- Preparation of a berth for bitumen and bunker fuel

  At present, bitumen and bunker fuel are handled mainly at Quay No.27 connected with the NAFTAL's tanks adjacent to the quay by pipelines. However, the quay will be unusable after the start of construction works for the new container terminal project mentioned previously. Thus, another berth for bitumen and bunker fuel will be required near the NAFTAL's premise.

- Safe operations

  In making the port plan, safe operations need to be considered both on water and land. The access channels and basins need to be protected from violent waves by breakwaters, especially in the winter season, though construction cost for the breakwaters is very costly. On the other hand, in order to ensure safe operations on land, the existing congestion needs to be reduced by preparing sufficient yard areas, since the excessive congestion is apt to cause accidents.

- Environmental impact on areas around the port induced by the port development

  In selecting sites for the port development, environmental impact on the areas both during the periods under construction and after the start of operations must be considered.

10.2 Usage Plan for the Existing Port Facilities

As mentioned previously in Section 5.4.1, vessels calling at the Port of Algiers at present are divided into five types; general cargo vessel, Ro-Ro vessel, cereal carrier, tanker and car ferry. In addition to the present five types, a fully-cellular container vessel is added in the stage of the Master Plan. These six types are further divided into the following fifteen categories:

- General cargo vessel laden with various kinds of cargoes
- General cargo vessel laden with one kind of commodity
  - Cement
  - Foodstuffs or agricultural products excluding cereals
  - Wood
  - Steel products

    - Sugar
    - Animal feed
- Ro-Ro vessel
- Cereal carrier
- Tanker
    - Butane, diesel oil, gasoline or fuel oil
    - Naphtha
    - Bitumen
    - Vegetable oil or animal fat
- Car ferry
- Container vessel

The volume of cargoes estimated by the demand forecast(see Chapter 8) is distributed to vessels categorized in the above. The usage plan for the existing port facilities by vessel type is proposed as follows.

(1) General Cargo Vessel(Various Kinds of Cargoes)

The total volume of cargoes to be transported by the vessels of this type through the Port of Algiers is estimated as 709 thousand tons in 2010, showing a decrease of 284 thousand tons from 1990 due to the expected progress of containerization. In making the plan for berth allocation for the vessels, the following premises are adopted considering the actual operations. The average dwelling time for unloaded cargoes is expected to be reduced from the present time of around 50 days to the actual times at other principal ports where shorter dwelling times are accomplished as a result of increased efficiency of necessary procedures including customs clearance.

- Total volume of cargoes: unloaded: 688 thousand tons
  loaded: 21 thousand tons
- Average cargo-handling volume: 2,000 tons per vessel
- Number of calling vessels: 355 vessels per year
- Cargo-handling productivity: 23 tons per hour
- Average dwelling time: unloaded: 20 days: loaded: 14 days
- Storage: sheds: 59%: open yards: 41%
- Land transport: by trucks: 90%: by railways: 10%

Though the volume of handled cargoes is expected to be reduced from the present level, wide storage areas for both sheds and open yards behind berths will be still required even in 2010, the Wharf Bologhine in the Central Zone is mainly planned to serve the vessels. The following berths are allocated:

- Quay No.8(1 berth)
- Quay No.17(1 berth)
- Quay No.21(1 berth)
- Quay No.22(4 berths)
- Quay No.22P/Coupe(1 berth)
- Quay No.23P/Coupe(1 berth)
- Quay No.23(3 berths)
- Quay No.31-2, No.31-3(2 berths)

Total:14 berths

(2) General Cargo Vessel(Cement)

The following premises are adopted considering the record of actual operations. The average cargo-handling productivity is expected to be improved to the level of the cases where efficient cargo-handling were actually recorded.

- Total volume of cargoes unloaded from the vessels: 868 thousand tons
- Average cargo-handling volume: 21,400 tons per vessel
- Number of calling vessels: 41 vessels per year
- Cargo-handling productivity: 250 tons per hour
- Land transport: by trucks: 80%: by railways: 20%

Quay No.34 at the Wharf Skikda is planned to serve the vessels exclusively as it does at present.

(3) General Cargo Vessel(Foodstuffs or agricultural products excluding cereals)

The following premises are adopted considering the record of actual operations:

- Total volume of cargoes unloaded from the vessels: 58 thousand tons
- Average cargo-handling volume: 2,100 tons per vessel
- Number of calling vessels: 28 vessels per year
- Cargo-handling productivity: 17 tons per hour
- Land transport by trucks

Unloaded foodstuffs and agricultural products can be brought out from the port in an exceptionally short period of time according to the customs regulation. Therefore, wide storage areas are not necessary for the cargoes. Thus, the following berths in the North Zone are planned to serve the vessels:

- Quay No.6(1 berth)
- Quay No.9-1(1 berth)
- Quay No.10(1 berth)
- Quay No.11-1(1 berth)

  Total:4 berths

(4) General Cargo Vessel(Wood)

The following premises are adopted considering the record of actual operations. As for the average dwelling time of unloaded wood, the same assumption as mentioned in the Paragraph (1) is used.

- Total volume of cargoes unloaded from the vessels: 356 thousand tons
- Average cargo-handling volume: 5,100 tons per vessel
- Number of calling vessels: 70 vessels per year
- Average dwelling time of unloaded cargoes: 10 days
- Cargo-handling productivity: 61.2 tons per hour
- Land transport: by trucks: 80%: by railways: 20%

Since wide open yards need to be prepared behind berths, the berths of Ghara Djebilet and Skikda, where there are only open yards just behind berths, are planned to serve the vessels. The following berths are allocated:

- Quay No.18(2 berths)
- Quay No.19(1 berth)
- Quay No.20(2 berth)
- Quay No.33-3(1 berth)

  Total:6 berths for exclusive use

Existing sheds behind Quay 20 on the Wharf of Ghara Djebilet need to be demolished to prepare open yards.

(5) General Cargo Vessel(Steel products)

The following premises are adopted considering the record of actual operations. As for the average dwelling time of unloaded wood, the same assumption as mentioned in the Paragraph (4) is used.

- Total volume of cargoes: unloaded: 542 thousand tons
  loaded: 73 thousand tons
- Average cargo-handling volume: 4,700 tons per vessel
- Number of calling vessels: 131 vessels per year
- Average dwelling time of unloaded cargoes: 10 days
- Cargo-handling productivity: 97 tons per hour
- Land transport: by trucks: 80%: by railways: 20%

Since wide open yards need to be prepared behind berths as in the case of handling wood, the same berths as listed in Paragraph (4) are allocated. As a result of the preparation of the exclusive open yard, the average cargo-handling productivity is expected to be improved to the level of the cases where efficient cargo-handling was actually recorded.

(6) General Cargo Vessel(Sugar)

The following premises are adopted considering the record of actual operations.

- Total volume of cargoes unloaded from the vessels: 66 thousand tons
- Average cargo-handling volume: 12,400 tons per vessel
- Number of calling vessels: 5 vessels per year
- Cargo-handling productivity: 33 tons per hour
- Land transport: by trucks: 90%: by railways: 10%

Since sugar vessels are large, the berths with deep water depths are selected for actual utilization as follows:

- Quay No.6(1 berth)
- Quay No.9-1(1 berth)
- Quay No.10(1 berth)
- Quay No.11-1(1 berth)

  Total:4 berths

(7) General Cargo Vessel(Animal feed)

The following premises are adopted considering the record of actual operations. Cargo-handling productivity is expected to be improved from the present level, since sheds for storing feed are now under construction just behind the Quay No.26-1 conceded to the ONAB.

- Total volume of cargoes unloaded from the vessels: 298 thousand tons
- Average cargo-handling volume: 15,200 tons per vessel
- Number of calling vessels: 20 vessels per year
- Cargo-handling productivity: 128 tons per hour
    - Lifting capacity: 5 tons per crane
    - Cycle time: 3 minutes
    - Number of cranes: 2
    - Cargo-handling efficiency: 0.8
    - Operational ratio: 0.8

    (5 tons/cycle/crane x 60 min/hr/3min/cycle x 2 cranes x 0.64 = 128 tons/hr)
- Land transport: by trucks: 30%: by railways: 70%

(8) Ro-Ro Vessel

The total volume of cargoes to be transported by Ro-Ro vessels through the port is estimated as 327 thousand tons in 2010, showing a decrease of 114 thousand tons from 1990 due to the expected progress of containerization, as in the case of general cargo vessels. Hence, some of the berths which are presently used mainly for Ro-Ro vessels are planned to be adopted for other uses. The following premises are adopted considering the record of actual operations.

- Total volume of cargoes: unloaded: 294 thousand tons
  loaded: 33 thousand tons
- Average cargo-handling volume: 1,100 tons per vessel
- Number of calling vessels: 297 vessels per year
- Cargo-handling productivity: 23 tons per hour
- Average dwelling time: unloaded: 20 days: loaded: 14 days
- Storage: sheds: 69%: open yards: 31%
- Land transport by trucks

The following berths are allocated for Ro-Ro vessels:

- Quay No.5(1 berth) for exclusive use
- Quay No.7(1 berth) for exclusive use
- Quay No.22-4(1 berth)
- Quay No.23-3(1 berth)
- Quay No.24(1 berth) for exclusive use
- Quay No.25(1 berth) for exclusive use
- Quay No.31-3(1 berth)

  Total:7 berths for priority use except for No.5, No.7, No.24 and No.25

(9) Cereal Carrier

The volume of cereals to be unloaded at the port in 2010 is estimated as 3,600 thousand tons, 2.7 times greater than the volume in 1990. In order to discharge the forecast volume, the present level of cargo-handling productivity needs to be considerably heightened. For the purpose, in addition to the existing rail-mounted pneumatic unloaders installed along Quay No.35-3, new unloaders are planned to be installed along Quays No.35-1 and No.33-1. Actual productivity is computed as follows:

- Type: rail-mounted pneumatic unloader
- Nominal productivity: 400 tons per hour and unit
- Number of units per berth: 2
- Cargo-handling efficiency: 0.8
- Operational ratio: 0.8
- Actual productivity per berth:
  400 tons/hr/unit x 2 units/berth x 0.8 x 0.8 = 512 tons/hr/berth

In order to obtain the above productivity, silos with sufficient storage capacities need to be prepared. The average dwelling time is planned to be extended from the present average time of 10 days. The following premises are further adopted:

- Average cargo-handling volume: 23,000 tons per vessel
- Number of calling vessels: 157 vessels per year
- Average dwelling time in silos: 18 days

- Land transport: by trucks: 30%: by railways: 70%

The following berths are allocated for cereal carriers:

- Quay No.33-1(1 berth)
- Quay No.35(2 berth)

Total:3 berths for exclusive use

(10) Tanker(Butane, diesel oil, gasoline or fuel oil)

The following premises are adopted considering the record of actual operations. The average cargo-handling productivity is expected to be improved to the level of the cases where efficient cargo-handling was actually recorded.

- Total volume of cargoes unloaded from the tankers: 1,656 thousand tons
- Average cargo-handling volume: 4,600 tons per vessel
- Number of calling vessels: 360 vessels per year
- Cargo-handling productivity: 274 tons per hour

Quay No.37(3 berths) along the Brise Lames Est is planned to serve the tankers as it does at present.

(11) Tanker(Naphtha)

The following premises are adopted considering the record of actual operations. The average cargo-handling productivity is expected to be improved to the level of the cases where efficient cargo-handling was actually recorded.

- Total volume of cargoes loaded into the tankers: 240,000 thousand tons
- Average cargo-handling volume: 20,000 tons per vessel
- Number of calling vessels: 12 vessels per year
- Cargo-handling productivity: 380 tons per hour

Quay No.37(3 berths) along the Brise Lames Est is also planned to serve the tankers as it does at present.

(12) Tanker(Bitumen)

The following premises are adopted considering the record of actual operations. The average cargo-handling productivity is expected to be improved to the level of the cases where efficient cargo-handling were actually recorded.

- Total volume of cargoes unloaded from the tankers: 144 thousand tons
- An average cargo-handling volume: 2,300 tons per vessel
- Number of calling vessels: 63 vessels per year
- Cargo-handling productivity: 100 tons per hour

Quay No.26-2 is planned to be newly allocated for the tankers.

(13) Tanker(Vegetable oil or animal fat)

The following premises are adopted considering the record of actual operations. The average cargo-handling productivity is expected to be improved to the level of the cases where efficient cargo-handling were actually recorded.

- Total volume of cargoes unloaded from the tankers: 493 thousand tons
- Average cargo-handling volume: 3,100 tons per vessel
- Number of calling vessels: 159 vessels per year
- Cargo-handling productivity: 100 tons per hour

The following berths are allocated for the tankers:

- Quay No.32(1 berth) for exclusive use
- Quay No.36(1 berth) for exclusive use

Total:2 berths

(14) Car ferry

The volume of cargoes to be transported in 2010 is estimated as 160 thousand tons, 1.7 times greater than the volume in 1990. In order to meet the forecast demand, in addition to the Quay No.11-2 which now serves the car ferries, Quay No.9-2 is planned to be allocated for exclusive use. The following premises are further adopted:

- Total number of passengers: 526 thousand
- Average cargo-handling volume: 420 tons per vessel
- Number of calling vessels: 366 vessels per year
- Average mooring period: 1 day

(15) Container vessel

The number of containers to be handled at the port is estimated as 532 thousand TEUs in 2010. Approximately 150 thousand TEUs will be handled at the new container terminal to be constructed by restructuring the existing facilities. In order to receive the remaining number of containers, an additional full-scale container terminal with areas of at least 24 ha and berths of 600 meters long is needed. However, it is clear that there is no room to install such a spacious terminal within the existing port limits even if restructuring of the existing facilities is conducted for that purpose. Thus, the additional container terminal is planned outside of the existing facilities.

In the next step, the proposed usage plan for the existing port facilities is determined by using a computer simulation, excluding containers that are planned to be handled at the new container terminals. In this study, The actual statistical distribution forms for ship arrivals and mooring periods at the Port of Algiers are referred. Operational conditions at the port are assumed as follows:

- Annual working days: 310 days
- Daily working hours: excluding liquid bulk and cement: 7:00-19:00
  liquid bulk and cement: 24 hours

A result of the simulation is summarized as follows:

- Average ship waiting times:
  1 General cargo vessels(various kinds of cargoes): 5.5 hrs
  2 General cargo vessels(cement): 0 hr
  3 General cargo vessels(foodstuffs or agricultural products): 0 hr
  4 General cargo vessels(wood): 0.3 hrs
  5 General cargo vessels(steel products): 0.8 hrs
  6 General cargo vessels(sugar): 0 hr
  7 General cargo vessels(animal feed): 14.8 hrs
  8 Ro-Ro vessels: 13.8 hrs

9 Cereal carriers: 31.9 hrs
10 Tankers(butane, diesel oil, gasoline or fuel oil): 0 hr
11 Tankers(naphtha): 0 hr
12 Tankers(bitumen): 0 hr
13 Tankers(vegetable oil or animal fat): 7.5 hrs
14 Car ferries: 0 hr

- Percentage of berth occupancy:
  1 Berths for general cargo vessels(Various Cargoes): 78.9%
  2 Berths for general cargo vessels(Cement): 33.7%
  3 Berths for general cargo vessels(Foodstuffs): 33.2%
  4 Berths for general cargo vessels(Wood): 51.6%
  5 Berths for general cargo vessels(Steel products): 51.6%
  6 Berths for general cargo vessels(Sugar):32.2%
  7 Berths for general cargo vessels(Animal feed): 58.3%
  8 Berths for Ro-Ro vessels: 68.2%
  9 Berths for cereal carriers: 66.9%
  10 Berths for tankers(Butane, diesel oil, etc.): 20.0%
  11 Berths for tankers(Naphtha): 20.0%
  12 Berths for tankers(Bitumen): 12.2%
  13 Berths for tankers(Vegetable oil or animal fat): 25.4%
  14 Berths for car ferries: 50.0%

As to general cargo berths excluding those used for Ro-Ro vessels in common, Quay No.17 used mainly for handling marble, and Quays No.22P/Coupe and No.23P/Coupe, the resulting berth throughput is estimated as 640 tons per unit berth length of one meter. The standard berth throughput used internationally ranges from 700 - 1,000 tons per unit berth length of one meter.

Areas of public sheds and open yards occupied by various cargoes fluctuate according to daily arrivals, dwelling time and departures of the cargoes. When estimating the required areas for storing them, a moderate service level of 95% non-excess probability is adopted. The result of the simulation is statistically processed and shown as follows:

- Area in sheds: 4.4 ha: peaking factor: 1.23
- Area in open yards: 10.3 ha: peaking factor: 1.38
- Total area: 14.3 ha: peaking factor: 1.30

Areas for public sheds and open yards which are expected to be available in the year 2010 are computed by reducing areas for the new container terminal and modernized cereal terminal from the existing areas. The areas are shown as follows:

- Area for sheds: 5.8 ha
- Area for open yards: 13.1 ha
- Total area: 18.9 ha

Thus, the required areas will be prepared within the existing port limits except for container-stacking.

The volume of cereals dwelling in silos within the port also fluctuates. The variation is also statistically processed and 95% non-excess probability is also computed using the result of the simulation so as to determine require storage capacity of silos.

- Required capacity of silos: 250 thousand tons: peaking factor: 1.39

Subtracting the existing capacity of 30 thousand tons, silos of capacity of 220 thousand tons will be additionally required.

Total ship waiting days in 2010 excluding container vessels are estimated as 443 days, a remarkable reduction from that of 1,833 days in 1990. Among the above average ship waiting times, that of cereal carriers is comparatively large. Therefore, in order to reduce the time from the original case (referred to as Case 1), another alternative use plan (referred to as Case 2) for the existing facilities is examined. In Case 2, Quay No.33-3 is converted to use for cereal carriers from use for general cargo vessels laden with steel products or wood. Additional pneumatic unloaders are also planned to be installed at quay No.35-1 and No.33-1. The similar simulation is conducted and the result of Case 2 is summarized as follows:

- Average ship waiting times:
  1 General cargo vessels(wood): 22.3 hrs
  2 General cargo vessels(steel products): 22.4 hrs
  3 Cereal carriers: 2.4 hrs

According to the result, the difference in cost between Case 1 and Case 2 is computed and shown as follows:

Table 10.2.1 Comparison between the Two Alternative Cases

Unitl Million DA

	Ship waiting cost			Pneumatic unloaders		Grand total
	Cereals	Steel & wood	Total	No. of units	Cost	
Case 1	318	-	318	-	-	318
Case 2	-	81	81	2	458	539

Note (1) : Only different portions of the two cases are listed in the above table.

Note (2) : Ship waiting cost is discounted to the Present Value through a project life of 30 years. A sensitivity analysis adopting a project life of 50 years shows the same selection.

Comparing the above total costs, the Case 1 is selected as the most economical plan.

Concerning handling cereals, the case of a new cereal terminal being constructed outside of the existing port facilities (referred to Case 3) is compared with Case 1. In Case 3, there is no restriction in water depth along the new berths, various similar cases within Case 3 are compared so as to select the optimum water depth. Referring to the present major trade partners, namely the United States, Canada and France, the following shipping routes and respective representative loading ports are adopted:

Shipping route	Loading port	Share(%)	Distance(Miles)
The United States	New Orleans	50	4,964
Canada	Montreal	30	3,616
France	Rouen	20	1,600

Transportation cost by vessel size is computed as follows:

Vessel size		Unit cost	
DWT	U.S.A.	Canada	France
	DA/Ton	DA/Ton	DA/Ton
28,000	301	232	129
32,000	282	218	124
50,000	244	194	120
65,000	227	184	120

A size of 28,000 DWT is the maximum that can be received by the existing berths at the Wharf of Skikda. In order to receive vessels of larger sizes, the following three derivative cases of Case 3 are proposed and compared with Case 1:

Table 10.2.2 Comparison between the four Alternative Cases

Unit: Million DA

	Berth water depth (m)	Berth length(m)	Vessel size(DWT)	Berth construction cost	Transportation cost	Total cost
Case 1	-	-	28,000	-	596	596
Case 3-1	12	210	32,000	695	432	1,126
Case 3-2	13	250	50,000	828	128	956
Case 3-3	14	270	65,000	896	-	896

Note (1) : Only different variables of the alternative cases are listed in the above table.

Note (2) : Ship transportation cost is discounted to the Present Value through a project life of 30 years.

Among the derivative cases of Case 3, Case 3-3, in which a new cereal terminal with a water depth of 14 m is planned to be provided out side of the existing port facilities, is considered to be the most economical plan. However, Case 1 is more economical than Case 3-3. Moreover, another case in which the Port of Djen Djen is used as a mother port for feeder service (referred to as Case 4) is also examined. However, transportation cost excluding port cost at the Port of Djen Djen is almost the same as that in Case 1 of direct shipping. Considering necessary investment for port facilities such as unloaders, silos, etc.

at Djen Djen, Case 1 is still more economical. Thus, through the above comparison, Case 1 is selected as the optimum plan.

As for the handling of steel products, an alternative plan, Case 2, in which a crane specialized for handling heavy and bulky steel products is introduced at the Wharf of Ghara Djebilet is compared with the original plan, namely Case 1. The following premises are assumed in Case 2:

- Average weight lifted by a crane: 10 tons
- Cycle time: 3 minutes
- Number of cranes: 1 unit
- Cargo-handling efficiency: 0.8
- Operational ratio: 0.8
  (10 tons/cycle/crane x 60min/hr/(3min/cycle) x 0.64= 128 tons/hr)
- Average mooring time per vessel: 3.6 days
- Number of vessels received per berth and year: 66 vessels (the total number is 131 and two berths will receive them)

Since, in Case 1, an average mooring time is estimated as 4.8 days, 2.2 days are saved by the introduction of the specialized quay crane. The result of the comparison between the two cases is summarized as follows:

Comparison between the Two Alternative Cases

Unit: Million DA

	Ship staying cost	Specialized quay crane		Grand total
		No. of units	Cost	
Case 1	302	-	-	302
Case 2	227	1	134	361

Note (1) : Ship staying costs are counted for the 66 vessels.

Note (2): The costs are discounted to the Present Value through a project life of 30 years.

From the above comparison, the introduction of the specialized quay crane cannot recover the capital investment cost.

10.3 Modernization Plan of the Existing Facilities

10.3.1 Modernization of the Cereal Terminal

Modernization of the cereal terminal at the Wharf of Skikda is planned for in the target year 2010. An outline of the terminal is summarized as follows:

- Volume of cereals to be unloaded: 3,600 thousand tons
- Number of berths specialized for cereal carriers: 3
- Maximum vessel size under full draft: 28,000 DWT
- Type of unloaders: rail-mounted pneumatic unloaders
- Number of required units of unloaders: 6 units (2 units presently exist and 4 units will be additionally purchased)
- Nominal capacity of new unloader per unit: 400 tons per hour
- Nominal capacity of belt conveyor per unit: 400 tons per hour
- Capacity of silos: 250 thousand tons (220 thousand tons will be additionally required)
- Access road
- Siding railway
- Building
- Other facilities: dust collector, electric equipment

A layout plan of the above facilities is shown in Fig. 10.3.1.

10.3.2 Preparation of Open Yards for Steel Products and Wood

At the Wharf of Ghara Djebilet where steel products and wood are planned to be handled, additional open yards will be prepared by demolishing the existing sheds behind the Quay No.20.

10.3.3 Preparation of a Berth for Bitumen and Bunker Fuel

The berth for handling bitumen and bunker fuel, which currently exists at Quay No.27, is planned to be transferred to Quay No.26-2 which is presently used for buoy stocking.

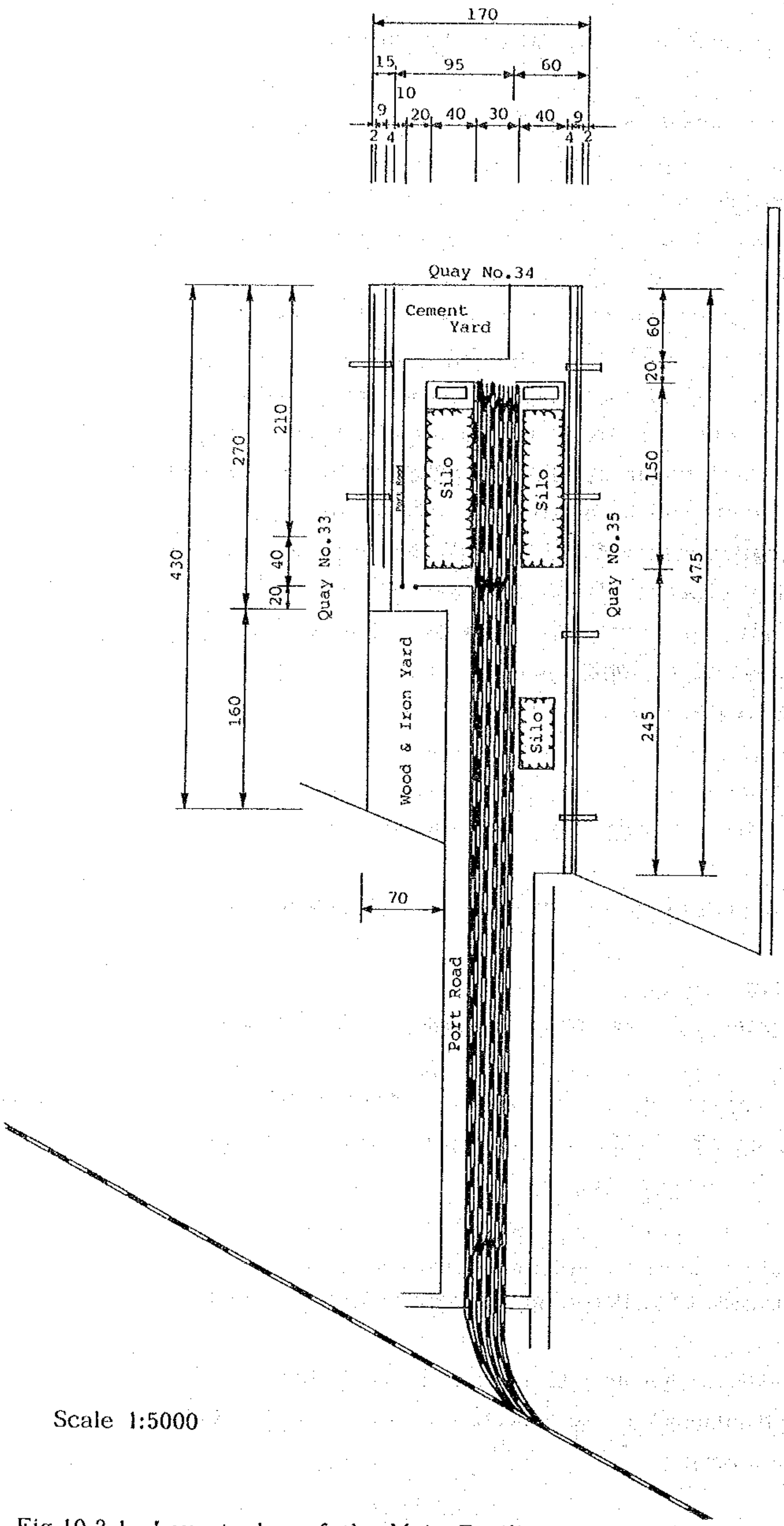

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Fig.10.3.1 Layout plan of the Main Facilities for the Cereal Terminal

10.4 Establishment of an Additional Container Terminal

10.4.1 General

In order to meet the demand of container-handling at the port in 2010, a new full-scale container terminal (referred to as the Terminal-2) will be required to be established outside of the existing port district in addition to the terminal to be constructed by restructuring the existing facilities (referred to as the Terminal-1) as mentioned in Section 10.1.

10.4.2 Number of Containers Handled at the Container Terminal

The number of containers handled at the Terminal-1 and Terminal-2 in the Port of Algiers is assumed according to the demand forecast described in Chapter 8. The numbers are divided into unloaded and loaded categories with the number of stuffed and empty categories shown as follows:

Unit: Thousand TEUs

Year	Unloaded			Loaded			Total		
	Stuffed	Empty	Subtotal	Stuffed	Empty	Subtotal	Stuffed	Empty	Total
2010	253	13	266	21	245	266	274	258	532

10.4.3 Major Shipping Routes

Referring to the present major shipping routes for transportation of general cargoes, namely the Mediterranean Sea, the North Sea, North America and Asia, the following routes and respective representative origin or destination ports are adopted:

Shipping route	Origin and destination port	Share(%)	Distance(Miles)
Mediterranean Sea	Marseille	47	410
North Sea	Rotterdom	40	1,780
North America	New York	7	3,621
Asia	Yokohama	6	9,452

Transportation cost by vessel size is computed as follows:

Vessel size				Unit cost
DWT	Marseille	Rotterdom	New York	Yokohama
	DA/TEU	DA/TEU	DA/TEU	DA/TEU
3,800	1,282	3,813	7,215	17,984
6,500	1,218 *	3,133	5,705	11,858 (Feeder)
12,000	1,252	2,921 *	5,162	12,263
22,000	1,861	3,192	4,981	10,645
27,000	1,995	3,214	4,853	10,043
35,000	2,207	3,277	4,716	9,269
50,000	2,534	3,430	4,634 *	8,448 *

Note (1) : If cost by feeder service is cheaper than that of direct shipping, the former cost is listed with "Feeder" in parenthesis.
Note (2) : "*" shows the minimum cost by route.

10.4.4 Required Scale of the Main Facilities of the Terminal-2

(1) Berths

Required scale of berths of Terminal-2 is determined by comparing the ten alternatives. Ship waiting times are estimated by using computer simulation including operations at Terminal-1. The following premises are adopted:

- Crane
  - Type: container gantry crane
  - Number per berth: 2
  - Cycle time: 25 boxes per hour
  - Cargo-handling efficiency: 0.9
  - Percentage of 20-foot containers: 50%

- Operational conditions
  - Annual working hours: 310 days
  - Daily working hours: 7:00-19:00
  - Hours for necessary procedures, mooring and unmooring, preparation of stevedoring, etc.: 4 hours

As for Terminal-1, the following conditions are used:

- Water depth: 11 m
- Maximum vessel size to be received: 22,000 DWT
- Number of gantry cranes: 2
- Berth length: 320 m

As required berth length to receive the medium and maximum vessel sizes of 12,000 DWT and 22,000 DWT is 170 and 250 meters, respectively, the number of berths at Terminal-1 is one. Results of the comparison between the ten alternative cases are shown in Table 10.4.1. According to the results, the Case 4-1 is selected as the optimum plan. The percentage of berth occupancy is 84%. Required number of berths and the water depth at Terminal-2 is summarized as follows:

- Number of berths: 2
- Total berth length: 300 x 2 = 600 m
- Water depth: 13 m
- Number of container gantry cranes: 2 units x 2 = 4 units

The resulting berth throughput is 590 TEUs per unit berth length of one meter per year. In the leading container terminals, the average productivity is roughly estimated as 400 TEUs/m/year. Hence, the resulting value seems to reach the level of high productivity.

As for the water depths of the above new berths, though the planned water depth is 13 meters, it is advisable to construct berths of 14 meters so as to keep the possibility of receiving larger container vessel, namely, that of Panamax size beyond the target year 2010.

Table 10.4.1 Comparison between the Ten Alternative Cases

Case No.	Terminal-2			Maximum ship size (DWT)	Loading capacity (TEU)	Ship size by route				Construction cost (Million DA)	Transportation cost (Million DA)	Ship waiting cost (Million DA)	Total cost (Million DA)
	Water depth(m)	Unit length	No. of berths			Mediterranean	North Sea	North America	Asia				
1-1	9	170	2	12,000	500	6,500	12,000	12000	6500	2,062	1,204	988	4,254
1-2	9	170	3	12,000	500	6,500	12,000	12000	6500	3,093	1,204	151	4,448
2-1	11	250	2	22,000	1,200	6,500	12,000	22,000	22,000	2,560	777	988	4,325
2-2	11	250	3	22,000	1,200	6,500	12,000	22,000	22,000	3,840	777	151	4,768
3-1	12	280	2	27,000	1,500	6,500	12,000	27,000	27,000	2,764	553	988	4,306
3-2	12	280	3	27,000	1,500	6,500	12,000	27,000	27,000	4,146	553	151	4,850
4-1	13	300	2	35,000	2,000	6,500	12,000	35,000	35,000	2,911	274	988	4,172
4-2	13	300	3	35,000	2,000	6,500	12,000	35,000	35,000	4,366	274	151	4,790
5-1	14	350	2	50,000	3,000	6,500	12,000	50,000	50,000	3,249	0	988	4,237
5-2	14	350	3	50,000	3,000	6,500	12,000	50,000	50,000	4,874	0	151	5,024

Note(1): Only different portions of the alternative cases are listed.
Note(2): Construction cost of the Terminal-1 is excluded.
Note(3): Construction cost of breakwaters to be extended is allocated to each case.
Note(4): Transportation cost by ship and waiting times are estimated for operations at both terminals, Terminal-1 and TErminal-2.
Note(5): Ship waiting cost and annual maintenance costs of berths and breakwaters are discounted to the Present Value through a project life of 30 years.

(2) Marshaling Yard

Required number of containers stored at marshaling yards in both terminals is determined taking account of the fluctuating number of containers dwelling at the yards by using the computer simulation mentioned above. When conducting the simulation, in addition to the premises mentioned above, the following premises are adopted:

- Average dwelling times: Import: 10 days
  Export: 5 days

- Percentage of CFS cargoes: Import: 20%
  Export: 10%

According to the result of the simulation, the numbers of loaded and empty containers dwelling at the yard fluctuate to a great extent showing large peaking factors of 1.26 and 2.76, respectively. The total number of the loaded and empty containers, however, fluctuates only in a narrow range due to their converse movements. This can be easily understood by recognizing the flow of container boxes at the yards. According to the result, the required number of containers stored at the marshaling yards of the Terminal-1 and Terminal-2 totals 7,650 TEUs.

When determining the required slot number of the marshaling yards needed to store the above containers, four alternative cargo-handling systems, namely straddle carrier system, transfer crane system, forklift system and chassis system, are considered. The following premises are adopted to determine the number:

- Cargo-handling efficiency: 0.75
- Number of layers of stacked containers:

	Straddle carrier	Transfer crane	Forklift	Chassis
Import(dry)	2	3	2	1
Export(dry)	3	4	2	1
Reefer(stuffed)	2	1	1	1
Empty	3	4	3	1

Thus, the total required slot numbers are shown as follows:

	Straddle carrier	Transfer crane	Forklift	Chassis
Slot number	4,912	3,338	5,061	10,196

The total required slot numbers will be shared by Terminal-1 and Terminal-2. The total number of berths required in 2010 is three, one at Terminal-1 and two at Terminal-2. Therefore, two thirds are planned to be shared by Terminal-2 as follows:

	Straddle carrier	Transfer crane	Forklift	Chassis
Slot number	3,275	2,225	3,374	6,797

(3) Container Freight Station

In order to determine the required area and number, the result of the above simulation is also adopted. According to the result, the cargo volume dwelling in CFSs fluctuates, showing a maximum volume equivalent to 1,251 TEUs and a peaking factor of 1.26. In order to avoid overinvestment for CFSs, a moderate service level of 95% non-excess probability is also adopted. In this level, the volume equivalent to TEUs is 1,200 TEUs with a reduced peaking factor of 1.20 to the average of 998 TEUs, which is a modest figure compared to the experiential figure adopted in leading container ports.

The required number of bays at CFSs for trucks is determined considering the fluctuation of the cargo volume passing through CFSs. The maximum volumes equivalent to TEUs at container and truck sides are 382 TEUs and 376 TEUs, respectively. Adopting the service level of 95% non-excess probability, the figure of 340 TEUs, with a peaking factor of 1.79 to the average of 190 TEUs, is considered as the target for bay number planning.

Thus, the total principal dimensions of CFSs for trucks are determined and shown as follows:

- Total number of bays on each side: 97
- Total length excluding office space: 340 m: Width: 45 m
- Area: 15,300 sq. m

Next, the above scale is allocated to Terminal-2 as follows:

- Total number of bays on each side: 65
- Total length excluding office space: 230 m: Width: 45 m
- Area: 10,300 sq. m

A part of container cargoes are expected to be transported by railway. Hence, a railway yard with a CFS for railway wagons is planned to be prepared outside of a terminal gate. The required area for the CFS is 3,600 sq. m.

(4) Van Pool

A storage yard for empty container boxes (referred to as a van pool) not scheduled to be shipped away from the container terminals will be needed to increase operational efficiency at the marshaling yards. Such a van pool can be leased to private-sector firms which possess the boxes, if so desired. For the above purpose, the van pool is planned to be allocated adjacent to Terminal-2. The principal dimensions are as follows:

- Number of layers of stacked containers: 3
- Storage capacity of one block: 75 TEUs
- Dimensions of one block: length: 32.5m: width: 13.5 m
- Number of blocks: 10

(5) Terminal Office

The head office of the container terminal is planned as follows:

- Stories: 3

- Site area for building: 30 m x 25 m = 750 sq. m
- Floor space: 2,250 sq. m.

(6) Repair Shop

The following repair shop is planned:

- Site area for building: 40 m x 25 m = 1,000 sq. m

10.4.5 Layout of the Main Facilities of Terminal-2

The main facilities of Terminal-2, of which the required sizes are shown in the previous section, are arranged. Then the required terminal area is computed according to the different cargo-handling systems. The required areas are summarized in Table 10.4.2 (see Fig.10.4.1).

Table 10.4.2 Required Terminal Area by Different Cargo-handling Systems

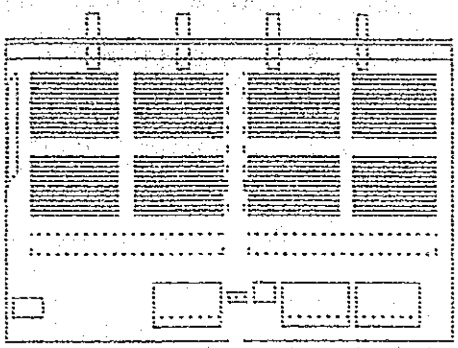
Unit: sq.m

Cargo-handling system	Straddle carrier	Transfer crane	Forklift	Chassis
Total area	228,500	206,200	325,000	437,100
(Length x width)	(600 x 393)	(600 x 345)	(600 x 545)	(655 x 670)
Marshaling yard				
Sub-total	124,800	100,600	223,100	347,900
Slot area	77,800	44,800	58,700	169,400
Others	47,000	55,800	164,400	178,500
(Length x width)	(600 x 210)	(600 x 170)	(600 x 375)	(655 x 530)
Apron	24,000	24,000	24,000	24,900
(Length x width)	(600 x 40)	(600 x 40)	(600 x 40)	(655 x 40)
Backyard				
Sub-total	79,700	81,600	78,000	64,300
CFS	11,700	11,700	11,700	11,700
Head office	800	800	800	800
Repair shop	1,000	1,000	1,000	1,000
Open yard	11,900	12,700	12,700	12,700
Others	54,300	55,400	51,600	38,100
(Length x width)	(600 x 145)	(600 x 135)	(600 x 130)	(655 x 100)

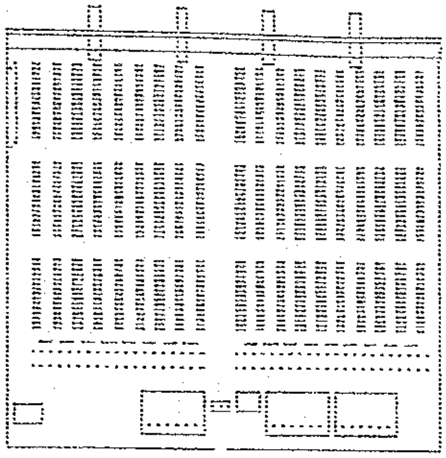
Note (1) : Parentheses give approximate values of yard dimensions, and so there are slight differences between their products and areas in the table.

Note (2) : Areas for a van pool and a railway yard are excluded.

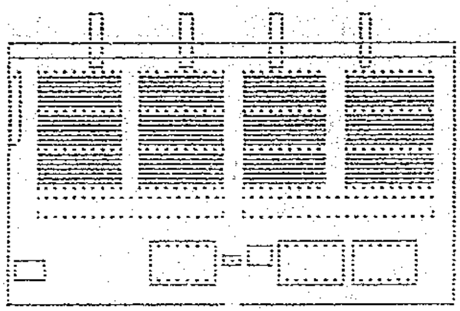
Scale 1:10000



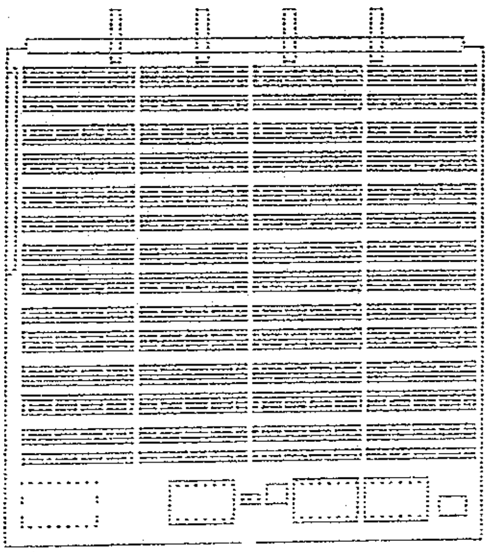
Straddle Carrier System



Forklift System



Transfer Crane Stsyem



Chassis Sysyem

Scale 1:10000

Fig.10.4.1 Layout Plans of the Facilities of the Container Terminal for the four Different Systems

10.4.6 Alternative Development Plans of Terminal-2

Considering the required scale of the container terminal, alternative development plans of the terminal with the target year 2010 are proposed as follows (see Fig. 10.4.2-10.4.4):

Project Site

- Case 1 East of the Brise-Lames Est
- Case 2 East of the Brise-Lames Est
- Case 3 East of the Jetee De l'Agha

The alternative plans listed above are compared with the following points:

a. Land acquisition

In all cases, the sites for the proposed container terminals must be reclaimed. Case 3 needs a much larger volume of reclamation materials than other cases, Case 1 and Case 2, due to the difference of water depths between them. The average water depth of Case 3 is around 20 meters. On the other hand, the average water depths of Case 1 and Case 2 are around 6 meters.

b. Breakwaters and sea walls to combat violent waves

Berths and basins in front of them need to be protected from violent waves by breakwaters. For that purpose, in Case 1 and Case 2, it is necessary to extend breakwaters of 620-660 meters long from the end of the Jetee de Mustapha. On the other hand, in Case 3, instead of breakwaters, it is necessary to construct sea walls of 1,100 meters long in waters of around 24 meters deep so as to protect reclaimed land from the waves.

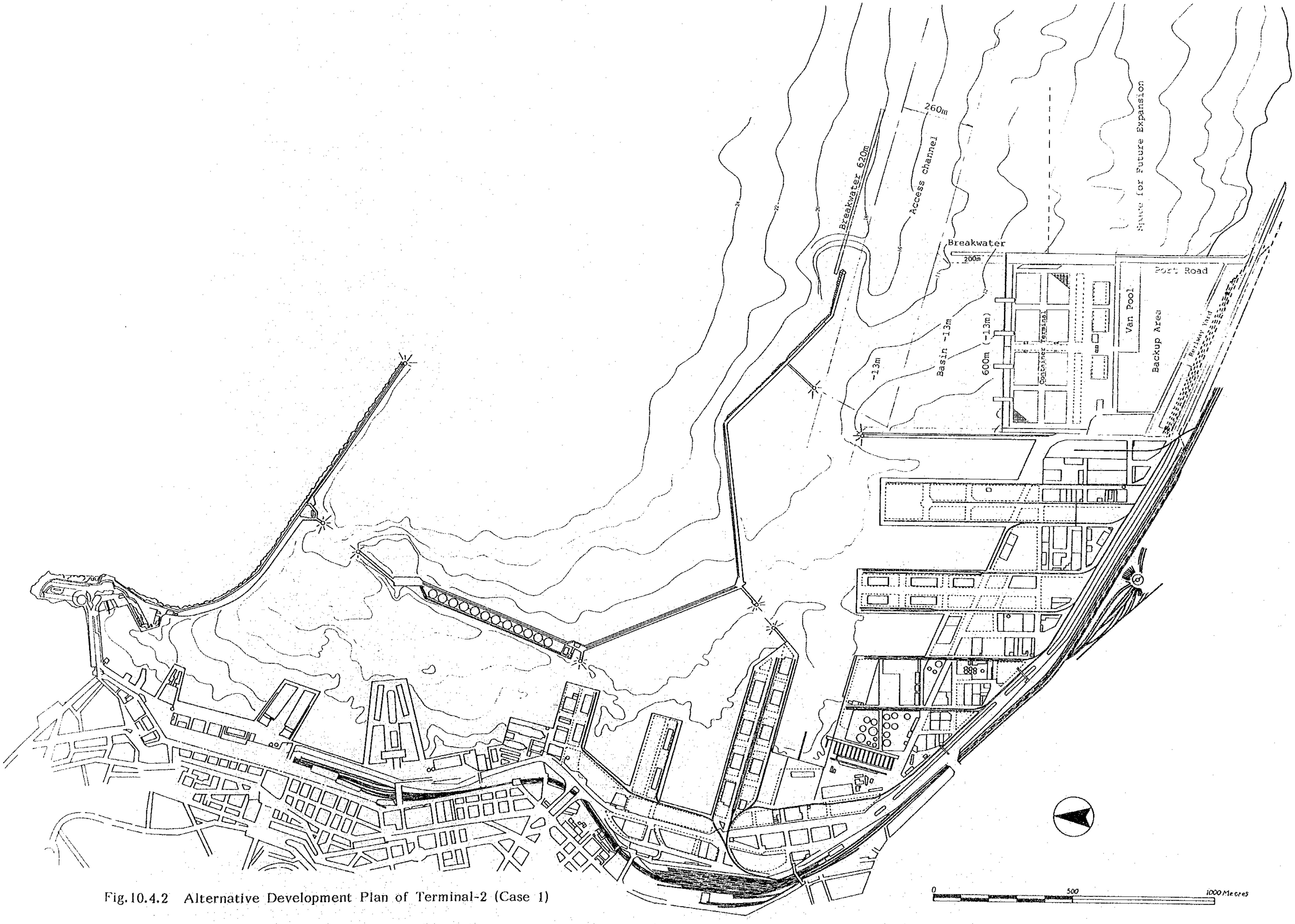


Fig.10.4.2 Alternative Development Plan of Terminal-2 (Case 1)

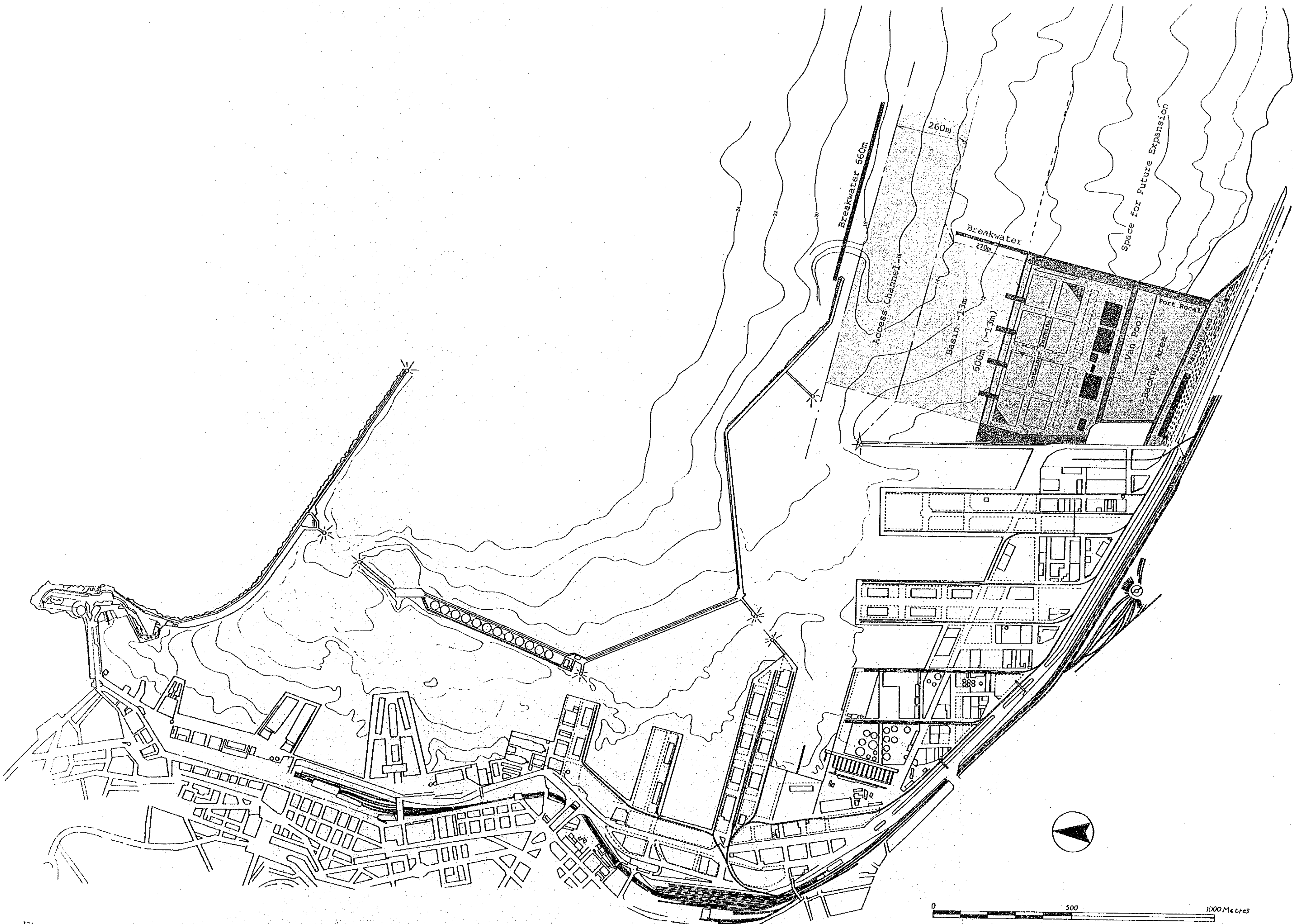


Fig.10.4.3 alternative Development Plan of Terminal-2 (Case 2)

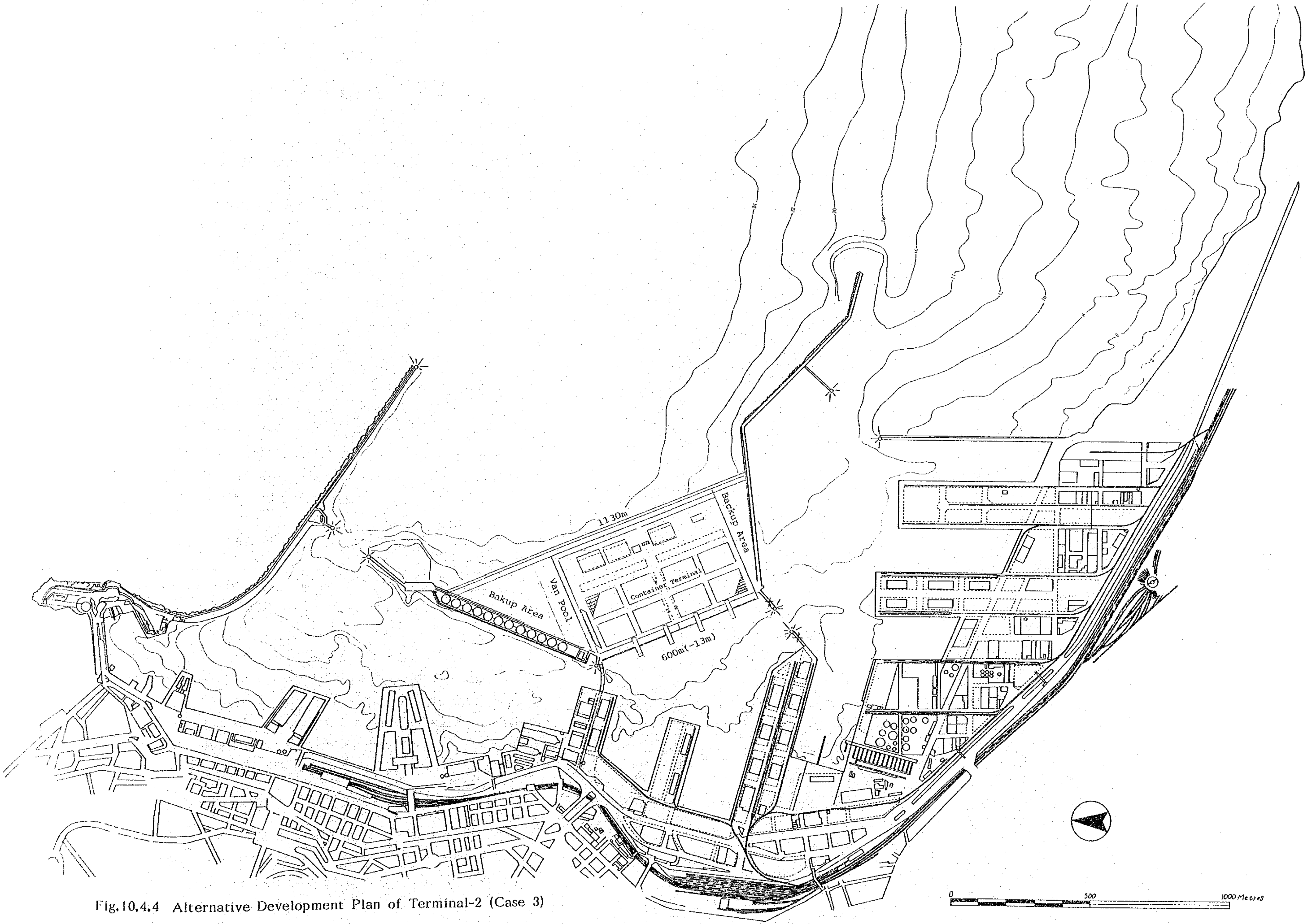


Fig.10.4.4 Alternative Development Plan of Terminal-2 (Case 3)

c. Basins for maneuvering container vessels

Basins for maneuvering container vessels need to be located in a place that will serve safe maneuvering for container vessels. In Case 1 and Case 2, necessary turning basins which are protected by the breakwaters are allocated just adjacent to the berths. On the other hand, water area in front of the site of Case 3 is insufficient for maneuvering a container vessel of 35,000 DWT with a length of around 260 meters. when turning her, she is forced to back astern to the water outside of the south entrance of the port without protection of breakwaters. Such maneuvering of a large container vessel in Case 3 is clearly dangerous. In this regard, Case 1 and Case 2 have advantages over Case 3.

d. Access to the container terminal by land

An expressway runs along the port limits from the west to east. The west end is connected to a common road of only two lanes. On the other hand, the east end is connected to another expressway bypassing heavily congested urbane areas of the City of Algiers. Since the western part of the expressway running along the port is already seriously congested, it is necessary to connect the access road at the eastern part of the expressway as much as possible. In this point, Case 1 and Case 2 have advantages over Case 3.

e. Potential for further expansion beyond the target year 2010

As for the potential for further expansion beyond the target year 2010, in Case 1 and Case 2, it is easy to expand the container terminal in the east by further economical reclamation. On the other hand, in Case 3, it seems to be difficult to expand the terminal economically due to the irregular shape of the existing breakwaters and deep water depths behind them. In this point, Case 1 and Case 2 have advantages over Case 3. Moreover, in Case 2, a front line of berths can be kept straight in the further expansion, which enables efficient usage of berths. In this point, Case 2 have advantages over Case 1.

f. Construction cost

The three cases, namely Case 1, Case 2 and Case 3, are further divided by four different container-handling systems as mentioned in Section 10.4.6. However, since it is difficult to prepare the spacious area of around 44 ha for a chassis system economically, the chassis system should be avoided. Thus, nine cases in total are compared with each other as alternatives (see Table 10.4.3). As to location of the terminal, capital cost of Case 3 is much higher than Case 1 and Case 2. As to cargo-handling system, there is no decisive difference in cost between the three cases, namely straddle, transfer crane and forklift systems. However, there is a risk of damaging containers in the forklift system in cargo-handling operation compared with straddle and transfer crane systems.

According to the above comparison, the following four cases are considered as suitable cases:

		Project Site	Cargo-handling System
1	Case 1-1	East of the Brise-Lames Est	Straddle carrier
2	Case 1-2	East of the Brise-Lames Est	Transfer crane
3	Case 2-1	East of the Brise-Lames Est	Straddle carrier
4	Case 2-2	East of the Brise-Lames Est	Transfer crane

Case 1 and Case 2 were compared in detail. There is no decisive difference in operational conditions and cost between the two cases. Taking account of the future expansion beyond the Master Plan, however, Case 2 has advantages over Case 1, since additional berths will be extended in a continuous berth line in the former case. Thus, Case 2 is selected as the optimum plan.

As the alternative cargo-handling systems for the container terminal, the straddle carrier system has advantages over the transfer crane system in flexible operation owing to less number of container handling times. Moreover, Case 2-1 of the straddle carrier system is more economical than Case 2-2 of the transfer crane system. Thus, the straddle carrier system seems to be suitable. A layout plan of the main facilities in Case 2-1 is shown in Fig. 10.4.5.

In order to support container-handling operation in the container terminal, backup area for warehouses, office space of shipping companies, shipping agencies and forwarders, etc. needs to be prepared adjacent to the container terminal. The required areas for the Master Plan are summarized as follows:

- Terminal area: 25.1 hectares (Van pool: 2.3 hectares)
- Access road: 2.6 hectares
- Backup area: 7.7 hectares
- Others: 3.0 hectares
- Subtotal: 38.4 hectares

- Railway yard: 3.6 hectares

- Grand total: 42.0 hectares

Table 10.4.3 Comparison in Capital Cost between the Nine Alternatives

Unit: Million DA

Case No.	Project Site	Container-Handling System	Terminal Area (m^2)	Infra- & Upper-Structures	Container-Handling Equipment	Breakwaters or Sea Walls	Total
1-1	East of Brise-Lames Est	Straddle Carrier	236,100	972	1,060	2,224	4,256
1-2	East of Brise-Lames Est	Transfer Crane	206,200	958	1,461	2,224	4,643
1-3	East of Brise-Lames Est	Fork Lift	325,000	1,018	1,092	2,224	4,334
2-1	East of Brise-Lames Est	Straddle Carrier	236,100	999	1,060	2,291	4,350
2-2	East of Brise-Lames Est	Transfer Crane	206,200	985	1,461	2,291	4,737
2-3	East of Brise-Lames Est	Fork Lift	325,000	1,045	1,092	2,291	4,428
3-1	East of Jetee De l'Agha	Straddle Carrier	236,100	1,616	1,060	2,567	5,243
3-2	East of Jetee De l'Agha	Transfer Crane	206,200	1,602	1,461	2,567	5,630
3-3	East of Jetee De l'Agha	Fork Lift	325,000	1,662	1,092	2,567	5,321

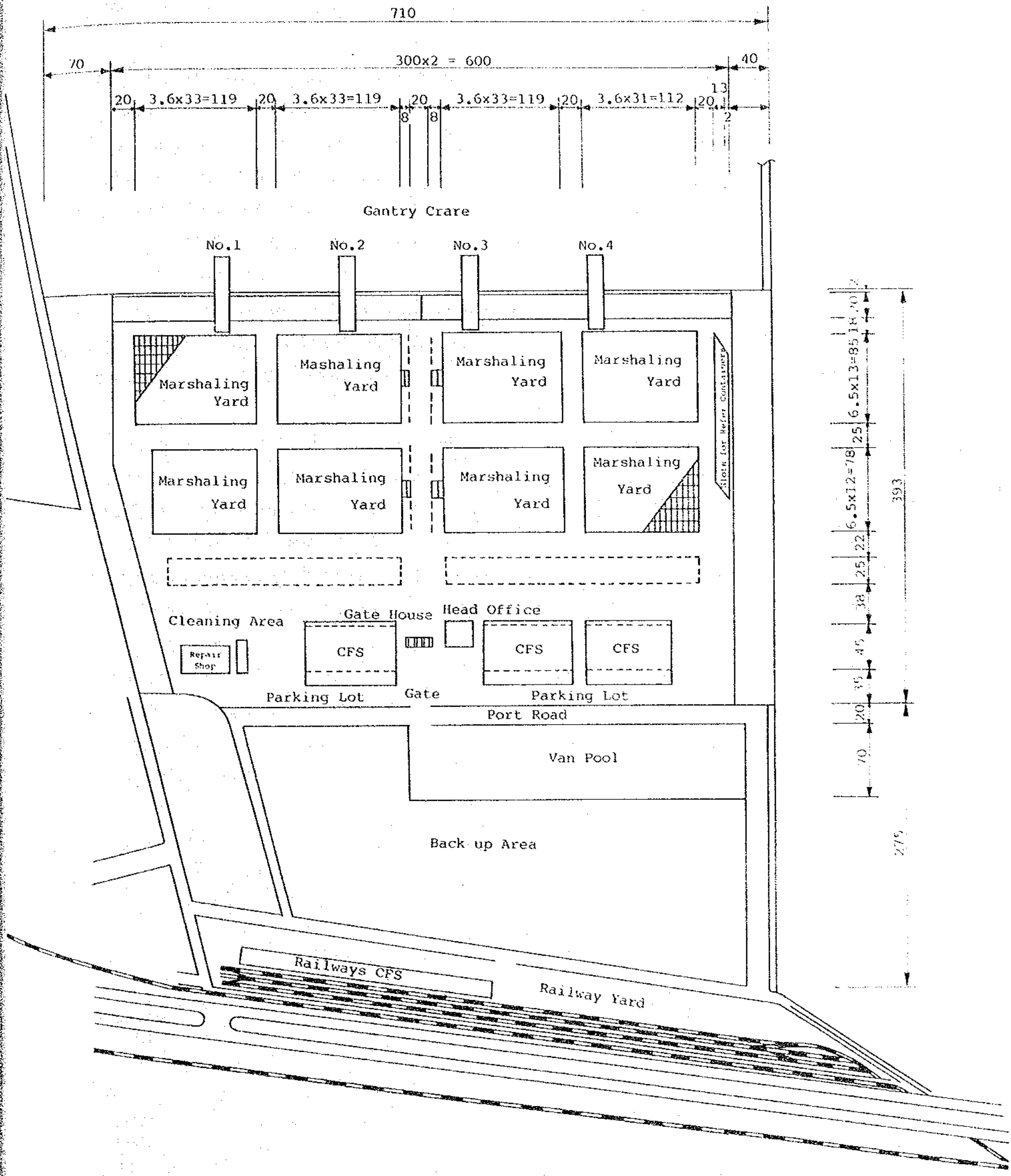


Fig. 10.4.5 Layout Plan of the Main Facilities in Case 2-1
(Straddle Carrier System)

10.5 Examination of Cargo Handling System

It is common knowledge that there is a traditional cargo handling system at every port, and also that cargo handling systems are diversified, according to packing style, handling volume and nature of cargo, and type, kind and size of carrying vessel and method of storage in port. The type, size and capacity of the cargo handling equipment and facilities such as cranes, forklifts, etc., are also diversified in accordance with the above-mentioned items.

On the basis of the demand forecast in the Port of Algiers, the future cargo handling system is examined with regard to the following vessel's types, considering the present cargo handling system and cargo flow within the port.

- General cargo vessel
  - General cargo vessel laden with various kinds of cargoes
  - General cargo vessel laden with one kind of commodity
    - Cement
    - Foodstuffs or agricultural products excluding cereals
    - Wood (Timber)
    - Iron (Steel Goods)
    - Sugar
    - Animal feed
- Ro-Ro vessel
- Cereals carrier
- Tanker
  - Butane, diesel oil, gasoline or fuel oil
  - Naphtha
  - Bitumen
  - Vegetable oil or animal fat
- Car ferry
- Container vessel

10.5.1 General Cargo Vessel

Although the flow of containerized cargo is increasing, the amount of conventional break bulk cargo traffic will still be considerable, so in this paragraph, the cargo handling systems for general cargo vessels stowed with imported general cargo are examined.

(1) General idea of unloading /loading equipment

At present, the unloading and loading of cargoes from/to vessels are generally carried out using the following four types of equipment.

- Ship's Crane/Gear
- Rail-mount Quay Crane
- Mobile Crane
- Floating Crane

The characteristics of each type of equipment are summarized in Table No.10.5.1.

The packaging of general cargoes is tending conspicuously towards unitization, such as palletization and containerization, enlargement, and the unit weight per package is becoming heavier. Nevertheless it is difficult to select the most advisable equipment for general cargo vessels because besides the unitized cargoes, various kinds, types and sizes of general cargoes are co-stowed in the vessel's holds. Following these trends, the lifting capacity of ship's cranes/gear have become larger and the number of vessels having cranes with lifting capacities between 10 -15 T (SWL) is increasing in the world's maritime fleets. Heavy cargoes exceeding this range are generally handled by means of floating cranes and/or mobile cranes. Hence it seems that the necessity of common quay cranes will rather decline.

Table 10.5.1 Comparison of Cranes for Handling General Cargo

Kind of Crane	Ship Gear/Crane	Quay Crane	Mobile Crane	Floating Crane
Investment Scale	-	High	Medium	Very High
Maintenace Cost	-	High	Medium	Medium
Ranning Cost	-	Yes	Yes	Yes
Skill for Repairing	-	Required	Required	Required
Cycle Time	Gear : Vaiable Crane : Some 20 times/Hr	Some 20 times/Hr	Variable	Low
Working Range at Apron	Small	Large	Medium	Large
Flexibility in Port	None	None	High	Medium
Others	Unfit for direct loading to rail cars/ trucks	Fit for direct loading to rail cars Drivers are skilled in driving Obstructs forklift handling at apron due to rails	Fit for direct loading to rail cars Drivers are skilled in driving	Fit for handling of heavy cargoes Some times, to be forced idleing

(2) General cargo vessel laden with various kinds of cargoes

There are two cases of cargo flows by method of delivery of cargo to consignees.

- In case of direct delivery from port

In this type of flow, loading onto trucks or rail wagons is carried out simultaneously with unloading from the vessel. Although the cargo is only handled once in the port, the overall cargo handling rate is low because the landing of cargoes by cranes onto trucks/cars is very difficult due to the small working area of each truck/rail wagon, and the throughput of cargo is affected by the marshaling of the trucks/rail wagons and turn-around at apron. It is advised that this method be only adopted for the handling of particular cargoes, such as dangerous cargo, frozen cargo, perishable cargo and heavy cargo, taking the nature of cargo into consideration.

- In case of delivery after custody in storage facilities in the port area

This type of cargo flow consists of four stages, "unloading from vessel", "transferring from apron to storage area", "storage" and "delivery from port". In order to achieve smooth cargo handling throughout the port, it is required that cargo handling operations during each stage are properly carried out with an aim toward achieving compatibility among the four different stage.

Therefore the under-mentioned items should be carefully examined in planning the cargo handling operation, management of storage facilities and/or allocation of berths to vessels.

1) Handling operation on board vessel

In order to achieve smooth unloading and loading from/into vessels, the proper type and capacity of handling tools, such as sling, spreader, etc., and forklifts should be chosen and separately used per kind, type and weight of cargoes.

2) Handling at the apron and transfer from ship side to storages areas

In order to ensure effective handling and transfer, the cargo unloaded from vessels should be handled using the following methods

Case 1 When the storage area is located near the berth, handling is carried out in one or two stages by forklifts

Case 2 When the storage area is located far from the berth, handling is carried out in three stages

1 : Arranging and loading onto trucks or trailers by forklifts
2 : Transfer from apron to storage area by trucks or trailers
3 : Unloading from trucks/trailers by forklifts at storage area

3) Utilization of transit shed and open yard

At present, in the port of Algiers, almost all of the unloaded cargoes are stored in the open yards and only valuable and perishable cargoes are stored in the transit sheds in the port, subsequently the open yards are congested and the transit sheds are almost vacant. In order to ensure the effective use of the transit sheds and open yards, it is necessary to examine the storage of cargoes in the transit sheds depending on the nature and kind of cargo, and also to designate the utilization of the transit sheds and the open yards per kind of cargo. Also, in order to ensure the effective use of the transit sheds and the open yards, the cargo should be stacked in tires when possible with proper and sufficient wooden dunnage, and the stacking of cargo should be done in a block per kind and lot of cargo with proper clearance between piles thereby facilitating cargo handling at the time of delivery.

4) Delivery of cargo to hinterland

Delivery of the cargoes is premeditatedly carried out using proper handling equipment such as forklifts and/or mobile crane, taking storage capacity into consideration.

(3) General cargo vessel laden with one kind of commodity

1) Cement in bulk

Almost all of the imported cement is carried to the port by cement carriers in bulk and bagged on a processing barge. The bagged cement is discharged onto trucks by a conveyer system provided on board the barge. With respect to the forecast handling volume, this system is considered to be suitable.

2) Foodstuffs or agricultural products excluding cereals

At present, most foodstuffs, which are packaged in various way, are directly delivered from the port by trucks as they are. Given the nature of such cargo, this handling system is considered to be unavoidable. However, in order to ensure smooth operation at the berth apron in future, it is necessary to examine the use of transit sheds for short periods. Some palletized foodstuffs are now found to be stacked in open yards, but in view of sanitary control, these cargoes should be stored in transit sheds.

3) Timber

Timber cargo is usually bundled in cubes fit for forklift handling, so the handling throughout the port is mainly carried out by forklifts. This cargo is kept in open yards of the port in accordance with the nature and packing of the cargo, and requires a wide apron and wide open yards for smooth handling and storage.

4) Steel products

There are many kinds of steel products and many types of packaging for international trade. These cargoes, except for high quality goods, are kept in open yards in the port, and require a wide apron and wide open yards for smooth handling and storage given the type of cargo packaging. In addition, the handling of these goods is very difficult because they are lengthy and/or heavy and in order to ensure quick handling and prevent damage at all stages of port traffic, it is necessary that the equipment and handling tools are properly chosen and used.

The marshaling of cargoes from apron to open storage yard should be basically done as follows.

- When the storage yard is located near the berth

After landing on the apron, the cargoes should be forwarded and stacked by forklifts in one stage.

- When the storage yard is located far from the berth

The cargoes should be directly loaded on trailers or trucks by unloading equipment and forwarded to storage yards, and stacked in the yards by forklifts and/or mobile cranes.

When stacking the cargoes, sufficient wooden dunnage should be inserted between the tiers of the cargo to prevent damage and enable quick handling at the time of unstacking.

Although the necessity of ordinary quay cranes for handling general cargoes is rather declining as mentioned in section 10.5.1 (1), in order to ensure safety and efficient cargo handling, to prevent damage to cargoes and to dispatch vessels quickly, the Japanese mill ports equip the following types of quay cranes specially designed for handling steel products at the specialized berths which are supported with extensive backup storage yard. In addition, transfer cranes are equipped for stacking and unstacking of steel goods in the storage yard in order to increase flow rate at the open yard.

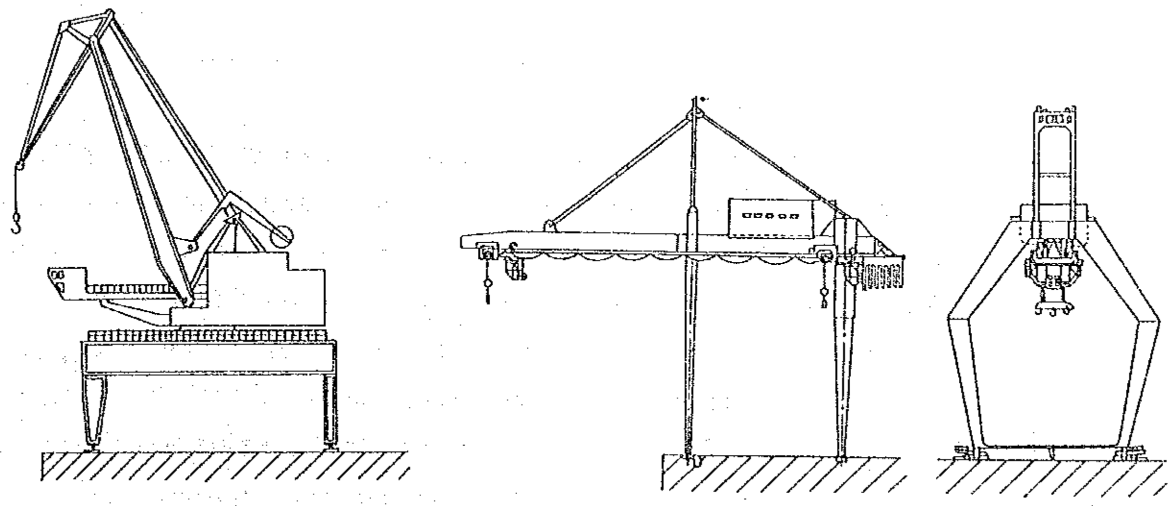
- Wide pedestal gantry crane

This crane is specially designed to handle lengthy steel goods, such as steel bar, pipe, shaped beam, rail, etc.

- Level luffing crane

This crane is mainly used for handling various kinds of steel goods, other than lengthy goods.

The quay cranes and the handling equipment, forklifts, mobile cranes, etc., will be arranged on a step-by-step along with increase of handling volume of cargo in the future.



Level Luffing Crane   Wide Pedestal Gantry Crane

Fig.10.5.1 Quay Cranes for Handling Steel Goods

5) Sugar

Refined sugar is presently imported either in bulk or in sacks. Some sugar in bulk is carried by specialized sugar carriers and sacked on board the vessels while they are lying alongside the berth, and the cargo in sacks is discharged by means of conveyer systems provided on board the vessel and directly landed onto trucks. Some sugar without unitizing is carried by general cargo vessels laden only with sacked sugar as mono-cargo and is unloaded directly onto trucks by means of ship's gear/cranes and or quay cranes with rope slings. The present handling system of bulk sugar is considered to be proper, however, in order to raise the cargo handling rate, the handling system for sacked sugar needs some reformation throughout the port, eg. introduction of palletization and/or provision of temporary storage facilities within the port.

6) Animal feed in bulk

New sheds for storage and handling of Animal Feed in bulk are now being constructed just behind berth No.26 where there are two gantry cranes provided with grab buckets. Cargo handling will be done using these facilities at this berth.

In order to cope with increased cargo handling in future, it is necessary to replace the grab buckets with a remote control systems

10.5.2 Ro-Ro Vessels

In general, the major cargoes transported by Ro-Ro Vessels consist of trailers, containers on/off chassis, vehicles, palletized cargoes and cased cargoes. These cargoes are handled by horizontal cargo handling equipment such as forklifts and tractors through the vessel's ramp way, except some cargo that is stowed on weather decks. In accordance with the type of cargo, cargoes are often kept in sheds. In order to carry out quick dispatch, the cargo handling area at the apron needs to be larger than for general cargo vessels and it is desirable that the storage yards are located behind the aprons. The cargo handling rates depend on the efficiency of the horizontal cargo handling equipment and this is obviously affected by the distance between the vessel's ramp way and the designated storage areas, as well as the stowage location in the vessel's holds.

There are many methods of handling as mentioned below. It is necessary to adopt the best method in each case, taking the kind of cargo and the location of the storage areas into consideration.

(1) Unloading

Case 1 When cargo is stowed in the hold near the vessel's ramp way and the storage area is located near the berth

Handling from hold to storage area is carried out in one stage by forklifts

Case 2 When cargo is stowed in hold far from the ramp way and the storage area is located near the berth Handling is carried out in two stages

1 : Shifting of cargo to near ramp way by one or two forklifts and then

2 : Discharging and transferring/storing are carried out in one continuous operation by forklifts

Case 3 When cargo is stowed near ramp way and storage area is located far from the berth Handling is carried out in three stages

1 : Discharging to apron is carried out by forklifts

2 : Transfer from apron to storage areas is carried out by trucks

3 : Storing in storage areas by forklifts

Case 4 When cargo is stowed in hold far from the ramp way and storage area is located far from the berth Handling is carried out in four stages

1 : Shifting of cargo near ramp way by one or two forklifts

2 : Discharging to apron by forklifts

3 : Transport from apron to storage area by trucks

4 : Storing in storage areas by forklifts

Case 5 Vehicles

Driving under own power through ramp way to storage areas

When storage areas are near the berth, handling is carried out in one operation

When storage areas are far from berth, handling is divided into two stages, discharging from hold to apron and transport from apron to storage areas

Case 6 Trailers, containers on chassis and mafi trailers

Handling is carried out by trailer trucks and the flow is similar to that for vehicles

(2) Loading

In order to carry out quick dispatch, cargoes are arranged on the apron before the vessel's entry into port. In case of a small amount of cargo and/or bulky cargo, loading is carried out as in the above-mentioned Case 1, and in case of a large amount of cargo, loading is carried out as in Case 2 in reversible way.

10.5.3 Cereals in Bulk

At present, handling is roughly divided into three systems, according to the handling equipment and machines used for unloading the bulk cereals as mentioned in Appendix A.5.1. It is recommended for the handling system for the cereals terminal to be planned for target year 2010 that unloading from vessels is carried out by rail-mounted pneumatic unloaders and the cargoes are directly put in silos through conveyer systems, and the evacuated from silos into trucks and rail wagons for transportation to hinterland. (See Fig.10.5.1 Outline Cargo Handling Flow in Cereals Terminal)

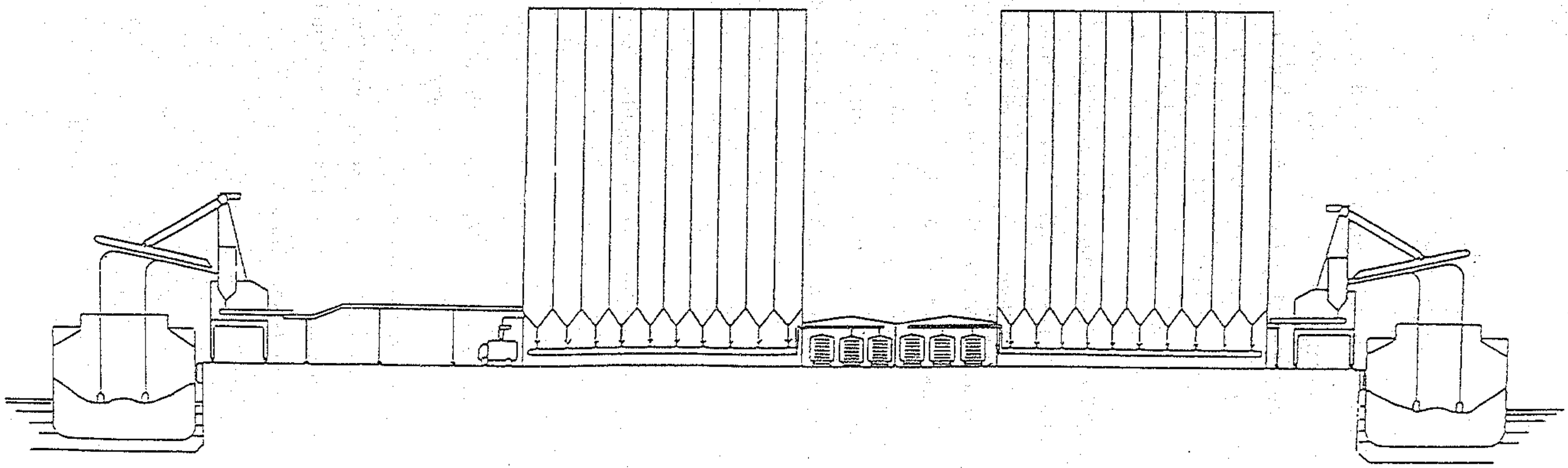


Fig.10.5.2 Outline Cargo Handling Flow in Cereals Terminal

10.5.4 Tanker

(1) Petroleum products handling system

According to the demand forecast for the year 2010, the major petroleum products to be handled at the port are liquefied butane gas and naphtha which are handled at Quay No.37 by long distance piping systems running from the berth to inland storage tanks. Diameter of each pipe line is 16 inches for naphtha and six inches of liquid line for liquefied butane gas, and no return gas line is laid.

The present handling rate of liquefied butane gas is rather low given the diameter of the shore pipeline, (refer appendix A.5.2), which is assumed to be due to their being no return gas line for regulating the internal pressure of tanks and long distance pipeline. It is considered that the handling rate at the present unloading/loading berths can be increased by laying a return gas line between shore tanks and berth, and by some improvement to shore piping systems and/or inland storage facilities. The handling of other petroleum refinery products which are handled at quay no.37 are carried out by the present systems.

(2) Bitumen

This cargo is handled in a similar way to the current handling system.

(3) Vegetable oil and animal fat

These cargoes are unloaded at quays Nos.32 and 36 with the existing shore pipe lines running to storage tanks in the user's factories within the port area; the actual unloading rates per hour fluctuate per carrying vessel. The fluctuating unloading rate is probably determined by the shore tank capacity, vessel's pump capacity or lack of cargo heating. It is possible to handle the forecast cargo providing the current high rate is maintained.

10.5.5 Car Ferry

The expected cargoes carried by the car ferries are imported/exported vehicles or those owned by passengers and trucks laden with some imported and/or exported cargoes. The unloading from and/or loading to vessels is carried out by driving the vehicle through the vessel's ramp way, and transferring between the storage area to the vessel is accomplished by the same means.

10.5.6 Container Vessel

At present, there are four handling systems related to the handling machinery used at the container yard as mentioned in Appendix A.5.3. The straddle carrier system or the transfer crane system are being considered for the container terminal that is planned for the target year 2010.

10.6 Access Channel and Basins

It is necessary to plan an access channel and basins so as to receive container vessels of the maximum size to approach Terminal-2. The principal dimensions of the vessels are as follows:

- Length over all: 260 meters
- Full draft: 12 meters
- Breadth: 32 meters

Considering the above dimensions and the forecast traffic volume, the following access channel and basins are planned:

- Access channel: Breadth: 260 meters
  Water depths: 14 meters to 13 meters
- Basins (including a turning basin with a diameter of 520 meters):
  Water depth: 13 meters

10.7 Breakwaters

It is necessary to prepare new breakwaters to protect container vessels to be maneuvered at the above basins or to moor at the berths of Terminal-2. In ordinary sea conditions, wave height in front of berths needs to be kept under the critical height for cargo-handling over 95% or more of the year. Taking account of the sizes of calling vessels, a critical wave height of 0.5 m is adopted. Moreover, in storm conditions, it is also necessary to keep wave height under the critical conditions for mooring vessels taking shelter from the storm. In this case, a critical wave height of 1.0 m is adopted. According to the conditions, the new breakwaters are arranged. In the storm conditions, a significant wave height of 7.3 m with period of 11.8 sec. and the direction of northeast is used. Return period of 50 years is adopted.

10.8 Access Roads and Railways

The traffic volume of vehicles originating from or destined to the port in the year 2010 during peak time with a peaking factor of 2.2 is estimated to be

6,908 vehicles per day each way in total. The hourly traffic corresponding to that daily traffic is also estimated to be 1,036 vehicles each way. Traffic volume by type of cargo is shown as follows:

Kind of cargo	Daily traffic	Hourly traffic
General cargoes including Ro-Ro cargoes	756	113
Cereals	846	127
Cement	544	82
Containers	2,200	330
Steel products and wood	609	93
Foodstuffs and agricultural products	92	14
Animal feed	70	11
Car ferry	1,791	269
Total:	6,908	1,036

In the stage of the Master Plan, the Port of Algiers is divided into four zones; the North, Central and South zones, and Terminal-2. In addition to the existing access roads and gates located in each zone, a new access road and a gate is planned to be prepared in Terminal-2 in the Master Plan for smooth delivery and receiving of container cargoes through the terminal. Taking account of the locations of those gates, the above estimated traffic volumes each way are distributed through those gates in the following manner:

Zone	Hourly traffic each way
North Zone	292
Central Zone	157
South Zone	367
Terminal-2	220
Total:	1,036

As hourly capacity of traffic volume per road lane is estimated as 600 vehicles, two lanes each way needs to be shared for the entire above traffic.

As for railway wagons, daily traffic is estimated as follows:

Kind of cargo	Daily traffic
Cereals	138
Containers	45
Animal feed	11
Cement	10
Others	15
Total:	219

As for siding railway providing access to Terminal-2, a single track is planned to be newly installed. In a marshaling yard of the railway, three tracks with an effective length of 500 meters each are planned. At the cereal terminal, it is necessary to install additional tracks to transport the forecast volume. When installing the siding railway, the existing express way running along the port will be modified to overpass the siding railway in order to avoid plane intersection.

10.9 Use Plan for Space East of Terminal-2

The existing port limits extend on the east coast beyond Brise-Lames Est. Water area in front of the coast is suitable for port development. In this study, a part of the space is proposed for the port development with the target year 2010. Beyond that year, the water area seems to be still only space for further port development, and therefore, it is essential to reserve the space for the development. The space is expected to be used for various purposes such as additional container terminals, bulk terminals with deep water depths and sites for port-related industries to be newly established or transferred from the existing port district as a result of redevelopment of the existing facilities.

10.10 Environmental Consideration in the Port Activities

10.10.1 Environmental Impacts Induced by the Development of Terminal-2

It is necessary to consider the possibility of pollution induced by the development of Terminal-2. Pollution is categorized into various items such as water and air pollution, soil contamination, noise and vibration.

According to the proposed development plan, capital dredging is necessary for the creation of the basins. At the time of construction, dredged materials will be dumped into an enclosed embankment which will be constructed at the site for the development. Then, the dumped materials will be covered with high quality land soil, thereby eliminating the risk of leakage into the sea; though seabed materials to be dredged at the above site do not seem to be contaminated different from those inside of the existing basins which are partly contaminated. Other items of pollution such as air, water and noise can be easily prevented by proper countermeasures.

On the other hand, it is also necessary to consider environmental impacts induced by operations at the container terminal. However, container-handling is essentially pollution-free; unlike other operations in which severe countermeasures must be taken, there is no discharge of polluted water or air in container-handling. Some degree of noise may be generated from the operations. However, it seems to be negligible taking account of the land use around Terminal-2 where there is no residential areas to be affected.

10.10.2 Improvement of Environment Within the Existing Port District

As mentioned in Section 4.3, water and seabed soil within the existing basins of the port are presently polluted mainly due to sewage from the city and discharge from industries in and around the port. In order to improve the conditions, polluted water needs to be treated before being discharged into the basins regardless of the cost.

10.10.3 Provision of Facilities for Reception of Waste Water from Vessels

As mentioned in Section 4.3, according to the MARPOL Convention, it is necessary to provide facilities to receive waste such as ballast, bilge and tank cleaning waters from vessels at ports of the countries that ratified the convention. Presently, a simple oil and water separator exists at the port to receive only petroleum tankers. Therefore, it is advisable to provide full-scale facilities to receive the waste from not only petroleum tankers but also other vessels as required. A site near the existing separator is proposed for installation of the above reception facilities. Quay No.36 is also proposed as a barge site to receive the waste water from vessels on its way to the reception facilities.

10.11 Contents of the Master Plan

The contents of the Master Plan proposed by this study are summarized as follows:

- Terminal-2

  - Site: East of the Brise-Lames Est

  - Dimensions: Terminal area: 25.1 hectares
    Berths: Total length: 600 meters (2 berths)
    Water depth: 13 meters
    Main breakwaters: Length: 660 meters
    Sub-breakwaters: Length: 270 meters
    Access channel: Breadth: 260 meters
    Basin: Area: 19.7 hectares
    Water depth: 13 meters

  - Cargo-handling facilities: 4 Units of gantry cranes of 40 ton capacity for containers
    15 Straddle carriers
    4 Toplifters of 5 ton capacity
    23 Forklifts of 3 ton capacity
    2 Tractors
    6 Trailers

  - Other main facilities: Container freight stations
    Terminal office
    Repair shop
    Marshaling yard
    Van pool
    Railway yard
    Access road: 1.8 km

  - Required areas: Terminal area: 25.1 hectares
    Access road: 2.6 hectares
    Backup area: 7.7 hectares
    Others: 3.0 hectares

Railway yard: 3.6 hectares
Total: 42.0 hectares

- Terminal-1

  - Cargo-handling facilities: 2 Units of gantry cranes of 40 ton capacity for containers

- Open Yard for Steel Products and Wood

  - Project site: Wharf of Ghara Djebilet
  - Demolishing the warehouses behind Quay No.20 to prepare an open yard

- Cereal Terminal

  - Site: Wharf of Skikda
  - Cargo-handling facilities: 4 Units of rail-mounted pneumatic unloaders: nominal capacity of 400 tons per hour each
  - Silos: Total capacity of 220,000 tons excluding the existing silos
  - Other main facilities: belt conveyors
    siding railway
    loaders for railway wagons

- Facilities for Reception of Waste from Vessels

  - Project site: near the existing facilities

- Siding railway overpassed by the existing express way

10.12 Cost Estimation

The main conditions for the cost estimation are as follows;

(a) Construction costs have been estimated using the prices and rates obtained in October 1991 in principle

(b) The inflation factor has been excluded from the estimation.

(c) The exchange rates of the U.S.$ against the Algerian Dinar (DA) and the Japanese Yen (JY) are as follows;

1 US$ = 21.899 DA = JY 131.25

A summary of estimation results is presented in Table 10.12.1.

Table 10.12.1 Summary Construction Cost of the Port of Algiers

Unit: Million DA

Facilities		Case 1-1			Case 2-1			Case 3-1		
Item	Sub Item	Foreign Portion	Local Portion	Total Cost	Foreign Portion	Local Portion	Total Cost	Foreign Portion	Local Portion	Total Cost
1.Main structures	1)Main Breakwater	1,102.9	538.2	1,641.1	1,172.4	573.3	1,745.7	1.960.0	825.0	2,785.0
	2)Sub BreakWater	546.4	221.7	768.1	523.7	212.8	736.5	-	-	-
	3)Besin & Channel	14.2	78.0	92.2	22.1	121.3	143.4	-	-	-
	4)Reclamation of Land	277.1	89.4	366.5	240.1	77.3	317.4	822.9	289.2	1,112.1
	Sub Total	1,940.6	927.3	2,867.9	1,958.3	984.7	2,943.0	2,782.9	1,114.2	3,897.1
2.Container Terminal 2	1)Civil Works & Buildings	385.6	240.3	625.9	401.9	248.2	650.1	396.0	219.4	615.4
	2)Container Crane etc.	1,012.3	157.7	1,170.0	1,012.3	157.7	1,170.0	1,012.3	157.7	1,170.0
	Sub Total	1,397.9	398.0	1,795.9	1,414.2	405.9	1,820.1	1,408.3	377.1	1,785.4
3.Container Terminal 1	1)Civil works	10.2	6.9	17.1	10.2	6.9	17.1	10.2	6.9	17.1
	2)Container Crane	646.1	98.5	744.6	646.1	98.5	744.6	646.1	98.5	646.1
	Sub Total	656.3	105.4	761.7	656.3	105.4	761.7	656.3	105.4	761.7
4.Cereals Terminal	1)Silos & Buildings	1,685.0	752.3	2,437.3	1,685.0	752.3	2,437.3	1,685.0	752.3	2,437.3
	2)Civil Works	51.2	45.4	96.6	51.2	45.4	96.6	51.2	45.4	96.6
	3)Preumatic Unlooder	618.3	56.2	674.5	618.3	56.2	674.5	618.3	56.2	674.5
	Sub Total	2,354.5	853.9	3,208.4	2,354.5	853.9	3,208.4	2,354.5	853.9	3,208.4
5.Steel/Wood Terminal	1)Civil Works	0.3	0.1	0.4	0.3	0.1	0.4	0.3	0.1	0.4
	2)Handling Equipmens	516.1	80.4	596.5	516.1	80.4	596.5	516.1	80.4	596.5
	Sub Total	516.4	80.5	596.9	516.4	80.5	596.9	516.4	80.5	596.9
6.Miscellanies	1)Railway Siding	25.5	23.2	48.7	25.5	23.2	48.7	-	-	-
	2)Other Equipments	41.3	2.5	43.8	41.3	2.5	43.8	41.3	2.5	43.8
	Sub Total	66.8	25.7	92.5	66.8	25.7	92.5	41.3	2.5	43.8
7.Direct Cost		6,932.5	2,390.8	9,323.3	6,966.5	2,456.1	9,422.6	7,759.7	2,533.6	10,293.3
8.Indirect Cost	1)Physical Contingency	359.5	177.7	537.2	362.4	183.6	546.0	432.0	190.5	622.5
	2)Engineering Services	327.9	159.6	487.5	330.6	228.1	558.7	394.0	171.1	565.1
	Sub Total	687.4	337.7	1,024.7	693.0	411.7	1,104.7	826.0	361.6	1,187.6
9.Total Cost		7,619.9	2,728.1	10,348.0	7,659.5	2,867.8	10,527.3	8,585.7	2,895.2	11,480.9
10.Tax(VAT)		533.4	191.0	724.4	536.2	200.7	736.9	601.0	202.7	803.7
11.Project Cost		8,153.3	2,919.1	11,072.4	8,195.7	3,068.5	11,264.2	9,186.7	3,097.9	12,284.6

CHAPTER 11 MASTER PLAN FOR THE PORT OF ORAN

11.1 Strategy of the Master Plan

The port planning strategy for accomplishing these goals is considered as follows:

(1) Expansion of area for port development

Due to limited space is available within the existing port area of Oran, an expanded site and creation of new port space will be necessary for the increased port functions for the port of Oran. For this purpose, the water areas north-east of the port are being considered. On this side, there are steep sea and high cliff just behind. However, if the port is expanded to the north-east side, the integrated use of existing and new port facilities would be highly feasible. Therefore, future development space for port of Oran will be developed at the north-eastern sea area by the northern and eastern breakwaters.

(2) Promoting the development of cereals wharf

At the port of Oran, the specialization of cargo handling by berth, streamlining of loading and unloading, and the quick dispatch of ships are generally practiced at present.

Increased cargo volume, as forecasted, will result in the construction of large ships and special carriers. At this port, this trend is expected to grow, particularly in regard to cereals from the economic point of view. Therefore, it will be necessary to develop cereal berths and cargo-handling equipment. Unloading capacity will thus be increased and the overall functions of the port will be improved.

(3) Promoting the development of container terminal

Quay No.21 at the port of Oran will be improved in order to cope with the increasing container transportation traffic. However, these are merely temporary measures and there is still a limit to the handling of large container cargo volume at that berth.

If the development of container terminals at the port is allowed to lag behind container terminal construction in other countries, the port of Oran will fall from its central position as a foreign trade port.

Therefore, it is important to actively promote the container terminals at the port of Oran in order to facilitate the berthing of large container ships.

(4) Reserving space for future development

The port plan must consider room for further development in the long term. As further expansion of port facilities may be necessary after the year 2010, space should be set aside for future development.

(5) Optimization of investment size and time of investment

In port planning, consideration must be given not only to minimizing the total investment size, but also to the timing of each investment to maximize its effect at each stage.

11.2 Present Capacity of the Port of Oran

In order to determine the required scale of plan for future cargo traffic, it is necessary to determine the present cargo-handling capacity of the port. Port capacity is generally calculated in terms of the volume of cargo.

Since port capacity varies according to the type of the cargo, size of lot, size of the berth, method of loading and unloading, ets., it is often represented simply as the volume of cargo handled at the port.

The present capacity of Oran is estimated by analyzing the relationship between the volume of cargo handled at each berth, in term of general cargoes, cereals and petroleum products.

(1) General cargoes

1) Cargo handling capacity at berths

Some of the data related to the handling of general cargoes is as shown below.

a. Average loading/unloading capacity per gang: 30.8 tons/hour
b. Average working hours per day: 12.0 hours
c. Average mooring days per ship: 6.4 days
d. Number of berths for general cargo: 22 berths
e. Working days per year: 280 days

These are used to estimate the annual port capacity for handling general cargo.

The number of ships which can moor at the general cargo berths per year is obtained from c, d and e above. This figure is about 963. The actual number of general cargo ships entering the port in 1990 was 558. This indicated berth occupancy ratio is 58%.

The annual cargo-handling capacity is estimated at 2,276 thousand tons. This is obtained from the daily cargo handling volume of 367 tons calculated from a, and b above. The volume of general cargo handled at the port of Oran in 1990 was 1,322 thousand tons. This shows that port of Oran is being operated below full capacity according to the berth data analysis.

2) Capacity of cargo storage facilities

The present transit shed measures 21,000 m^2, and the open storage area is 132,000 m^2. Since data on the cargo handling capacity of the port of Oran from the view point of storage space is not available, we substitute the actual values for the port of Yokohama in Japan, where transit shed capacity is estimated at 0.55 t/m^2, and open storage area is 1.05 t/m^2, assuming 1.0 times a month cargo turnover rate. The capacity of cargo storage facilities is estimated at 1.8 million tons. In view of the present handling volume of 834 thousand tons, the accommodating capacities of the transit sheds and open storage area seem to be sufficient.

3) Situation of ship entry

From the time a ship arrives out side the port to its final berthing, a minimum of 0.5 hours is required. As shown in Fig. 6.4.2.(2).1 which indicates elapsed time from arrival of a general cargo ship to final berthing, 32% of all ships are forced to wait outside the port for more than 24 hours. They at least indicate that ship have to wait at port of Oran.

(2) Cereals

1) Capacity of cargo handling equipment

Cargo handling equipment, working hours and other items concerning cereals handling are as follows:

a. Cargo handling equipment:

	Nominal capacity	Actual
Screw type # 1	400 t/hr.	-
Pneumatic type # 2	400 t/hr.	-
Total	800 t/hr.	137 t/hr.

b. Working hours: 16 hours/day

c. Average mooring days per ship: 9.3 days

d. Annual working days: 300 days

These are used to estimate the annual handling capacity cereals.

The volume of cereals that can be handled in a year by these equipments is estimated from the relation of a, b and d, to be about 658 thousand tons.

The volume of cereals handled at cereal berths in 1990 was 582 thousand tons. The mooring capacity of cereal berth has already reached its limit, however, the cargo handling equipment is not operating at full capacity.

2) Silo capacity

The storage capacity of the silos at the port of Oran is 40,000 tons. The annual handling volume of cereals in 1990 was 1.186 million tons, and the volume handled at the silos was 823 thousand tons, remaining 363 thousand tons was directly dumped at the other berths and hauled out by truck. The average annual silo turnover rate was 20.5 turns.

(3) Petroleum products

1) Cargo handling capacity at berth

Some of the data related to the handling of petroleum products is as shown below.

a. Average unloading capacity per hour: 83.0 tons/hour
b. Working hours: 24 hours/day
c. Average mooring days per ship: 2.7 days
d. Annual working days: 300 days

These are used to estimate the annual petroleum products handling capacity.

The volume of petroleum products that can be handled in a year is estimated from the relation of a, b and d, to be about 598 thousand tons.

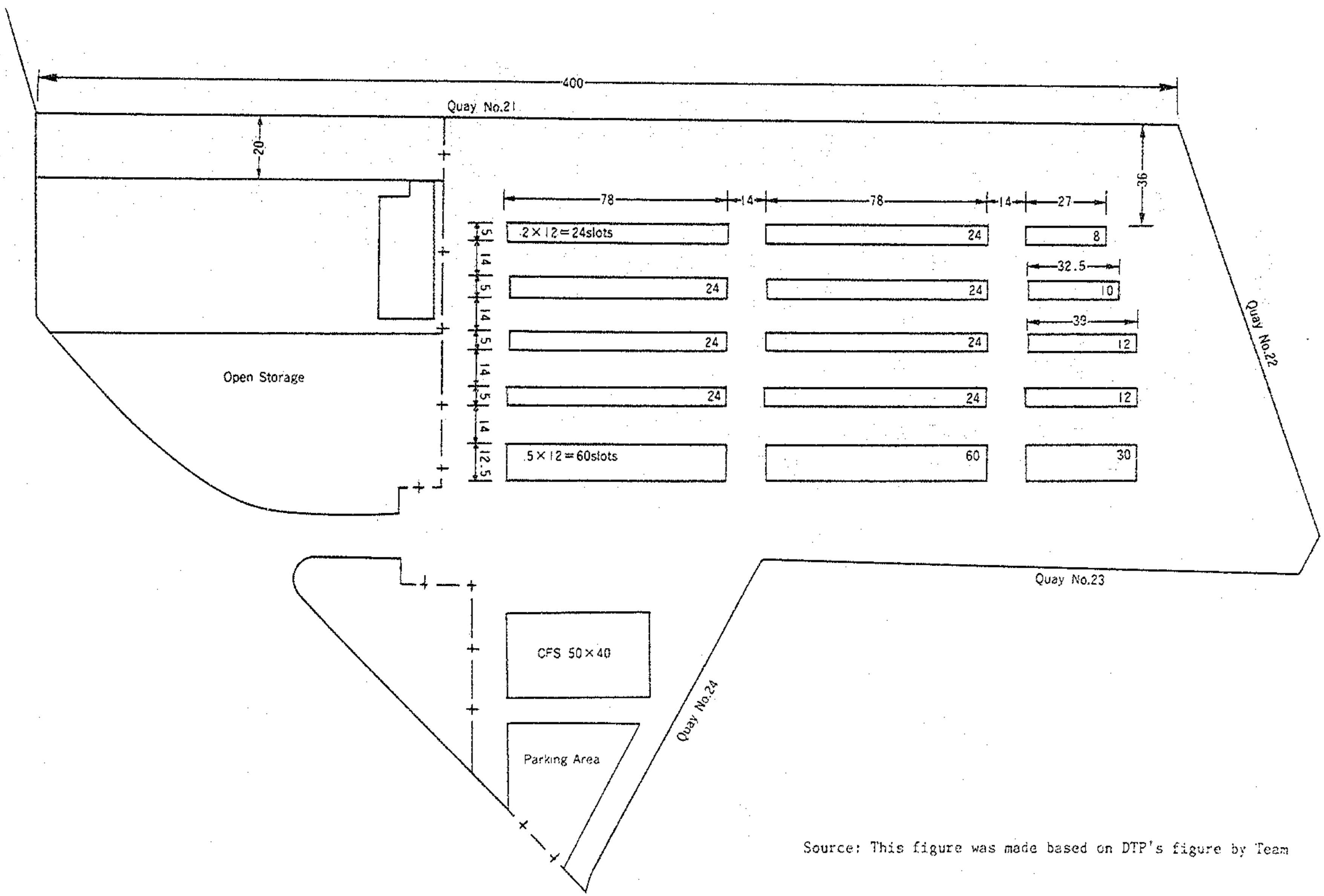
The volume of petroleum handled at Berth No.21 in 1990 was 504 thousand tons.

The number of ships which can moor at the petroleum berth per year is obtained from c and d above. This figure is about 111. The actual number of petroleum products carriers which moored at that berth in 1990 was 95. This indicates a berth occupancy ratio of 86%. The mooring capacity of the petroleum berth has already reached its limit. However, it will be possible to increase the handling capacity beyond the present level by improving the unloading and storage capacities.

(4) Container handling capacity

The container handling capacity is estimated for the container terminal planned at Quay No.21 and its related area as shown in Fig. 11.2.1.

The number of containers handled per year is calculated according to the



Source: This figure was made based on DTP's figure by Team

Fig. 11.2.1 The Layout of the Container Terminal at Quays Nos. 21-23 following assumptions.

a. Number of containers loaded/unloaded per ship: 500 TEU
b. Handling capacity of container: 15 TEU/hour
c. Working hour per ship: 12.0 hour

It will take 33 hours to load/unload 500 TEU. Thus it is necessary for container ships to berth at least 3.0 days. The maximum number of container ships which can be berthed per month is estimated at 10.

Therefore the annual number of containers handled is estimated at 60,000 TEU. The actual number is given at 48,000 TEU which is 80% of the estimate (calculated in terms of berth occupancy, loading efficiency, etc.).

The maximum number which can be stored is 384 judging from the amount of yard area. With an average of 2.5 layers for storage, and twice a month rate of turnover, the annual number handled will be 23,000 TEU.

From the above, the capacity of the container handling facilities is determined by the number of containers stored, and is estimated to be around 140 thousand tons per year.

11.3 Proposed Scale in Master Plan

11.3.1 Methods to Determine Number of Berths

The methods are mentioned in the previous Section 10.2, and therefore are not explained here.

The proposed scale in the master plan (2010) must be in accordance with the volume of cargoes handled. Already mentioned in Chapter 8, the volume of cargoes that will be handled at the port of Oran in 2010 is shown in Table 11.3.1.

Table 11.3.1 Volume of Cargoes Handled in 2010

Commodities	Volume of Cargoes (tons)		
	Import	Export	Total
(General Cargoes)			
Timber	125,000		125,000
Sugar	64,000		64,000
Other Agricultural Prod.	10,000		10,000
Other Foodstuff	28,000		28,000
Fertilizer	10,000		10,000
Fiat Parts	7,000		7,000
Chemical P.,Manufactrd G.	141,000	25,000	166,000
Aluminium		71,000	71,000
Sub-total	385,000	96,000	481,000
(Bulk Cargoes)			
Cereals	2,700,000		2,700,000
Vegetable Oil	150,000		150,000
Animalfeed	246,000		246,000
Petroleum Prod.	1,320,000		1,320,000
Metallic Prod.	395,000		395,000
Cement	433,000		433,000
Almina	600,000		600,000
Costrution Materials	114,000		114,000
Metallurgical Scrap		19,000	19,000
Sub-total	5,958,000	19,000	5,977,000
(Container Cargoes)			
	936,000		936,000
		168,000	168,000
Sub-total	936,000	168,000	1,104,000
Grand Total	7,279,000	283,000	7,562,000

The port facilities required to handle this volume are determined by referring to past performances at the port of Oran.

11.3.2 General Cargo Wharf

As mentioned in the previous chapter, the majority of ships transporting general cargo which call at the port of Oran were divided into between 1,000 - 3,000 DWT and 9,000 - 20,000 DWT and average ship size was 7,300 DWT.

Considering shipping trends, general cargo ships which currently call at the port of Oran will maintain their size in the future.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of general cargoes handled in 2010 is 1.009 million tons.
b. In principle, a ship gear is used for cargo handling and its capacity of 30.8 tons/hours is used for calculation.
c. The average per-ship loading/ unloading volume is 2,400 tons.
d. Average time for using berths is 3,720 hours per year(12.0 hours/days x 310 days).
e. Necessary processing time for entry and departure is 2 hours per ship.

Based on the above data, the required number of general cargo berths in 2010 is determined as follows: The hourly volume of handled cargoes is 30.8 tons. The per-ship berthing time of about 80 hours is derived from the relation between the average per-ship loading/unloading volume and the cargo handling productivity. Since the annual number of ships calling at this port is 420, the total berthing time is 33,600 hours. Since the available time for using berths is 3,720 hours, the berth occupancy ratio is 64.5% for fourteen berths. Base on these results, the required number of berths is 14.

According to the simulation based on the queuing theory, the berth occupancy ratio is 57.5%, the ship waiting ratio between waiting time and service time is less than 1% and the per-waiting ship waiting time is 1.2 hours in the case of fourteen berths. Therefore, fourteen berths are considered to be reasonable.

(2) Planning of cargo handling and storage facilities

The size of cargo handling and storage facilities including the storage yard, transit shed and warehouse has to be decided taking account of the types, quantities of cargoes and the conditions of handling.

In 2010, the volumes of cargoes through transit shed and open storage yards area are estimated as shown in Table 11.3.2.

Table 11.3.2 Volume of Cargoes Passing through Transit Shed and Open Storage Yard in 2010

Commodities	Volume of Cargo (tons)	(tons) Open Storage	Transit Shed	Sub-total
Timber	125,000	125,000		125,000
Sugar	64,000		64,000	64,000
Other Agricultural Prod.	10,000		10,000	10,000
Other Foodstuff	28,000		28,000	28,000
Fertilizer	10,000		10,000	10,000
Flat Parts	7,000		7,000	7,000
Chemical, Manufacture Prod.	166,000		166,000	166,000
Alminium	71,000	71,000		71,000
Metallic Prod.	395,000	395,000		395,000
Construction Materials	114,000	114,000		114,000
Metallurgical Scrap	19,000	19,000		19,000
Total	1,009,000	724,000	285,000	1,009,000

1) Transit shed

The necessary area of the transit sheds is determined by the following formula:

$A = (N \times p / R \times a \times W) / B$

where, A: Necessary area of transit shed (m^2)

N: Annual volume of cargoes handled

R: Turnover of transit shed

a: Utilization rate: 0.5

W: Volume of cargoes per unit area: 2.5 tons/m^2

P: Peak ratio: 1.3

B: Efficiency storage rate: 0.75

The result of the required area for the transit shed is in the following table.

Table 11.3.3 Required Area of Transit Shed

Volume of Cargo Handled N		Annual Storage Volume R x a x W (tons/m2)			Required Area (N x P / R x a x W) /B (m2)
Sugar	64,000	122	0.5	2.5	727
Other Agricultural Prod.	10,000	122	0.5	2.5	114
Other Foodstuff	28,000	122	0.5	2.5	318
Fertilizer	10,000	37	0.5	2.5	375
Flat Parts	7,000	37	0.5	2.5	262
Chemical, Manufacture Prod	166,000	37	0.5	2.5	6,221
Total					8,000

2) Open storage yard

The necessary area of open storage yard is determined by the following formula:

$A = (N \times p / R \times a \times W) / B$

where, A: Necessary area of open storage yard (m^2)

N: Annual volume of cargoes handled

R: Turnover of open storage:

a : Utilization rate: 0.5

W: Volume of cargoes per unit area:

P: Peak ratio: 1.3

B: Efficiency storage rate: 0.75

The result of the required size of the open storage yard is shown in the following table.

Table 11.3.4 Required Size of the Open Storage Yard

Volume of Cargo Handled N		Annual Storage Volume R x a x W (tons/m2)			Required Area (N x P / R x a x W) /B (m2)
Timber	125,000	37	0.5	1.2	9,760
Alminium	71,000	37	0.5	2.0	3,326
Metallic Prod.	395,000	37	0.5	2.0	18,505
Construction Materials	114,000	24	0.5	2.0	8,233
Metallurgical Scrap	19,000	24	0.5	2.0	1,372
Total					41,200

11.3.3 Cereals Wharf

The type of cereals ship serving at the port of Oran is mainly in the 20,000- 40,000 DWT class. And the average ship size was about 30,000 DWT.

The volume of cereals to be handled at the port in 2010 will be 2.7 million tons or about 2.3 times the present level.

With the demand for cereals expected to increase in the near future, larger ship will be increasingly used; with the demand for rational transportation, ship size tends to increase. So, the new cereals wharf is planned with a view to accommodating the maximum ship size of 65,000 DWT.

The standard dimensions for a 65,000 DWT ship are as follows: length 224 m, width 32.2 m and maximum draft 13.1 m.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of cereals handled in 2010 is 2.7 million tons.
b. The cargo handling equipment consist of two unloaders (400 tons/hours x 2) for each berth. The work efficiency is 0.64.
c. The average per-ship unloading volume is 25,000 tons.
d. The per-berth available time for using berths is 3,720 hours per year (12.0 hours/days x 310 days).
e. Necessary processing time for entry and departure is 2 hours per ship.

The number of cereals berths required in 2010 is calculated as follows: The annual number of ships calling at port is 108. Since the per-ship berthing time is 51 hours based on the volume of unloading and the cargo handling capacity, the total berthing time is 5,508 hours. Since the per-berth available time for use is 3,720 hours per year, the berth occupancy ratio is 74.0% for two berths and 49.5% for three berths. So, it is judged that three berths are necessary.

(2) Planning of cereals silos

In planning, the following conditions are set:

a. The volume of cereals through silos in 2010 is 2.7 million tons.
b. The turnover rate of silos is 20 times.

The silo capacity required in 2010 is calculated to be 135,000 tons.

11.3.4 Vegetable Oil Wharf

The volume of vegetable oil to be handled at Quay No.20 in 2010 will be 150 thousand tons or 1.9 times the present level, therefore the berth must be used as efficiently as possible.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of vegetable oil handled in 2010 is 150 thousand tons.
b. A cargo handling capacity of 65 tons/hour is used for calculation.
c. The average per-ship unloading volume is 2,500 tons.
d. The per-berth available time for using berths is 7,440 hours per year (24 hours/days x 310 days).
e. Necessary processing time for entry and departure is 2 hours per ship.

The number of vegetable oil berths required in 2010 is calculated as follows: The annual number of ships calling at the port is 60. Since the per-ship berthing time is 40 hours based on the volume of unloading and the cargo handling capacity, the total berthing time is 2,428 hours. Since the per-berth available time for use is 7,440 hours per year, the berth occupancy rate is 32.6% for one berth. So, it is judged that one berth is necessary.

11.3.5 Animal Feed Wharf

The animal feed berth is planned at the head of Quay No.15. The handled volume of animal feed in 2010 will be 246 thousand tons.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of animal feed handled in 2010 is 246 thousand tons.
b. A cargo handling capacity of 200 tons/hour is used for calculation.
c. The average per-ship loaded/unloading volume is 15,000 tons.
d. The per-berth available time for using berths is 3,720 hours per year (12.0 hours/days x 310 days).
e. Necessary processing time for entry and departure is 2 hours per ship.
f. The size of ships is considered to be 30,000 DWT.

The number of animal feed berths required in 2010 is calculated as follows: The annual number of ships calling at the port is 16. Since the per-ship berthing time is 77 hours based on the volume of unloading and the cargo handling capacity, the total berthing time is 1,232 hours. Since the per-berth available time for use is 3,720 hours per year, the berth occupancy rate is 33.1% for one berth. So, it is judged that one berth is necessary.

11.3.6 Petroleum Products Wharf

The volume of petroleum products to be handled at the port of Oran in 2010 will be 1.32 million tons or about 2.5 times the present level. Therefore, the berth must be used as efficiently as possible and the cargo handling equipment has to be replaced to increase cargo handling volume.

The petroleum carriers calling at the petroleum berth are mostly in the 6,000 DWT class. Therefore, the ship size of 6,000 DWT is planned for and per-ship unloaded volume will remain the same as at present.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of petroleum products handled in 2010 is 1.32 million tons.
b. A cargo handling capacity of 260 tons/hour is used for calculation.
c. The average per-ship unloading volume is 5,000 tons.
d. The per-berth available time for using berths is 7,440 hours per year (24 hours/days x 310 days).
e. Necessary processing time for entry and departure is 2 hours per ship.
f. The size of ships is considered to be 6,000 DWT.

The number of petroleum berths required in 2010 is calculated as follows: The annual number of ships calling at port is 264. Since the per-ship berthing time is 21 hours based on the volume of unloading and the cargo handling capacity, the total berthing time is 5,605 hours. Since the per-berth available time for use is 7,440 hours per year, the berth occupancy rate is 75.3% for one berth and 37.7% for two berths. So, it is judged that two berths are necessary.

11.3.7 Cement Wharf

At present, cement is handled at the head of Quay No.19 (Berth No.23 and No.24) through the cement plant ship.

The volume of cement to be handled at the Quay No.19 in 2010 will be 433 thousand tons or about 1.6 times of the present level.

Of the cement carriers calling at this berth, the average ship size was in the 28,000 DWT class. The ship size and per-ship handling volume are considered to be the same as at present.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of cement handled in 2010 is 433 thousand tons.
b. A cargo handling capacity of 200 tons/hour is used for calculation.

c. The average per-ship unloading volume is 20,000 tons.

d. The per-berth available time for using berths is 5,580 hours per year (18.0 hours/days x 310 days).

e. Necessary processing time for entry and departure is 2 hours per ship.

The number of cement berths required in 2010 is calculated as follows: The annual number of ships calling at the port is 22. Since the per-ship berthing time is 102 hours based on the volume of unloading and the cargo handling capacity, the total berthing time is 2,208 hours. Since the per-berth available time for use is 5,580 hours per year, the berth occupancy ratio is 39.6% for one berth. So, it is judged that one berth is necessary.

11.3.8 Alumina Wharf

According to the port development plan by EPO and DTP, alumina wharf is planned at the base of Quay No.21 which has water depth of -12 m to -14 m, and a length of 200 m.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of alumina handled in 2010 is 600 thousand tons.

b. A cargo handling capacity of 450 tons/hour is used for calculation.

c. The average per-ship unloading volume is 15,000 tons.

d. The per-berth available time for using berths is 3,720 hours per year (12.0 hours/days x 310 days).

e. Necessary processing time for entry and departure is 2 hours per ship.

f. The size of ships is considered to be 30,000 DWT.

The number of Alumina berths required in 2010 is calculated as follows: The annual number of ships calling at the port is 40. Since the per-ship berthing time is 35 hours based on the volume of unloading and the cargo handling capacity, the total berthing time is 1,413 hours. Since the per-berth available time for use is 3,720 hours per year, the berth occupancy ratio is 38.0% for one berth. So, it is judged that one berth is necessary.

11.3.9 Car Ferry Wharf

The frequency of ferry services depends on both passengers and cargo. At present, the ferry services at the port of Oran are provided about twice a week. And the average mooring time per-ship is 1.8 days and the staying time is generally rather long. Then, it is seem to be controlled by the total time schedule.

(1) Number of berths

In planning, the following conditions are set:

a. The number of passengers in 2010 is 382,000
b. The average number of passengers per ship is 1,300.
c. The average mooring time per ship is 24 hours.
d. The annual available hours for using berth is 5,580 hours.
   (18 hours/days x 310 days)
e. The size of ships is considered to be in the 10,000 DWT class.

The number of car ferry berths required in 2010 is calculated as follows: The annual number of ships calling at the port is 293. Since the per-ship berthing time is 24 hours, the total berthing time is 7,032 hours. Since the per-berth available time for use is 5,580 hours per year, the berth occupancy ratio is 63.0% for two berths and 42.0% for three berths. So, it is judged that three berths are necessary.

(2) Passenger terminal

The required area of passenger terminals is estimated based on following formula:

$A = a \times n \times N \times c \times b$

where, a : Required area per person (1.2 m^2/person)
n : Fixed number of passengers
N: Number of departure/arrival vessels in the same period of time
c : Rate of concentration (1.0)
b : Rate of fluctuation (1.0)

The size of passenger terminal at the port Oran is as follows:

$$A = 1.2 \times 1{,}300 \times 2 \times 1.0 \times 1.0 = 3{,}120 \ m^2$$

(3) Size of parking lot

The required area for parking lots is estimated based on the following formula:

$$A = a \times n \times c \times b$$

where, a : Required area per vehicle : 30 m^2/car
n : Number of vehicles
c : Rate of concentration (0.8)
b : Rate of fluctuation (1.0)

The maximum number of vehicles for a car ferry is 600 cars, the area of the parking lot is calculated as follows:

$$A = 30 \times 600 \times 0.8 \times 1.0 = 14{,}400 \ m^2$$

11.3.10 Container Wharf

The volume of container cargoes to be handled at the port of Oran in 2010 will 1.1 million tons or about 4.4 times that of 1997's level, therefore, the container handling system should consider for efficient use of yard area.

Considering the total container volume, size of the yard, ease of maintenance and efficient operation, the straddle carrier system seem to be the most suitable for the port of Oran.

(1) Number of berths

In planning, the following conditions are set:

a. The volume of container cargoes handled in 2010 is 1.104 million tons.
b. Based on 1990 results, 10.2 tons is used as per-cotainer cargo volume.
c. The handling capacity of a container crane is 25 TEU/hour and its work

efficiency is 0.75.

d. The per-berth number of container crane is 2 units.

e. It is assumed that the per-ship number of loaded containers that are loaded or unloaded 500 TEU. Since the import/export ratio in 2010 is 84% for import and 16% for export, the ratio of empty containers to loaded container is 68%. So, the per-ship number of containers handled is 800 TEU.

f. The per-berth annual hours available for use are 5,580 hours (18 hours/days x 310 days).

e. The necessary processing time for entry and departure per ship is 2 hours

The number of container berths required in 2010 is calculated as follows: Since the total number of containers in 2010 is 182 thousand TEU, the number of ships calling at the port is 228 based on the per-ship number of container loaded or unloaded (800 TEU). Since the per-ship berthing time is 23 hours, the annual total berthing hours are 5,244 hours. Since the per-berth annual hours available for use are 5,580 hours per year, the berth occupancy ratio is 94.0% for one berth and 47.0% for two berths. So, it is judged that two berths are necessary.

(2) Required scale of storage facilities

1) Container yard

a. Calculation of storage volume

The required storage number of containers is calculated by the following formula:

$$Ml = (My \times Dw / Dy) \times p$$

where Ml : Required storage number of containers (TEUs)

My: Annual container throughput (TEUs)

Dw: Average dwelling days (days)

Imported containers: 10 days

Exported containers: 7 days

Empty containers : 10 days

Dy: Operation days (310 days)

P : Peak ratio (1.3)

b. Required number of ground slots

Sl = Ml / L

Where Sl : Required number of ground slots (TEUs)

Ml : Required storage number of containers (TEUs)

L : Stacking height of containers (Layers)

Imported containers: 2.2

Exported containers: 2.2

Empty containers : 3.0

The results of the calculation are shown in Table 11.3.5.

Table 11.3.5 Results of Required Storage Capacity in Container Yard

Items	Unit	Loaded Containers		Empty Containers	Total
		Import	Export		
Container Handling Volume	tons	936,000	168,000	-	1,104,000
Tons per-container	tons	10.2	10.2		
Annual Container Throughput (Hy)	TEUs	91,765	16,471	73,600	181,835
Hy x Dw x P /Dy	TEUs	3,848	483	3,086	7,418
Stacking Height	Layers	2.2	2.2	3.0	-
Required Number of Ground Slots	Slots	1,749	220	1,029	2,998
Slot area	m2				69,000

2) Container freight station

Considering the rather long period of cargo stay at the CFS (Container Freight Station), the required area for the CFS is calculated in the same manner as the warehouse, according to the formula below:

A = (Mc x Dw x P) / (w x u x Dy)

where A : Required floor area of CFS (m^2)

Mc: Annual handling volume of containerized cargo through CFS (tons)

Dw: Dwelling time at CFS (days)

Imported cargoes: 7 days

Exported cargoes: 5 days

P : Peak ratio (1.3)

w : volume of cargoes per unit area (1.3 tons/m^2)

u : Utilization rate of CFS floor (0.5)

Dy : Operation days of CFS (310 days)

Using the premises mentioned before, the required area of the CFS is calculated as follows:

$$A = (93,600 \times 7 + 16,800 \times 5) \times 1.3/(1.3 \times 0.5 \times 310) \doteqdot 4,800 \text{ m}^2$$

11.3.11 Harbor Facilities

(1) Layout of breakwater

It is necessary to arrange the northern and eastern breakwaters in consideration of the dominant wave direction, which is N-NE. The length of the northern breakwater will be 800 m which is decided in consideration of the critical wave height for cargo-handling. The detailed analysis concerned can be found in following A.7.

(2) Layout of channel

In planning harbor facilities for the port, the present channel lines will be used as much as possible. Changing the channel lines is deemed unnecessary due to natural conditions, such as waves and winds. At present, the channel width of 150 m is determined by the distance between the tips of both breakwaters. The widening of the channels will not considered to ensure the calmness of the harbor. An increase in the size of ships using the port is also likely, however, widening of the channels will be unnecessary if the control system at the harbor entrance is improved as required.

The water depth of the channels is planned at 14 meters based on the assumption that ship size will reach 65,000 DWT.

(3) Consideration of the high cliff

Just behind the proposed new development area in the Master Plan, there is a high cliff at a height of about 70 m. In order to avoid possible risk of slop failure of the cliff, the related new port facilities will be constructed about 50 m from the end of the slope.

11.3.12 Port Traffic Facilities

An access road and inner port road connecting to the national road are proposed for smooth distributing of port traffic generated at the wharves. The railway transportation of cargoes will be planned in accordance with the future transportation demand.

(1) Determination of traffic volume

The volume of traffic generated at a port is determine by the following formula:

$$T = N \times a / W \times m / 12 \times d / 30 \times (1 + v) / t \times h$$

where T : Proposed traffic volume (cars/hour)

N : Annual volume of cargoes handled (t/year)

a : Share of automobile = 1.0

W : Average tonnage/truck

m : Monthly rate of variation = 1.0

d : Daily rate of variation = 1.5

v : Rate of related vehicles = 0.5

t : Rate of loaded truck = 0.5

h : Rate of hourly variation = 0.1

Table 11.3.6 shows generated traffic volume by wharf.

Daily port generated traffic volume is about 5,530 cars.

Table 11.3.6 Generated Traffic Volume in 2010

Type	Cargo Volume ('000t)	Cargo weight of loaded (t/car)	Hourly generated traffic volume (car/hour)
Genral Cargo	1,009	8	158
Container Cargo	1,049	8.1	162
Cereals	1,458	12.0	152
Other Bulk	679	10.5	81
Total	4,195		553

(2) Road plan

Future port roads in the master plan have to be able to cope with such qualitative and quantitative changes as the increase of volume of port cargo and the introduction of container transportation. Taking the speciality of vehicles using inner port roads and the convenience of parking into consideration, four lanes and two lanes are proposed for trunk and branch roads, respectively. And it is necessary to consider another new road entrance at the new port development site.

Fig. 11.3.1(1)-(3) shows the standard section of roads.

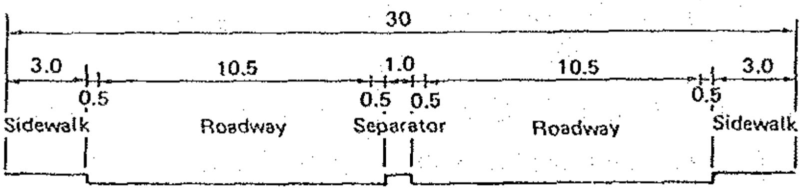


Fig. 11.3.1(1) Standard Section of Trunk Road

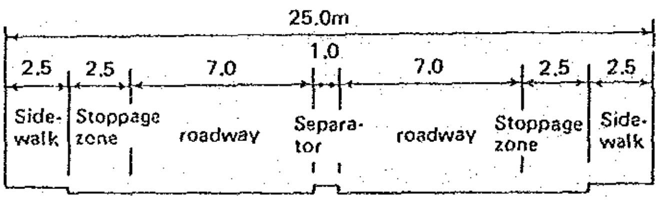


Fig. 11.3.1(2) Standard Section of Principal Road

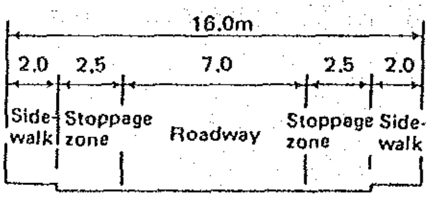


Fig. 11.3.1(3) Standard Section of Branch Road

(3) Railway plan

Railway transportation at the port Oran in 1990 moved about 690 thousand tons or 24.% of port-handled cargo.

The total volume of railway cargoes at the port of Oran in 2010 is assumed to be about 3.4 million tons.

The average number of arrival trains per day is calculated by the following formula:

$T = (A / W \times 1 / V \times K \times P) \times N$

where, A : Cargo handling volume per year: 3.4 million tons
W : Working days per year: 310 days
V : Actual wagon loading volume: 50 tons
K : Empty wagon rate: 1.0
P : Peak rate: 1.3
N : Average number of wagons per train: 25 wagons

The average number of arrival trains in 2010 is 11.4 trains.

In planning, a rail connection between existing and new port facilities has to be considered, though the obstruction of efficient cargo handling in the port area must be avoided.

11.4 Master Plan and Evaluation

11.4.1 Preparation of Alternative Plans

(1) Alternative master plans and rationales for each plan

The alternative master plans are termed A and B as shown in Fig. 11.4.1 - 2. Special consideration is made in preparing each alternative plan, as outlined below.

(Plan A)

In order that the construction of cereals and container berths and the commencement of services begins as soon as possible, these berths are arranged in a row to make for efficient use of facilities. The possibility of shaping the development area is studied in consideration that there might be further expansion of the port of Oran after the year 2010.

(Plan B)

Plan B is minimized the breakwater length, and it can be adapted to the Short Development Plan at a greatly reduced cost. However this plan is difficult to consider the further expansion of the port of Oran after the year 2010.

11.4.2 Evaluation of Alternative Plans

Alternative plans for each case are evaluated from the following viewpoints.

(1) Criteria for evaluation

1) Convenience

a. Maneuverability of ship - ease with which entry/departure and berthing/ deberthing of ships is possible.

b. Land use - ease with which cargo can be stored or transported, from the standpoint of users, and with regard to shape of the reclaimed land and the arrangement of facilities and roads.

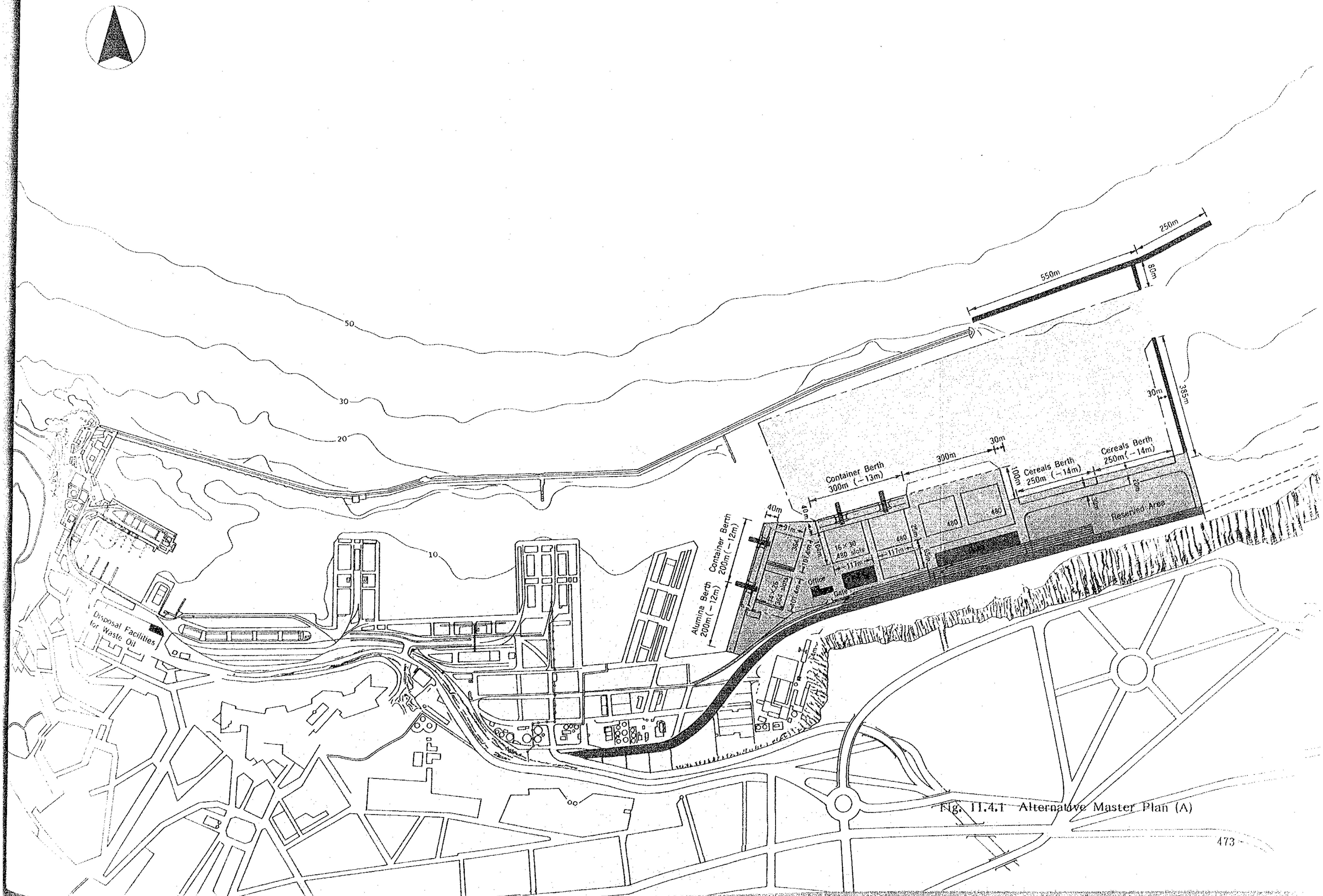


Fig. 11.4.1 Alternative Master Plan (A)

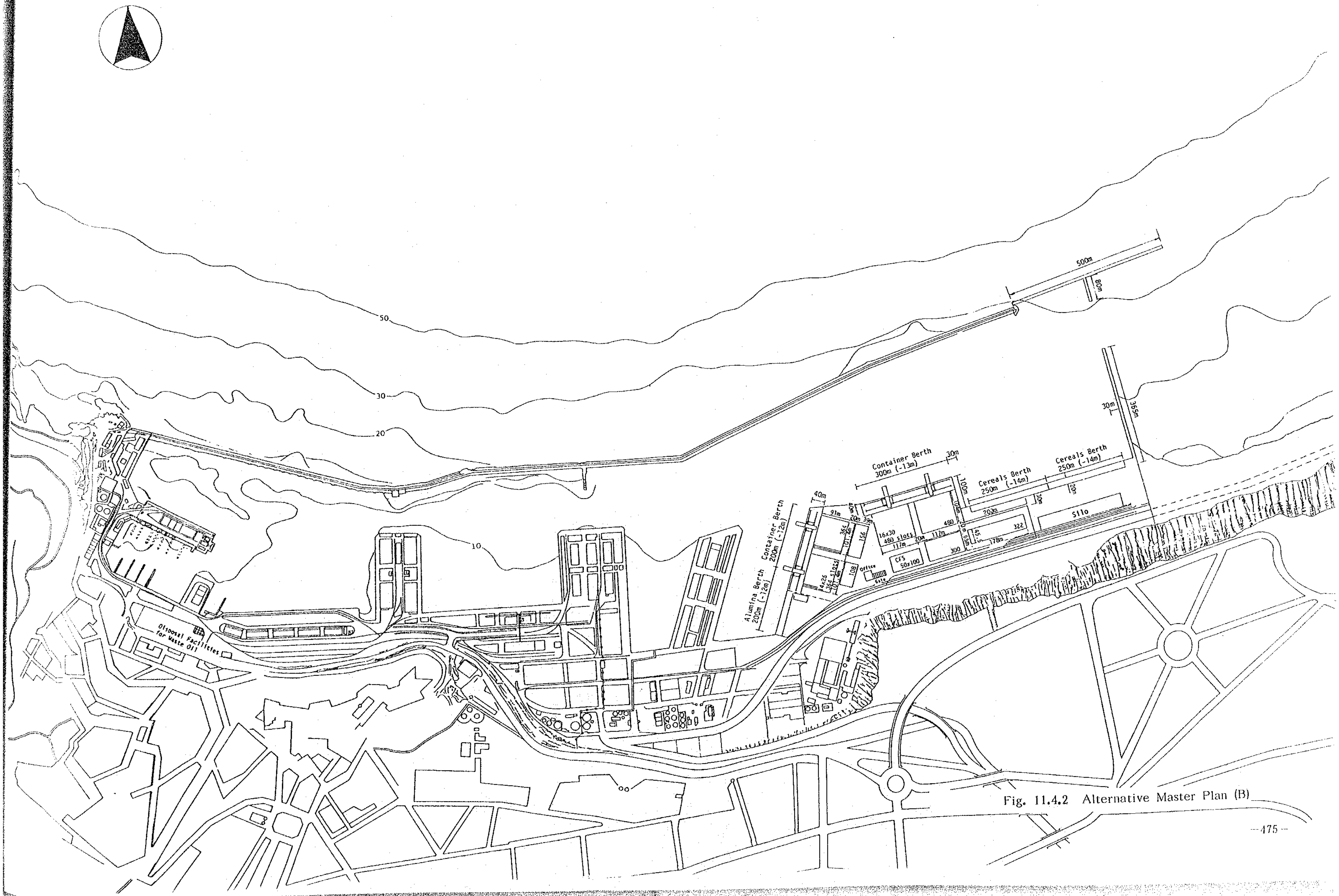


Fig. 11.4.2 Alternative Master Plan (B)

2) Safety

a. Calm waters inside the port - sufficient width of calm water area secured against invading waves in front of the berths, for easy loading and unloading inside the port.

b. Emergency measures - effectiveness and adaptability of measures to deal with accidents occurring inside the port.

3) Economy

a. Total construction cost - minimization of total construction budget, in consideration of costs for topography, soil conditions, balance between dredging and reclamation volume, etc.

b. Graduated investment - minimization of investment and maximization of effect while conforming to the requirement of early construction and early start of service.

4) Flexibility of the plan

a. Adaptability to changing conditions - whether it is possible to adapt the plan according to changing circumstances.

b. Potential for future development - availability of space for future expansion in order to meet post 2010 future demands.

5) Environmental Protection

a. Impact on the social environment - harmful effects on the living standards of citizens in terms of noise and vibrations created by port activities, and harmful effects on scenery.

b. Impact on the natural environment - the effect of port pollution on marine life.

(2) Selection of the optimum plan

Alternative plan A and B is evaluated according to the above mentioned criteria, as follows.

Table 11.4.1 Evaluation of Alternative Plans

Items of evaluation		Evaluation	
		Plan A	Plan B
Convenience	Maneuvability of ship	○	○
	Land use	◎	○
Safety	Calmness of waters within the port	◎	◎
	Emergency measures	○	○
Economy	Total construction cost	○	◎
	Investment by stage	○	◎
Flexibility	Changing conditions	◎	○
	Future development	◎	△
Environment preservation	Effects on social environment	○	○
	Effects on natural environment	○	○

Note: Ranking of evaluation ◎ Excellent
○ Ordinary
△ Some problems

As can be seen from the foregoing evaluation, the construction cost of these plans do not differ much, however, Plan A will be able to flexibly cope with future cargo volumes.

In consideration of these factors, Plan A is selected as the most appropriate master plan.