

7.3.6 Cost Estimate and Implementation Program

(1) General

The cost estimate and implementation schedule were carried out for the identified structures of river improvement in the feasibility study; the discharge control dike in the Tortola Channel and the bank protection revetment close to Barrancas.

The major construction work components of the proposed structure are composed of rock mounting, rubble stone placing, gabion installation, dredging etc. The collected data and information related to these items of works are discussed in this section.

(2) Basis of Cost Estimate

1) Basic Conditions of Cost Estimates

- i) Contract Method: - It is assumed that the construction will be performed by general contractor selected under international competitive bidding.
- ii) Basis of cost: - All base costs are expressed under the economic conditions in Venezuela that prevailed in October 1999.
- iii) Exchange rate: - Foreign currency exchange rate is US\$ 1.00= BS 630. =Yen 105.
- iv) Project Cost: - Project cost is composed of "Direct Cost" and "Indirect Cost"
 - (Direct Cost): - Construction cost and procurement cost
 - (Indirect Cost): - Administration cost, assumed at 5 % of the direct cost
 - Engineering cost for detailed design and construction supervision, assumed at 10 % of the direct cost
 - Physical contingency, assumed at 20 % of the direct cost
- v) Unit Price: - The unit prices of labor, materials and rental cost of equipment are determined based on the current data collected in Pto. Ordaz and Caracas.
 - (Material Price) - The major materials required for the construction of dike and revetment would be composed of rock, crushed stone and gabion net. The unit prices of the materials are listed in Table 7.3.6.
 - (Wages) - The minimum labor wages of common labor, skilled labor, operator/driver, etc are determined by the Government Decree. The wages in the market/construction sites, however, are to be 4 to 6 times of the minimum wages according to the collected information at sites. The current unit price of wages is shown in Table 7.3.7.

(Equipment cost) - It is required for major construction works to adopt heavy equipment/machinery taking the large scale of stone works, effectiveness of workability and limited construction time into consideration. The major equipment/machinery involved in the works are hopper type barge, tag boat, dump truck, crane, bulldozer, back-hoe, and so on. The list of rental cost of heavy equipment/machinery is shown in Table 7.3.8.

(Land Acquisition and compensation)

- Owing to the fact that the proposed construction sites would be along riverbank and water areas belonging to the Government, land acquisition would not be basically required. Also only a few housing compensation along the banks for revetment works at Barrancas is anticipated.

2) Unit Construction Cost

Unit costs of construction works are surveyed by interviewing with the general contractors, which are considered as the basic data for a detailed cost estimate. The unit costs include construction cost, site expenses, contractor's overhead and profit and tax, for each work item of dredging, filter setting, exploring rock materials from the quarry, transportation of the materials, installation of stone materials and gabion at the site and excavation, mass concrete works of waterway for fishing boats. The detailed information of the components of main work is shown in Table 7.3.9 and Table 7.3.10.

(3) Construction and Procurement Cost

The cost for the proposed channel improvement composed of closing dike and revetment at Barancas is estimated. The costs of each of the two alternatives of closing dikes, i.e. complete closing dike and submerged closing dike composed of main body, revetment for the dike and water way for fishing boats are also estimated.

The costs of main work item consist of preparatory work, main work and their site expenses & overhead. The rate of costs for the preparatory work is assumed as 3% of main works and the site expenses & overhead is assumed as 7% of cost of construction works. The direct construction costs for both alternatives along with quantity of each work item are shown in Table 7.3.11.

The project costs for both complete closing dike and submerge dike are estimated based on the "Basis of Cost Estimates". The results are shown below:

1) Project cost of Complete Closing Dike: (Refer to Table 7.3.11: Project Cost)

Direct Cost

- Closing Dike	: US\$ 66,078,000
- Revetment at Barancas	: US\$ 8,804,000

Indirect Cost

-Administration Cost	: US\$ 3,744,000
-Engineering Service cost	: US\$ 7,488,000

Physical Contingency : US\$ 14,977,000

Total : US\$ 101,092,000

2) Project cost of Submerged Closing Dike: (Refer to Table 7.3.11: Project Cost)

Direct Cost

- Closing Dike	: US\$ 86,823,000
-Revetment at Barancas	: US\$ 8,804,000

Indirect Cost

-Administration Cost	: US\$ 4,781,000
-Engineering Service cost	: US\$ 9,563,000

Physical Contingency : US\$ 19,125,000

Total : US\$ 129,097,000

(4) Operation and Maintenance Cost (O & M Cost)

The annual operation and maintenance cost for routine O&M works is estimated as 0.5 % of direct construction cost as shown in Table 7.3.11.

Table 7.3.6 MATERIALS UNIT PRICES

1US\$= Bs. 630

Nº	ITEMS	UNIT	UNIT PRICE (Bs)	UUNIT PRICE (Equivalent US \$)	REMARKS
1	Gasoline	Lit	85	0.13	
2	Diesel oil	Lit	55	0.09	
3	Motor oil	Lit	850	1.35	
4	Transmision oil	Lit	1,150	1.83	
5	Stone weight between 3 and seven tons	Ton	6,353	10.08	at Quarry
	Stone weight between 4 and seven tons	M³	12,705.00	20.17	at Quarry
6	Stone	M³	9,000	14.29	at Quarry
7	Crushed Stone	M³	9,500	15.08	at Quarry
8	Cobble Stone	M³	7,750	12.30	at Quarry
9	Sand for concrete	M³	8,000	12.70	on site
10	Washed Sand	M³	13,852	21.99	on site
11	Portland Cement	Kg	77	0.12	at plant
12	Plain Steel Bar	Kg	378	0.60	at plant
13	Corrugated Steel Bar	Kg	280	0.44	at plant
14	Ready Mixed Concrete	M³	85,000	134.92	at plant
15	Metal Form	Kg	1,800	2.86	at plant
16	Steel for Shaped Plate	Kg	1,050	1.67	at plant
17	Timber (Saqui - Saqui)	M³	350,000	555.56	at sawmill
18	Wooden Form Saqui-Saqui	M³	350,000	555.56	at sawmill
19	Steel Pile (1,0" m. T =15mm)	Ton	855,000	1357.14	fromoil industry
20	Gabion Net	Kg	1,653	2.62	
21	PVC Pipe 50 mm - 2"	M	1,200	1.90	hardware store
22	PVC Pipe-3"	M	1,800	2.86	hardware store
23	PVC Pipe 4"	M	2,650	4.21	hardware store
24	Bagcrete	Ton	4,650	7.38	at site
25	Wire Caliper 18	Kg	5,650	8.97	at site

Source: 1. SICOP - Contraloría General de la República Ing. Edwin Werner october 1999.

2. Instituto de Costos - Colegio de Ingenieros de Venezuela october 1999.

Table 7.3.7 MINIMUN DAILY LABOR WAGE BY CLASIFICACION

No.	Clasification	Unit	Labor Wage
1	Labor	day	7,000
2	Labor (Foreman)	day	8,400
3	Mason/Tile	day	9,400
4	Mason/Tile (Foreman)	day	10,400
5	Carpintero	day	9,800
6	Carpenter (Foreman)	day	10,400
7	Steel Worker	day	9,400
8	Steel Worker (Foreman)	day	10,400
9	Pipe Worker	day	9,400
10	Pipe Worker (Foreman)	day	10,400
11	Electrician	day	9,400
12	Electrician (Foreman)	day	10,400
13	Painter	day	9,400
14	Painter (Foreman)	day	10,400
15	Waterproofer	day	9,400
16	Waterproofer (Foreman)	day	10,400
17	Concrete Worker	day	8,400
18	Guard	day	7,060
19	Driver (8~15t)	day	8,515
20	Driver (15t~)	day	8,745
21	Driver of Trailer	day	10,300
22	Driver of Mixer	day	8,745
23	Driver 3 to 8 tons	day	8,000
24	Driver up to 3 tons	day	7,825
25	Assistant of Operator	day	7,500
26	Operator of Heavy Machinery	day	10,400
27	Operator of Tractor	day	10,400
28	Operator of Trailer	day	10,400
29	Operator of Shovel up to 1 cu/yd	day	10,400
30	Operator of Shovel + 1 cu/yd	day	9,400
31	Operator of Bulldozer	day	10,400
32	Operator of Crane	day	10,400
33	Operator of scraper 1 ^a	day	10,400
34	Operator of grader 2 ^a	day	9,400
35	Equipment foreman	day	10,400
36	Machinery (Foreman)	day	10,400
37	Tire Worker	day	7,500
38	Mechanic of Heavy Machinery	day	10,400
39	Mechanic (Foreman)	day	12,000
40	Welder	day	9,400
41	Sheet Metal Worker	day	9,400
42	Assistant of Surveyor	day	7,600
43	Operator of Paving	day	8,500
44	Light equipment operator	day	8,400
45	Hammer operator	day	7,600
46	Wich operator	day	8,400
47	Watchman	day	7,000
48	Superintend builder 1 ^a	day	12,000
49	Superintend builder 2 ^a	day	10,400
50	Pipeline builder	day	9,400
51	Pipe set up operator	day	9,400
52	Asistant Diesel Medium	day	7,500

- Note: 1. Working Hours Monday to Friday : 8 hr.
2. Overtime fee of Saturday and Sunday are 2 and 5 times of basic wage
3. In these minimun salaries are included bonus and subsidies according decreeds N° 617 and 1240 dated april 11, 1996 and march 6, 1996.
- Source: 1. Tabulador de oficios y salarios minimos de la convención colectiva de trabajo para laindustria de la construcción. November 1999.
2. Controlaria General de la República. October 1999.
3. Instituto Nacional de Costos. October 1999.

Table 7.3.8 LIST OF RENTAL AND PURCHASE COSTS FOR HEAVY EQUIPMENT

US\$1= Bs. 630

N°	ITEMS	DAILY COST (Bs.)	DAILY COST (US\$)	Price Equipment / Machinery (US\$)	REMARKS
1	NORMAL WORKING TRUCK	42,948	68.2	12,286	FORD 350
2	DUMP TRUCK 6 m ³	80,780	128.2	42,207	FORD F-7000
3	DUMP TRUCK 28 TON	194,080	308.1	91,524	IVECO MP38E37H
4	ROCK TRUCK 15 m ³	202,980	322.2	99,361	IVECO MP720E37HT
5	POWER SHOWER 1,6 m ³	410,530	651.6	216,000	CAT 325
6	POWER SHOWER 1,2 m ³	280,750	445.6	159,425	CAT 320
7	BACKHOE 1,0 YD3	791,730	1256.7	61,170	CAT 416 C 4X2
8	BACKHOE 1,37 YD3	791,730	1256.7	67,365	CAT 428C 4X2
9	MOTOGRADE (PATROL) BLADE 14''	301,980	479.3	197,805	CAT 148
10	MOTOGRADE (PATROL) BLADE 12''	260,120	412.9	165,895	CAT 12
11	SCRAPER 31 YD3	1,170,000	1857.1	697,430	CAT 631
12	SCRAPER 20 YD3	791,730	1256.7	456,340	CAT 621 F
13	SCRAPER 11 YD3	474,500	753.2	269,670	CAT 613 C
14	BULLDOZER D7	534,810	848.9	309,920	CAT D7
15	BULLDOZER D8	599,750	952.0	387,155	CAT D8
16	BULLDOZER D8 WITH RIPPER	736,750	1169.4	447,660	CAT D8
17	BULLDOZER D9	921,630	1462.9	466,700	CAT D9
18	BULLDOZER D9 WITH RIPPER	1,078,400	1711.7	566,150	CAT D9
20	SHOVEL-LOADER 1,3 YD3	135,340	214.8	75,953	CAT 933
21	SHOVEL-LOADER 3,0 YD3	420,920	668.1	218,446	CAT 963
22	WHEEL LOADER 2.40YD3	91,725	145.6	109,460	CAT 926 - G
23	WHEEL LOADER 4.30YD3	411,070	652.5	191,974	CAT 960 - F
24	WHEEL LOADER 7.80YD3	799,700	1269.4	560,429	CAT 988
25	ROLLER COMPACTER (SHEEPSFOOT)	451,535	716.7	255,893	CAT 8115
26	ROLLER COMPACTER	193,450	307.1	127,852	CAT CB-634C
27	ROLLER COMPACTER	91,725	145.6	61,156	CAT CS-323C
28	P&H CRANE (44,5T)	68,900	109.4	44,439	P&H CMN114
29	P&H CRANE (65 T)	229,500	364.3	137,097	P&H
30	TELESCOPIC CRANE (18 T)	130,500	207.1	62,903	BUCYRUS
31	25 TON HOAKLIFT	256,000	406.3	158,871	
32	TUG BOAT 6000 HP	1,596,000	2533.3		
33	FLAT BARGE 2000 DWT	912,000	1447.6		
34	HOPPER BARGE 1700 DWT	427,500	678.6		
35	HELICOPTER (20 PERSON)HOUR	456,000	723.8		

SOURCE: SICOP-CONTRALORIA GENERAL DE LA REPUBLICA INGENIERO EDWIN WERNER. OCTOBER 1999.
 INSTITUTO DE INGENIERIA - COLEGIO DE INGENIEROS DE VENEZUELA. OCTOBER 1999.

Table 7.3.9 LIST OF UNIT COST FOR CONSTRUCTION WORKS

1US\$= Bs. 630

No.	ITEMS	UNIT	UNIT PRICE (Bs)	UNIT PRICE (US\$)	REMARKS
1	Compact fill with percussion hammer	M ³	8,800	14.0	
2	Compact fill with sheepsfoot roller	M ³	1,250	2.0	
3	Compact fill with bulldozer	M ³	770	1.2	
4	Excavation with bulldozer and loader for levelling	M ³	2,120	3.4	Includes Machinery
5	Excavation with boulders 0.75 M ³ or higher	M ³	1,970	3.1	Includes Machinery
6	Excavation with ripper, scrapper and pushig bulldozer	M ³	2,470	3.9	Includes Machinery
7	Excavation with two bulldozer, ripper and loader	M ³	2,700	4.3	Includes Machinery
8	Structural concrete works	M ³	2,900	4.6	Includes Machinery
9	Mass concrete works	M ³	250,000	396.8	
10	Asphalt pavements	M ²	9,000	14.3	
11	Pavement of yards	M ²	3,900	6.2	
12	Construction of office building	M ²	275,000	436.5	
13	Cementbag works	M ³	65,550	104.0	
14	Dredging for construction	M ³	2,300	3.7	price in site
15	Trasportation Fees for rock materials	M ³	3,876	6.2	By barge (1500 m ³)
16	Enbankment works	M ³	3,000	4.8	
17	Excavation works	M ³	4,000	6.3	

SOURCES:

SICOP-CONTRALORIA GENERAL DE LA REPUBLICA INGENIERO EDWIN WERNER OCTOBER 1999.

INSTITUTO DE INGENERIA - COLEGIO DE INGENIEROS DE VENEZUELA OCTOBER 1999.

Table 7.3.10 Breakdown of Unit Cost for Closing Dike and Revetment

Works	Items	Unit	Contents/Breakdown					Unit Cost (US\$)	Remarks
1	Preparatory Works								
	Site office,survey,etc	L.S	3% of main work						
2	Main works								
	2.1 Closing Dike								
	Dredging for base	m³						3.7	
		Unit	Material Cost at Site				Installation of Material	Unit cost	
	Base Filter	m²	3				3	6.0	
	Rubble Stone Works	Unit	Material Cost at Quarry	Transportation to Port	Loading to Barge	Transportation to Site	Installation of Material	Unit cost	
	1) Large stone	m³	20	8	12	6	15	61.0	Stage I,II& III
	2) Core stone	m³	15	8	8	6	10	47.0	Stage II& III
	3) Cobble stone	m³	12	8	8	6	3	37.3	Stage I
	Stone Setting Works								
	1) Large stone	m³	20	8	12	6	25	71.0	
	2) Core stone	m³	12	8	8	6	6	40.3	
	2.2 Revetment								
		Unit	Material Cost at Quarry	Transportation to Port	Loading to Barge	Transportation	Installation of Material	Unit cost	
	Stone for Gabion	m³	12	8	8	6	15	49.0	
	Gabion Net/m3	m³					60	60.0	
3	Site expenses,Over head	L.S	7% of Construction Work (Item1+ 2)						

Note: Weight of stone is more than 2tons : Large Stone

Table 7.3.11 Project Cost and Operation & Maintenance Cost for Both Alternatives (1/2)

Alternative [B2-1]: Complete Closing Dike

A. Direct Construction Cost							
A.1. Closing Dike							
	Item	Unit	Quantity	Unit Cost	Cost (US\$)	Remarks	
	1).Preparatory Works	Site Office, Temporary Works, etc		1	L.S	2,860,539	5% of main works
	2). Main Works						
	I. Closing Dike						
	I-1.Main Works of Closing Dike						
	(L=2200 m)	1).Dredging for base work	m³	156,000	3.65	569,400	
		2).Base filter	m²	156,000	6.0	936,000	
		3).Rubble Stone Works					Stage I & II
		-Large stone	m³	261,000	61.0	15,921,000	
		-Core stone	m³	265,000	47.0	12,455,000	
		-Cobble stone	m³	158,000	37.3	5,893,400	
		Sub-Total		684,000		34,269,400	
		4).Grading/Stone Setting Works					Stage III
		-Large stone	m³	87,000	71.0	6,177,000	
		-Core stone	m³	127,000	40.3	5,118,100	
		Sub-Total		214,000		11,295,100	
		(Total Cost of Main Works)				47,069,900	
	II. Revetment of Closing Dike						
	(L=800 m)	Gabion Work	m³	48,800	109.0	5,319,200	
		Filter Work	m²	48,800	6.0	292,800	
		Sub-Total				5,612,000	
	III. Channel for Fishing Boats						
	(L=600m)	Excavation Work	m³	242,550	4.6	1,115,730	
		Concrete Revetment Works	m³	14,367	202.5	2,909,318	
		Filter Work	m²	28,734	6.0	172,404	
		Gate Work	m²	116	2857.1	331,429	
		Sub-Total				4,528,880	
	3.Site expenses & Overhead :10% of (I+II+III)					6,007,132	
	Total of A1					66,078,451	Say 66,078,000
A.2 Revetment Work for Waterway in Rio Grande							
	1).Preparatory Works	Site Office, Temporary Works, etc	L.S	1		381,133	5% of main works
	2). Main Works						
	(L=4000m)	Gabion Work	m³	62,006	109.0	6,758,654	
		Filter Work	m²	144,000	6.0	864,000	
						7,622,654	
	3).Site expenses & Overhead :10% of 1)+2)					800,379	
	Total of A2					8,804,165	Say 8,804,000
Total of Direct Cost (A1+A2)						74,882,616	Say 74,882,000
B. Indirect Cost							
B.1 Administration Cost			L.S.			3,744,131	5 % of Direct Cost Say 3,744,000
B.2 Engineering Cost			L.S.			7,488,262	10% of Direct Cost Say 7,488,000
Total of Indirect cost (B1+B2)						11,232,392	Say 11,232,000
C. Physical Contingency (20%)			L.S.			14,976,523	Say 14,977,000
Project Cost (A+B+C)						101,091,532	Say 101,092,000
Operation & Maintenance Cost (0.5% of direct construction cost)						374,413	Say 374,000

Table 7.3.11 Project Cost and Operation & Maintenance Cost for Both Alternatives (2/2)

Alternative [B2-3]: Submerged Closing Dike

A. Direct Construction Cost

A.1. Closing Dike

	Item		Unit	Quantity	Unit Cost	Cost	Remarks
	1).Preparatory Works	Site Office, Temporary Works, etc	L.S	1		3,758,579	5% of main works
	2). Main Works						
	I. Closing Dike						
	I-1.Main Works of Closing Dike (L=2200 m)						
		1).Dredging for base work	m ³	199,000	3.7	726,350	
		2).Base filter	m ²	199,000	6.0	1,194,000	
		3).Rubble Stone Works					Stage I & II
		-Large stone	m ³	335,000	61.0	20,435,000	
		-Core stone	m ³	228,000	47.0	10,716,000	
		-Cobble stone	m ³	169,000	37.3	6,303,700	
		Sub-Total		732,000		37,454,700	
		4).Stone Setting Works					Stage III
		Gabion Work	m ³	159,000	109.0	17,331,000	
		Core stone	m ³	50,000	40.3	2,015,000	
		Sub-Total		209,000		19,346,000	
		(Total Cost of Main Works)				58,721,050	
	II. Revetment for Closing Dike (L=1500 m)						
		Gabion Work	m ³	91,500	109.0	9,973,500	
		Filter Work	m ²	91,500	6.0	549,000	
		Sub-Total				10,522,500	
	III. Channel for Fishing Boats (L=800m)						
		Excavation Work	m ³	323,400	4.6	1,487,640	
		Concrete Revetment Works	m ³	19,156	202.5	3,879,090	
		Filter Work	m ²	38,312	6.0	229,872	
		Gate Work	m ²	116	2857.1	331,429	
		Sub-Total				5,928,031	
	3).Site expenses & Overhead :10% of (I+II+III)					7,893,016	
	Total of A1					86,823,176	Say 86,823,000
	A.2 Revetment Work for Waterway in Rio Grande						
	1).Preparatory Works	Site Office, Temporary Works, etc	L.S	1		381,133	5% of main works
	2). Main Works (L=4000m)						
		Gabion Work	m ³	62,006	109.0	6,758,654	
		Filter Work	m ²	144,000	6.0	864,000	
						7,622,654	
	3).Site expenses & Overhead :10% of 1)+2)					800,379	
	Total of A2					8,804,165	Say 8,804,000
	Total of Direct Cost (A1+A2)					95,627,341	Say 95,627,000
	B. Indirect Cost						
	B.1 Administration Cost		L.S.			4,781,367	5 % of Direct Cost Say 4,781,000
	B.2 Engineering Cost		L.S.			9,562,734	10% of Direct Cost Say 9,563,000
	Total of Indirect cost (B1+B2)					14,344,101	Say 14,344,000
	C. Physical Contingency (20%)		L.S.			19,125,468	Say 19,125,000
	Project Cost (A+B+C)					129,096,910	Say 129,097,000
	Operation & Maintenance Cost (0.5% of direct construction cost)					478,137	Say 478,000

(5) Implementation Program

1) Basis of Construction Methods and Schedule

- Workable days and working hours

The main work of closing dike and revetment consist of rubble stone and gabion works. The works are not affected directly by rainfall amount. However, high flow velocity and water level may cause disturbances to the works. Based on this condition, the annual workable day is estimated taking into consideration of the period difficult to work in flood season and national holidays.

- Period of flood season : 60 days (August and September)
- National Holiday : 11 days
- Sunday : 52 days (working in Saturday is subjected to agreement with union)

The annual and monthly workable days are estimated about 240 days and 24 days respectively while working hours per day is 8 hours based on normal working condition.

- Construction methods and available machinery

Most of machinery /equipment needed for the construction are available in the country. Thus the construction of closing dike of which main work is rubble stone work is to be carried out by heavy machinery.

- Construction materials

The basic construction materials such as large stone, core stone is procured from a quarry located within 50 km distance from the site of closing dike.

2) Construction Methods

i) Closing Dike

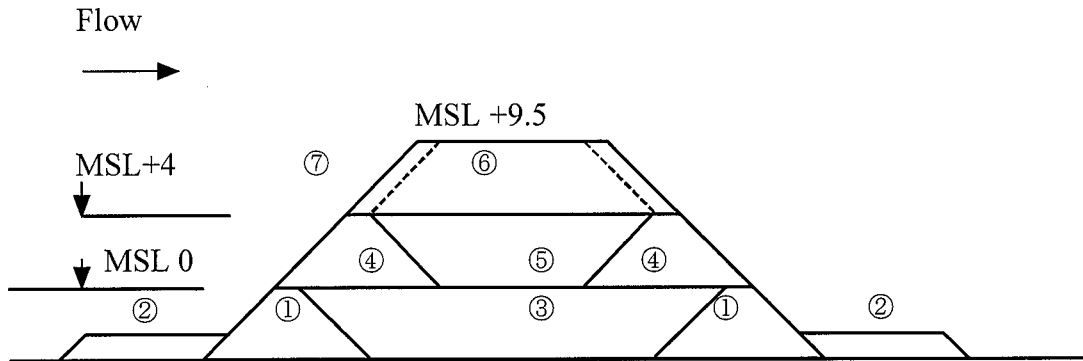
The closing dike is constructed with following construction methods and steps.

- Preparatory work

Preparatory works consist of construction of the office, site survey for setting the location, preparing stockyard for materials and any temporary works for main work shall be made before the start of main work.

- Construction Works

The construction of closing dike is carried out as following steps shown in Fig. 7-3-18. The major points for the construction methods are described below.



Steps of construction:

Stage I: ① (large Stone), ② and ③ of core and cobble stone

Stage II: ④ (large stone), ⑤ (core stone)

Stage III: ⑥ (core stone) and ⑦ (large stone)

Fig. 7-3-18 Construction Stages of Closing Dike

(1) Grading of riverbed

In order to install the filter mat, grading of riverbed shall be carried out by cutter suction type dredge. This work is to be carried out in dry season for easy operation and accurate grading. As soon as the grading is done, filter sheets will be installed with setting the large stone installation.

(2) Rubble stone work

The rubble stone works with large stone and core/cobble stone will be carried out with following three stages.

Stage I:

The rubble stone work with large stone is first to be carried out until level of MSL by grab boat. After getting the mound in both sides of up and down stream, core stone will be installed by hopper type barge.

Stage II:

The large stone will be first installed both sides of dike section by grab type boat. After the large stone work completed, core stone will be set up by grab type boat. In the dry season, core stone will be filled by using dump truck and bulldozer.

Stage III:

This stage will be principally carried out in dry season for easiness in setting the large stone for covering the slope of dike on up and down stream.

(3) Revetment Works for Closing Dike

In order to protect the banks of closing dike, revetment work is to be carried out. A gabion work with filter mat is selected taking the requirement of flexibility into consideration.

(4) Channel Work for Fishing Boat and Fishes

The construction of closing dike affects the transportation of fishing boats and ecology for fishes. In order to solve this problem, a channel work is to be carried out. The location is selected out of closing body for easy operation and maintenance. This channel has two gates for transportation of fishing boats.

ii) Revetment Work of Barrancas (Waterway in Rio Grande)

- Construction methods of revetment work

The construction of revetment at Barrancas consists of following construction methods and steps.

(1) Preparatory works include alignment setting and grading of bank slope for gabion work are made by means of barge with crawler and manpower. The work shall be carried out in dry season.

(2) Setting gabion net with filter work and installation of cobble/crushed stone are to be carried out by combination of heavy machine with manpower. The work in lower elevation of the riverbank shall be carried out in dry season principally.

3) Estimation of time allocation

The required period for each stage is estimated based on the work volume of closing dikes as shown in Fig. 7-3-19, capacity of machine and number of team employed. Also it is considered that construction work is not carried out during August and September. The result shows that the total construction period for closing dike is about 31 months (2.5 years). After

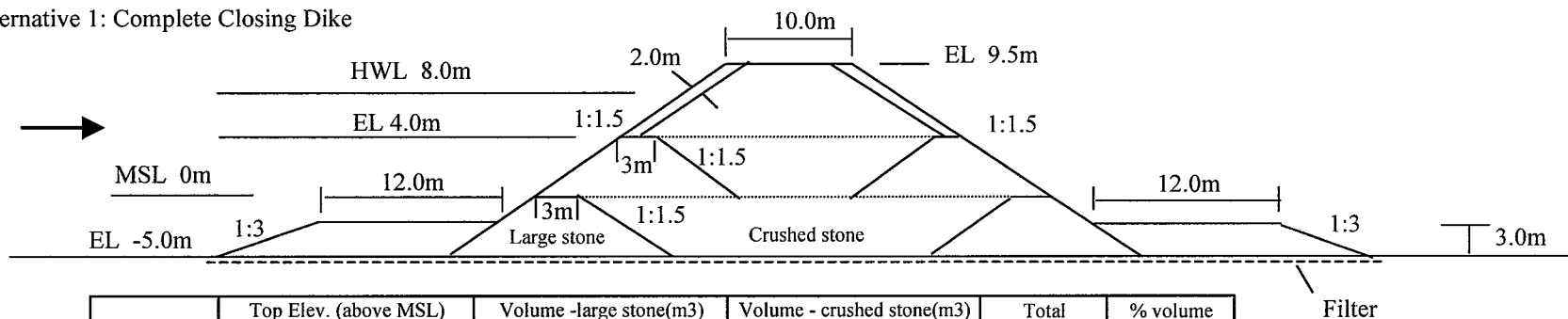
completion of closing dike, dredging works up to some extent are still required due to the hydraulic conditions of the Rio Grande channel. The construction schedules for both alternatives are shown in Fig. 7-3-20. The detailed information is summarized in the Table 7.3.12.

Table 7.3.12 Time requirement of construction activities in each stage.

Stage	Item	Filter (m2)	Large stone (m3)	Core / Cobble stone (m3)	Grading work (m2)
Stage I	Volume	156,000	113,000	300,000	80,000
	Capability/day	350	500	1000	400
	Required days	446	226	300	200
	No. of teams	4	2	3	2
	Required period (months)	4.7	4.6	4.2	4.2
	Major machine	Barge with crane	Gutter boat with 2.5m3 bucket	Hopper barge of 800m3	Barge with crawler
Stage II	Volume	35,000	148,000	119,000	45,000
	Capability/day	350	500	500	400
	Required days	100	296	238	113
	No. of teams	1	2	2	1
	Required period (months)	4.2	6.2	5	4.7
	Major machine	Barge with crane	Gutter boat with 2.5m3 bucket	Gutter boat with 2.5m3 bucket	Barge with crawler
Stage III	Volume	-	87,000	127,000	25,000
	Capability/day	-	200	500	400
	Required days	-	435	254	113
	No. of teams	-	3	2	1
	Required period (months)	-	6	5.3	4.7
	Major machine		Barge with crane	Gutter boat with 2.5m3 bucket	Barge with crawler

Based on the above conditions, implementation program can be summarized dividing into two phases as shown in Fig. 7-3-21.

Alternative 1: Complete Closing Dike

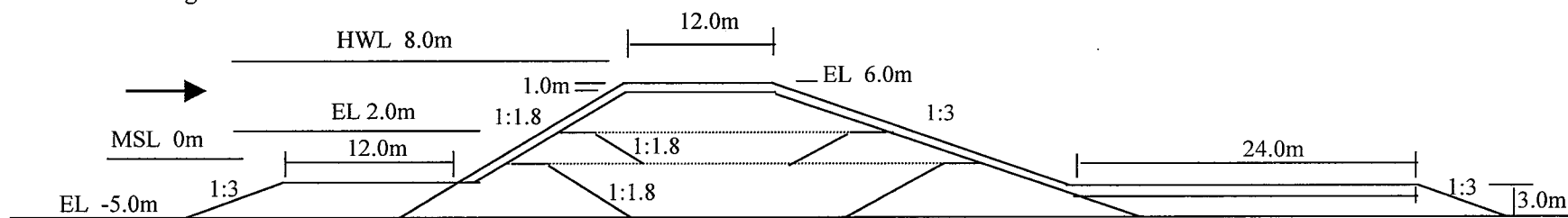


	Top Elev. (above MSL)	Volume -large stone(m3)	Volume - crushed stone(m3)	Total	% volume
Stage 1	0m	113000	158000 +146000*	417000	46
Stage 2	4m	148000	119000	267000	30
Stage 3	9.5m	87000	127000	214000	24
Total	9.5m	348000	550000	898000	100

* Footing volume (m3)

Base Area (Filter) (m2)	156000
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Alternative 2: Submerged Dike



	Top Elev. (above MSL)	Volume -large stone(m3)	Volume - crushed stone(m3)	Total	% volume
Stage 1	0m	152500	169000 +210000*	531500	56
Stage 2	2m	61500	68000	129500	14
Stage 3	5m	121000	-	121000	13
Stage 4	6m	-	159000**	159000	17
Total	6m	335000	606000	941000	100

* Footing volume (m3)

** Gabion volume (m3)

Base Area (Filter) (m2)	199000
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Fig. 7-3-19 Comparative Study of Closing Dike

A. Complete Closing Dike

		1st Year												2nd Year												3rd Year												4 th Year											
Quantity		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1. Dike																																																	
1-1.Closing Dike																																																	
Preparatory Works	L.S																																																
Dredging for Base Filter	L.S																																																
Stage I																																																	
Filter Sheet Setting	156,000m ²																																																
① Large Stone Installation	113,000m ³																																																
②③ Core Stone Installation	300,000m ³																																																
Grading of 1st Layer (20% of 1+2)	80,000m ²																																																
Stagell																																																	
④ Large Stone Installation	148,000m ³																																																
⑤ Core Stone Installation	123,000m ²																																																
Grading of 2nd Layer (15% of 4+5)	45,000m ²																																																
Stage III																																																	
⑥ Core Stone Installation by Gutter Boat	127,000m ³																																																
⑥ Filter Sheet with Large Stone Setting	87,000m ³																																																
Grading of 3rd Layer (20% of 6)	25,000m ²																																																
1-2.Revetment Works																																																	
Filter Work	48,800m ²																																																
Gabion Work	48,800m ³																																																
1-3.Channel Works for Fishing Boats																																																	
Excavation Work	242,550m ³																																																
Filter Work	28,734m ²																																																
Concrete Works	14,367m ³																																																
Gate Works	2 Unit																																																
2.Revetment Work for Waterway in Rio Grande																																																	
		1st Year												2nd Year												3rd Year												4 th Year											
Preparatory Works																																																	
Filter Works	144,000m ²																																																
Gabion Work	62,000m ³																																																

B.Submerged Closing Dike

[illegible]

Fig. 7-3-20 Implementation Schedule

Cost Allocation for Complete Closing Dike

Unit : US\$

		1st Year												2nd Year												3rd Year												4 th Year											
	Construction Cost (US \$x1000)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1.Closing Dike	61,343																																																
Preparatory work and Site Expenses	5,166																																																
1-1. Dike Work	48,866																																																
1-2.Revetment Work	2,782																																																
1-3.Channel Works for Fishing Boats	4,529																																																
	56,177																																																
Cost Allocation (US\$)													18,322												27,083											15,938													
Cost Allocation (%)													30												44											26													
2.Revetment Work for Waterway in Rio Grande	4,437																																																
Cost Allocation (US\$)																									4,437																								
Cost Allocation (%)													0												100											0													

Cost Allocation for Submerged Closing Dike

Unit : US\$

		1st Year												2nd Year												3rd Year												4 th Year																																															
	Construction Cost (US \$x1000)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48																																				
1.Closing Dike	71,263																																																																																				
Preparatory work and Site Expenses	7,328																																																																																				
1-1. Dike Work	52,791																																																																																				
1-2.Revetment Work	5,216																																																																																				
1-3.Channel Works for Fishing Boats	5,928																																																																																				
	63,935																																																																																				
Cost Allocation (US\$)														21,541																								30,293																								19,429																							
Cost Allocation (%)														30																								43																								27																							
2.Revetment Work for Waterway in Rio Grande	4,437																																																																																				
Cost Allocation (US\$)																																																																										4,437											
Cost Allocation (%)														0																								100																								0																							

Fig. 7-3-21 Cost Allocation