(2) Macareo Canal

Macareo Canal is the shortest waterway from Puerto Ordaz to the Transfer Vessel anchoring at the south open sea of Trinidad. The Canal branches off the Rio Grande at Barrancas. It is 211 km in distance from the divided point to the mouth of the river, and the Canal has a width of 200 m-300 m, a navigable waterway of 76 m, and 8 m in guaranteed depth there. But at both ends, at the mouth of the river and at Barrancas, only 4.5-5.1 m of depth is maintained even in the rainy season. Additional dredging and installation of navigation aids are required for optional utilization of the channel. The channel has not been used by large size vessels since dredging was suspended 30 years ago.

(3) Manamo Canal

A water dam was constructed upstream of the Manamo Canal, to the south of Tucupita, in 1967. Tucupita city has been protected against floods since its completion but the dam had the negative effect of dividing the Manamo Canal into two sections. The lower stream has become an independent channel stretching between the ocean and Tucupita, where some pusher barges are operated. The upper stream has no waterway for vessels to serve the route between Ciudad Guyana and Tucupita. Tucupita city is eager to have an access to upstream of the Manamo channel.

There are three water gates of approximately 7m in width at the dam. CVG is in charge of water control and patrol once a week.

5.3 Review of Waterway Transportation System

5.3.1 Review of Shipping

(1) Freight Rate Trends of Iron ore

1) Freight Rate Trends

Iron ore is transported by chartered carriers which are contracted either on a long-term basis or on the spot in response to demands of steel industries.

The long time-charter makes it possible to lower the shipping cost from a loading port to a destination because of efficient operation and management. In order to contract with a long time-charter, it is necessary that the volume of iron ore bound for one destination is sufficient to operate a chartered carrier for a full year.

The iron ore of Ferrominera is exported to around fifteen destinations in Europe, America and Far East, and exported volume to each destination varies within the range of 100,000 to 2,000,000 tons. Most of these shipping routes are supposed to be operated by spot charters according to the analysis on flow of exported iron ore.

Shipping cost in long time charter or in spot charter depends on the climate of supply and demand in the market. The demand means the transportation cost and volume requested by consignees and the supply is shown in the number of carriers available. The charterage in every size has varied across a wide range in the past decade, and the difference in cost between large carriers and small carriers was sometimes small.

The trend of iron ore freight rate, transported from Hampton Roads in the U.S. to Japan, is shown in Fig.5-3-1. The freight rate has ranged between US$ 10 per ton to US$ 20 per ton in the past decade. Fig.5-3-2 shows the charter fee of 65,000 DWT vessels in the Atlantic Round in the past decade. The charter fee has varied from US$ 6,000 per day to US$ 18,000 per day. Fig.5-3-3 shows the movement of the grain freight rate in the shipping route between the USA and Rotterdam in the past decade.

These three figures show a common trend in which both the freight rate and charter fee rose at the same time and fell at the same time.

Accurately forecasting the shipping cost to a destination is difficult because that shipping cost depends largely on the market charterage. Therefore, a prudent and comprehensive study is required on the market price, exporting volume for destinations, shipping methods and so on when considering investment.

2) Freight Rate Case Study

To examine the calculation of the freight rates, a case study is introduced in which a 150,000 DWT carrier, chartered at Rotterdam, transports iron ore to Kawasaki in Japan from the Transfer Vessel at Boca de la Serpiente or Tubarao in Brazil. Results of the case study are shown in Table 5.3.1.

The freight rates are calculated as US$ 7.19 at the charter fee of US$ 10,000 and US$ 11.83 at the charter fee of US$ 20,000 in the case from the Transfer Vessel to Kawasaki. On the other hand, the freight rates are calculated as US$ 6.52 at the charter fee of US$ 10,000 and US$ 10.79 at the charter fee of US$ 20,000 in the case from Tubarao to Kawasaki. The freight rates from the Transfer Vessel are nearly US$ 1 higher than the freight rates from Tubarao for all charter fees.

Fig. 5-3-1 Trend of Iron ore Freight Rate (from H.Roads to Japan)

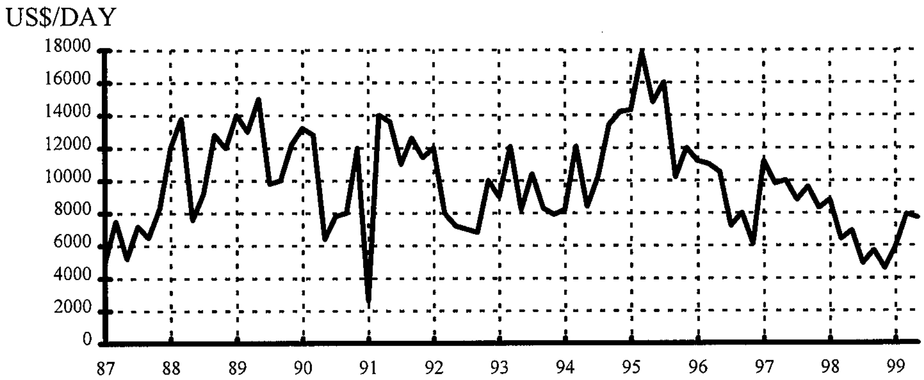


Fig. 5-3-2 Charter Fee of 65,000 DWT in Atlantic Round

Fig. 5-3-3 Grain Freight Rate (between US Gulf and Rotterdam)

Table 5.3.1 Case Study of Iron ore Freight Rate

1. Conditions

Carrier	DWT	149,633.00
	LOA(m)	280.00
	BEAM(m)	43.00
	DRAFT(m)	17.57
Sea Speed	Ballast	14.5 knot
	Laden	13.5 knot

Sea miles, Port charge, Handling rate

Origin	Port	Sea Miles	Port Charge (US$)	Handling Volume (long tons/day)
from Tubarao	Rotterdam			
		4,974		
	Tubarao		60,000	80,000
		11,725		
	Kawasaki		65,000	30,000
from Boca Grande	Rotterdam			
		4,057		
	Boca Grande		89,000	40,000
		13,626		
	Kawasaki		65,000	30,000

2. Iron ore Freight Rate(from Origin to Kawasaki)

Charterage in Market	Iron ore Freight Rate		Balance
	from Tubarao	From Boca Grande	
(US$/day)	(US$/MT)	(US$/MT)	(US$/MT)
10,000	6.52	7.19	0.67
12,000	7.37	8.11	0.74
14,000	8.22	9.04	0.82
16,000	9.08	9.97	0.89
18,000	9.93	10.90	0.97
20,000	10.79	11.83	1.04
22,000	11.64	12.75	1.11

The voyage from Transfer Vessel to Kawasaki takes 42 days compared to 36 days from Tubarao to Kawasaki. The one week longer voyage raises the freight rate from Transfer Vessel and puts it at a disadvantage of 6 days. When a carrier is chartered at Japanese ports, the charter fee of two weeks is charged on the freight rate because the carrier has to make a round voyage. On the other hand, the voyage from Rotterdam to the Transfer Vessel takes 12 days while it takes 14 days from Rotterdam to Tubarao. The Transfer Vessel has an advantage of 2 days in the voyage from Rotterdam.

It should be emphasized that voyage days, namely sea miles, is a large factor in the shipping cost of iron ore when the same sized carriers are engaged in transportation to the same destination from different loading ports. In other words, shipping cost can be competitive if voyage days to the destination are fewer than from other exporting ports.

3) Shipping Competitiveness

The charterage of market is applied not only to Venezuela but also to other exporting countries like Brazil. Since large carriers also engage in exporting of other countries' iron ore, it is necessary to take account of geographical location such as which destinations are closer to Venezuela than other exporting countries.

The competitiveness of iron ore depends not only on shipping cost but on various factors such as the selling price and quality. Therefore, a detailed marketing study is required to ensure that Venezuelan iron ore remains competitive.

4) Economical Iron ore Transportation

In order to reduce the transportation cost between Puerto Ordaz and the Transfer Vessel or the coast of Delta Amacuro, the most economical transportation system is examined taking account of both the forecast export volume and the ages of Transfer Vessel and two Shuttle Vessels. In addition, it is important to avoid, as far as possible, a rapid increase in the canal toll which is imposed on all carriers navigating the Canal.

(2) Traffic Trends in the Channel

The annual number of iron ore carriers in each direction is 220 vessels at present but is estimated to drop to a maximum of around 90 vessels when the exported iron ore volume decrease to 4 million tons as examined in Chapter 4. The annual number of vessels carrying steel products and direct reduced iron is estimated to increase to around 500 vessels in 2010, 600 in 2020 in reverse proportion to the decreasing traffic of exported iron ore. The traffic of other cargo including export, import and domestic will likely remain unchanged. The total annual traffic in each direction in the channel is estimated at more than 1,100 vessels in 2010 and around 1,300 vessels in 2020 in case of high grow case in demand forecast as shown in Table 5.3.2.

Table 5.3.2 Traffic Trend in the Channel

(unit : vessels)

Cargo	1997	2003	2010	2020
Iron ore	220	89	89	89
Direct Reduced Iron	62	211	211	211
General	390	409	524	604
Dry Bulk	125	163	190	257
Liquid	101	101	101	101
Wood	0	34	34	34
Total	898	1,007	1,148	1,296

Note : rearrangement table of Table 4.8.3

5.3.2 Review of New Port Development Plans

There are several new port development plans identified in relation to the improvement of the future waterway transportation system on the Orinoco River, with a varied depth of detail that goes from a mere conceptual proposal to a detailed project with designed works. These plans can be categorized into three groups: one for Puerto Ordaz, one for the transfer ports, and one for regional ports in the Delta (See section 5.5).

(1) Plans for Puerto Ordaz

1) Multipurpose Terminal

This terminal was planned as a pioneering project for the large scale new industrial port complex zone development by CVG during 1989 to 1993 [*11) *12) *13) *14)]. This planned industrial development complex is located in a zone on the right margin of the Orinoco River to the west of SIDOR and to the east of the 2nd bridge over the River. To serve a wide range of new industries including the new steel and aluminum industry, 10 module terminals (to efficiently deal with specialized cargo) were planned along with a multipurpose terminal.

This multipurpose terminal is designed with three 600 m long berths and 23.5 ha. of cargo handling and storage space which can serve up to 1.4 million tons of annual cargo, of which 0.8 millions is for general cargo and 0.6 millions is for bulk cargo. All 10 module terminals are designed with nineteen 3,700 m long berths and 114 ha. of cargo handling and storage spaces to serve up to 12 million tons of annual cargo forecasted for the zone. These terminals are linked with peripheral road and railway systems. The Multipurpose Terminal can be used at the construction stage of the industrial zone as a logistics base receiving construction materials. The study report also includes institutional consideration, for using the terminal as a public port.

Projected investments are US$ 47.3 million for the Multipurpose Terminal and US$ 203.2 million for the 10 terminals as a whole. (1990 constant price at Bs. 50 = US$1).

Although this terminal plan is reported as authorized by CVG as a project, implementation of the project has not yet been activated mainly due to the change of economic and financial climates.

2) Orinoco Transshipment Terminal

This plan was put forward by ACBL, which transports more than 3 million tons of bauxite by a barge train system from the port of El Jobal (BAUXILUM Terminal), at progressive mile 544 on the Orinoco River navigation channel, to the INTERALUMINA Terminal.

Location of the planned terminal is between the SIDOR and VENALUM Terminals at mile 194.5. This terminal is designed as a detached steel pier on piles that can serve up to two 65,000 DWT vessels and barge trains at the same time. Target cargo of the terminal is briquettes, bauxite, copper concentrates, slag, and iron pellets. The terminal is facilitated with a loader/conveyor system of 500 (briquettes) to 4,000 (bauxite) tons/hour capacity and storage area.

Management and operation of this terminal is undertaken by ACBL which contracts with user customers in an all-in-one package handling service that differs from the practice at other public ports, such as the San Felix terminal.

By law in Venezuela, the private sector participates through concessions granted by the Central Government for port construction within certain designated waterfront areas. ACBL proposes this project on a BOT basis, and it is now reportedly in the preliminary negotiation process. Investments are planned as: Phase I (to be completed by the year 2000) with 1 berth for an amount of US$ 23.3 million, and Phase II (to be completed by 2003) with an additional berth and storage area expansion for US$ 127.8 million.

(2) Plans for Transfer Ports

In pursuit of a more optimal river navigation system, in terms of economizing transportation costs in the course of expanding the market for Venezuelan iron ore export, not only in terms of trade volume but also of distance to the destination, a number of reports on improving the canal capacity have been prepared. Several plans or ideas on transfer port construction were put forward and their feasibility examined in these reports.

It should be noted that a system which is justified by the 20 million tons of annual iron ore export may not be justified by the 4 million tons of annual cargo.

1) Boca Grande Area

An OMC & INC report [*15)] examined the feasibility of a transfer port construction at the Boca Grande area as opposed to other alternatives of channel deepening projects and a railway construction to the northern coast port of Guanta, on the basis of 22 million tons per year of cargo movement for annual iron ore export. The report discarded this alternative as economically unfeasible, leaving room for further consideration of a direct vessel to vessel transfer system.

Another report done by MTC [*4)] examined the feasibility of constructing a transfer port at Punta Yatica, at channel mile 42, among a wide range of alternatives including canal deepening or widening, reuse of the Macareo Canal, on the basis of 15 million tons of annual iron ore export. This alternative was discarded as uneconomical.

2) Punta Pescador Area

The MTC report [*4)] also examined the feasibility of constructing a transfer port at Punta Pescador at the mouth of the Macareo canal. It assumed the reuse of the canal for the transiting of return trips of the existing shuttle vessels, or for round trips of 17,000 DWT barges equipped with self-unloading systems. Although these alternatives related to the reuse of Macareo canal were not justified as economically feasible, the report mentioned future possibilities of this project as a substitution of the Transfer Vessel at Boca Grande, in case the demand increases to the point where a second Transfer Vessel would be required, or in the case of replacing the Vessel after its useful life.

Another idea was put forward by a CVG material [*1)] proposing the construction of a deep-water port at Punta Bombeador on the out-skirts of the Macareo river mouth with a similar idea as the above mentioned plan [*16)].

3) Manamo Outlet Area

A supplementary study report [*17)] to the earlier mentioned OMC & INC report [*15)] examined the feasibility of two alternative plans via the Macareo Canal: One alternative, based on the installation of navigation lock, and another, based on a bypass railway link to crossover the barrage of the Manamo Dam. After examining both the technical and the economic points of view, the report concluded that both alternatives were unjustifiable and less attractive than those examined in the main report.

Also, a report for INC [*18)] studied the feasibility of the use of the Manamo Canal and mentioned the possible installation of a transfer port at either Pedernales, Capure, or Isla Cotorra in the Manamo Outlet area. Conclusions in favor of further detailed studies were drawn only on a preliminary analysis basis. The same engineer wrote a paper [*19)] for the seminar "EL RIO ORINOCO: Aprovechamiento Sustentable" ("THE ORINOCO RIVER: Sustainable Exploitation") held on Nov., 1998 to maintain his notion of comparative economic competitiveness of reopening the Manamo Canal with a huge navigation lock which could accommodate up to 80,000 DWT at a cost of US$ 200 million. A comparison with the Rio Grande Channel was made, assuming a discount rate of 8 % per annum with 20 years for amortization which seems to be unrealistic given the recent economic and financial climate in Venezuela. Also, an inappropriate assumption was made on the unit cost of the construction and maintenance dredging in the Manamo Canal as at the same level as in Rio Grande. A more balanced evaluation in the earlier mentioned study [*15) *17)], in terms of equal footing comparison, will be expected.

The MTC report earlier mentioned [*4)] also studied the use of the Manamo Canal in less depth than the other alternatives and concluded in disfavor of this alternative.

4) Ports on the Northern Coast

As mentioned earlier, the OMC & INC report [*15)] examined the feasibility of a railway link to the port of Guanta and strongly denied the economic feasibility of this alternative. Again it should be remembered that this study was undertaken on the basis of 20 million tons of annual iron ore export. It also justified deepening the Channel to accommodate up to 40 million tons of annual exports.

5.3.3 Review of Existing Channel Capacity

(1) Channel Capacity

In terms of traffic, the channel capacity of the existing system is evaluated in the MTC report[*4)].

The report pointed out that the estimated capacity of the channel was 1,100 vessels per year in each direction, which meant 3 vessels per day in each direction. Boca Grande Canal is 42 sea miles of longitude in a single way and limits the capacity of traffic. The report also pointed out that the arrival of more than 3 vessels per day would quickly lead to congestion.

(2) Measures to Increase the Channel Capacity

Possible measures to increase the capacity of the existing channel of Boca Grande were included in the MTC report [*4)] as follows.

The report mentioned that introducing convoys of vessels would increase the capacity of the channel. When the number of vessels arriving would get close to four per day, the authority concerned would order the formation of convoys. The convoy would consist of three to six vessels. The convoy could pass 42 sea miles of the channel in 9.6 hours, and 2.5 convoys per day would be possible to pass 42 sea miles of the channel in each direction. Therefore, it would be possible to have five convoys in each direction every two days, and the annual capacity of the channel would increase to 2,700 vessels per year in each direction with a convoy of three vessels on average. In this case the average waiting time would be 4.8 hours.

In order to implement this convoy system, the report noted that it would be necessary to develop a better control system for the vessels and to manage the formation and navigation of the convoys.

Furthermore, if a crossing zone sufficiently wide to accommodate six vessels per convoy (average of three) were to be introduced, the number of vessels navigating in each direction would be 4,300 and the average waiting time could be shortened to 1.8 hours.

The crossing zone would have 7 sea miles of length and would be located on the northwest side of the channel, desirable in between the 22 mile post and 29 mile post of the channel. The report commented that the crossing zone would be economically justified once the traffic gets to 1,400-1,500 vessels per year. It should be noted that installation of the crossing zone would be examined taking account of both the cost for initial and maintenance dredging and the number of vessels navigating in the channel.

5.4 Future Waterway Transportation System

5.4.1 Viewpoint of Study

Economical and efficient transportation of iron ore to the final destinations is in general possible if carriers as large as feasible are employed. To realize this, the channel must be deepened to allow large vessels to navigate, and dredging to maintain the depth must be done every year. However, it should be noted that shippers and/or consignees, who do not need large carriers for transportation of their cargoes, do not directly receive benefits from a deep channel.

The government of Venezuela is responsible for determining the tariff that varies according to individual cargo commodities and tonnage actually loaded. The Canal toll is imposed on shippers and is used to cover the development and maintenance of the channel.

As mentioned above, the Canal toll is imposed not only on carriers of iron ore but also on carriers of other cargo. Carriers loading other cargo are not as large as the carriers of iron ore, and there is no sign that large carriers loading other cargo will appear in the near future based on investigation.

In other words, despite the fact that the development and maintenance of the deep channel is financed by the Canal toll imposed on all shippers, almost the entire benefit is enjoyed by the large carriers loading iron ore.

The waterway transportation system should be examined taking account of the benefit and the imposition for the users navigating the channel. The proposed waterway transportation system should be examined to economize, as far as possible, the transportation cost of iron ore as the main exporting cargo at present and to save the initial and maintenance cost of the channel in order to balance the benefit and the imposition. The proposed waterway transportation system must also not discourage future regional development.

5.4.2 Alternatives of Waterway Transportation System

(1) Formulation of the Alternatives

Table 5.4.1 is a list of possible alternative projects for future waterway transportation system and Fig. 5-4-1 shows the schematic diagram of the alternatives.

The alternatives can be categorized into 3 groups by navigation route:

1) Use of Rio Grande Channel alone,
2) Use of Macareo Canal in combination with Rio Grande Channel,
3) Use of Macareo Canal alone.

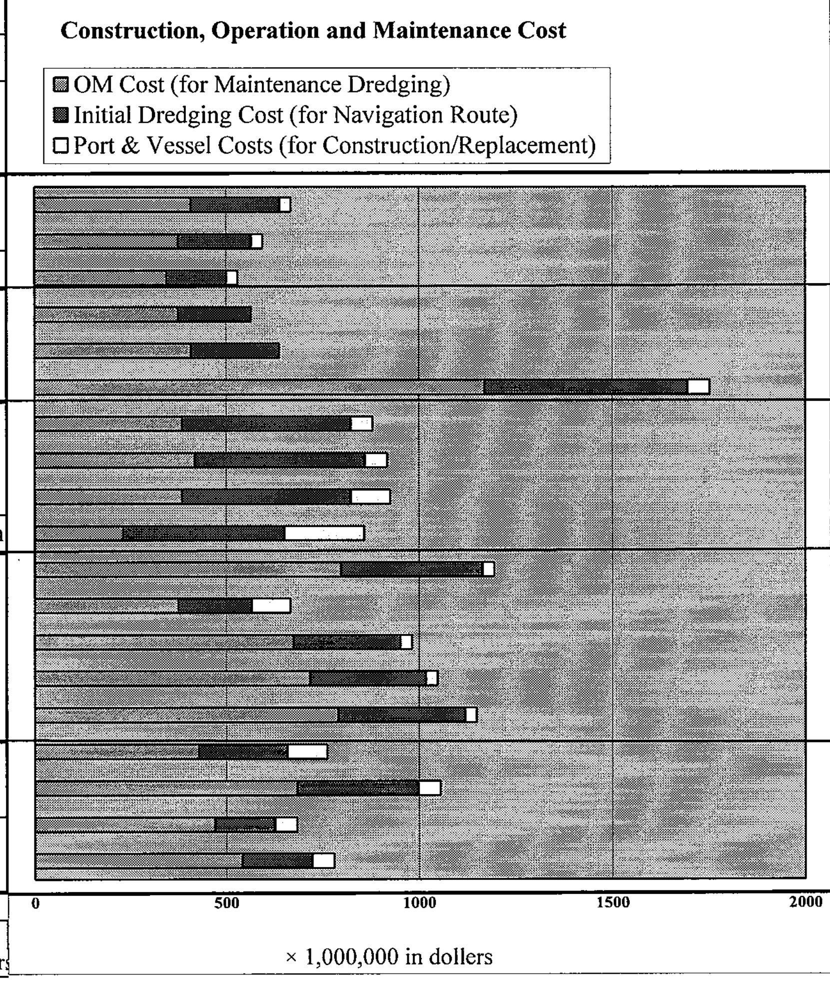
The alternatives will also be characterized by iron ore export with or without a transfer port and its location into 4 groups:

1) Without transfer port,
2) Use of a new transfer port at Boca Grande area,
3) Use of the existing Transfer Vessel via either of Rio Grande or Macareo Canal,
4) Use of a new transfer port at Punta Pescador area.

The existing system is identified as the "without a project" case with which the feasibility of each of the other alternatives are compared. For appropriate comparison purposes, possible replacement cost of the Transfer Vessel in the near future will be included in this case. Also, possible improvement of the existing ports and the channel capacity will be duly considered.

Table 5.4.1 Possible Alternative Waterway Transportation System

Navigation Route	Trans Shipment		No.	Vessel Type: for Iron Ore Export – Route	Vessel Type: for Iron Ore Export – Vessel Type	Vessel Type: for Other Cargo Export – Route	Vessel Type: for Other Cargo Export – Vessel Type	No.
Rio Grande Channel	**Alternative P**	Transfer Vessel	P1	RG-BG-OA	Panamax	RG-BG	Handymax	P1
			P2		Handymax			P2
			P3		Small Handy		Small Handy	P3
	Alternative A	Without Transfer Vessel	A1	RG-BG	Handymax	RG-BG	Handymax	A1
			A2		Panamax			A2
			A3		Capesize			A3
	Alternative B	New Port at Boca Grande	B1	RG-BG	Handymax	RG-BG	Handymax	B1
			B2		Panamax			B2
			B3		Barge Train			B3
			B4		Barge Train		Barge Train	B4
Combination of Macareo / Rio Grande Channel	**Alternative C**	Transfer Vessel	C1	RG-BG-OA-MC	Panamax(OT,RT)	RG-BG	Handymax	C1
			C2	MC	Barge Train			C2
			C3		Small Handy			C3
			C4		Handymax			C4
			C5		Pamamax			C5
	Alternative D	New Port at Pt. Pescadores	D1	MC	Barge Train	RG-BG	Handymax	D1
			D2		Small Handy			D2
Macareo Channel			D3		Handymax	MC	Handymax	D3
			D4		Pamamax			D4



O/M Cost for dredging is calculated as amount of present value for 30 years

Legend:
RG: Rio Grande Channel
BG: Boca Grande
MC: Macareo Channel
OA: Ocean Atlantic
OT: Outer-going Transportation
RT: Returnway Transportation

The type and size of vessel will be studied and determined as the design vessel for each of navigation route and transfer port system. The design vessel for other-than-iron-ore transport will be separately studied with a given priority to continuing use of the Rio Grande Channel unless it is unjustified. Main focus will be concentrated to compare the improvement cost of the channel among Panamax, Handymax, and Small Handy size vessels. Also, a barge train system, which can possibly economize dredging cost for the reuse of the Macareo Canal, will be studied. Typical sizes of vessels are shown in Table 5.4.2.

Table 5.4.2 Typical Sizes of Vessels

Type	DWT	Beam	Full load Draft
Cape size	150,000	45.0 m	17.5 m
Panamax	65,000	32.2 m	12.8 m
Handymax	45,000	30.5 m	11.8 m
Small Handy	38,000	28.5 m	10.9 m

(2) Evaluation of the Alternatives

In alternatives D1-D4 shown in Table 5.4.1, a new transfer port would be constructed at Punta Pescador, the Macareo Canal would be used by vessels or barge train loading iron ore and the other cargo would be transported either through the Rio Grande Canal or the Macareo Canal. The cost of the construction of the new transfer port is US$ 90-150 million and the improvement of the Macareo Canal is necessary for reuse at a cost of US$ 30 million (-4.5m designed depth) -180 million (-14m designed depth). The maintenance dredging of both the Rio Grande Canal/Boca Grande Canal and the Macareo Canal is required at an annual cost of US$ 40-100 million. Therefore those alternatives are uneconomical as stated in the previous studies.

The Macareo Canal has highly meandering bends with eroding banks along half of the upstream reach and is not a stable canal. The average depth below LWL is only 8 m in the Macareo Canal comparing to 11 m depth in the Rio Grande Canal. Because of its low depth, narrow width and unstable conditions, in 1950s, navigation route was shifted from the Macareo Canal to the Rio Grande Canal to accommodate bigger vessels coping with the increased transportation capacity.

In alternatives C1-C5, the existing Transfer Vessel would be replaced with a new one, the Macareo Canal would be used by vessels or barge train loading iron ore and other cargo would be transported through the Rio Grande Canal. The cost of a new transfer vessel remodeled from a used vessel is US$ 30 million and the improvement of the Macareo Canal is necessary for reuse at a cost of US$ 30 million (-4.5m designed depth) -150 million (-14m designed depth). The maintenance dredging of both the Rio Grande Canal/Boca Grande Canal and the Macareo Canal is required at an annual cost of US$ 45-120 million. Therefore those alternatives are also uneconomical.

In alternatives B1-B4, a new transfer port would be constructed at the area of Boca Grande and both iron ore and other cargo would be transported through the Rio Grande Canal. The cost of the new transfer port is US$ 210-270 million and therefore those alternatives are also uneconomical as stated in previous studies.

The barge train of alternatives B3, B4, C2 and D1 is difficult to navigate in the ocean, especially during inclement conditions. Moreover, it cannot be equipped with a self-unloading system. In addition, it would cost US$ 10 million to convert existing facilities of Puerto Ordaz into barge oriented ones. Therefore barge train is inadequate to transport cargo to a transfer port in the ocean.

In alternative A3, iron ore shipped on Cape size carriers is directly transported to the final destinations through the Rio Grande, and other cargo is also transported by Handymax carriers. In this case, the cost of development of the channel of 19 m depth is US$ 150 million and the maintenance dredging would increase to 68.8 million cubic meters per year compared with the present dredging volume of 20 million cubic meters. This means that new dredging vessels would be necessary for over 48.8 million cubic meters. It would be also necessary for the ports to accommodate Cape size carriers. Therefore alternative A3 is uneconomical.

The remaining alternatives are P1, P2, P3, A1 and A2. In these alternatives, navigation routes are the same, Rio Grande and Boca Grande Canal. The differences are vessel sizes, Panamax, Handymax or Small Handy, and whether cargo is transshipped at Boca de la Serpiente or not.

It should be noted that the service life of the existing Transfer Vessel will likely expire around 2003, and that of the two Shuttle Vessels will expire approximately 10 years after. Also the exported iron ore is expected to decrease to 4 million tons in 2003.

Therefore the proposed transportation system of iron ore export should be flexible enough to respond to the changes that will come in the near future. The flexibility of the system is a key point to economize transportation cost. By saving the initial and maintenance cost of the channel, the benefit and the imposition can be better balanced.

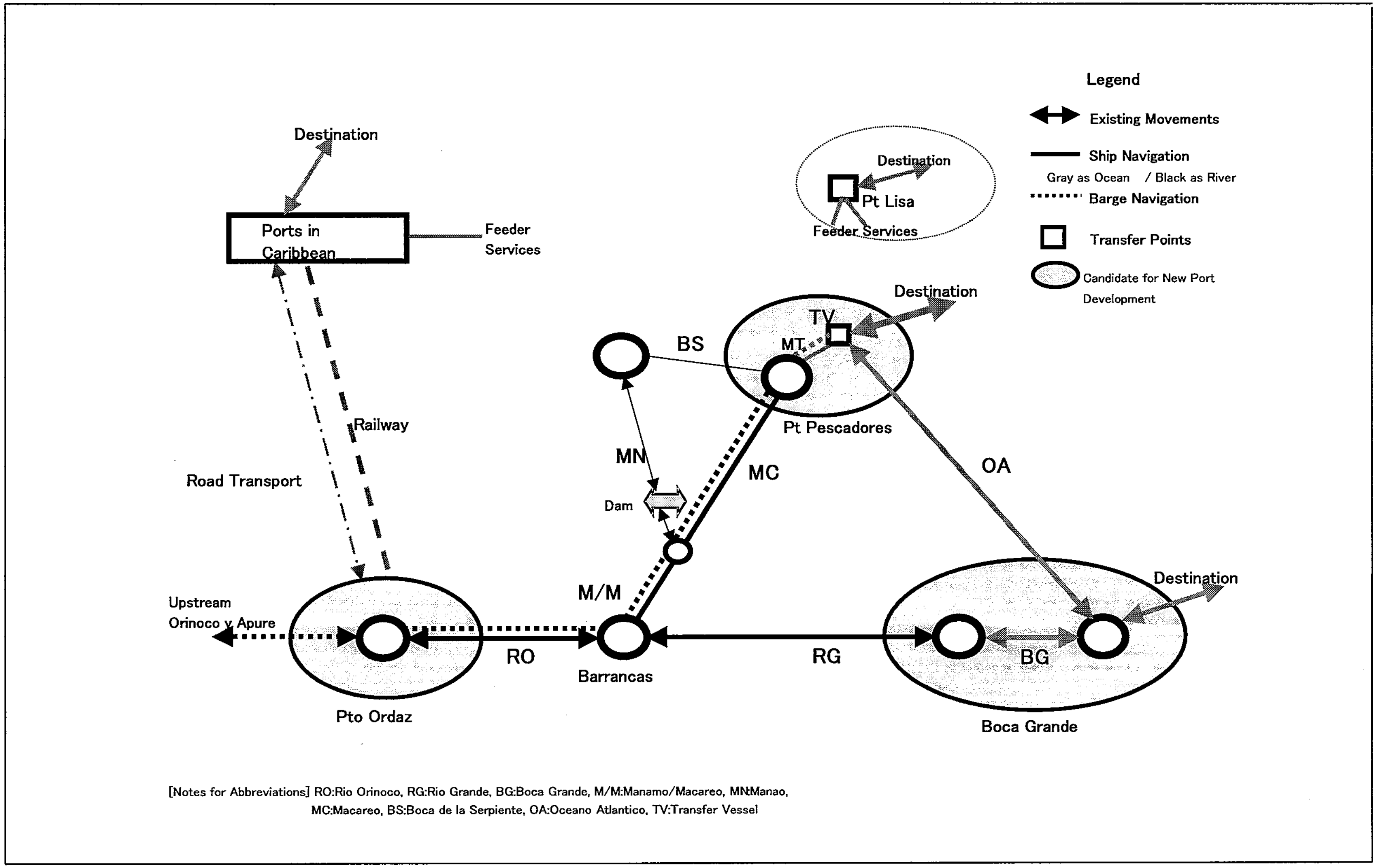


Fig. 5-4-1 Schematic Diagram of Alternatives of Waterway Transportation System