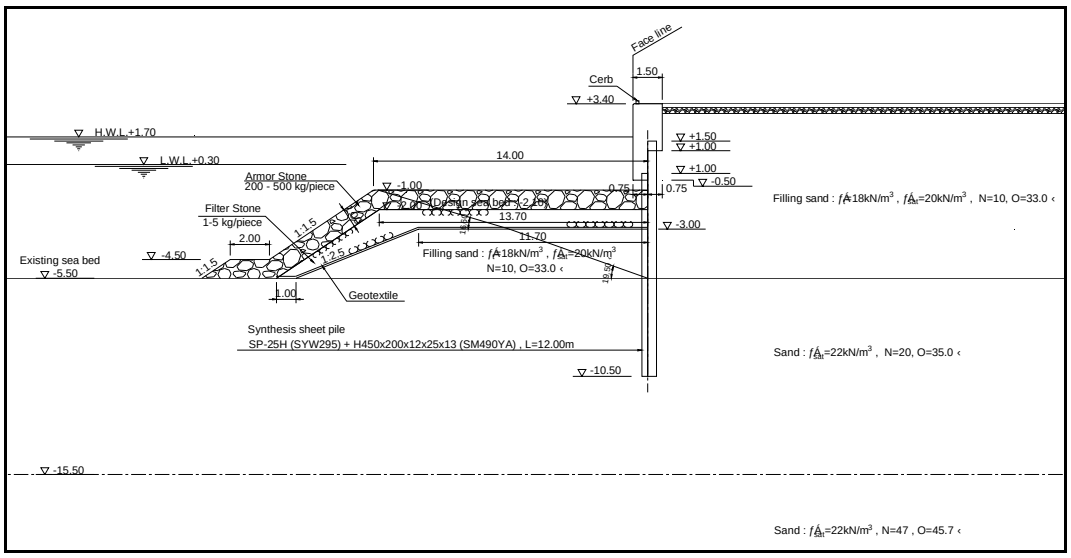


Figure 3.3.4.5-1 Typical Section of Transitional Part with Existing West Quay (Steel Sheet Pile Section)

Results of Circular Arc Analysis for Transitional Part with Existing Wet Quay (Steel Sheet Pile Section) is shown in Figure 3.3.4-13(2), Minimum case of safety factor is 2.584 > 1.3 (OK)

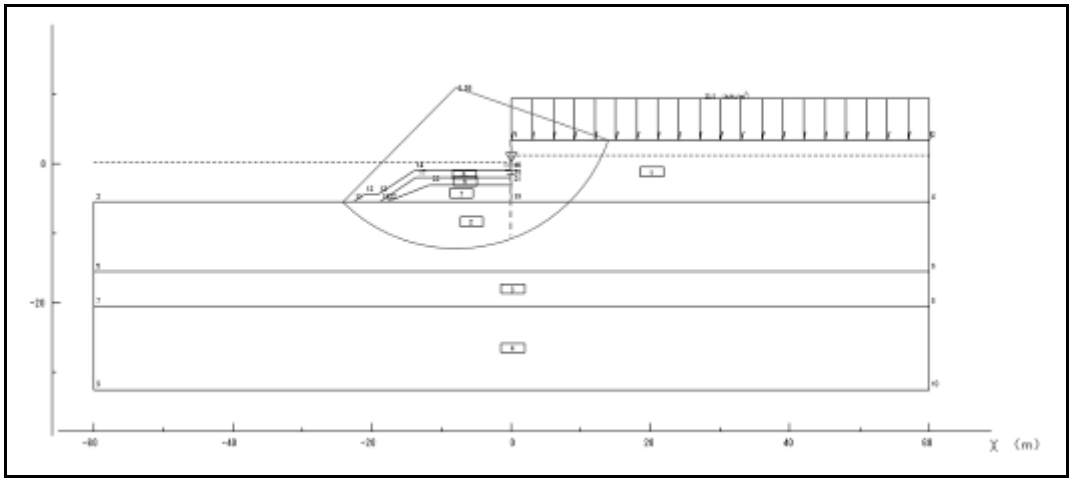


Figure 3.3.4.5-1(2) Results of Circular Arc Analysis for Transitional Part with Existing Wet Quay (Steel Sheet Pile Section)

3.3.5 Pavement for In-port Road

Terminal apron and road pavement is planned as the Figure 3.2-2 Terminal Facility Layout.

The terminal apron and road is adopted the heavy duty pavement and it is better to adopt the Interlocking concrete block pavement for the surface due to easy maintenance for the reclaimed area of which is same type pavement of existing port apron and yard. Moreover, the walkways are also provided along the boundary between the terminal and other areas (harbor master and tug-service company areas). These walkways are also planned to adopt interlocking concrete pavement as light duty pavement.

The pavement structure is calculated using the formulas in THE STRUCTURAL DESIGN OF HEAVY DUTY PAVEMENTS FOR PORTS AND OTHER INDUSTRIES EDITION 4 (The Precast Concrete Paving and Kerb Association), which adopting the recently published British and European Standards including: *BS 5328* (Concrete); *BS 7533* (Pavements constructed with clay, natural stone or concrete pavers); *BS EN 14277* (Hydraulically bound mixture); *BS EN 1338* (Concrete paving blocks - Requirements and test methods).

In general, the thickness of C8/10 cement bound granular mixture calculated based on the relationship between Equivalent Wheel Loads and Number of Passes in 25 years as shown in right Figure 3.3.5-1.

Apron and terminal road is utilized for heavy trucks and trailers which is passing estimated 2,500 tons cargos loaded and carrying out of the terminal every day. Truck numbers passing the road and apron is estimated as follows.

2,500 ton / 20 ton/truck = 125 numbers / day

For calculation of the pavement structure, the truck numbers during the design life is required.

Design standard for the Eurocode for pavement is applied 25 years design life. Therefore, the truck numbers during the design life is as follows

125 x 365 x 25 = 1,140,625 numbers

Therefore the 1,500,000 passes line in the above figure is adopted.

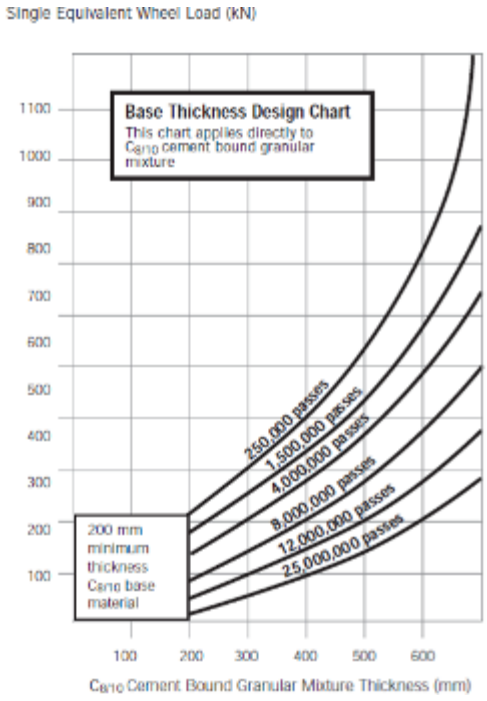


Figure 3.3.5-1

Evaluation of Design CBR (%) for Structure of the Pavement
Compacted sub-grade (sand) evaluated as follows

φ＝33°, N = 10 - 12 (after compaction)
E_0＝25N (sand base)
Where, E_0 : Deformation coefficient of ground (kgf/cm^2),
N : N Value of Standard Penetration Test (SPT)
Therefore, E_0＝25 x N = 10 - 12 x 25＝250 - 300 kgf/cm

CBR(%) : CBR of Sub-Grade for Road Pavement
E_0＝40 × Design CBR (Sub-grade material)
Design CBR(%) Sub-Grade CBR = NX 1/40 = 250 - 300/40＝6.25 - 7.5

For the compacted road sub-grade = evaluated as CBR= 7%

The input data and calculation results are shown Table 3.3.5-1. in which the number of passes during design life of pavement is estimated as following:

1) Design Calculation for Pavement

Table 3.3.5-1: Input condition and results

Calculation conditions for cases of		Trailer	Truck
Number of likely passes during design life of pavement	pass	1,500,000	1,500,000
CBR of soil	%	7	7
Sub-base thickness	mm	150	150
Total number of wheels of front axle		4	4
Equivaqlent wheel load	kN	85.75	49
fd = Dynamic Factor for braking *Table 17/ p.38*	Branking	1	1
	Cornering	0.3	0.3
	Acceleration	0	0
	Uneven Surface	0	0
Maximum Static wheel load	kN	85.750	49.000
Wheel proximity	kN	94.325	53.900
Proximity factor		1.100	1.100
Equivalencing wheel loads	kN	216.9475	123.97
C8/10 Thickness *(mm)*		**200**	**200**

The pavement structure for both of the trailer and the truck is as following Figure 3.3.5-2 based on the calculation sheet as above Table 3.3.5-1.

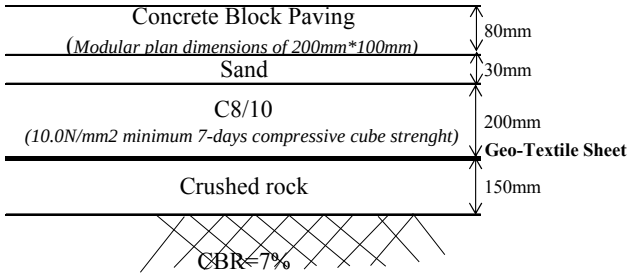


Figure 3.3.5-2 Calculation Result of Pavement Structure

However, based on the difficulty to make smooth surface after enough compaction of the crushed rock base by the Heavy Roller, the crushed rock shall be better to increase its thickness to 200mm in minimum. In the Abidjan Port, the apron pavement has been adopted the Interlocking Concrete Block Surface having 130mm in thick as heavy duty pavement. PAA requested using the Interlocking concrete block having 130mm in thick. Moreover, to require the elasticity for the concrete base layer, the concrete of C8/10 is reduced to 100mm.

Therefore, the remaining of 100mm thick of the concrete of C8/10 will be replaced by the thickness of Interlocking Concrete Block (increasing 50mm thick = 130mm) and the Crushed Rock. According to Table 3.3.5-2, the equivalent thickness of crushed rock is 50mm of concrete of C8/10 ×3=150mm.

Its means that the Interlocking Concrete Block shall be 130mm in thick and the crushed rock base shall be 150mm +150mm = 300mm> 200mm

Table 3.3.5-2 Material Equivalence Factors relating C8/10 CBGM to other material

Material Grouping	Preferred Pavement Base Construction Material	Material Equivalence Factor (MEF)
Traditional Cement Bound Materials	*CBM1 (4.5N/mm² minimum 7-days compressive cube strength)*	*1.60*
	CBM2 (7.0N/mm² minimum 7-days compressive cube strength)	*1.20*
	CBM3 (10.0N/mm² minimum 7-days compressive cube strength)	**1.00**
	CBM4 (15.0N/mm² minimum 7-days compressive cube strength)	0.80
	CBM5 (20.0N/mm² minimum 7-days compressive cube strength)	0.70
	No-fines Lean Concrete for Permeable Paving	1.00
Bitumen Bound Materials	HDM as defined by SHW	0.82
	DBM as defined by SHW	1.00
	HRA as defined by SHW	*1.25*
Unbound Materials	Crushed rock sub-base material of CBR ≥ 80%	3.00

Therefore, the pavement structure for both of the trailer and the truck is as the structure of the following Figure 3.3.5-3

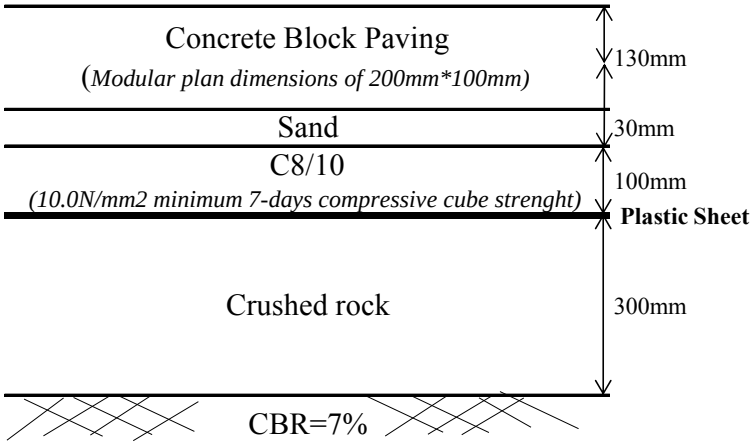


Figure 3.3.5-3 Pavement Structure for Terminal Apron and Road

In this project, all of the pavement (Apron, truck road and road for tugboat) are obtained as above structure. For the walkway in the terminal as light duty pavement, the surface of the pavement is also adopted the interlocking concrete blocks. Manufacturer of the blocks is fabricating only 60mm in thick blocks as light duty (walkway type). Therefore, the structure of the walkway pavement is generally adopted as following Figure 3.3.5-4.

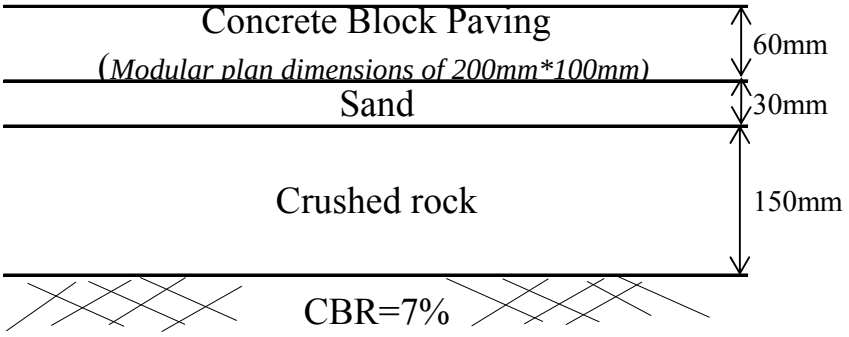


Figure 3.3.5-4 Pavement Structure for Terminal Walkway

3.3.6 Utilities for the New Cereal Berth

3.3.6.1 Apron and Road Storm Drainage

1) Design Criteria of Drainage System

Storm drain capacity in project area (Abidjan) is estimated on the basis of the rainfall data. The return period of storm rain water are designed as 10 years for all drainage structures.

i) Estimated Rainfall Intensity

The empirical formulas are used to construct the rainfall Intensity Duration Frequency (IDF) curves. The Intensity-Duration-Frequency (IDF) curves for the precipitation were established using the parameters of Montana model and the results for Abidjan stations are displayed in Figure 3.3.6.1-1 on double logarithmic axes. (Tc (min) = 0.1610 $(L/\sqrt{S})^{0.64}$: Chow(1962))

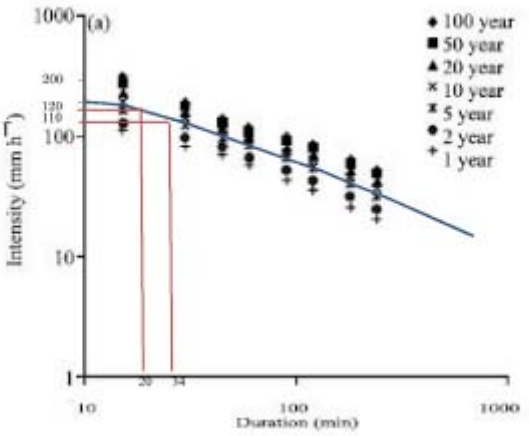


Figure 3.3.6.1-1 Rainfall Intensity Duration Frequency Curve in Abidjan

Based on the Intensity-Duration-Frequency (IDF) curves, maximum rainfall intensity /hour and distance from furthest point to drainage outlet, the rainfall intensity for the yard and road is estimated as following two cases

a) I=120mm / hour (distance from farthest point to drainage inlet: less than 150m and less than 20 min. for inlet time)
b) I= 110mm/hour (distance from farthest point to drainage inlet: less than 300m and less than 34 min. for inlet time)

ii) Discharge Volume

A rational formula shown below design calculation

$Q = 0.278 \times C \times I \times A$ (Q= peak flow rate (m^3/sec))

Where; C: coefficient of runoff (pavement / roof: 0.8)
I: average rainfall intensity (mm/hr)
A: Catchments area (Km^2)

iii) Outlet Elevation

The outlet of the storm water drainages are planned to discharge into the sea. The low water level is CDL+0.3 m and mean water level is CDL + 1.1 m. Therefore, the lowest elevation of drainage outlet shall not be higher than the middle tide of LWL = CDL+1.1 m.

iv) Water Velocity

Maximum velocity of drainage water shall not be higher than 3 m/s
Minimum Velocity of drainage water shall not be less than 0.3 m/s

v) Catchments area

Catchments areas are separated by surface elevation of yard and road pavement for each inlet of the drainage system.

vi) Design drainage section (Drain Pipe: 80%, Culvert or Ditch: 90%)

Section area of drain is calculated as shown below:

$A=Q/V$

Where A: section area of drain structure in m^2
Q: drainage volume of drain m^3/sec
V: average velocity of flowing drain calculated by Manning equation as following formula.
$V= 1/n \times R2/3 \times I\ 1/2$
Where n= Concrete : 0.018, R= A/P, I = Slope（in case 0.5%, I=0.005）

vii) Drainage structure slope not less than 0.2%

viii) Surface pavement slope S: 0.3 %< s<2.0%

ix) Minimum covering fill above pipe culvert: 1.0m (Pipe manufacture’s instruction)

2) Design of Drainage Line A, Line B and Line C

Line A is located along the warehouse area at the west side of the 450 m quay and tugboat quay side apron. Line B is located along the warehouse area at the east side of 450 m quay and 250 m north quay apron. Line C is located along the land side road installed under the pavement of the road. Drainage layout in the terminal is shown in Figure 3.3.6.1-2

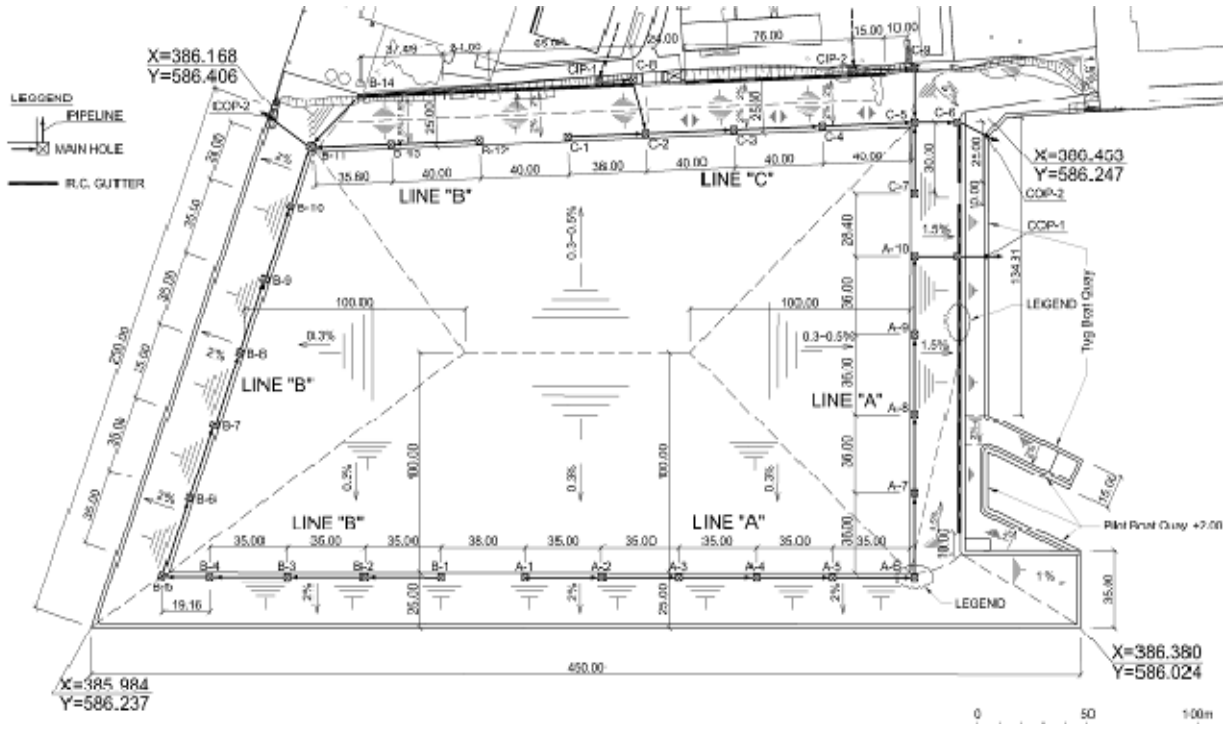


Figure 3.3.6.1-2 General Layout for Storm Water Drainage

All the drainage line in the yard is planned to construct manhole inlets with heavy duty grating cover collecting the rain water around the surface as catchment area, and install R.C pipes connecting the manholes to the outlet.

Typical section of R.C. Pipe Culvert and R.C. Box Culvert are shown in Figure 3.3.6.1-3.

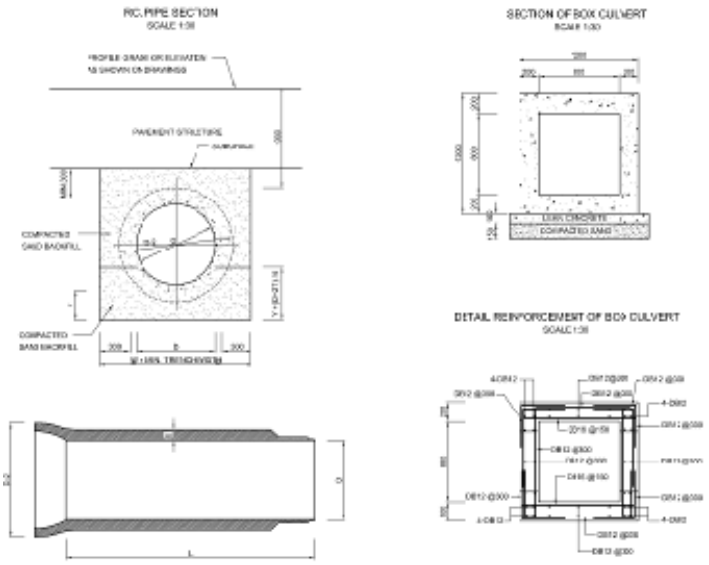


Figure 3.3.6.1-3 Typical section of R.C. Pipe Culvert and R.C. Box Culvert

Line A Storm water Volume (Q=0.278 x C x I x A)

Drainage Manhole No.		Catchment Area (m2)	I mm/h	Q m3/sec	Sum Q Inlet m3/sec	Dinstance to Inlet
From	To					
Catchment Area	**A1**	1900	120	0.050	**0.050**	100m
Catchment Area	**A2**	3500	120	0.093	**0.143**	135m
Catchment Area	**A3**	3500	120	0.093	**0.236**	170m
Catchment Area	**A4**	3122	120	0.083	**0.319**	205m
Catchment Area	**A5**	1873	120	0.05	**0.369**	240m
Catchment Area	**A6**	613	120	0.016	**0.385**	275m
Catchment Area	**A7**	648	110	0.016	**0.401**	311m
Catchment Area	**A8**	1944	110	0.048	**0.449**	347m
Catchment Area	**A9**	3176	110	0.078	**0.527**	383m
Catchment Area	**A10**	3253	110	0.08	**0.607**	419m
Catchment Area	**A11**	3757	120	0.1	**0.707**	128m
A8	**COP-1**				**0.707**	

Line A Drainage Plan (Q=AV , V= 1/n x $R^{2/3}$ x $I^{1/2}$)

Manhole No. and Type		**R.C pipe inner Diameter (mm)**	**Slope (%)**	Velocity (m/sec)	**Q m3/sec**	**Pipe length**	**Outlet**	**Inlet**
From (Type)	**To (Type)**						**Bottom Elv (CDL+)**	**Bottom Elv (CDL+)**
A1 (Type 1)	**A2 (Type 1)**	**500**	**0.3**	0.76	**0.119**	**35m**	**+2.37**	**+2.265**
A2	**A3 (Type 1)**	**500**	**0.5**	0.98	**0.154**	**35m**	**+2.26**	**+2.085**
A3	**A4 (Type 1)**	**600**	**0.5**	1.11	**0.251**	**35m**	**+208**	**+1.885**
A4	**A5 (Type 2)**	**800**	**0.3**	1.04	**0.418**	**35m**	**+1.88**	**+1.775**
A5	**A6 (Type 2)**	**800**	**0.3**	1.04	**0.418**	**35m**	**+1.77**	**+1.665**
A6	**A7 (Type 2)**	**800**	**0.3**	1.04	**0.418**	**36m**	**+1.66**	**+1.552**
A7	**A8 (Type 3)**	**800**	**0.3**	1.04	**0.418**	**36m**	**+1.55**	**+1.442**
A8	**A9 (Type 3)**	**800 x800 Box Clvert**	**0.3**	1.26	**0.725**	**36m**	**+1.44**	**+1.332**
A9	**A10 (Type 3)**	**800 x800 Box Clvert**	**0.3**	1.26	**0.725**	**36m**	**+1.33**	**+1.222**
A10	**A11 (Type 4)**	**800 x800 Box Clvert**	**0.3**	1.26	**0.725**	**21m**	**+1.22**	**+1.157**
A11	**COP-1**	**800 x800 Box Clvert**	**0.3**	1.26	**0.725**	**13.5m**	**+1.15**	**+1.11**

Line B Storm water Volume (Q=0.278 x C x I x A)

Drainage Manhole No.		Catchment Area (m2)	I mm/h	Q m3/sec	Sum Q Inlet m3/sec	Dinstance to Inlet
From	To					
Catchment Area	**B1**	1900	120	0.050	**0.050**	100m
Catchment Area	**B2**	2940	120	0.078	**0.128**	135m
Catchment Area	**B3**	1943	120	0.052	**0.18**	170m
Catchment Area	**B4**	1190	120	0.032	**0.212**	205m
Catchment Area	**B5**	290	120	0.008	**0.220**	228m
Catchment Area	**B6**	528	120	0.014	**0.234**	263m
Catchment Area	**B7**	1634	120	0.044	**0.278**	298m
Catchment Area	**B8**	2756	110	0.067	**0.345**	333m
Catchment Area	**B9**	2756	110	0.067	**0.412**	368m
Catchment Area	**B10**	1633	110	0.028	**0.440**	403m
Catchment Area	**B12**	1000	120	0.027	**0.027**	115m
Catchment Area	**B13**	2775	120	0.074	**0.101**	140m
Catchment Area	**B14**	500	120	0.013	**0.013**	55m
Catchment Area	**B11**	1425	110	0.034	**0.588**	438m

Line B Drainage Plan (Q=AV , V= 1/n x $R^{2/3}$ x $I^{1/2}$)

Manhole No. and Type		R.C pipe inner Diameter (mm)	Slope (%)	Velocity (m/sec)	Q m3/sec	Pipe length	Outlet	Inlet
From (Type)	To (Type)						Bottom Elv (CDL+)	Bottom Elv (CDL+)
B1 (Type 1)	B2 (Type 1)	500	0.3	0.76	0.119	35m	+2.37	+2.265
B2	B3 (Type 1)	500	0.35	0.82	0.129	35m	+2.26	+2.14
B3	B4 (Type 1)	600	0.3	0.86	0.195	35m	+2.14	+2.035
B4	B5 (Type 2)	600	0.4	0.99	0.224	19.2	+2.03	+1.938
B5	B6 (Type 2)	800	0.3	1.04	0.418	35m	+1.93	+1.825
B6	B7 (Type 2)	800	0.3	1.04	0.418	35m	+1.82	+1.715
B7	B8 (Type 2)	800	0.3	1.04	0.418	35m	+1.71	+1.605
B8	B9 (Type 2)	800	0.3	1.04	0.418	35m	+1.60	+1.495
B9	B10 (Type 2)	800	0.35	1.12	0.45	35m	+1.49	+1.365
B10	B11 (Type 2)	800	0.35	1.12	0.45	28m	+1.36	+1.262
B12 (Type 1)	B13 (Type 1)	500	0.3	0.76	0.119	40m	1.55	+1.43
B13	B11	500	0.3	0.76	0.119	35.6m	+1.43	+1.323
B14 (Type 1)	B11	500	0.3	0.76	0.119	34m	+1.55	+1.45
B11	COP-2	800	0.6	1.47	0.591	26m	+1.262	+1.1

Line C Storm water Volume (Q=0.278 x C x I x A)

Drainage Manhole No.		Catchment Area (m2)	I mm/h	Q m3/sec	Sum Q Inlet m3/sec	Dinstance to Inlet
From	To					
Catchment Area	**C1**	4410	120	0.118	**0.118**	100m
Catchment Area	**C2**	4322	120	0.115	**0.233**	140m
CIP1	**C8**	Existing Peek flow = RC dia 500x 50% I=0.3%		0.075	**0.075**	150m estimated
C8	**C3**	1000	120	0.027	**0.102**	240m
Catchment Area	**C3**	4370	120	0.117	**0.452**	176m
Catchment Area	**C4**	3820	120	0.102	**0.554**	216m
Catchment Area	**C5**	2100	120	0.056	**0.610**	256m
Catchment Area	**C7**	870	120	0.023	**0.271**	75m
C7	**C5**	490	120	0.013	**0.013**	60m
CIP2	**C9**	Existing Peek flow = RC dia 500x 50% I=0.3%		0.075	**0.075**	150m
C9	**C5**	1782	120	0.048	**0.123**	270m
Catchment Area	**C6**	956	110	0.038	**0.784**	317m
C6	**COP-3**	0	0	0	**0.807**	

Line C Drainage Plan (Q=AV , V= 1/n x $R^{2/3}$ x $I^{1/2}$)

Manhole No. and Type		R.C pipe inner Diameter (mm)	Slope (%)	Velocity (m/sec)	Q m3/sec	Pipe length	Outlet	Inlet
From (Type)	To (Type)						Bottom Elv (CDL+)	Bottom Elv (CDL+)
C1 (Type 1)	C2 (Type 1)	500	0.3	0.76	0.119	36m	+1.95	+1.83
C2	C3 (Type 2)	600	0.5	1.11	0.251	40m	+1.83	+1.67
CIP 1 (Type 1)	C8 (Type 1)	500	0.3	0.76	0.119	19m	+1.85	+1.79
C8	C3	500	0.3	0.76	0.119	26m	+1.79	+1.71
C3	C4 (Type 3)	800	0.4	1.2	0.483	40m	+1.67	+1.51
C4	C5 (Type 3)	800 x800 Box Clvert	0.3	1.26	0.725	40m	+1.51	+1.39
C7	C5 (Type 3)	500	0.3	0.76	0.119	30m	+1.5	+1.41
CIP2 (Type 1)	C9 (Type 1)	500	0.3	0.76	0.119	25m	+1.6	+1.525
C9	C5 (Type 3)	500	0.4	0.88	0.138	25m	+1.52	+1.42
C5	C6 (Type 4)	800 x800 Box Clvert	0.4	1.46	0.84	21m	+1.41	+1.326
C6	COP-2	800 x800 Box Clvert	0.4	1.46	0.84	15m	+1.32	+1.26

3) Road Surface Drainage System

The rainfall on the apron (450 m West Quay, 250 m North Quay and Tugboat Quay) are directory flowing to sea through the apron surface having 2% slope.

Only the rainwater falling on the half of road at land side road and the terminal road at west-side (nearby Tugboat Berth) having 25 m in width is collected to the R.C U-Gutter trench along the boundary and the walkway, see the Figure 3.3.6.1-2.

The collected rainfall to the U-Gutters is flowing into “A-11 man-hole”, C-8 man-hole and CIP-2 man-hole respectively. The results of the water flow capacity of U-Gutters, the dimensions

of the U-Gutters are adopted as 300 mm in inner width and from 100 mm to 400 mm in inner depth with 2.5 m interval of catchment grating covers. General Plan and Typical Section of the U-Gutter are shown in Figure 3.3.6.1-4.

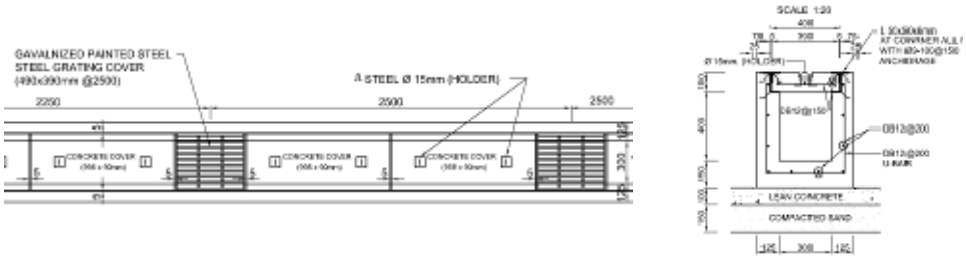


Figure 3.3.6.1-4 General Plan and Typical Section of the R.C. U-Gutter

3.3.6.2 Water Supply and Fire Hydrant System

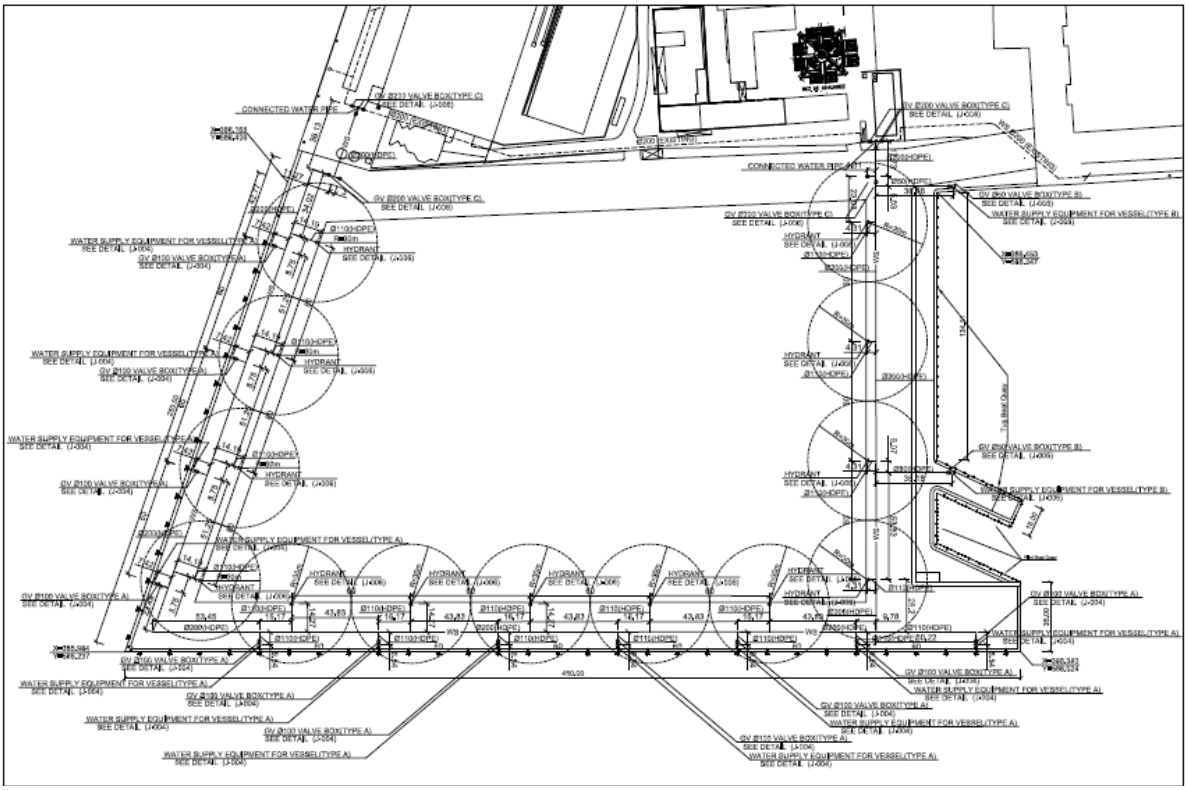
1) Planned system in the Project comprises the followings;

- Underground main water supply piping.
- Underground water hydrant valves along the wharf's front wall for vessels.
- Aboveground outdoor fire hydrants around Yard.

2) Underground Main Water Supply Piping.

Water supply piping with a diameter of 200 mm is planned to provide in the extension of an existing underground main water distribution network pipe having 200 mm diameter. Allowable maximum water flow velocity in the pipe is set not more than 2.0 m/sec in piping size calculations for main pipe (200 mm dia.), branch pipes (100 mm dia.) for water and fire hydrants. Each of the branch points from the existing water main pipe is provided with a control valve for piping network. Underground main pipe is laid with a minimum depth of 1.5 m.

Figure shown below shows main water supply piping layout including water and fire hydrants.



Source: JICA Study Team

3) Water Supply System for Vessels

a) New berth is provided with underground "guide in head" type valves for vessels along the wharf front wall. Water supply volume is measured by mobile type water meter of the vessel. Valve size and the location of the underground valves planned are as follows;

- New north quay : 100 mm × 4 Nos.
- New west quay : 100 mm × 5 Nos.
- New south quay : 100 mm × 4 Nos.

b) Water Supply Capacity of Underground Water Hydrant (Valve)

- 30 m3/hr. per location
- Simultaneous usage factor: 3 valves at peak

c) Valve Installation interval

Underground water supply valves for vessels are planned to locate between each bollard with a horizontal distance of 60 m.

4) Fire Hydrant System

Fire hydrants are of exposed aboveground pillar type and provided with a horizontal distance of 60 m. Hydrant・ valve size and the location of the pillar type fire hydrants planned are as follows;

- New north quay : 100 mm × 4 Nos.
- New west quay : 100 mm × 5 Nos.
- New south quay : 100 mm × 6 Nos.

3.3.6.3 Electrical System

1) Scope of Electrical Systems

The electrical systems for the Project are proposed as follows:

- Power Supply System
- Low Voltage (LV) Power Distribution System
- Yard Light System

For electric loads in all warehouse areas, warehouse operator(s) will construct all electrical systems including power supply, LV distribution, and yard light systems and so on by themselves.

The JICA project will prepare electrical rooms only, in which operator will install switchgear, transformer and switch board to meet their electric power demand as required.

2) Power Supply System

a) Electrical loads

Electric loads or consumers supplied from a new substation constructed by the JICA Project are proposed as follows.

- Yard light in quay areas
- The existing consumers or distribution board(s) to be relocated belonging to Security Company
- The existing consumers or distribution board(s) to be relocated belonging to Tugboat Company
- Gates equipment including light, motor driven gate
- Other small loads in the new substation such as light

b) Estimated electrical power demand

Electrical loads in the site and demand power are estimated as follows.

c) Transformer capacity

Required minimum transformer capacity is 365.8 kVA according to the above-mentioned calculation. Then, a 400 kVA transformer is proposed from manufacture's standard product.

Table 3.3.6.3-1 Electrical Load and Demand Power

Consumer (Connected Distribution Board)	Connected Load (kVA)	Remarks
Yard lights (DB-LT1, DB-LT2 & DB-LT3)	16.0	Quay areas
Security Company Equipment Security (DB-SE)	34.6	The existing loads 3-phase 50 A x 1 circuit
Tugboat Company Equipment (DB-TB1, DB-TB2 & DB-SB)	346.5	The existing loads 3-phase 200A x 2 circuits and 100A x 1 circuit
Gate Equipment (DB-G1, DB-G2, DB-G3 & DB-G4)	20.0	For four (4) new gates
Other small loads	1.0	Light and etc. in substation
Total Load (TL)	418.1	
Total Demand Factor [Diversity Factor] (Di)	0.70	
Growth Factor (Gf)	1.25	For future extension
Total Demand Power [Required transformer capacity] (TRr=TL x Di x Gf)	365.8	

Source: JICA Study team

d) Rating of equipment and cable

The existing distribution line of Ivorian Electricity Company (CIE) is 3-phase, 3-wire, 15kV, 50Hz. However, following equipment and cables with rated voltage are proposed to fit for future system voltage upgrade.

Medium Voltage switchgear (RMU): 24 kV for upgrade

Medium Voltage cables: 12/20 kV for upgrade

Transformer: 15kV / 230-400V, should fit to the current system

3) Low Voltage (LV) Power Distribution System

a) LV power feeder

U1000 R2V (XLPE/PVC) cable is proposed for all power feeders installed from Low Voltage Switch Board (LVSB) in the substation to each Distribution Board (DB). Allowable voltage drop and current carrying capacity (or ampacity) are proposed as follows:

- Voltage drop: The maximum voltage drop at the Distribution Board's ends from the LVSB, under normal load conditions, is not exceed 3.0 % at the design current and nominal voltage.
- Cable ampacity : Reducing factor to current carrying capacity is as follows:
  U1000 R2V (XLPE/PVC) cable: 0.70, factor in underground conduit pipe

b) Underground conduit run

Pressure PVC (P-PVC) Pipe complying with NF is proposed for all underground conduits

run. Nominal outer diameter of 140 mm is proposed for all feeders from the LVSB to each DB.

All underground P-PVC conduit pipes will be installed 1,500 mm below from finish ground level according to the CIE's regulation.

Pressure strength to manhole frame and cast iron cover are proposed Traffic Rate T-20/25 ton in all traffic areas.

c) Distribution board

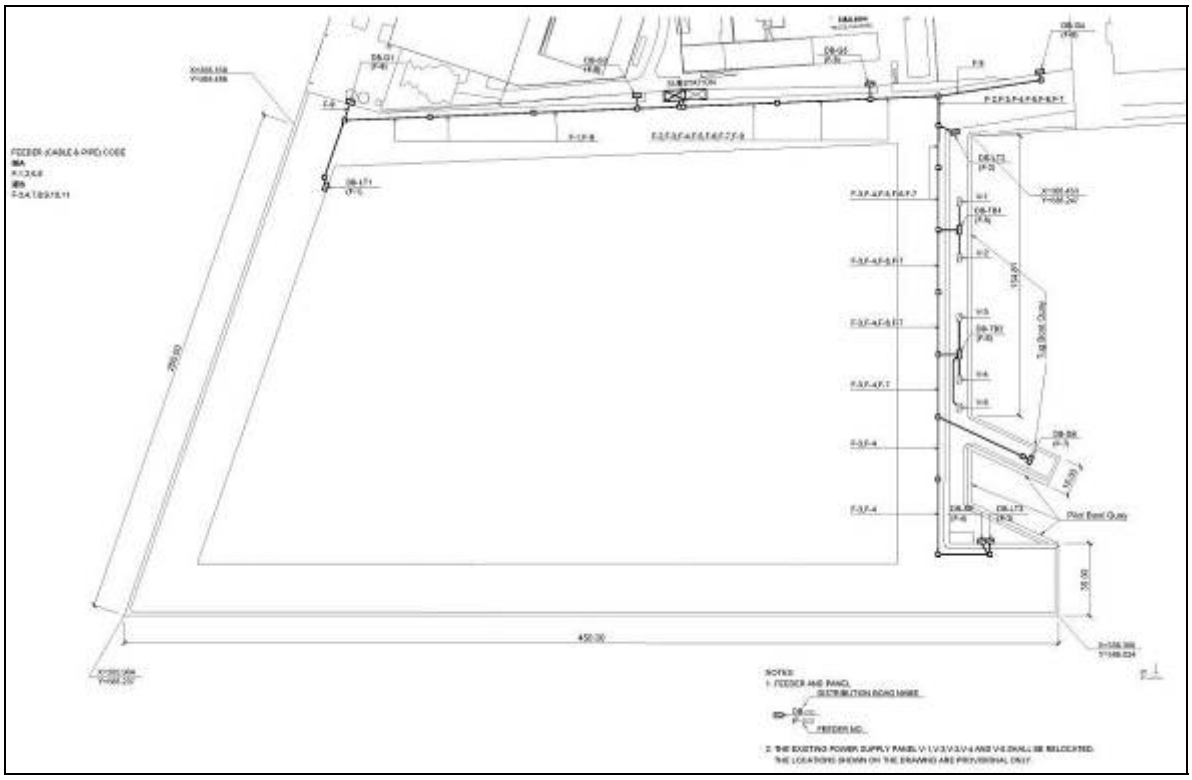
Outdoor type Distribution Boards (DBs) are proposed to install as follows.

- For yard light in quay area
- For security company's equipment to be relocated
- For tugboat company's equipment to be relocated
- For gates

Indoor type DB will be installed in the substation.

d) LV distribution plan

LV distribution plan is proposed as Figure 3.3.6.3-1 below.



Source: JICA Study Team

Figure 3.3.6.3-1 LV Distribution System Plan

4) Yard Light System

a) Light intensity

Light intensity in quay area is proposed as follows.

Average light intensity: 40 Lux

ISO-Lux are shown in Attachments

b) Yard light

Twenty (20) meters high mast with LED type floodlights is proposed in quay areas.

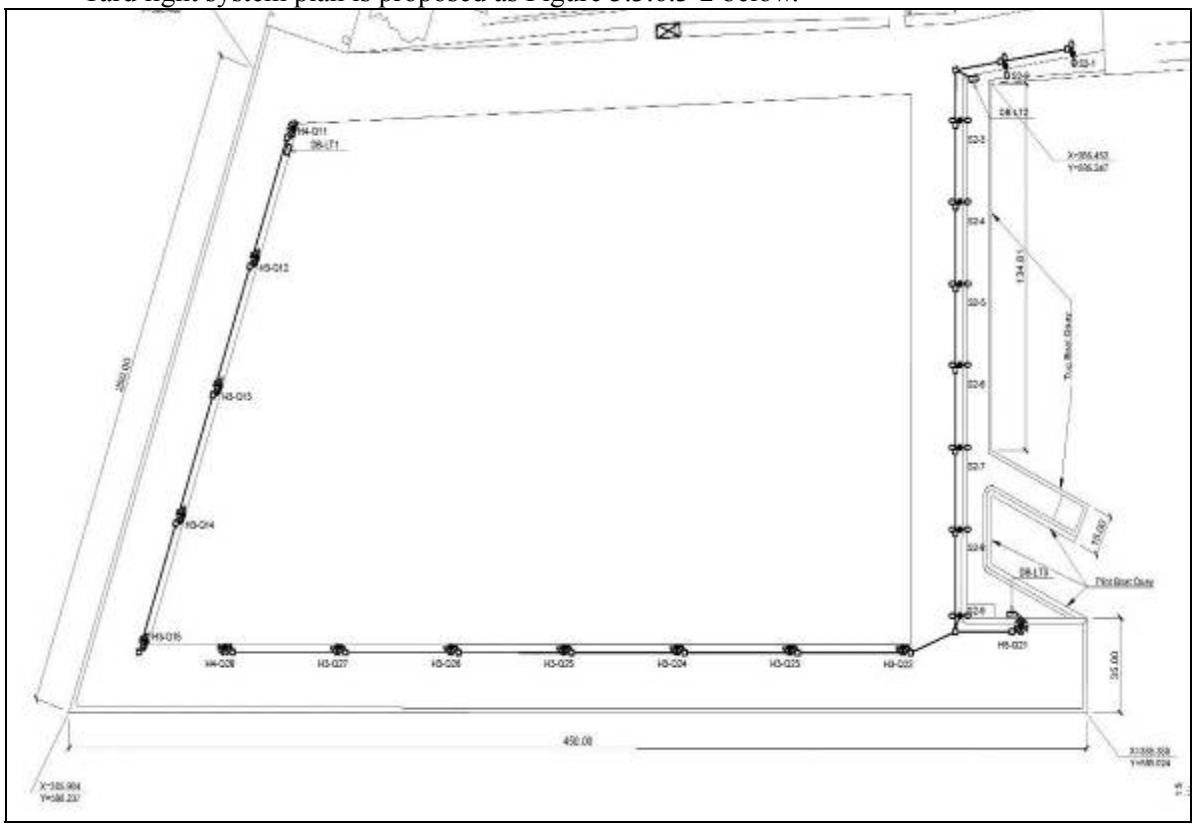
Twelve (12) meters street light pole with LED type road light is proposed in tugboat area.

c) Light control

Yard light is proposed to control with Photo-cell switch automatically with override manual switch installed in each distribution board for yard light.

d) Yard light system plan

Yard light system plan is proposed as Figure 3.3.6.3-2 below.



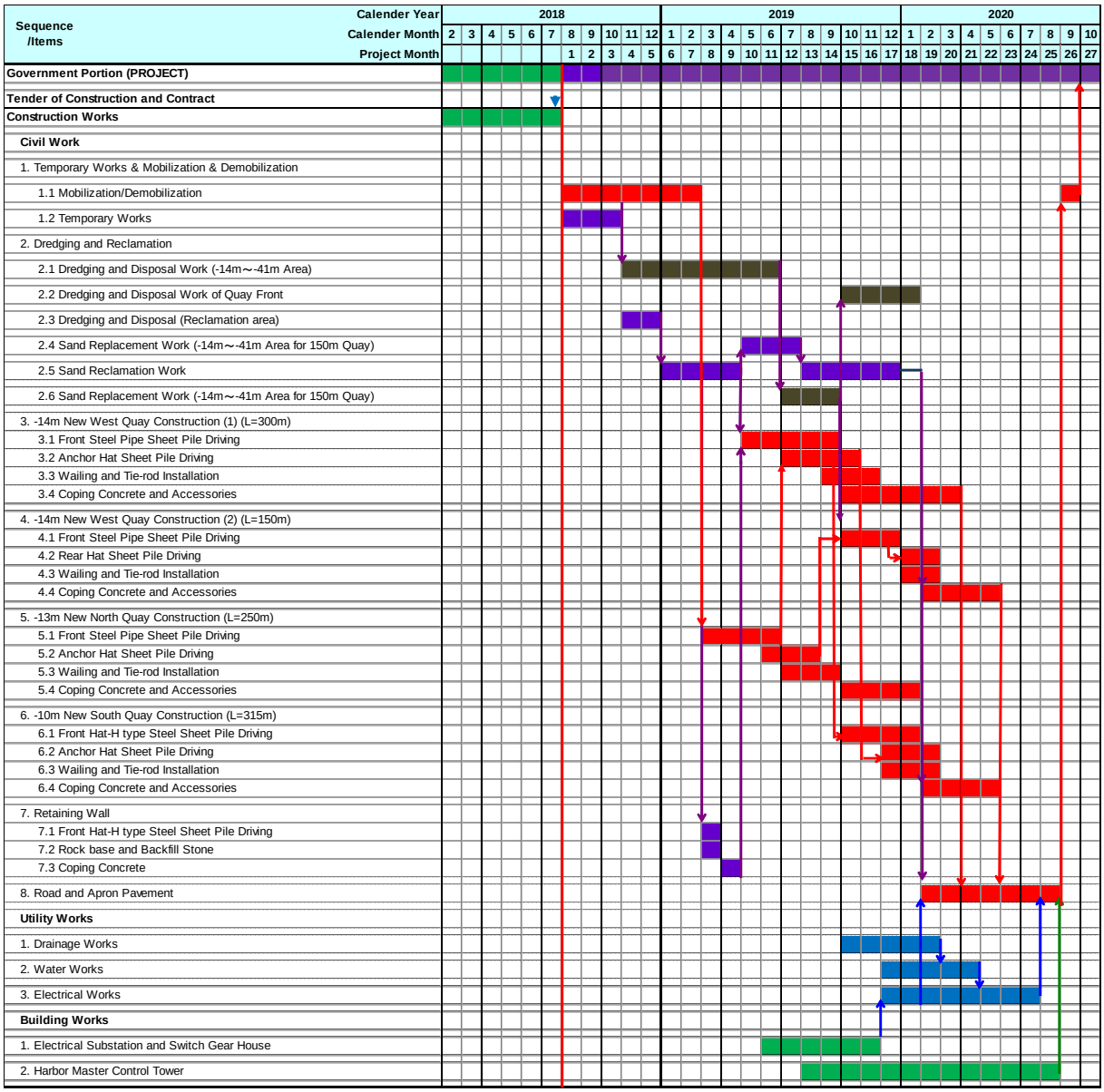
Source: JICA Study Team

Figure 3.3.6.3-2 Yard Light System Plan

3.4 Construction plan and schedule

3.4.1 Construction Schedule

Construction schedule is shown in Figure 3.4.1-1 and this construction work is to complete in 26 months after the commencement.



(Source: JICA Study Team)

Figure 3.4.1-1 Construction Schedule (draft)

3.4.2 Outline of main construction

(1) Temporary Construction

- Offices for the Consultant and the Contractor shall be prepared by PAA.
- Tug boat and pilot boat at site shall be transported by PAA and the Contractor shall prepare temporary floating jetty at relocation site for the loading.
- Facilities owned by PAA, Tug boat company (BOULUDA) and Security Company shall be demolished.
- There is no land to be used as temporary yard around construction area. It is secured on the reclaimed area preceding the dredging works and reclaimed works.

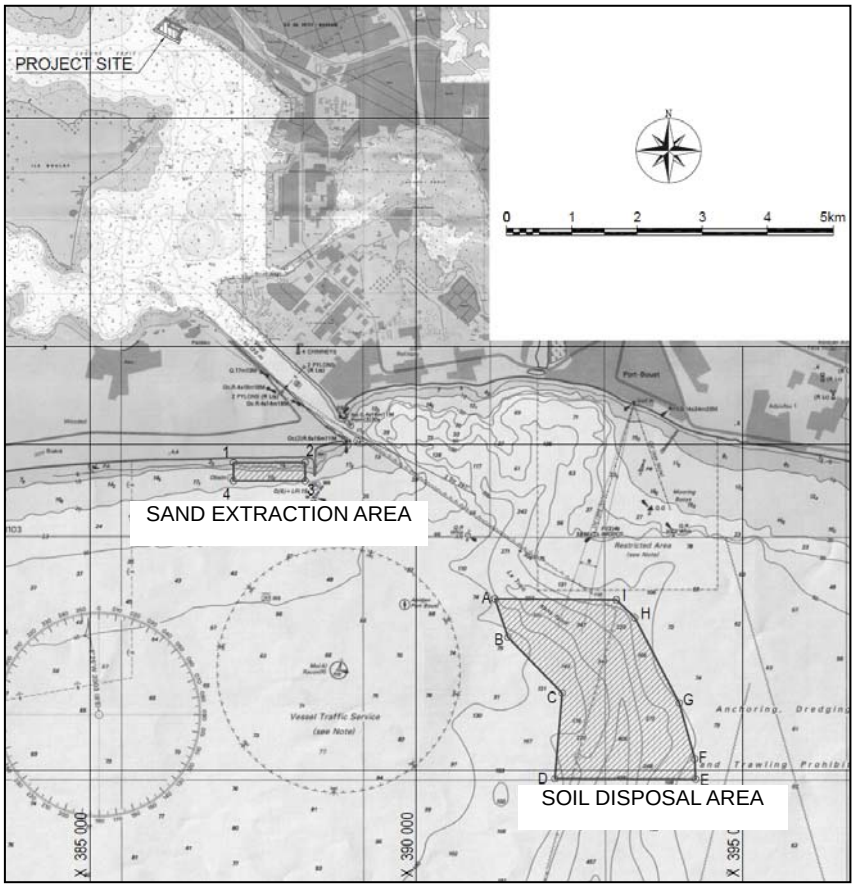
- Monitoring for pre-surveys (topographic and bathymetric) and pre-environment shall be executed.
- Planning site shall be secured its safety by installing temporary fence or others.
- Navigation and mobilization of operation boats and machines

Firstly, the navigation of operation boats like grab dredger (20 m^3), crane barge (150t), split hopper barge (800 m^3), pusher barge and trailing suction hopper dredger (3,000 to 10,000 m^3 class hopper) shall be made. Land construction machineries like crawler crane, bulldozer and backhoe shall be mobilized to the construction site upon the condition of reclamation works.

(2) Dredging and Reclamation Works

After execution of pre-bathymetric survey, the dredging works of soft layer and peat of quay foundation structure and reclaiming area and the dredging is planned in front of quay after the completion of main quay structure. The dredging is made by Grab Dredger and crane barge. Dredged soil is loaded onto dump barge and carry to oceanic dumping site (nominated by PAA) shown in Figure 3.4.2-1 and dump there.

The reclamation works are made by trailing suction hopper dredger. Sand for the reclamation is obtained from sand extraction area shown in Figure 3.4.2-1, and self-transported and dump it to reclaimed area and replacement area.

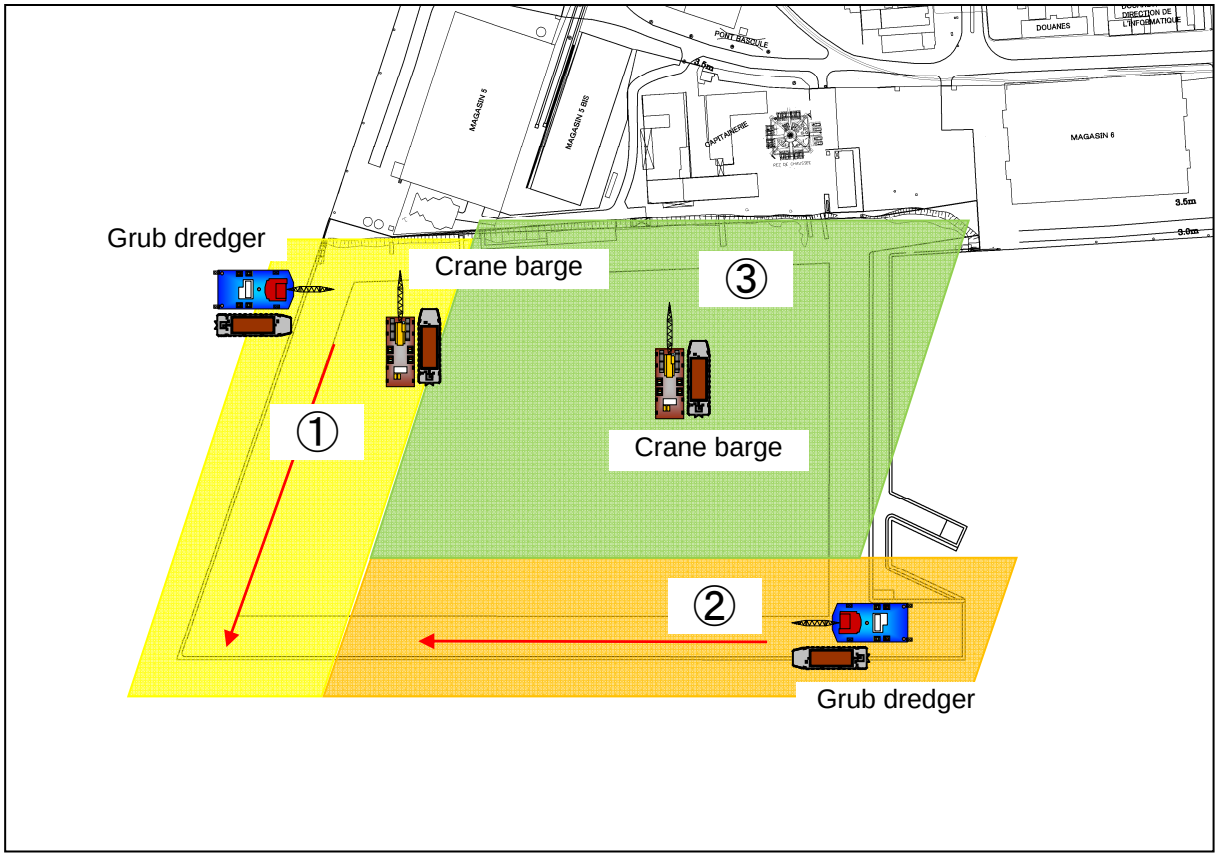


(Source: JICA Study Team)

Figure 3.4.2-1 Location Map of Soil Disposal Area and Sand Extraction Area

The order of dredging is shown in Figure 3.4.2-2. The dredging is commenced from the existing north quay side (①), -14 m quay foundation structure (②) and reclaimed area (③). Reclamation works shall be executed and managed so as to become natural slope (about 1:3) finished shape by direct sand dumping from hopper after dredging of ①. Utilizing this, temporary yard to store construction materials for quay construction shall be secured. In addition to the dredging of ②, all

remaining areas shall be reclaimed after execution of sand replacement of quay foundation structure.



(Source: JICA Study Team)

Figure 3.4.2-2 Order of Dredging and Reclamation

(3) Quay Construction Work

1) Procurement of construction material

Immediately after entering the contract with the Client, the procurement of steel pipe sheet pile, Hat-type sheet pile, Hat-H pile, steel pipe pile, tie-rod and other steel materials shall be commenced and navigate and mobilize. Navigation of pile driving barge, pile driving machine and the barge shall be commenced to meet with the manufacturing and procurement period of piles. All steel pipe piles and Hat-H piles are used as is where is base in the factory and planned not to joint piles nor joint welding at site.

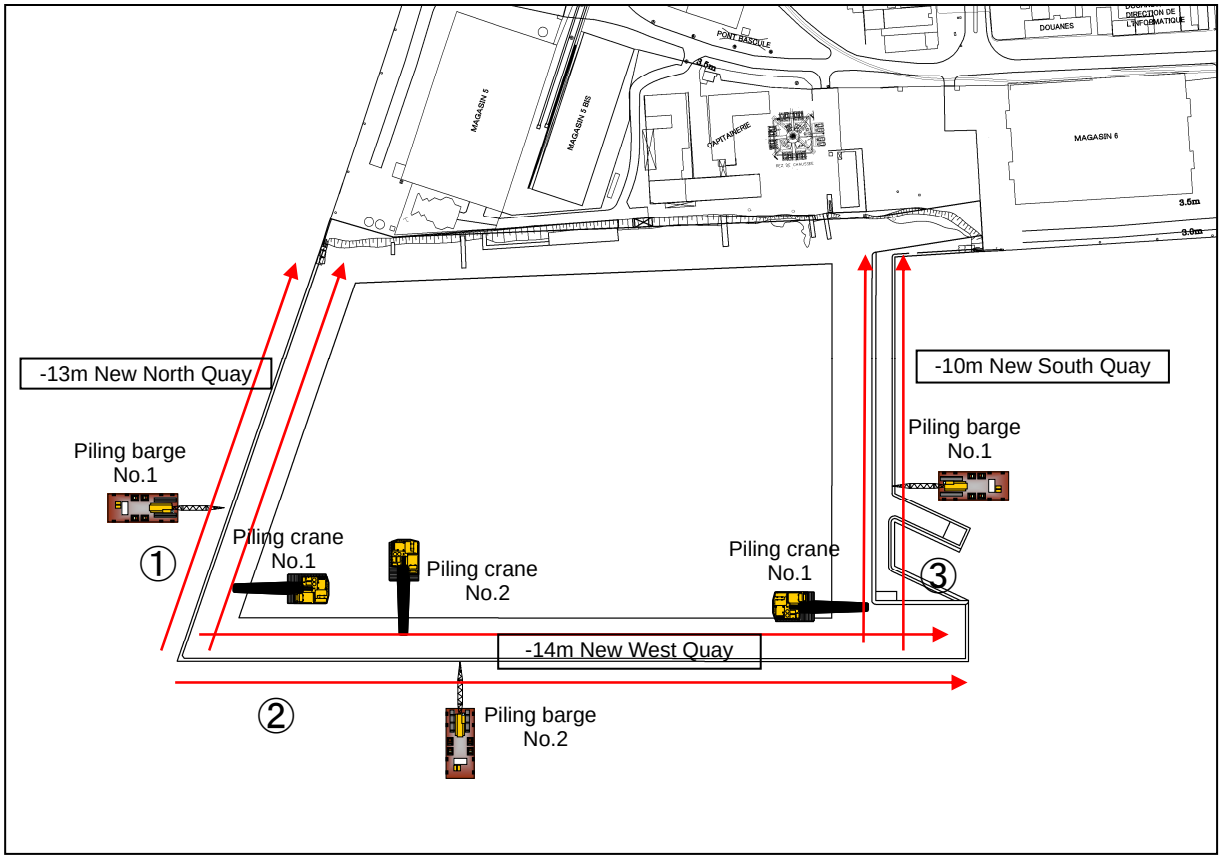
2) Construction Works of Main Quay Structure (-13 m New North Quay, -14m New West Quay, and -10m New South Quay)

Construction works of quay is commenced from corners of -13 m New North Quay and -14 m New West Quay being concurrently with the reclamation works and quay foundation replacement works. Front steel pipe sheet piles are driven by vibration hummer on crane barge. The construction of -13 m New North Quay shall be prioritized so as not to compete the operation areas of 2 piling fleets. Retaining steel sheet piles shall be piled by vibration hummer and the crawler crane from land side having around 50 m distance in pursue of the construction works of front steel pipe piles. After piling front and retaining piles, waling and tie rod shall be installed.

3) Coping concrete (-13 m New North Quay, -14 m New west Quay and -10m New South Quay)

After installation of Tie Rod, backfilling the backside of quay and casting for super structure concrete shall be made. The procurement of concrete is planned to use neighboring ready-mixed concrete and the casting is to use concrete pump from land side. Lower side of superstructure and the top concrete of retaining piles shall become the underwater concrete. After piling for -13 m

Quay, piling fleet No.1 shall move to -10 m New South Quay and the same works are done.



(Source: JICA Study Team)

Figure 3.4.2-3 Plan View of Quay Construction by Piles

(4) Pavement, Drainage, Power・ Lighting and Plumbing

Aiming the construction completion of -13 m New North Quay, the construction of related infrastructures (drainage, water facility, power supply facility, lighting facility) shall be commenced and it is planned so as to complete installation of infrastructures to meet with the completion of -10 m New South Quay and the apron pavement. Piping for electricity and water uses HDPE pipe being possible to reflect flexibly even for the settling of reclaimed land.

The pavements on apron and road shall be heavy pavement assuming 40t trailer load and it is composed of surface layers with the lower base course (crusher run with t=30 cm), the upper base course (lean mixture concrete with t=10 cm) and the inter-rocking block (t=13 cm) after rolling compaction of subgrade. Pavement shall be commenced sequentially from the area where infrastructure facilities are installed, cleaning up the site after pavement and handed it over.

(5) Construction of Watch Tower for Harbor Master

In addition, Watch Tower for Harbor Master is planned so as to be able to complete the construction to meet with the construction completion of related infrastructures under the period getting the construction of -14 m Quay underway.

3.5 Cost Estimation

After JICA Study Team estimated the construction cost, PAA and the JICA Study Team turned out to differently recognize the quantities and unit price in respect of particular types of work. Although the quantities in Bid Documents are based on PAA's direction, the drawings in Bid Documents are drafted on recognition of JICA Study Team with the consent from PAA. Table 3.5-1 shows the result of cost estimation based on direction from PAA, and Table 3.5-2 shows the result of cost estimation based on recognition of JICA Study Team.

Table 3.5-1 The Result of Estimation (Draft by PAA)

PAY ITEM	LOCAL (F.CFA in millions)	FOREIGN (USD in thousands)	FOREIGN (YEN in millions)	TOTAL (YEN in millions)
Part-1 CIVIL WORKS				
MOBILIZATION & DEMOBILIZATION	537	8,247	2	1,027
DEMOLISION WORK	49	0	0	10
DREDGING AND RECLAMATION	0	13,735	0	1,521
-13m NEW NORTH QUAY	404	6,831	143	983
-14m NEW WEST QUAY	442	14,276	240	1,913
-10m NEW SOUTH QUAY	144	4,166	172	664
TRANSITIONAL PARTS WITH EXISTING WEST QUAY	290	670	39	173
YARD AND ROAD PAVEMENTS	1,206	617	6	323
YARD AND ROAD STORM DRAINAGE SYSTEMS	141	127	20	63
WATER SUPPLY AND FIREFIGHTING SYSTEMS	7	109	30	43
ELECTRICAL SYSTEM	299	187	94	177
OTHER PORT RELATED FACILITIES	44	33	0	13
Part-2 BUILDING WORKS				
WATCH-TOWER FOR HARBOUR MASTER	1,289	0	0	266
Specified Provisional Sum for Dispute Board	0	260	0	29
Subtotal of Bills (A)	4,852	49,258	745	7,205
Add Provisional Sum for Contingencies Allowance (at 5% of Sub Total of Bills (A)) (B)	243	2,463	37	360
VAT (18%) (C)	917	9,310	141	1,362
Estimated Contract Price for Japan's Loan (A+B+C)	6,012	61,031	923	8,927

(Source: JICA Study Team)

Note:
- *1 : Quantities and unit prices of dredging and reclamation works specified by PAA were applied.
- *2 : Procurement prices of steel materials such as steel pipe sheet piles, steel sheet piles, Hat-H type sheet piles, beam steels, reinforcing bars, tie rods, etc. specified by PAA were applied.
- *3 : Cost for pile driving works specified by PAA were applied.
- *4 : 18% of the sum of construction cost (A) and Contingencies Allowance (B) was set as Value Added Tax.

Table 3.5-2 The Result of Estimation (Draft by JICA Study Team)

PAY ITEM	LOCAL (F.CFA in millions)	FOREIGN (USD in thousands)	FOREIGN (YEN in millions)	TOTAL (YEN in millions)
Part-1 CIVIL WORKS				
MOBILIZATION & DEMOBILIZATION	537	8,247	2	1,027
DEMOLISION WORK	49	0	0	10
DREDGING AND RECLAMATION	2,912	17,448	0	2,533
-13m NEW NORTH QUAY	447	7,395	205	1,118
-14m NEW WEST QUAY	533	15,721	372	2,225
-10m NEW SOUTH QUAY	202	4,371	252	779
TRANSITIONAL PARTS WITH EXISTING WEST QUAY	294	671	44	179
YARD AND ROAD PAVEMENTS	1,206	617	6	323
YARD AND ROAD STORM DRAINAGE SYSTEMS	141	127	20	63
WATER SUPPLY AND FIREFIGHTING SYSTEMS	7	109	30	43
ELECTRICAL SYSTEM	299	187	94	177
OTHER PORT RELATED FACILITIES	44	33	0	13
Part-2 BUILDING WORKS				
WATCH-TOWER FOR HARBOUR MASTER	1,289	0	0	266
Specified Provisional Sum for Dispute Board	0	260	0	29
Subtotal of Bills (A)	7,960	55,185	1,026	8,783
Add Provisional Sum for Contingencies Allowance (at 5% of Sub Total of Bills (A)) (B)	398	2,759	51	439
VAT for Local Sub -contractor and Foreign Sub-contractor (Without Japanese Firms) (C)	891	5,568	0	801
Estimated Contract Price for Japan's Loan (A+B+C)	9,250	63,512	1,077	10,024

(Source: JICA Study Team)

Note:

*1 : Quantities and unit prices of dredging and reclamation works based on the survey by JICA Study Team were applied.

*2 : Procurement prices of steel materials such as steel pipe sheet piles, steel sheet piles, Hat-H type sheet piles, beam steels, reinforcing bars, tie rods, etc. based on the survey by JICA Study Team were applied.

*3 : Cost for pile driving works based on the survey by JICA Study Team were applied.

*4 : Value Added Tax was estimated as being borne by firms in Cote d'Ivoire or third countries.

*5 : 5% of the construction cost was estimated as contingency.

<Common Conditions for Both Estimation>

Exchange Rate : 1.00 USD = 110.85 YEN (The average rate from December, 2017 to January, 2018)
: 1 F.CFA = 0.2063 YEN
(1.00 EUR = 132.47 YEN, The average rate from December, 2017 to January, 2018)

4. Environmental and Social Impact Assessment

4.1 ESIA Application based on Decree No. 96-894

In conformity to the Decree No. 96-894 of November 08, 1996 determining the Rules and Procedures applicable to Environmental Impact Studies for Development Projects, already confirmed during the JICA Preparatory Survey stage of the subject project, all port development projects must undergo the environmental and social impact assessment (ESIA) (hereinafter called ESIA, abbreviation for Etude d'Impact Eivornnemental et Sociale) procedure; based on Annex II (Infrastructure Development Projects requiring ESIA) – b) Commercial, Fishing Ports, and Mariners, of the Decree.

The following ESIA study and procedure was basically implemented in accordance with Cote d'Ivoire's related domestic laws, codes, standards and other regulations, as well as in compatibility with requirements regulated in the JICA Environmental and Social Consideration Guideline (April 2010 version) (hereinafter called, JICA Guideline).

Firstly, as for the subject project, the ESIA application letter, along with an ESIA TOR proposal was submitted to the Agence National De Environnement (hereinafter called, ANDE) as ESIA Authority, by PAA on October 2, 2017. The ESIA application and the following ESIA studies and procedure was implemented by a local consultant, called 2D Consulting Afrique (hereinafter called, ESIA consultant). Officially registered and approved by ANDE as qualified ESIA consultant, subcontracted by the JICA Study Team, but on behalf of PAA as the project implementer.

4.2 Organization of a Public Consultation Meeting (on October 11, 2017)

Meanwhile, PAA also organized a Public Consultation Meeting, inviting related stakeholders for undertaking the ESIA procedure on October 11, to confirm on invited stakeholders opinions on any concerns to be aware of in managing the ESIA procedure, in advance. Incidentally, this had been the third time in gaining opinions from the stakeholders, following the stakeholder meetings held in the past in July 22, 2015 and January 26, 2016.

The invited stakeholders this occasion were as follows:

a) The Autonomous District of Abidjan (DAA)
b) Treichville Town Hall
c) Directorate of Sanitation, Urbanism and Drainage (DAUD)
d) Ministry of Water and Forest (DGPRE)
e) Directorate General for Maritime Affairs and Ports (DGMG)
f) Regional Directorate for Sanitation, Environment and Sustainable Development
g) Directorate of Fisheries and Aquaculture
h) Oceanographic Research Center (CRO)
i) Agency for the Management and Development of Industrial Infrastructure (AGEDI)
j) Ivorian Towing and Rescue System (IRES) (BOLUDA)
k) The Secretary General of the Port Community of Abidjan
l) The Association of Shipowners and Consignees
m) The Association of the Aconiers
n) The Freight Forwarders Association

Among the discussion, focal notice was firstly raised from IRES BOLUDA, of whom office is currently neighboring to the Harbor Masters Office, but having concerns over the required demolishment of the current boat reservoir for the tugboats, pilot boats and security boats that BOLUDA is all managing, due to construction of the new cereal berth. Although, a clear official answer was not available at the Public Consultation Meeting, a consultation meeting among PAA and BOLUDA had been scheduled to take place, for BOLUDA to confirm on the new boat reservoir area as one component of the subject cereal berth to be constructed, and in reaching to an agreement on how and what stage of the construction phase, or after operation phase, BOLUDA will be able to relocate their boats to this new boat reservoir. Basically, the construction plan should be carefully

prepared, not to disturb the function of the currently operating tugboat, pilot boat and security boat operations to the extent possible, and if at the stage of relocation of these boats during the construction phase, any such disturbance can be assumed to a certain degree at that point, a consultation meeting between the two parties, including the Contractor should take place to resolve on the matters smoothly. Mitigation measures such as these should be addressed to BOULDA at the interministrial meeting.

Also, information on authorization of sediment dumping was requested from the Centre of Ivorian Anti-Pollution (CIAPOL). This issue may well have to do with PAA's requirement of the Dredging and Dumping Permits, discussed in detail at below item 1.4.1 – (3), of which PAA require to submit an application form to CIAPOL. Both of these concerns shall be taken into account at the inter-ministerial meeting.

4.3 Project Site Visit and official ESIA TOR instructed by ANDE

Parallel to the public consultation meeting, ANDE officials paid a visit to the subject Project site on October 31, 2017, to seek relevancy of the proposed ESIA TOR by PAA.

Based on findings of the project site visit, and through validation of the initial ESIA TOR proposal by PAA, ANDE set forth the official ESIA TOR on November 20, 2017, and presented the official TOR in question to PAA for the ESIA consultant to undergo the official ESIA study based on the TOR.

4.4 Submission of the Draft ESIA Report to ANDE

In accordance with the official ESIA TOR instructed by ANDE, the ESIA consultant prepared the Draft ESIA Report, in collaboration with PAA, and PAA submitted the Draft ESIA Report to ANDE on January 3, 2018. The Draft ESIA incorporated also results of the seabed analysis conducted for the second time, after failure to detect certain low concentration level environmental data during the JICA Preparatory Survey stage; as well as the result of additional water quality study (also at this JICA detailed design study stage), supplementing certain number of parameter data that was not covered during the Preparatory Survey stage, in conformity with the JICA Guideline monitoring requirements regulated in Appendix 6 of the Guideline.

However, PAA as of February 28, 2018 present, PAA is not yet prepared to apply for the soil excavation / dredging permit to the Ministry of Mining, as well as dumping permit to the Ministry of Environment / Ministry of Merchant Navy through CIAPOL. The inter-ministerial meeting at which these related Ministries and CIAPOL will be attending, should rule the argument on PAA's requirement of gaining these permits.

4.4.1 Seabed Analysis

Please refer to the Draft ESIA Report, at Chap. 3, Part 2, Para 3.1.7, in identifying the result of the seabed analysis in more detail. Below is the result of the major issue that required to be confirmed (especially on that no significant heavy metal contamination of concern was detected).

(1) Sampling stations

Seabed (bottom sediment) samples were all collected in August 10, 2017, at below sampling stations (locations) and sampling conditions.

Table 4.4.1-1 Sampling Stations of the Seabed Quality Analysis

Sampling STNs	Longitude	Latitude	Sampling hour	Depth (m)	Substrate	Color
S-1	4° 1’29.28”W	5° 18’7.16”N	11h00	11.4	Very silty and liquid	Grey in surface, black underneath
S-2	4° 1’32,78”W	5° 18’4.56”N	11h15	14.5	Very silty and liquid	Grey in surface, black underneath
S-3	4° 1’39.70”W	5° 18’8.41”N	11h30	10.9	Silt and sand, liquid	Grey
S-4	4° 1’40.33”W	5° 18’13.36”N	11h45	10.3	Coarse sand	Grey
S-5	4° 1’43.77”W	5° 18’6.53”N	12h00	10.8	Coarse sand	Grey
S-6	4° 1’43.53”W	5° 18’15.67”N	12h15	10.5	Coarse Sand	Brown
S-7	4° 0’39.41”W	5° 14’21.51”N	09h20	24.8	Fine sand	Brown
S-8	4° 1’45.11”W	5° 14.21.50”N	10h00	24.8	Coarse sand with shells	Brown & light grey

Source: JICA Study Team

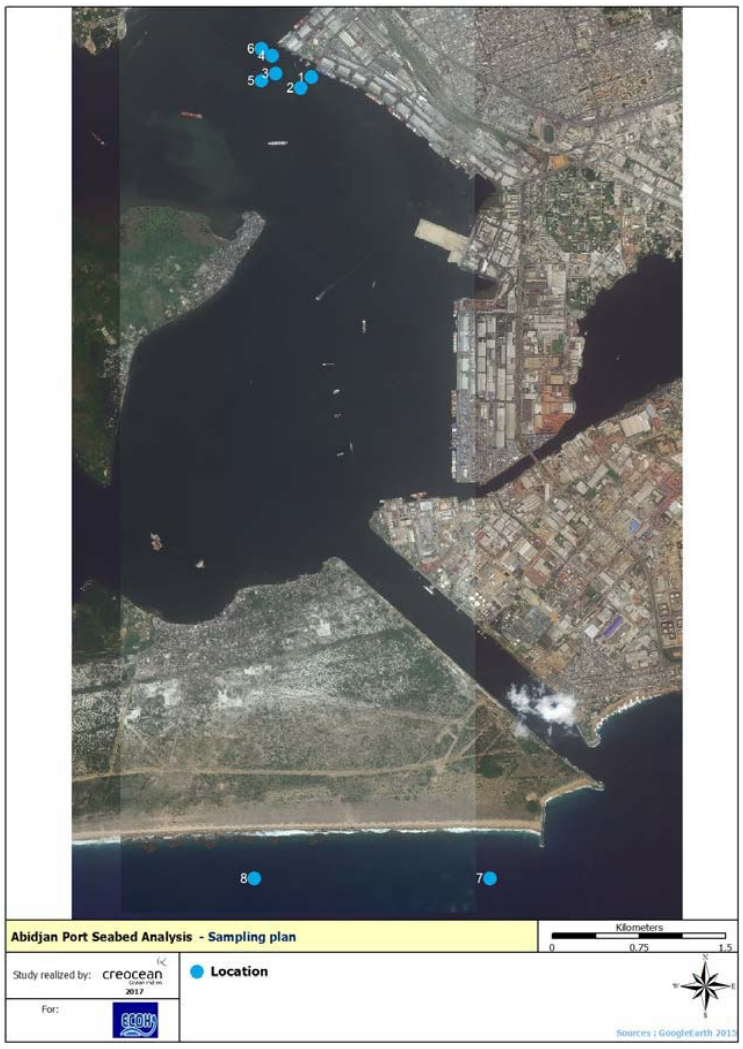


Figure 4.4.1-1 Horizontal Distribution Map of the Seabed Quality Analysis Sampling Stations

As for sampling stations S-7 and S-8, only the physical and biological analysis was conducted for reference means (omitted for description here, but details indicated in the Draft ESIA Report), apart from the other stations surrounding the project site, with full lab analysis.

(2) Heavy Metal Concentration within the Seabed appears generally moderate

The result of the seabed analysis, at this JICA Detailed Design Study stage, shows that as for heavy metal content within the collected seabed samples, that can be considered as environmentally harmful pollutants, appears generally moderate. The values have been compared to (a) the reference levels of the French legislation considered in the context of Port facilities (since there are no bottom sediment quality standard in Cote d'Ivoire, French legislation standard is applied), and (b) the geochemical background (BDF) used as a reference in many Abidjan bay studies. Results show that:

- All metals show low contamination, under N1 threshold of the French legislation,
- Arsenic concentration is above the geochemical background for almost all samples, which indicates an anthropogenic effect,
- Concentration decreases as the distance from the action berth increases, tendency relative to impact from port activities (normally from peeling of ship bottom paint)
- It clearly appears that highest concentrations are found on samples with highest fine fraction (S1 & S2), which gives a high ability to retain pollutants. These samples show dramatically different concentrations, close to N1 threshold for Copper and Nickel.
- Metal concentration is the most contaminated sample (S1) are two to five times higher than concentrations in the least contaminated samples (S6).

These values are globally higher for all parameters than those measured in 2017 in the middle of the channel. This shows low metal contamination close to the berth due to port activity, and in accordance with the French legislation as reference standard. Also, these concentrations should not threaten aquatic life.

Table 4.4.1-2 Heavy Metal Concentrations in the 6 Port Area Samples

	Arsenic	Copper	Nickel	Lead	Zinc	Mercury	Cadmium	Chromium
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
N1	25	45	37	100	276	0.4	1.2	90
N2	50	90	74	200	552	0.8	2.4	180
BDF	4.4	35	20	47	115	0.2	0.5	45
1	11.7	33.9	24.7	24.1	171	0.26	0.43	55.8
2	12.8	27.9	18.6	17.2	97.9	0.17	0.2	56.6
3	8.21	14.8	8.87	9.12	57.7	0.1	＜0.10	28.7
4	3.89	8.26	5.15	6.3	38.8	0.06	＜0.10	16.4
5	6.8	12.4	8.46	8.99	53.9	0.09	＜0.10	25.7
6	4.48	8	4.89	6.78	57.2	0.07	0.15	15.7
Avg.	8 ± 3.7	17.5 ± 10.8	11.8 ± 8.1	12.1 ± 7.1	79.4 ± 49	0.1 ± 0.1	＜0.2	33.2 ± 18.6
Middle Channel (March 2017)	＜2	4.3	4	5	28	＜1	＜0.3	8.1

Note 1. N1 and N2 represent the sediment contamination threshold for European Ports (French Interdepartemental order of June 14th relating to dredging). N1: Moderately polluted. N2: Highly polluted.

Note 2. BDF represents the geochemical background (1993 Geode Report), used as reference in many past Abidjan Bay studies.

Source: JICA Study Team

(3) Seabed Analysis result, etc., as basis of non-violation to the London Convention

The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (hereinafter called as, the London Convention) 1972, which came into force on August 30, 1975 ratified by 15 nations (Cote d'Ivoire, later ratifies in July 28, 1987).

The London Convention, in principle, prohibits dumping of waste into the ocean, except for

those items presented in Annex 1 (including the first item indicated as “dredged material”), that can be a subject of “consideration” for dumping. As an obligation, the Convention, also imposes the ratifying countries to set forth an administrative and mandatory step to apply an assessment procedure, in order to seek the relevancy of waste that can be considered for dumping, in reference to the so-called “Waste Assessment Framework (hereinafter called, WAF)” (and “Waste Assessment Guidelines” for its implementation) set up under the Convention. And only based on this assessment, the competent authorities of each ratifying country may issue the Certificate to approve the dumping.

In the case of Cote d’Ivoire, the Decree No. 97-678 of December 3, 1997 on the protection of the marine and lake environment against pollution, is the respective regulation that certifies the environmentally friendly condition which the London Convention imposes on to its ratifying countries.

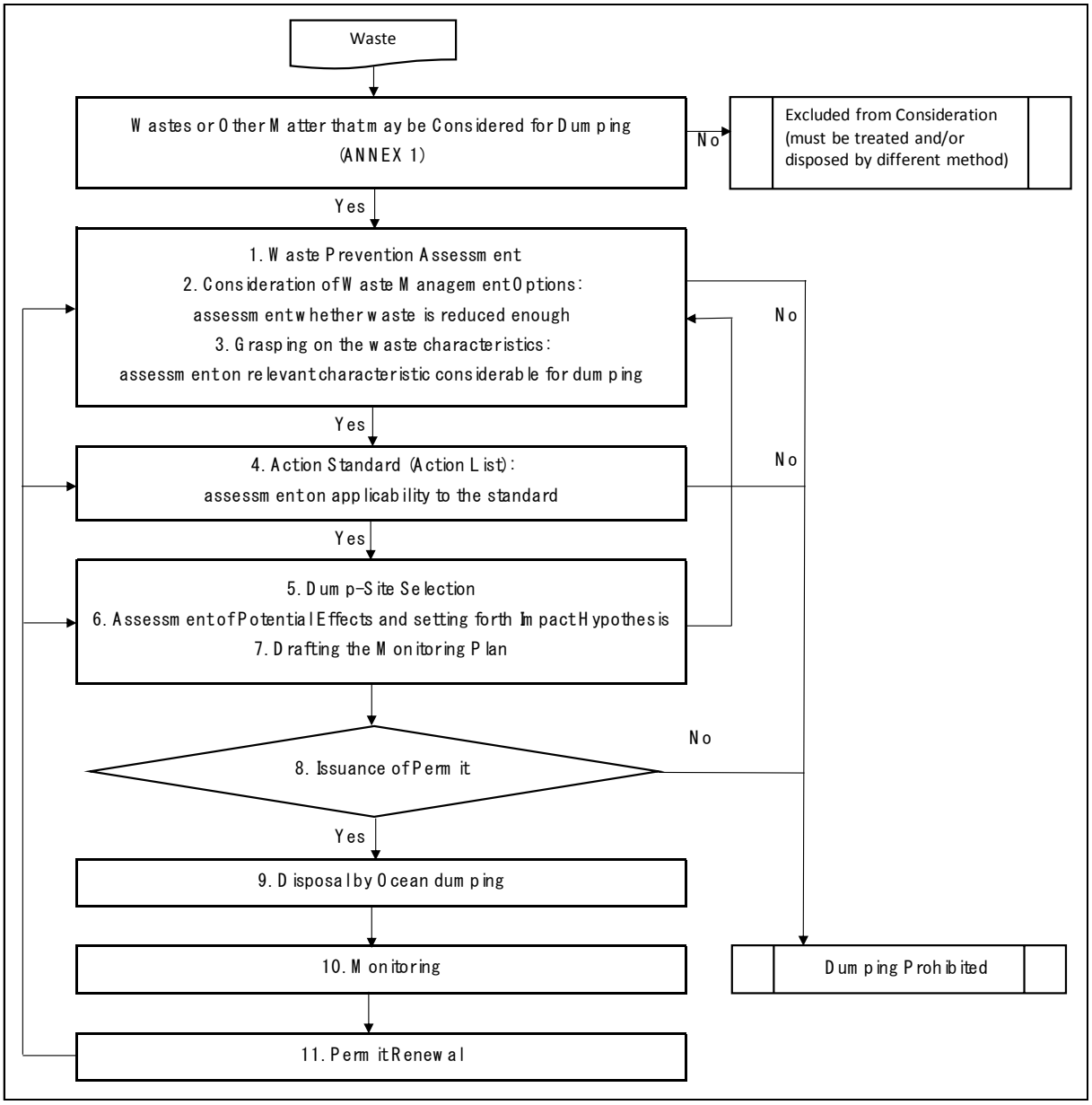


Figure 4.4.1-2 Permit Issuance Procedural Chart, based on Waste Assessment Guideline of London Convention (Annex2), as reference guideline for ratified countries

It is therefore, important and essential to incorporate these London Convention requirements into the waste management plan to be applied to the subject project, including consideration on reduction of the to-be-dredged materials.

(a) As for above Figure item 3, 4 and 6 on grasping of the waste (dredged material) characteristics, setting up the action list (= inventory of the waste characteristics), and assessment of the potential effects and setting forth the Impact Hypothesis, our subject project's result of the seabed analysis on the physical, chemical and biological characteristic of the seabed quality of the dredging area, can be recognized as equivalent in addressing to these requirements. As for the impact hypothesis, can also be noted as can be possibly mitigated, upon implementation of waste reduction plan, as per explained in item (b) below.

(b) As for item 1, 2 and 7 of the above Figure, on waste (dredged material) prevention assessment and consideration of waste management options, the Contractor of our subject project, must firstly consider on reducing the amount of the dredged material to be disposed by dumping into the ocean, by utilizing as much of the dredged material to be re-used for other means (ex. construction material). The management of the dredged material, should then be implemented by monitoring on this waste reduction plan and dumping at the designated site by PAA.

(c) As for item 5 and 9 of the above Figure, on dump-site selection and actual disposal by oceanic dumping, PAA shall explain on the process and reason of selecting the current designated dumping area, including comparison with the other dumping area options considered.

(d) As for item 8 on the permit, PAA requires to achieve the related and respective permit as per below:

Dredging/ Soil Excavation Permit: The subject project shall involve some vast amount of dredging (approximately, 1.4 Mil. m^3) and soil extraction works (of sediments; approximately, 2.4 Mil. m^3) for reclamation. PAA requires to achieve the Dredging/ Soil Excavation Permit from the Ministry of Mining, based on Order No. 002/MIN/CAB of 11 January, 2016.

Dumping Permit: The subject project shall involve dumping of dredged sediments (Approximately 1.4 Mil m^3) at the off-coastal area of the Vridi Canal designated by PAA. As stipulated in Article 16 of Decree No. 97-678 of 3 December 1997 on the Protection of the Marine and Lake Environment against Pollution, based on Decree No. 98-43 of 28 January 1998 related to classified activities for protection of the environment, Title 1: Articles 1 to 6, PAA requires to achieve the Dumping Permit from the Ministry of Environment. To apply for this permit, PAA must submit an application form to CIAPOL (Centre of Ivorian Anti-Pollution).

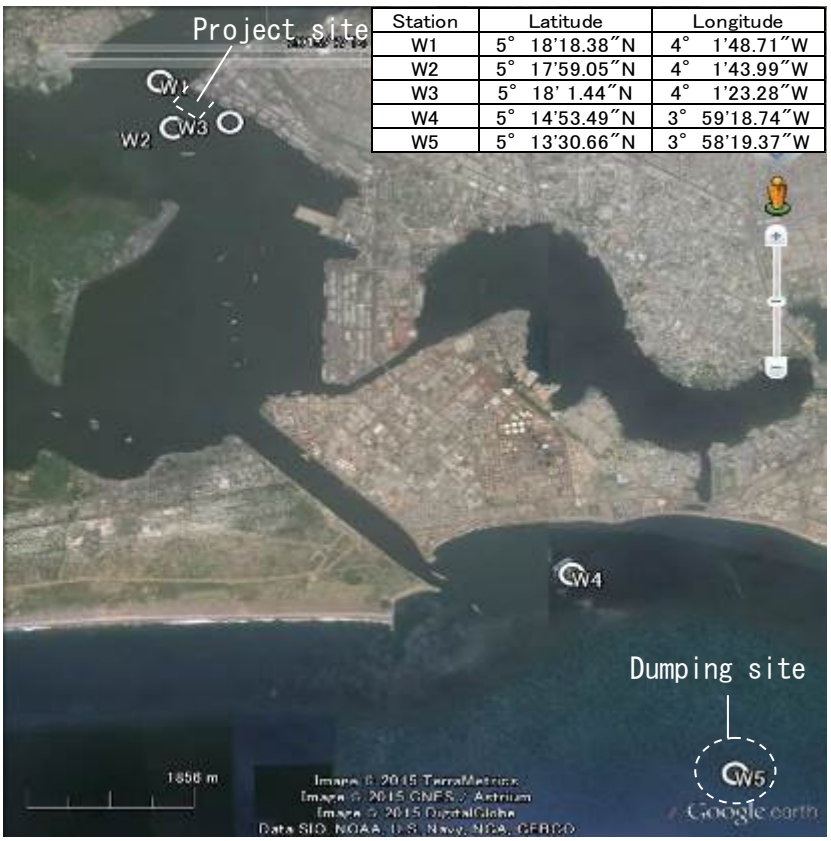
As for the ESIA Certificate from the Minister of Environment, it is strongly recommended for the donor to ask the related stakeholders, that PAA's acquisition of the above two permits before commencement of constructions should be recognized by ANDE, to be set forth as mandatory binding supplementary condition upon issuance of the ESIA Certificate to PAA.

4.4.2 Additional Water Quality Analysis

For more details, Chap. 3, Part 2, Para 3.1.5 of Draft ESIA Report should be referred.

(1) Sampling Stations:

As per Figure 4.4.2-1 below, Sampling Stations W1 to W3 were located surrounding the project site area, while W4 and W5 were located at off-coastal area of the Vridi Canal, near the dredged material dumping area designated by PAA.



Station	Latitude	Longitude
W1	5° 18'18.38"N	4° 1'48.71"W
W2	5° 17'59.05"N	4° 1'43.99"W
W3	5° 18' 1.44"N	4° 1'23.28"W
W4	5° 14'53.49"N	3° 59'18.74"W
W5	5° 13'30.66"N	3° 58'19.37"W

Figure 4.4.2-1 Horizontal Distribution Map of Water Quality Sampling Stations with Coordinates

(2) Environmental Data on results of the Additional Water Quality Survey

As per Table 4.4.2-1 below, samples were taken and analyzed for both low tide and high tide period for each sampling stations. As shown below, in comparison with the French Decree of Jan. 11, 2007 (NOR: SANP0720201A) regulated Surface Water Quality Standard, none of the results proved evidence of water contamination above the level of the Standard in question, excluding Nickel without applied standard regulated for comparative analysis.

Table 4.4.2-1 Results on Laboratory Analysis on Surface Water Quality

LOW TIDE									
Parameters	Units	Sample Dates (2017)	Methods	References : Samples/ Results					French Decree of Jan. 11, 2007
				STATION W1	STATION W2	STATION W3	STATION W4	STATION W5	
Cyanide	mg/L	11/03	HACH	< 0,002	0,005	< 0,002	0,045	< 0,002	0,05
Phenol	mg/L	11/03		< 0,002	< 0,002	< 0,002	< 0,002	< 0,002	0,005
Cadmium	mgCd/L	11/02	AAS ContrAA 700	< 0,0012	< 0,0012	< 0,0012	< 0,0012	< 0,0012	0,005
Chrome	mgCr/L	11/02		< 0,005	< 0,005	< 0,005	< 0,005	< 0,005	0,05
Copper	mgCu/L	11/02		< 0,003	< 0,003	< 0,003	< 0,003	< 0,003	0,05
Lead	mgPb/L	11/02		< 0,013	< 0,013	< 0,013	< 0,013	< 0,013	0,05
Nickel	mgNi/L	11/02		< 0,004	< 0,004	< 0,004	< 0,004	< 0,004	-
Arsenic	mgAs/L	11/02		< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	0,05
Mercury	mgHg/L	11/02		$1,15.10^{-5}$	$2,10.10^{-5}$	$1,17.10^{-5}$	$1,02.10^{-5}$	$1,03.10^{-5}$	0,001

HIGH TIDE									
Parameters	Units	Sample Date (2017)	Methods	REFERENCES : SAMPLES/RESULTS					French Decree of Jan. 11, 2007
				STN W1	STN W2	STN W3	STN W4	STN W5	
Cyanide	mg/L	11/03	HACH	0,004	< 0,002	0,036	< 0,002	< 0,002	0,05
Phenol	mg/L	11/03		< 0,002	< 0,002	< 0,002	< 0,002	< 0,002	0,005
Cadmium	mgCd/L	11/02	AAS ContrAA 700	< 0,0012	< 0,0012	< 0,0012	< 0,0012	< 0,0012	0,005
Chrome	mgCr/L	11/02		< 0,005	< 0,005	< 0,005	< 0,005	< 0,005	0,05
Copper	mgCu/L	11/02		< 0,003	< 0,003	< 0,003	< 0,003	< 0,003	0,05
Lead	mgPb/L	11/02		< 0,013	< 0,013	< 0,013	< 0,013	< 0,013	0,05
Nickel	mgNi/L	11/02		< 0,004	< 0,004	< 0,004	< 0,004	< 0,004	-
Arsenic	mgAs/L	11/02		< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	0,05
Mercury	mgHg/L	11/02		$2{,}58.10^{-5}$	$1{,}13.10^{-5}$	$2{,}25.10^{-5}$	$2{,}11.10^{-5}$	$1{,}47.10^{-5}$	0,001

Source: JICA Study Team

4.5 Public Hearing and Inter-Ministerial Meeting

After PAA's submission of the Draft ESIA Report to ANDE on January 3, 2018, the Minister of Environment approved the Draft, and issued a Ministerial Order to nominate a Chief Investigator from the Prefecture of Abidjan for implementation of the public inquiry. The subject public inquiry was announced to the public through local newspapers and local radio. After the commencement date of the public inquiry was fixed by the Chief Investigator, an opening public inquiry event took place (implemented by the Chief Investigator, but on behalf of ANDE) on its first day in February 22, 2018. The main stakeholders to be invited for this first day opening public hearing, were selected by ANDE based on past stakeholder meeting records, incorporated in the Draft ESIA Report.

At the public inquiry event on Feb. 22, 27 participants attended the event (full list of attendants, omitted), including focal opinions raised, such as the following:

a) On that, vector control measure should be considered and incorporated in the ESIA Report (Ministry of Health and Public Hygine).
b) Inquiry on whether this Cereal Berth Construction Project was a part of State reforms or not (DREL: Regional Environmental Directorate).
c) Inquiry on whether PAA achieved the necessary permits to carry out the type of dredging and dumping works (Ministry of Health and Public Hygine).
d) Anticipation on assumed additional congestion surrounding the port area, during construction and operation phase (Town Hall of Treichville).
e) Confirmation on whether water flow studies as well as geotechnical studies were carried out or not (Water and Forest Ministry).
f) Confirmation on level of sediment pollution (Regional Environmental Branch).

In response, a) the ESIA consultant in charge (2D Consulting Afrique) agreed to incorporate vector control measure within the ESIA Final Report, but separately reported with PAA on that e) the Report had already incorporated the results of water flow, geotechnical studies, f) and seabed analysis. The Deputy Director of Engineering and Project Management Department (DIMO) of PAA also responded, by b) explanation of various other PAA harbor projects, among other the subject project to increase export and import capacity of cereals, and d) clarification on that both Harbor Master Department and IT Department in charge, have had dealt on measures to reduce the assumed traffic congestion issue.

Separately, PAA stated that c) since borrowing and dredging works are to be done on internal areas of the port, PAA has the autonomy to carry out the operations, but would of course comply with the requirements of national authorities. As for this comment by PAA, it is important to note in this JICA Report, on that, since JICA Study Team, had not yet been able to confirm on PAA's concrete steps to acquire the official dredging and dumping permits, at February 28, 2018 present, based on mandatory requirements mentioned above in item 4.4.1 (Seabed Analysis) (3) - (d), for PAA to affirmatively comply with these respective domestic regulations to gain the required permits as per commented by the participated stakeholder of the public inquiry.

For the following consecutive 9 working days, the Chief Investigator prepared a desk in his office where he will be able to achieve opinions on the subject project from the public in general at any time of the day.

After a minutes on the public inquiry results is summarized by the Chief Investigator, it will be validated by both ANDE's Validation Committee as well as by the ESIA consultant in charge, and comments shall be given from both sides, to have them raised to the interministerial meeting.

Only after then, the final one day Inter-Ministerial Meeting can be organized by ANDE. In this meeting the related Ministries and governmental agencies shall participate, as well as other major stakeholders will be invited to join. Yet again, the Draft ESIA Report shall be the subject of validation in this meeting, and also in reference to the result of the public inquiry and comments by both ANDE and the ESIA consultant in charge. At the end of the meeting, the major stakeholders apart from the related Ministries and governmental agencies will be asked to temporary leave the meeting room for the Ministries and agencies to make its final decision. After they reach to a decision, the major stakeholders shall be called back to the meeting room to be orally reported on the final decision of the meeting.

Only after the inter-ministerial meeting, the Draft ESIA Report will be revised into the Final ESIA Report by the ESIA consultant in charge on behalf of the project implementer, reflecting the opinions raised by the stakeholders who attended the meeting; and shall be submitted to ANDE.

4.6 ESIA approval by the Minister in charge of Environment

The Final ESIA Report, along with the minutes of the Inter-Ministerial Meeting and the Draft Ministerial Order shall be submitted from ANDE to the Minister of Environment, and the Minister shall make the final decision to sign on to the Order to issue the ESIA Certificate to PAA. A supplementary condition may be added upon issuance of the Certificate,if such conditions are found as obligatory at the Inter-Ministerial Meeting.

It should be additionally quoted, however, that as far as confirmation by the JICA Study Team, directly to ANDE, PAA's acquisition of both the soil excavation/ dredging permit and oceanic dumping permit are recognized as prerequisites for the Minister of Environment to make the ESIA approval. Therefore, it can be concluded that there is great risk that the ESIA Certificate may well not be achieved unless PAA acquires the permits in question; though situation may differ in case ANDE's Validation Committee approves on the Draft ESIA Report, with only confirmation on the actual applications of the permits by PAA.

4.7 Tentative ESIA Schedule- projection of ESIA approval

As of February 28, 2018, the ESIA procedure is still left with (1) the public inquiry (along with consecutive Public Inquiry period till March 7, 2018) and (2) inter-ministerial meeting events to be organized both by ANDE, in gaining final opinions from all the stakeholders including the related Ministries and governmental agencies, before Final ESIA Report to be approved with issuance of the ESIA Certificate by the Minister in charge of Environment.

Based on confirmation of the remaining ESIA procedure above, the provisional ESIA Schedule can be indicated as per below Figure 4.7-1. Note that from submission of the Draft ESIA Report, by prior confirmation to ANDE, the standard duration till gaining of the ESIA approval is considered around 2 months. But set up date for the remaining inter-ministerial meeting is merely assumption by JICA Study Team, since ANDE is the organizer for the event and thus it is all up to ANDE to decide when it should be taken place. There are also no mandatory duration regulated for

preparation of these events, except that after the inter-ministerial meeting, the Minister of Environment must make the decision to give the Ministerial Order to issue the ESIA Certificate within 15 days.

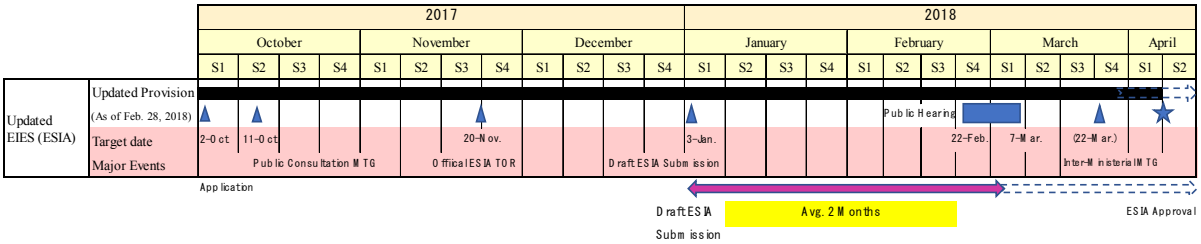


Figure 4.7-1 ESIA Provisional Schedule (as of February 28, 2018)

We must also note, equally to the previous item 1.6, that acquisition of the ESIA Certificate may well be prolonged according to procedural delays at ANDE side, and especially, if PAA's acquisition of the soil excavation/ dredging permit and dumping permit is delayed, and if they were validated at the inter-ministerial meeting as prerequisite condition of achieving the ESIA Certificate.

4.8 Environmental and Social Management and Monitoring TOR for the Contractor as part of the Bidding Document

In consistency with the Environmental and Social Management Plan (ESMP), including the Environmental and Social Monitoring Plan (ESMoP) of the approved Final ESIA Report, we have attached the Environmental and Social Management and Monitoring TOR as part of the Bidding Documents for the Contractor.

5. Cargo Handling Plan

Cereal cargo handling capacity at the existing cereal berth at Abidjan Port is about 1000 tons / ship / day which is an unsatisfactory level.

In addition, loading efficiency of trucks which transport rice bags discharged from bulk carriers to the port in warehouses and for transporting to ports outside / to neighboring countries differs significantly by company.

To improve this situation, the cargo handling plan for the newly constructed cereal berth is proposed hereinafter.

The Purpose of the "Cargo Handling Plan" is as follows.

1) Main purpose is to propose ideas and plans to improve cargo handling work in order to load 3,600 tons/vessel/day of rice (in bags) in the New Cereal Berth.
2) The handling works at berth and transportation from the berth to the warehouse and within the warehouse have to be improved in the New Cereal Berth.
3) The present handling works at berth, transportation from the berth to the warehouse and in warehouse are shown in the Cargo handling Plan. It is important to grasp the actual state of rice handling works.

5.1 Current status of cargo handling

5.1.1 Review of existing materials

The cargo handling volumes included in the existing FS report and latest report of PAA and cargo handling volume at the new Cereal berth will be reviewed.

(1) Prediction of future ship shape

The size of the Handy-max type bulk carriers has been increasing since 1999 (see table 5.1.1-1). A typical size of a Handy-max type bulk ship is said to range from 52,000 to 58,000 DWT. These types are usually equipped with ship gears (derricks).

1) Increasing size of Handy-max type bulk carriers

Table 5.1.1-1 Enlargement of Handy-max type bulk carriers

Built Year	DWT	LOA (m)	B (m)	Summer Draft (m)	Gears
1999	48,900	190	32.20	11.6	4 ship gears (25t)
2001	50,000	190	32.26	11.9	4 ship gears (30t)
2003	52,000	190	32.20	12.3	4 ship gears (30t)
2003	58,500	186	32.26	12.8	4 ship gears
2005	58,500	190	32.26	12.6	4 ship gears

Source: Preparatory Survey Report

(2) Annual handling volume of cargo handled at each quay

The estimated cargo handling volume at Abidjan Port in 2014 is shown in Table 5.1.1-2.

Table 5.1.1-2 Estimation of handling volume

(tons)

Quay	Target freight rate a (%)	Quantity of berth (n)	Quantity of conversion berth n x a	Semi-annual gross cargo c	Semi-annual target cargo handling volume c x a	Share of handling volume S (%)	Annual handling volume
North	48.2	5	2.5	683,311	329,356	38.4	755,527
West	70.3	7	5.0	603,487	424,251	49.5	973,921
South	63.1	4	2.5	163,446	103,134	12.1	238,069
Total		16	10		856,741	100.0	1,967,517

Source: Preparatory Survey Report

In the future, PAA will convert the existing quay into a dedicated berth for cargo handling as much as possible, and will proactively promote concessions to private companies.

For this reason, target cargo (rice bag, sugar, salt) shall be handled at the new cereal berth until the target year of 2030.

1) Forecast future handling volume of target cargo at Abidjan Port

Table 5.1.1-3 shows the estimation of future handling volume of targeted cargo handled at Abidjan Port.

Table 5.1.1-3 Future estimation of handling volume of target cargo handled at Abidjan Port

(tons)

	Quantity of present conversion berth (n)	Quantity of future cereal handling berth	Annual cereal handling volume (ton)
North	2.5	0	0
West	5		
South	2.5	0	0
New Cereal berth	0	3	2,308,012
Total	10	3	2,308,012

Source: Preparatory Survey Report

As shown in Table 5.1.1-2 and 5.1.1-3, annual cereal handling volume in 2014 is 1,967,517 tons, while 2,308,012 tons is forecast to be handled in 2030. Following the construction of the new cereal berth to 2030, the whole amount of the target cargo will be handled at the new cereal berth.

Table 5.1.1-4 shows the transition of handling volume of foreign trade at Abidjan Port during 2007-2016.

The imported cargo volume is increasing every year except for 2011, but the total export cargo volume has been decreasing in line with the decrease in the volume of petroleum products.

The ratio between imported cargo volume and export cargo volume in 2014 is 67% and 33%.

Table 5.1.1-4 Handling volume of foreign trade at Abidjan Port (2007 - 2016)

unit:ton

	2007	2008	2009	2010	2011	2012	2013	2014
IMPORT	10,836,426	11,170,460	11,895,949	12,800,826	9,628,024	13,612,599	13,984,421	14,006,166
- Petroleum products	3,538,777	3,753,012	4,295,085	5,075,007	3,126,309	4,590,853	4,575,038	4,195,765
- General cargo	6,919,045	6,933,942	7,088,733	7,220,966	6,034,761	8,528,813	8,894,973	9,253,255
- Fisheries	378,603	483,506	512,131	504,853	466,954	492,932	514,410	557,146
EXPORT	9,118,783	9,656,466	10,831,286	9,683,089	7,014,518	8,101,211	7,492,143	6,806,787
- Petroleum products	4,837,237	4,832,178	6,599,897	5,641,275	3,546,153	3,938,596	3,165,299	2,790,681
- General cargo	4,204,263	4,713,854	4,116,495	3,901,997	3,351,790	4,051,588	4,202,332	3,908,805
- Fisheries	77,283	110,434	114,894	139,818	116,575	111,027	124,512	107,301
TOTAL	19,955,209	20,826,926	22,727,236	22,483,915	16,642,542	21,713,810	21,476,564	20,812,953
- Petroleum products	8,376,014	8,585,190	10,894,982	10,716,282	6,672,462	8,529,449	7,740,337	6,986,446
- General cargo	11,123,308	11,647,797	11,205,229	11,122,962	9,386,551	12,580,401	13,097,305	13,162,060
- Fisheries	455,887	593,939	627,025	644,671	583,529	603,959	638,922	664,447

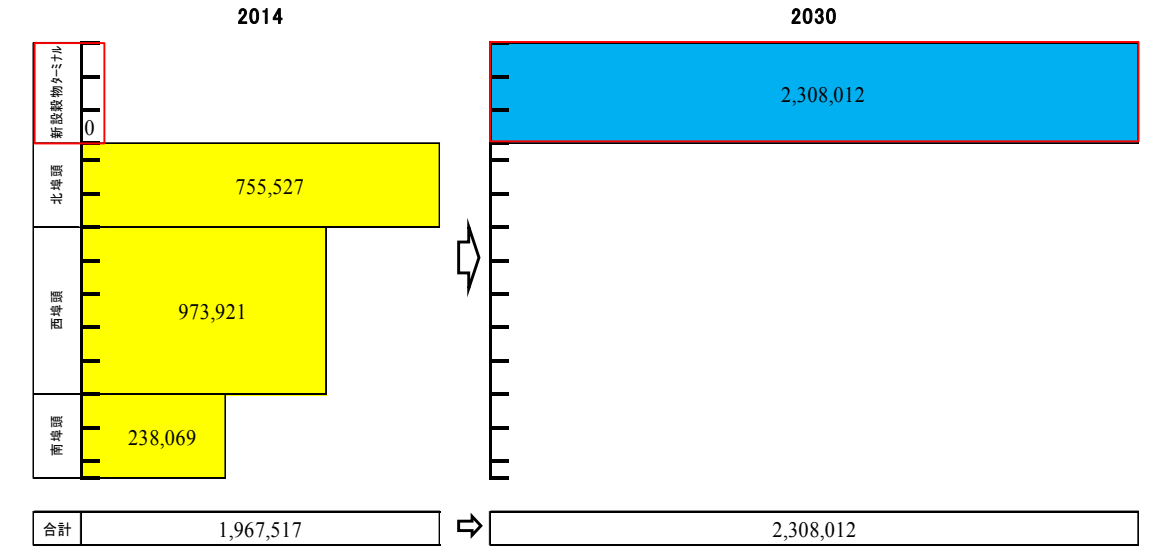
Source: PAA, 2015

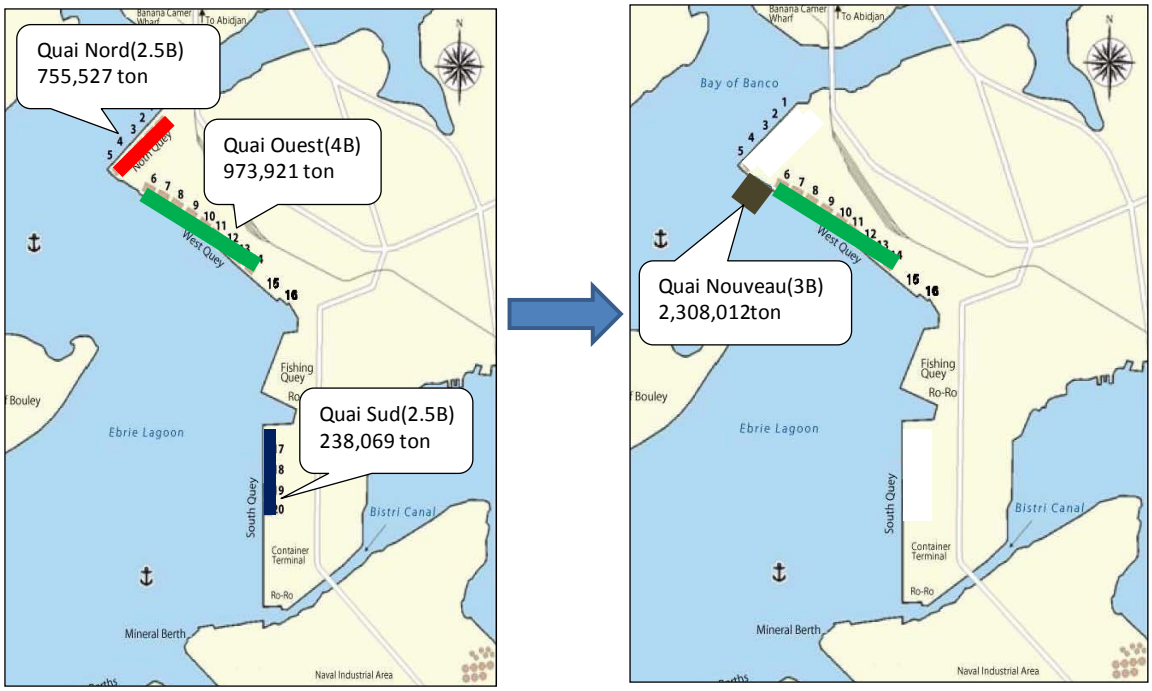
	2015	2016
IMPORT	15,259,881	14,951,906
-Petroleum products	4,671,111	3,992,954
-General cargo	9,978,754	10,290,935
-Fisheries	610,016	668,017
EXPORT	6,666,360	6,782,734
-Petroleum products	2911,498	3,187,192
-General cargo	3,624,190	3,430,665
-Fisheries	130,672	164,876
TOTAL	21,926,241	21,734,640
-Petroleum products	7,582,609	7,180,147
-General cargo	13,602,944	13,721,601
-Fisheries	740,688	832,893

Source: PAA, 2017

Figure 5.1.1-1 shows the present status of each quay and the future handling volume of target cargo.

Cargo handling volume for each quay (assumed value)





Source: FS Report

Figure 5.1.1-1 Present status of each quay and Future handling volume of target cargo

5.1.2 Examination of the handling capacity of the existing grain berth

The handling capacity of the latest cereal cargo of the existing cereal berth is evaluated.

(1) Handling method and quay handling capacity of rice bags (1)

Figure 5.1.2-1 shows handling method of rice bags at the existing berths.

The actual cargo handling data obtained from a cargo handling company in August 2017 is summarized in Table 5.1.2-1.

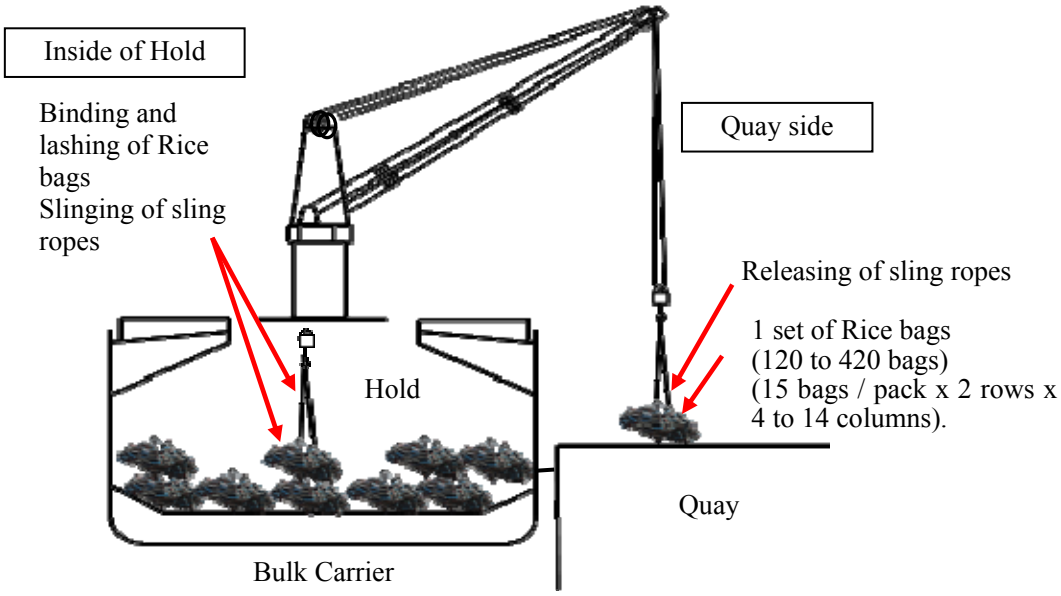


Figure 5.1.2-1 Handling method of Rice bags

Table 5.1.2-1 Handling method of Rice bags, quay handling capability 1 (in the case of GMCI)

Date	2017/08/08 AM 10:00 - 11:30 (Tue)
Vessel name	ARYBBAS (Import of Vietnamese rice from Vietnam)
Handling cargo	Rice (bags)
Handling style	22.5kg and 50Kg rice bags
Unloading rice weight	66,480tons (2,119,277bags)
Berthing days	21days (July 15 - Aug 9, 2017)
Average unloading capacity per day	66,480/21= 3,166 ton/day (Including days that handling works cannot be conducted due to rain etc.)

Source: GMCI

<Remarks>:

The average daily handling capability mentioned above corresponds to the average daily handling capacity of GMC.I at the time of the previous preparatory survey.

In the previous survey, the actual handling capacity was 4,320 tons/day by 4 derricks of VOSCO SKY, or 3,240 tons by 3 derricks (4,320 x 3/4 = 3, 240 ton/day).

This ability corresponds to 3,166 ton/day which is average handling capacity calculated from the results of ARYBBAS this time.

In order to confirm the handling capacity of grain cargo, the JICA Study Team measured the cargo handling capacity during unloading work of the bulk carrier ARYBASS. The handling capacity was measured by paying attention to the first and second derricks of the bow side of the four derricks in charge of unloading the bulk carrier. The results are shown below.

<Measurement of handling capacity by No.1 Derrick> Unloading work of 22.5kg rice bags

	unit	1st time	2nd time	3rd time	4th time	Average
No. of Unloading Cycle Time	(min)	11.03	5.8	6.32	4.62	6.94
Volume(No.) of Bags of 1 Cycle	(bag)	480	420	300	240	360
Average Weight of 1 bag	(kg)	22.5	22.5	22.5	22.5	22.5
Weight of 1 Lift	(ton)	10.8	9.45	6.75	5.4	8.1

<Measurement of handling capacity by No.2 Derrick> Unloading work of 50kg rice bags

	unit	1st time	2nd time	3rd time		Average
No. of Unloading Cycle Time (min)	(min)	7.07	7.62	5.78		6.82
Volume(No.) of Bags of 1 Cycle (bag)	(bag)	330	360	300		330
Average Weight of 1 bag (ton)	(kg)	50	50	50		50
Weight of 1 Lift (Kg)	(ton)	16.5	18	15		16.5

<Measurement of handling capacity by No.1 and 2 Derricks> (Summary)

		22.5kg rice bag handling by No. 1 Derrick	50kg rice bag handling by No. 2 Derrick
Unloading cycle time (average)	min	6.94	6.82
Number of times of unloading per hour	cycle	8.64	8.80
Working hours in daytime	hour	9	9
Daytime cargo handling cycles per day	cycle	62.4	79.2
Unloading amount of 1 lift	ton	8.10	16.5
Unloading amount by 1 Derrick in daytime of day	ton	505	1,306
Unloading amount by 1 Derrick per day (day and night)	ton	1,010	2,612
Unloading amount per day (day and night) when 2 units of Derrick are used	ton	2,020	5,224

As shown in the table above, the theoretical daily handling capacity of 22.5 kg and 50 kg rice bags which are stowed in different holds in the bulk carrier is 3,620 Tons ((2,020 + 5,224) / 2). (The average handling capacity in the daytime by two derricks is 1,810 Tons ((1,010 + 2,612) / 2) In this survey, it turned out that not only 50 Kg bag but 22.5 Kg and 30 Kg are used in handling of rice bags.

Table 5.1.2-2 shows the average cargo handling capacity of Rice bags during the day and at night

Table 5.1.2-2 Average handling capacity of daytime and nighttime of Rice bags

(in case of the bulk carrier ARYBAS)

Unloading capacity (Handling capacity)	unit	Value heard from GMCI	Value calculated from actual data (In case of not considering rainy day)
Unloading amount in daytime	(ton/daytime)	1,488	1,810
Unloading amount at night	(ton/nighttime)	1,700	1,810
Unloading amount per of day	(ton/day)	3,188	3,620

Source: GMCI (August 2017)

Judging from the theoretical handling capacity calculated from the cargo handling data measured at the site, 3,188ton/day of handling capacity of the bulk carrier "ARYBAS" by GM can be said to be the average cargo handling capacity.

(2) Handling method and quay handling capacity of rice bags (2)

In November 2017, the JICA Study Team measured the cargo handling data at the site and obtained handling data of rice bags loaded/unloaded from a bulk carrier from the director of GMCI. The results are summarized in Table 5.1.2-3. The data in the table below shows cargo handling capacity of the bulk carrier BOMAR AMBER.

Table 5.1.2-3 Handling method of Rice bags, quay handling capability 2 (in the case of GMCI)

Date	2nd&3rd Nov,2017 AM 10:00 - 11:30 (Tue)
Vessel Name	BOMAR AMBER
Handling Cargo	Chinese rice (import)
Handling Style	Vessel derrick lifting
Style of packing	Rice bags 50Kg
Unloading rice weight	47,366.250tons (Approx. 947,325Bags) Total number of unloading weight and number of bags (ton/bag)
Berthing days	22days (13th Oct, 2017 – 3rd Nov, 2017)
Average unloading capacity per day	47,366.250tons/14days=3,383ton/day 28,445.000tons (Approx. 568,900Bags) for Abidjan port 9,025.200tons (Approx. 230,005Bags) for Burkina Faso Average unloading amount per day = 47,366.250tons/14days= 3,383 ton/day ※Berthing days: 22days (including 8days of stop of operation owing rain) <Remarks>: Calculating by using of berthing days of 22 days, average unloading capacity per day = 47,366.250tons/22days= 2,153ton/day
Number of working days	14days (Non-operation: 9days)

Source: GMCI

From the table above, the average daily handling capacity of 50 kg rice bag from bulk carrier by two derricks is 3,383 ton/day. Almost the same handling capacity was observed during the previous survey in another bulk carrier.

- Previous handling capacity: 3,166 ton/day (for 21 days) - In case of the bulk carrier "ARYBBAS"
- Handling capacity in the present survey: 3,383 ton/day (for 14 days) - in case of the bulk carrier "BOMAR AMBER"

Handling work in the hold of bulk ship (binding work of rice bags, securing work, lashing work)

Working time and number of workers in charge of bundling of 50 kg Rice bags into 5 rows and 3 tiers and bundling of 25.5 kg Rice bag into 6 rows and 5 tiers are shown in Table 5.1.2-4

Figure 5.1.2-2 shows the bundling and securing works of Rice bags.

Table 5.1.2-4 Working time and number of workers of bundling work of Rice bags

Work	Number of workers of 1 bundle of rice bags	Number of Rice bag of 1 bundle	Weight of 1 bundle	Working time of 1 bundle	Remarks
Bundling of 50 kg Rice bags into 5 rows and 3 tiers	2 persons	15bags	750kg	1 - 2 min	Each rice bag is loaded by 2 persons.
Bundling of 25.5 kg Rice bag into 6 rows and 5 tiers	2 persons	30bags	765kg	45sec - 1.5 min	2 persons will stack 22.5 kg bags from both sides. (Sometimes workers can take a rest in turns.)

Source: JICA Study Team

Source: JICA Study Team

Figure 5.1.2-2 Bundling and securing works of Rice bags in the hold

(3) Quay handling capacity of Rice bags (Summary)

Based on an interview with the director of GMCI, the JICA Study Team summarized the daily average cargo handling capacity of GMCI in Table 5.1.2-5.

Judging from the handling capacity calculated from the handling data measured at the site so far, the handling capacity (actual value) of the bulk carrier "BOMAR AMBER" by GMCI can be said to be the average cargo handling capacity.

Table 5.1.2-5 Quay handling capacity of Rice bags (in case of GMCI)

Unloading capacity (Handling capacity)	unit	Value heard from GMCI	Value calculated from actual data
Unloading amount in daytime	(ton/daytime)	1,488	1,532
Unloading amount at night	(ton/nighttime)	1,700	1,851
Unloading amount per of day	(ton/day)	3,188	3,383

Source: JICA study team (December 2017)

<Supplementary explanation>

The daily cargo handling capacity of the above GMCI is lower than the theoretical handling

capability calculated from the data measured by the study team so far, but it can be assumed that it is the average value in the current shipboard capacity in consideration of the discontinuation of cargo handling due to rain.

Moreover, this handling capacity is not attainable for cargo handling companies other than GMCI at the present time.

5.1.3 Examination of loading capacity of truck and transportation capacity to warehouse

Table 5.1.3-1 shows the loading capacity of truck at the existing cereal berth at Abidjan Port and packing styles.

(1) Loading capacity of truck and packing style

Examples of loading capacity of truck and packing style are shown in Table 5.1.3-1.

Table 5.1.3-1 Loading capacity of truck and packing style

Destination	Quantity of loading Rice bag	Loading weight of Rice bag	Transportation packing style
Warehouse inside the port	270～300bags (15bagsx 18 – 20 bundles = 150bags)	13.5 - 15.0 tons	Figure 5.1.3-1
Warehouse outside the port (GM warehouses 3 km away from the port)	300 bags (15bagsx10 bundles x 2 lanes)	15 tons	Figure 5.1.3-2
Mali (Mali, Burkina Faso)	1,224～1,326 bags (17rows x 6 lanes x (12 - 13)tiers	61 - 66 tons	Figure 5.1.3-3

Source: JICA Study Team

1) Loading capacity of port-truck and packing style

In the case of 50 kg Rice bag, the loading amount of the port-truck is 18 to 20 bundles / (14 m Flat body), and the transportation capacity is 13.5 tons (at loading 270 bags) to 15 tons (at loading 300 bags).

Transport speed in the port is 10 to 30 km/hour which is based on a loading limit value to ensure that bundles do not fall off the truck.

Figure 5.1.3-1 shows the packing style of rice bags being transported to the warehouse in the quay.

15 bags/bundle x 18 bundles (270bags)

15 bags/bundle x 20 bundles (300bags)

Source: JICA Study Team

Figure 5.1.3-1 Rice bays being transported to the warehouse in the quay

2) Loading capacity and packing style of trucks which transport rice to warehouse outside of quay

Figure 5.1.3-2 shows the packing style of rice bags being transported to the warehouse outside of the quay.

Rice bags are transported to the warehouse outside of quay after being secured with ropes and protected with nylon seats.

Packing style inside Gate (when passing through the quay, no awning sheets)

Secured with ropes at the side of the road inside Gate

Source: JICA Study Team

Figure 5.1.3-2 Rice bags being transported to warehouse outside of the quay

3) Packing style of trucks which transport rice to Mali

Figure 5.1.3-3 shows the packing style of trucks which transport rice bags to Mali.

Before departure, they are protected with nylon sheets.

<Loading capacity>:

Loading capacity depends on the actual size of the truck and the loading method. There are 4 main patterns.

- Loading capacity: 45 tons (About 900 bags) - 12 m flat body Truck
- Loading capacity: 52 tons (About 1,040 bags) - 12 m flat body Truck
- Loading capacity: 60 tons (About 1,200 bags) - 14 m flat body Truck
- Loading capacity: 66 tons (About 1,300 bags) - 14 m flat body Truck

Packing style of Rice bags on Mali-truck

Packing style of Rice bags of Mali-truck before packing & lashing

Packing & lashing work of truck bound for Mali

Source: JICA Study Team

Figure 5.1.3-3 Packing style of truck to transport Rice bags to Mali

4) Handling of rice bags by forklift

Figure 5.1.3-4 shows the handling packing style of Rice bags by forklift.

One unit of 50 kg of rice bag is one bundle (5 rows and 3 tiers) x 2 bundles, total 30 bags (1.5 tons).

In the case of 22.5 kg rice bag, one bundle is handled in 6 rows and 5 tiers (total 30 bags).

Handling unit of 1 unit (1.5 tons)

2 units (3.0 tons - 60 bags)

In case of Forklift handling

Handling unit of 1 pallet (2.25 tons)

1 unit (2.25 tons- 45 bags)

In case of Pallet handling

Source: JICA Study Team

Figure 5.1.3-4 Packing style of rice bags handled by forklift

(2) Quay handling capacity, loading capacity and transport capacity of trucks of the existing cereal berths

Table 5.1.3-2 shows transportation capacity of trucks which convey rice bags from the quay to the warehouse outside of the quay of GMCI (Standard cargo handling equipment and composition of workers of GMCI).

Table 5.1.3-2 Transportation capacity of truck to convey Rice bags from the quay to the warehouse outside of the quay

Bulk Carrier Hold No.		No. 1 Hold	No. 2 Hold	No. 3 Hold	No. 4 Hold	No. 5 Hold
Derrick No. (from bow side)		No. 1	No.2	No. 3	No.4	
Number of Forklifts	unit	3	3	3	3	
Number of Trucks	unit	6	6	6	6	
Capacity of Trucks		30 tons	30 tons	30 tons	30 tons	
Number of round transportation (Number of round trips to warehouse 3 km away)	cycle	3	3	3	3	
Amount of Cargo weight (Rice bags)	ton	540 tons	540 tons	540 tons	540 tons	
When 2 Derricks are in operation	ton	1,080 tons/12tracks/day				
When 3 Derricks are in operation	ton	1,620 tons/18tracks/day				
When 4 Derricks are in operation	ton	2,160 tons/24tracks/day				

Source: GMCI

When using four derricks, six trucks allocated per 1 derrick can only make 3 roundtrips to the warehouse of GMCI outside the port due to congestion of the roads outside the port. While the cargo receiving trucks from Mali and Burkina Faso are parking on the side of road outside the port or inside the port, the agents of the transportation companies have to come to the Chamber of commerce of Mali or Burkina Faso and two customs offices, which are located around the port of Abidjan, to process customs clearance procedures and consignment documents.

As shown in the table above, the transportation capacity of the truck to the warehouse outside the port (about 3 Km away from the port) when the four Derricks installed on bulk carrier are fully operated is 540 tons / (6 units x 3 round trips) x 4 derricks = 2,160ton/day. Therefore, due to the congestion of the road, the amount of rice being transported to the warehouse outside the port is less than the current quay handling capacity (3,200 tons/day).

As for the transportation to the warehouse in the port, 3,200 tons of rice bags per day which corresponds to the current quay handling capacity can be transported.

5.1.4 Examination of transport method from existing cereal berth to warehouse

(1) Confirmation of current transportation method to the warehouse and packing style in the port (packing style, cargo handling equipment and personnel)

The method of transportation from the quay to the port warehouse of GMCI, which is performing efficient work in cargo handling of current Rice bags, is shown below.

The 50kg Rice bags unloaded from the bulk ship by derrick are loaded to truck (flat body type)

by two units of forklifts.

The number of rice bags on the truck conveyed from the quay to the warehouse of GMCI inside port is about 18 to 20 bundles (1 bundle consists of 5 rows x 3 tiers, total 15 bags/bundle), i.e. total 270 - 300bags.

One monitoring car follows the trucks and monitors the transport from the gate near the quay to the arrival at the gate near the warehouse in the port. Such monitoring is carried out to prevent theft and to notify drivers if rice bags fall from a truck.

<Remarks>:

Trucks from Mali carry cargo received in Abidjan such as rice bags etc. and travel in a group of eight to nine trucks or more (Combo). It seems that the main purpose is to prevent theft of cargo loaded on the return truck.

Figure 5.1.4-1 shows the Transportation method to port warehouse by truck (in case of GMCI).

Figure 5.1.4-2 shows the surveillance car and the port truck carrying rice bags to the warehouse in the port.

Figure 5.1.4-3 shows the unloading work and storage work from the port truck to the warehouse (the port warehouse of GMCI).

Loading on trucks at quay

Transporting rice to warehouse in the port (without awning sheets)

Source: JICA Study Team

Figure 5.1.4-1 Transportation method to port warehouse by truck (in case of GMCI)

Surveillance vehicles between the quay and the warehouse (Moving in a row of 1 to 3 trucks)

Source: JICA Study Team

Figure 5.1.4-2 Surveillance car and port truck carrying Rice bags to the warehouse in the port.

Unloading work from the truck

Storage work of rice bags in warehouse inside the port

The transferred rice bags are sorted and stored based on the stowage table in the warehouse.

Source: JICA Study Team

Figure 5.1.4-3 Unloading work and storage work from the port truck to the warehouse (in case of GMCI)

(2) Confirmation of current transportation method to the warehouse outside the port and packing style (packing style, cargo handling equipment and personnel)

The rice bags transported to the warehouse outside the port are loaded onto a truck having a flat rack body or a body with side walls; the rice bags are protected by a nylon sheet for preventing collapse and secured to the body of the truck with ropes.

Figure 5.1.4-4 shows the packing style of a truck transporting rice bags to the warehouse outside the port.

Packing style inside Gate

(No awning sheets at the time of passage of the quay)

Packaging after locking by awning

Source: JICA Study Team

Figure 5.1.4-4 Packing style of truck carrying rice bags to the warehouse outside the port

a) Confirmation of transportation method of truck from Mali (Current packing style)

Many of the trucks that come to receive rice bags from Mali have a 14 m long flat body and are

capable of carrying many rice bags at once.

Figure 5.1.4-5 shows the transportation truck from Mali, and Figure 5.1.3-3 shows the packing style of transportation after loading rice bag.

Overall length 18.5 m, vehicles with side walls, 4 axis vehicles (65 ton loading vehicle)

Vehicles with awning sheets on loading pallet products

Source: JICA Study Team

Figure 5.1.4-5 Transportation truck from Mali

5.2 General study of cargo handling plan

The cargo handling plan covering the required cargo handling method, warehouse incidental facility cost and cargo handling personnel will be prepared based on the forecast cereal cargo handling volume.

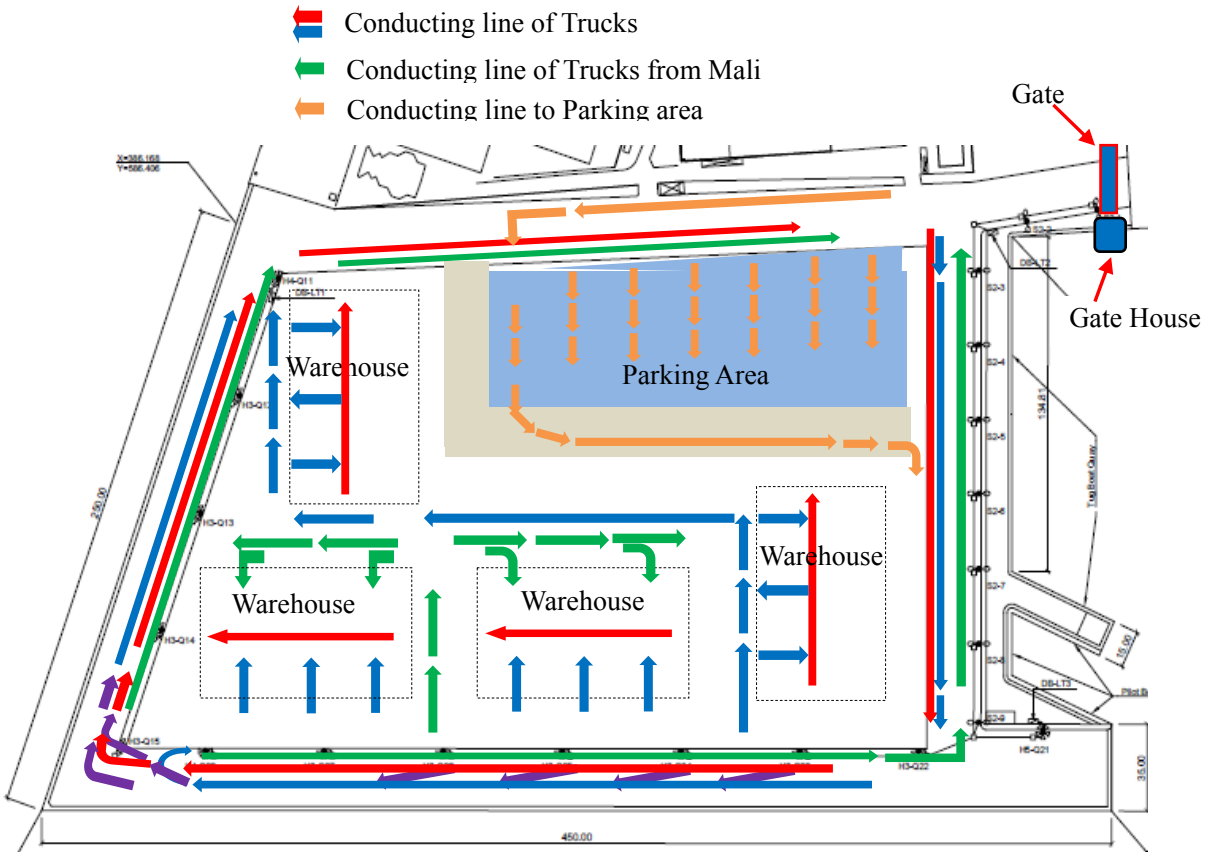
5.2.1 Concepts in cargo handling plan

As a cargo handling plan, the following concept will be adopted.

- Regarding the quay handling, the ship handling system by derricks equipped to bulk carrier will be adopted.
- The warehouse installed in the new cereal berth shall be comprised of four buildings with a width of 60 m and a length of 100 m. In each warehouse, two hoist type overhead cranes (about 57 m span, double girder, remote control system) with a rated load of 3 ton will be installed.
- Maximum 2 units of bulk carriers can berth at quay (450 m in length) of the new cereal berth, and one bulk carrier can berth at the quay of 250 m in length; accordingly, three bulk carriers can simultaneously carry out cereal handling operations.
- The number of derricks used for one bulk ship is assumed to be two. (In order to calculate the quay handling capacity, it was set based on the unloading capacity at the existing quay.)

- On the front side quay of 35 m width (quay wall length: 450 m), three lanes for trucks are provided, one of which is set as a counterclockwise passing lane.
- In same way, 250 m north quay is provided with three lanes for trucks, one of which is a counterclockwise passing lane.
- Movement of all trucks in the berth shall be counterclockwise.
- The truck which transports the grain from the quay to the warehouse travels counterclockwise, and it passes the determined route and carries the grain to the warehouse.
- Movement of outside truck inside the berth shall be counterclockwise. (It should be determined from the viewpoint of preventing accidents and improving the efficiency of cargo handling.)
- The parking area for trucks from Mali and Burkina Faso will be installed at the back yard of the Cereal berth.

Based on the above concept, the layout (draft) of the Cereal berth developed is shown in Figure 5.2.1-1.



Source: JICA Study Team

Figure 5.2.1-1 Layout of the Cereal berth (Draft)

5.2.2 Estimation of the required cargo handling capacity of New Cereal Berth

(1) Quay handling capacity

The target ship is the 60,000DWT bulk carrier with 5-holds, and equipped 4 units of derrick.

From the actual quay handling capacity of the existing berth, the quay handling capacity of the

new cereal berth is set as shown in Table 5.2.2-1.

Table 5.2.2-1 Quay handling capacity of Cereal berth

Item	(Unit)	Design Conditions (Unloading Capacity)
Target vessel		Bulk Carrier, 60,000DWT
Quantity of Holds	hold	5
Quantity of Derricks installed	unit	4
Handling capacity in daytime (unloading)	ton/vessel/daytime	1,700
Handling capacity in nighttime (unloading)	ton/vessel/nighttime	1,900
Quay handling capacity per vessel	ton/vessel/day	3,600 ton/vessel/day

Source: JICA Study Team

a) <Quay handling capacity of Cereal berth: 3,600 ton/vessel/day>

The quay handling capacity when using two Derricks of the four Derricks equipped with bulk carriers, shall be taken as the quay handling capacity of the cereal berth. Based on this concept, the work in the hold of bulk carrier, the loading/unloading work of rice bags at the quay, the transportation work to the warehouse, required quantity of cargo handling equipment (for example, forklift, transportation truck) and required number of workers and the number of Gang per derrick shall be estimated

In the new cereal berth, the cargo handling plan of the grain berth shall be planned on the assumption that the quay handling capacity is 3,600 ton/vessel/day (1,700 ton/daytime and 1,900 ton/nighttime).

<Remarks>:

The handling capacity of 3,200 to 3,300 ton/vessel/day obtained from GMCI is assumed to be the average handling capacity of bulk carrier at the existing berth, and the quay handling capacity of the newly constructed cereal berth will be set at 3,600 ton/vessel/day or about 1.1 times the quay handling capacity at the existing berth.

Table 5.2.2.-2 shows the quay handling capacity by 2 units of derrick.

Table 5.2.2-2 Quay handling capacity by 2 units of derrick

(Number of derricks used to achieve 3,600 tons/vessel/day of quay handling capability: 2 units)

	(unit)				Cargo handling capacity (Theoretical unloading)	
Handling number of derrick	unit	**2**			3	4
Derrick Name		D1	D2	**D1 & D2**	D1, D2, D3	4 units of D1 - D4
Handling capacity in daytime (unloading)	tons/daytime	850	850	**1,700**	2,550	-
Handling capacity in nighttime (unloading)	tons/nighttime	950	950	**1,900**	2,850	-
Quay handling capacity per vessel	tons/vessel/day	1,800	1,800	**3,600**	5,400 (	-
					5,400 > 3,600	

Source: JICA Study Team

By using 3 units of derrick, the achievable quay handling capacity

If 4 units of derrick are used, naturally the cargo handling capacity will be larger than when 3 units of derrick, but in the case of usage of 4 units of derrick, the composition of Gang per one derrick can be reduced, and actual handling capacity can achieve the handling capacity in case of 3 units of derrick. (From the viewpoint of the area of the limited work area on the quay and safety work)

As stated above, the quay handling capacity per bulk carrier shall be the cargo handling capacity that can be achieved using only 2 of 4 derricks on board.

The basic planning for the following works with 2 derricks-operations will be carried out.

- Cargo handling work in the hold of bulk carrier
- Quay work and transportation from the quay to the warehouse (4 dedicated warehouses newly established in cereal berth) inside the port
- Loading work in warehouse and discharging work from warehouse to receiving truck

Therefore, when 3 or 4 units of derrick are used at the same time, the quay loading capacity becomes large, the theoretical quay handling capacity of the cereal berth considerably exceeds 3,600 ton/vessel/day, and the actual cargo handling capacity also increases.

Based on this basic plan, the counterpart (PAA) side will consult with the cargo handling company which will borrow the cereal berth, decide the minimum quay handling capacity as a dedicated "Cereal berth" of Abidjan Port, and PAA can reflect it to the Port Regulation.

As a result, the cargo handling capacity of the entire cereal berth to be constructed will be larger than one of the existing berth.

b) < Quay handling capability: Confirmation of cargo handling capacity during daytime (working time: 9 hours) >

- Driver of Derrick: 3 persons (2 hour change)
- Work indicator in Derrick and Hold on Deck: 1 person
- Workers in Hold: 4 persons/1 place (corner) x 3 corner = 12 persons in total, 1 person for safety confirmation and work conductor, 1 person for record of Rice bags taken out from Hold,
  Total workers in Hold: 14 people / Hold
  Bundling 15 rice bags by 4 persons securing, Sling ropes rigging work (always 2 persons) and rigging ropes to Derrick hooks (2 persons) with 2 persons/pair x 2 pairs (so as not to get tired and do it in turn.
- Number of workers on the quay (on the ground) side: 3 persons (work of removing the rope for slinging and loading of loads carried by Derrick, subsidizing work of load rotating position)

- Workers engaged in quayside cargo handling: total of 21 persons

c) <Loading work on the truck >

- Forklift driver: 4 persons
- Assistant worker at the truck carrier: 4 persons (one person for each forklift assists when loading to truck.)
- Driver of truck: 6 persons (Transportation truck: 6 units)
- Work leader: 1 person
- (Safety checker: 1 person)

- Workers in charge of loading to truck at the quay side: 13 (excluding safety checker)

The composition of one gang per one derrick in the cereal berth is shown in Table 5.2.2-3.

Table 5.2.2-3 Composition of one gang per one derrick in the cereal berth

Bulk Carrier Hold No.		No. 1 Hold	No. 2 Hold	No. 3 Hold	No. 4 Hold	No. 5 Hold
Derrick No. (from bow side)		No. 1	No.2	No. 3	No.4	
Number of Forklifts	unit	4	No operation	4	No operation	
Quantity of Trucks	unit	6	-	6	-	
Capacity of Trucks		30 tons	30 tons	30 tons	-	
Number of round transportation (Transportation to the warehouses installed at the Cereal berth)	turn	Daytime: 6 times Nighttime: 6 times	-	Daytime: 6 times Nighttime: 6 times	-	
Amount of Cargo weight (Rice bags)		2,160 tons	-	2,160 tons	-	
When 2 Derricks are in operation		4,320 tons/12tracks/day				
Cargo Handling Capacity of Cereal Cargo		**3,600 tons/vessel/day**				
<Remarks> When 3 Derricks are in operation		6,480 tons/18tracks/day (Theoretical value)				

Source: JICA Study Team

d) <Basis for calculation>

Loading weight of transportation truck in berth: 15bags x 10rows x 2lines x 50kg/1000 = 15tons

Loading time to truck on quay: 20 bundles x 1.5min = 30min (Loading work with two forklifts)

Required time for returning to and from the warehouse in the berth: 8min

(One way: About 600m/(10km/hour x 1000/60) = 3.6min, Say 4min/one way, one round trip: 8min)

Waiting time for unloading in warehouse: 20 bundles x 1.5 min = 30 min

---

Transport time of one truck: 68 min Say 70min

Daytime work hours: 9hours = 9 x 60 = 540min

Break and wait time (total): 1hour = 60min

Number of movements between quay and warehouse per one truck = (540 - 60) / 70 = 6.8times

Therefore, there will be 6 movements during the daytime and 6 movements at night.

5.2.3 Estimation of cargo handling & transportation equipment, warehouse incidental equipment and personnel in charge of cargo handling

(1) Breakdown of cargo handling equipment and workers in charge of loading in warehouse

The breakdown of cargo handling equipment for unloading rice bags, transportation and loading work in the warehouse, and also the breakdown of workers are summarized hereinafter.

Table 5.2.3-1 shows the breakdown of cargo handling equipment and workers in case of using 2 units of derrick.

1) Cargo handling equipment and workers

Table 5.2.3-1 Breakdown of cargo handling equipment and workers in case of using 2 units of derrick

Bulk Carrier Hold No.		No. 1 Hold	No. 2 Hold	No. 3 Hold	No. 4 Hold	No. 5 Hold
Derrick No. (from bow side)		No. 1	No.2	No. 3	No.4	
Number of Forklifts	unit	4	-	4	-	
Quantity of Trucks	unit	6	-	6	-	
Number of workers						
Number of workers at ship side and quay side per Derrick	person	**21**		**21**		
Driver of Derrick	person	3	-	3	-	
Work instructor on deck and inside of the Hold	person	1		1		
Work instructor / Safety checker in the Hold	person	12		12		
Work instructor / Safety checker	person	1		1		
Registrar of unloading amount of rice bags from the Hold	person	1		1		
Worker at quay side	person	3		3		
Workers on quay side (Total)	person	**15**		**15**		
Driver of Forklifts	person	4		4		
Driver of trucks	person	6		6		
Supporter to load to truck (for the number of Forklift)	person	4		4		
Work instructor	person	1		1		
Workers (Total)	person	**36**		**36**		

Source: JICA Study Team

2) Loading work in warehouse

Figure 5.2.3-1 shows the current state of handling method in the warehouse and the improvement plan, and Figure 5.2.3-2 shows the storage area of rice bags in the warehouse.

Table 5.2.3-2 shows the equipment and personnel for handling of Rice bags in warehouse (Plan).

Packing style of rice transported to warehouse

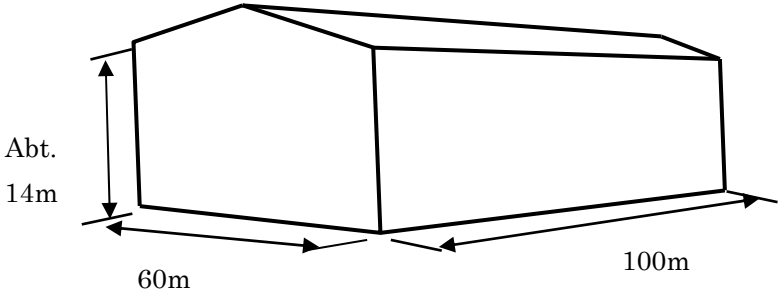
1 or 2 bundles are lifted from a truck by a forklift 1 bundle (1 bundle = 15 Rice bags)

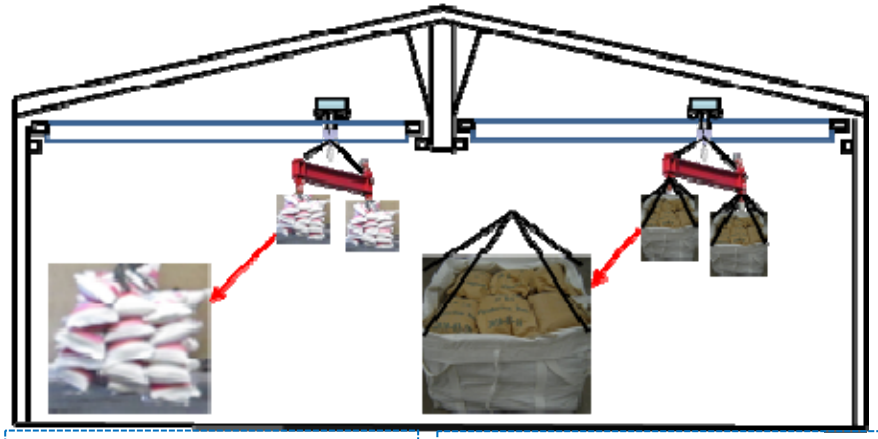
Stacking next rice bag on the pile of rice bags

1 or 2 bundles from a truck are lifted onto the pile of rice bags by a forklift

< Handling by Forklift >

Present handling work in warehouse





1 Bundle (15 Rice bags) x2

1 ton Big bag (20 Rice bags) x2
2 ton Big bag (40 Rice bags) x 2

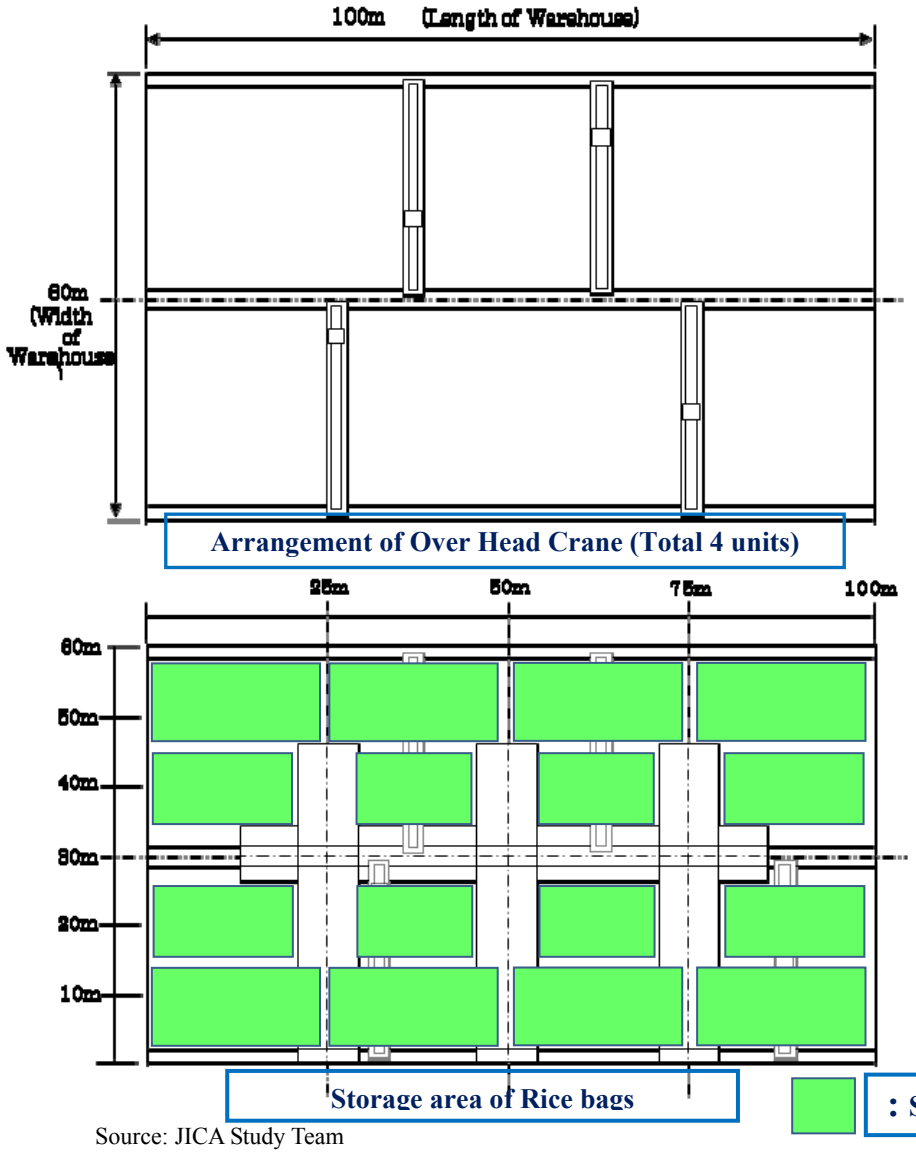
Total 4 sets of OHCs will be introduced in the warehouse in New Cereal Berth to stack rice bags

< Handling by Over Head Crane with 1 or 2 hook(s) >

Proposal of handling work in warehouse

Source: JICA Study Team

Figure 5.2.3-1 Current state of handling method in the warehouse and the improvement plan



Source: JICA Study Team

When 40,000 tons of rice bags are unloaded from the bulk carrier and 30% of them are directly loaded on the trucks to Mali and Burkina Faso, the necessary number of warehouses to store the remaining 28,000 is estimated as follows.

***Floor storage area: 6,000m2**
***Occupancy ratio: 0.75**
***Total floor area of Rice-bag storage: 4,500m2**
***Unit area & Number of Rice bag:**
Unit area: 25m2, 2 tiers,
Number of bags: 60 bags / Unit area
Number of stacking: 40 tiers
***Storage portions = 4,500/25 = 180 portions**
Number of bag: 180 x 60 x (40/2) = 21,600 bags
Total storage weight of Rice bag
= 216,000 x 50 / 1000 = 10,800 tons

Average unloading weight a vessel
= 40, 000 tons / vessel
Necessary number of warehouses
= 40,000 / 10,800 = 3.70 → 4 warehouses

*** Transportation amount to Mali, etc. : 30%**
Stowage amount of Rice bags
= 40,000 x 0.7 = 28,000 tons / vessel
Necessary number of warehouses
= 28,000 / 10,800 = 2.60 → 3 warehouses

Figure 5.2.3-2 Storage area of rice bags in the warehouse

Table 5.2.3-2 Equipment and personnel for handling of Rice bags in warehouse (Plan)

Bulk Carrier Hold No.		No. 1 Hold	No. 2 Hold	No. 3 Hold	No. 4 Hold	No. 5 Hold
Derrick No. (from bow side)		No. 1	No.2	No. 3	No.4	
Quantity of Forklifts	unit	4	No work	4	No work	
Quantity of Trucks	truck	7		7		
Number of round transportation/truck	turn	Daytime : 12 Nighttime: 12		Daytime : 12 Nighttime: 12		
< Handling Work in Warehouse >						
Quantity of OHC	unit	2		2		
Forklift	unit	3		3		
Driver of OHC	person	2		2		
Driver of Forklift	Person	3		3		
Assistance of Forklift work	person	4 (4 / 3 Forklifts)		4 (4 /3 Forklifts)		
workers piling bag (per 2 OHCs)	person	16 (8 / 2 OHCs)		16 (8 / OHC)		
Workers / 2 OHCs	person	25		25		
Total number of Workers / warehouse	person	50				

Source: JICA Study Team

3) Layout of waiting area of trucks and number of standby tracks

Trucks waiting in the truck standby area are mainly those receiving cargo from Mai and Burkina Faso. It is also necessary to consider trucks which transport cargo from the quay to the warehouses outside and inside the port when setting up the waiting area.

The waiting area of trucks is located at the rear of the cereal berth, and the arrangement of waiting trucks will be set as shown below.

The specifications of trucks inside and outside the port, and trucks from Mari/Burkina Faso are as follows.

- Trucks from Mari / Burkina Faso
  Total Length: approximately 18.5 m (Body length: approximately 14.2 m)
- Trucks inside and outside the port
  Total length: approximately 16.5 m (Body length: approximately 12 m)

Fig. 5.2.3-3 shows "Layout of the parking area (draft)".

The required parking capacity for each type of truck is as follows.

In case of trucks from Mali / Burkina Faso:

- Number of trucks to be parked: 64units (2 units / lane x 32 lanes = 64 units)

- Receiving track size: total length: about 18.5 m (body length: about 14 m)
- Loading weight: about 60 tons

In case of trucks inside and outside the port:

- Number of trucks to be parked: 64units (3 units / lane x 32 lanes = 96 units)
- Receiving track size: total length: about 16.5 m (body length: about 12 m)
- Loading weight: about 20 tons

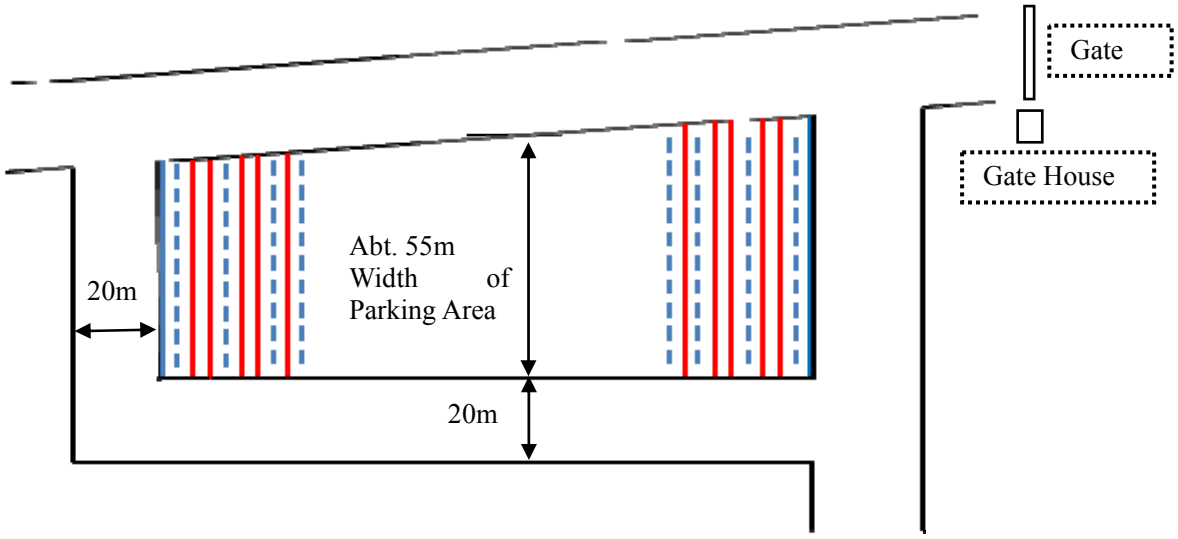


Figure 5.2.3-3 Layout of the parking area in Cereal berth (draft)
(Parking area for 18.5m long trucks from Mali and 16.5m long receiving trucks)

Figure 5.2.3-4 shows the arrangement of trucks from Mali and trucks inside the port (draft).

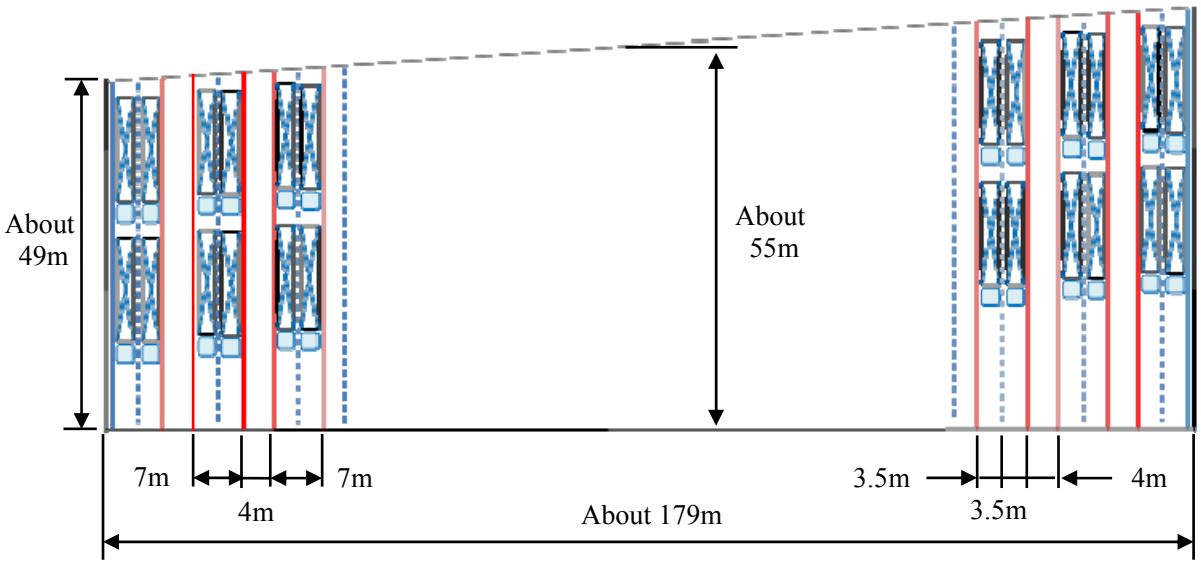


Figure 5.2.3-4 Arrangement of trucks from Mali and trucks inside the port (draft)

5.2.4 Proposal for improving efficiency of cargo handling work

(1) Improvement measures for cargo handling operations

1) Improvement measures in the current cargo handling method

In cargo handling work from the hold of the bulk carrier to the quay, it is necessary to unload as many (as many tons) rice bags as possible or increase the number of times of unloading by Derrick.

The following three methods can be considered as measures for improving the cargo handling work.

A) Improvement measure 1: Method to increase the number of times of unloading with 3 or 4 units of derrick
B) Improvement measure 2: Method to increase the weight of one cycle by ship derrick, increase the number of bundles of rice bags and increase the handling volume of rice bags
C) Improvement measure 3: Method to shorten the time of bundling of rice bag (5 rows x 3 tiers = 15 bags) or other methods to minimize the time required for lashing of bundling bags

At the existing berth, the current handling volume is about 3,000 tons / day. By implementing measures 1 to 3 above, it would be possible to dramatically increase the number of tons handled.

The cargo handling capacity of new cereal berth could be easily increased by adopting a lifting beam (attachment) to the under hook of derrick under the same condition of current cargo handling form.

- Cargo handling work: The same procedure is applied until the slinging of rice bags in the current handling work.
- Improvement of cargo handling work: Using a lifting attachment called "Lifting beam", the load of rice bags under lifting beam will be doubled. As the result, the lifting work efficiency per one handling cycle is improved.

However, as shown in Figure 5.2.4-1, it is difficult to secure working space on the quay apron.

Shooting from ATLANTICA shipboard (November 20, 2017)
Source: JICA Study Team

Figure5.2.4-1 Present state of Quay Apron at current handling method

Current handling work **Improvement of handling capacity**

Cargo handling capacity can be immediately doubled by applying the special lifting beam to the same work procedure as before. Furthermore, this measure is considered to be easy to understand and adopt.

Source: JICA Study Team

Figure 5.2.4-2 Handling method by Lifting beam equipped with 2 hooks

2) Use of big bags

The existing 1 unit (30 bags = 1.5 tons) requires bundling by sling ropes and release of bundling in the warehouse, but if big bags were adopted packing work would be easier and safer as there would be no need for bundling by slinging ropes. Accordingly, the JICA Study Team proposes the use of big bags as an improvement measure.

By packing 30 rice bags (50 kg) in one big bag and attaching a common attachment called a "Lifting beam" under the hook of the Derrick as one package, a large amount (number of bags / tons) can be lifted.

This will contribute to improving cargo handling capacity (See Figure 5.2.4-3.).

Source: JICA Study Team, UTOC

Figure 5.2.4-3 Handling method with big bags

Table 5.2.4-1 Comparison study of improvement measures of handling method

Packing style in the hold of bulk carrier	Rice bag	Rice bag	Rice bag
Countermeasures	Existing cargo handling method	Improvement measures of handling capacity by adopting "Lifting beam"	Improvement measures of handling capacity by adopting large bags
Working time per day	16	16	16
Bundling time of one lift of lifting cargo (min)	4.0	4.0	-
Slinging time of 1 lift (min)	1	2	3
Round trip time between quay side and vessel side of Derrick (min)	1.5	1.5	1.5
Slinging and releasing time of ropes at quay side (min)	0.5	1.0	3
One cycle time of Derrick (min)	About 7	About 8.5	7.5
Number of times of unloading per hour (cycle)	8.6	7.1	8.0
Number of cargo handling cycles per day (cycle)	137	113	128
Number of bags of 1 lift (bag)	270	540	600
	15 bags x 2 rows x 9 sets	(15 bags x 2 rows x 9 sets) x 2 lifts	30 bags/set x 20 sets
Weight of bag (kg)	50	50	50
Unloading weight of 1 lift (ton)	13.5	27	30
Unloading weight per Derrick (ton/day)	1,851	3,049	3,840
Rate of change of handling amount per Derrick (%)	-	165	207
SWL of Derrick (ton)	35	35	35

Source: JICA Study Team

(2) Proposal of transportation route, transportation time zone for congestion avoidance

Traffic control of the conveying route to the point A (see the figure) passing through the first bridge located near the gate from the cereal berth and connected to the road outside the port should be newly defined.

This will alleviate traffic congestion around the Abidjan Port.

As a way to reduce traffic congestion, traffic control by day and night time zones of general cars and grain carrying trucks should be adopted. Table 5.2.4-2 shows the traffic restrictions on vehicles while Figure 5.2.4-3 shows the traffic control (draft) of the truck / general car after completion of the cereal berth.

Table 5.2.4-2 Traffic restrictions on vehicles (around Abidjan port)

Time	Truck	Cars General cars	
AM05:00～09:00	**Not permitted**	**(Permitted)**	
AM09:00～PM05:00	**(Permitted)**	**(Permitted)**	
PM05:00～PM08:00	**(Not permitted)**	**(Permitted)**	
PM08:00～AM05:00	**(Permitted)**	**(Permitted)**	

Source: JICA Study Team

<Remarks>:

Although trucks should comply with the above restrictions, it has been observed that trucks are travelling during restricted times.

The "daytime and nighttime traffic control measures (draft)" for Trucks and general cars to be done according to the completion timing of the grain berth are shown below.

Table 5.2.4-3 Traffic control of the truck / general car after completion of the Cereal berth (draft)

(around Abidjan port)

Time zone	Time	Lane	Truck	General car
Zone 1	AM06:00～09:00	Both lanes	**Not Permitted**	**(Permitted)**
Zone 2	AM09:00～11:00	Right lane	**Not Permitted**	**(Permitted)**
		Left lane	**(Permitted)**	**(Not permitted)**
Zone 3	AM11:00～PM02:00	Both lane	**Not Permitted**	**(Permitted)**
Zone 4	PM02:00～05:00	Right lane	**Not Permitted**	**(Permitted)**
		Left lane	**(permitted)**	**(Not permitted)**
Zone 5	PM05:00～08:00	Both lane	**Not Permitted**	**(Permitted)**
Zone 6	PM08:00～AM06:00	Right lane	**Not Permitted**	**(Permitted)**
		Left lane	**(Permitted)**	**(Not permitted)**

Source: JICA Study Team

Figure 5.2.4-4 shows the area of the traffic control target (draft) of trucks and general cars after completion of the cereal berth

Source: JICA Study Team

Figure 5.2.4-4 Area of the traffic control target of trucks and general cars after completion of the cereal berth

(3) Proposal for sharing of transported cargo information (Proposal of efficient transportation method)

The JICA Study Team will propose to adopt the "Cargo terminal management system" by the computer system to constantly manage transported cargo in the new cereal berth.

This "Cargo terminal management system " has the following composition at the beginning of

introduction, and it shall be upgraded through operation.

It is necessary to grasp and analyze the grain information stored in the cereal berth every day in order to grasp of necessary data in the future.

1) Introduction period after completion of cereal berth

Information on the cargo carried in and out of the cereal berth should be recorded similar to the procedure conducted at the existing berth. The information to be collected is as follows.

A) Information on grain to be unloaded (bulk ship, unloading grain information, etc.)

- Name of Bulk carrier and shipping company, berthing / leaving information, daily unloading amount, total unloading amount
- Type of cereal to be unloaded (type of rice bags), supplier / importer name, unloading amount, weight of one bag, total number of bags to be unloaded, total weight
- Import source company, supplier (customer)

B) Storage warehouse information (warehouse management)

- Storage warehouse No. in the berth, storage place in the warehouse (area and storage location)
- Storage warehouse outside the port, storage place (storage area) in the warehouse, kind of grain, number of bags, storage period etc.

C) Direct loading truck information (Track information from Mali, Burkina Faso, etc.)

- Export destination country (Mali, Burkina Faso, etc.)
- Track truck information, number of trucks, vehicle number,
- Delivery date, loading amount
- Loading amount, handover volume

D) Management of Loading and unloading of warehouse

- Customs clearance date, grain information of customs subject (type, bag number, quantity, etc.)
- Receiver information

E) Inventory management

Confirmation work at stocktaking every month and year becomes easy.

F) Creating sales information

It can be reflected in the import / sales plan every year.

2) After 5 years from the start of operation

The same system as the Terminal Operation System (TOS) adopted at the container terminal for the carry-in /carry-out at the quay of the current cargo handling method will be adopted to manage the grain related data at the warehouse loading / unloading / storage. By adopting Cargo Terminal Operation System (CTOS), efficient operation management of the cereal berth can be carried out.

The target deadline and merits of introducing CTOS are shown below.

A) Deadline of target: Start operation management after 5 years from the completion of grain berth

By applying the "CTOS" (Cargo Terminal Operation System) to the management of Cereal berth, the grain berth, the management of the Cereal berth will be more efficient.

B) Benefits of introducing CTOS

- Management in the warehouse becomes easy, and it is possible to instantly grasp the present condition of the grain berth.
- Stocktaking is easy.
- It can be reflected in plan and sales plan of grain import amount every year (data on sales strategy).
- Monthly report and annual report data as cargo handling company can be created.

(4) Proposal on integrated operation of new warehouse and existing warehouse

When 40.000 tons of rice bags are unloaded from a multipurpose bulk carrier and 30% of them are directly loaded on the trucks to Mali and/or Burkina Faso, the remaining rice bags will be stored

in the warehouse in the cereal berth.

In this case, 28,000 tons or 70% of the 40,000 tons that will be unloaded and temporarily stored in the warehouse and three of the 4 warehouses installed in the berth will be occupied. For this reason, unless the storage period of the rice bags unloaded from the bulk carrier in the berth (for example, 5 days as the maximum dwell time) is determined and managed, the warehouse will become full before the transporter comes to collect the cargo, and the function as a temporary storage warehouse of the cereal berth will be lost.

For this reason, integration with the existing warehouse in Abidjan Port is a necessary measure. Accordingly, the JICA study team will propose measure to realized integrated operation of new warehouse and existing warehouse.

1) Challenges for integrated operation of new warehouse and existing warehouse

A) Setting the number of storage days of cereals stored in the warehouse of the newly constructed grain berth

B) Specified custody fee, storage / management fee setting when exceeding the prescribed number of days

C) Accelerating of loading / unloading procedures for new warehouse

D) Centralizing of storage management of new warehouse and existing warehouse

2) Countermeasures for integrated operation of new warehouse and existing warehouse

A) Setting the number of storage days of cereals stored in the warehouse of the newly constructed cereal berth

The number of storage days in the warehouse will be set based on the record of calling at regular bulkers and the actual amount of unloading.

For example, the number of days that can be kept in a bonded warehouse in the berth will be set at 5 days or 7 days after arrival in the warehouse.

B) Specified custody fee, storage / management fee setting when exceeding the prescribed number of days

This will be decided by referring to past storage fees.

C) Accelerating of loading / unloading procedures of new warehouse

The system that allows quick delivery procedures by CTOS adopted for grain berths will be adopted.

In actual loading / unloading, it is possible to carry in and carry out efficiently by using the overhead crane (OHC) installed in the warehouse.

D) Centralizing of storage management of new warehouse and existing warehouse

It is possible to manage the new warehouses and existing warehouses in one unit by the above-mentioned "CTOS" (Cargo Terminal Operation System).

Appendix

Appendix 1 Provisional Environmental Checklist (Port)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) ESIA and Environmental Permits	(a) Have ESIA reports been already prepared in official process? (b) Have ESIA reports been approved by authorities of the host country's government? (c) Have ESIA reports been unconditionally approved? If conditions are imposed on the approval of ESIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) NA (b) NA (c) NA (d) NA (as of Feb. 28, 2018)	(a) The Draft ESIA Report had been submitted to ANDE by PAA on January 3, 2018. The Final ESIA Report shall be compiled based on official ESIA TOR instructed from ANDE on November 20, 2017, and result of the public inquiry event that took place in February 22, 2018 (along with consecutive 9 days public inquiry period until March 6), and the upcoming interministerial meeting after then. Disregarding the risk related to acquisition date of the dredging and dumping permits, the Final ESIA Report maybe submitted to ANDE by PAA around late March, 2018. (b) Also, similarly to above item (a), the Final ESIA Report should be approved by the Environmental Minister in charge, around by early to late March, 2018. (c) The Environmental Minister in charge, may issue the ESIA Certificate around mid-March, 2018, provided if the interministerial meeting approves all conditions of the ESIA Report (along with the supplementary condition, most probably including PAA's requirement to acquire the dredging and dumping permits before construction). (d) The JICA Study Team recognizes PAA's requirement to achieve (i) the Dredging Permit based on Mining Order No. 002/MIM/CAB of 11 January, 2016 (Title IV), and also (ii) the Dumping permit based on Decree No. 98-43 of 28 January 1998 relative to Classified Installation Activities for Environmental Protection, by application to CIAPOL (Centre of Ivorian Anti-Pollution), at least as supplementary condition for acquiring the ESIA certificate.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) NA (b) NA (as of Feb.28, 2018)	(a) As the project site is located in the port, it was explained to the port users and the surrounding fishermen as the Local stakeholders. On top, in Oct. 11, 2017, a Public Consultation Meeting was held, with 11 stakeholder attendance, as well as the Public Inquiry event that took place in Feb. 22, 2018 whereby, 27 stakeholders were present (including District and Town authority, related Directorates, Agencies along with related private associations, etc.). The issue still remains on when the interministerial meeting that follows will be held, to reflect the opinions from the public as well as from related Ministries and governmental agencies into the Final ESIA Report. Although there had been some opinions raised from stakeholders like IRES BOLUDA, CIAPOL (Centre of Ivorian Anti-Pollution),

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				during the Public Consultation Meeting, and by Ministry of Health and Public Hygine, DREL (Regional Environmental Directorate), Town Hall of Treichville, Water and Forest Ministry and the Regional Environmental Branch, etc. at the Public Inquiry event, in principle, there were no objection on implementation of the subject project. (b) There were no comments to be reflected to the project design. Question and comments from the stakeholders were answered in the meetings and understating was obtained, at least until the Public Inquiry event. All of these concerns and answers shall be reflected into the Final ESIA Report.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Two layout plants were examined including social and environmental considerations: one is the original plan in front of the west berth and the other is an alternative at the north-west of the west berth. As the results of the comparison, the latter option was selected.
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted from ships, vehicles and project equipment comply with the country's emission standards? Are any mitigating measures taken?	(a) Y	(a) Ships have already been arriving at the surrounding existing berths and no issues have been identified related to the emission standards. No project equipment is planned which emits air pollutants apart from existing ones. More environmentally friendly construction vehicles and equipment (with less air pollutants) shall be selected for construction.
	(2) Water Quality	(a) Do effluents from the project facilities comply with the country's effluent and environmental standards? (b) Do effluents from the ships and other project equipment comply with the country's effluent and environmental standards? (c) Does the project prepare any measures to prevent leakages of oils and toxicants? (d) Does the project cause any alterations in coastal lines and disappearance/appearance of surface water to change water temperature or quality by decrease of water exchange or changes in flow regimes? (e) Does the project prepare any measures to prevent polluting surface, sea or underground water by the penetration from reclaimed lands?	(a) Y (b) Y (c) Y (d) N (e) Y	(a) Water discharges will be in accordance with current domestic regulation and the national standard. This may include treated sewage from temporary toilets with septic tank/cesspool systems to be installed during construction, and discharged by a specialized company authorized by CIAPOL. (b) Effluent discharge from ships are restricted by the decree No.97-678. (c) Oil fence is regularly prepared at the port. (d) Change of water exchange may occur, but impact to the flow of lagoon water should be minimal and limited, as proven by the hydrologic impact assessment. (e) The seabed analysis of the bottom sediment to be utilized for reclamation, proved that heavy metal concentrations are relatively moderate compared with the French standards, and therefore pollution by penetration from the reclaimed land is not of significant issue to be anticipated. A silt protector will be installed to prevent diffusion of sand and mud during dredging and reclamation works. Surface

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				water as well as groundwater quality will be monitored before and during construction phase.
	(3) Wastes	(a) Are wastes generated from the ships and other project facilities properly treated and disposed of in accordance with the country's regulations? (b) Is offshore dumping of dredged soil properly disposed in accordance with the country's regulations? (c) Does the project prepare any measures to avoid dumping or discharge toxicants?	(a) Y (b) NA (c) NA	(a) Waste from grain vessels will be collected by authorized companies in the field. Other project facilities which generate waste are not included in the project plan. (b) The dredged soil will be disposed at the offshore dumping site which is designated by PAA. PAA must acquire the dumping permit through the regulated permit issuance procedure, in conformity with Decree No. 97-678, 1997 on the protection of the marine and lake environment against pollution (in reference to Annex 2 of the London Convention) and Decree No. 98-43 of 28 January 1998 related to Classified Activities for the Protection of the Environment. Since, the seabed analysis result revealed that harmful substances such as heavy metal concentrations proved to be relatively moderate in comparison with, and below the French standard, we assume basic condition in gaining the required permit by PAA is already met, but should also take into account other domestic requirements, if any, in reference and conformity with Annex 2 of the London Convention. (c) It was confirmed that the concentration of harmful substances, such as heavy metal concentration of the dredged soil was below the level of bottom sediments based on French Standard. Nonetheless, the Contractor is obligated to implement the waste management plan set up in collaboration with ANAGED (National Agency for Waste Management) and CIAPOL, as one prerequisite for achieving the dumping permit, including consideration of a reduction plan. if possible.
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a) Y	(a) As for the construction vehicles and equipment to be adopted for construction, selection of vehicles and equipment that complies with the domestic noise and vibration standard, and more environmentally friendly vehicles and equipment, shall be respected. The state of noise and vibration at the project site shall be monitored during construction.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) Extraction of groundwater is not planned and therefore, risk of land subsidence shall not be anticipated. The Contractor should ensure that the wharves nearby the project site will not be destabilized due to implementation of the subject project.
	(6) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) Y	(a) Untreated sewage, discharged into the ocean (lagoon) may become a source of offensive odor. Therefore, as for temporary toilets to be installed around the project site during construction phase, sewage will be properly treated by the septic

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				tank/cesspool systems, and the treated effluents shall be disposed by a specialized company authorized by CIAPOL. (b) Construction waste (ex. construction debris, hazardous substances, etc.) will be treated properly, in accordance with the waste management plan in collaboration with ANAGED (National Agency for Waste Management) and CIAPOL. As for hazardous waste, the contractor will be obligated to have it properly treated or disposed to a designated landfill, in compliance with the domestic regulation and by a specific authorized company authorized by CIAPOL.
	(7) Sediment	(a) Are adequate measures taken to prevent contamination of sediments by discharges or dumping of hazardous materials from the ships and related facilities?	(a) NA	(a) Discharges or dumping of hazardous materials which cause sediment contamination are not expected. PAA is obligated to acquire the dumping permit as mandatory procedure, in conformity with Decree No. 97-678, 1997 on the protection of the marine and lake environment against pollution (in reference to Annex 2 of the London Convention) and Decree No. 98-43 of 28 January 1998 related to Classified Activities for the Protection of the Environment. A relevant waste management plan in collaboration with ANAGED (National Agency for Waste Management) and CIAPOL is to be implemented to treat the dredged material relevantly, including reduction measures, if possible, in compliance with the Decrees mentioned above and hence in conformity with the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1992 (as amended in 2006).
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There are no protected areas in/around the project site.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the project will adversely affect aquatic organisms? Are adequate measures taken to reduce negative impacts on aquatic organisms? (e) Is there a possibility that the project will adversely affect vegetation or	(a) N (b) N (c) Y (d) N (e) N	(a) There are no primeval forests, tropical rain forests, ecologically valuable habitats in/around the project site. (b) Three rare aquatic species, including 2 Near Threatened (NT) and one Endangered (EN) species, were identified as existing species within the Ebire Lagoon. (c) Nonetheless, identified monitoring point is remote from the project site, and since they are mobile species, impact can be considered low or not anticipating level. Silt protector shall be installed during dredging and reclamation works, so that the construction works will not bring about significant disturbance in impact

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		wildlife of coastal zones? If any negative impacts are anticipated, are adequate measures taken to reduce the impacts on vegetation and wildlife?		to the turbidity of the project site water area, and thus mitigating impact to the nearby habitat of aquatic species. (d) Same as above item (c). (e) There are no natural vegetation and wildlife habitat in/around the project site.
	(3) Hydrology	(a) Do the project facilities affect adversely flow regimes, waves, tides, currents of rivers and etc if the project facilities are constructed on/by the seas?	(a) N	(a) Although there is a possibility of water current change around the facility, according to the assessment of the hydrologic impact, past related studies prove that such adverse impacts should remain at minimal level with no anticipation on any significant impact. Nonetheless, monitoring on the water current speed during construction phase shall be implemented.
	(4) Topography and Geology	(a) Does the project require any large scale changes of topographic/geographic features or cause disappearance of the natural seashore?	(a) N	(a) Impact to natural topography and geology will be minimal and limited in the existing port. Although due to construction of the berth by reclamation (approximately. 9.9 ha), certain level of seashore line changes by scoring and sedimentation impact may be assumed, but in accordance with past related studies at Port of Abidjan, the impact should remain minimal with no anticipation on any significant impact.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N (i) N (j) N	Involuntary resettlement is not required.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(j) Is the grievance redress mechanism established?		
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that changes in water uses (including fisheries and recreational uses) in the surrounding areas due to project will adversely affect the livelihoods of inhabitants? (c) Is there a possibility that port and harbor facilities will adversely affect the existing water traffic and road traffic in the surrounding areas? (d) Is there a possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are considerations given to public health, if necessary?	(a) N (b) N (c) N (d) N	(a) The project will not affect living conditions of inhabitants as the project site is in the existing port and the surrounding is a distribution and industrial area. (b) There is no fishing ground in/around the project site. (c) The area around the project site is not used for water traffic and road traffic for inhabitants. (d) Consideration is required during construction phase while immigration due to operation is not anticipated. Infectious diseases including HIV/AIDS prevention measures will be taken.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There are no cultural nor religious heritages of concern around the project site, and shall not be affected.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There are no anticipation on significant adverse impact to the local landscape. The design and location of the watch tower to be built, on top of the current Harbor Master Office building, has been selected and considered in consultancy with PAA, including confirmation on no concern to the landscape.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	Ethnic minorities and indigenous people are not identified around the project site.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the	(a) Y (b) Y (c) Y (d) Y	(a) PAA should keep in compliance with Convention regulating the Dockers and Transit Dockers Works in Côte d'Ivoire, April 9, 2013, national labor law and national social welfare law. SEMPA, which employs stevedoring workers, is providing working conditions and social welfare complying with the agreement with labor union in addition to the national labor law. (b) Emergency equipment such as fire extinguisher will be equipped. (c) Stevedoring companies will provide safety equipment and training to the workers. (d) Safety of local residents and the other individuals will not be affected by the port security guards as they are dispatched from private companies and not allowed

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		project not to violate safety of other individuals involved, or local residents?		to carry weapons.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) Y (c) Y	(a) Measures are planned such as water quality monitoring for dredging and dumping of the dredged soil, water sprinkling for dust prevention, and maintenance of vehicle and equipment for reduction of air pollutant emission. Proper waste management plan in collaboration with ANAGED (National Agency for Waste Management) and CIAPOL, will be implemented to reduce and properly treat or dispose, construction waste (ex. debris), harmful substances, and dredged material. Waste management will also include, treatment to reduce the volume of dredged material to be dumped at the designated dumping site by PAA. (b) Same as above item (a). In principle there will be no anticipation of impact to environmentally protected area (since there are no protected areas, within nor surrounding the project site). Three rare aquatic species, including 2 Near Threatened (NT) and one Endangered (EN) species, were identified as existing species within the Ebire Lagoon, but impact is considered low, since their existence was confirmed by sampling at remote area, with no confirmation of suitable habitat around the project site water area. Mitigation measure such as installation of silt protector during dredging and reclamation works, should also avoid impact to turbidity of the surrounding waters and thus to the habitat of aquatic and benthic species surrounding the project site. (c) HIV/AIDS prevention program is to be implemented as the risk of spread of infectious disease is concerned.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) N	(a) PAA implemented the ESIA study by assistance of JICA, during the course of this JICA Detailed Design Study stage, and the Environmental and Social Management Plan (ESMP), including the Environmental and Social Monitoring Plan (ESMoP) was established. (b) It was proposed as follows: air quality monitoring once in pre-construction phase and once in every six months during construction, water quality monitoring (turbidity) every day during dredging, monitoring of number of incidents of HIV every month during construction, monitoring of amount of harmful waste and the disposal method during construction, and monitoring of number of accidents during construction, etc. (c) Same as item (a) above.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				(d) Monitoring report system is not regulated although Decree No.96-894 requests establishing monitoring program as a part of ESIA. A monitoring follow-up system (monitoring report format to JICA) after operation, however, shall be set forth in the Environmental and Social Monitoring Plan (ESMoP) in the ESMP of the ESIA Report.
6 Note	Note on Using Environmental Checklist	(a) Where necessary, impacts on groundwater hydrology (groundwater level drawdown and salinization) that may be caused by alteration of topography, such as land reclamation and canal excavation should be considered, and impacts, such as land subsidence that may be caused by groundwater uses should be considered. If significant impacts are anticipated, adequate mitigation measures should be taken. (b) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	-	(a) There will be no groundwater utilization, therefore, risk of land subsidence is not anticipated. (b) The subject project is not situated nor near any transboundary area, and therefore, no such impact shall be expected. The construction of the berth does not involve construction of facility/ nor substructure that may emit greenhouse gas (GHG), therefore has no impact towards global warming (except for non-anticipating amount during construction).

1) Regarding the term “Country's Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of European countries.
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.