5.4.3 Future Waterway Transportation System

In this proposed waterway transportation system, emphasis is given to iron ore transportation because this is the most critical factor in deciding capacity of the channel.

(1) Iron ore Transportation in Future

The exported iron ore in the region has been declining in the past two decades, and is forecasted to decline further because Venezuelan policy is encouraging export oriented steel industries and the introduction of value added industries. In fact, according to the plan of Ferrominera, the forecasted volume of exported iron ore will be declining little by little to 4 million tons until 2003 but will maintain 4 million tons after that.

In the period until around 2003 : in the period while existing Transfer Vessel is still in operation.

The existing transportation system should be maintained. The capacity of the Canal is mentioned below.

In the period from around 2003 to around 2007 : in the period while two existing Shuttle Vessels are still in operation after the retirement of existing Transfer Vessel.

The Transfer Vessel will be 30 years old in 2003 and annual maintenance costs including maritime insurance premium will be rapidly increasing. In this period the volume of exported iron ore is estimated at 4 million tons. The decision has to be made whether to maintain the existing transfer system or not on the basis of both final destinations and their imported volumes.

In the case of maintaining the transfer system, there would be two choices: either replacing of the existing Transfer Vessel with a new one remodeled from a used vessel or repairing of the existing Transfer Vessel year by year. The choice has to be made carefully on the basis of the replacement or repair cost, of final destinations and of their imported volumes.

In case of the retirement of Transfer Vessel, it would be desirable that two Shuttle Vessels directly transfer the iron ore to Cape size carriers at Boca de la Serpiente if requested to by Cape size carriers. Three trips of the Shuttle Vessel are sufficient to transfer the volume of iron ore for a Cape size carrier although it takes approximately 10 days for a Cape size carrier to be fully loaded.

On the other hand there would be other options in exporting to the destinations in Europe. One option is that a Panamax size carrier, loading at Puerto Ordaz within the allowance of the depth of the channel, makes a direct trip to the final destination. Another is that a Panamax size carrier partially loading at Puerto Ordaz, additionally loads from the Shuttle Vessels at Boca de la Serpiente to full capacity.

In the period from around 2008 to around 2013 : in the period while one existing Shuttle Vessel is still in operation after the retirement of both existing Transfer Vessel and one existing Shuttle Vessel.

The Shuttle Vessel RIO ORINOCO will probably be retired around 2008 because of increasing maintenance costs. In this period the volume of exported iron ore is estimated at 4 million tons.

Even in this situation it would be desirable that the remaining Shuttle Vessel directly transfer the iron ore to Cape size carriers at Boca de la Serpiente if requested to by Cape size carriers. Direct trips to the destinations in Europe would be desirable as mentioned above.

After 2013 : in the time after the retirement of both existing Transfer Vessel and two existing Shuttle Vessels.

The remaining Shuttle Vessel "RIO CARONI" will retire around 2013. It would be desirable that a Panamax size carrier, loading with full cargo at Puerto Ordaz, makes a direct trip to the final destination.

It should be noted as mentioned above that the use of Panamax size carriers makes competitive sense in the world freight market if appropriate final destinations are chosen.

Table 5.4.3 Future Waterway Transportation System in Orinoco Delta (Target Year 2020)

Transport Cargo	Period	Navigation System	Remarks
Iron Ore	① Period: Present-2003	The navigation route should be along Rio Grande. While existing Transfer Vessel (TV) and two shuttle vessels are still in operation, the existing transportation system with TV should be maintained.	Same as the present transportation system
	② Period: 2003-2007	The navigation route should be along Rio Grande. With retirement of the Transfer Vessel, two existing Shuttle Vessels will be in operation.	The Transfer Vessel will be 30 years old in 2003 and annual maintenance costs including maritime insurance premium will be increasing rapidly. In this period the volume of exported iron ore is estimated at 4 million tons. The decision has to be made whether to maintain the existing transfer system or not, on the basis of both final destinations and their imported volumes.
	③ Period: 2007-2013	The navigation route should be along Rio Grande. With retirement of one shuttle vessel, remaining shuttle vessel will be in operation.	Exporting to the destinations in Europe, one option is that a Panamax size carrier, loading at Puerto Ordaz within the allowance of the depth of the channel, making a direct trip to the final destination. Another is that a Panamax size carrier, partially loading at Puerto Ordaz, and additionally loaded from the Shuttle Vessels at Boca de la Serpiente to full capacity.
	④ Period: After 2013	The navigation route should be along Rio Grande. After 2013, in the time after the retirement of both existing Transfer Vessel and two existing Shuttle Vessels.	It would be desirable that a Panamax size carrier, fully loaded at Puerto Ordaz, makes a direct trip to the final destination. It should be noted that the use of Panamax size carriers makes competitive sense in the world freight market if appropriate final destinations are chosen.

(2) Other Cargo Transportation in the Future

Cargoes other than iron ore are forecasted to increase to 22 million tons per year in 2020 from 10 million tons per year at present. The sizes of ships are almost all Small Handy class at present and this will likely remain unchanged up to 2020 according to the investigations on kinds of cargoes. Even if ship sizes are larger than the Small Handy, they would probably be no more than Handymax class because most Panamax size carriers are not equipped with self-loading/unloading systems.

(3) Channel Capacity in relation to the Waterway Transportation

The carriers navigating the channel, as mentioned above, would be Panamax size class for transporting the iron ore and up to Handymax size class for transporting other cargoes.

In one view, the channel is an indispensable transportation infrastructure for development for the region and thus it is important to maintain the channel as an access route to America and Europe.

Therefore the channel would be maintained to accommodate Panamax size carriers in terms of its depth and width.

The annual traffic of iron ore carriers for each direction is 220 vessels at present and is estimated to drop to a maximum of around 90 vessels when the exported iron ore volume decreases to 4 million tons. The annual traffic of other cargoes for each direction is around 680 vessels at present and is estimated to increase to a maximum of around 1,050 vessels when other cargoes increase to 19 million tons in 2010, and to 1,200 vessels when the cargo volume reaches 24 million tons in 2020.

The total annual traffic for each direction in the channel is estimated at more than 1,100 vessels in 2010 and around 1,300 vessels in 2020 compared with 900 vessels in 1997.

The MTC report [*4)] pointed out that the traffic capacity of the channel was 1,100 vessels per year in each direction, which will be insufficient in future. When the traffic is foreseen to exceed 1,100 vessels, it would be desirable to introduce a convoy system and the crossing zone as necessary according to the recommendations in the MTC report [*4)].

(4) Pilot and Traffic Control

In addition to an increase in pilots to accommodate growing future traffic, it would be desirable to introduce the vessel traffic management system, by which officials could easily identify the positions of all vessels within the Canal in an instance and could give instructions to the vessels. The vessel traffic management system (VTMS) consists of control center, stations and buoys. The system is outlined in the Supporting Report.

There is a project that was proposed by INC for introducing a GPS assisted navigational aid at a modest operational cost. In the long run, these efforts and costs will be compensated by the possible reduction of maritime insurance costs.

5.4.4 Ports in Future

(1) Port Development

The port capacity for the specialized cargo seems to be adequate for the present and foreseeable future demand that is forecasted within the range of the peak load recorded in the past.

On the other hand, several terminals will be allowed for third party use while excess capacity remains. And, along the line of export substitution strategy of the region, the demand for a port open to public use will increase because the increasing medium to small-scale industries can not afford specialized port facilities. In this sense, the San Felix Terminal will play a valuable role. However the Terminal is located in the east district, almost 10 to 20 km away from the growing industrial zone in the west of city center, and its annual capacity of 200,000 tons seems to be small for the foreseeable future demand.

A large scale industrial port complex zone development is planned by CVG [*11) *12) *13) *14)] in the area west of SIDOR. As this development plan includes some multipurpose terminals for public use, the timing in which these terminals are realized should coincide with the actual demand.

(2) Port Management

Venezuela is now in the middle of the age of decentralization and privatization, and Venezuelan ports other than in Puerto Ordaz were handed over to the State governments, among which there are several cases of State-owned autonomous enterprises taking charge as the port management body. Furthermore, in the course of privatizing the CVG owned enterprises, SIDOR was privatized and allowed to keep its own port facilities.

The Office of the Executive Secretariat under the Inter-ministerial Committee on the Authority of the Orinoco River had been in charge of coordinating all the ports owned by CVG subsidiary enterprises until the resolution of the Committee in 1992.

However, there is no single entity in Puerto Ordaz that is in control of planning, coordination, management and operation as port authority for the common objectives of serving the cargo transportation demands. At present, it is not easy to compile even the present data on cargo volume, number of ships and their sizes, and activities of industries concerned as a whole in Puerto Ordaz.

This entity, called a port authority, should be established. The function of the port authority covers a wide range of port activities related to development, maintenance, administration and management of port facilities as well as the enhancement of port use. This function is important for achieving sustainable economic growth of the region and consequently for accomplishing the country's development strategy.

INC is in charge of maintenance, management and operation of the Canal. The maintenance of both an adequate depth and adequate width of the channel based on the information on vessels navigating the channel both at present and in future should be conducted. Consequently, channel maintenance would become efficient and costs would be minimized. In this sense, the establishment of a port authority would be helpful to INC.

(3) Ports for Regional Use in the Delta Area

Due to the geographical conditions of the Lower Orinoco Delta area, the regional road transportation network does not cover the majority of the area: a minor portion of the population is sparsely scattered in small towns or villages along the waters of effluents of Orinoco River. Accordingly, small boat navigation has been playing an important role in passenger transportation for business and school commuting and cargo transportation for livelihood commodities as well as for trade in local agricultural products and imported goods.

A report on an extensive study undertaken by PDVSA-DAO [*20)] developed a practical program to improve the regional transportation system by proposing an integrated waterway networks which linked the centers of production, consumption, and tourism for both the passenger and cargo transportation by small boats. Six routes are identified as principal and another 14 routes are to be developed for local circulation purpose.

It proposes a simple and low cost for ships passing through the Manamo Dam. The proposed system is composed of ship lifting cranes and a mobile-driven train on the road, and at later stage, with ship lift elevators to accommodate up to 50 t boat that will replace the cranes.

This report mentioned that the Macareo Canal could be used as a navigation channel for exporting vessels, referring to the MTC report [*4)]. It should be noted that there were no comments on the reuse of the Manamo Canal as a navigational channel.

The project for the 20 port improvement is given high priority. Those ports are categorized into 3 groups as Type I, II, III models of which costs are 300 to 680 million Bs, 150 to 200 million Bs, and 30 million Bs respectively. An investment plan is proposed in the form of Short, Medium, and Long term plans. (Table 5.4.4)

This practical program is expected to be implemented in due time. Alternatives systems for ships passing through the Manamo Dam are shown in the Appendix.

Table 5.4.4 Types of Regional Use Ports

Type I	6	Volcan, Pedernales, La Horqueta, Piacoa, Boca de Araguao, Curiapo
Type II	4	Tucupita, Santa Catalina, San Jose de Amacuro, San Francisco de Guayos
Type III	10	(El Muerto, Vuelta Larga, Siaguani, Mision de Araguaimujo, Guiniquina etc)

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*5) The Guayana Region Installed Port Capacity (and Transfer Stations) CVG, Vice-presidency of Industrial Promotion 1996

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*10) Informacion General sobre las Condiciones del Canal de Navegacion del Rio Orinoco ; INC 1996

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*14) Revised version of *12) 1993

*15) Transporte de Mineral de Hierro de Puerto Ordaz al Mar ; Orinoco Mining C.A.(OMC) , INC 1970

*16) Puerto Oceanico en Aguas Profundidad, Punta Bombeador, Delta del Orinoco(mimeo)

*17) Transporte de Mineral de Hierro de Puerto Ordaz al Mar via Cano Manamo ; Orinoco Mining C.A.(OMC) , IN(1971

*18) Cano Manamo – factibilidad de su canalizacion ; INC 1986

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5.4.5 Case Study for Barge Transportation System in Macareo Channel

(1) General

In order to get a clear view of barge navigation along the Macareo channel, a case study is introduced in which barge train transports iron ore from Puerto Ordaz to the sea, instead by Shuttle Vessels (Panamax Size) through the Rio Grande channel.

In the previous section, barge train navigation in the Macareo channel is discussed and confirmed as the second desirable alternative for the iron ore transportation among the possible alternatives for waterway transportation, though the present navigation of Panamax size vessel with maximum fleet in Rio Grande channel is the best alternative. Since possible iron ore transportation system is the most critical factor to be discussed for cargo transportation system in Orinoco delta, it would be desirous to study further the suitability of this alternative as a reference for future navigation in case of circumstances are changed.

The basis of the study is determined considering the future exportation demand of iron ore according to the Cargo Throughput Forecast that is reduced to 4 million tons in year 2003 from 9.3 million tons in the year 1997. In addition, suitability of the channel characteristics for barge train carriers, required facility planning for barge system, environmental impact evaluation and economic and financial evaluation are also taken into consideration.

(2) Characteristics of Macareo Channel

The Macareo channel of 194km long is branched off at the Ya-ya section of Rio Grande channel and flows northeast ward to the sea with approximately 14% of Rio Grande discharge varying seasonally from minimum of 1,000 m3/s in March to maximum of 7,000 m3/s in August. At 20 km distance downstream of this diversion, Macareo channel has a sub tributary Manamo channel of 185km long flowing north ward to the sea. At the upstream of Manamo channel, however, there exists a closing dam so that discharge of the Macareo channel is not affected by its discharge distribution.

In view point of vessel transportation along Macareo channel, smaller size vessels like barge trains possibly navigate without any large scale improvement works of the channel. However, vessels like Panamax size, Handymax size etc., can not navigate without channel improvements such as short cut channels at sharp meandering bends and continuous maintenance dredging at shallow depths. Though it has a 8 m water depth in average below LWL, the both ends of the channel reaches close to the Barrancas and to the river mouth consist of shallow reaches with only 4.5-5.0m depth. In addition, the Macareo channel is irregularly meandering with sharp curved bends with inter angle greater than 120^0 at several locations of upper and middle reaches, in contrast to the smooth lower reach of 60 km long from the river mouth. Nevertheless, in case of barge trains, the "Flanking Maneuvering Method" allows for maneuvering even at sharp bend portions, though it is not applicable for other vessel types.

The water levels at upstream section of the channel vary seasonally from 0.5-6.5m above MSL, while tidal range is about 1.8-2.0m at the estuary close to Boca Pedernales. The annual maximum velocity is 0.8-1.0m/s along the channel, which would not cause any significant difficulty for maneuvering of barge navigation. The width of channel is in the range of 400-800m at the datum of MSL and 200-700m at 4.5m below MSL.

In the coast of Macareo estuary, depth increases gradually illustrating parallel and more uniform depth contours than those at Boca Grande. The bottom has a mild slope (1/320) up to 5m depth below MSL and then has a steeper slope (1/50) between depths of 5m and 30m. In case of the alternative for the new port construction to be discussed in latter sections, continuous dredging work is required to maintain the navigable depth in accessing and berthing for the oceangoing vessels.

A part of the South Equatorial Current up to about 1-2.5 knots in average sub divides off at the south-east coast of Trinidad and flows in to westward along the south coast of the island. However, effect of current is less marked at the estuary where tidal influence may predominate. Regarding wave phenomena, according to the observation data of US Defense Mapping Agency, waves are mainly wind waves and wave height is about 1.5m with a wave period of 6 to 7 seconds at offshore the Orinoco delta. Figs. 5-4-2 to 5-4-5 summarize the characteristics of the channel.

(3) Barge Transportation Planning

(I) Possible Alternatives

As for iron ore transportation by barge trains in Macareo channel, two possible alternatives are envisaged for transferring iron ore from barge to oceangoing vessel through either existing transfer vessel (TV) or a new port to be constructed at the estuary of the channel (Fig. 5-4-2).

- Alternative C2: Transfer Vessel (TV) + Marine Barge Train (Fig. 5-4-6)
- Alternative D1: New Port Construction + River Barge Train (Fig. 5-4-7)

For the Alternative C2 of the transfer vessel placed at Boca Serpiente in the sea, Marine barge is required due to the difficulty of navigation in waved ocean. The existing transfer vessel can be used till the termination of its durable life. Then, it would be required to replace it with a new transfer vessel to continue large shipments to oceangoing vessels and maintain the competitive shipping cost.

In the Alternative D1, a new port to be constructed at Pt. Pescadores in the estuary will replace the function of the TV. In this case, river barge trains can be used for iron ore transportation in Macareo channel since the ocean wave phenomenon is not significant even close to the port located in the estuary.

In the basis of planning, the required number of barges for transportation is calculated to satisfy the estimated iron ore transportation volume of 4 million tons per year or in average 11,000 tons per day. For the alternative C2 and D1, the total transportation time for a cycle is 112 hours and 95 hours respectively as shown in Table 5.4.5. The capacity of a marine barge is 6000 tons and that of a river barge is 1800 tons. Hence, for the alternative C2, the number of marine barge needed is 5 trains with 2 barges each and for alternative D2, the number of river barge would be 4 trains with 8 barges each.

Table 5.4.5 Transportation features for alternative barge train systems

	Alternative C2	Alternative D1	Remarks
Transportation Distance	285km	271km	
Navigation Speed	14* km/hr	17 km/hr	Downward
	6* km/hr	7 km/hr	Upward
Cycle Time for Navigation	68+22**hr	55+22**hr	P. Ordaz to TV/Port
Loading Capacity of Crane at P. Ordaz	1,500 ton/hr	1,500 ton/hr	Efficiency 0.8
Unloading Capacity of Crane at TV/Port	1,200 ton/hr	1,800 ton/hr	Efficiency 0.8
Loading Time	10 hr	10 hr	
Unloading Time	12 hr	8 hr	
Total Cycle Time for Transportation	112	95	

* Operation efficiency of marine barge at bends is estimated as about 0.8 of that of river barge due to its longer length.

** Additional time for turning operation in a round trip at 11 sharp bends in upper and middle reaches of Macareo channel.

(II) Facility Planning:

For both alternatives, loading facilities to barge trains are required at Puerto Ordaz. In the alternative C2 shown in Fig. 5-4-6, loading facilities to transfer vessel are also needed at Pt.Pescadores, in addition to the replacement of existing transfer vessel (cape size) equipped with unloading facilities to oceangoing vessels. For the alternative D1 shown in Fig. 5-4-7, a new port with berthing, loading, unloading facilities as well as stockyard are required together with continuous maintenance dredging of 14 km in length and17 m in depth, for allowing the access of 150,000DWT oceangoing vessel. The main facilities required for alternative C2 and D1 are summarized in Table 5.4.6.

Table 5.4.6 The main facilities required for the alternative C2 and D1

Facility		Alternative C2	Alternative D1
Port at Pt. Ordaz	Unloading facilities	1 unit of ship loader 1500ton/hr	1 unit of ship loader 1500ton/hr
Barge Trains	Iron ore transportation	5 groups of Marine barge train which consists of two 6000DWT barges with a 6000HP tug boat	4 groups of river barge train which consists of eight(8) 1800DWT barges with a 6000HP tug boat
Transfer Vessel	Transfer Vessel for iron ore stock	One transfer vessel (cape size) equipped with loading facilities	-
	Loading facilities for TV	2 sets of Barge equipped with crane capacity of three buckets each 200 ton/hr loading	-
New Port	Berthing facilities and Stockyard	-	Pier of concrete slab with steel pile (20,000m2) and stock yard by reclamation (40,000m2)
	Loading and unloading facilities at new port	-	Ship loader (1800ton/hr) and Grab Bucket Unloader (1500ton/hr)
	Dredging	-	Dredging of ocean route 14km long and port for ocean going vessel of more than 150,000DWT

(III) Maintenance Dredging Volume

In the alternative C2 and D1, Macareo channel is used for iron ore transportation utilizing barge trains, whereas other cargo transportation is through Rio Grande by at most Handymax size vessels, instead of alternative P1 in which all cargo is transported through Rio Grande channel by at most Panamax size vessels. Therefore, due to the change of allowable vessel sizes, the maintenance dredging volume along Rio Grande for the both alternatives would be reduced by 1.488 million m3 compared to the Alternative P1, as shown in Fig. 5-4-8 and Table 5.4.7.

Table 5.4.7 Maintenance Dredging Volume of Three Alternatives of P1,C2 and D1

Channel Section	Alt.-P_1	Alt.-C_2	Alt.-D_1	Remarks
1.Rio Grande				
(1) Inner Channel	8,480	6,992	6,992	P_1-C_2=1,488
(2) Outer Channel (Boca Gnande)	10,000	10,000	10,000	P_1-D_1=1,488
2.Macareo				
(1) Inner Channel	-	0	0	
(2) Outer Channel (Boca Macareo)	-	0	1,933	
(3) New Port	-	0	453	
Total	18,480	16,992	19,378	P_1-D_1= 898

(unit= ×1,000m3)

Due to the maintenance dredging of the proposed new port and 14 km long access channel for oceangoing vessels, however, total annual dredging volume in the alternative D2 is increased by 0.898 million m3 comparing to the alternative P1, though the dredging in the Macareo channel is not required for river barge navigation.

It is noted that, in viewpoint of changes in maintenance dredging volumes among the alternatives, annual dredging volume in outer channel of Boca Grande is not affected by vessel drafts, owing to the fact that the maintenance dredging volumes are smaller than the initial dredging volume required for development stage of the channel as shown in Fig. 5-4-8. In contrary to that, the maintenance dredging volume of inner channel would vary depending on the vessel sizes, as the channel is completely filled by the bed load sediments during a rainy season.

It could be, moreover, emphasized that if the depth of 10.2 m during the dry season is kept along Rio Grande in the alternatives of C2 and D1 in order to maintain as present navigation condition for Handymax size vessels, the annual maintenance dredging volume would not be reduced as 1.488 million m3 in the Rio Grande than the alternatives P1.

The reduction of maintenance dredging volume discussed in the above paragraph is determined based on 9.2 m depth, which is 1.0 m shallower than present depth, with taking into consideration of difference in draft between the Panamax and Handymax as shown below in Table 5.4.8.

Table 5.4.8 Vessel Draft and Dredging Depth of Rio Grande

Vessel Type	Panamax (65,000 DWT)	Handymax (45,000 DWT)
1. Full Load Draft	12.8m	11.8m
2. Channel Depth to be Dredged		
- Flood Season	13.2m	12.2m
- Dry Season	10.2m	9.2m

Remarks : Depth is used for calculation of dredging volumes.

However, under the present navigation condition with 10.2 m depth during the dry season, restricted due to rock exposures on river bed, even Handymax vessel with 11.8 m draft can not navigate with full cargo load. Therefore, if Handymax vessels are required to maintain present navigable condition in the alternatives C2 and D1, 10.2 m depth along Rio Grande should be kept same as at present, not 9.2 m depth as assumed for the calculation of dredging volume reduction. In this case, the annual maintenance dredging in Rio Grande channel would be same for the alternatives P1, C2 and D1.

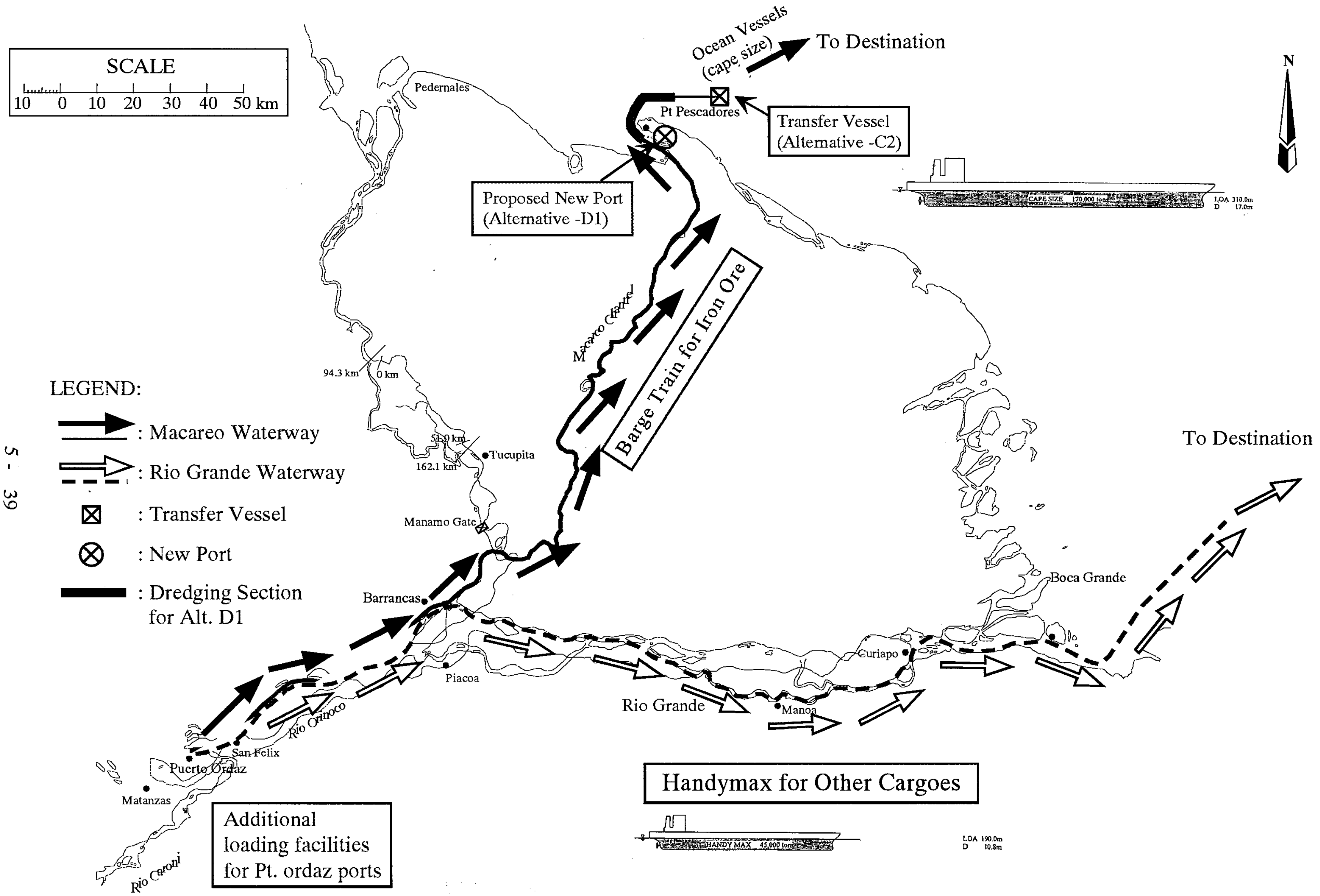


Fig. 5-4-2 Iron Ore Transportation by Barges in Macareo Channel

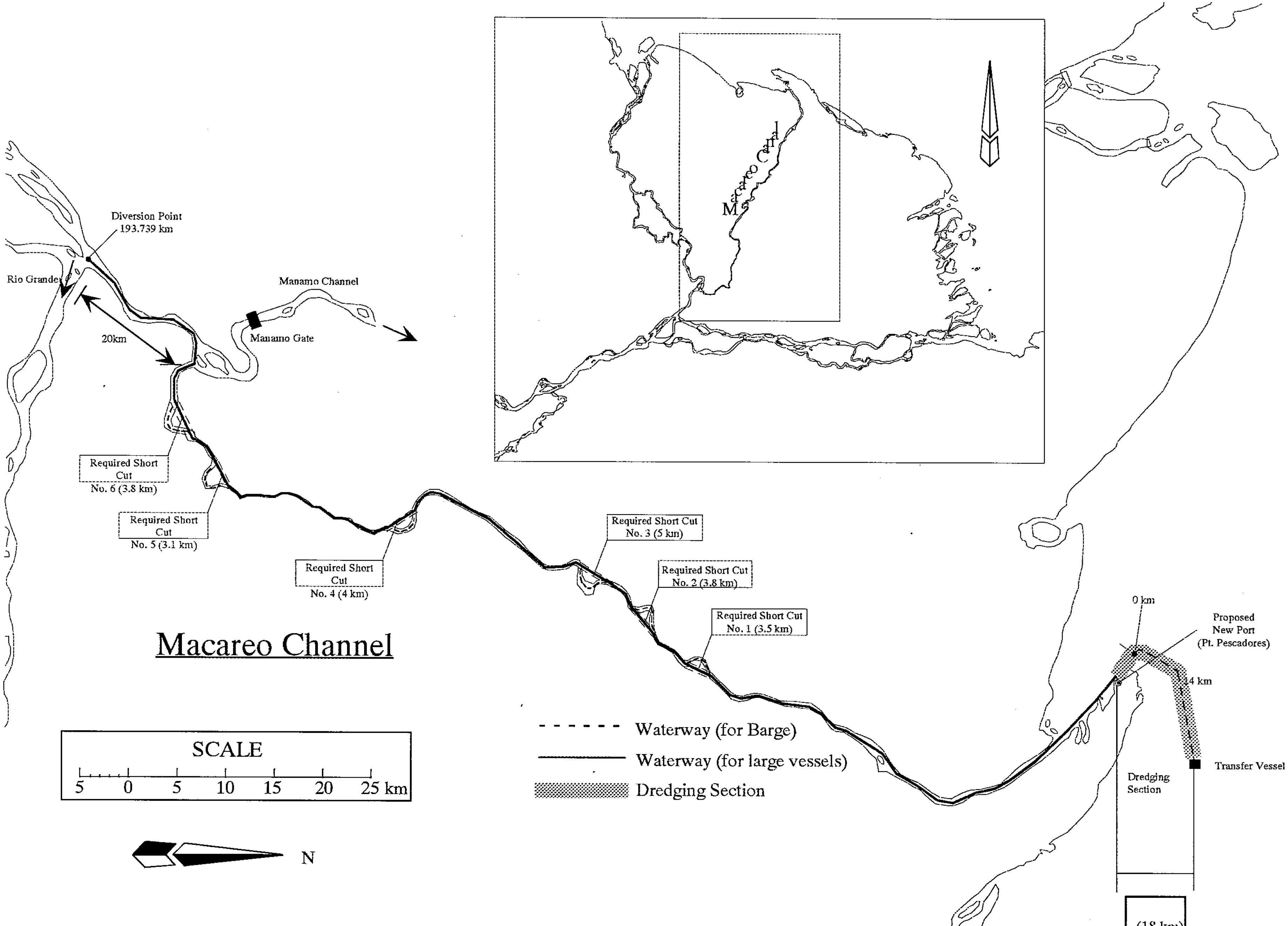
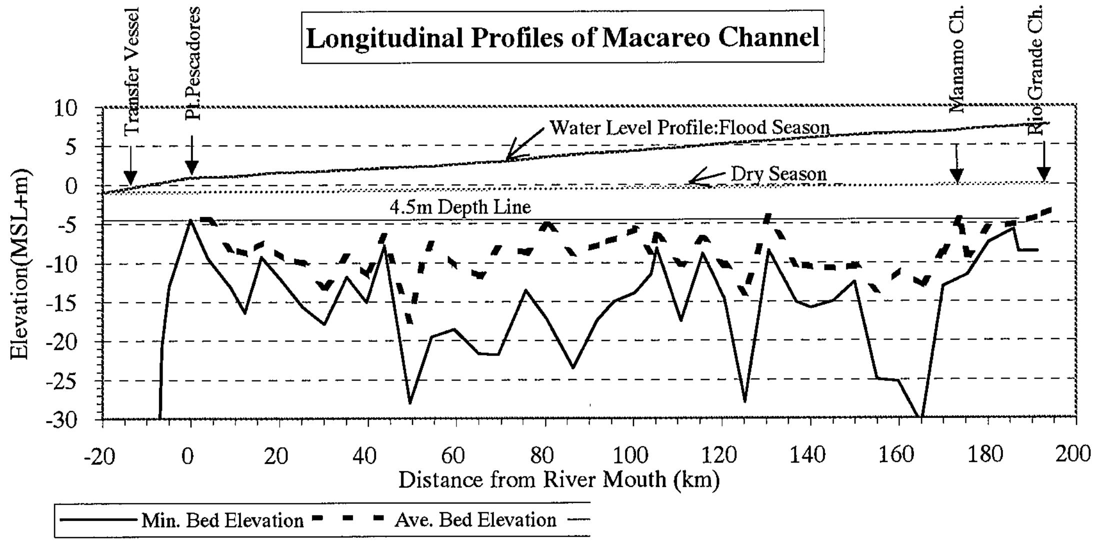
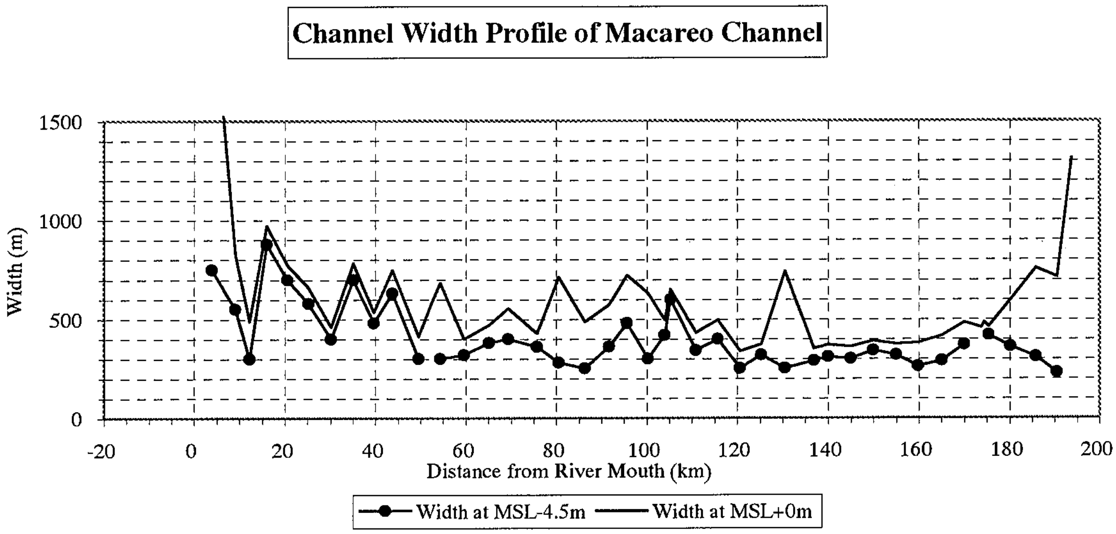


Fig. 5-4-3 Configuration of Macareo Channel





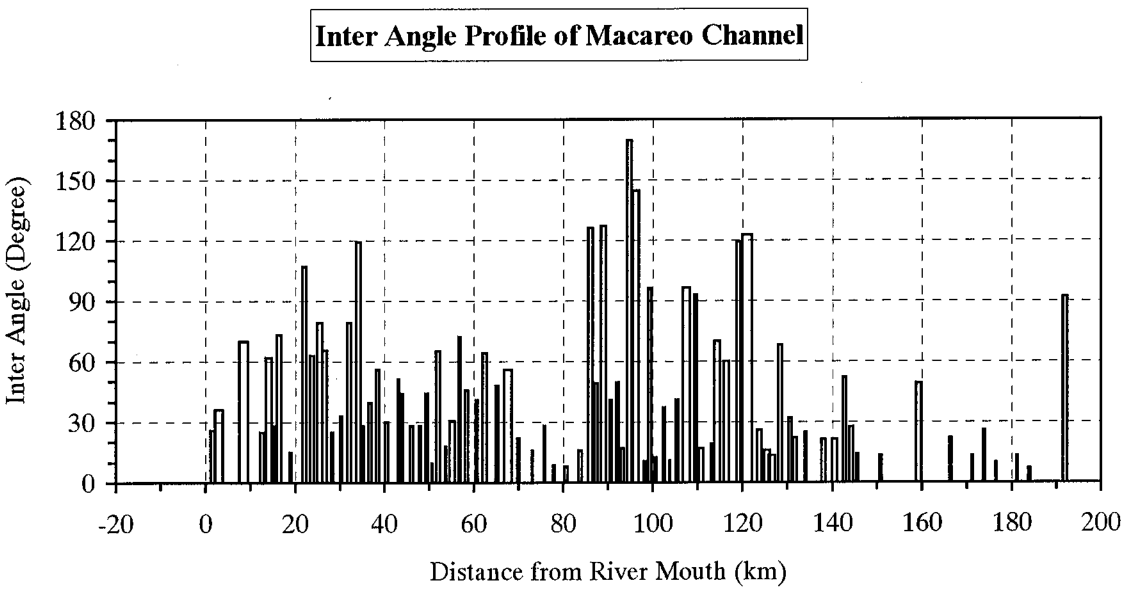
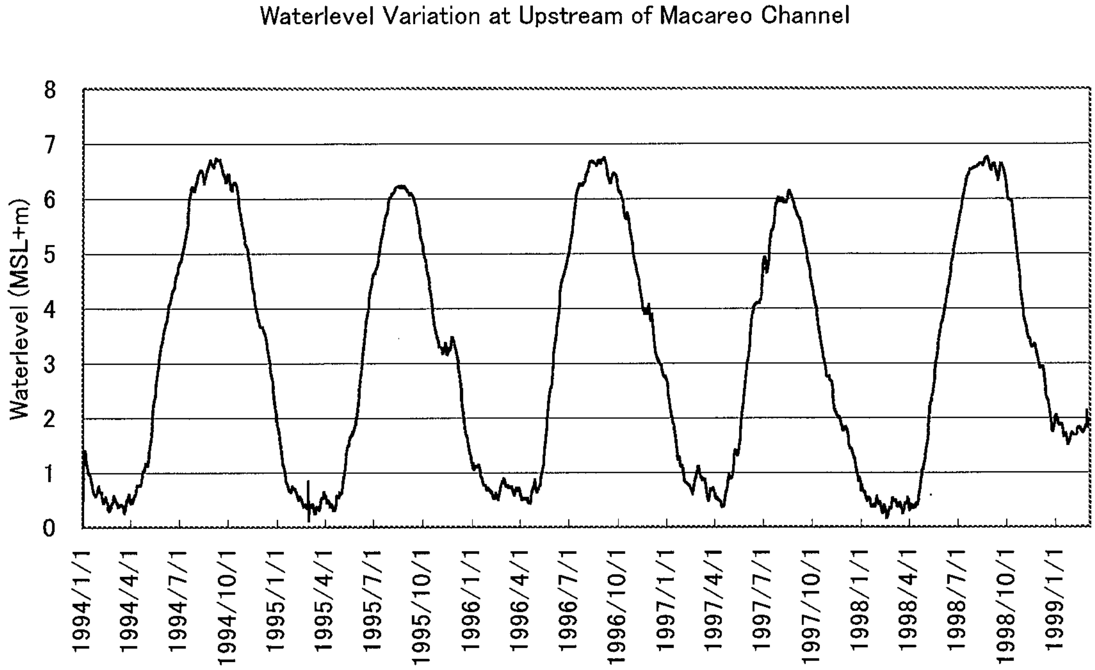
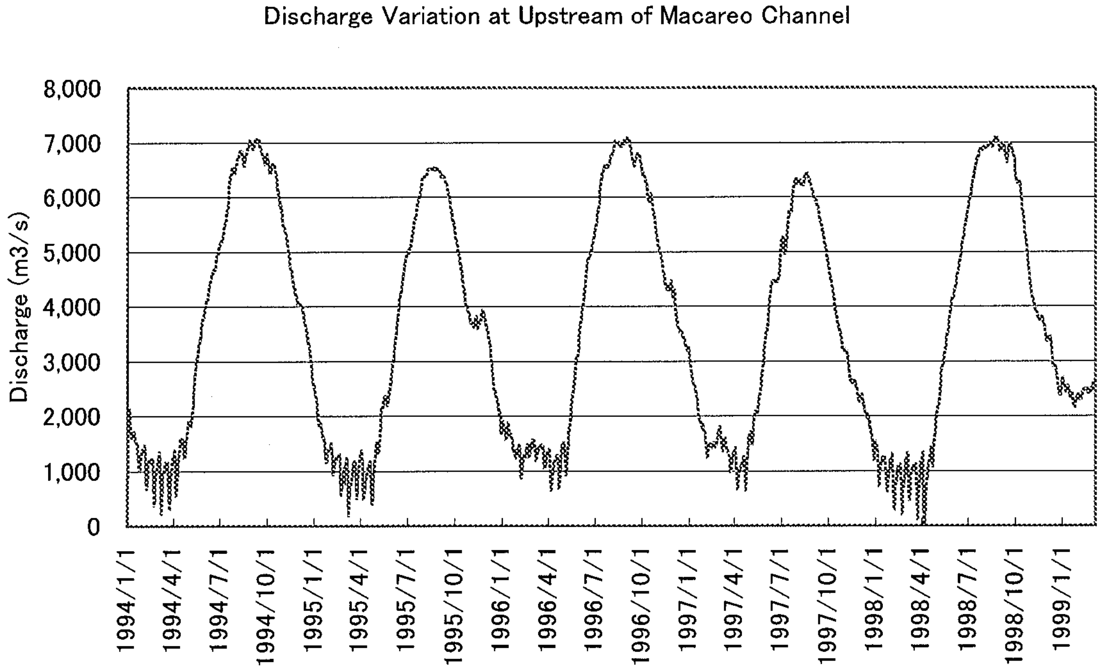


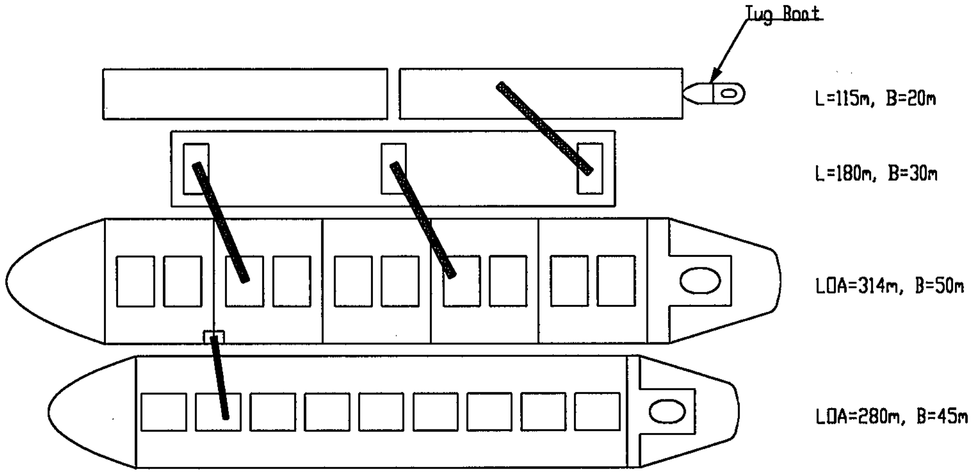
Fig 5-4-4 Characteristics of Macareo Channel



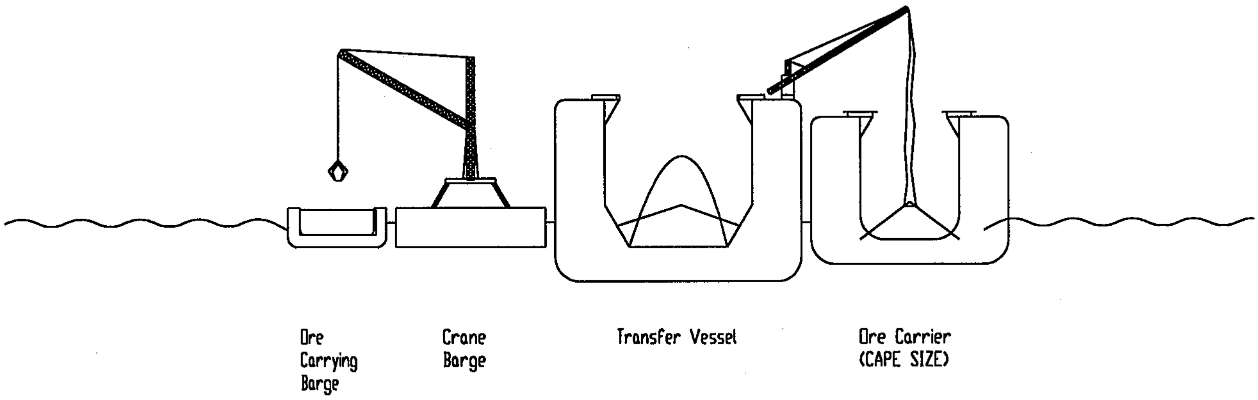


Note: Simulated Data based on 1−D Simulation Analysis

Fig 5-4-5 Water Level and Discharge Variations in Macareo Channel



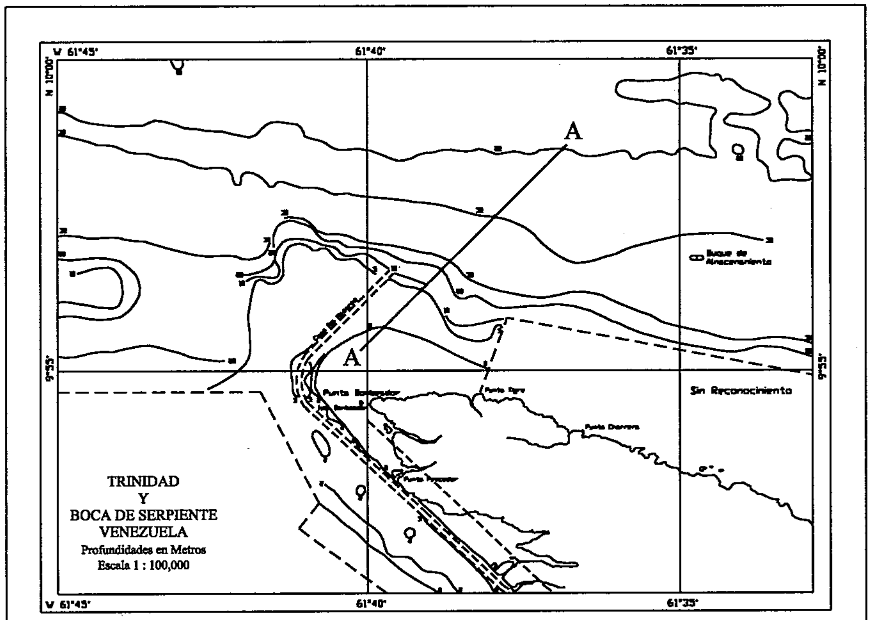
Concept of Rio Orinoco TV Ststem



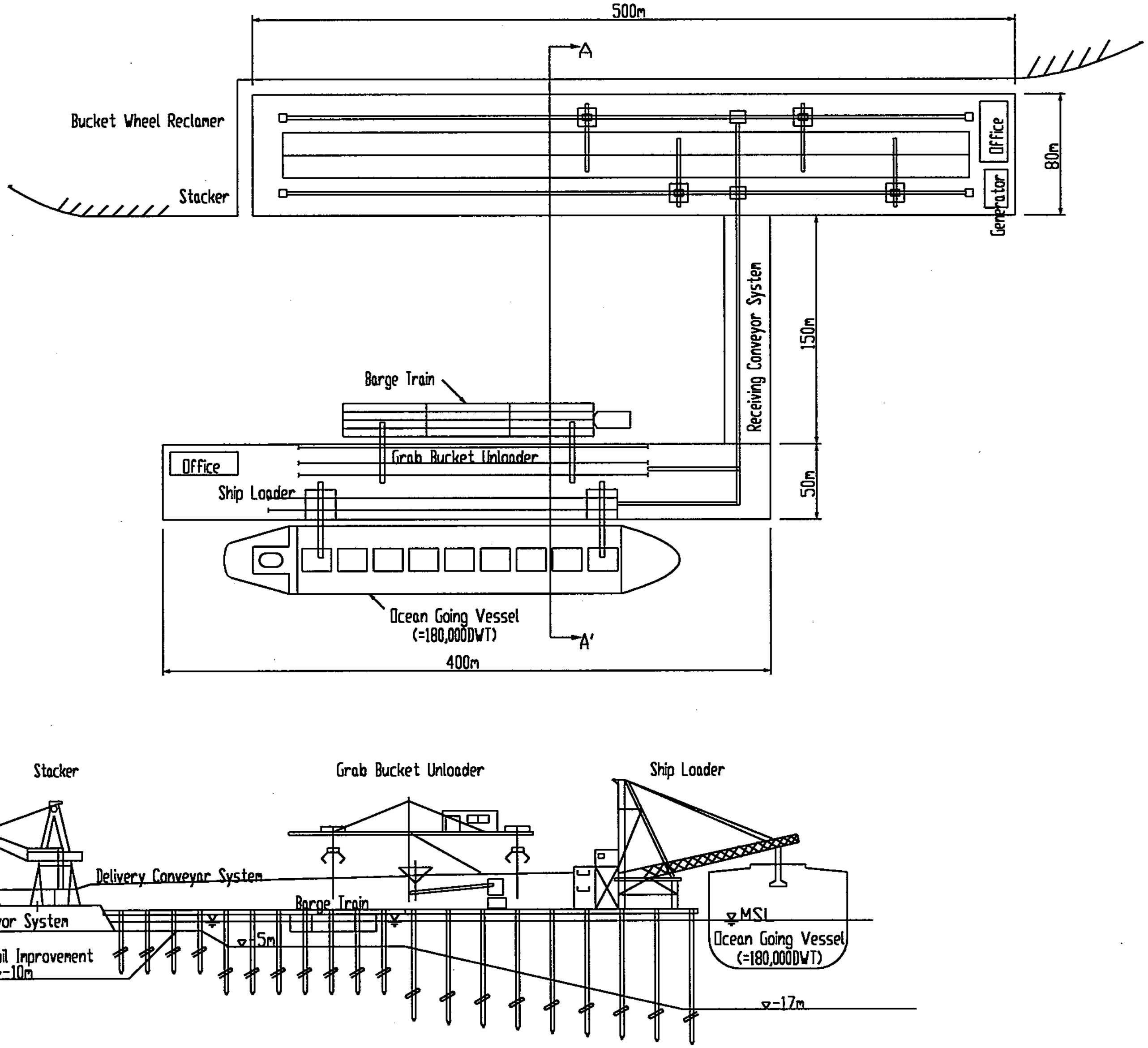
Crane Capacity : 5 m^3 * 3 units
600 w/t per hr.

Ore Transferring Station 14 km off Pt. Pescadores

Fig. 5-4-6 PROPOSED TRANSFER VESSEL SYSTEM (ALTERNATIVE-C2)



Figra 3.3.6.8 Area de la Costa en Punta Bombeador



Section A-A'

Fig. 5-4-7 PROPOSED NEW PORT SYSTEM (ALTERNATIVE-D1)

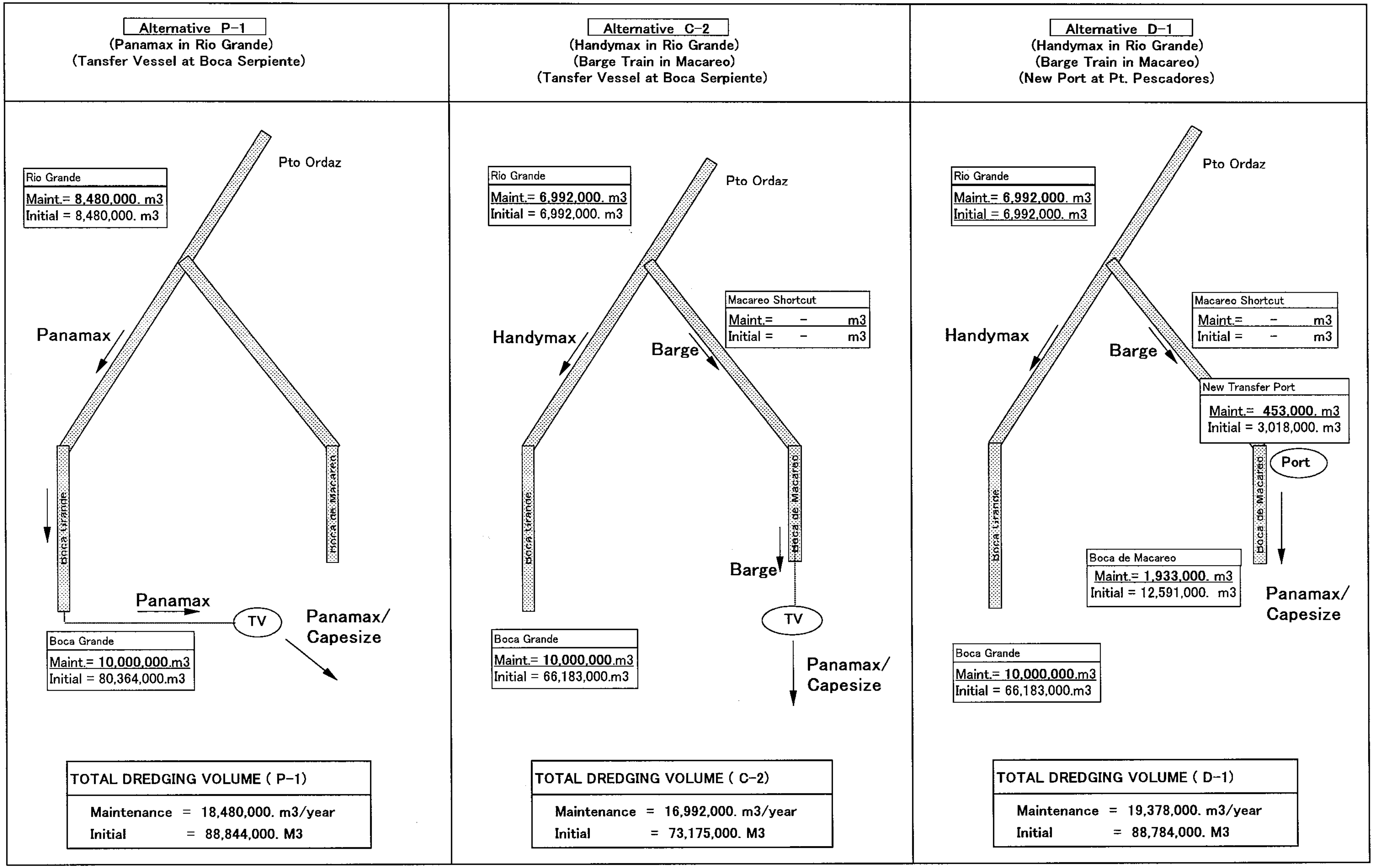


Fig. 5-4-8 Comparison of Dredging Volume (for Alternatives P-1,C-2 and D-1)