

692



REPORT OF THE PRACTICAL TRAINING DONE IN THE GENERAL DIRECTORATE OF PORTS IN PORTUGAL, DURING THE MONTHS SEPTEMBER AND OCTOBER 1986.

J.C.G Hesen.

REPORT OF THE PRACTICAL TRAINING DONE IN THE GENERAL DIRECTORATE OF  
PORTS IN PORTUGAL, DURING THE MONTHS SEPTEMBER AND OCTOBER 1986.

J.C.G Hesen.  
january 1987

Hydraulic and Geotechnical Engineering Group  
Coastal Engineering Division  
Department of Civil Engineering  
Delft University of Technology  
Delft, The Netherlands.

## Preface.

The foundation of the maritime school in Sagres in the year 1450 as centre of research and studies for nautical purposes, was the base of the leading position of the Portuguese fleet concerning the discoveries of new continents. Famous discoverers like Vasco da Gama and Christoffer Columbus graduated on this school. The efforts became successful when Vasco da Gama discovered the sea route to India, and set foot in Calicut on the 23<sup>th</sup> of may 1498. A flourishing trade was set up with the discovered countries, which started the growth of the Portuguese empire. Of course the flourishing trade required the development of new harbours which concentrated on Lisbon harbour. Nowadays these harbours still exist but are adjusted according the requirements of modern times. The rich culture, the various types of harbours and the amount of different coastal phenomena form an interesting field to explore, in order to enlarge the scope of my civil engineering study.

The study is performed in a practical training period of 9 weeks as part of the study specialisation coastal engineering, under supervision of prof.dr.ir. E.W Bijker. This report expresses the results of both desk and field studies in the period.

Herewith I want to thank all the people of the General Directorate of Ports for the help, the interest, the hospitality and the friendship I encountered during this practical training period at work, but also outside. Especially the director of the Directorate of Physiographic Services eng<sup>o</sup>. Manuel Rodrigues Martins I thank for his dedication to make this study a success in all aspects.

Also I thank the people involved of the contractors CPTP and Condotte, the consultants Frederic Harris and Consulmar and the port authorities of Lisbon and Sines, for the access to, the company with, and explanations about the projects visited. And last but not least I would like to thank the Ballast Nedam Engineering b.v for providing the facilities to make this report.

J.C.G. Hesem

Index	
	page
Preface	
Summary	
List of attachments	
list of pictures	
1. Introduction	1
2. Organisation and activities of the Direcção Geral de Portos	2
3. Time schedule	5
4. Activities and experiences	7
4.1 Praia de Areia Branca	7
4.2 Baleal	7
4.3 Peniche	8
4.4 Nazaré	9
4.5 Aveiro	10
4.6 Viano do Castello	11
4.7 Esposende	12
4.8 Sines	13
4.9 Portimao	17
4.10 Faro	19
4.11 Lisbon	20
5. General experiences and comments	23
6. Conclusions and recommendations	24
7. Evaluation	26
Attachments	
Pictures	

## Summary.

Portugal has a coast of approximately 800 Km containing a lot of interesting coastal phenomena, such as estuaries, land spits, rock coasts, lagoons, cliffs and rias (areas of sandbanks and canals in open connection with the sea). Also a lot of different harbours can be found along this coast.

The problems encountered during the desk studies and the visits vary drastically, from the closure of a river by sedimentations of the littoral drift in Praia de Areia Branca, to the stability of the tetrapods on the rubble mound breakwater in Nazaré.

For the lay out of a fishing harbour and the handling of the fish, the D.G.P has developed a procedure which is applied in many harbours. Erosion and sedimentation form the problem in Aveiro where also a new commercial dock is just finished. Viano do Castello is the harbour in the north of Portugal where the river bed was changed as one of the necessary works in order to enlarge the capacity of the harbour.

A new coal terminal is almost finished in Sines harbour as the first phase of the master plan for the development of this area. The breakwater which is exposed to very severe storm conditions is protected with blocks up to 72 tons, to resist the design waves of 11 meters!

The development of the harbour of Portimao in the Algarve was done in only 10 years, including a fishing dock, a commercial and tourist dock and a naval quay.

The entrance of the Ria de Faro suffered from severe erosion after the entrance was stabilized by the construction of two breakwaters. The repairing is in full action at the moment.

The harbour of Lisbon contains a lot of different harbour activities, but will concentrate in future on the development of containers, cereal, and tourism.

**List of attachments.**

attachment 1: blockdiagram of the organisation of the D.G.P.

attachment 2: explanations of the Portuguese abbreviations in attachment 1.

attachment 3: map of Portugal.

attachment 4: map of Peniche harbour.

attachment 5: map of Nazaré harbour.

attachment 6: map of the "ria de Aveiro".

attachment 7: map of the new docks in the "ria de Aveiro".

attachment 8: map of the Viano do Castello harbour.

attachment 9: map of the expansion of Sines harbour 1<sup>st</sup> phase.

attachment 10: map of the estuary of the Tejo river.

attachment 11: map of Portimao harbour.

**List of pictures.**

picture 1: Tombolo of Baleal

picture 2: Erosion south of Aveiro.

picture 3: Erosion near apartment building in Esposende.

picture 4: Explosion in quarry (Sines).

picture 5: 72 tons block on truck at the fabrication site (Sines).

picture 6: Inside slope of breakwater (Sines).

picture 7: Blocks used as formwork for the cap wall (Sines).

picture 8: Caisson building pontoon (Sines).

picture 9: Sliding formwork of the caisson building pontoon (Sines).

picture 10: Temporary coal terminal seen from the sea side (Sines).

picture 11: Stonemill plant (Sines).

picture 12: Entrance of the "ria de Faro".

picture 13: Loading berth of the Tagol company in Lisbon.

picture 14: Dutch student trying to handle a huge machine.

## 1. Introduction.

This is the report of a practical training which was offered by the Direcção geral de Portos (D.G.P) and was realized during the months September and October 1986. The duration of the training was 9 weeks. Within the D.G.P I was placed at the Directorate of physiographic Services (D.S.F) which is the service that deals with coastal engineering problems.

The main purpose for this practical training was to get acquainted with coastal engineering problems, their technical solutions, and the realisation techniques of the necessary civil works in a foreign country.

To achieve this purpose the D.G.P gave the opportunity to make a study which could be decided at my own discretion. The work was mostly done in the main office of the D.G.P in Lisbon where I had a desk in an office with three engineers of the Directorate of physiographic Services. This work consisted the reading of design reports of finished projects, executed under the supervision of the D.G.P, and the planning of the study visits to several projects along the coast. The other part of the study was done by executing this planning through visits, on which I was mostly accompanied by a D.G.P engineer, to coastal engineering projects and several finished harbours and harbourworks in execution. The total duration of these visits were 14 working days.

The two main reasons for doing the practical training in Portugal within the D.G.P are:

1. In the D.G.P there was an opportunity to get practical experience in a foreign country in the field of my study specialisation, which is coastal engineering.
2. During the training I would be able to learn some basics of the Portuguese language and practise languages in general.

In the report the institute in which the work was done is described first. The time schedule indicates how time was filled in during the practical training period. Because the desk studies were done in order to prepare for the study visits, the experiences of them both are described in one chapter: Activities and experiences  
General experiences, conclusions and recommendations, and the evaluation of the practical training follow in the corresponding chapters.



## 2. Organisation and activities of the D.G.P.

The organisation of the D.G.P can be seen in the blockdiagram attached. In this report several Portuguese abbreviations are used which are written fully in English. Therefore a list is attached which explains the Portuguese abbreviations (attachments 1+2). Some complementary information will be given in order to explain the diagram.

The general director is responsible for the activities of the D.G.P and has to report directly to the Ministry. Contrary to what is shown in the diagram there is no sub-general director in office.

The general director is assisted by a technical and administrative council (conselho tecnico and conselho administrativo). The general director is president of these councils. The administrative council consists of the general director, the director of the administrative directorate (internal) and a representation of the Ministry of Finances. In the technical council the directors of the technical directorates, and directors of other general directorates with an interest in D.G.P projects have a place.

The D.G.P is divided into 5 directorates as can be seen in the diagram. The directors of the directorates have to report to the general director and the councils.

These directorates are:

D.S.E.P.P : Directorate of research, planning and programming services

D.S.P.O : Directorate of design and executive services

D.S.F : Directorate of physiographic services

D.S.E : Directorate of exploration services

D.S.A : Directorate of administrative services

Each of these directorates has its own staff and is divided into several divisions. The directorate of physiographic services for example is divided into a division of coasts and estuaries and a geotechnical division. Every division has its own head. The total number of persons working in the D.S.F is approximately 30. These directorates have their offices in the head office of the D.G.P in Lisbon.

In the diagram seven other departments can be found of which two are:

N.R.E : department of public relations.

N.D.I : department of documentation and information

The other five are attached organisations, called juntas (assembly). In the harbour itself the junta, which is an autonomous department, is responsible for the harbour maintenance and exploitation. The commercial exploitation is done by other services and private companies. The junta has its own director who reports directly to the general director of the D.G.P. The junta is financially independent but can obtain money from the D.G.P to finance expansion activities or maintenance works.

The D.G.P is in charge of more than the name suggests by itself. In general terms the D.G.P is responsible for the whole coast of Portugal including constructions and harbours and 50 meters of land perpendicular to the waterline.

The work of the D.G.P includes:

- maintenance of the coast (beaches, cliffs, estuaries, ria's etc).
- maintenance of existing harbours.
- planning and development of harbours.
- administration of the public maritime domines.
- controlling the regulations and norms for harbour exploitation (tariffs and traffics).
- controlling equipment applied in the harbours.

Three harbours in Portugal are not under the supervision of the D.G.P. These harbours have their own administration, which means that the functions of the D.G.P and of the juntas are combined in one department. These administrations are autonomous and report directly to the Ministry. These harbours are:

- Lisbon harbour.
- Porto harbour.
- Sines harbour.

These harbours have their own administration because they are very big, and can not be controlled from one department. Of course activities of these administrations which affect the whole coast have to be discussed with the D.G.P and the Ministry.

The organisation of the D.G.P however will be changed. In the future it will be an institute called: national institute of ports and maritime coasts (Istituto Nacional de Portos e Costas Maritimas).

The new institute will be in charge of defining a national policy for the coast and ports, it will assist the administrations of the ports when a decision has to be made by the government, and will take care of the maintenance of the coast which is not under the supervision of the port administrations.

These administrations are the old juntas and the existing administrations of Lisbon, Porto and Sines.

This means in case of the juntas that some activities which in former times were handled in the D.G.P will be done by the former juntas. The status of these juntas increases because of this, and therefore they will become autonomous administrations.

### 3. Time schedule of the practical training in the D.G.P in 1986.

- 01-05 Sept : - arrival in Lisbon  
- arranging accommodation  
- first contact with D.G.P in Portugal
- 08-12 Sept : - making a program for the practical training with the director of the directorate of physiographic services.  
- studying erosion report of "Ria de Faro".  
- studying Portuguese language.
- 15-19 Sept : - no work activities.
- 22-26 Sept : - studying design report of the harbour of Figueira da Foz.
- 29-03 Oct : - studying design report of : - the harbour of Nazare.  
- coastal defence of Costa de Lavos.  
- planning visits to the harbours of north Portugal.
- 06-10 Oct : - studying design report of : - the harbour of Viano do Castello.  
- coastal defence of Espinho.  
- first visit to the coast and harbour projects of the north, to: Praia de Areia Branca, S. Martinho do Porto, Peniche, Baleal, Nazare, Figueira da Foz. (these places are marked with a. in attachment 3).
- 13-17 Oct : - visit to the national laboratory of civil engineering.  
- second visit to the north, to: Costa nova do Prado, Aveiro, Viano do Castello, Esposende, Povia de Varzim, Vila do Conde, Porto (marked with b.).  
- planning and preparing visits to the south.
- 20-24 Oct : - introductory visit to Lisbon harbour.  
- preparing visit to the south.  
- visit to Sines harbour.  
- visit to Sesimbra harbour (marked with c.).

- 27-31 Oct : - visit to the harbours and coast of the south, to: Setubal, Sagres, Baleeira, Lagos, Portimao, Villamoura, Faro, Tavira, ria de Faro.  
- second visit to Sines. (marked with d.)
- 03-07 Oct : - gathering material for report.  
- second visit to Lisbon harbour.  
- departure to Holland.

These places visited can be found on the map of Portugal (attachment 3), with the indication of letter and number corresponding with the study visits as mentioned above.

#### **4. Activities and experiences.**

The study which was done can be divided into two main sections as can be seen from the time schedule. The first is the preparation for the visits to the coast which was done in the office in Lisbon. This preparation itself can be subdivided into two categories:

- planning the trips to the projects
- studying reports of these projects.

The second section of the study covers the visits to the harbour and beach projects.

The design reports could not be read for all the places visited. The main reason for this was that all reports were written in Portuguese, and therefore at the beginning of the practical training rather difficult to read.

This part "activities and experiences", is a mixture of both studies made in the office in Lisbon and experiences during the visits themselves. However while visiting many different places, an overlapping of experiences is inevitable. So in this part, only characteristic information of the places visited is given. The discussion of the topics is chosen in the sequence of the visits.

The places discussed can be found on the map of Portugal.

##### **4.1 Praia de areia branca (a.1).**

This place is called translated literally: "beach of white sand". At this moment there is a pollution problem because the mouth of a small river is closed by sedimentation coming from the littoral drift from the north along the coast.

During the summer the effluent of the river is very small. The result is that the barrier, formed through sedimentations, can not be broken in a natural way. The water starts rotting, becomes black and produces a bad smell. This affects the tourism, which is rather important for this place, in a negative way. A place called beach of black sand is not too attractive for tourists!

The D.G.P is thinking of solving this problem by protecting the river mouth with the construction of two breakwaters. Although the river is very small, these breakwaters have to be quite heavy constructions, because conditions at sea are very bad.

#### 4.2 Baleal (a.3).

Baleal is an artificial peninsula. In former times it was a tombolo. During a severe storm the connection with the main land was broken. By making a dam of stones between the island and the mainland, the accretion of sand was accelerated. At the moment big beach has already been formed. On top of the dam a road has been built to provide the connection with the mainland. It seems that the solution is stable now because the beach is still growing.

(see picture 1).

#### 4.3 Peniche (a.2).

In the harbour of Peniche a brand new fishing dock with installations has been completed (see attachment 4). The D.G.P has developed a procedure for handling the fish, which is applied in many other harbours, for example Figueira da Foz, Viano do castello, and Portimao.

The fishing boats are unloaded at the unloading quay in the fishing dock. Parallel to the quay an auction building (1) is situated, to which the fish is immediately transported. In this lota the fish of all fishermen is collected, roughly selected, cleaned and after that sold to the wholesale dealers in an auction.

The fish is then carried away from the auction place to another part of the building where every wholesale dealer has his own workplace. Here the personnel clean the fish and prepare it for transport or for further treatment if necessary. Directly behind the auction building the wholesale dealers can rent places with facilities to treat the fish (fresh and salt water), and accommodations for temporary storage (2).

The harbour of Peniche is a typical example of the lay out of fishing harbours in Portugal. Typical is the situation of the auction building (1), the wholesale building (2), the ice-factories (3) and the places reserved for cleaning and maintenance of the fishing equipment (4). The offices for the harbour authorities (5), and a restaurant (6) are located further away from the quay. Also typical is the large place reserved for expansion (marked with "ampliação"). Besides the fishing activities in this harbour there is also a recreational dock (7) and a line service to the Berlenga islands (8) which lie at a distance of approximately 50 km from the coast.

#### 4.4 Nazaré (a.4).

The harbour of Nazaré is a fishing and commercial harbour. In former years (1960) the fishermen had only a natural harbour where they used the beach to store the small fishing boats. A new harbour was built ten years ago south to the place Nazaré. For the lay-out of the harbour see attachment 5. The breakwaters are built as rubble mound breakwaters with an upper layer of tetrapods having a weight of 30 tons each.

The problem here is caused by the head of the southern breakwater. The toe of this breakwaterhead is not stable and causes the tetrapods to slide into the sea. This has two different reasons:

- Near to the coast here, there is a very deep sea canyon (canhao de Nazaré). The slopes of this canyon are very steep compared with the slope of the rest of the sea bottom. The toe of the breakwaterhead is situated on the slope of this canyon. So the stability of this part of the breakwater is much less than of the other parts of the breakwater.
- Because the canyon is very deep, high waves from westerly storms can approach the breakwaterhead over deep water. Waves, which would break before other parts of the breakwater, will not break while approaching it over the canyon. So the forces on this part of the breakwater are bigger than elsewhere.

The combination of the stronger wave attack and steep slope under the toe of the breakwater cause the instability of the toe during storms coming from the west.

At this moment repair of the southern breakwater is in full action. The repairing is done by covering the breakwaterhead with a new top layer of heavier tetrapods. The question arises of why the harbour has been built here and not further to the south, or on the north side of the city, because it was obvious that the canyon was expected to cause problems. The answer is partly political and partly technical. The local authorities did not want to have the harbour built more to the south because the distance to the city would become too big. On the north side an enormous rock coast prohibits the construction of the harbour.



In the design phase of Nazaré harbour there were two different solutions for the location of the river bed. One in which the river flowed through the harbour and one in which the river bed was led beside the harbour. The design was chosen in which the river flows beside the harbour, so there would be no danger of sedimentation in it.

The solution to change the river bed demanded an extra defence work for the mouth of the river. Obviously the costs for the dredging maintenance of the harbour must have been estimated to be higher than the costs of the extra work for changing the river bed and the defence construction.

If this was the only reason why this solution was chosen I doubt if this really was the cheapest solution.

#### 4.5 Aveiro (b.2).

The harbour of Aveiro is one of the larger harbours of Portugal, with a big codfish dock (3), a coastal fishing dock (1), a commercial dock (2) and an industrial dock (4). (see attachment 6).

The harbour is situated in the "ria de Aveiro". A ria is an area with sandbanks and canals in connection with the open sea. In former times when ships were smaller, the fishing harbour was very near to the city. When bigger ships were needed for especially the codfish, which has to be caught near Greenland, and commercial activities, the distance from the newly built harbour and the city became larger because deeper water was needed. Later an industrial quay was built for oil and chemical industries.

The harbour of Aveiro is planned to grow in future because the capacity of the second largest harbour of Portugal, porto de Leixoes (Porto), has reached its maximum capacity and can not expand any more. The extra capacity for commercial activities will be obtained by expanding the harbours of Aveiro (south of Porto) and Viano do Castello (north of Porto).

Therefore the D.G.P is finishing at the moment a commercial dock (5) very near to the sea. This new commercial dock has 1000 mtrs of quay available with a depth of 8.00 mtrs below minimum sea level (Msl). The old fishing dock requires maintenance and expansion too, and because the distance to the sea from this dock is extremely long (7 Km), the authorities decided to build a new fishing dock (6) also very near to the entrance of the ria. This fishing dock will have 300 mtrs of quay available with a depth 5.00 mtrs below Msl (see attachment 7).

The entrance of the ria needs a lot of maintenance. The littoral drift coming from the north is stopped by the northern breakwater. The result is that the beach has grown up to the head of the breakwater. In order to avoid sedimentation in the entrance of the ria, the breakwater has to be enlarged for approximately 500 mtrs. This is the third time that this breakwater will have to be enlarged because of accretion of the beach north of the breakwater.

Because the sand transport is stopped by the northern breakwater, it is clear that south of the other breakwater an erosion problem occurs. Here the erosion is very severe and is stopped by armouring the coast with natural rocks, and the construction of several groins. At the moment however the thickness of the dune line is decreasing at high speed (see picture 2).

#### **4.6 Viano do Castello (b.3).**

Viano do Castello is the most northern harbour of Portugal of importance with commercial, fishing, ship repairing and recreational activities. The harbour is situated at the mouth of the Lima river. As mentioned before, in the section on Aveiro, the capacity of the harbours in the north of Portugal can not be enlarged in the harbour of Leixoes, and therefore the harbour of Viano do Castello will be expanded.

The northern part of the harbour is the old harbour with a ship repair dock (17), a fishing dock (15) and a commercial dock (14) as can be seen in attachment 8. The capacity of the harbour has now been enlarged with a new commercial quay (12), which has a length of 450 mtrs and a depth of 8.00 mtrs below Msl. This commercial dock can easily be expanded in the direction of the bridge if necessary. In the construction a recreational dock and another (small) fish berthing quay were also built (13).

In order to expand the capacity of the harbour not only did the total quay-length have to be enlarged, but also a deeper river bed was necessary to allow bigger ships to enter the harbour. There were two possible solutions to this:

1. to dredge the river bed to the desired depth of 6.00 mtrs below Msl. A rock-layer of four meters would have to be cut away over a length of approximately 600 mtrs to achieve this.

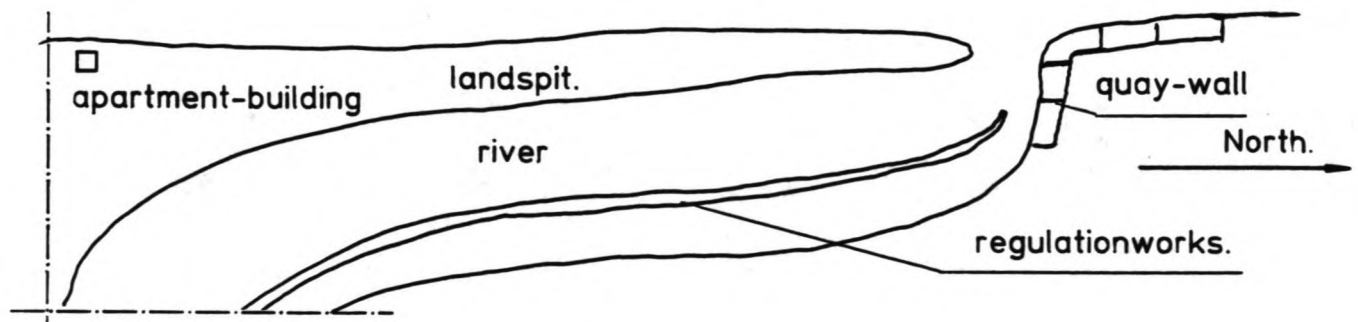
2. to bend the river mouth 500 mtrs down to a very old bed of this river. This river bed was covered with a layer of sediments which could be removed relatively easily.

The second solution was chosen although it required the construction of several regulating works in order to change the flow of the river. The mouth of the river had to be forced to the south. This was established by building a large breakwater (6) of 2 Km and the regulation works (8,9). Another breakwater was needed to enarrow the mouth of the river so that sediments would be drawn into the sea.

The system works perfectly except for one little problem. The resulting sand transport comes from the north and will not cause sedimentation problems in the harbour, looking at the configuration of it. However, during severe storms, coming from the south-east, the sand transport has a northern direction. The south breakwater of the harbour can not prohibit that this sand coming from the south sedimentates in the calm harbour. The authorities in Viano do Castello are thinking of attacking this problem by enlarging the south breakwater, but studies are still being made.

#### 4.7 Esposende (b.4).

The river flows a few kilometers parallel with the coast in Esposende and is separated from the sea by a 100-meters-wide land spit. The river bed was too large compared with the amount of water flowing through the river, so the water speed was too slow and sedimentation started. The problem was solved by construction of river regulation works.



The sedimentation has stopped now, but erosion of the sea side of the barrier has not. The barrier is becoming dangerously thin, and if nothing

is done, it will break and the regulation works have been built for nothing. The problem is attacked by armouring the sea side of the barrier up to the head of the land spit. The river mouth becomes stable through this operation because the north side of it is already defended by quay walls.

Erosion more to the south is so heavy that an apartment building was endangered. The sea came up to 5 mtrs from the building! Here the erosion was stopped just in time by the construction of several groins. The situation is stable at the moment but there is not too much reserve in the coastal defence (see picture 3).

#### 4.8 Sines (c.2).

In the master plan for the development of the area around Sines the expansion of the harbour of Sines with a coal terminal is included. The project will be executed in four phases of which the first phase will be finished in 1987.

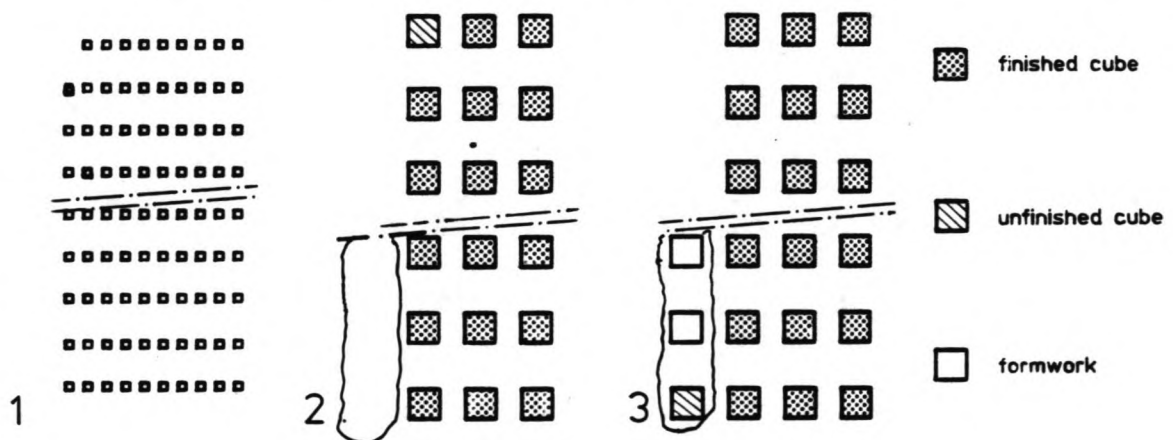
The coal terminal will receive in the first place coal for the electricity plant which is also integrated in the master plan. The electricity plant will be a major power plant for the south-west part of Portugal, and is situated at approximately 4 Km from the coal terminal. In the first phase of the master plan an unloading berth will be built with a length of 345 mtrs and a depth of 8.00 mtrs below Msl. Two cranes will be installed to unload the coal ships (see attachment 9). The transport to the stock piles and to the power plant will be done fully automatically with conveyor belts.

During the construction of the coal berthing quay, the coal can be berthed on the temporary coal terminal. The coal will be transported to the temporary stockpiles with a conveyor belt. From there it will be transported to the power plant with trucks until the conveyor belt to the plant is finished. By that time the transport will be able to be done automatically. It seems however that this terminal will not only be a temporary construction. In a later phase of the expansion of the coal harbour, the breakwater will be extended to the south side, and in the new protected area another coal terminal will be built. The idea is to leave the temporary coal terminal where it is, and use it to handle peaks in the delivery of coal. Anyway it is better to leave it there and only use it after ten years, than to break it down and rebuild another by that time.

The lay out of the site.

Stones blasted out of the quarry (A) were either directly used for armouring works, filter layers, groundfill works, or transported to the stonemills (B) where they were crushed, washed and graded to serve as aggregates in the concrete. The different aggregates can be transported from here to the concrete manufacturing plant (C) and used without further treatment. Here the enormous amount of concrete was manufactured to make the thousands of blocks, the caissons for the coal berthing quay and the greasting dolphins for the temporary coal terminal. These blocks were produced in two weight classes, 60 and 72 tons, and manufactured at two different places on the site.

The manufacturing of the cubes was a continuous and effective process. The concrete for the cubes was mixed in the trucks during transport from the concrete plant to the fabrication site (K). The blocks were built in rows in which each row represents a stage of the fabrication.



Drawing 1: gives the view of the fabrication site from which the location of the detail of the other drawings is indicated.

Drawing 2: In front of the allmost finished row of blocks, plastic foil is laid in order to facilitate the removal of the blocks which will be built in this row, and prevent dehydration of the bottom of the block.

Drawing 3: The crane takes off the formwork of the-one-day-old cube behind the place where the new block will be built. After this a plastic foil is put over the one-day-old cube in order to prohibit dehydration. After the first mixer truck has arrived, the filling of the formwork can be started. Great attention was given to the compaction of the concrete. The crane that takes off the formworks, operates a few blocks ahead of the block which is filled.

The row is just so long that when the last cubes of one row have to be filled the first cube of that row is already one day old.

The plastic foil can be put on again before this almost finished row of blocks and the crane can come back to lift off the first formwork of this row. In this organisation the manufacturing of the blocks was done 24 hours a day. The second reason for this system of production was that an orderly fabrication site was created.(see picture 5).

A cruise ship was brought to the harbour to serve as a hotelship, which supplied housing to 500 men during the maximum production on the site. The ship was protected against the severe storm conditions by a dam closing the specially built artificial lake. The construction harbour existed already as a remainder of the construction of the west breakwater of Sines harbour.

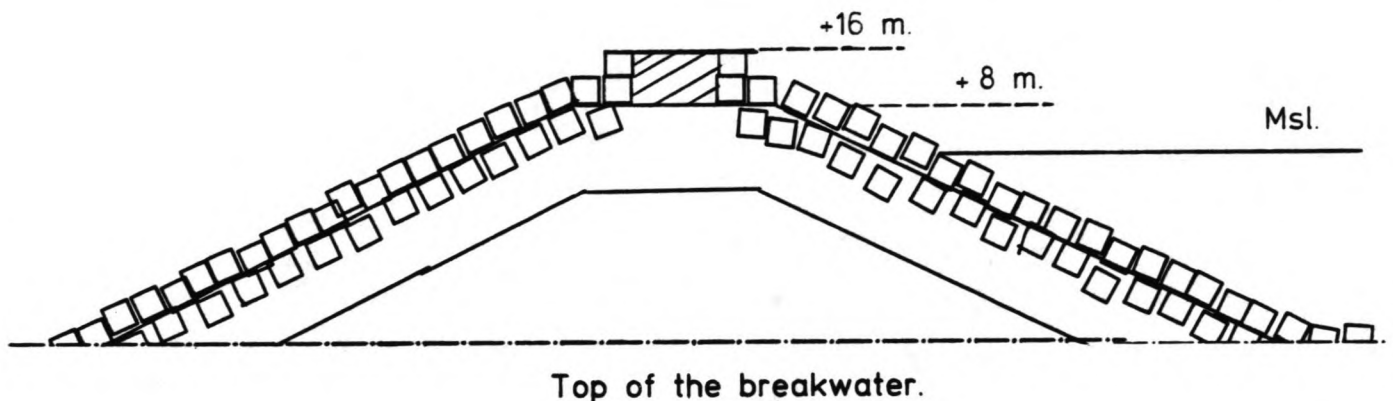
The rubble mound breakwater is built with blocks weighing a maximum of 72 tons. These enormous blocks are necessary to resist the wave attack with a significant height of 11 mtrs, and a period of more than 20 seconds. The seawaves can approach the harbour over relatively deep water of 30 mtrs. The 72 ton blocks are only installed at the ends of the breakwater. In the main part of the breakwater 60 ton blocks were used. The size of the blocks however is the same, because high density concrete was used in the 72 ton blocks. The density was obtained by using ore instead of the normal aggregate used in the other blocks (3.2 tons/m<sup>3</sup> instead of 2.6 tons/m<sup>3</sup>).

The breakwater was built by dumping the rockfill material with splitting barges. When this was not possible any more the construction was done by dumping the material over the head of the breakwater. The last upper layers of the breakwater were put on the slopes with high accuracy. In this way a very smooth surface of the upper layer was obtained. On this layer the concrete blocks had to be placed. This job was done with special care and the contractor tried to achieve an accuracy of 0.1 mtr per block. These blocks had to be placed in a special configuration of two layers in which the density of the upper layer was thinner than that of the first layer. The positioning of the blocks was done with two theodolites forming a triangle with the block, when seen from above.

Although the possible accuracy of 0.1 mtr seemed to be sufficient to achieve a good positioning of the blocks, it appeared from soundings that in some places gaps existed in the armouring layer. Checks were done by divers on demand of the consultant in order to convince the contractor that something had to be done.

Of course these gaps were filled with blocks. The formation of these gaps was possible because a small fault per location of one block can grow to a much bigger fault in a series of a lot of blocks. A better positioning of the blocks could have been achieved if it had been done using the pontoons position and the angle of the beam to my opinion.

An interesting part of the breakwater is the construction of the cap wall. The level of the not yet finished breakwater is 8.00 mtrs above sea level.



The cap wall is designed as a massive reinforced concrete construction of 8 mtrs height and a width of 10 mtrs. The construction will be done by using the armouring blocks as a formwork. The best result is obtained by placing the blocks as shown in the drawing above, and in picture 7. The gaps between the blocks can be filled with wood, in order to reduce the loss of concrete through these gaps. By constructing the cap wall this way, the regulation of the temperature during the hardening of the wall will be improved. The mass of the already hardened blocks will reduce the temperature gradients at the sides of the wall. However special attention has still to be given to the temperature gradients on top of the cap wall. The quality of the concrete concerning influences by temperature can be assured in this way. Another interesting point about this solution is that the contractor does not have to bother about building a special formwork which is strong enough to be stable during the pouring, and which also assures good insulation qualities at the same time.

The method with the blocks seems the best solution because the construction of the extra blocks needed only cost the price of the construction material and will therefore be relatively cheap.

The coal berth quay is made with caissons of 40 mtrs long, 22 mtrs wide, and 25 mtrs deep. The caissons were made in a floating pontoon with a sliding formwork (picture 8,9).

The construction of a caisson is done as follows. The bottom of the caisson is made on a steel floor which is hanging on the roof of the pontoon. After the concrete floor has hardened the steel floor can be removed by another small pontoon. On top of the concrete floor the sliding formwork is placed, and after the reinforcement steel is put between walls, the concrete can be poured in. Instead of moving the formwork up, the already finished part of the caisson can be lowered by the cables which carry the caisson. The cables are led through the formwork walls. New steel can be put in the formwork and another layer can be poured in. The advantage of this way of constructing the caissons is that they can be transported floating directly after one is completed. In eight days a caisson was built and could be placed directly afterwards. The restriction of the building time is that the concrete of the upper part which has not already hardened can not resist the hydrostatic force on the outside of the wall.

After the caissons were sunk they were filled with waste material from the quarry. On top of the caissons a two meter high beam would be constructed to support the rails for the berthing cranes.

At the end of my visit:

- the breakwater was almost finished, except that the upper layer of armour cubes had to be placed, and the cap wall had to be built.
- the temporary coal terminal was almost finished and was expected to become productive in September 1986 ( see picture 10).
- The caissons were placed and filled. The groundfill works behind the quay were half finished.
- The dam of the artificial lake was dredged through in order to remove the hotel ship which was not required any more.

#### **4.9 Portimao (d.1).**

The harbour of Portimao is located in the estuary of the Arade river and besides the harbour of Faro is the most important harbour of the Algarve. The area of the harbour is 3.5 Km long and it is 1.5 Km wide at its widest place. A master plan was made in 1976 for the development of the harbour of Portimao and the area around Portimao (see attachment 11).



In the plan a general cargo quay (A), a fishing dock (B), a ship repair quay (C), a commercial and tourist quay (D), a navy quay (E), and a recreational dock (F) are included. The execution of the works started at the end of 1976. The works which are just finished are the fishing dock, the commercial and tourist quay, the ship repair quay and the naval quay.

The fishing dock contains 440 mtrs of quay of which 280 mtrs is available for trawlers, 100 mtrs for coasters and 60 mtrs for freezer trawlers. These quays have a depth of 6.00 mtrs below Msl.

Further there is 170 mtrs of quay available for provisioning, and also 450 mtrs of jetties to moor the fishing boats. On the left quay of the fishing dock, a ramp has been built from which the ships can be let in or taken out of the water. Ships up to 85 mtrs can be handled. On this quay the ship repairing takes place.

The auction building for the fishermen has been built as described in the section of the harbour of Peniche.

On the tourist and commercial quay of 300 mtrs, with a depth of 8.00 mtrs below Msl, cruise ships can be berthed. 100 mtrs further upstream a jetty to berth car ferries will be built. Further downstream a naval quay is finished. The entrance channel of the harbour is dredged to a depth of 8 mtrs. In order to stabilize the depth of the channel, the left and right banks of the river needed to be regulated.

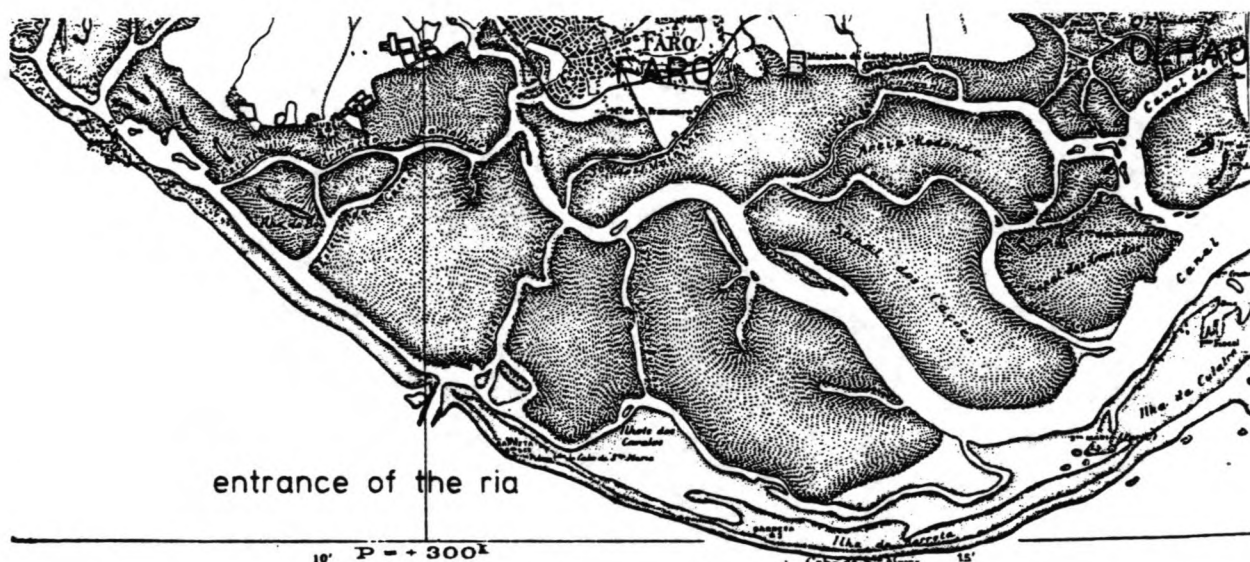
In the general plan a recreational dock was also included. The marina will be built by a private company under the supervision of the Autonomous Administration of the Harbours of the West-Algarve (J.A.P.B.A). After these works have been finished, a commercial quay will be built near the fishing dock for general cargo ships. The railway will be extended from the station to this quay.

The Algarve has 270.000 inhabitants of which more than 100.000 depend on the harbour of Portimao. The junta of Portimao is planning to have a fishingtrade of 26.000 tons/year, and a merchandise of 120.000 tons/year, at the end of the first phase.

The construction of the first phase of the expansion cost 12.000.000 guilders. The influence of the expansion is expected to be great on the economic activities of Portimao. The fishing fleet will expand, especially with the bigger ships (freezer trawlers). Also the ship repairing activities will increase. In future this harbour will serve as a berthing harbour for the car ferries between Portugal and Africa.

#### 4.10 Faro (d.5).

The ria de Faro is an area in which very quick changes of the configuration take place during the year but also during decades. The sandbanks suffer from severe erosion and the channels change their position accordingly. The dislocation of the sea channels can grow up to 100 mtrs a year. Also the depth of the channels was variable, which caused problems for the access of the ships to the harbour of Faro. A thorough measurement program was started of which the reports were finished in 1985.



For the development of the harbour it is necessary to have permanent access to it. Because the development of the biggest commercial harbour of the Algarve was slowed down by the permanent change of the environmental conditions, the D.G.P decided to stabilize the entrance of the Ria de Faro. This entrance should also become the connection with the important fishing harbour in Olhao.

The stabilisation of the entrance was obtained by the construction of two rubble mound breakwaters at the sea side of the entrance. The average depth of the entrance channel after construction was 8 mtrs below Msl. The erosion however in this channel was so heavy that it was only stopped after a rock layer at minus 13 mtrs was reached. The stability of the breakwaters came in danger because the toes of the breakwaters started to erode as well. At the moment repairing of the breakwaters is in full process. Here the material is shipped to the construction site on pontoons from which the material is shoved in to the sea (see picture 12,14).

#### 4.11 Lisbon .

The harbour of Lisbon is located at the banks of the Tejo river (see attachment 10). The natural basin of Lisbon harbour and the position of it in the international traffic form good physical conditions for an international harbour. The area of the basin is 32.500 ha, with a bank length of approximately 25 Km and a minimum entrance depth of 14.5 mtrs.

The total length of the unloading berths reaches up to 16 Km of which 13 Km is situated on the north side and 3 Km on the south. The water depths along these berths vary from 4 up to 17 mtrs. On the north bank of the basin a depth of 8 mtrs dominates and on the south bank an average water depth of 13 mtrs.

The economic exploitation is done by the autonomous general administration of the port of Lisbon (A.G.P.L), and is concentrated on the north bank. On the other side the berths are exploited by private companies but as far as harbour activities are concerned, those are under the supervision of the A.G.P.L.

On the north bank two general cargo docks (1), two container terminals (2), a liner terminal to the Açores and Madeira (3), an oil terminal (4), a petrochemical terminal (5), a recreational dock (6), a maintenance and operation dock for the harbour authorities (7) and a fishing dock (12) are situated. On the south bank several important terminals are located, such as, liquid and bulk cereal (8), chemical (9), oil (10), fertilizer (11) and ship cleaning terminals (12).

Further there is a ship repair dock, which is supposed to be one of the biggest in Europe, with a dock adjusted for ships up to 1.000.000 tons!(13), the bulk grain terminal Tagol (14) with a capacity to unload ships up to 90.000 tons, and a cereal terminal Trafaria (8) with a capacity of 200.000 tons storage and unloading berths up to a depth of 17 mtrs.

On both sides of the river various smaller specialized terminals can be found like small construction and repair docks, distributors of civil construction materials and passenger ferries.

In the development of the harbour the general administration of the port of Lisbon will concentrate on the areas of:

- containers
- cereal
- tourism

Therefore two container terminals ( Santo Appolonia and Alcantara sul ), and the cereal terminal Trafaria have been built in the last few years. The Tagol grain terminal and several recreational docks already existed. The two container terminals differ from each other in the way of exploitation. The terminal Santo Appolonia is exploited directly by the A.G.P.L, but the other is rented to a private company, Liscont.

The first terminal has 860 mtrs quay with a depth of 8 to 9 mtrs and a storage area of 80.000 m<sup>2</sup> available. The maximum load capacity of the cranes installed is 35 tons and three ships can be berthed at the same time. The transit capacity of this terminal is 120.000 containers a year.

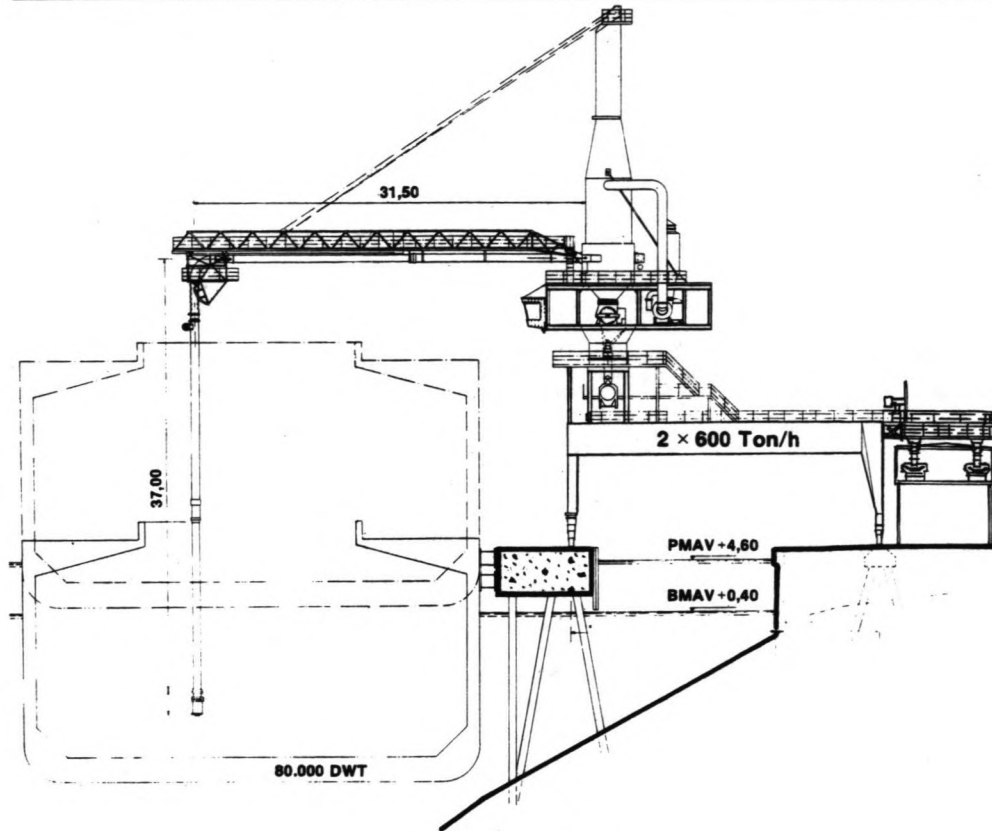
The terminal exploited by Liscont contains 650 mtrs quay, 13 mtrs deep, and a storage area of also 80.000 m<sup>2</sup>. This terminal is fully equipped to handle containers up to 60 tons, and provides a 24 hour service. The goal for this terminal is to become a leading transshipment terminal in Europe. The capacity at the moment is a transshipment of 150.000 containers a year.

During the visit to the Tagol terminal special attention was given to the design of the loading and unloading berths of the company. For expansion reasons the construction of a new unloading berth was desired. First a temporary berth (three breasting dolphins) had to be built in order to continue the production of the plant during construction of the berth. After the construction of the unloading berth was finished a loading berth was also needed.

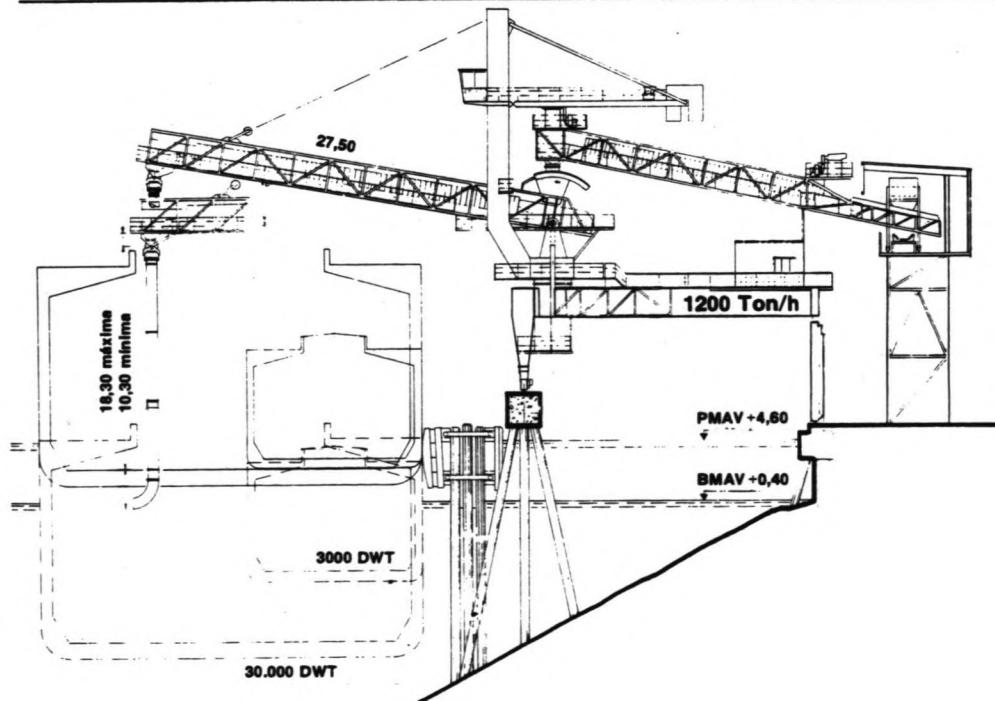
The unloading berth which had to be completely newly built had to be able to withstand vertical forces from the cranes, and horizontal forces from the ships. The result was a rather heavy construction in concrete on steel piles. For the loading berth however the existing construction used as temporary berth could be used, because this loading berth would be constructed in the same place. If the old construction was used, the new one had only to absorb the vertical forces and could therefore be constructed relatively lightly.

The combination of the old breasting dolphins and the new construction could be made if these two constructions would be able to move independently from each other. The new construction had to be rigid because one leg of the crane rests on it, in contrast with the temporary construction (the breasting dolphins) which was constructed very flexibly. The solution was found by building the new construction higher than the breasting dolphins so that the these dolphins could move independently from the berth while absorbing the ships energy. Although it is not the most elegant solution, it is cheap, and it works!

# PÓRTICOS DE DESCARGA PNEUMATIC SHIP UNLOADERS



# PÓRTICO DE CARGA SHIP LOADER



## 5. General experiences and comments.

Besides coastal engineering experiences the practical training also contained more general experiences. For example acquaintance was made with several organisations involved in the construction of civil projects.

1. The owner of these projects was in most cases the D.G.P. Their point of view towards projects contained a broad field of aspects of which the main ones are technical, environmental, political and economic aspects as can be expected from a governmental institute. Also the point of view of a private company as owner was given attention. Here the objective was to obtain the maximum functioning against the lowest costs.

The position and point of view of a consultant in projects under execution was made clear in talks with site engineers of two different consultants on different projects. By accompanying these engineers for several days at the construction site, a good impression was obtained of the kind of work a representative of the consultant has to do. The emphasis is on controlling if the construction is built as specified and checking construction alternatives of details proposed by the contractor, but also advising the contractor.

The contractor's point of view was given attention during interviews with the site managers of the projects visited, and can be condensed to: building the project as specified against the lowest costs.

2. At the production site it was interesting to see how quality control was done. Simple tests to check the concrete quality (Slump test) and consolidation tests (Proctor test) were done in the field. The sizes of rocks for armourment were checked visually but quantity control was done by weighing. Little attention was paid by the contractors to the men at work. People working at the stone mill plant were not obliged to wear gas masks, although the air was filled with dust. People filling the formworks 8 hours a day at the block-manufacturing site do not have to wear earphones although the noise of the internal vibrators is extremely loud.

## 6. Conclusions and recommendations.

1. In almost all projects of the harbours in Portugal, very ambitious expansion plans can be found. A lot of work to improve the capacity of the existing harbours has already been done. For the future development of the harbours it is not likely that new harbours will be necessary. At this moment it is necessary to improve the connection with the "hinterland". Most roads are single track and there is only one highway from the north to the south. For this reason the infrastructure has to be improved drastically in accordance with the demands for transport of the existing harbours, and in accordance with the future development and specialisation of these harbours. Especially the connection has to be improved for the development of the harbours with container terminals.

A start has been made with the improvement of the infrastructure, and the construction of a North-South connection with a highway is almost finished.

The "hinterland" of the Portuguese ports can be expanded by adding the west centre of Spain to it. The shortest way to these places for transatlantic transport is the road connection through Portugal. Here also it will be necessary to improve the roads first.

By integrating the D.G.P in the Ministry of Public Works, Transport and Communications there will be a good opportunity to design a master plan for the development of the harbours and the infrastructure.

2. The defence of the 800 Km long Portuguese coast seems a problem because of the very heavy conditions to which this coast is exposed and the various types of coast. In some places severe erosion is damaging the coast and in two places the situation was even critical. Sometimes it seems that the problem of one place on the coast is solved by moving it to an other place. This happens when erosion is stopped by just building groins at the place where erosion takes place.

In this way it will be necessary to continue building groins and placing armour rocks. The solution of sand suppletion where needed, taking the sand away where available, could be taken more into account in my opinion. It has a good chance because in some places sedimentation and in other places erosion forms the problem (Aveiro), especially when the distance between the two places is not too big.

The advantage of this solution is not only that the problem is not moved to another place (on the contrary, two problems are attacked at the same time), but also that the natural coast configuration is maintained.



## 7. Evaluation.

The purpose which was formulated at the beginning of the practical training and repeated in this report, can be achieved on different quality levels. Knowing that the study had to be done in only 9 weeks and knowing that almost all information was written in Portuguese, this purpose seems a little ambitious.

The loss of a full week therefore had a great impact on the practical training. As a result the last few weeks were overplanned, knowing that time was too short to see all there was to see.

However at the end of this practical training, the purpose was achieved in my opinion. By studying reports and by intensive contacts with engineers, insight was obtained into the way of engineering in the D.G.P. The visits to the works and harbours were very valuable to obtain a feeling of the size of the projects, the way of constructing them and the organisations involved, but also for insight into harbour activities. A carefully considered choice was made between the projects for the visits in order to get a broad view of civil engineering.

Besides this it was a good experience to get acquainted with the Portuguese way of management and organisation, which sometimes seems rather chaotic, but creates a very good atmosphere to work with, and not to be forgotten, it works!

The contacts with the different organisations involved in civil projects gave a better insight into what the work of a civil engineer consisted of, in different organisations with different insights, interests and goals.

Although the timing was not perfect for the practical training because of holidays and reorganisations in the D.G.P a lot of help was given to turn it into a success.

In the office in Lisbon study material was given to me with extra explanations as well. It was sometimes rather embarrassing how much time was dedicated to helping and advising, especially by the director of the Directorate of Physiographic Services and the engineers in the office. An advantage was that progress in the Portuguese language was made rather fast.

The visits to the projects were all made in the company of a D.G.P engineer and even once with the director of the D.S.F, or with an engineer of the consultant in the specific place visited. Exceptionally good transport facilities were provided, and besides the engineering aspects these visits also contained cultural and even gastronomic aspects!

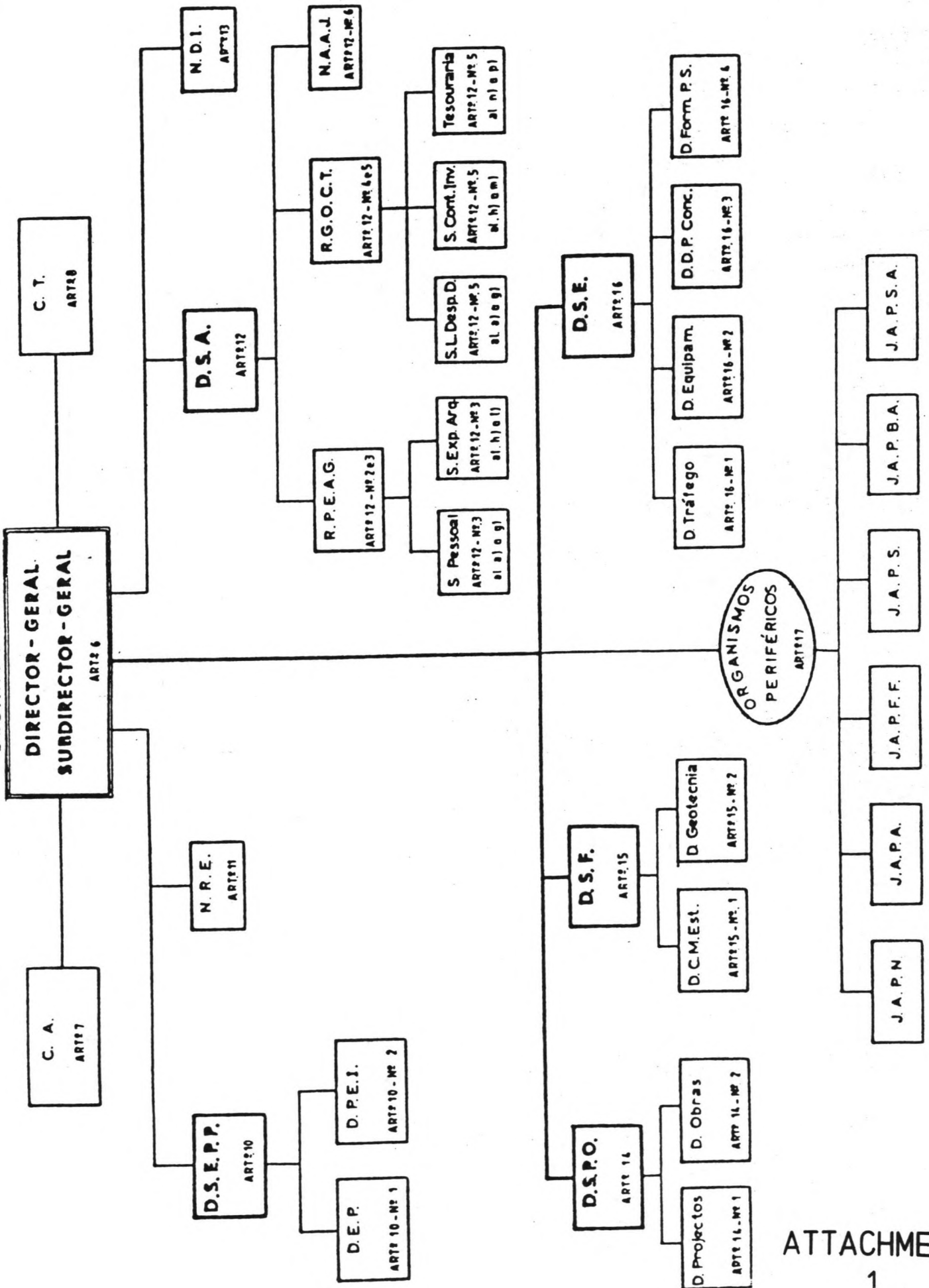
The visit to the west breakwater of Sines was absolutely the most spectacular and impressing vissit during the practical training.

To me this practical training was a very good experience and has indeed enlarged the scope of my study in civil engineering. Besides and a rather good impression was obtained of the Portuguese way of work and living.

For the D.G.P it was the first experience of having a foreign student doing practical training in their office. I hope their experience is good enough to give others the same opportunity they gave to me.

To guarantee that some physical work was performed also during the practical training the last picture shows the more practical side of my activities, although this part was not dominant.

ORGANOGRAMA



DIRECÇÃO-GERAL DE PORTOS

D.G. - Director-Geral  
S.D.G. - Subdirector-Geral  
C.T. - Conselho Técnico  
C.A. - Conselho Administrativo  
N.R.E. - Núcleo de Relações Exteriores  
N.D.I. - Núcleo de Documentação e Informação

A - Serviços de Apoio

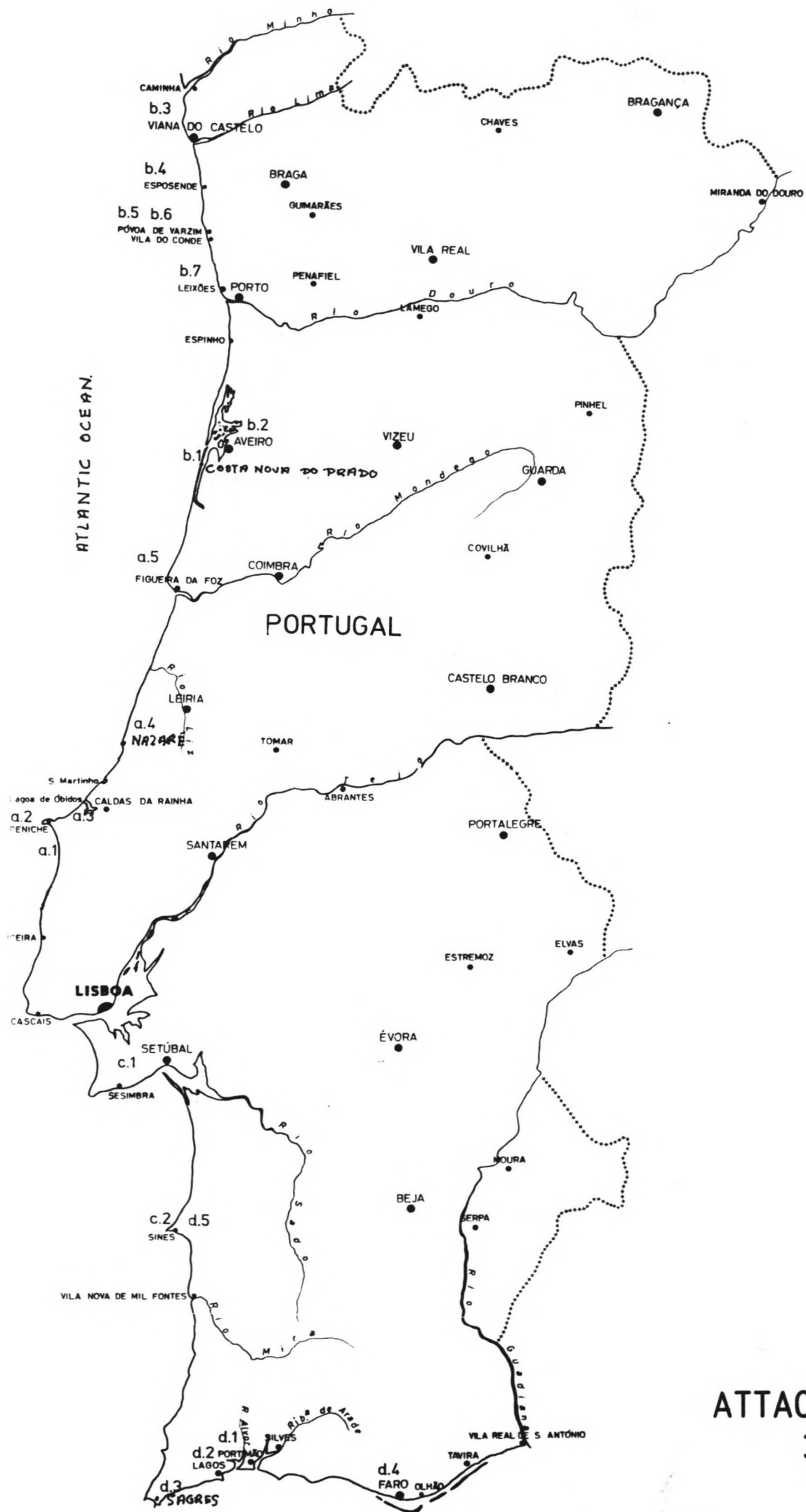
D.S.E.P.P. - Direcção dos Serviços de Estudos, Planeamento e Programação  
D.S.A. - Direcção dos Serviços de Administração

B - Serviços Operativos

D.S.P.O. - Direcção dos Serviços de Projectos e Obras  
D.S.F. - Direcção dos Serviços de Fisiografia  
D.S.E. - Direcção dos Serviços de Exploração  
D.E.P. - Divisão de Estudos e Planeamento  
D.P.E.I. - Divisão de Programação, Estatística e Informática  
R.P.E.A.G. - Repartição de Pessoal, Expediente e Arquivo Geral  
R.G.O.C.T. - Repartição de Gestão Orçamental, Contabilidade e Tesouraria  
D.P. - Divisão de Projectos  
D.O. - Divisão de Obras  
D.C.M.E. - Divisão de Costas Marítimas e Estuários  
D.G. - Divisão de Geotecnia  
D.T. - Divisão de Tráfego  
D.E. - Divisão de Equipamentos  
D.D.P.C. - Divisão do Domínio Público e Concessões  
D.F.P.S. - Divisão de Formação Profissional e Segurança  
S.P. - Secção de Pessoal  
S.E.A. - Secção de Expediente e Arquivo  
S.L.D.R. - Secção de Liquidação de Despesas e Receitas  
S.C.I. - Secção de Contratos e Inventário  
N.A.A.J. - Núcleo de Apoio Administrativo às Juntas  
T. - Tesouraria

C - Organismos Periféricos

J.A.P.N. - Junta Autónoma dos Portos do Norte  
J.A.P.A. - Junta Autónoma do Porto de Aveiro  
J.A.P.F.F. - Junta Autónoma do Porto da Figueira da Foz  
J.A.P.S. - Junta Autónoma do Porto de Setúbal  
J.A.P.B.A. - Junta Autónoma dos Portos de Barlavento do Algarve  
J.A.P.S.A. - Junta Autónoma dos Portos de Sotavento do Algarve





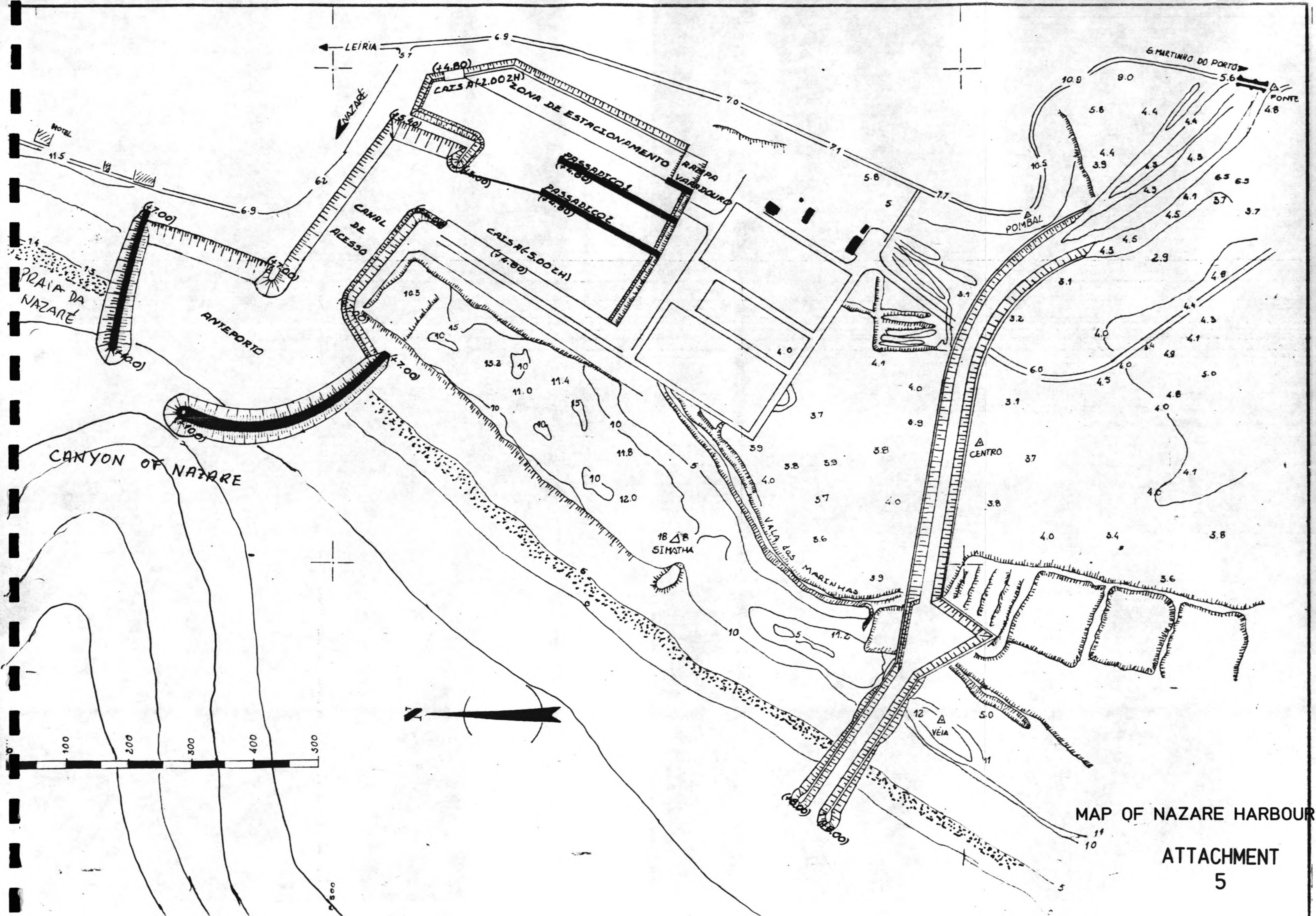
**ATTACHMENT**  
**4**

**DIRECÇÃO - GERAL DE PORTOS**

**PORTO DE PENICHE**  
**EDIFÍCIOS E INSTALAÇÕES**  
**COMPLEMENTARES**

**PORTO DE PENICHE**  
**PLANO GERAL DE PLENO DESENVOLVIMENTO**  
**REVISTO EM 1975 - ACTUALIZADO EM 1976**

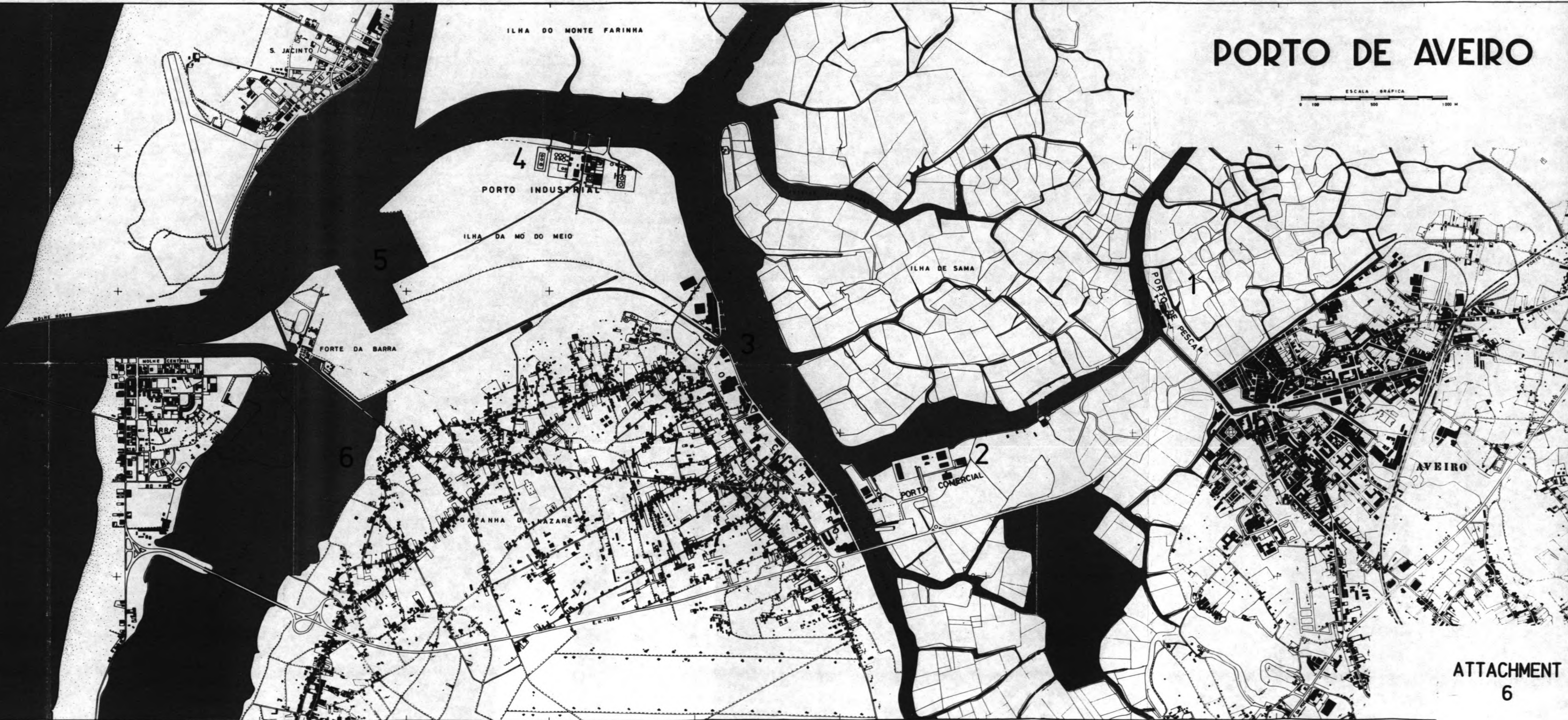
36.16
7
38.20



MAP OF NAZARE HARBOUR

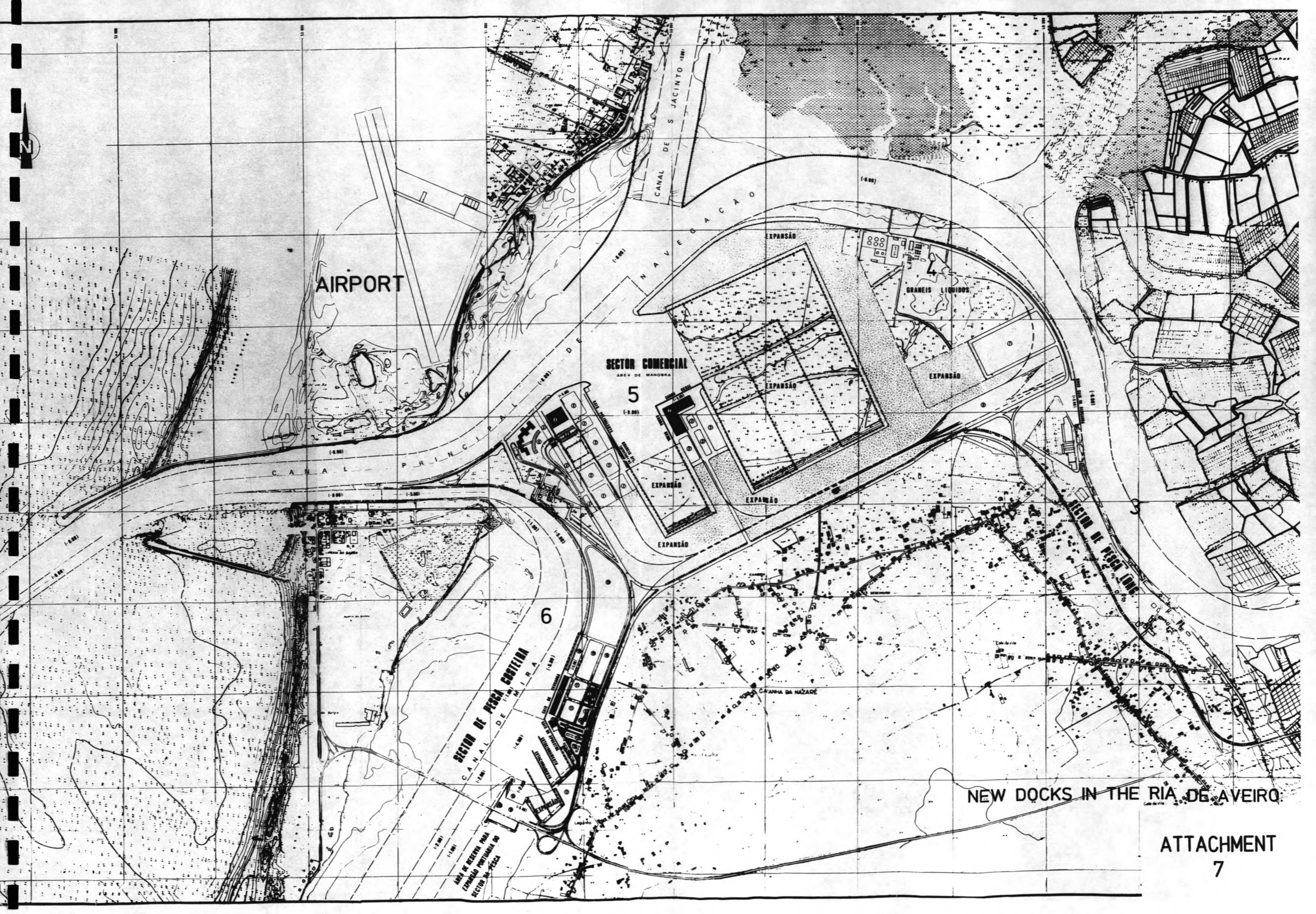
# PORTO DE AVEIRO

ESCALA GRAFICA  
0 100 200 300 M



ATTACHMENT  
6





AIRPORT

SECTOR COMERCIAL

5

(-8.00)

6

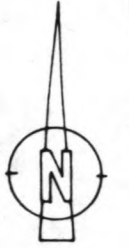
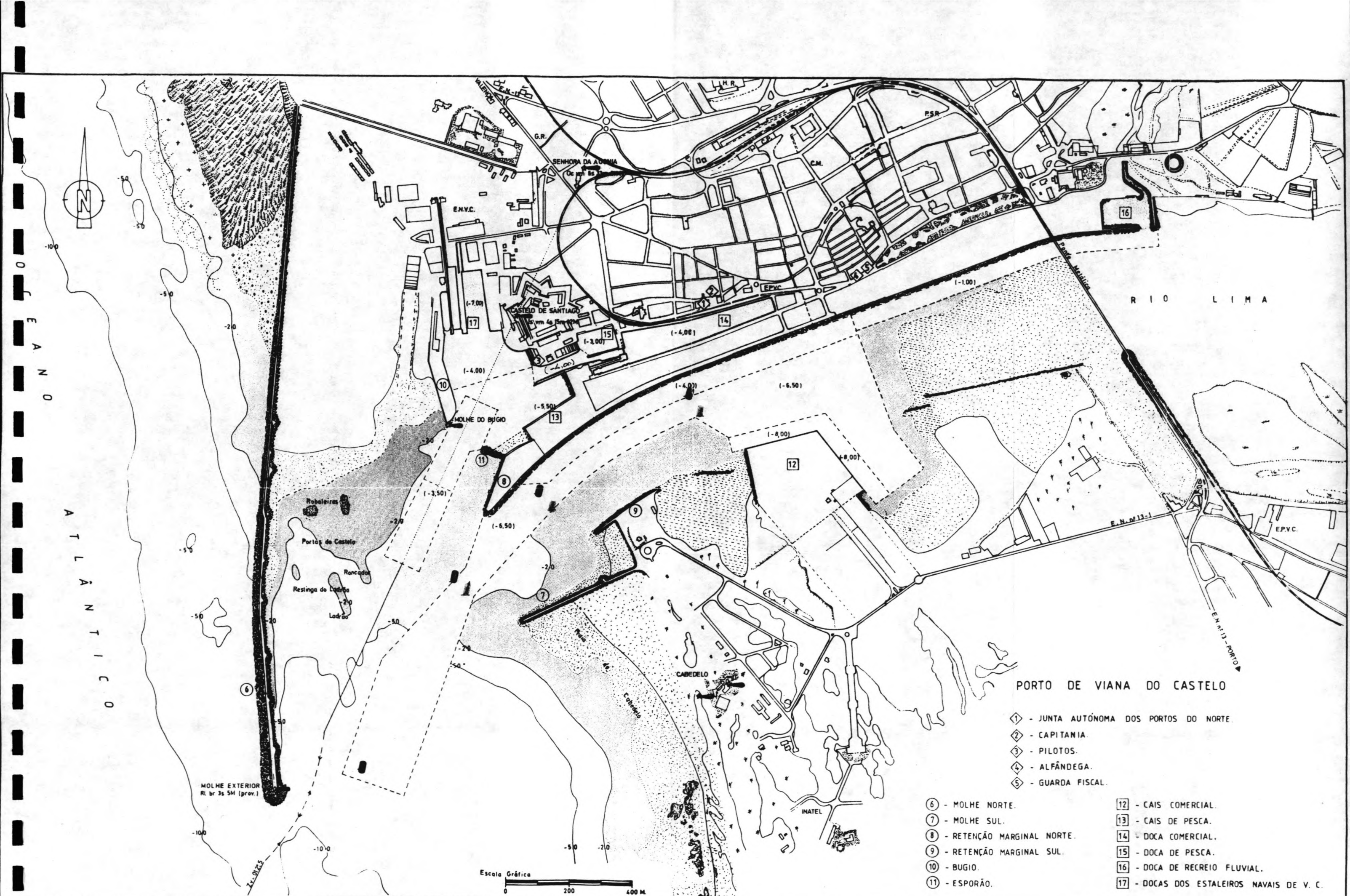
SECTOR DE PESCA COSTEIRA  
CANAL DE S. JACINTO

ÁREA DE RESERVA PARA  
EXPANSÃO PORTUÁRIA DO  
SECTOR DE PESCA

NEW DOCKS IN THE RIA DE AVEIRO

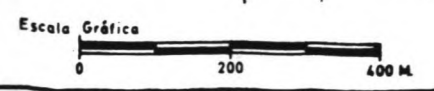
ATTACHMENT

7



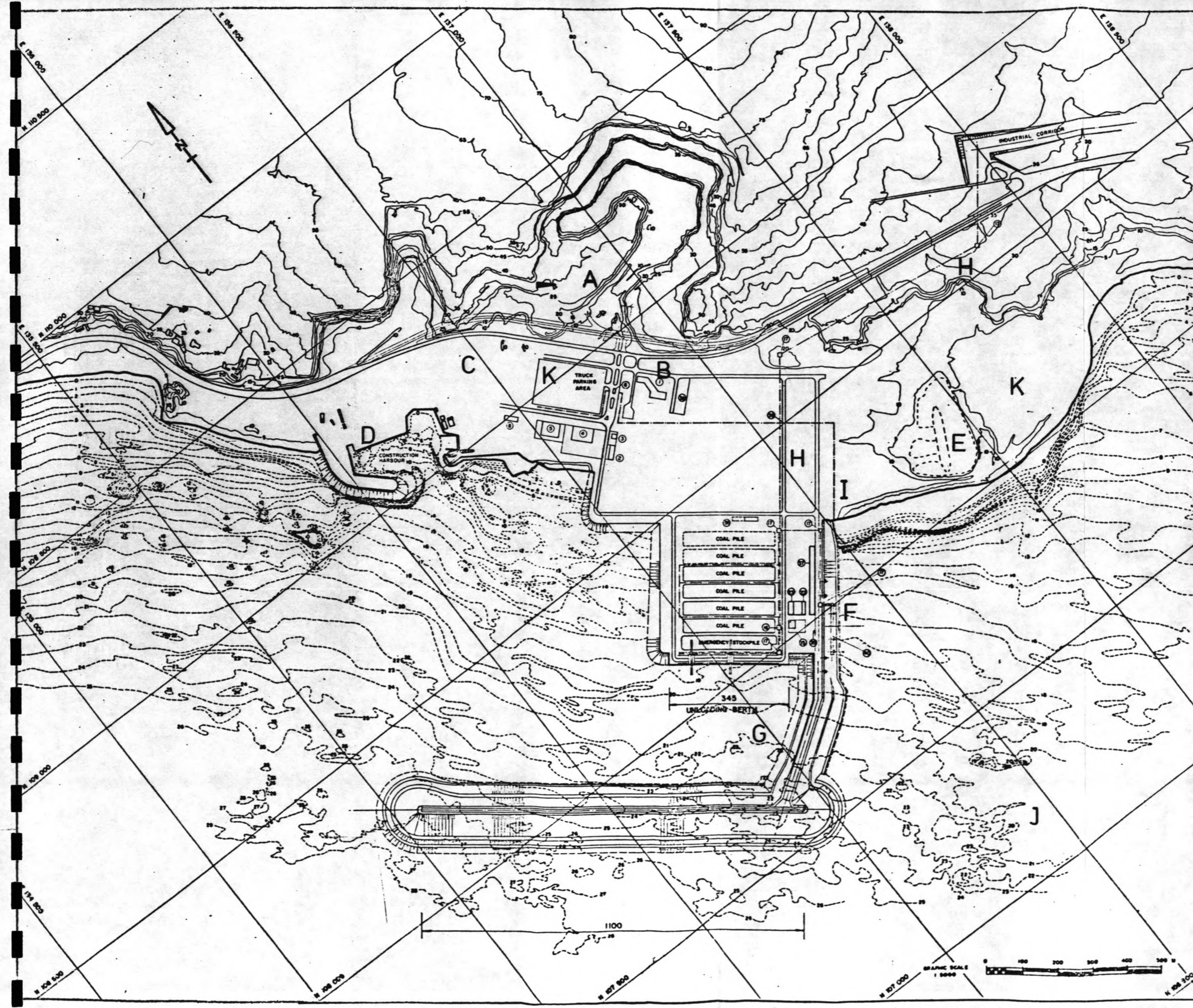
A T L Â N T I C O

MOLME EXTERIOR  
RL br 35 SM (prov.)



PORTO DE VIANA DO CASTELO

- ① - JUNTA AUTÓNOMA DOS PORTOS DO NORTE.
- ② - CAPITANIA.
- ③ - PILOTOS.
- ④ - ALFÂNDEGA.
- ⑤ - GUARDA FISCAL.
- ⑥ - MOLME NORTE.
- ⑦ - MOLME SUL.
- ⑧ - RETENÇÃO MARGINAL NORTE.
- ⑨ - RETENÇÃO MARGINAL SUL.
- ⑩ - BUGIO.
- ⑪ - ESPORÃO.
- ⑫ - CAIS COMERCIAL.
- ⑬ - CAIS DE PESCA.
- ⑭ - DOCA COMERCIAL.
- ⑮ - DOCA DE PESCA.
- ⑯ - DOCA DE RECREIO FLUVIAL.
- ⑰ - DOCAS DOS ESTALEIROS NAVAIS DE V. C.



**KEY PLAN**

**NOTES**

- LEGEND**
- PORT BUILDINGS**
- 1 GENERAL ADMINISTRATION
  - 2 CAFE
  - 3 FIRE/AMBULANCE STATION
  - 4 CENTRAL WORKSHOP
  - 5 CENTRAL STORES
  - 6 MAIN GATE HOUSE
  - 7 ELECTRICAL SUBSTATION
  - 8 ADMINISTRATION/CONTROL BUILDING (COAL)
  - 9 ELECTRICAL SUBSTATION
  - 10 STORE

- PORT FACILITIES AND UTILITIES**
- 16 SAMPLING STATION
  - 17 TRANSFER STATION
  - 25 FUELLING AND WATER POINT
  - 26 SETTLING POND
  - 27 MOBILE EQUIPMENT PARKING AREA
  - 28 CAR PARKING AREA
  - 29 SERVICE ENTRANCE
  - 30 TEMPORARY COAL UNLOADING PLATFORM

Notes referring to the report.

- A. Quarry
- B. Stonemills.
- C. Concrete factory
- D. Constrution harbour
- E. Hotelship
- F. Temporary coal terminal
- G. Caisson building pontoon
- H. Conveyor belt
- I. Temporary stockpile
- J. Expansion location breakwater.
- K. Cube construction site

**EXPANSION OF SINES HARBOUR.**

REV	DATE	DESCRIPTION	BY	CHKD	APPD

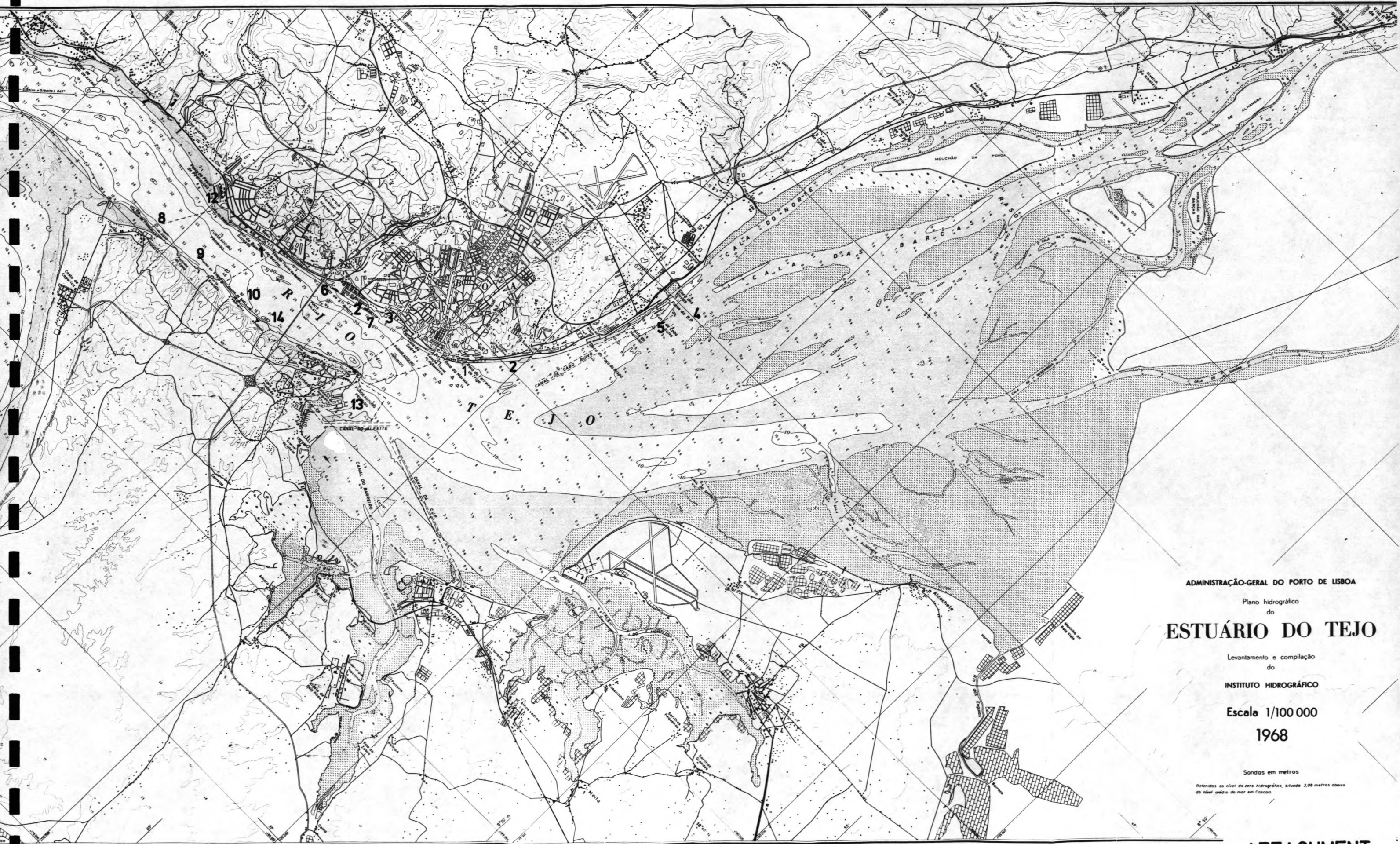
**GABINETE DA AREA DE SINES**  
CONTRACT JOB No CG-13/86 PORT OF SINES

MASTER PLAN  
PHASE 1A-1986  
REVISION 1.

BY: L.S. / DP: P.L.

CLASSIFICACAO: ...

1:5000  
1:5000  
1:5000



ADMINISTRAÇÃO-GERAL DO PORTO DE LISBOA

Plano hidrográfico  
do

# ESTUÁRIO DO TEJO

Levantamento e compilação  
do

INSTITUTO HIDROGRÁFICO

Escala 1/100 000

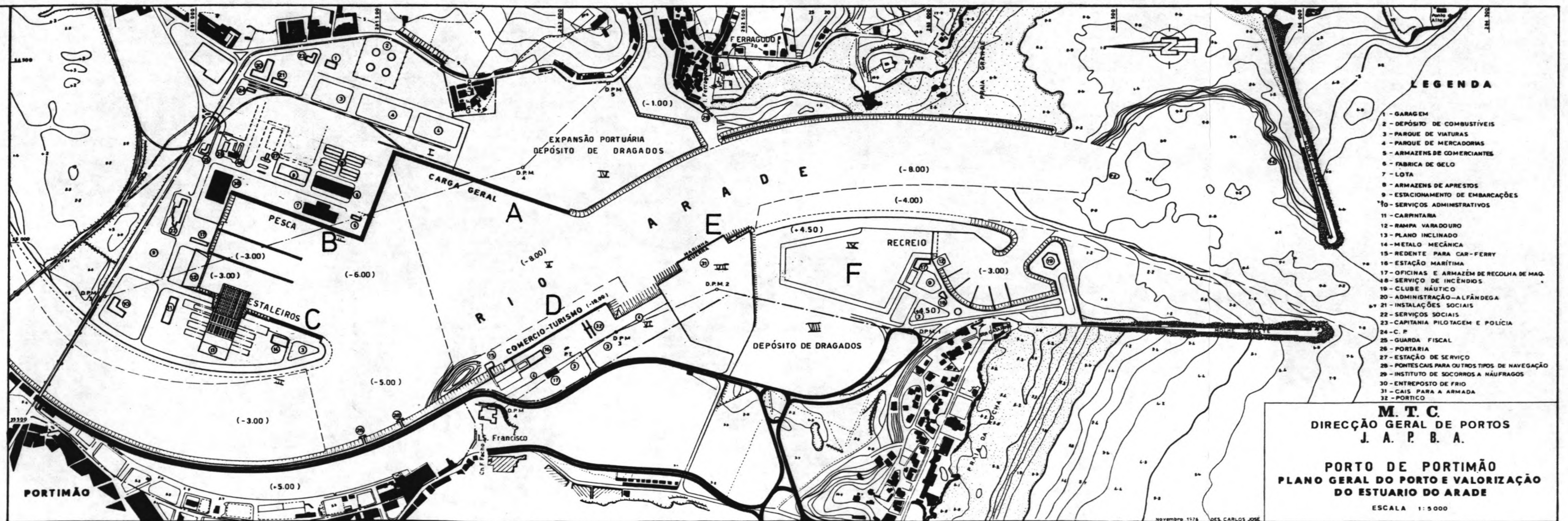
1968

Sondas em metros

Referidas ao nível do zero hidrográfico, situado 2,08 metros abaixo  
do nível médio do mar em Cascais

ATTACHMENT

10



**LEGENDA**

- 1 - GARAGEM
- 2 - DEPÓSITO DE COMBUSTÍVEIS
- 3 - PARQUE DE VIATURAS
- 4 - PARQUE DE MERCADORIAS
- 5 - ARMAZENS DE COMERCIANTES
- 6 - FABRICA DE GELO
- 7 - LOTA
- 8 - ARMAZENS DE APRESTOS
- 9 - ESTACIONAMENTO DE EMBARCAÇÕES
- 10 - SERVIÇOS ADMINISTRATIVOS
- 11 - CARPINTARIA
- 12 - RAMPA VARADOURO
- 13 - PLANO INCLINADO
- 14 - METALOG. MECÂNICA
- 15 - REDENTE PARA CAR-FERRY
- 16 - ESTACÇÃO MARÍTIMA
- 17 - OFICINAS E ARMAZÉM DE RECOLHA DE MAQ.
- 18 - SERVIÇO DE INCÊNDIOS
- 19 - CLUBE NÁUTICO
- 20 - ADMINISTRAÇÃO-ALFÂNDEGA
- 21 - INSTALAÇÕES SOCIAIS
- 22 - SERVIÇOS SOCIAIS
- 23 - CAPITANIA PILOTAGEM E POLÍCIA
- 24 - C. P.
- 25 - GUARDA FISCAL
- 26 - PORTARIA
- 27 - ESTACÇÃO DE SERVIÇO
- 28 - PONTES CAIS PARA OUTROS TIPOS DE NAVEGAÇÃO
- 29 - INSTITUTO DE SOCORROS A NÁUFRAGOS
- 30 - ENTREPÓSITO DE FRIO
- 31 - CAIS PARA A ARMADA
- 32 - PORTICO

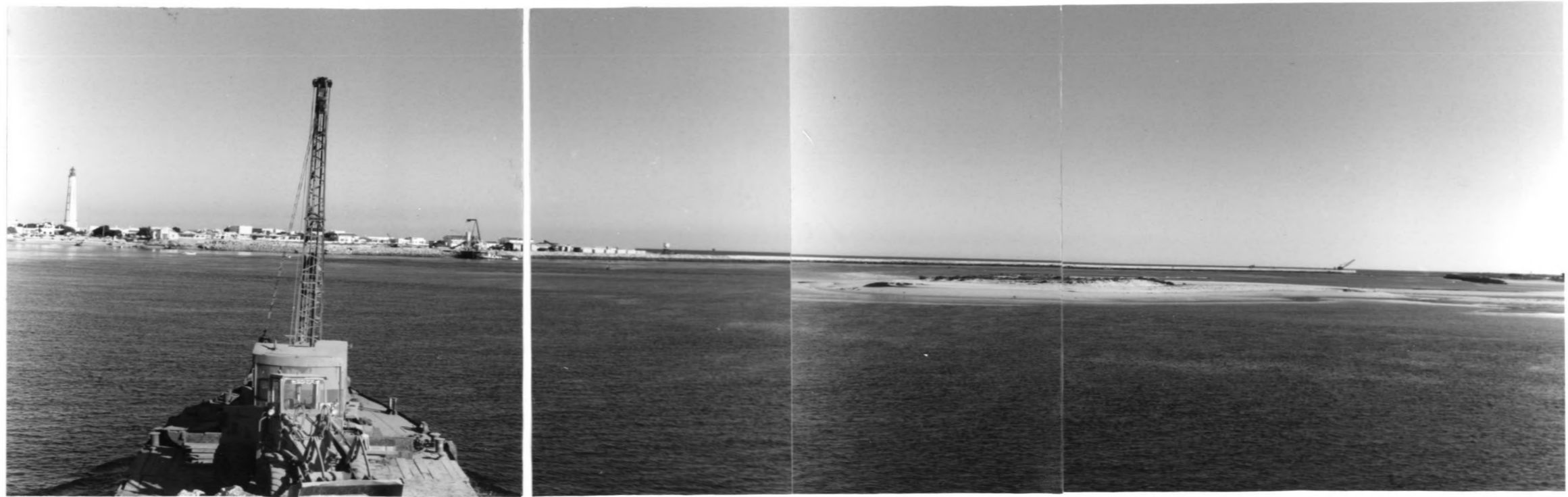
**M. T. C.**  
**DIRECÇÃO GERAL DE PORTOS**  
**J. A. P. B. A.**

**PORTO DE PORTIMÃO**  
**PLANO GERAL DO PORTO E VALORIZAÇÃO**  
**DO ESTUÁRIO DO ARADE**

ESCALA 1:5000



TOMBOLO OF BALEAL ( PICTURE 1 ).



ENTRANCE OF THE RIA DE FARO ( PICTURE 12 ).



SANDWALL 8 MTRS HIGH ( PICTURE 2)



ESPOSENDE  
(PICTURE 3)



EXPLOSION IN QUARRY ( PICTURE 4)



BLOCK FABRICATION  
SITE.(PICTURE 5)





INSIDE SLOPE OF BREAKWATER ( PICTURE 6 )



BLOCKS USED AS FORMWORK FOR CAPWALL ( PICTURE 7 )



CAISSON BUILDING PONTOON (PICTURE 8)



DETAIL  
SLIDING-FORMWORK  
(PICTURE 9)



TEMPORARY COAL TERMINAL ( PICTURE 10)



STONEMILL-PLANT ( PICTURE 11)



LOADING BERTH TAGOL (PICTURE 13)



AT WORK  
(PICTURE 14)

