Final Report of the Commission for the Study of Alternatives to the Panama Canal

Volume IX

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COMMISSION FOR THE STUDY OF ALTERNATIVES
TO THE PANAMA CANAL

THE STUDY OF ALTERNATIVES TO THE PANAMA CANAL
(COMPONENT STUDY: ENGINEERING AND COST ESTIMATES)

PHASE 2 ADDITIONAL WORK

PRELIMINARY ENGINEERING AND COST ESTIMATES

ANNEX TO FINAL REPORT

JUNE 1993

YACHIYO ENGINEERING CO., LTD.
under the contract with
JAPAN INTERNATIONAL COOPERATION AGENCY

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The Study of Alternatives to the Panama Canal
(Component Study : Engineering and Cost Estimates)

Phase 2 Additional Work

Preliminary Engineering and Cost Estimates

Annex to Final Report

PREFACE

The Study of Alternatives to the Panama Canal is being carried out under a Commission representing the Governments of the Republic of Panama, the United States of America, and Japan. The Study is managed by a Secretariat composed of technical staff from the member nations.

Yachiyo Engineering Company Limited (YEC) was appointed as the Contractor for the Engineering and Cost Estimates Component Study (ECE Study) and has carried out the Study in two Phases. The Phase 1 report was submitted in February 1992. In accordance with the results of the prescreening carried out by the Commission at the end of Phase 1, the Phase 2 Study focused on several variations of the High Rise Lock Canal and the Route 10 Sea Level Canal. The purpose of the Phase 2 Study was to provide sufficient engineering and cost estimate information, data, analysis, and conclusions to enable the Commission, after considering the results of all component studies, to select the best and most viable alternative to the Panama Canal. The Final Report for Phase 2 was submitted in April 1993.

Subsequent to submission of the Phase 2 Final Report, YEC was asked to submit a proposal for evaluation of additional canal configurations. For the High Rise Lock Canal, the variation was for a single lane canal through the Culebra Cut, while for the Sea Level Canal evaluation of single lane tidal locks and a single lane Atlantic approach to the tidal gate was required.

YEC was subsequently requested to undertake the additional work and the attached Annex to the Phase 2 Final Report has been prepared as the result of the additional work.

SUMMARY

SUMMARY

1. General

This report reviews the engineering, preliminary design, construction plans and cost estimates for some additional variations of the canal alternatives which were considered in Phase 2.

For the High Rise Lock Canal, single lane Culebra Cut variations of Cases (1) and (2) of the Phase 2 Final Report (Phase 2 FR) are considered. The 18 km section between Station No. 42.00 km and Station No. 60.00 km of the Culebra Cut Section (Zone III and Zone IV) is reduced from the originally planned double lanes to a single lane (see Figs. 2-1, 2-2 and 2-3 of Intro. and Object.).

In the case of the Route 10 Sea Level Canal, the triple tidal locks planned for Case (a) in the Phase 2 FR have been reduced to a single lane tidal lock (see Figs. 2-4 and 2-5 of Intro. and Object.) and the width of the approach channel adjacent to the tidal lock has also been revised. A variation of Case (b) where the Atlantic approach is reduced from two lanes to a single lane for the section between Station No. 0.50 km and Station No. 15.00 km has also been costed (see Fig. 2-6 of Intro. and Object.).

The target year of the canal variations considered in the Additional Work is 2020 and revisions for the year 2060 are not included.

2. Canal Variations

The canal variations already examined in the Phase 2 Final Report are:

(i) Phase 2 - High Rise Lock Canal (HRLC)

- Case (1) : Design Ship 150,000 DWT, Gatun Lake WL = 85'
- Case (2) : Design Ship 200,000 DWT, Gatun Lake WL = 85'
- Case (3) : Design Ship 150,000 DWT, Gatun Lake WL = 90'
- Case (4) : Design Ship 200,000 DWT, Gatun Lake WL = 90'

(ii) Phase 2 - Route 10 Sea Level (SLC)

- Case (a) : 3 Lane Tidal Locks at Pacific Entrance
- Case (b) : Tidal Gates at each ocean side (2 Lane Approach Channel)
- Case (c) : Combination of Pacific Entrance Tidal Locks and a Tidal Gate towards the Atlantic Entrance

Under the Additional Work, the following variations have been studied:

(i) Additional Variations of the High Rise Lock Canal (HRLC)

- Case (5) : Single Lane Culebra Cut (Gatun Lake WL=85', 150,000 DWT)
- Case (6) : Single Lane Culebra Cut (Gatun Lake WL=85', 200,000 DWT)

The main differences from HRLC Cases (1) and (2) of Phase 2 are:

- Reduction of the excavation volume in the Culebra Cut Section (Zones III and IV).
- Deletion of the excavation volume for the potential fourth lock of the Miraflores and Gatun Locks.

(ii) Additional Variations of the Sea Level Canal (SLC)

- Case (d) : Single Lane Tidal Locks at the Pacific Entrance

The main differences from SLC Cases (a) of Phase 2 are:

- Scaling-down of the triple lane tidal lock to a single lane tidal lock.
- Reduction of the excavation volume in the Tidal Lock Approach Channel (approximately 10 km in length).
- Shortening of the canal crossing span of the bridge on the Pacific side.

- Case (e) : Tidal Gate at each Side (Single Lane Atlantic Approach Channel)

The main differences from SLC Cases (b) of Phase 2 are:

- Reduction of the excavation volume on the Atlantic side between the shoreline and the Atlantic side tidal gate.
- Shortening of the canal crossing span of the bridge on the Atlantic side.

3. Dredging of the Culebra Cut

3.1 General

Of the additional canal variations considered as part of the Additional Works, HRLC Cases (5) and (6) required the most significant changes to the construction plans established in Phase 2. The changes were necessitated by the limited working area available for dredging in the single lane Culebra Cut while still allowing vessels to transit the canal. The proposals for dredging are critical to the feasibility and costs of Cases (5) and (6) and are summarised below. The dredging work for Zone III is explained in more detail in Part II of this Annex and only the key features are explained here.

The Culebra Cut Section (Zone III) of the existing canal stretches for 10 km and the construction plan for this section has been completely revised. The work now consists of dredging only and the standard cross-section is shown in Fig. S-1 below. The Bypass Section (Zone IV) will be subject to dry excavation using the same method. described in the Phase 2 FR.

3.2 Working Width Available During Dredging Work

The channel width is reduced to a single lane during the dredging work for the Culebra Cut section. The degree of difficulty of this dredging work depends on the adopted width of the single lane. While there is no unified standard for a single lane width, the adopted channel width in this report takes into consideration reference books, Japanese and British standards, the PCC reference standards and the design values for the Suez Canal.

Based on the reference "Port Engineering" (By Per Bruun, Gulf Publishing Company, see Attachment 1), the required width should satisfy conditions (a), (b) and (c) which are shown in Fig. S-1 and which are defined as follows:

(a) channel width required for ship navigation (1.6B - 2.2B depending on the navigationability of the channel)
(b) clearance required to allow counter traffic flow
(c) minimum clearance (0.6B or more) from the sloping section of the channel for safe passage

The proposed value for each of these conditions during dredging works is as follows:

(a) 1.8B (average value of allowable range above)
(b) 0.6B which is the same as the value for (c)
(c) 0.6B as the minimum value

$$W = (a) + (b) + (c)$$
$$= 1.8B + 0.6B + 0.6B = 3B$$

Consequently, the minimum channel width for navigation during dredging work is 3B, i.e. 96m for a 65,000 DWT ship, which should allow dredging work to be carried out without increasing the existing channel width. As this value is not the result of a thorough test or study, however, a detailed study should be conducted in the future prior to the implementation of the actual work.

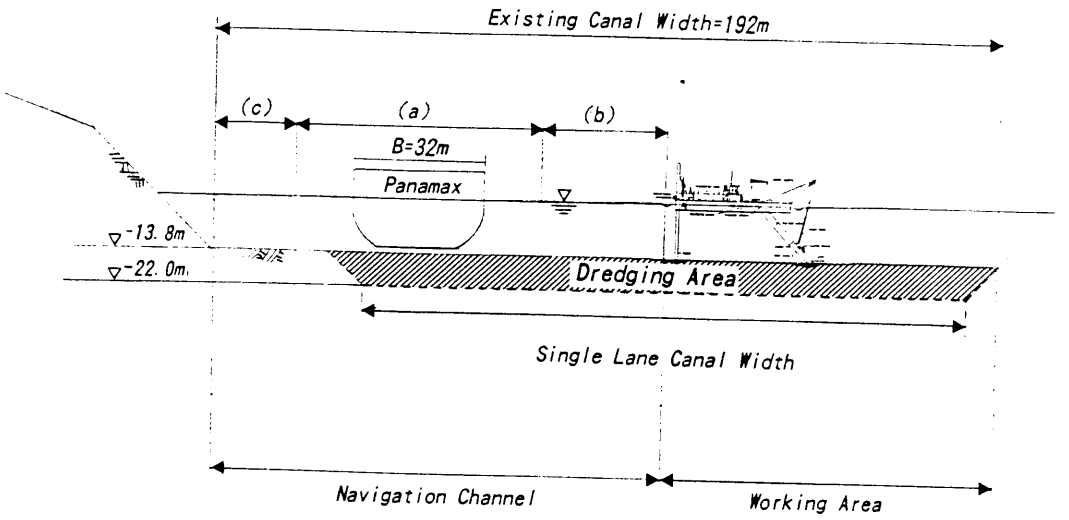


Fig. S-1 Cross-Section of Canal during Construction

3.3 Order of Work

The planned dredging work commences in the western part of the canal channel. This initial work is further divided into Steps 1, 2 and 3 with the order of implementation as shown in Fig. S-2.

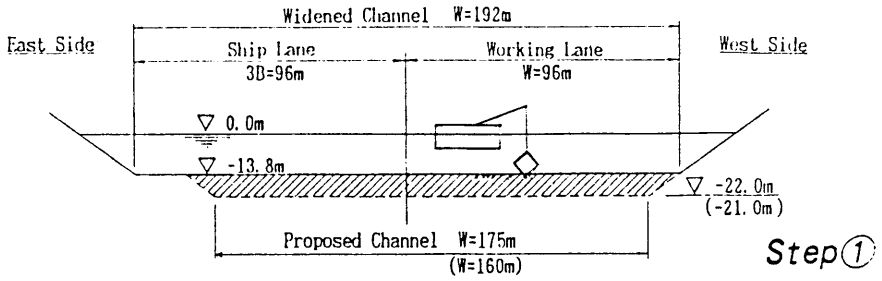
Step 1: Dredging of clayey materials and loose materials using a grab dredger ($50m^3$) and transportation by split barges ($5,000m^3$ each).

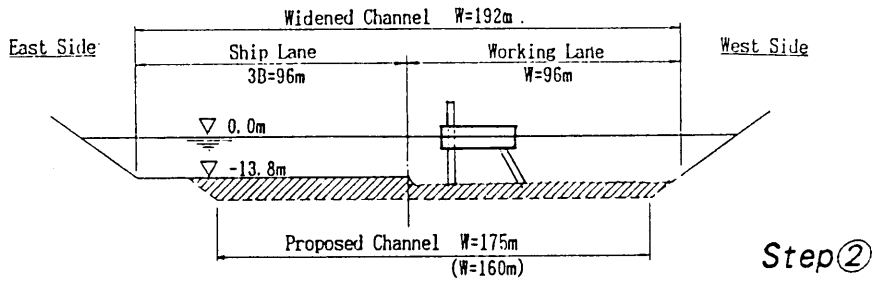
Step 2: Dredging of soft rock using a cutter suction dredger (27,500 HP) and transportation by split barges ($5,000m^3$ each).

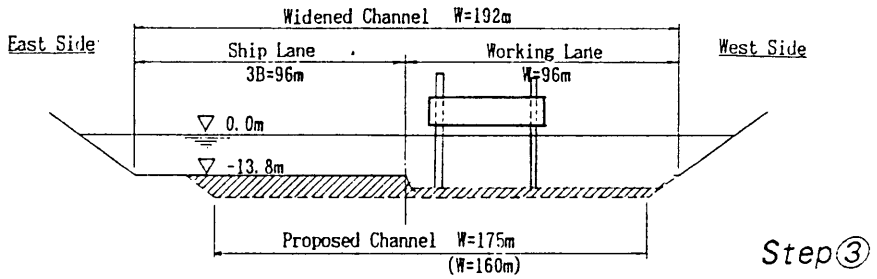
Step 3: Drilling and blasting of remaining hard rock using a SEP (self elevating platform) and dredging of blasted rock using a grab dredger ($50m^3$) for transportation by split barges ($5,000m^3$ each).

Upon completion of dredging in the western half, the ship lane will be moved to the western part. The eastern part of the canal can then be dredged in the same manner as the western part during the second stage of the work.

Stage-1







Stage-2

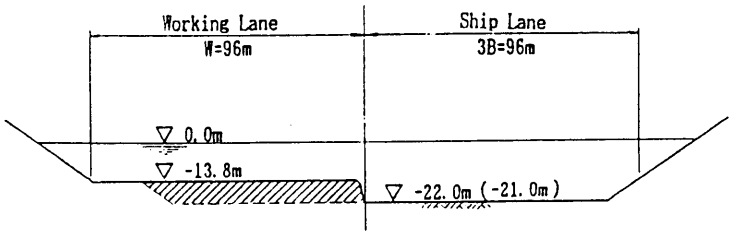


Fig. S-2 Method of dredging in Culebra Cut

3.4 Construction Plan

In addition to items already mentioned, the study of dredging in the Culebra Cut for Cases (5) and (6) arrived at the following conclusions:

(a) When taking the expected traffic volume into consideration, the productivity rates of the grab dredger, cutter suction dredger and drilling and blasting are reduced to 57%, 50 – 65% (depending on the type of rock) and 57% respectively of the full capacity, substantially affecting the work schedule and unit cost.

(b) For safety reasons, blasting is not possible when ship convoys are passing.

(c) A protective net should be in place during blasting work to prevent rocks from being deposited in the shipping lane. Side scans sonar surveys should be used to verify that the shipping lane is clear before ship transits recommence.

(d) The dredging fleet will consist of split barges, tug boat, pusher boat, grab dredger and/or cutter suction dredger, etc. and the actual combination will vary depending on the type of rock to be dealt with.

The construction schedule proposed in the Phase 2 FR has been revised in the light of the reduced excavation volume and reduced productivity. The length of the excavation work in Zone III has now been shortened from 6 years to 2 years and from 6 years to 4 years in the case of Zone IV. The total length of the construction work, however, has only been shortened from 10.5 years to 10 years (case (6)) only as the excavation work in other zones and both the civil and mechanical work relating to locks are the dominant factors in determining the total length of the construction work. The Construction Schedules are presented in Part II, Chapter 2.

4. Facilities Unaffected by Additional Canal Variations

The following facilities and items are unaffected by the variations of the High Rise Lock Canal and Sea Level Canal studied under the Additional Works. Proposals for these items therefore remain unchanged from the Phase 2 FR.

(a) Dams
(b) Barrier dams
(c) Pump stations
(d) Diversion scheme and freshwater barriers
(e) Breakwaters

5. Study Results

The facilities proposed for each of the additional canal variations studied as part of the Additional Works are listed in Table S-1.

Table S-1 Summary of the Additional Canal Variations (Year 2020)

Item	High Rise Lock Canal (85')		Sea Level Canal	
Case	(5)	(6)	(d)	(c)
Ship Size	150,000 DWT	200,000 DWT	250,000 DWT	
Canal Width (m)	160 320	175 350	190 380	
New Facilities				
Canal	2 lane canal with 1 lane Culebra Cut		1 lane canal and 2 lane approach	
Lock and Gate	third lane of locks (one lane of new locks)		1 lane tidal lock	1 lane, 2 tidal gates
Water Supply	n.a.	Indio	n.a.	
Pump Station (MCM)	n.a.			
Barrier Dam	n.a.		3	
Freshwater Barrier	n.a.		considered	
Diversion Scheme	n.a.		considered	
Crossing Bridges	2 places		3 places	
Breakwater	existing		new addition	

Note: n.a. not applicable

6. Comparison with Phase 2 FR Costs

New cost estimates have been prepared for for the additional canal variations studied under the Additional Work. In addition to the major cost adjustments for the excavation volumes and tidal locks, the extent of works for the drainage system, site clearing and canal slope protection have also been reduced.

The comparison results of the estimated costs of the Phase 2 FR and the additional study for various types of work are shown in Table S-2. The total project cost estimated in the Phase 2 FR has been reduced by 27% for Case (5) and 25% for Case (6) of the HRLC and by 19% for Case (d) and 15% for Case (e) of the SLC.

Table S-2 Comparative Cost Table

ITEMS	Unit	HIGH RISE LOCK ALTERNATIVES				SEA LEVEL CANAL ALTERNATIVES			
		Case(1)	Case(5)	Case(2)	Case(6)	Case(a)	Case(d)	Case(b)	Case(e)
		2020	2020	2020	2020	2020	2020	2020	2020
D. CONSTRUCTION COST									
1. Canal Excavation									
Total Canal Excavation	mill US$	3.012	1.593	3.477	1.893	6.244	6.244	7.373	5.900
2. Placing Area	mill US$	88	88	88	88	189	189	189	189
3. Lock & T. Gate structure	mill US$	991	855	1.127	971	2.037	504	429	429
4. Lock & T. Gate (Mechanical)									
-Gates Related	mill US$	889	889	1.011	1.011	950	316	738	738
5. New Dams									
a. Upper Gatun Dam (as regulating)	mill US$	-	-	-	-	-	-	-	-
b. Trinidad Dam (as regulating)	mill US$	-	-	-	-	-	-	-	-
c. Ciri Dam (as regulating)	mill US$	-	-	-	-	-	-	-	-
d. Indio Dam (as water source)	mill US$	-	-	237	237	-	-	-	-
6. Pumping Stations	mill US$	-	-	-	-	-	-	-	-
7. New Permanent Road	mill US$	9	9	9	9	19	19	19	19
8. Canal Crossings	mill US$	450	450	501	501	222	188	309	222
9. Barrier Dams	mill US$	-	-	-	-	494	494	494	494
10. Diversion Scheme	mill US$	-	-	-	-	75	75	75	75
11. Navigation Support System	mill US$	414	414	414	414	546	546	477	477
12. Breakwaters	mill US$	-	-	-	-	402	402	402	402
13. Supporting Construction	mill US$	425	291	425	291	574	481	574	481
14. Indirect Cost	mill US$	1.096	829	1.257	960	1.767	1.430	1.668	1.425
Total Project Cost	mill US$	7.374	5.418	8.546	6.375	13.519	10.888	12.747	10.851

7. Summation Table (1)

(File: Sum-1)

Alternatives		High Rise Lock Canal		SEA LEVEL CANAL	
I T E M S	Unit	Case (5)	Case (6)	Case (d)	Case (e)
		2020	2020	2020	2020
A. FEATURES OF ALTERNATIVES					
1. Design Ship	1000DWT	150	200	250	250
2. Route		I	I	10	10
3. Lake Level	ft	85	85	-	-
4. Number of Lift	no.	2	2	-	-
5. Canal Width	m	160, 320	175, 350	190	190
6. Approach Channel Width	m	320	350	190, 380	190, 380
7. Total Route Length	Km	84.1	87.6	88.4	86
- Pacific Approach	Km	14.3	17.5	25.1	22.7
- Channel	Km	55.7	55.7	60	60
- Atlantic Approach	Km	14.1	14.4	3.3	3.3
8. Channel Depth	m	21	22	24	24
B. WATER MANAGEMENT					
1.Abailable Water					
a. Average year	Mill M3	5,647	5,647	4,331	4,331
b. Dry year	Mill M3	3,951	3,952	3,148	3,148
2.Water Consumption for Existing Canal					
a. Ship Transits	no.	16,200	16,200	16,200	16,200
b. Water Volume Required	Mill M3	2,867	2,867	2,867	2,867
3.Water Consumption for New Lock					
a. Ship Transits	no.	2,000	2,000	-	-
b. Water Volume Required	Mill M3	1,014	1,201	-	-
4. Total Water Consumption: 2.b + 3.b	Mill M3	3,881	4,068	2,867	2,867
5. Available Freshwater (as barrier)					
a. Freshwater from Gatun Watershed	Mill M3	-	-	1,159	1,159
b. Freshwater from Outside Gatun	Mill M3	-	-	737	737
6. Countermesures to be taken					
a. Upper Gatun Dam (as regulating)	Mill M3	-	-	-	-
b. Trinidad Dam (as regulating)	Mill M3	-	-	-	-
c. Ciri Dam (as regulating)	Mill M3	-	-	-	-
d. Indio Dam (as water source)	Mill M3	-	591	-	-
e. Pumping Station	Mill M3	-	-	-	-
C. MAIN ELEMENTS OF ALTERNATIVES					
1. Lock & Gate					
(1) High Rise Lock					
a. Lock Chamber (LxWxD)	note*1	(A)	(B)	-	-
b. Gates					
- Max. Operating Gate Dimensions (BxH)	m	50x39.1	55x40.6	-	-
- Operating Gate Total Number(in pair)	nos.	6	6	-	-
- Operating Gate Total Weight	1000 ton	15.8	19.2	-	-
- Culvert Gate Number	nos.	18	18	-	-
- Culvert Gate Dimensions (BxH)	m	7.5x8.1	8.2x8.4	-	-
- Maintenance Gate (weight x number)	ton	5600 x 1	6700x1	-	-
- Emergency Gate (weightx number)	ton	2500 x 2	2950x2	-	-
c. Number of Mules	nos.	40	40	-	-
(2) Tidal Lock					
a. Lock Chamber (LxWxD)	m	-	-	(c)	-
b. Gates		-	-		-
- Operating Gate Dimensions (BxH)	m	-	-	60x30.6	-
- Operating Gate Total Number	nos.	-	-	2	-
- Operating Gate Total Weight	1000 ton	-	-	3.1	-
- Culvert Gate Number	nos.	-	-	4	-
- Culvert Gate Dimensions (BxH)	m	-	-	6.0x6.0	-
- Maintenance Gate Weight	1000 ton	-	-	7.4	-
c. Number of Mules	nos.	-	-	10	-
(3) Tidal Gate					
- Gate Dimensions (BxH)	m	-	-	-	190x27.5
- Gate Total Number	nos.	-	-	-	4
- Gate Total Weight	1000 ton	-	-	-	33.8
2. Barrier Dams (E),(F),(G)in Volume	mill M3	-	-	29	29
3. Canal Excavation					
- Dry Excavation	mill M3	91	100	948	951
- Dredging	mill M3	247	303	304	278
- Total Volume	mill M3	338	403	1,252	1,229
4. Diversion Scheme					
- Cofferdams	nos.	-	-	7	7
- Channels	km	-	-	39	39
5. Canal Crossing (Bridges)	place	2	2	3	3

Note*1:(A)=390x50x20, (B)=420x55x21.5, (C)=430x60x23

Summation Table (2)

(File: Sum-1)

I T E M S	Unit	High Rise Lock Canal		SEA LEVEL CANAL	
		Case (5) 2020	Case (6) 2020	Case (d) 2020	Case (e) 2020
Design Ship	1000DWT	150	200	250	250
Route		1	1	10	10
Lake Level	ft	85	85	-	-
6. New Roads	km	32	32	71	71
7. Breakwater	mill.m3			18	18
8. Navigation Support System					
a. Jetty for Small Boats	nos.	8	8	7	5
b. Berthing Dolphin	nos.	8	8	8	8
c. Navigation Bouy	set	74	74	78	78
d. Canal Lighting	set	60	60	786	786
e. Tug Boats					
- 6000 HP	nos.	23	23	16	10
- 3000 HP	nos.	2	2	9	7
D. CONSTRUCTION COST					
1. Canal Excavation	mill US$	1,593	1,893	6,244	5,900
2. Placing Area	mill US$	88	88	189	189
3. Lock & T. Gate structure	mill US$	855	971	504	429
4. Lock & T. Gate (Mechanical)					
-Gates Related	mill US$	889	1,011	316	738
5. New Dams					
a. Upper Gatun Dam (as regulating)	mill US$	-	-	-	-
b. Trinidad Dam (as regulating)	mill US$	-	-	-	-
c. Ciri Dam (as regulating)	mill US$	-	-	-	-
d. Indio Dam (as water source)	mill US$	-	237	-	-
6. Pumping Stations	mill US$	-	-	-	-
7. New Parmanent Road	mill US$	9	9	19	19
8. Canal Crossing	mill US$	450	501	188	222
9. Barrier Dams	mill US$	-	-	494	494
10. Diversion Scheme	mill US$	-	-	75	75
11. Navigation Support System	mill US$	414	414	546	477
12. Breakwater	mill US$	-	-	402	402
13. Supporting Construction	mill US$	291	291	481	481
14. Indirct Cost	mill US$	829	960	1,430	1,425
Total Project Cost	mill US$	5,418	6,375	10,888	10,851
E. O & M COST					
1. Electrical Power	mill US$	10.4	10.8	2.6	0.6
2. Man Power and Other O&M Costs	mill US$	103.9	112.2	154.6	144.3
3. Total O&M Cost	mill US$	114	123	157	145
F. CONSTRUCTION ASPECTS					
1. Adaptablity of Partial Construction	grade	Possible	Possible	Impossible	Impossible
2. Sufficiency of Engineering/Cost Data	grade	Fair	Fair	Poor	Poor
3. Interference by Existing Canal Operations	grade	Heavy	Heavy	Some	Some
4. Construction Period	year	10.0	10.0	15.0	15.0
G. IMPACT ON EXISTING SITUATION					
1. Impact on Existing Panama Canal					
a. Interference to Existing Canal Operations	grade	Considerable		Some	
b. Modification Works to Existing Panama Canal	grade	Minor		Minor	
2. Potential Environmental Impact					
a. Possible Gatun Lake Salinity Increase	grade	Same as SQ		Same as SQ	
b. Both Oceans Intermixing	grade	Same as SQ		Significant	
c. Ecologically Sensitive Areas	grade	Low		Medium	
3. Socioeconomic Impacts					
a. Relocation of Residents	grade	Small		Small	
b. Increased Work Opportunity	grade	Large		Large	

INTRODUCTION AND OBJECTIVES

INTRODUCTION AND OBJECTIVES

Chapter 1 - Introduction

1.1 Background and Objectives

Yachiyo Engineering Company Limited (YEC) was appointed as the Contractor for the Engineering and Cost Estimates Component Study (ECE Study) and has carried out the Study in two phases. The Phase 1 report was submitted in February 1992 and the Final Report for Phase 2 was submitted in April 1993.

At the Fourteenth Meeting of the Board of Commissioners of the Canal Alternatives Study (CAS) it was agreed that the ECE Contractor would be asked to carry out for Additional Work under Phase 2 to evaluate single lane options for both the High Rise Lock Canal and the Sea Level Canal.

Subsequently an Addendum to the Phase 2 Terms of Reference (TOR) was prepared by CAS (refer Attachment 4 of this Annex) and YEC submitted a proposal to the Japan International Cooperation Agency (JICA) to carry out the Additional Work. YEC was asked to proceed and this Annex to the Phase 2 Final Report has been prepared.

The objective of the Additional Work was to study and report on the additional variations set out in the Addendum to the Terms of Reference and to prepare construction plans and cost estimates. The additional work was carried out to a similar level of detail as the Phase 2 Study, but where work items were similar to those in the earlier Phase 2 Study then detailed descriptions have been omitted. The results are presented in a similar manner to that adopted for the Phase 2 Final Report to allow easy comparison with the earlier work.

The variations studied under the additional work are described in Chapter 2 below.

Chapter 2 - Study Alternatives for Additional Work

2.1 General

The alternative canal configurations to be studied under the additional work are presented in the TOR and are described in more detail below based on further clarification from CAS.

2.2 Variations of the High Rise Lock Canal (HRLC)

In Phase 2 the following alternatives for the High Rise Lock Canal were studied:

Case (1) : Design Ship 150,000 DWT, Gatun Lake at 85'
Case (2) : Design Ship 200,000 DWT, Gatun Lake at 85'
Case (3) : Design Ship 150,000 DWT, Gatun Lake at 90'
Case (4) : Design Ship 200,000 DWT, Gatun Lake at 90'

Under the additional works, further variations of the HRLC for 150,000 DWT and for 200,000 DWT design ships with a Gatun Lake level of 85' are studied. Whereas a two lane canal was adopted throughout for all variations of the High Rise Lock Canal considered in Phase 2, the variations considered in the additional works involve a single lane canal through the Culebra Cut section. The additional variations have been designated Case (5) and Case (6) and apart from the Culebra Cut width they are similar to Case (1) and Case (2) of the Phase 2 Final Report. The route, profile and excavation zones are shown in Fig. 2-1 (no change from Phase 2). The schematic layouts in Zones III and IV for the Phase 2 FR and the Additional Work are shown in Figs. 2-2 and 2-3 respectively. Further descriptions are given below:

(a) Engineering and Preliminary Design

- There is no widening of the Culebra Cut zone beyond the widening now being carried out by the Panama Canal Commission (630' on straight sections, up to 730' on curves).

- The Culebra Cut zone is defined as Zones III and IV from the Phase 2 Study. Refer to Fig. 2-1.

- The Culebra Cut zone is not widened but only deepened, to 21m for 150,000 DWT design ships [Case (5)] and to 22m for 200,000 DWT design ships [Case (6)].

- The deepening is required only over the width necessary to allow one way passage of the design ship. Using the one way width of 3.5 x (design ship beam) as adopted in Phase 2, the base width to be

deepened will be 160m for 150,000 DWT ships [Case (5)] and 175m for 200,000 DWT design ships [Case (6)]. See Part I, Chapter 1.1 of this Annex for more details.

- The assumed Gatun Lake level is 85'.

- Excavation for the 4th lane of locks (ie. the 2nd lane of new locks) at both Gatun and Miraflores is not be included in the additional variations to be considered.

- Engineering, preliminary design, construction planning and cost estimates for the additional variations are required for the year 2020 only and the cost of widening the canal and locks at a later date will not be considered.

- The number of canal crossings is the same as adopted in the Phase 2 Study.

- In other respects, features are unchanged from the Phase 2 Study.

(b) Construction Planning and Costing

- The highest priority must be given to maintaining canal traffic without disruption during construction. Brief closure of Culebra Cut to navigation may only be considered during underwater excavation by blasting.

- Barges hauling excavated material should use the working lane (not the navigation lane) as much as possible unless the barges need to pass the work area. In this case the barges may use the navigation channel traveling at not less than 6.5 knots.

- The dredging equipment may use the navigation channel if necessary when long distance removal of the dredging equipment from one site to another is required.

- The cost of completing a single lane Culebra should be broken down into year by year expenditure.

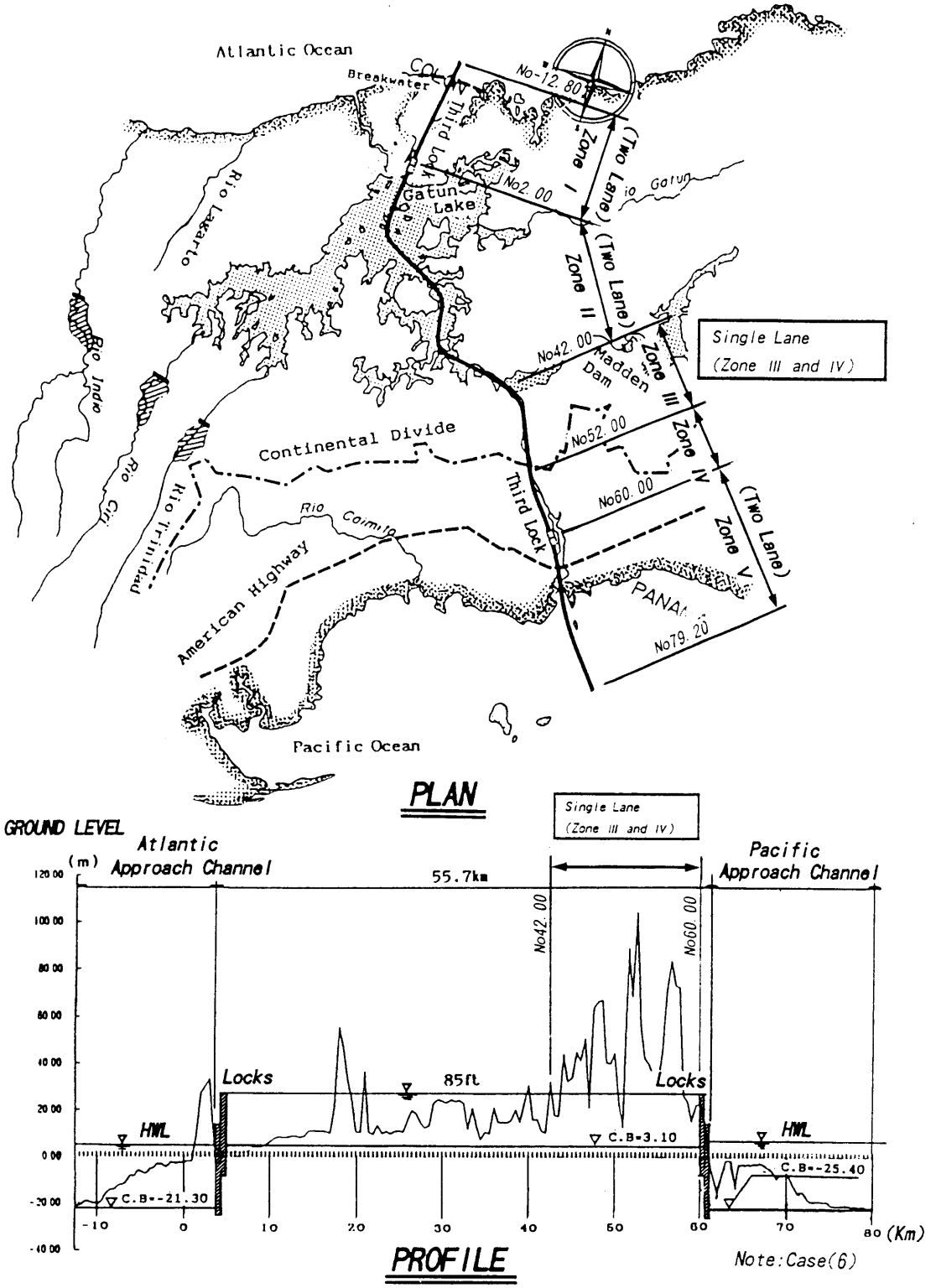


Fig. 2-1 Layout of HRLC Variations (Case (6) - 200,000 DWT)
(Case (5) - 150,000 DWT similar except for canal bottom levels)

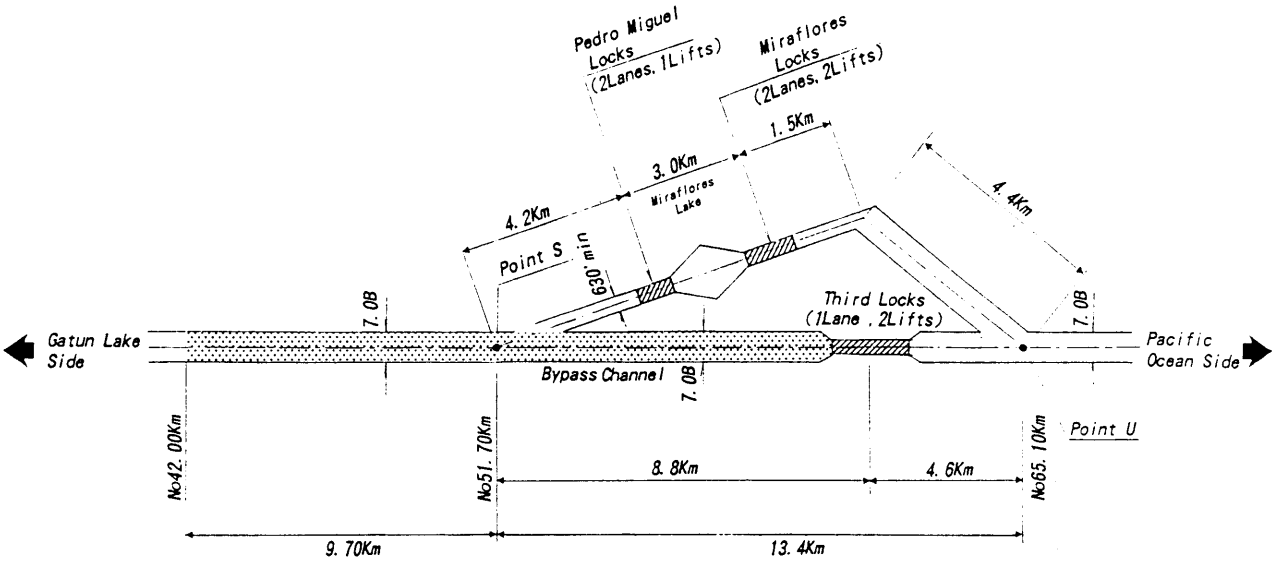


Fig. 2-2 HRLC - Layout of Zone III and Zone IV in Phase 2 FR

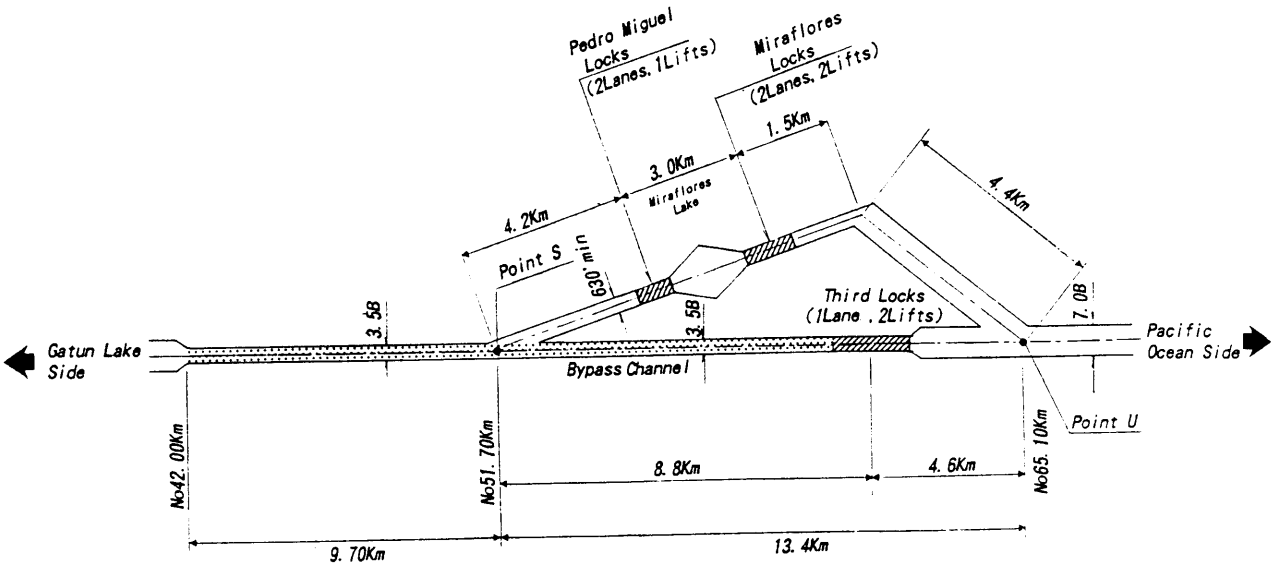


Fig. 2-3 HRLC - Layout of Zone III and Zone IV in Phase 2 Additional Work

2.3 Variations of the Sea Level Canal (SLC)

In Phase 2 the following 250,000 DWT alternatives were studied for the Sea Level Canal:

Case (a) : Single lane canal with 2 lane approaches. Tidal locks on the Pacific side (3 lanes with the option of adding a 4th lane later).

Case (b) : Single lane canal with 2 lane approaches. Tidal gates (1 lane) on both the Pacific and Atlantic sides.

Case (c) : Single lane canal with 2 lane approaches. Tidal locks on the Pacific side, as in Case (a), plus a tidal gate (1 lane) on the Atlantic side.

Under the additional works, further variations of Case (a) and Case (b) of the SLC have been studied. As a variation of Case (a), single lane tidal locks are considered [Case (d)]. As a variation of Case (b) a single lane Atlantic approach channel between the coast line and the Atlantic tidal gate is considered [Case (e)]. The route, profile and excavation zones are shown in Fig. 2–4 (no change from Phase 2). The schematic layout of the Pacific tidal locks in Case (a) and Case (d) are shown in Fig. 2–5 and the schematic layouts of the Atlantic approach in Case (b) and Case (e) are shown in Fig. 2–6. Further descriptions are given below:

- Case (d) – Pacific tidal locks:
  - The tidal locks have a single lane (chamber) only, and excavation for the additional lock chambers will not be included.
  - The widening at the lock approaches shall be reduced appropriately.
- Case (e) – A pair of tidal gates:
  - The Atlantic approach channel between the coast line and the Atlantic tidal gate is a single lane channel.
  - A transition zone over an appropriate length shall be provided at the Atlantic coast.
  - Proposals are required for the year 2020 only. The cost for later expansion to three tidal locks for Case (d) and to a two lane Atlantic approach for Case (e) will not be estimated.
  - The number of canal crossing is the same as adopted in the Phase 2 Study, but the crossing lengths are adjusted as required to suit the reduced channel and lock widths.
  - In other respects, features are unchanged from the Phase 2 Study.

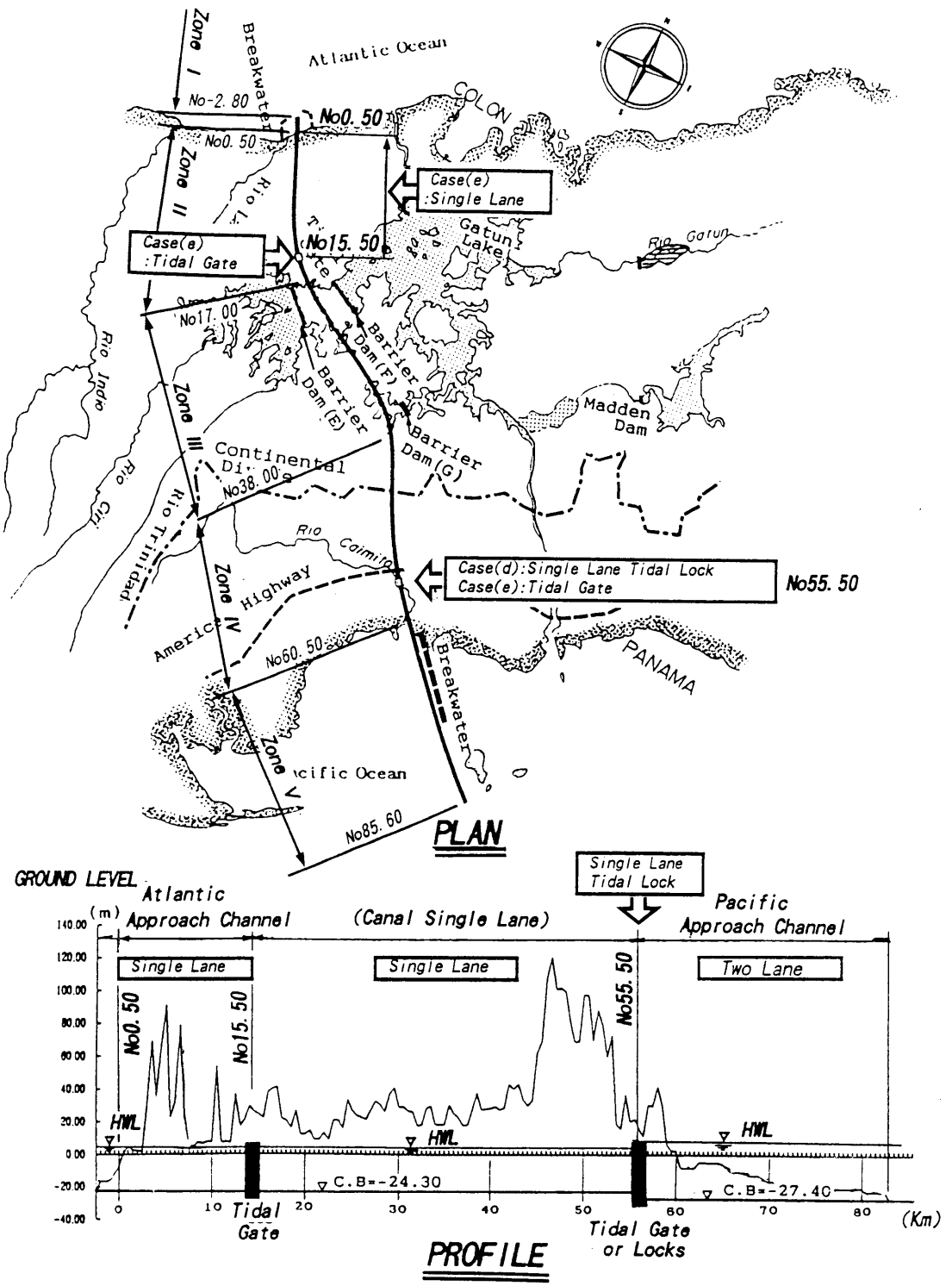


Fig. 2-4 Layout of SLC Variations [Case (d) and Case (e)]

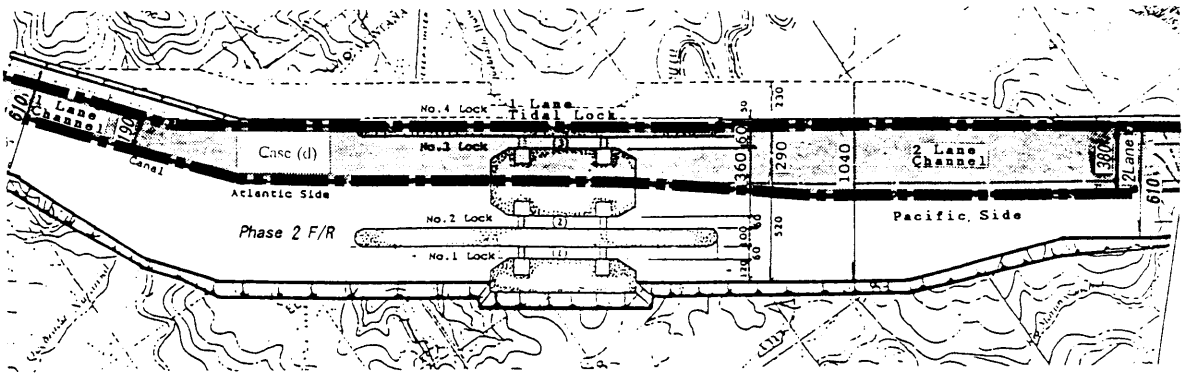


Fig. 2-5 SLC - Layout of Tidal Lock Modifications - Cases (a) and (d)

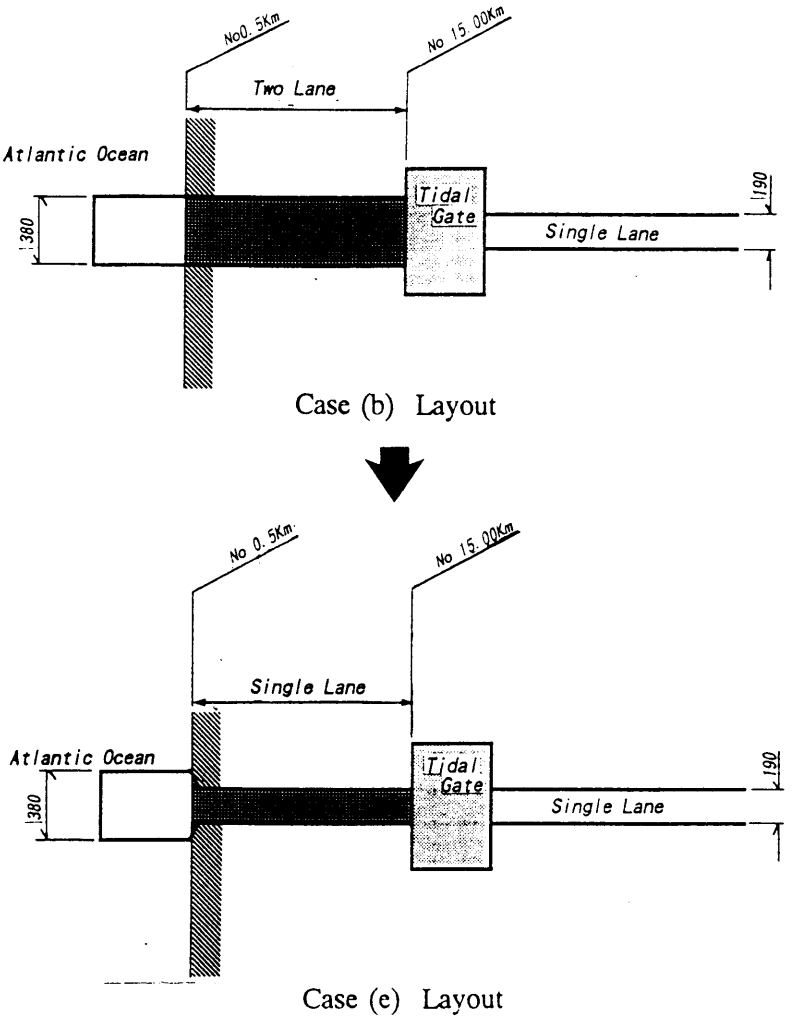


Fig. 2-6 SLC - Layout of Atlantic Approach - Cases (b) and (e)

Chapter 3 – Terms of Reference

An Addendum to the Phase 2 Terms of Reference was prepared to define the Additional Works and a copy is included as Attachment 4 to this Annex.

PART I : Engineering and Preliminary Design

PART I ENGINEERING AND PRELIMINARY DESIGN

I. Chapter 1 - Basic Engineering Criteria

The basic engineering criteria adopted for the additional work are the same as those for the Phase 2 FR. Therefore, only the most basic issues are described here.

1.1 Design Ships

The ship sizes to be adopted for the alternative studies are 150,000 DWT and 200,000 DWT for the High Rise Lock alternatives and 250,000 DWT for the Route 10 Sea Level Canal alternatives as shown in Table I.1-1 below.

Table I.1-1 Design Ship Dimensions

Ship Size (DWT)	Ship Dimensions (m)		
	Length	Beam	Draft
65,000	295	32	12
150,000	306	46	18
200,000	333	50	19
250,000	356	54	21

1.2 Canal Cross-Section

In the Phase 2 additional work, both the High Rise Lock Canal (HRLC) and Sea Level Canal (SLC) have a mixture of single and double lanes. In the case of the HRLC which caters for design ship sizes of 150,000 DWT and 200,000 DWT, the Culebra Cut Section has a single lane while other sections have two lanes. In the case of the SLC which caters for a design ship size of 250,000 DWT, the approach section has two lanes and other sections have a single lane.

As in the case of the Phase 2 FR, the following formulas are used to determine the channel width.

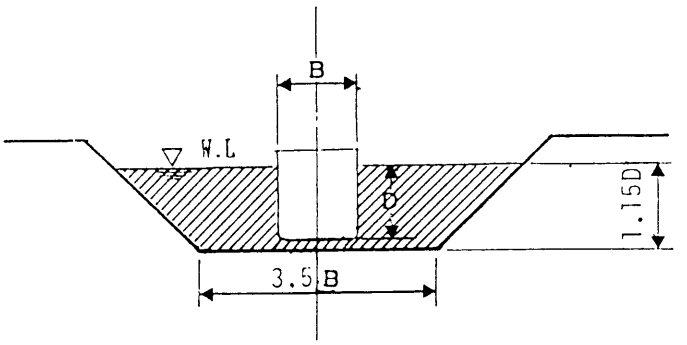
Width at Base = Ws = 3.5 B (single lane canal)
Wd = 7.0 B (two lanes canal)
Depth = 1.15 D;

Where B and D are the beam and draft respectively of the design ship.

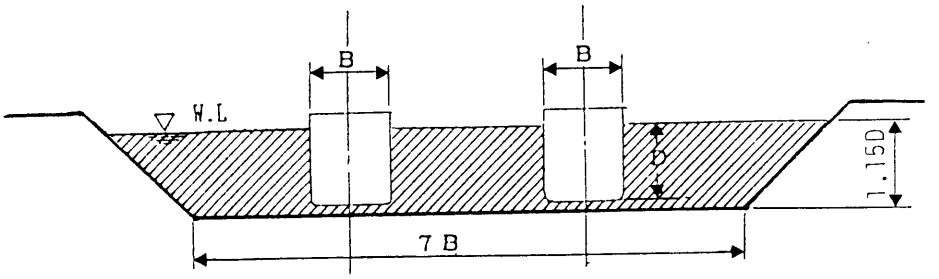
Using the above formulas, the required cross-section dimensions have been calculated and slightly rounded off. The resulting dimensions are given in the following Table I.1-2 and Fig. I.1-1.

Table I.1-2 Canal Cross-Section Dimensions

Ship Size	HRLC		SLC
	150,000 DWT	200,000 DWT	250,000 DWT
Width (m)	160 (1-way) 320 (2-ways)	175 (1-way) 350 (2-ways)	190 (1-way) 380 (2-ways)
Depth (m)	21	22	24



(a) One-Way



(b) Two-Way

Fig. I.1-1 Typical Canal Sections

I. Chapter 2 - Excavation Volumes

2.1 General

The excavation volume of the channel is calculated for 3 cases: Case (5) (150,000 DWT) and Case (6) (200,000 DWT) for the High Rise Lock Canal and Case (c) for the Sea Level Canal.

2.2 Cross-Section Preparation

As for Phase 2, marine charts were used to calculate the expected excavation volume at the Gatun Lake Sections because of their better accuracy compared to the topographical maps (scale: 1/25,000) used for the similar calculation for dry excavation. The shape of the excavation slope is the same as that adopted in the Phase 2 FR. The cross-section was determined at 0.5 km intervals for calculation of the excavation volume.

2.3 Excavation Volumes

The excavation volume was determined for dredging and dry excavation, each of which were classified in accordance with such categories as common rock, weathered rock, earth and clayey material. The classification results are shown in Table I.2-1. Graphic representations of dredging and dry excavation volumes for all cases are shown in Fig. I.2-1 while the excavation volume for each zone is shown in Figs. I.2-2 and I.2-3.

2.3.1 High Rise Lock Canal: Case (5) and Case (6)

Two lane traffic was proposed for all zones in the Phase 2 FR. In contrast, the Additional Works consider a single lane for the 18 km section in Zone III and Zone IV, leaving other zones with two lanes. Under this proposal, the widened canal (minimum width of 192m) of the ongoing Culebra Cut Widening Project in Zone III of the existing canal will be dredged over a channel width of 160m with an average depth of 7m in Case (5) or a channel width of 175m with an average depth of 8m for Case (6).

2.3.2 Sea Level Canal: Case (e)

The channel width of the 15.00 km section from the Atlantic shoreline (Station No. 0.50 km) to the Tidal Gate (Station No. 15.00 km) is reduced in Case (e) to a single lane (190m) instead of the lanes (380m) adopted in the Phase 2 FR.

Table I.2-1 Excavation Volumes

High Rise Look Canal 150.000 DWT. 85'. 1Lane (Zone III, IV) Case (5)

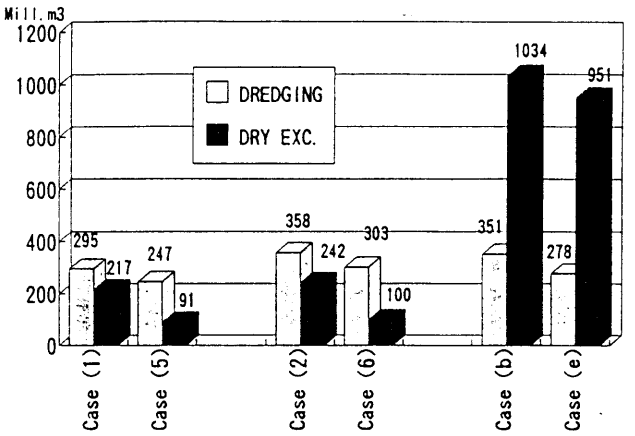
ZONES	STATION	Dry Excavation (1000m3)				Dredging (1000m3)				
		Rock	Weathered	Earth	Total	Rock	Weathered	Loose M.	Clayey M.	Total
I	-12.50 - 2.00	0	195	127	322	52	23.510	16.189	6.862	46.613
II	2.00 - 42.00	5.677	6.373	904	12.954	14.592	37.268	35.526	34.480	121.866
III	42.00 - 52.00	0	0	0	0	2.047	4.044	3.232	2.382	11.705
IV	52.00 - 60.00	34.939	33.797	7.800	76.536	225	76	20	24	345
V	60.00 - 76.00	290	383	104	777	326	30.569	21.241	13.955	66.091
Total	88.50	40.906	40.747	8.935	90.589	17.242	95.466	76.208	57.703	246.620

High Rise Look Canal 200.000 DWT. 85'. 1Lan e (Zone III, IV) Case (6)

ZONES	STATION	Dry Excavation (1000m3)				Dredging (1000m3)				
		Rock	Weathered	Earth	Total	Rock	Weathered	Loose M.	Clayey M.	Total
I	-12.80 - 2.00	0	217	141	358	58	27.194	18.687	7.908	53.847
II	2.00 - 42.00	6.291	7.000	996	14.288	17.344	43.667	42.097	42.856	145.964
III	42.00 - 52.00	0	0	0	0	2.752	5.192	3.765	2.725	14.434
IV	52.00 - 60.00	38.198	37.389	8.659	84.245	269	87	33	25	414
V	60.00 - 79.20	346	458	124	929	376	36.917	27.907	23.027	88.227
Total	92.00	44.836	45.064	9.921	99.820	20.799	113.056	92.489	76.542	302.886

Sea Level Canal Route 10. 250.000 DWT Case (e)

ZONES	STATION	Dry Excavation (1000m3)				Dredging (1000m3)				
		Rock	Weathered	Earth	Total	Rock	Weathered	Loose M.	Clayey M.	Total
I	-2.80 - 0.50	0	0	0	0	0	2.242	5.163	8.857	16.262
II	0.50 - 17.00	51.419	89.409	15.755	156.584	40.486	28.698	18.104	0	87.288
III	17.00 - 38.00	68.196	117.992	23.229	209.416	0	10.386	6.612	7.755	24.754
IV	38.50 - 60.50	173.005	370.149	41.419	584.573	13.979	30.946	7.657	0	52.582
V	60.50 - 83.20	0	0	0	0	0	26.820	32.824	37.546	97.190
Total	86.00	292.620	577.550	80.403	950.574	54.465	99.093	70.360	54.158	278.075



Figs. I.2-1 Excavation Volume for Each Case

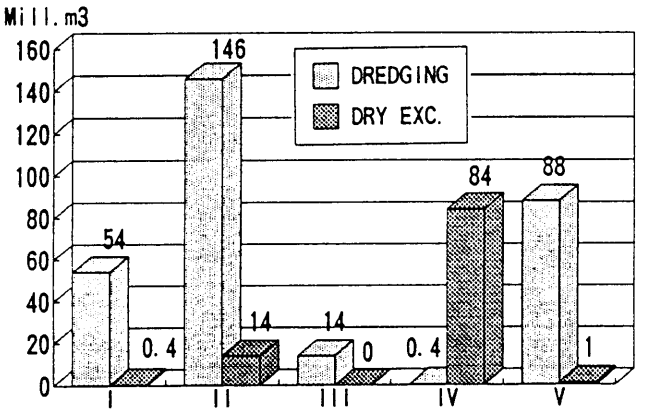


Fig. 1.2-2 Excavation Volume for Each Zone - HRLC Case (6)

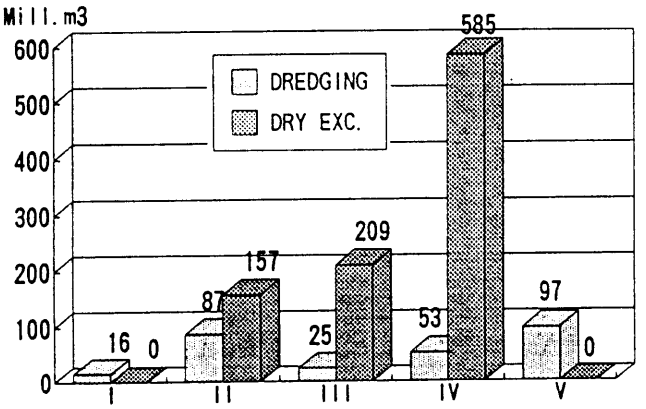


Fig. 1.2-3 Excavation Volume for Each Zone - SLC Case (e)

I. Chapter 3 - Transportation Plan

3.1 High Rise Lock Canal - Cases (5) and (6)

Proposals for improvements and modifications to the existing road network are not affected and remain the same as in the Phase 2 Final Report.

For the year 2020, two additional bridge crossings were recommended in the Phase 2 FR. One bridge (2 lane) was recommended for the Atlantic side near Gatun and another bridge (4 lane) was recommended for the Pacific side since the main span of the existing Bridge of the Americas would not provide the required clearance. The canal layout at these bridge locations does not change for either Case (5) or Case (6) compared to the Phase 2 FR, so no change is required to the previous proposals and cost estimates.

3.2 Sea Level Canal - Cases (d) and (e)

Proposals for improvements and modifications to the existing road network are not affected and remain the same as in the Phase 2 Final Report.

For the year 2020, three additional bridge crossings were recommended in the Phase 2 FR. The proposed bridges were at the Atlantic coast (2 lane), in the middle of the isthmus near Escobal (2 Lane), and on the Pacific side near the Pan American Highway and the autopista. The canal width at the crossing point on the Atlantic side is reduced for Case (e), and reducing the tidal locks to one lane in Case (d) reduces the cost of the Pacific side bridge.

The revised bridge span lengths required for the year 2020 are summarized in Table I.3-1 below. A typical elevation view is shown in Fig. I.3-1 and the location of the crossing points are shown in Fig. I.3-2.

Table I.3-1 SLC Cases (d) and (e) - Summary of Bridges

Sea Level Canal - Case (d)

No.	Location of Bridge	Canal Width	Bridge:		Main Spans Bridge Length (m)				Approach Length
		(m)	Lanes (No.)	Width (m)	L	L1	L2	L3	L4
⑧	Atlantic	190	2	10.0	430	250	90	90	600
⑦	Escobal Rd.	190	2	10.0	630	350	140	140	600
⑤	Pan American	190	4	20.5	220	120	50	50	600

Sea Level Canal - Case (e)

No.	Location of Bridge	Canal Width	Bridge:		Main Spans Bridge Length (m)				Approach Length
		(m)	Lanes (No.)	Width (m)	L	L1	L2	L3	L4
⑧	Atlantic	190	2	10.0	430	250	90	90	600
⑦	Escobal Rd.	190	2	10.0	630	350	140	140	600
⑤	Pan American	190	4	20.5	430	250	90	90	600

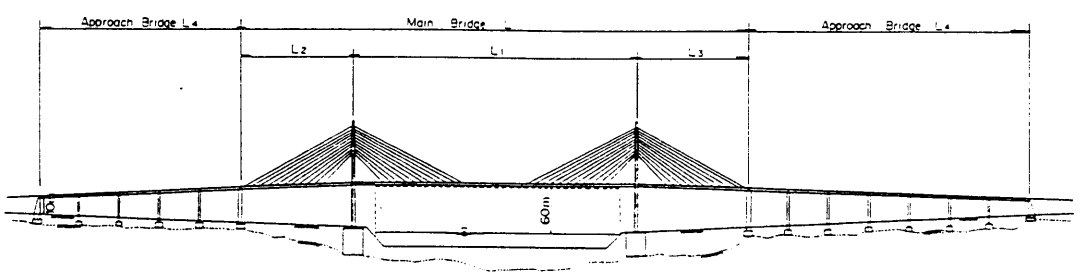


Fig. I.3-1 Typical Elevation for Canal Bridges

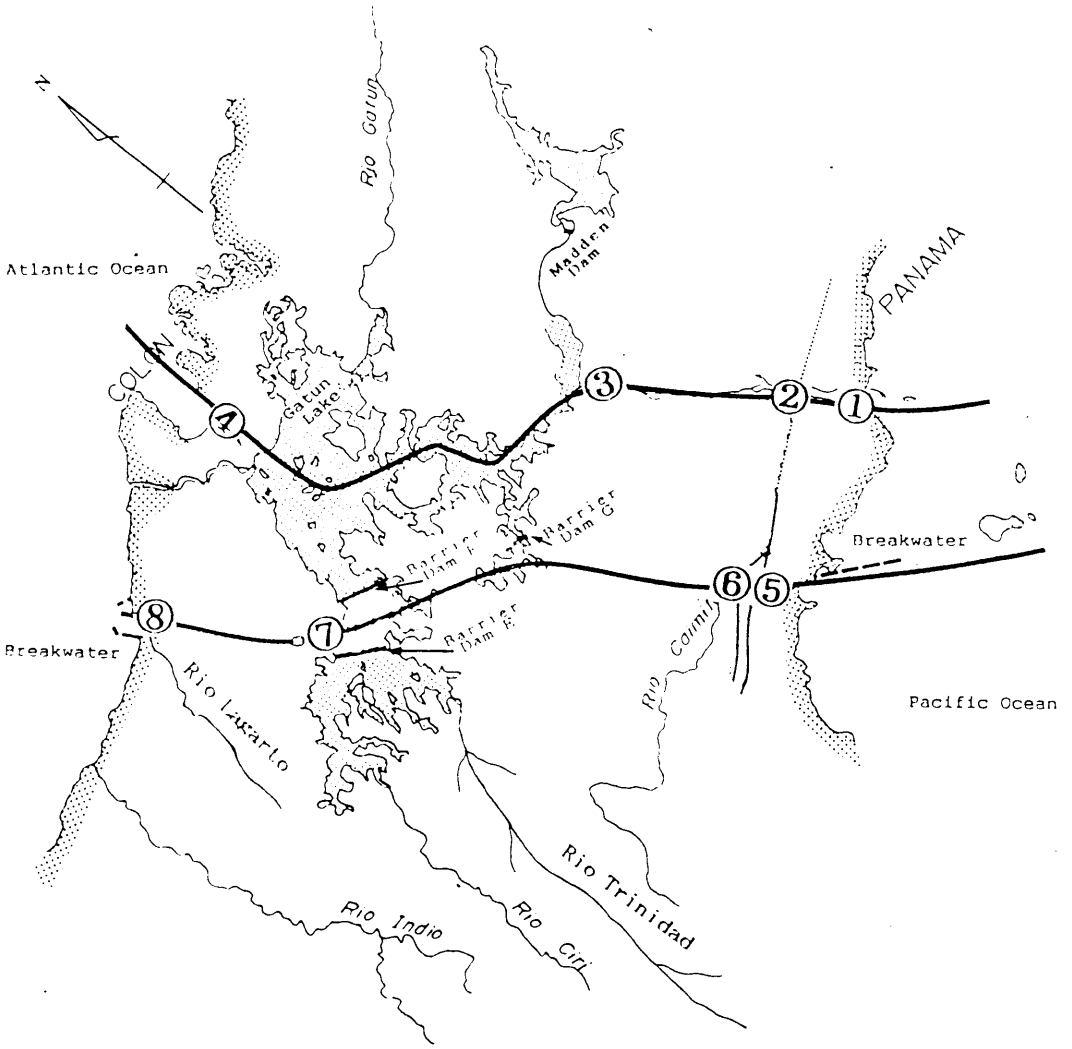


Fig. I.3-2 Canal Crossing Locations

PART II : Construction Plan for Culera Cut Zone

PART II CONSTRUCTION PLAN

II. Chapter 1 - Canal Excavation (Zone III)

1.1 General

This construction plan is for a single lane in the Culebra Cut Zone. It is designed for 150,000 DWT and 200,000 DWT vessels. The main focus of the construction plan is detailed examination of the dredging work.

(1) High Rise Lock Canal, Single Lane Culebra Cut Option, Case-(5), 150,000 DWT, Rise 85' (in year 2020)

(2) High Rise Lock Canal, Single Lane Culebra Cut Option, Case-(6), 200,000 DWT, Rise 85' (in year 2020)

Mandatory condition:
During the construction period, the dredging and other works must not interfere with the passage of Panamax vessels (65,000 DWT) through the existing canal.

1.2 Required Width of Single Lane for Ship Transit

The minimum lane width for ship transit will be determined as follows:

According to the attached copy from Port Engineering (Third Edition, Gulf Publishing Company) by Per Bruun (*1), it is necessary to consider the following three factors in determining the channel width (W) that must be maintained to ensure the safe transit of vessels.

(*1) see Attachment 1

In the case of a single lane, W is calculated as follows:

$$W = (a) + 2(c)$$

But, for the purpose of the dredging work, dredging vessels must also be taken into consideration so it should be calculated as:

$$W = (a) + (b) + (c)$$

(a): Width of maneuvering lane

(b): Width of ship clearance lane (for passing vessels)

If the ship clearance lane is too small, suction forces will arise as a result of the fast flow between vessels and may cause them to collide.

(c): Minimum bank clearance required for safe transit

(a) is determined by referring to Table II.1-1 on the following page. According to the Japan Association for Preventing Marine Accidents, there are still some vessels of the Panamax size whose controllability is not very good though the controllability of vessels has greatly improved in recent years. So, it would be difficult to select the "Very Good" classification in Table II.1-1 for the controllability even if the ship's navigator is very experienced. In consideration of the long period of the dredging work and ship safety, it is felt that "Good" is appropriate in this case.

(a) = 1.8B

where B is the vessel's beam

Table II.1-1 Maneuvering Lane Width

Controllability	Width Factor*
Very good	1.6
Good	1.8
Poor	2.2

*Times vessel beam

Regarding the determination of a safe ship clearance, transitting vessels are most likely to come close to the drilling rig used for underwater blasting. If the drilling rig is the SEP (Self Elevating Platform) type that is considered for the dredging work, then it can be thought of as a fixed structure. So, (b) is considered to be the same as the safe bank clearance (c).

The safe bank clearance (c) can be taken as 60% of the beam of the design vessel, despite the fact that vessels will transit at more than 5 knots, (refer to "width of bank clearance" in Attachment 1) because of the calm water conditions in the Culebra Cut and the great experience of ships' navigators.

Thus:

(b) = 0.6B

(c) = 0.6B

The minimum required width for the ship lane is therefore calculated as follows:

W = 1.8B + 0.6B + 0.6B = 3.0B

In the case of Panamax vessels, (B) is 32.0 meters. Therefore:

W = 3.0B = 3.0 x 32.0 = 96.0 m

Different parts of the world have their own standards for the safe width of a single lane vessel channel. The value of the standard varies with vessel size. The major ones are listed in Table II.1-2 below.

Table II.1-2 Channel Width Standards

Country/Organization	W/B	Remarks
Japan	3.8	Japan Ports Association Technical Standards for Port Facilities
U.K.	4~6	BS 6349
PIANC	3~4	Permanent International Association of Navigation Congresses
PCC (Directive)	4.8	Existing (152m/32m)
PCC (Directive)	2.74	Temporary (88m/32m) (*2)
Suez Canal	3.0	Existing
Suez Canal	2.6~2.7	Future expansion (*3)

(*2) see Attachment 2
(*3) see Attachment 3

The Suez Canal has set W/B at 2.7 in its future dredging plans. Even with such a low W/B, vessels should still be able to transit safely because of the gentle slope of the canal banks, which varies between 1:3 and 1:4. In the case of the Panama Canal, a W/B of 3.0 is the minimum required to ensure safe vessel transit because the banks have been given a slope of 1:1 in order to reduce the excavation volume. Considering the values in Table II.1-2 above, setting W/B at 3.0 is thought to be appropriate.

1.3 Basic Conditions

(1) Minimum required width for vessel transit

As mentioned in Paragraph 1.2, a suitable minimum required width for vessel transit can be calculated as follows:

$$W = 3.0B$$

Where (W) is the minimum required width in meters and (B) the vessel beam in meters.

(2) Canal cross section and vessel dimensions

The initial conditions are determined to be those of the canal cross section after the Culebra Cut Widening Project has been completed.

Canal:	Canal width:	192.0 m
	Water depth:	13.8 m
Vessel:	65,000 DWT (Panamax)	
	Length:	295.0 m
	Beam:	32.0 m
	Depth:	12.0 m

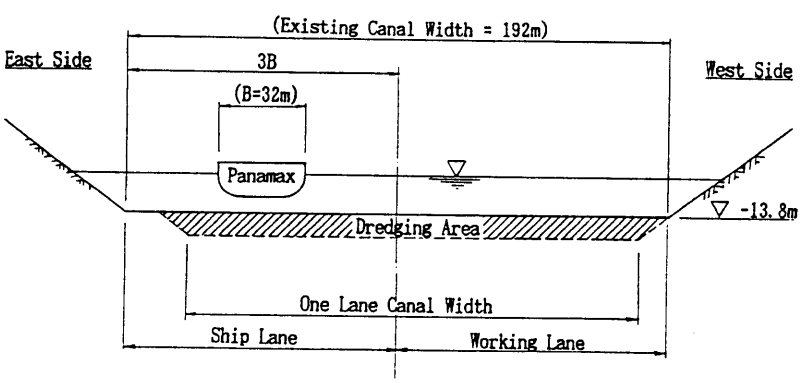


Fig.II.1-1 Lane Width

(3) Transit projection

The number of vessels transitting the canal during the construction period is estimated at 50/day on average.

No. of vessels transitting per year: 18,350

Ave. No. of vessels transitting per day: 50

Table II.1-3 Transit Projection for the Year 2020 (File:TRANSIT)

Canal DWT	Load Condition and Direction		Ship Size Range (DWT) 0 to 21,999	25,000 to 65,000	25,000 to 149,999	25,000 to 200,000	Total
No Major Improvements (65,000DWT)	Ballast	North	379	664	---	---	1,043
		South	1,431	360	---	---	1,791
	Laden	North	4,397	3,287	---	---	7,684
		South	3,427	4,405	---	---	7,832
	Total	North	4,776	3,951	---	---	8,727
		South	4,858	4,765	---	---	9,623
	Grand Total		9,634	8,716	---	---	18,350
New High Rise Locks (150,000DWT)	Ballast	North	374	---	703	---	1,077
		South	1,424	---	334	---	1,758
	Laden	North	4,398	---	2,956	---	7,354
		South	3,427	---	4,532	---	7,959
	Total	North	4,772	---	3,659	---	8,431
		South	4,851	---	4,866	---	9,717
	Grand Total		9,623	---	8,525	---	18,148
New High Rise Locks (200,000DWT)	Ballast	North	374	---	---	709	1,083
		South	1,424	---	---	334	1,758
	Laden	North	4,398	---	---	2,953	7,351
		South	3,427	---	---	4,561	7,988
	Total	North	4,772	---	---	3,662	8,434
		South	4,851	---	---	4,895	9,746
	Grand Total		9,623	---	---	8,557	18,180

(Data from WEFA and TAMS Interim report)

(4) Location of placing areas

The locations of placing areas will be the same as those in the Final Report.

(5) Excavation in Culebra Cut (Zone III)

1) Excavation in the Culebra Cut is carried out by dredging. Dredging depths are shown in Table II.1-4.

Table II.1-4 Dredging Depths in Culebra Cut

(Unit: m)

	Existing Canal	Single Lane Option	
	65,000 DWT	Case-(5) 150,000 DWT	Case-(6) 200,000 DWT
Canal Width	192.0	160.0	175.0
Canal Depth	13.8	21.0	22.0
Dreding Depth	---	7.2	8.2

2) Dredging space

The required width for the operation of dredging equipment in the single lane Culebra Cut Option (Case-5,6) is half that of the existing canal (192 m). The required lane width for the transit of vessels is 96 meters (3.0B) so the other 96 meters may be used for the dredging works.

1.4 Dredging Procedure

(1) Dredging sequence

The dredging is carried out according to the following sequence so that Panamax transit is not adversely affected in any way.

1) (Stage-1) Dredging west half of canal bed

The dredging of the west half of the canal bed is carried out first. The 96 meters (3.0B) of the east half will be used for the transit of Panamax. The dredging equipment, consisting of dredger, split barge, tug boat, pusher boat, etc, will operate in the 96 meter wide west half of the canal. Panamax will thus be reduced to single lane traffic with vessels passing through the Culebra Cut in convoys at fixed times.

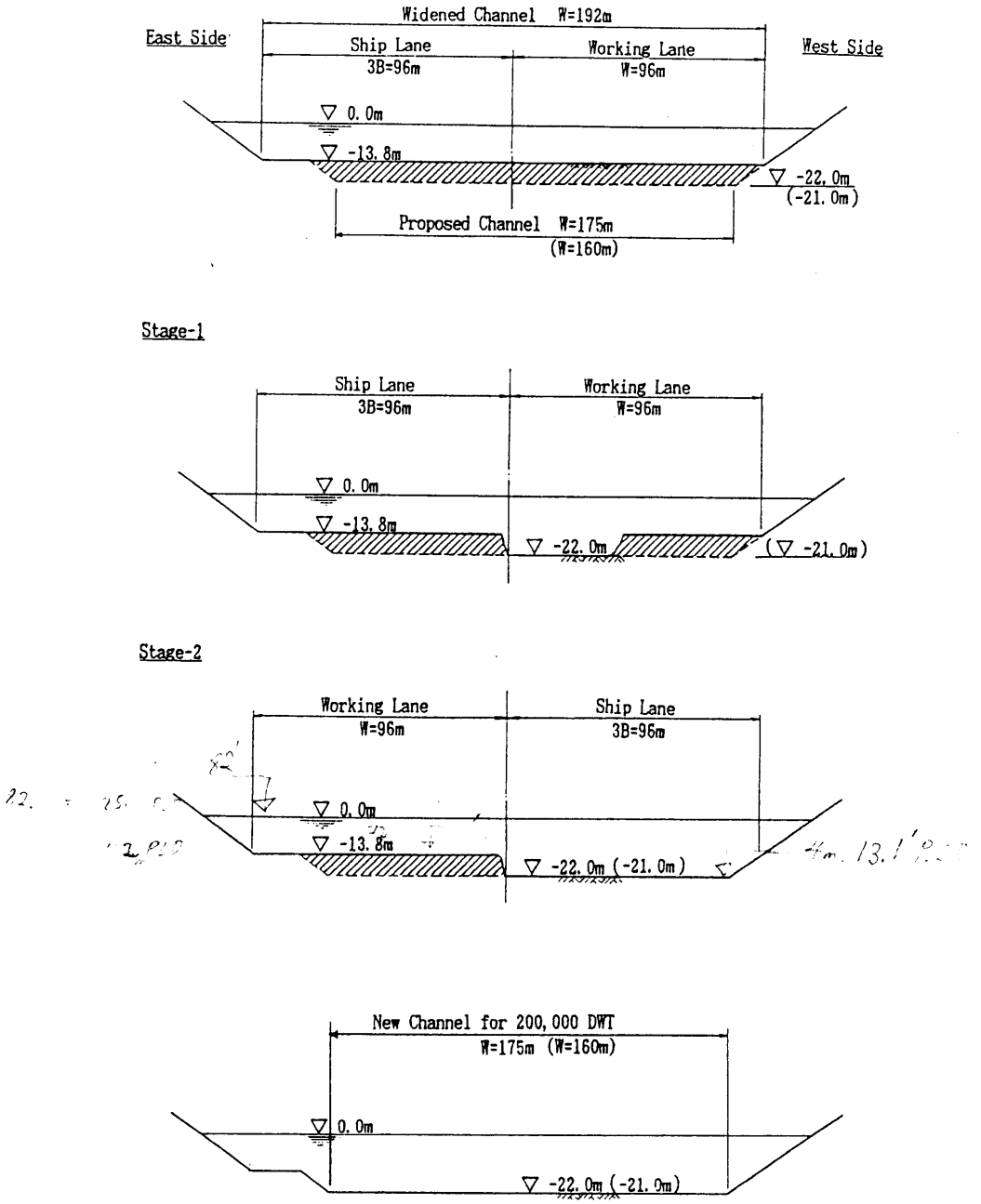
Any soft clay encountered in the canal bed will be excavated by grab dredger and loaded on to split barges for disposal at the placing areas in Gatun Lake. Any sandy clay, stiff, hard clay or soft rock will be excavated using a cutter suction dredger and loaded on to split barges for disposal.

Cutter suction dredgers cannot be used for the excavation of hard rock. Such material will be excavated by means of drilling and blasting from an SEP (Self Elevating Platform) and then dredged by grab dredger. Dredged material will be loaded on to split barges for disposal.

2) (Stage-2) Dredging east half of canal bed

After completing the dredging of the 13.8 meter deep, 96 meter wide channel on the west side, the Panamax lane will be switched to the west side and the dredging of the east half of the canal bed carried out. The dredging sequence will be the same as for Stage-1, selecting equipment according to the soil conditions as before.

The above dredging operations can be carried out, with the transit of Panamax confined to one lane, as long as a canal width of 192 meter is available.



( ): 150,000 DWT Option

Fig.II.1-2 Dredging Sequence

(2) Maximum possible size of dredging equipment and its location

The dredging equipment to be operated in the 96 meter wide working area will be selected on the basis of maximum economy of operation. In this, equipment size as well as the relation of equipment location to the ship lane and equipment working range will be considered. It will also be necessary to consider how the curtailment of operation time by the transit of vessels will affect efficiency.

The composition of dredging equipment units will be the same as in the Phase 2 Final Report.

1) Grab dredger

If a grab dredger with spuds is employed, there is no need to drop anchor in the lane kept for vessel transit, so dredging operations can be continued even when vessels are in transit. As the lane width available to dredgers is about 110 meters(bed width + slope width), a large grab dredger can be used, which will make the dredging more economical to carry out. A 50 cubic meter grab dredger with spuds will therefore be used for the work.

However, grab dredgers will be rocked by tracking waves from convoys of large vessels passing through the ship lane, endangering their operation. So, the operation of dredgers must be suspended while a convoy is passing.

Split barges may cross into the ship lane to pass areas where dredging is in progress but not when a convoy is passing through it.

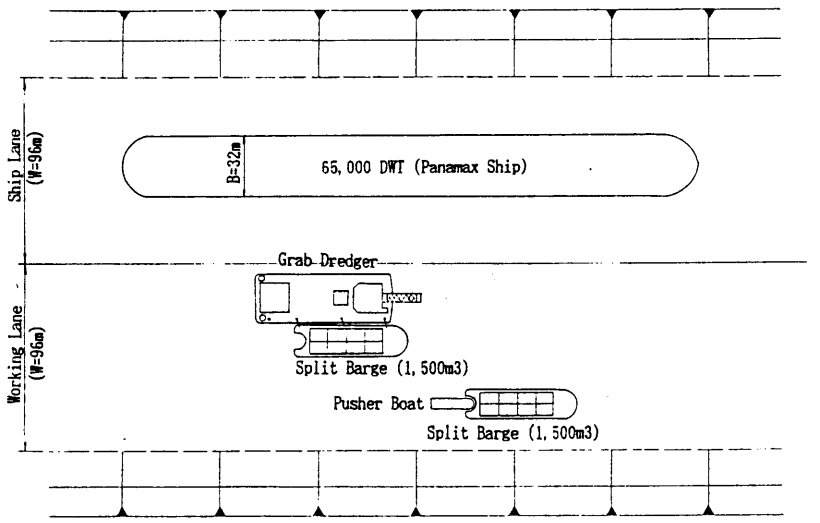


Fig.II.1-3 Location of Grab Dredger during Dredging

2) Cutter suction dredger

As the width of the dredging space is 110 meters, a large cutter suction dredger is required to carry out the dredging in a single swing. If the rock excavation is to be done as much as possible by means of cutter suction dredgers, the largest size of equipment available must be considered.

As shown in Fig.II.1-4, the dredger should be positioned close to the ship lane to prevent its hull hitting the canal side when excavating the slope portion. As the anchor wire has to be swung into the ship lane, dredging operations must be suspended while large vessels are passing. If the stand-by time is very long, the use of smaller equipment may reduce dredging costs because they are much less subject to suspension.

However, in most cases, costs will increase as the shorter swing will mean that the dredging has to be carried out in two swings.

In consideration of weathered rock and medium, hard rock excavation, a 27,500 H.P. cutter suction dredger will be employed.

The locations of cutter suction dredger and anchors during dredging are shown in Fig.II.1-4.
In the case of vessels of less than 10,000 DWT, while there is sufficient depth below them during their transit through the Culebra Cut to anchor the cutter suction dredger, dredging must be suspended during the transit of a convoy of vessels larger than this.

Split barges are to be used for transporting excavated material when the placing area is more than 2 kilometers away. So the restrictions on split barge movement mentioned above will apply to them.

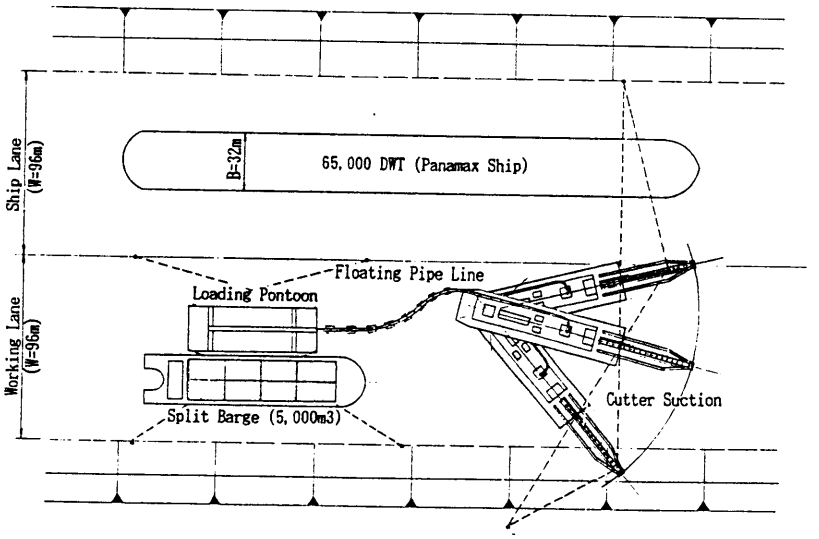


Fig.II.1-4(a) Location of Cutter Suction Dredger during Dredging

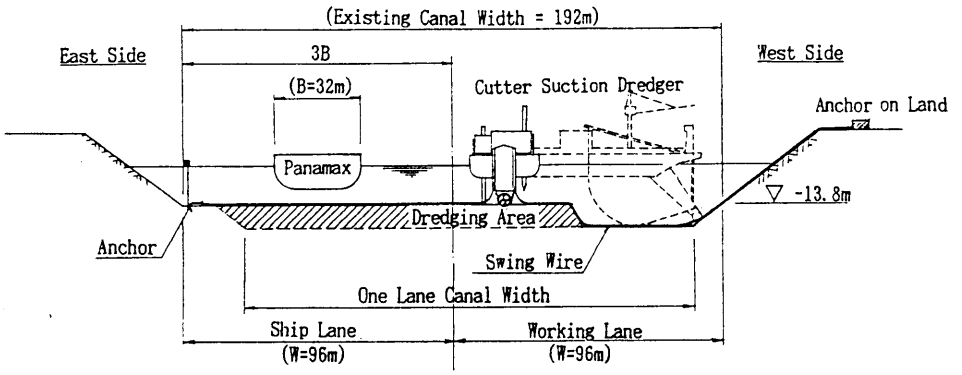


Fig.II.1-4(b) Sectional View of Dredging by Cutter Suction Dredger

3) Drilling and blasting rig

As the drilling and blasting rig has spuds, drilling can be carried out even during the transit of vessels in the ship lane. As there is a working space of 110 meters, the largest type of drilling and blasting rig may be used for greater economy. An SEP (Self Elevating Platform) type will be employed.

When drilling, the platform is jacked up. Being unaffected by ship tracking waves, there will be no need for it to stop drilling when convoys are passing.

Blasting cannot be carried out when there are vessels in the ship lane. But, it may be done in the intervals between convoys. Including preparation, the total time required for blasting will be around four (4) hours. Vessels will pass through Zone III in the daytime. It will be necessary to make a convoy timetable as shown in Fig.II.1-7(a) in which blasting is scheduled in the evening after all convoys have passed through.

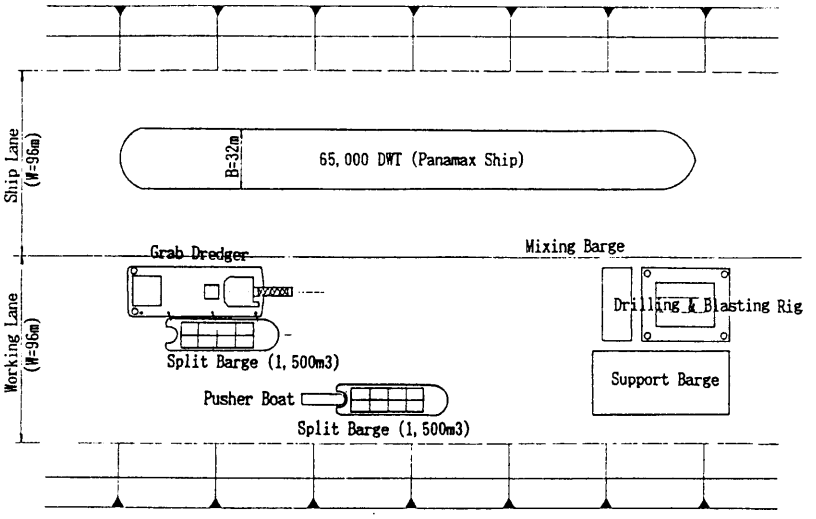
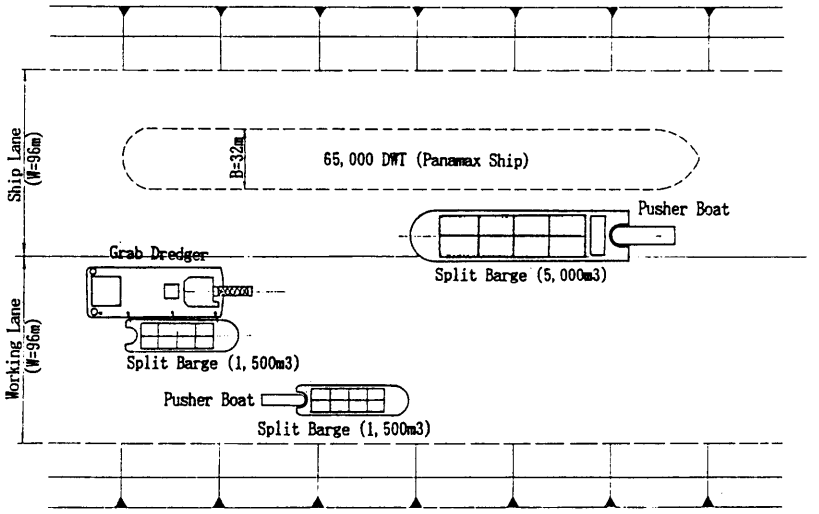


Fig.II.1-5 Location of Drilling & Blasting Rig during Dredging

4) Split barge

Split barges used for soil disposal operate in the working lane. However, they may have to go into the ship lane as shown in Fig.II.1-6 to pass areas where dredging is being carried out. In such cases, they will have to wait for any convoys in the ship lane to pass.



Note: Split barges may go into the ship lane to pass areas where dredging is in progress but only when there are no vessels in it.

Fig.II.1-6 Split Barge Movement

(3) Blasting safety measures

Because more explosive is required per cubic meter of rock in underwater blasting, a large pressure wave will be produced. Detonation with delays will be employed to reduce the pressure wave.

For safety reasons, no ships will be allowed to pass during blasting or while explosive charges are being connected up because of the danger of miss fires. In addition, a net will be installed between the working and ship lanes to prevent rock flying into the ship lane. Immediately after blasting, a side scan survey will be performed to make sure that there is no rock obstructing the ship lane. Once this has been done, it will be opened to traffic again.

As mentioned previously, the estimated time required for the whole blasting operation is around four (4) hours. As there will be an interval of more than four hours between convoys, blasting may be scheduled in the time between transits.

(4) Dredging efficiency

1) Time available for dredging

The effect of vessel transit on dredging operations will be examined based on a transit projection (by vessel size) for the year 2020 (Table II.1-3).

According to this projection, a total of 18,350 vessels is expected to transit the Panama Canal annually in the year 2020; 8,730 vessels Atlantic-bound and 9,620 Pacific-bound. This translates to 50 vessels/day; 24 Atlantic-bound and 26 Pacific-bound.

In the case of the Suez Canal, around 12 minutes was required for each ship in a convoy to pass the dredging area. Based on this, the total time taken by all convoys to pass the area of dredging operations in this case is ten (10) hours per day; 4.8 hours for Atlantic-bound vessels and 5.2 hours for Pacific-bound vessels.

This data will be used to examine the effect of vessel transit on dredging operations.

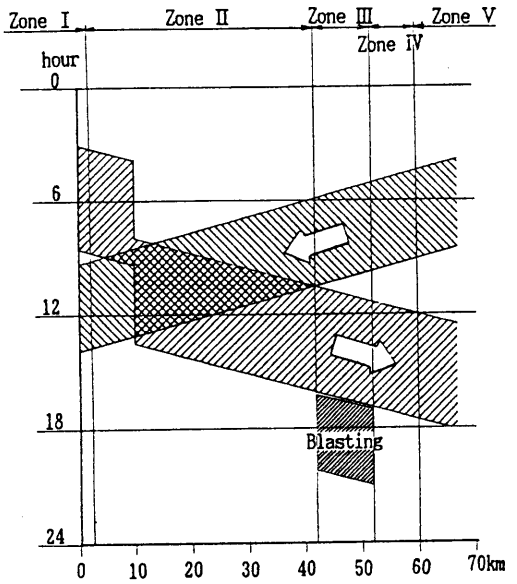


Fig.II.1-7(a) Convoy Transit Time

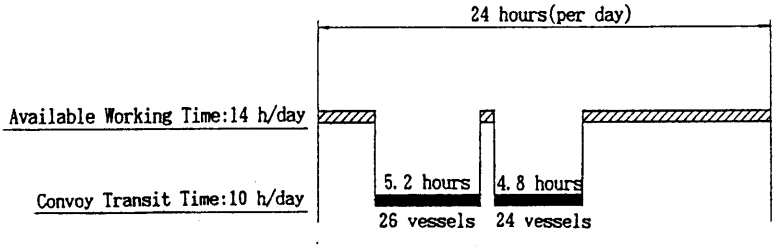


Fig.II.1-7(b) Culebra Cut (Zone III, 10 km)
- Convoy Transit Time, Available Working Time (Av. hours/day)

2) Operation hours/efficiency

a) Grab dredger

If maintenance on dredging equipment is carried out during the transit of convoys, the available operating time is 14 hours/day.

However, on average, a total of two hours is lost in the intervals between the transits of Atlantic and Pacific-bound convoys bringing the available time down to 12 hours. If full efficiency (100%) is taken as 18 hours a day, the efficiency of the grab dredger is 67%.

b) Cutter suction dredger

As above, allowing for the transit of convoys when equipment cannot work, the available working time is 14 hours. If this is taken as 12 hours, for the same reason as above, the efficiency of the cutter suction dredger is 60% for loose material and weathered rock, for which full efficiency is taken as 20 hours/day, and 75% for hard and medium rock, for which full efficiency is taken as 16 hours.

c) Drilling and blasting barge

There is no drop in efficiency because drilling and blasting barges are not affected by the transit of convoys.

d) Split barge

Because split barges have to wait until convoys have passed to use the ship lane in order to pass areas where dredging is in progress, there will be a further loss in operation time.

Vessels will require about one hour to pass through the 10 km of the Culebra Cut, if they are assumed to be moving at seven knots. In consideration of this, it is estimated that the split barge will cause a further 10% drop in the efficiency of dredging equipment as follows:

- Grab dredger: 67-10 = 57%

- Cutter suction dredger: 60 to 75-10 = 50 to 65%

- Drilling and blasting rig: 67-10 = 57%
  (though the efficiency of the rig is 100% in principle, the requirement for using a grab dredger reduces it to 57%)

1.5 Dredging Equipment and Schedule

(1) Dredging equipment units

The dredging equipment units and annual productivities for each soil condition in the Culebra Cut (Zone III, 10 km) as well as the required dredging periods are shown in Table II.1-6.

(2) Required dredging period

The dredging periods for each Culebra Cut case have been determined as shown Table II.1-5 below.

Table II.1-5 Period for Dredging Culebra Cut

Case	Qty.	Required Time
Case-(5), 150,000DWT	11,705,000m^3	2 Years
Case-(6), 200,000DWT	14,434,000m^3	2 Years

(3) Dredging Schedule (Zone III)

1) Case-(5)

The dredging of the west half of the canal bed will be done first; then the east half.

The dredging schedule for Case-(5) has been planned as shown in Fig. II.1-8 below.

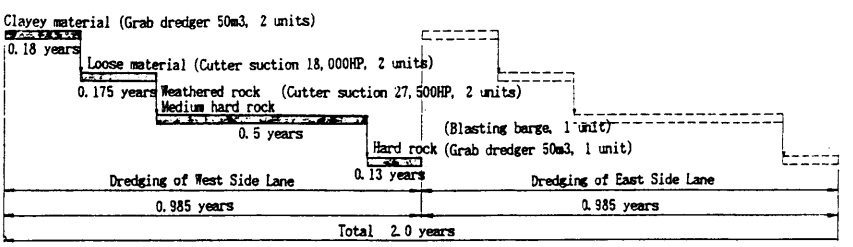


Fig. II.1-8 Dredging Schedule for Case-(5)

Two dredging units will be provided for the 10 km section.

2) Case-(6)

The dredging of the west half of the canal bed will be done first; then the east half.

In order to complete the dredging in two years, four dredging units will be provided at the peak period (around 1/2 a year).

However, there will be no mutual interference between dredging units in dredging or soil disposal operations.

The dredging schedule for Case-(6) has been planned as shown in Fig. II.1-9 below.

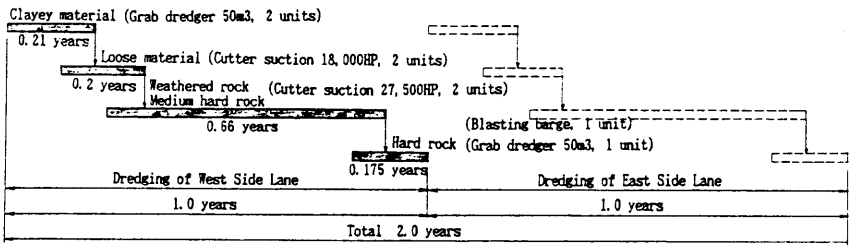


Fig. II.1-9 Dredging Schedule for Case-(6)

Table II.1-6 Dredging Scheme

HIGH RISE LOCK CANAL 150,000 & 200,000 DWT

(File:ZONE-III)

CLASSIFICATION	DESCRIPTION	UNIT	CASE (5) 150,000DWT ZONE-III	CASE (6) 200,000DWT ZONE-III	REMARKS
COMMON (CLAYEY)	Q'TY(m3)	m3	2,382,000	2,725,000	
	HAULING DISTANCE(km)	km	22.5	22.5	
	EQUIPMENT	group	2	2	
	GRAB(50m3)	fleet	2.0	2.0	
	SPLIT BARGE(5,000m3)	unit	6.0	6.0	
	PUSHER TUG(3,200HP)	unit	4.0	4.0	
	REQUIRED PERIOD	year	0.36	0.42	
	CAPACITY(m3/hr)	m3/hr	1,368	1,368	
	CAPACITY(m3/year)	m3/year	6,549,984	6,549,984	
COMMON (LOOSE)	Q'TY(m3)	m3	3,232,000	3,765,000	
	HAULING DISTANCE(km)	km	22.5	22.5	
	EQUIPMENT	group	2	2	
	CUTTER(18,000HP)	fleet	2.0	2.0	
	SPLIT BARGE(5,000m3)	unit	6.0	6.0	
	PUSHER TUG(3,200HP)	unit	4.0	4.0	
	REQUIRED PERIOD	year	0.35	0.40	
	CAPACITY(m3/hr)	m3/hr	1,755	1,755	
	CAPACITY(m3/year)	m3/year	9,336,600	9,336,600	
WEATHERED ROCK	Q'TY(m3)	m3	4,044,000	5,192,000	
	HAULING DISTANCE(km)	km	22.5	22.5	
	EQUIPMENT	group	2	2	
	CUTTER(27,500HP)	fleet	2.0	2.0	
	SPLIT BARGE(5,000m3)	unit	6.0	6.0	
	PUSHER TUG(3,200HP)	unit	4.0	4.0	
	REQUIRED PERIOD	year	0.56	0.72	
	CAPACITY(m3/hr)	m3/hr	1,350	1,350	
	CAPACITY(m3/year)	m3/year	7,182,000	7,182,000	
MEDIUM HARD ROCK	Q'TY(m3)	m3	1,842,000	2,477,000	
	HAULING DISTANCE(km)	km	22.5	22.5	
	EQUIPMENT	group	2	2	
	CUTTER(27,500HP)	fleet	2.0	2.0	
	SPLIT BARGE(5,000m3)	unit	4.0	4.0	
	PUSHER TUG(3,200HP)	unit	2.0	2.0	
	REQUIRED PERIOD	year	0.44	0.60	
	CAPACITY(m3/hr)	m3/hr	976	976	
	CAPACITY(m3/year)	m3/year	4,154,069	4,154,069	
HARD ROCK	Q'TY(m3)	m3	205,000	275,000	
	HAULING DISTANCE(km)	km	22.5	22.5	
	EQUIPMENT	group	1	1	
	BLASTING BARGE	fleet	1.0	1.0	
	GRAB(50m3)	fleet	1.0	1.0	
	SPLIT BARGE(1,500m3)	unit	3.0	3.0	
	PUSHER TUG(1,300HP)	unit	2.0	2.0	
	REQUIRED PERIOD	year	0.26	0.35	
	CAPACITY(m3/hr)	m3/hr	165	165	
	CAPACITY(m3/year)	m3/year	791,456	791,456	
TOTAL VOL. OF DREDGING		m3	11,705,000	14,434,000	
TOTAL OF REQUIRED YEARS		years	2	2	

II. Chapter 2 - Overall Schedule

2.1 Overall Schedule

(1) High Rise Lock Canal, Single Lane Culebra Cut Option Case-(5), 150,000 DWT, Rise 85' (in year 2020)

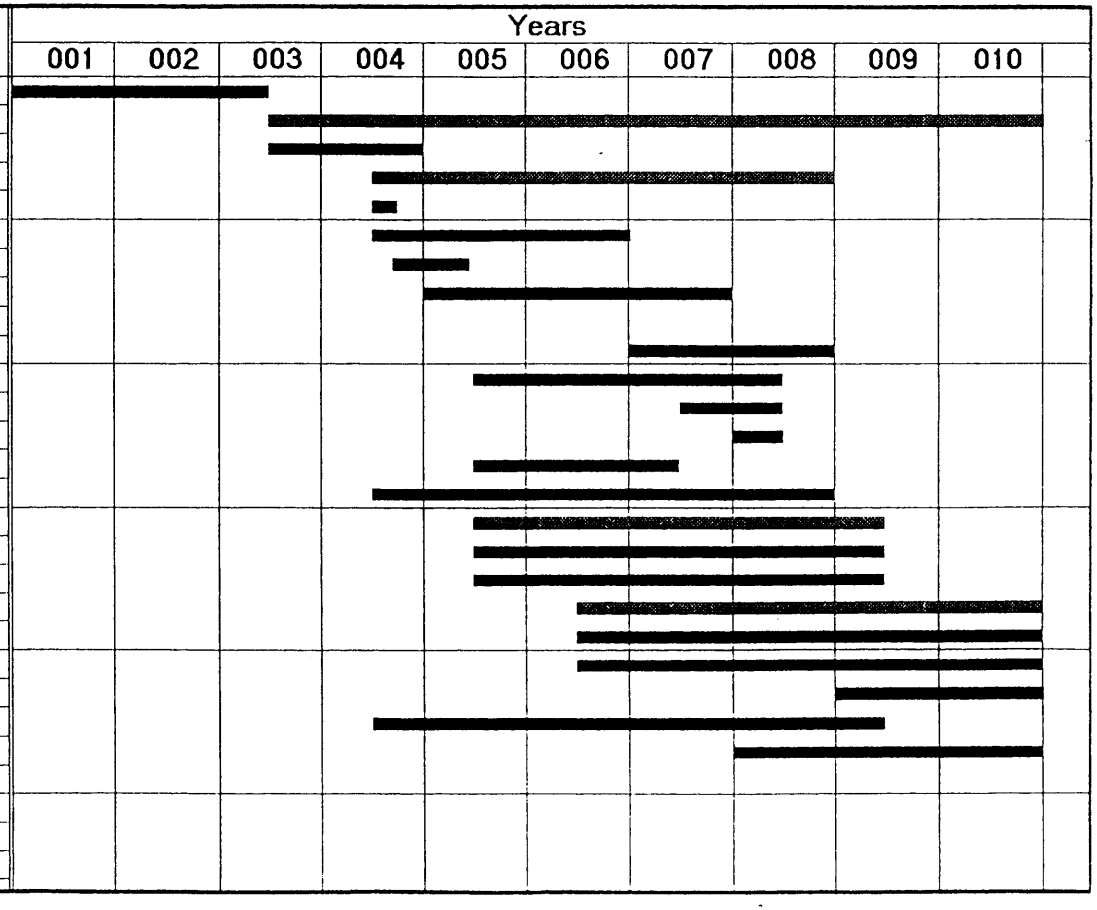
(2) High Rise Lock Canal, Single Lane Culebra Cut Option Case-(6), 200,000 DWT, Rise 85' (in year 2020)

(3) Sea Level Canal, Route 10 Single Lane in Tidal Lock on Pacific Side Case-(d), 250,000 DWT (in year 2020)

(4) Sea Level Canal, Route 10, Single Lane in Zone II Tidal Gates on Pacific & Atlantic Side Case-(e), 250,000 DWT (in year 2020)

Overall Work Schedule
HRLC, Single Lane Culebra Cut Option
Case-(5), 150,000 DWT, 85' (A.D. 2 020)

Task Name	Q'ty
Engineering,Design&Tender	
Construction	
Supporting construction	
Canal Excavation	
Zone I Dry Excavation	322,000m3
Zone I Dredging	46,613,000m3
Zone II Dry Excavation	12,954,000m3
Zone II Dredging	121,866,000m3
Zone III Dry Excavation	0m3
Zone III Dredging	11,705,000m3
Zone IV Dry Excavation	76,536,000m3
Zone IV Dredging	345,000m3
Zone V Dry Excavation	777,000m3
Zone V Dredging	66,093,000m3
Placing Area	22.5 km2
Lock Structure	
Atlantic Side	3,200,000m3
Pacific Side	3,200,000m3
Gate Leaves, etc.	
Atlantic Side	1 ls
Pacific Side	1 ls
New Permanent Road	32 km
Canal Crossing(Bridges)	2 Bridges
Navigation System	1 ls



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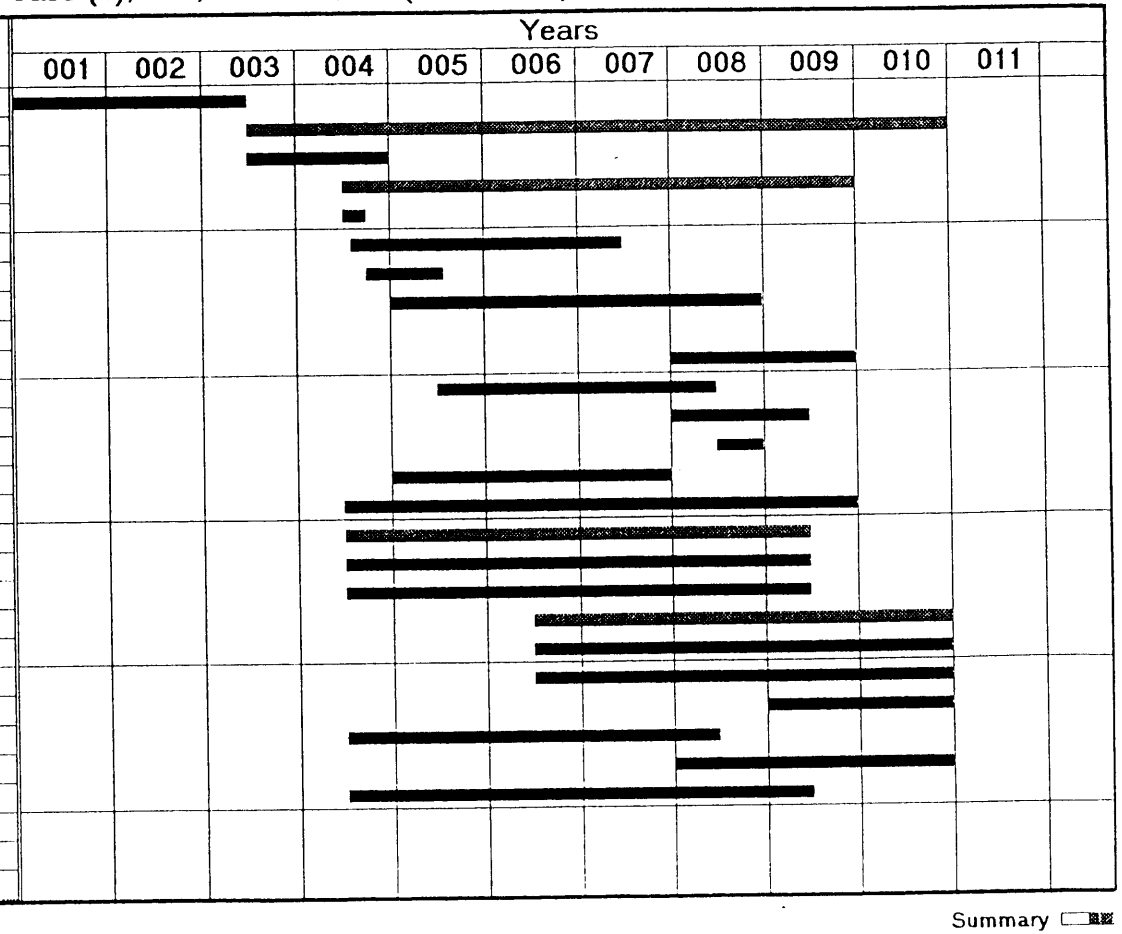
Page 1

Summary

Overall Work Schedule
HRLC, Single Lane Culebra Cut Option
Case-(6), 200,000 DWT, 85' (A.D. 2 020)

Task Name	Q'ty
Engineering,Design&Tender	
Construction	
Supporting construction	
Canal Excavation	
Zone I Dry Excavation	358,000m3
Zone I Dredging	53,847,000m3
Zone II Dry Excavation	14,287,000m3
Zone II Dredging	145,964,000m3
Zone III Dry Excavation	0m3
Zone III Dredging	14,434,000m3
Zone IV Dry Excavation	84,246,000m3
Zone IV Dredging	414,000m3
Zone V Dry Excavation	929,000m3
Zone V Dredging	88,227,000m3
Placing Area	22.5 km2
Lock Structure	
Atlantic Side	3,600,000m3
Pacific Side	3,600,000m3
Gate Leaves, etc.	
Atlantic Side	1 ls
Pacific Side	1 ls
New Permanent Road	32 km
Canal Crossing(Bridges)	2 Bridges
Navigation System	1 ls
New Dam	1 ls



Summary

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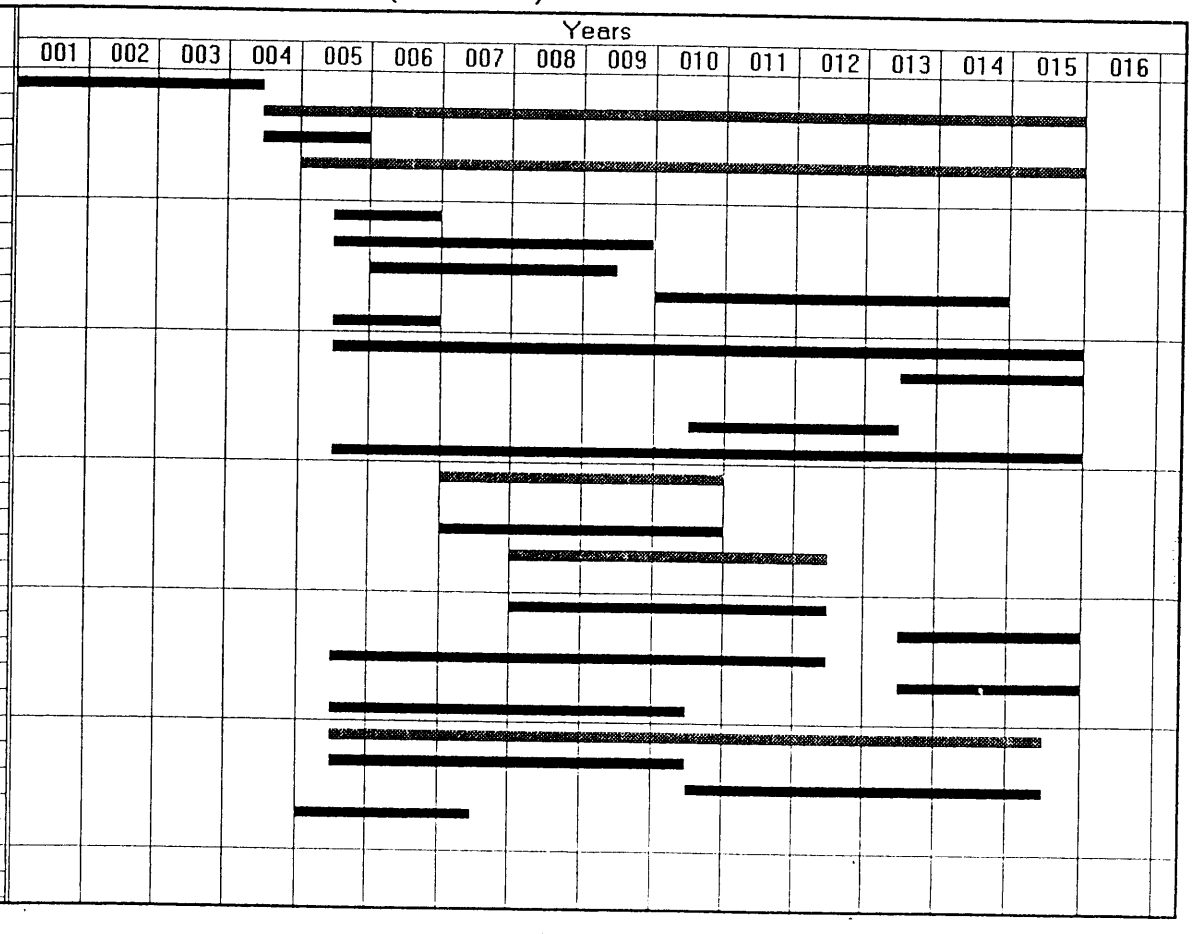
Overall Work Schedule
Sea Level Canel , Route 10, Case-(d)
250,000 DWT,(A.D. 2020)

Task Name	Q'ty
Engineering,Design&Tender	1 ls
Construction	
Supporting construction	1 ls
Canal Excavation	
Zone I Dry Excavation	0m3
Zone I Dredging	16,262,000m3
Zone II Dry Excavation	149,516,000m3
Zone II Dredging	84,939,000m3
Zone III Dry Excavation	209,417,000m3
Zone III Dredging	24,753,000m3
Zone IV Dry Excavation	589,204,000m3
Zone IV Dredging	57,369,000m3
Zone V Dry Excavation	0m3
Zone V Dredging	121,020,000m3
Placing Area	51.0 km2
Lock Structure	
Atlantic Side	0m3
Pacific Side	2,000,000m3
Gate Leaves, etc.	
Atlantic Side	
Pacific Side	1 ls
New Permanent Road	71 km
Canal Crossing(Bridges)	3 Bridges
Navigation System	1 ls
Barrier Dams E.F.G Dams	3 Dams
Breakwater	
Atlantic Side	1 ls
Pacific Side	1 ls
Diversion Scheme	1 ls



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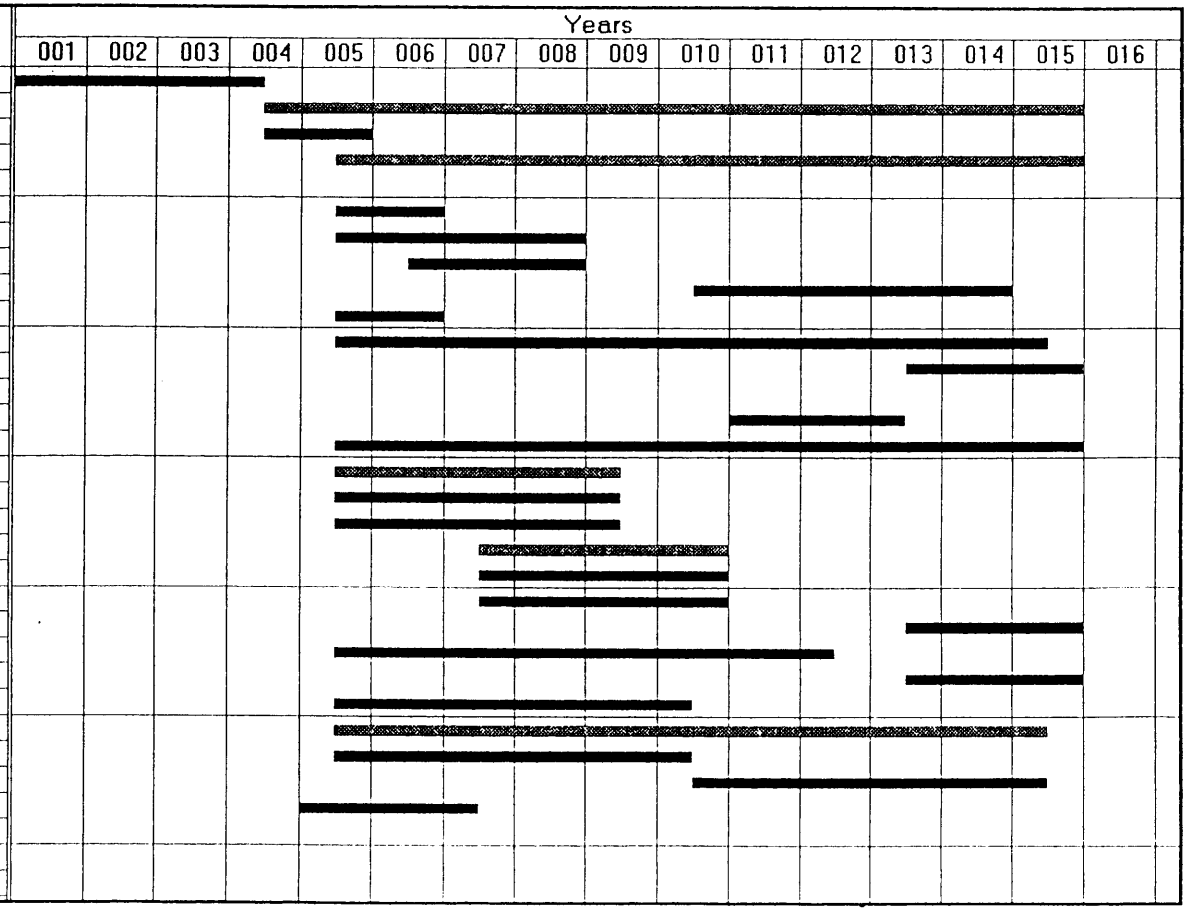
Overall Work Schedule
Sea Level Canel , Route 10, Case-(e)
250,000 DWT,(A.D. 2020)

Task Name	Q'ty
Engineering,Design&Tender	
Construction	
Supporting construction	
Canal Excavation	
Zone I Dry Excavation	0m3
Zone I Dredging	16,262,000m3
Zone II Dry Excavation	156,565,000m3
Zone II Dredging	87,288,000m3
Zone III Dry Excavation	209,417,000m3
Zone III Dredging	24,753,000m3
Zone IV Dry Excavation	584,574,000m3
Zone IV Dredging	52,582,000m3
Zone V Dry Excavation	0m3
Zone V Dredging	97,189,000m3
Placing Area	51.0 km2
Gate Structure	
Atlantic Side	980,000m3
Pacific Side	980,000m3
Gate Leaves, etc.	
Atlantic Side	1 ls
Pacific Side	1 ls
New Permanent Road	71 km
Canal Crossing(Bridges)	3 Bridges
Navigation System	1 ls
Barrier Dams E.F.G Dams	3 Dams
Breakwater	
Atlantic Side	1 ls
Pacific Side	1 ls
Diversion Scheme	1 ls



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PART III : Cost Estimate

PART III COST ESTIMATES

III. Chapter 1 - Project Costs Summary

1.1 Project Costs Summary for High Rise Lock Canal

Table III.1-1 indicates the project costs estimated for the following cases:

(1) Single Lane Culebra Cut Option
Case-(5), 150,000 DWT, Rise 85'(in year 2020)

(2) Single Lane Culebra Cut Option
Case-(6), 200,000 DWT, Rise 85'(in year 2020)

The project costs mainly comprise Construction costs and Indirect Costs.

1.2 Project Costs Summary for Sea level Canal

Table III.1-2 indicates the project costs estimated for following cases:

(1) Route 10, Single Lane in Tidal Lock on Pacific Side Case-(d), 250,000 DWT (in year 2020)

(2) Route 10, Single Lane in Zone II Tidal Gates on Pacific & Atlantic Side Case-(e), 250,000 DWT (in year 2020)

The project costs mainly comprise Construction costs and Indirect Costs.

1.1 Project Costs Summary
High Rise Lock Canal
Single Lane Culebra Cut Option

Table III.1-1 Project Costs Summary, High Rise Lock Canal
Single Lane Culebra Cut Option

(Currency in US dollars) (File : SUMHRLC)

	Description	150,000 DWT Case-(5) Rise 85' in the year 2020	200,000 DWT Case-(6) Rise 85' in the year 2020	Remarks
		($)	($)	
I	CONSTRUCTION COSTS			
(A)	CIVIL WORKS			Single Lane in Zone III, ZoneIV for both cases
1	Canal Excavation	1,592,899,990	1,893,026,260	
2	Placing Area	87,794,350	87,794,350	
3	Lock Construction	855,159,822	970,621,400	
5	New Dams	-	236,998,948	
6	Pump Station	-	-	
7	New Permanent Roads	8,752,280	8,752,280	
8	New Canal Crossing	450,199,285	501,187,820	
10	Barrier Dams	-	-	
11	Breakwater	-	-	
12	Diversion Scheme	-	-	
13	Supporting Construction	291,242,500	291,242,500	
	Subtotal	3,286,048,227	3,989,623,558	
(B)	PLANT FORMING A PART OF PERMANENT WORKS			
4	Gate Leaves and Related Facilities	888,887,500	1,011,237,350	
9	Navigation Support System	414,209,530	414,209,530	
	Subtotal	1,303,097,030	1,425,446,880	
	CONSTRUCTION COSTS, TOTAL(I)	4,589,145,257	5,415,070,438	
I I	INDIRECT COSTS			
1	Administrative Costs	56,365,900	66,510,300	
2	Headquarter's Costs	96,219,500	113,536,500	
3	Construction Supervision	112,856,900	133,168,200	
4	Land Aquisition & Rights	-	-	
5	Compensation Costs	105,000,000	105,000,000	
6	Contingency	458,915,000	541,507,000	
	INDIRECT COSTS, TOTAL(II)	829,357,300	959,722,000	
	PROJECT COSTS, GRAND TOTAL(I+II)	5,418,502,557	6,374,792,438	

1.2 Project Costs Summary
Sea Level Canal, Route 10

Table III.1-2 Project Costs Summary, Sea Level Canal, Route 10

(Currency in US Dollars) (File: SUMSLCEX)

	Description	250,000 DWT Single Lane in Tidal Lock Case-(d) in the year 2020	250,000 DWT Single Lane in Zone II Case-(e) in the year 2020	Remarks
		($)	($)	
I	CONSTRUCTION COSTS			
(A)	CIVIL WORKS			Case-(d):
1	Canal Excavation	6,244,222,840	5,899,707,910	Single Lane in
2	Placing Area	188,682,691	188,682,691	Tidal Lock
3	Lock Construction (Tidal Lock/Gate)	504,496,730	428,936,820	
5	New Dams	-	-	Case-(e):
6	Pump Station	-	-	Single Lane in
7	New Permanent Roads	19,419,590	19,419,590	Zone II
8	New Canal Crossings	187,672,650	221,936,760	
10	Barrier Dams	493,502,306	493,502,306	
11	Breakwater	402,015,840	402,015,840	
12	Diversion Scheme	75,285,156	75,285,156	
13	Supporting Construction	481,440,000	481,440,000	
	Subtotal	8,596,737,803	8,210,927,073	
(B)	PLANT FORMING A PART OF PERMANENT WORKS			
4	Gate Leaves and Related Facilities	316,008,430	737,960,800	
9	Navigation Support System	546,295,047	477,046,333	
	Subtotal	862,303,477	1,215,007,133	
	CONSTRUCTION COSTS, TOTAL(I)	9,459,041,280	9,425,934,206	
I I	INDIRECT COSTS			
1	Administrative Costs	96,482,200	96,144,500	
2	Headquarter's Costs	163,429,600	162,857,600	
3	Construction Supervision	182,957,600	182,317,300	
4	Land Aquisition & Rights	27,337,175	27,337,175	
5	Compensation Costs	13,557,600	13,557,600	
6	Contingency	945,904,000	942,593,000	
	INDIRECT COSTS, TOTAL(II)	1,429,668,175	1,424,807,175	
	PROJECT COSTS, GRAND TOTAL(I+II)	10,888,709,455	10,850,741,381	

III. Chapter 2 - Construction Costs

2.1 Bill of Quantities for Case-(5)

(1) High Rise Lock Canal, Single Lane Culebra Cut Option Case-(5), 150,000 DWT, Rise 85' (in year 2020)

1) Summary
2) Direct Construction Costs
3) Supporting Construction
4) General Conditions

2.2 Bill of Quantities for Case-(6)

(1) High Rise Lock Canal, Single Lane Culebra Cut Option Case-(6), 200,000 DWT, Rise 85' (in year 2020)

1) Summary
2) Direct Construction Costs
3) Supporting Construction
4) General Conditions

2.3 Bill of Quantities for Case-(d)

(1) Sea Level Canal, Route 10, Single Lane in Tidal Lock on Pacific Side Case-(d), 250,000 DWT (in year 2020)

1) Summary
2) Direct Construction Costs
3) Supporting Construction
4) General Conditions

2.4 Bill of Quantities for Case-(e)

(1) Sea Level Canal, Route 10, Single Lane in Zone II Tidal Gates on Pacific & Atlantic Side
Case-(e) : 250,000 DWT (in year 2020)

1) Summary
2) Direct Construction Costs
3) Supporting Construction
4) General Conditions

2.1 Bill of Quantities for Case-(5)

(1) High Rise Lock Canal(85′)
Single Lane Culebra Cut Option, 150,000DWT
the Year of 2020

1) Summary

Item No.	Description	Unit	General Cond.	D. Const. Cost	Project Costs
			$	$	$
			(II)	(I)	(I)+(II)
	SUMMARY				
I	DIRECT CONSTRUCTION COSTS				
(A)	CIVIL WORKS				
1	Canal Excavation	ls	199,287,000	1,393,612,990	1,592,899,990.00
2	Placing Area	ls	10,984,000	76,810,350	87,794,350.00
3	Lock Construction	ls	116,680,000	738,479,822	855,159,822.00
5	New Dams(to be provided in A.D. 2,060)		-	-	-
6	Pump Station(- ′-)		nil	nil	nil
7	New Permanent Roads	ls	1,095,000	7,657,280	8,752,280.00
8	New Canal Crossing	ls	inclusive	450,199,285	450,199,285.00
10	Barrier Dams	ls	nil	nil	nil
11	Breakwater	ls	nil	nil	nil
12	Diversion Scheme	ls	nil	nil	nil
13	Supporting Construction	ls	36,437,200	254,805,300	291,242,500.00
				-	
	Subtotal		364,483,200	2,921,565,027	3,286,048,227.00
(B)	PLANT FORMING A PART OF PERMANENT WORK				
4	Gate Leaves and Related Facilities	ls	inclusive	888,887,500	888,887,500.00
9	Navigation Support System	ls	56,516,000	357,693,530	414,209,530.00
	Subtotal		56,516,000	1,246,581,030	1,303,097,030.00
	CONSTRUCTION COSTS, TOTAL		420,999,200	4,168,146,057	4,589,145,257.00
III	INDIRECT COSTS				
1	Administrative Costs(*1)	ls	-	-	56,365,900.00
2	Headquarter′s Costs(*1)	ls	-	-	96,219,500.00
3	Construction Supervision(*1)	ls	-	-	112,856,900.00
4	Land Aquisition & Rights	ls	-	-	-
5	Compensation Costs	ls	-	-	105,000,000.00
6	Contingency(10% of Const. Costs)	ls	-	-	458,915,000.00
	Subtotal				829,357,300.00
	(*1): to be assigned as percentage of Construction Costs				
	GRAND TOTAL(PROJECT COSTS)				5,418,502,557.00

BILL NO. : 1 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A.D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
					0.00
I	DIRECT CONSTRUCTION COSTS				
1	CANAL EXCAVATION				
(1)	Grubbing & clearing in the Canal Area				
1)	ZONE 1	m2	683,500	0.21	143,535.00
2)	ZONE 2	m2	2,049,000	0.21	430,290.00
3)	ZONE 3	m2	0	0.21	0.00
4)	ZONE 4	m2	2,295,000	0.21	481,950.00
5)	ZONE 5	m2	374,500	0.21	78,645.00
	Grubbing & Clearing Total m2		5,402,000		
(2)	Dry Excavation				
	ZONE 1				
	Average hauling distance 2.5km				
1)-1	Common	m3	127,000	1.82	231,140.00
1)-2	Weathered rock (using ripper)	m3	195,000	2.76	538,200.00
1)-3	Medium Hard rock (using ripper)	m3	-	2.76	0.00
1)-4	Hard rock (using blasting)	m3	-	4.59	0.00
2)	ZONE 2				
	Average hauling distance 2.0km				
2)-1	Common	m3	904,000	1.67	1,509,680.00
2)-2	Weathered rock (using ripper)	m3	6,373,000	2.58	16,442,340.00
2)-3	Medium Hard rock (using ripper)	m3	5,677,000	2.58	14,646,660.00
2)-4	Hard rock (using blasting)	m3	-	4.38	0.00
	Subtotal this Sheet				34,502,440.00

Item No.	Description	Unit	Q'ty	Unit Cost	Amount
				$	$
3)	ZONE 3				
	Average hauling distance 4.0km				
3)-1	Common	m3	0	2.27	0.00
3)-2	Weathered rock (using ripper)	m3	0	3.32	0.00
3)-4	Medium Hard rock (using ripper)	m3	0	3.32	0.00
3)-5	Hard rock (using blasting)	m3	0	5.22	0.00
4)	ZONE 4				
	Average hauling distance 4.0km				
4)-1	Common	m3	7,800,000	2.27	17,706,000.00
4)-2	Weathered rock (using ripper)	m3	33,797,000	3.32	112,206,040.00
4)-3	Medium Hard rock (using ripper)	m3	24,458,000	3.32	81,200,560.00
4)-4	Hard rock (using blasting)	m3	10,481,000	5.22	54,710,820.00
5)	ZONE 5				
	Average hauling distance 6.0km				
5)-1	Common	m3	104,000	2.87	298,480.00
5)-2	Weathered rock (using ripper)	m3	383,000	4.06	1,554,980.00
5)-3	Medium Hard rock (using ripper)	m3	290,000	4.06	1,177,400.00
5)-4	Hard rock (using blasting)	m3	0	6.06	0.00
	Dry Excavation Total m3		90,589,000		
	Subtotal this Sheet				268,854,280.00

BILL NO. : 3 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A.D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(3)	Dredging				
1)	ZONE 1				
	Average hauling distance 12km				
1)-1	Clayey material(clay, silt)	m3	6,862,000	2.47	16,949,140.00
1)-2	Loose material(sand, gravel)	m3	16,189,000	2.84	45,976,760.00
1)-3	Weathered rock	m3	23,510,000	4.34	102,033,400.00
1)-4	Medium Hard rock	m3	52,000	9.02	469,040.00
1)-5	Hard rock (using blasting)	m3	-	70.6	0.00
2)	ZONE 2				
	Average hauling distance 18.5km				
2)-1	Clayey material(clay, silt)	m3	34,480,000	3.33	114,818,400.00
2)-2	Loose material(sand, gravel)	m3	35,526,000	2.88	102,314,880.00
2)-3	Weathered rock	m3	37,268,000	5.11	190,439,480.00
2)-4	Medium Hard rock	m3	14,592,000	9.05	132,057,600.00
2)-5	Hard rock (using blasting)	m3	-	70.65	0.00
3)	ZONE 3				
	Average hauling distance 22.5km				
3)-1	Clayey material(clay, silt)	m3	2,382,000	5.89	14,029,980.00
3)-2	Loose material(sand, gravel)	m3	3,232,000	5.79	18,713,280.00
3)-3	Weathered rock	m3	4,044,000	10.26	41,491,440.00
3)-4	Medium Hard rock	m3	1,842,000	13.95	25,695,900.00
3)-5	Hard rock (using blasting)	m3	205,000	107.75	22,088,750.00
4)	ZONE 4				
	Average hauling distance 22km				
4)-1	Clayey material(clay, silt)	m3	24,000	5.88	141,120.00
4)-2	Loose material(sand, gravel)	m3	20,000	5.79	115,800.00
4)-3	Weathered rock	m3	76,000	10.26	779,760.00
4)-4	Medium Hard rock	m3	157,000	13.94	2,188,580.00
4)-5	Hard rock (using blasting)	m3	68,000	103.88	7,063,840.00
5)	ZONE 5				
	Average hauling distance 8km				
5)-1	Clayey material(clay, silt)	m3	13,956,000	2.45	34,192,200.00
5)-2	Loose material(sand, gravel)	m3	21,242,000	2.26	48,006,920.00
5)-3	Weathered rock	m3	30,569,000	4.32	132,058,080.00
5)-4	Medium Hard rock	m3	326,000	9.00	2,934,000.00
5)-5	Hard rock (using blasting)	m3	-	70.56	0.00
	Dredging Total m3		246,622,000		
	Subtotal this Sheet				1,054,558,350.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(4)	Vegetation(Seeding) of Canal Slope				
1)	ZONE 1	m2	215,300	0.75	161,475.00
2)	ZONE 2	m2	459,300	0.75	344,475.00
3)	ZONE 3	m2	0	0.75	0.00
4)	ZONE 4	m2	634,500	0.75	475,875.00
5)	ZONE 5	m2	65,500	0.75	49,125.00
	Total Area, m2		1,374,600		
(5)	Temporary Works				
1)	Access Roads (W = 22 m, t=1.5m) starting from excavating spot in the Canal to the main construction road which is lying along the Canal	km	16,500.00	1,002.98	16,549,170.00
2)	Dewatering for Dry Excavation	m3	90,589,000	0.20	18,117,800.00
	Subtotal this Sheet				35,697,920.00
	Total-Item No. 1 Canal Excavation				1,393,612,990.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
2	Placing Areas for Surplus Material				
(1)	Grubbing & Clearing for Placing Areas				
1)	D-01 Area	m2	2,800,000.0	0.21	588,000.00
2)	D-02 Area	m2	1,700,000.0	0.21	357,000.00
3)	D-03 Area	m2	1,200,000.0	0.21	252,000.00
4)	D-04 Area	m2	100,000.0	0.21	21,000.00
5)	D-05 Area	m2	800,000.0	0.21	168,000.00
6)	D-06 Area	m2	700,000.0	0.21	147,000.00
7)	D-07 Area	m2	3,300,000.0	0.21	693,000.00
8)	D-08 Area	m2	1,600,000.0	0.21	336,000.00
9)	D-09 Area	m2	2,600,000.0	0.21	546,000.00
10)	D-10 Area	m2	2,300,000.0	0.21	483,000.00
11)	D-11 Area	m2	1,900,000.0	0.21	399,000.00
12)	D-12 Area	m2	1,100,000.0	0.21	231,000.00
13)	D-13 Area	m2	2,400,000.0	0.21	504,000.00
	Total Area, km2		22,500,000.0		
(2)	Placing Area Preparation including Surface Drainage(Open Ditch) Vegetation Underground Drainage	km2	22.5	2,535,140.00	57,040,650.00
(3)	Access Roads (W = 22 m, t=1.5m)	m	15,000.0	1,002.98	15,044,700.00
	Subtotal this Sheet				76,810,350.00
	Total-Item No. 2 Placing Areas for Surplus Materials				76,810,350.00

BILL NO. : 6 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A.D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3	LOCK CONSTRUCTION				
(1)	ATLANTIC SIDE				
1)	Excavation, Hauling Distance 5.0km				
1)-1	Common	m3	5,940,000	2.57	15,265,800.00
1)-2	Weathered Rock	m3	3,564,000	3.69	13,151,160.00
1)-3	Hard Rock	m3	2,376,000	5.64	13,400,640.00
	Total m3		11,880,000		
1)-4	Dewatering	ls	1	6,233,000.00	6,233,000.00
2)	Backfill	m3	7,000,000	3.85	26,950,000.00
3)	Grouting				
3)-1	Bore Hole	m	200,900	20.05	4,028,045.00
3)-2	Consolidation Groutiong	m	200,900	66.68	13,396,012.00
4)	Concrete including form works, etc.	m3	3,200,000	87.68	280,576,000.00
5)	Reinforcing Bar(Deformed)	ton	32,000	804.10	25,731,200.00
(2)	PACIFIC SIDE				
1)	Excavation				
1)-1	Common	m3	5,940,000	2.57	15,265,800.00
1)-2	Weathered Rock	m3	3,564,000	3.69	13,151,160.00
1)-3	Hard Rock	m3	2,376,000	5.64	13,400,640.00
	Total m3		11,880,000		
1)-4	Dewatering	ls	1	6,233,000.00	6,233,000.00
2)	Backfill	m3	7,000,000	3.85	26,950,000.00
3)	Grouting				
3)-1	Bore Hole	m	200,900	20.05	4,028,045.00
3)-2	Consolidation Grouting	m	200,900	66.80	13,420,120.00
4)	Concrete including form works, etc.	m3	3,200,000	69.24	221,568,000.00
5)	Reinforcing Bar(Deformed)	ton	32,000	804.10	25,731,200.00
	Subtotal this Sheet				738,479,822.00
	Total-Item No.3 Lock Construction				738,479,822.00

BILL NO. : 7 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A. D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
4	GATE LEAVES AND RELATED FACILITIES				
(1)	GATE LEAVES AT ATLANTIC ENTRANCE LOCK				
1)	Gate Leaves	ton	10,619	9,830	104,384,770.00
2)	Mechanical Equipment				
2)-1	Gate Frames	ton	4,467	11,120	49,673,040.00
2)-2	Gate Hoists	ton	1,918	15,970	30,630,460.00
2)-3	Locomotives	unit	20	3,600,000	72,000,000.00
2)-4	Rails and Racks for Locomotives	ton	3,371	8,140	27,439,940.00
2)-5	Power Supply Line for Locomotives	set	1	5,000,000	5,000,000.00
2)-6	Other Mechanical Component (Compressed Air System, Piping and Misc. Mechanical Equipments)	set	1	31,315,000	31,315,000.00
3)	Electrical Power & Control				
3)-1	Electrical Power & Control Equipment (35000KW)	set	1	32,900,000	32,900,000.00
3)-2	Emergency Power Plant	kw	35,000	770	26,950,000.00
3)-3	Misc. Electrical Equip.	set	1	7,000,000	7,000,000.00
4)	Others				
4)-1	Local Control Buildings	set	1	400,000	400,000.00
4)-2	Their Electrical Equipment	set	1	100,000	100,000.00
4)-3	Cathodic Protection	set	1	1,400,000	1,400,000.00
4)-4	Monitoring & Surveillance Equip. Communication System	set	1	1,600,000	1,600,000.00
4)-5	Grounding System	set	1	400,000	400,000.00
4)-6	Other Electric works and Consumable	set	1	600,000	600,000.00
	Subtotal this Sheet				391,793,210.00

BILL NO. : 8 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A.D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	GATE LEAVES AT PACIFIC ENTRANCE LOCK				
1)	Gate Leaves	ton	17,619	9,810	172,842,390.00
2)	Mechanical Equipment				
2)-1	Gate Frames	ton	4,730	11,130	52,644,900.00
2)-2	Gate Hoists	ton	2,622	15,730	41,244,060.00
2)-3	Locomotives	unit	20	3,600,000	72,000,000.00
2)-4	Rails and Racks for Locomotives	ton	3,371	8,140	27,439,940.00
2)-5	Power Supply Line for Locomotives	set	1	5,000,000	5,000,000.00
2)-6	Other Mechanical Component (Compressed Air System, Piping and Misc. Mechanical Equipments)	set	1	51,873,000	51,873,000.00
3)	Electrical Power & Control				
3)-1	Electrical Power & Control Equipment (35000KW)	set	1	32,900,000	32,900,000.00
3)-2	Emergency Power Plant	kw	35,000	770	26,950,000.00
3)-3	Misc. Electrical Equip.	set	1	7,000,000	7,000,000.00
4)	Others				
4)-1	Local Control Buildings	set	1	600,000	600,000.00
4)-2	Their Electrical Equipment	set	1	100,000	100,000.00
4)-3	Cathodic Protection	set	1	2,300,000	2,300,000.00
4)-4	Monitoring & Surveillance Equip. Communication System	set	1	2,600,000	2,600,000.00
4)-5	Grounding System	set	1	600,000	600,000.00
4)-6	Other Electric works and Consumable	set	1	1,000,000	1,000,000.00
	Subtotal this Sheet				497,094,290.00
	Total-Item No. 4 Gate Leaves and Related Structure				888,887,500.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
5	NEW DAMS				
(1)	CIRI DAM(H=80M) will be provided in the year of 2,060		-	-	-
(2)	UPPER GATUN DAM(H= M)		nil	-	-
(3)	TRINIDADO DAM(H= M)		nil	-	-
(4)	INDIO DAM(H=80M) will be provided in the year of 2,060		-	-	-
	Subtotal this Sheet				-
	Total-Item No. 5 Lock Construction				-

BILL NO. : 10 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A. D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
6	PUMP STATIONS				
(1)	PUMP STATION AT ATLANTIC LOCK to be provided in the year of 2,060		-	-	-
(2)	PUMP STATION AT PACIFIC LOCK to be provided in the year of 2,060		-	-	-
	Subtotal this Sheet				-
	Total-Item No. 6 Pump Stations				-

BILL NO. : 11 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A. D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
7	NEW PERMANENT ROADS				
(1)	ROADS FOR INSPECTION (NEW ROADS) W =6.8m				
1)	Subgrade, Base Course(t = 0.4m)	km	32.0	110,490.00	3,535,680.00
2)	Asphalt Paving(t=70mm)	m2	320,000.0	12.88	4,121,600.00
	Subtotal this Sheet				7,657,280.00
	Total-Item No. 7 New Permanent Roads				7,657,280.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
8	NEW CANAL CROSSINGS				
(1)	BRIDGES				
1)	Bridges Over The Canal on Pacific Side				
1)-1	Cable Stayed Bridge Canal Width 320m Span = L1(Main)+L2+L3=450+180+180=810m Width = 20.5m (Four Lane)	m2	16,605	14,387.00	238,896,135.00
1)-2	Approaching Bridges(Steel Box Girder) Total Length = 850m (One Span 60m) Width = 20.5m (Four Lane)	m2	16,605	2,950.00	48,984,750.00
2)	Bridges Over the Canal for Van Dam Bypass(1) (to be provided in the year of 2,060)		-	-	-
3)	Bridges Over the (Existing) Canal for Van Dam Bypass(2) (to be provided in the year of 2,060)		-	-	-
	Subtotal this Sheet				287,880,885.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
4)	Bridges Over the Canal at Middle Gamboa (to be provided in the year of 2,060)		-	-	-
5)	Bridges Over The Canal on Atlantic Side				
5)-1	Cable Stayed Bridge Canal Width 320m Span = L1(Main)+L2+L3=410+165+165=740m Width = 10.0m (Two lane)	m2	7,400	12,716.00	94,098,400.00
5)-2	Approaching Bridges(Steel Box Girder) Total Length = 1,500m (One Span 60m) Width = 10.0m (Two lane)	m2	15,000	2,980.00	44,700,000.00
(2)	Demolition of Existing Bridge				
1)	Balboa Bridge(Bridge of the Americas)				
1)-1	Super-structure	t	14,000	1,120.00	15,680,000.00
1)-2	Sub-structure	ls	1	7,840,000	7,840,000.00
	Subtotal this Sheet				162,318,400.00
	Total-Item No. 8 New Canal Crossings				450,199,285.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
9	NAVIGATION SUPPORT SYSTEMS				
(1)	Navigation Lights and Leading Channel Range Marker Lights				
	For Two-Way Newly Excavated Canal				
1)	Navigation Lights 10 w, Lens Type Light Range : Three Nautical miles Power supply : Solar Battery				
1)-1	Pacific Ocean Navigation Light(Buoy) For 11km (Interval 927m) 11,000 / 927 m = 12 * 2 sides	sets	24	121,506.00	2,916,144.00
1)-2	Atlantic Ocean Navigation For 11km (Interval 927m)	sets	24	121,506.00	2,916,144.00
1)-3	At turning points, S and T 2 points x 2 sets	sets	4	121,506.00	486,024.00
1)-4	At turning points, B, C and D 3 points x 2 sets	sets	6	121,506.00	729,036.00
1)-5	Leading Channel Range Marker Light 4 points x 2 lanes x 2 sets	sets	16	473,496.00	7,575,936.00
	For Two-way widened-portion of the Canal, 30 km				
1)-6	Relocation of existing Navigation Lights (Buoys) (specification)	sets	-	12,874.00	0.00
1)-7	Leading Channel Range Marker Light 30 points x 2	sets	60	473,496.00	28,409,760.00
	Subtotal this Sheet				43,033,044.00

BILL NO. : 15 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A.D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	TUG STATION				
1)	Provide Tug Boats, 6,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	23	6,649,286	152,933,578.00
2)	Provide/Supply Tug Boats, 3,000 HP-4,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	2	4,652,857	9,305,714.00
3)	Launches(for 10 persons) Twin Screw (maintenance/running Cost not included)	unit	14	163,571	2,289,994.00
(3)	EMERGENCY TIE UP STATION (Mooring Dolphin Type)				
1)	Located at the north end of the new Pacific Locks	nos	1	14,043,200	14,043,200.00
2)	Located at Gatun Lake	nos	1	14,043,200	14,043,200.00
3)	Excavation				
	Dry Excavation(Hauling distance 4.0km)				
3)-1	Common	m3	1,600,000	2.27	3,632,000.00
3)-2	Weathered Rock	m3	960,000	3.32	3,187,200.00
3)-3	Hard Rock	m3	640,000	5.22	3,340,800.00
	Dredging(Hauling Distance 22km)				
3)-4	Clayey material(clay, silt)	m3	1,600,000	4.79	7,664,000.00
3)-5	Weathered Rock	m3	960,000	7.33	7,036,800.00
3)-6	Hard Rock	m3	640,000	100.95	64,608,000.00
	Total Excavation m3		6,400,000		
	Subtotal this Sheet				282,084,486.00

Item No.	Description	Unit	Q'ty	Unit Cost	Amount
				$	$
(4)	Jetty(10m x 50m)				
	Five(5) Locations for Tug Jetty				
1)	Colon	nos	2	4,072,000	8,144,000.00
2)	Gatun Lake	nos	2	4,072,000	8,144,000.00
3)	Gamboa	nos	1	4,072,000	4,072,000.00
4)	Pedro Miguel	nos	1	4,072,000	4,072,000.00
5)	Diablo	nos	2	4,072,000	8,144,000.00
	Subtotal this Sheet				32,576,000.00
	Total-Item No. 9 Navigation Support System				357,693,530.00

BILL NO. : 17 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A. D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
10	Barrier Dam (not applicable for the H. R. L. Canal)		nil	-	-
11	Break Water (not applicable for the H. R. L. Canal)		nil	-	-
12	Diversion Scheme (not applicable for the H. R. L. Canal)		nil	-	-
	Subtotal this Sheet				-

BILL NO. : 18 HRLC, SINGLE LANE CULEBRA CUT OPTION, CASE-(5)
(A. D. 2020) 150,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
13	SUPPORTING CONSTRUCTION To be assigned as percentage of Construction Costs	ls			254,805,300.00
	Subtotal this Sheet				254,805,300.00
	Total-Item No. 13 Supporting Construction				254,805,300.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
14	GENERAL CONDITIONS				
(1)	Canal Excavation, (14.3%, Item Total)	ls	1		199,287,000.00
(2)	Placing Area, (14.3%, Item Total)	ls	1		10,984,000.00
(3)	Lock Construction (15.8%, Item Total)	ls	1		116,680,000.00
(4)	Gate Leaves and Related Facilities		-		-inclusive-
(5)	New Dams(to be provided in 2,060)		-		-
(6)	Pump Station		-		-
(7)	New Parmanent Roads, (14.3%, Item Total)	ls	1		1,095,000.00
(8)	New Canal Crossing		-		-inclusive-
(9)	Navigation Support System(15.8%I.Total)	ls	1		56,516,000.00
(10)	Barrier Dams		nil		-
(11)	Breakwater		nil		-
(12)	Diversion Scheme		nil		-
(13)	Supporting Construction(14.3%, I.Total)	ls	1		36,437,200.00
	Subtotal this Sheet				420,999,200.00
	Total-Item No.14 General Conditions				420,999,200.00

2.2 Bill of Quantities for Case-(6)

(1) High Rise Lock Canal(85′)
Single Lane Culebra Cut Option, 200,000DWT
the Year of 2020

1) Summary

Item No.	Description	Unit	General Cond. $	D. Const. Cost $	Project Costs $
			(II)	(I)	(I)+(II)
	SUMMARY				
I	DIRECT CONSTRUCTION COSTS				
(A)	CIVIL WORKS				
1	Canal Excavation	ls	236,835,000	1,656,191,260	1,893,026,260.00
2	Placing Area	ls	10,984,000	76,810,350	87,794,350.00
3	Lock Construction	ls	132,434,000	838,187,400	970,621,400.00
5	New Dams	ls	29,651,000	207,347,948	236,998,948.00
6	Pump Station(to be provided in A.D.2060)		nil	nil	nil
7	New Permanent Roads	ls	1,095,000	7,657,280	8,752,280.00
8	New Canal Crossing	ls	inclusive	501,187,820	501,187,820.00
10	Barrier Dams	ls	nil	nil	nil
11	Breakwater	ls	nil	nil	nil
12	Diversion Scheme	ls	nil	nil	nil
13	Supporting Construction	ls	36,437,200	254,805,300	291,242,500.00
	Subtotal		447,436,200	3,542,187,358	3,989,623,558.00
(B)	PLANT FORMING A PART OF PERMANENT WORK				
4	Gate Leaves and Related Facilities	ls	inclusive	1,011,237,350	1,011,237,350.00
9	Navigation Support System	ls	56,516,000	357,693,530	414,209,530.00
	Subtotal		56,516,000	1,368,930,880	1,425,446,880.00
	CONSTRUCTION COSTS, TOTAL		503,952,200	4,911,118,238	5,415,070,438.00
III	INDIRECT COSTS				
1	Administrative Costs(*1)	ls	-	-	66,510,300.00
2	Headquarter's Costs(*1)	ls	-	-	113,536,500.00
3	Construction Supervision(*1)	ls	-	-	133,168,200.00
4	Land Aquisition & Rights	ls	-	-	-
5	Compensation Costs	ls	-	-	105,000,000.00
6	Contingency(10% of Const. Costs)	ls	-	-	541,507,000.00
	Subtotal				959,722,000.00
	(*1):to be assigned as percentage of Construction Costs				
	GRAND TOTAL(PROJECT COSTS)				6,374,792,438.00

BILL NO. : 1 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A.D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
					0.00
I	DIRECT CONSTRUCTION COSTS				
1	CANAL EXCAVATION				
(1)	Grubbing & clearing in the Canal Area				
1)	ZONE 1	m2	743,000	0.21	156,030.00
2)	ZONE 2	m2	2,228,000	0.21	467,880.00
3)	ZONE 3	m2	0	0.21	0.00
4)	ZONE 4	m2	2,415,000	0.21	507,150.00
5)	ZONE 5	m2	408,000	0.21	85,680.00
	Grubbing & Clearing Total m2		5,794,000		
(2)	Dry Excavation				
1)	ZONE 1				
	Average hauling distance 2.5km				
1)-1	Common	m3	141,000	1.82	256,620.00
1)-2	Weathered rock (using ripper)	m3	217,000	2.76	598,920.00
1)-3	Medium Hard rock (using ripper)	m3	-	2.76	0.00
1)-4	Hard rock (using blasting)	m3	-	4.59	0.00
2)	ZONE 2				
	Average hauling distance 2.0km				
2)-1	Common	m3	996,000	1.67	1,663,320.00
2)-2	Weathered rock (using ripper)	m3	7,000,000	2.58	18,060,000.00
2)-3	Medium Hard rock (using ripper)	m3	6,291,000	2.58	16,230,780.00
2)-4	Hard rock (using blasting)	m3	-	4.38	0.00
	Subtotal this Sheet				38,026,380.00

BILL NO. : 2 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3)	ZONE 3				
	Average hauling distance 4.0km				
3)-1	Common	m3	-	2.27	0.00
3)-2	Weathered rock (using ripper)	m3	-	3.32	0.00
3)-4	Medium Hard rock (using ripper)	m3	-	3.32	0.00
3)-5	Hard rock (using blasting)	m3	-	5.22	0.00
4)	ZONE 4				
	Average hauling distance 4.0km				
4)-1	Common	m3	8,659,000	2.27	19,655,930.00
4)-2	Weathered rock (using ripper)	m3	37,389,000	3.32	124,131,480.00
4)-3	Medium Hard rock (using ripper)	m3	26,739,000	3.32	88,773,480.00
4)-4	Hard rock (using blasting)	m3	11,459,000	5.22	59,815,980.00
5)	ZONE 5				
	Average hauling distance 6km				
5)-1	Common	m3	125,000	2.87	358,750.00
5)-2	Weathered rock (using ripper)	m3	458,000	4.06	1,859,480.00
5)-3	Medium Hard rock (using ripper)	m3	346,000	4.06	1,404,760.00
5)-4	Hard rock (using blasting)	m3	0	6.06	0.00
	Dry Excavation Total m3		99,820,000		
	Subtotal this Sheet				295,999,860.00

BILL NO. : 3 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A.D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(3)	Dredging				
	ZONE 1				
	Average hauling distance 12km				
1)-1	Clayey material(clay, silt)	m3	7,908,000	2.47	19,532,760.00
1)-2	Loose material(sand, gravel)	m3	18,687,000	2.84	53,071,080.00
1)-3	Weathered rock	m3	27,194,000	4.34	118,021,960.00
1)-4	Medium Hard rock	m3	58,000	9.02	523,160.00
1)-5	Hard rock (using blasting)	m3	-	70.60	0.00
2)	ZONE 2				
	Average hauling distance 18.5km				
2)-1	Clayey material(clay, silt)	m3	42,856,000	3.33	142,710,480.00
2)-2	Loose material(sand, gravel)	m3	42,097,000	2.88	121,239,360.00
2)-3	Weathered rock	m3	43,667,000	5.11	223,138,370.00
2)-4	Medium Hard rock	m3	17,344,000	9.05	156,963,200.00
2)-5	Hard rock (using blasting)	m3	-	70.65	0.00
3)	ZONE 3				
	Average hauling distance 22.5km				
3)-1	Clayey material(clay, silt)	m3	2,725,000	5.89	16,050,250.00
3)-2	Loose material(sand, gravel)	m3	3,765,000	5.79	21,799,350.00
3)-3	Weathered rock	m3	5,192,000	10.26	53,269,920.00
3)-4	Medium Hard rock	m3	2,477,000	13.95	34,554,150.00
3)-5	Hard rock (using blasting)	m3	275,000	107.75	29,631,250.00
4)	ZONE 4				
	Average hauling distance 22km				
4)-1	Clayey material(clay, silt)	m3	25,000	5.88	147,000.00
4)-2	Loose material(sand, gravel)	m3	33,000	5.79	191,070.00
4)-3	Weathered rock	m3	87,000	10.26	892,620.00
4)-4	Medium Hard rock	m3	188,000	13.94	2,620,720.00
4)-5	Hard rock (using blasting)	m3	81,000	103.88	8,414,280.00
5)	ZONE 5				
	Average hauling distance 7.5km				
5)-1	Clayey material(clay, silt)	m3	23,027,000	2.45	56,416,150.00
5)-2	Loose material(sand, gravel)	m3	27,907,000	2.26	63,069,820.00
5)-3	Weathered rock	m3	36,917,000	4.32	159,481,440.00
5)-4	Medium Hard rock	m3	376,000	9.00	3,384,000.00
5)-5	Hard rock (using blasting)	m3	-	70.55	0.00
	Dredging Total m3		302,886,000		
	Subtotal this Sheet				1,285,122,390.00

Item No.	Description	Unit	Q' ty	Unit Cost	Amount
				$	$
(4)	Vegetation(Seeding) of Canal Slope				
1)	ZONE 1	m2	215, 300. 00	0. 75	161, 475. 00
2)	ZONE 2	m2	459, 300. 00	0. 75	344, 475. 00
3)	ZONE 3	m2	0. 00	0. 75	0. 00
4)	ZONE 4	m2	634, 500. 00	0. 75	475, 875. 00
5)	ZONE 5	m2	65, 500. 00	0. 75	49, 125. 00
	Total Area, m2		1, 374, 600. 00		
(5)	Temporary Works				
1)	Access Roads (W = 22 m, t=1. 5m) Starting from excavating spot in the Canal to main construction road which is lying along the Canal	m	16, 000	1, 002. 98	16, 047, 680. 00
2)	Dewatering for Dry Excavation	m3	99, 820, 000	0. 20	19, 964, 000. 00
	Subtotal this Sheet				37, 042, 630. 00
	Total-Item No. 1 Canal Excavation				1, 656, 191, 260. 00

BILL NO. : 5 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
2	Placing Areas for Surplus Material				
(1)	Grubbing & Clearing for Placing Areas				
1)	D-01 Area	m2	2,800,000.0	0.21	588,000.00
2)	D-02 Area	m2	1,700,000.0	0.21	357,000.00
3)	D-03 Area	m2	1,200,000.0	0.21	252,000.00
4)	D-04 Area	m2	100,000.0	0.21	21,000.00
5)	D-05 Area	m2	800,000.0	0.21	168,000.00
6)	D-06 Area	m2	700,000.0	0.21	147,000.00
7)	D-07 Area	m2	3,300,000.0	0.21	693,000.00
8)	D-08 Area	m2	1,600,000.0	0.21	336,000.00
9)	D-09 Area	m2	2,600,000.0	0.21	546,000.00
10)	D-10 Area	m2	2,300,000.0	0.21	483,000.00
11)	D-11 Area	m2	1,900,000.0	0.21	399,000.00
12)	D-12 Area	m2	1,100,000.0	0.21	231,000.00
13)	D-13 Area	m2	2,400,000.0	0.21	504,000.00
	Total Area, m2		22,500,000.0		
(2)	Placing Area Preparation including Surface drainage (open ditch) Vegetation Underground Drainage	km2	22.5	2,535,140.00	57,040,650.00
(3)	Access Roads (W = 22 m, t=1.5m) starting from placing area to the main construction road	m	15,000.0	1,002.98	15,044,700.00
	Subtotal this Sheet				76,810,350.00
	Total-Item No. 2 Placing Areas for Surplus Material				76,810,350.00

BILL NO. : 6 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3	LOCK CONSTRUCTION				
(1)	ATLANTIC SIDE				
1)	Excavation, Hauling Distance 5.0km				
1)-1	Common	m3	6,975,000	2.57	17,925,750.00
1)-2	Weathered Rock	m3	4,185,000	3.69	15,442,650.00
1)-3	Hard Rock	m3	2,790,000	5.64	15,735,600.00
	Total Volume		13,950,000		
1)-4	Dewatering	ls	1	6,233,000.00	6,233,000.00
2)	Backfill	m3	8,500,000	3.85	32,725,000.00
3)	Grouting				
3)-1	Bore Hole	m	226,000	20.05	4,531,300.00
3)-2	Consolidation Groutiong	m	226,000	66.80	15,096,800.00
4)	Concrete including form works, etc (Atlantic side cost)	m3	3,600,000	87.68	315,648,000.00
5)	Reinforcing Bar(Deformed)	ton	36,000	804.10	28,947,600.00
(2)	PACIFIC SIDE				
1)	Excavation				
1)-1	Common	m3	6,975,000	2.57	17,925,750.00
1)-2	Weathered Rock	m3	4,185,000	3.69	15,442,650.00
1)-3	Hard Rock	m3	2,790,000	5.64	15,735,600.00
	Total Volume		13,950,000		
1)-4	Dewatering	ls	1	6,233,000.00	6,233,000.00
2)	Backfill	m3	8,500,000	3.85	32,725,000.00
3)	Grouting				
3)-1	Bore Hole	m	226,000	20.05	4,531,300.00
3)-2	Consolidation Grouting	m	226,000	66.80	15,096,800.00
4)	Concrete including form works, etc (Pacific side cost)	m3	3,600,000	69.24	249,264,000.00
5)	Reinforcing Bar(Deformed)	ton	36,000	804.10	28,947,600.00
	Subtotal this Sheet				838,187,400.00
	Total-Item No. 3 Lock Construction				838,187,400.00

BILL NO. : 7 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
4	GATE LEAVES AND RELATED FACILITIES				
(1)	GATE LEAVES AT ATLANTIC ENTRANCE LOCK				
1)	Gate Leaves	ton	12,786	9,820	125,558,520.00
2)	Machinery & Equipment				
2)-1	Gate Frame	ton	5,349	11,110	59,427,390.00
2)-2	Gate Hoist	ton	2,289	15,910	36,417,990.00
2)-3	Locomotives	unit	20	3,600,000	72,000,000.00
2)-4	Rails and Racks for Locomotive	ton	3,631	8,140	29,556,340.00
2)-5	Power Supply Line for Locomotives	set	1	5,000,000	5,000,000.00
2)-6	Other Mechanical Component (Compressed Air System, Drainage Pumps Piping and Misc. Mechanical Equip.)	set	1	37,676,000	37,676,000.00
3)	Electrical Power & Control				
3)-1	Electrical Power & Control Equipment (38000KW)	set	1	35,700,000	35,700,000.00
3)-2	Emergency Power Plant	kw	38,000	770	29,260,000.00
3)-3	Misc. Electrical Equip.	set	1	8,000,000	8,000,000.00
3)-4					
4)	Others				
4)-1	Local Control Buildings	set	1	400,000	400,000.00
4)-2	Their electrical equipment	set	1	100,000	100,000.00
4)-3	Cathodic Protection	set	1	1,600,000	1,600,000.00
4)-4	Monitoring & Surveillance Equipments, Communication System	set	1	1,900,000	1,900,000.00
4)-5	Grounding System	set	1	400,000	400,000.00
4)-6	Other Electric works and Consumables	set	1	700,000	700,000.00
	Subtotal this Sheet				443,696,240.00

BILL NO. : 8 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A.D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost	Amount
				$	$
(2)	GATE LEAVES AT PACIFIC ENTRANCE LOCK				
1)	Gate Leaves	ton	21,114	9,800	206,917,200.00
2)	Machinery & Equipment				
2)-1	Gate Frame	ton	5,591	11,110	62,116,010.00
2)-2	Gate Hoist	ton	3,073	15,720	48,307,560.00
2)-3	Locomotives	unit	20	3,600,000	72,000,000.00
2)-4	Rails and Racks for Locomotive	ton	3,631	8,140	29,556,340.00
2)-5	Power Supply Line for Locomotives	set	1	5,000,000	5,000,000.00
2)-6	Other Mechanical Component (Compressed Air System, Drainage Pumps Piping and Misc. Mechanical Equip.)	set	1	62,084,000	62,084,000.00
3)	Electrical Power & Control				
3)-1	Electrical Power & Control Equipment (38000KW)	set	1	35,700,000	35,700,000.00
3)-2	Emergency Power Plant	kw	38,000	770	29,260,000.00
3)-3	Misc. Electrical Equip.	set	1	8,000,000	8,000,000.00
4)	Others				
4)-1	Local Control Buildings	set	1	700,000	700,000.00
4)-2	Their electrical equipment	set	1	200,000	200,000.00
4)-3	Cathodic Protection	set	1	2,700,000	2,700,000.00
4)-4	Monitoring & Surveillance Equip. Communication System	set	1	3,100,000	3,100,000.00
4)-5	Systems, Grounding System	set	1	700,000	700,000.00
4)-6	and Other Electric works and Consumables	set	1	1,200,000	1,200,000.00
	Subtotal this Sheet				567,541,110.00
	Total-Item No. 4 Gate Leaves and Related Structure				1,011,237,350.00

BILL NO. : 9 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A.D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
5	NEW DAMS				
(1)	INDIO DAM (H=90M)				
1)	Earthwork Excavation for Dam Foundation				
1)-1	Top Soil Removal	m2	776,100	1.59	1,233,999.00
	Excavation(Hauling Distance 5km) Shovel(3.0m3), Dump Truck(32t)				
1)-1	Common	m3	850,000	4.77	4,054,500.00
1)-2	Weathered Rock	m3	850,000	6.68	5,678,000.00
	Total m3		1,700,000		
1)-3	Foundation Preparation (Finish excavation, t=0.5m) Foundation Area, 776,100m2*20%	m2	156,000	34.28	5,347,680.00
1)-4	Foundation Preparation by Washing	m2	156,000	30.50	4,758,000.00
1)-5	Excavation for Diversion tunnel	m3	152,000	120.00	18,240,000.00
	Excavation for Spillway				
1)-6	Common	m3	59,500	4.77	283,815.00
1)-7	Weathered Rock	m3	35,700	6.68	238,476.00
1)-8	Hard Rock	m3	23,800	8.46	201,348.00
	Total m3		119,000		
	Embankment(Hauling Distance 10.0km)				
1)-9	Core	m3	2,000,000	11.69	23,380,000.00
1)-10	Filter	m3	1,700,000	11.70	19,890,000.00
1)-11	Rock	m3	10,000,000	8.46	84,600,000.00
	Total m3		13,700,000		
	Subtotal this Sheet				167,905,818.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
2)	Grouting(Curtain)				
	Curtain Grouting				
2)-1	Drilling Grouting Hole	m	83,000	73.09	6,066,470.00
2)-2	Pressure Grouting	m	83,000	71.50	5,934,500.00
	Blanket Grouting				
2)-3	Drilling Grouting Hole	m	44,100	19.99	881,559.00
2)-4	Pressure Grouting	m	44,100	34.07	1,502,487.00
3)	Concrete Works including Formworks etc				
3)-1	Concrete for Spillway	m3	83,000	100.00	8,300,000.00
3)-2	Concrete for Diversion Tunnel	m3	26,000	120.00	3,120,000.00
3)-3	Concrete for Outlet	m3	50,000	100.00	5,000,000.00
	Total m3		159,000		
3)-4	Reinforcing Bars(Deformed)	t	9,540	804.10	7,671,114.00
4)	Steel Works & Equipment				
4)-1	Outlet Penstock	t	30	7,200.00	216,000.00
4)-2	Hollow-jet Valve Φ=1.3m	set	1	470,000.00	470,000.00
4)-3	Spare Valve Φ=1.3m	set	1	280,000.00	280,000.00
(2)	TRINIDADO DAM (H=80M) to be provided in the year of AC 2,060		-	-	-
(3)	CIRI DAM		nil	-	-
(4)	UPPER GATUN DAM		nil	-	-
	Subtotal this Sheet				39,442,130.00
	Total-Item No.5 New Dams				207,347,948.00

BILL NO. : 11 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
6	PUMP STATIONS				
(1)	PUMP STATION AT ATATLANTIC LOCK to be provided in the year of 2,060		-	-	-
(2)	PUMP STATION AT PACIFIC LOCK to be provided in the year of 2,060		-	-	-
	Subtotal this Sheet Total-Item No. 6 Pump Stations				0.00 -

BILL NO. : 12 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost	Amount
				$	$
7	NEW PERMANENT ROADS				
(1)	ROADS FOR INSPECTION (NEW ROADS) W =6.8m				
1)	Subgrade, Base Course(t = 0.4m)	km	32.0	110,490.00	3,535,680.00
2)	Asphalt Paving(t=70mm)	m2	320,000.0	12.88	4,121,600.00
	Subtotal this Sheet				7,657,280.00
	Total-Item No. 7 New Permanent Roads				7,657,280.00

BILL NO. : 13 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
8	NEW CANAL CROSSINGS				
(1)	BRIDGES				
1)	Bridges Over The Canal on Pacific Side				
1)-1	Cable Stayed Bridge Canal Width 350m Span = L1(Main)+L2+L3=480+190+190=860m Width = 20.5m (Four Lane)	m2	17,630	15,834.00	279,153,420.00
1)-2	Approaching Bridges(Steel Box Girder) Total Length = 800m (One Span 60m) Width = 20.5m (Four Lane)	m2	16,400	2,956.00	48,478,400.00
2)	Bridges Over the Canal for Van Dam Bypass(1) (To be provided in the year of 2,060)		-	-	-
3)	Bridges Over the Canal for Van Dam Bypass(2) (To be provided in the year of 2,060)				
	Subtotal this Sheet				327,631,820.00

BILL NO. : 14 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200, 000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q' ty	Unit Cost	Amount
				$	$
4)	Bridges Over the Canal at Middle Gamboa		-	-	-
	(To be provided in the year of 2, 060)				
5)	Bridges Over The Canal on Atlantic Side				
5)-1	Cable Stayed Bridge Canal Width 350m Span = L1(Main)+L2+L3=430+170+170=770m Width = 10. 0m (Two Lane)	m2	7, 700	13, 680. 00	105, 336, 000. 00
5)-2	Approaching Bridges(Steel Box Girder) Total Length = 1, 500m (One Span 60m) Width = 10. 0m (Two Lane)	m2	15, 000	2, 980. 00	44, 700, 000. 00
(2)	Demolition of Existing Bridge				
1)	Balboa bridge(Bridge of the Americas)				
1)-1	Super-structure	t	14, 000	1, 120. 00	15, 680, 000. 00
1)-2	Sub-Structure	ls	1	7, 840, 000	7, 840, 000. 00
	Subtotal this Sheet				173, 556, 000. 00
	Total-Item No. 8 New Canal Crossings				501, 187, 820. 00

BILL NO. : 15 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A.D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
9	NAVIGATION SUPPORT SYSTEMS				
(1)	Navigation Lights and Leading Channel Range Marker Lights				
	For Two-Way Newly Excavated Canal				
1)	Navigation Lights 10 w, Lens Type Light Range : Three Nautical miles Power supply : Solar Battery				
1)-1	Pacific Ocean Navigation Light(Buoy) For 11km (Interval 927m) 11,000 / 927 m = 12 * 2 sides	sets	24	121,506.00	2,916,144.00
1)-2	Atlantic Ocean Navigation For 11km (Interval 927m)	sets	24	121,506.00	2,916,144.00
1)-3	At turning points, S and T 2 points x 2 sets	sets	4	121,506.00	486,024.00
1)-4	At turning points, B, C and D 3 points x 2 sets	sets	6	121,506.00	729,036.00
1)-5	Leading Channel Range Marker Light 4 points x 2 lanes x 2 sets	sets	16	473,496.00	7,575,936.00
	For Two-way widened-portion of the Canal, 30 km				
1)-6	Relocation of existing Navigation Lights (Buoys) (specification)	sets	-	12,874.00	0.00
1)-7	Leading Channel Range Marker Light 30 points x 2	sets	60	473,496.00	28,409,760.00
	Subtotal this Sheet				43,033,044.00

BILL NO. : 16 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	TUG STATION				
1)	Provide Tug Boats, 6,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	23	6,649,286	152,933,578.00
2)	Provide/Supply Tug Boats, 3,000 HP-4,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	2	4,652,857	9,305,714.00
3)	Launches(for 10 persons) Twin Screw (maintenance/running Cost not included)	unit	14	163,571	2,289,994.00
(3)	EMERGENCY TIE UP STATION (Mooring Dolphin Type)				
1)	Located at the north end of the new Pacific Locks	nos	1	14,043,200	14,043,200.00
2)	Located at Gatun Lake	nos	1	14,043,200	14,043,200.00
3)	Excavation				
	Dry Excavation(Hauling distance 4.0km)				
3)-1	Common	m3	1,600,000	2.27	3,632,000.00
3)-2	Weathered Rock	m3	960,000	3.32	3,187,200.00
3)-3	Hard Rock	m3	640,000	5.22	3,340,800.00
	Dredging(Hauling Distance 22km)				
3)-4	Clayey material(clay, silt)	m3	1,600,000	4.79	7,664,000.00
3)-5	Weathered Rock	m3	960,000	7.33	7,036,800.00
3)-6	Hard Rock	m3	640,000	100.95	64,608,000.00
	Total Excavation m3		6,400,000		
	Subtotal this Sheet				282,084,486.00

BILL NO. : 17 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(4)	Jetty(10m x 50m)				
	Five(5) Locations for Tug Jetty				
1)	Colon	nos	2	4,072,000	8,144,000.00
2)	Gatun Lake	nos	2	4,072,000	8,144,000.00
3)	Gamboa	nos	1	4,072,000	4,072,000.00
4)	Pedro Miguel	nos	1	4,072,000	4,072,000.00
5)	Diablo	nos	2	4,072,000	8,144,000.00
	Subtotal this Sheet				32,576,000.00
	Total-Item No. 9 Navigation Support Systems				357,693,530.00

BILL NO. : 18 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
10	Barrier Dam (not applicable for the H. R. L Canal)		nil	-	-
11	Break Water (not applicable for the H. R. L Canal)		nil	-	-
12	Diversion Scheme (not applicable for the H. R. L Canal)		nil	-	-
	Subtotal this Sheet				-

BILL NO. : 19 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
13	SUPPORTING CONSTRUCTION To be assigned as percentage of Construction Costs	ls	1		254,805,300
	Subtotal this Sheet				254,805,300.00
	Total-Item No. 13 Supporting Construction				254,805,300.00

BILL NO. : 20 HRLC, SINGLE LANE CULEBRA CUT OPTION CASE-(6)
(A. D. 2020) 200,000 DWT (RISE 85 FEET)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
14	GENERAL CONDITIONS				
(1)	Canal Excavation, (14.3%, Item Total)	ls	1		236,835,000.00
(2)	Placing Area, (14.3%, Item Total)	ls	1		10,984,000.00
(3)	Lock Construction (15.8%, Item Total)	ls	1		132,434,000.00
(4)	Gate Leaves and Related Facilities		-		-inclusive-
(5)	New Dams, (14,3%, Item Total)	ls	1		29,651,000.00
(6)	Pump Station		nil		-
(7)	New Parmanent Roads, (14.3%, Item Total)	ls	1		1,095,000.00
(8)	New Canal Crossing		-		-inclusive-
(9)	Navigation Support System(15.8%, I. Total)	ls	1		56,516,000.00
(10)	Barrier Dams		nil		-
(11)	Breakwater		nil		-
(12)	Diversion Scheme		nil		-
(13)	Supporting Construction, (14.3%, I. Total)	ls	1		36,437,200.00
	Subtotal this Sheet				503,952,200.00
	Total-Item No. 14 General Conditions				503,952,200.00

2.3 Bill of Quantities for Case-(d)

(1) Sea Level Canal, Route 10
Single Lane in Tidal Lock on Pacific Side
250,000DWT, the Year of 2020

1) Summary

Item No.	Description	Unit	General Cond. $	D. Const. Cost $	Project Costs $
			(II)	(I)	(I)+(II)
	SUMMARY				
I	DIRECT CONSTRUCTION COSTS				
(A)	CIVIL WORKS				
1	Canal Excavation	ls	781,211,000	5,463,011,840	6,244,222,840.00
2	Placing Area	ls	23,606,000	165,076,691	188,682,691.00
3	Lock Construction	ls	68,835,000	435,661,730	504,496,730.00
5	New Dams(to be provided in A.D. 2,060)		-	-	-
6	Pump Station		nil	nil	nil
7	New Permanent Roads	ls	2,430,000	16,989,590	19,419,590.00
8	New Canal Crossing	ls	inclusive	187,672,650	187,672,650.00
10	Barrier Dams	ls	61,742,000	431,760,306	493,502,306.00
11	Breakwater	ls	50,296,000	351,719,840	402,015,840.00
12	Diversion Scheme	ls	9,419,000	65,866,156	75,285,156.00
13	Supporting Construction	ls	60,233,000	421,207,000	481,440,000.00
	Subtotal		1,057,772,000	7,538,965,803	8,596,737,803.00
(B)	PLANT FORMING A PART OF PERMANENT WORK				
4	Gate Leaves and Related Facilities	ls	inclusive	316,008,430	316,008,430.00
9	Navigation Support System	ls	74,538,000	471,757,047	546,295,047.00
	Subtotal		74,538,000	787,765,477	862,303,477
	CONSTRUCTION COSTS, TOTAL		1,132,310,000	8,326,731,280	9,459,041,280
III	INDIRECT COSTS				
1	Administrative Costs(*1)	ls	-	-	96,482,200.00
2	Headquarter's Costs(*1)	ls	-	-	163,429,600.00
3	Construction Supervision(*1)	ls	-	-	182,957,600.00
4	Land Aquisition & Rights	ls	-	-	27,337,175.00
5	Compensation Costs	ls	-	-	13,557,600.00
6	Contingency(10% of Const. Costs)	ls	-	-	945,904,000.00
	Subtotal				1,429,668,175.00
	(*1):to be assingned as percentage of Construction Costs				
	GRAND TOTAL(PROJECT COSTS)				10,888,709,455.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
					0.00
I	DIRECT CONSTRUCTION COSTS				
1	CANAL EXCAVATION				
(1)	Grubbing & clearing in the Canal Area				
1)	ZONE 1	m2	0	0.21	0.00
2)	ZONE 2	m2	5,878,000	0.21	1,234,380.00
3)	ZONE 3	m2	2,073,000	0.21	435,330.00
4)	ZONE 4	m2	11,910,000	0.21	2,501,100.00
5)	ZONE 5	m2	0	0.21	0.00
	Grubbing & Clearing Total m2		19,861,000		
(2)	Dry Excavation				
1)	ZONE 1				
	Average hauling distance 0.0km				
1)-1	Common	m3	0	-	0.00
1)-2	Weathered rock (using ripper)	m3	0	-	0.00
1)-3	Medium Hard rock (using ripper)	m3	0	-	0.00
1)-4	Hard rock (using blasting)	m3	0	-	0.00
2)	ZONE 2				
	Average hauling distance 4.5km				
2)-1	Common	m3	14,851,000	2.42	35,939,420.00
2)-2	Weathered rock (using ripper)	m3	84,678,000	3.51	297,219,780.00
2)-3	Medium Hard rock (using ripper)	m3	39,990,000	3.51	140,364,900.00
2)-4	Hard rock (using blasting)	m3	9,997,000	5.43	54,283,710.00
	Subtotal this Sheet				531,978,620.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3)	ZONE 3				
	Average hauling distance 3.5km				
3)-1	Common	m3	23,229,000	2.12	49,245,480.00
3)-2	Weathered rock (using ripper)	m3	117,992,000	3.14	370,494,880.00
3)-4	Medium Hard rock (using ripper)	m3	54,557,000	3.14	171,308,980.00
3)-5	Hard rock (using blasting)	m3	13,639,000	5.01	68,331,390.00
4)	ZONE 4				
	Average hauling distance 4.0km				
4)-1	Common	m3	41,967,000	2.27	95,265,090.00
4)-2	Weathered rock (using ripper)	m3	373,581,000	3.32	1,240,288,920.00
4)-3	Medium Hard rock (using ripper)	m3	121,559,000	3.32	403,575,880.00
4)-4	Hard rock (using blasting)	m3	52,097,000	5.22	271,946,340.00
5)	ZONE 5				
	Average hauling distance 0.0km				
5)-1	Common	m3	0		0.00
5)-2	Weathered rock (using ripper)	m3	0		0.00
5)-3	Medium Hard rock (using ripper)	m3	0		0.00
5)-4	Hard rock (using blasting)	m3	0		0.00
	Dry Excavation Total m3		948,137,000		
	Subtotal this Sheet				2,670,456,960.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(3)	Dredging				
1)	ZONE 1				
	Average hauling distance 2.5km				
1)-1	Clayey material(clay, silt)	m3	8,857,000	3.91	34,630,870.00
1)-2	Loose material(sand, gravel)	m3	5,163,000	3.61	18,638,430.00
1)-3	Weathered rock	m3	2,242,000	6.94	15,559,480.00
1)-4	Medium Hard rock	m3	0	-	0.00
1)-5	Hard rock (using blasting)	m3	0	-	0.00
2)	ZONE 2				
	Average hauling distance 10.5km				
2)-1	Clayey material(clay, silt)	m3	0	2.39	0.00
2)-2	Loose material(sand, gravel)	m3	18,104,000	2.25	40,734,000.00
2)-3	Weathered rock	m3	27,935,000	4.31	120,399,850.00
2)-4	Medium Hard rock	m3	31,120,000	8.98	279,457,600.00
2)-5	Hard rock (using blasting)	m3	7,780,000	70.53	548,723,400.00
3)	ZONE 3				
	Average hauling distance 2.0km				
3)-1	Clayey material(clay, silt)	m3	7,755,000	2.41	18,689,550.00
3)-2	Loose material(sand, gravel)	m3	6,612,000	2.22	14,678,640.00
3)-3	Weathered rock	m3	10,386,000	4.28	44,452,080.00
3)-4	Medium Hard rock	m3	0	-	0.00
3)-5	Hard rock (using blasting)	m3	0	-	0.00
4)	ZONE 4				
	Average hauling distance 2.5km				
4)-1	Clayey material(clay, silt)	m3	0	2.39	0.00
4)-2	Loose material(sand, gravel)	m3	8,579,000	2.22	19,045,380.00
4)-3	Weathered rock	m3	33,888,000	4.28	145,040,640.00
4)-4	Medium Hard rock	m3	10,431,000	8.95	93,357,450.00
4)-5	Hard rock (using blasting)	m3	4,471,000	70.46	315,026,660.00
5)	ZONE 5				
	Average hauling distance 2.5km				
5)-1	Clayey material(clay, silt)	m3	50,094,000	2.41	120,726,540.00
5)-2	Loose material(sand, gravel)	m3	39,840,000	2.22	88,444,800.00
5)-3	Weathered rock	m3	31,086,000	4.28	133,048,080.00
5)-4	Medium Hard rock	m3	0	-	0.00
5)-5	Hard rock (using blasting)	m3	0	-	0.00
	Wet Excavation Total m3		304,343,000		
	Subtotal this Sheet				2,050,653,450.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(4)	Vegetation(Seeding) of Canal Slope				
1)	ZONE 1	m2	12,000	0.75	9,000.00
2)	ZONE 2	m2	2,687,000	0.75	2,015,250.00
3)	ZONE 3	m2	2,199,000	0.75	1,649,250.00
4)	ZONE 4	m2	7,327,000	0.75	5,495,250.00
5)	ZONE 5	m2	-	0.75	0.00
	Total Area m2		12,225,000		
(5)	Temporary Works				
1)	Access Roads(W=22m, t=1.5m)	m	30,000	1002.98	30,089,400.00
	Starting from excavating spot in the Canal to main construction road which is lying along the Canal				
2)	Dewatering for Dry Excavation	m3	948,137,000	0.18	170,664,660.00
	Subtotal this Sheet				209,922,810.00
	Total-Item No.1 Canal Excavation				5,463,011,840.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
2	Placing Areas for Surplus Material				
(1)	Grubbing & Clearing for Placing Areas				
1)	D-01 Area	m2	2,100,000.0	0.21	441,000.00
2)	D-02 Area	m2	2,200,000.0	0.21	462,000.00
3)	D-03 Area	m2	3,700,000.0	0.21	777,000.00
4)	D-04 Area	m2	200,000.0	0.21	42,000.00
5)	D-05 Area	m2	400,000.0	0.21	84,000.00
6)	D-06 Area	m2	2,200,000.0	0.21	462,000.00
7)	D-07 Area	m2	4,600,000.0	0.21	966,000.00
8)	D-08 Area	m2	2,400,000.0	0.21	504,000.00
9)	D-09 Area	m2	1,600,000.0	0.21	336,000.00
10)	D-10 Area	m2	1,600,000.0	0.21	336,000.00
11)	D-11 Area	m2	2,300,000.0	0.21	483,000.00
12)	D-12 Area	m2	2,100,000.0	0.21	441,000.00
13)	D-13 Area	m2	2,300,000.0	0.21	483,000.00
14)	D-14 Area	m2	2,700,000.0	0.21	567,000.00
15)	D-15 Area	m2	5,300,000.0	0.21	1,113,000.00
16)	D-16 Area	m2	8,300,000.0	0.21	1,743,000.00
17)	D-17 Area	m2	4,700,000.0	0.21	987,000.00
18)	D-18 Area	m2	1,300,000.0	0.21	273,000.00
19)	D-19 Area	m2	1,000,000.0	0.21	210,000.00
	Total Area m2		51,000,000.0		
(2)	Placing Area Preparation Including Surface Drainage(Open Ditch) Vegetation Under Ground Drainage	km2	51.00	2,535,141.00	129,292,191.00
(3)	Access Roads (W = 22m, t=1.5m) Starting from placing area to the main construction road	m	25,000	1002.98	25,074,500.00
	Subtotal this Sheet				165,076,691.00
	Total-Item No. 2 Placing Areas for Surplus Material				165,076,691.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3	LOCK CONSTRUCTION				
(1)	PACIFIC TIDAL LOCK				
1)	Excavation(Hauling Distance 5.0m)				
1)-1	Common	m3	20,000,000	2.57	51,400,000.00
1)-2	Weathered Rock	m3	12,000,000	3.69	44,280,000.00
1)-3	Hard Rock	m3	8,000,000	5.64	45,120,000.00
	Total m3		40,000,000		
1)-4	Dewatering	ls	1.00	36,598,000	36,598,000.00
2)	Backfill	m3	7,800,000	3.85	30,030,000.00
3)	Grouting				
3)-1	Consolidation Groutiong	m	125,800	20.05	2,522,290.00
3)-2	Curtain Groutiong	m	125,800	66.80	8,403,440.00
4)	Concrete including form works, etc	m3	2,000,000	76.49	152,980,000.00
5)	Reinforcing Bar (Deformed)	t	80,000	804.10	64,328,000.00
6)	Excavation for Approaching Channel to the Lock (Dry Excavation)		nil		
6)-1	Common	m3	-	2.57	0.00
6)-2	Weathered Rock	m3	-	3.69	0.00
6)-3	Hard Rock	m3	-	5.64	0.00
	Total m3		-		
	Subtotal this Sheet				435,661,730.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	ATLANTIC TIDAL LOCK/GATE		nil	-	-
	Subtotal this Sheet				0.00
	Total-Item No. 3 Lock Construction				435,661,730.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
4	GATE LEAVES AND RELATED FACILITIES				
(1)	GATE LEAVES AT PACIFIC TIDAL LOCK				
1)	Gate Leaves	ton	10,776	9,730	104,850,480.00
2)	Mechanical Equipment				
2)-1	Gate Frames	ton	3,209	11,110	35,651,990.00
2)-2	Gate Hoists	ton	1,503	15,000	22,545,000.00
2)-3	Locomotives	unit	10	3,600,000	36,000,000.00
2)-4	Rails and Racks for Locomotives	ton	3,014	8,140	24,533,960.00
2)-5	Power Supply Line for Locomotives	set	1	4,000,000	4,000,000.00
2)-6	Other Mechanical Component (Compressed Air System, Drainage Pumps Piping and Misc. Mechanical Equip.)	set	1	31,467,000	31,467,000.00
3)	Electrical Power and Control				
3)-1	Electric Power and Control Equipments (84000KW)	set	1	25,900,000	25,900,000.00
3)-2	Emergency Power Plant(84000kw)	kw	28,000	770	21,560,000.00
3)-3	Miscellaneous El. Equipments	set	1	5,000,000	5,000,000.00
4)	Others				
4)-1	Local Control Builidings	set	1	400,000	400,000.00
4)-2	Electrical Equipments	set	1	100,000	100,000.00
4)-3	Cathodic Protection	set	1	1,400,000	1,400,000.00
4)-4	Monitoring & Surveillance Equip. Communication Syestem	set	1	1,600,000	1,600,000.00
4)-5	Grounding System	set	1	400,000	400,000.00
4)-6	Other Electric Works and Consumable	set	1	600,000	600,000.00
	Subtotal this Sheet				316,008,430.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	GATE LEAVES AT ATLANTIC SIDE		nil	-	-
	Subtotal this Sheet				-
	Total-Item No. 4 Gate Leaves and Related Structure				316,008,430.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
5	NEW DAMS				
(1)	UPPER GATUN DAM (H=100M) to be provided in the year of 2,060		-	-	-
	Subtotal this Sheet				-
	Total-Item No. 5 New Dams				-

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
6	PUMP STATIONS		nil	-	-
	Subtotal this Sheet				-
	Total-Item No. 6 Pump Stations				-

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
7	NEW PERMANENT ROADS				
(1)	ROADS FOR INSPECTION (NEW ROADS) W = 6.8m				
1)	Subgrade, Base Course(t=0.4m)	km	71.0	110,490.00	7,844,790.00
2)	Asphalt Paving(t=70mm)	m2	710,000.0	12.88	9,144,800.00
	Subtotal this Sheet				16,989,590.00
	Total-Item No. 7 New Permanent Roads				16,989,590.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
8	NEW CANAL CROSSINGS				
(1)	BRIDGES OVER THE NEW CANAL				
1)	Bridges Over The Canal on Pacific Side				
1)-1	Cable Stayed Bridge Canal Width 190m Span = L1(Main)+L2+L3=120+50+50=220m Width = 20.5m (Four Lane)	m2	4,510	4,255.00	19,190,050.00
1)-2	Approaching Bridges(Steel Box Girder) Total Length = 600m (One Span 60m) Width = 20.5m (Four Lane)	m2	12,300	2,956.00	36,358,800.00
2)	Bridges Over the Canal at Middle				
2)-1	Cable Stayed Bridge Canal Width 190m Span = L1(Main)+L2+L3=350+140+140=630m Width = 10.0m (Two Lane)	m2	6,300	11,146.00	70,219,800.00
2)-2	Approaching Bridges(Steel Box Girder) Total Length = 600m (One Span 60m) Width = 10.0m (Two Lane)	m2	6,000	2,980.00	17,880,000.00
3)	Bridges Over The Canal on Atlantic Side				
3)-1	Cable Stayed Bridge Canal Width 190m Span = L1(Main)+L2+L3=350+140+140=430m Width = 10.0m (Two Lane)	m2	4,300	6,080.00	26,144,000.00
3)-2	Approaching Bridges(Steel Box Girder) Total Length = 600m (One Span 60m) Width = 10.0m (Two Lane)	m2	6,000	2,980.00	17,880,000.00
	Subtotal this Sheet				187,672,650.00
	Total-Item No. 8 New Canal Crossings				187,672,650.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
9	NAVIGATION SUPPORT SYSTEMS				
	For Two-Way Canal Portion				
(1)	Navigation Lights (Buoys or Beacons) and Leading Channel Range Lights				
1)	Navigation Lights (Buoys or Beacons) 10 w, Lens Type Light Range : Three Nautical miles Power supply : Battery				
1)-1	Pacific Ocean Side Navigation For 30km (interval every 927m) 30,000/927=33 * 2 sides	sets	66	121,506.00	8,019,396.00
1)-2	At turning points, L and M 2 points * 2 sides	sets	4	121,506.00	486,024.00
1)-3	Atlantic Ocean Side Navigation For 3km (interval every 927m) 3,000/927 = 4 * 2 sides	sets	8	121,506.00	972,048.00
	For One-Way Canal Portion				
	Navigation Lights (Beacon, Pole Type) 5w, Lens Type Light Range : One Nautical miles Power supply : by supply				
2)-4	Navigation Lights (Beacon, Pole Type) 55,000m / 152m = 362 * 2 sides	sets	724	46,656.00	33,778,944.00
2)-5	Navigation Lights (Beacon, Pole Type) At turning points, B, C ... K 10 points x 2 sets	sets	20	46,656.00	933,120.00
	Subtotal this Sheet				44,189,532.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3)	Channel Range Marker(Light)				
3)-1	For One-Way Canal Portion 5 points x 1 lane x 2 sets	sets	10	473,496.00	4,734,960.00
3)-2	For Two-Way Canal Portion 4 points x 2 lanes x 4 sets	sets	32	473,496.00	15,151,872.00
	Subtotal this Sheet				19,886,832.00

BILL NO. : 16 SLC, SINGLE LANE IN TIDAL LOCK CASE-(d)
(A. D. 2020) 250,000DWT TIDAL LOCK(PACIFIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	TUG STATION				
1)	Provide Tug Boats, 6,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	16	6,649,286	106,388,576.00
2)	Provide/Supply Tug Boats, 3,000 HP-4,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	9	4,652,857	41,875,713.00
3)	Launches(for 10 persons) Twin Screw (maintenance/running Cost not included)	unit	14	163,571	2,289,994.00
(3)	EMERGENCY TIE UP STATION (Mooring Dolphin Type)				
1)	Located Near Station B	nos	1	14,043,200	14,043,200.00
2)	Located Near Station C	nos	1	14,043,200	14,043,200.00
3)	Excavation				
	Dry Excavation(Hauling distance 4.0km)				
3)-1	Common	m3	2,000,000	2.27	4,540,000.00
3)-2	Weathered Rock	m3	1,200,000	3.32	3,984,000.00
3)-3	Hard Rock	m3	800,000	5.22	4,176,000.00
	Dredging(Hauling Distance 22km)				
3)-4	Clayey material(clay, silt)	m3	2,000,000	4.79	9,580,000.00
3)-5	Weathered Rock	m3	1,200,000	7.33	8,796,000.00
3)-6	Hard Rock	m3	800,000	100.95	80,760,000.00
	Total Excavation m3		8,000,000		
	Subtotal this Sheet				290,476,683.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(4)	Jetty(10m x 50m) Three(3) Locations for Tug Jetty				
1)	Located Near Station A	nos	2	4,972,000	9,944,000.00
2)	Located Near Station B	nos	2	4,972,000	9,944,000.00
3)	Located Near Station C	nos	3	4,972,000	14,916,000.00
(5)	Mooring Buoy				
1)	Located at Atlantic Entrance (50,000 DWT * 2)	nos	2	20,600,000	41,200,000.00
2)	Located at Pacific Entrance (50,000 DWT * 2)	nos	2	20,600,000	41,200,000.00
	Subtotal this Sheet				117,204,000.00
	Total-Item No. 9 Navigation Support Systems				471,757,047.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
1 0	BARRIER DAMS				
(1)	BARRIER DAM 'E'				
1)	Dredging(Hauling distance 10km)				
1)-1	Clayey Material(Clay, Silt)	m3	2,900,000	2.89	8,381,000.00
1)-2	Loose Material(Sand, Gravel)	m3	3,000,000	2.88	8,640,000.00
	Total Excavation m3		5,900,000		
2)	Filling Materials Onland Hauling(10km) Dump Truck(240t), Shovel(30m3)				
2)-1	Core Material	m3	4,300,000	4.52	19,436,000.00
2)-2	Filter Material	m3	3,600,000	4.52	16,272,000.00
2)-3	Sand Material	m3	300,000	4.52	1,356,000.00
2)-4	Rock Material	m3	4,540,000	4.46	20,248,400.00
2)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	260,000	4.46	1,159,600.00
	Total Volume m3		13,000,000		
3)	Filling on Water Operation (Filling Below WL -4.0m)				
3)-1	Core Material	m3	3,700,000	5.67	20,979,000.00
3)-2	Filter Material	m3	3,380,000	6.54	22,105,200.00
3)-3	Sand Material	m3	240,000	5.67	1,360,800.00
3)-4	Rock Material	m3	4,295,000	6.54	28,089,300.00
3)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	120,000	21.58	2,589,600.00
4)	Filling on Water Operation (Filling, Above WL -4.0m)				
4)-1	Core Material	m3	600,000	8.70	5,220,000.00
4)-2	Filter Material	m3	220,000	14.38	3,163,600.00
4)-3	Sand Material	m3	60,000	8.70	522,000.00
4)-4	Rock Material	m3	245,000	14.38	3,523,100.00
4)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	140,000	84.04	11,765,600.00
	Total Filling m3		13,000,000		
	Subtotal this Sheet				174,811,200.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
5)	Curtain Grouting				
5)-1	Drilling	m	36,000	73.09	2,631,240.00
5)-2	Pressure Grouting(cement 50kg/m)	m	20,000	71.50	1,430,000.00
6)	Excavation for Spillway				
	Dredging				
6)-1	Clayey Material	m3	500,000	2.89	1,445,000.00
6)-2	Weathered Rock	m3	300,000	2.88	864,000.00
6)-3	Hard Rock	m3	200,000	70.53	14,106,000.00
	Toatal m3		1,000,000		
	Dry Excavation(Hauling Distance 0.5km)				
	Shovel(3.0m3), Dump Truck(32t)				
6)-4	Excavation Common	m3	2,150,000	1.82	3,913,000.00
6)-5	Weathered Rock	m3	1,290,000	3.03	3,908,700.00
6)-6	Hard Rock	m3	860,000	4.72	4,059,200.00
	Toatal m3		4,300,000		
7)	Concrete works including forms, etc.				
7)-1	For Spillway	m3	6,000	100.00	600,000.00
7)-2	Reinforcing Bars(Deformed)	t	360	804.10	289,476.00
8)	Gates				
8)-1	Sliding gates	t	17.0	10,000.00	170,000.00
8)-2	Sliding gates hoists	t	4.0	12,100.00	48,400.00
8)-3	Spare gate	t	6.0	9,300.00	55,800.00
8)-4	Radial gate	t	9.0	12,100.00	108,900.00
8)-5	Radial gate hoist	t	5.0	12,100.00	60,500.00
8)-6	Spare gate	t	9.0	9,300.00	83,700.00
	Subtotal this Sheet				33,773,916.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	BARRIER DAM 'F'				
1)	Dredging(Hauling Distance 15km)				
1)-1	Clayey Material(Clay, Silt)	m3	3,000,000	2.91	8,730,000.00
1)-2	Loose Material(Sand, Gravel)	m3	3,500,000	2.90	10,150,000.00
	Total Excavation m3		6,500,000		
2)	Filling Materials Onland Hauling(10km) Dump Truck(240t), Shovel(30m3)				
2)-1	Core Material	m3	4,650,000	4.52	21,018,000.00
2)-2	Filter Material	m3	3,900,000	4.52	17,628,000.00
2)-3	Sand Material	m3	350,000	4.52	1,582,000.00
2)-4	Rock Material	m3	5,040,000	4.46	22,478,400.00
2)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	260,000	4.46	1,159,600.00
	Total Volume m3		14,200,000		
3)	Filling on Water Operation (Filling Below WL -4.0m)				
3)-1	Core Material	m3	4,000,000	5.67	22,680,000.00
3)-2	Filter Material	m3	3,660,000	6.54	23,936,400.00
3)-3	Sand Material	m3	290,000	5.67	1,644,300.00
3)-4	Rock Material	m3	4,760,000	6.54	31,130,400.00
3)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	120,000	21.58	2,589,600.00
4)	Filling on Water Operation (Filling, Above WL -4.0m)				
4)-1	Core Material	m3	650,000	8.74	5,681,000.00
4)-2	Filter Material	m3	240,000	14.38	3,451,200.00
4)-3	Sand Material	m3	60,000	8.74	524,400.00
4)-4	Rock Material	m3	280,000	14.42	4,037,600.00
4)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	140,000	84.04	11,765,600.00
	Total Filling m3		14,200,000		
5)	Curtain Grouting				
4)-1	Drilling	m	38,000	73.09	2,777,420.00
4)-2	Grouting(cement 50kg/m)	m	23,000	71.50	1,644,500.00
	Subtotal this Sheet				194,608,420.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(3)	BARRIER DAM 'G'				
1)	Dredging(Hauling Distance 10km)				
1)-1	Clayey Material(Clay, Silt)	m3	500,000	2.89	1,445,000.00
1)-2	Loose Material(Sand, Gravel)	m3	500,000	2.88	1,440,000.00
	Total Excavation m3		1,000,000		
2)	Filling Materials Onland Hauling(10km) Dump Truck(240t), Shovel(30m3)				
2)-1	Core Material	m3	650,000	4.52	2,938,000.00
2)-2	Filter Material	m3	600,000	4.52	2,712,000.00
2)-3	Sand Material	m3	50,000	4.52	226,000.00
2)-4	Rock Material	m3	655,000	4.46	2,921,300.00
2)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	45,000	4.46	200,700.00
	Total Volume m3		2,000,000		
3)	Filling on Water Operation (Filling Below WL -4.0m)				
3)-1	Core Material	m3	540,000	5.67	3,061,800.00
3)-2	Filter Material	m3	560,000	6.54	3,662,400.00
3)-3	Sand Material	m3	40,000	5.67	226,800.00
3)-4	Rock Material	m3	610,000	6.54	3,989,400.00
3)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	20,000	21.58	431,600.00
4)	Filling on Water Operation (Filling, Above WL -4.0m)				
4)-1	Core Material	m3	110,000	8.70	957,000.00
4)-2	Filter Material	m3	40,000	14.38	575,200.00
4)-3	Sand Material	m3	10,000	8.70	87,000.00
4)-4	Rock Material	m3	45,000	14.38	647,100.00
4)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	25,000	84.13	2,103,250.00
	Total Filling m3		2,000,000		
5)	Curtain Grouting				
4)-1	Drilling	m	8,000	73.09	584,720.00
4)-2	Grouting(cement 50kg/m)	m	5,000	71.50	357,500.00
	Subtotal this Sheet				28,566,770.00
	Total-Item No.10 Barrier Dams				431,760,306.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
1 1	BREAKWATER				
(1)	BREAKWATER AT ATLANTIC OCEAN SIDE				
	East Break Water 3,000m (M. Depth -17m) West Break Water 3,400m (M. Depth -17m)				
1)	Core				
1)-1	Core Materials(below -4.0m)	m3	6,705,000	12.34	82,739,700.00
1)-2	Core Materials(above -4.0m)	m3	795,000	13.54	10,764,300.00
2)	Armor Rock				
2)-1	Armor Rock (0.5ton/piece, below-4.0m)	m3	1,488,000	15.31	22,781,280.00
2)-2	Armor Rock (0.5ton/piece, above-4.0m)	m3	112,000	19.69	2,205,280.00
2)-3	Armor Rock (3.0ton/piece below-4.0m)	m3	-	30.86	0.00
2)-4	Armor Rock (3.0ton/piece above-4.0m)	m3	700,000	109.40	76,580,000.00
	Total Fill m3		9,800,000		
2)-5	Armor Rock supply, hauling(6km)	m3	2,300,000	5.88	13,524,000.00
(2)	BREAK WATER AT PACIFIC OCEAN SIDE				
	East Breakwater 8,000m (M. Depth -17m) West Breakwater (nil)				
1)	Core				
1)-1	Core Materials(below-4.0m)	m3	4,774,000	5.97	28,500,780.00
1)-2	Core Materials(above-4.0m)	m3	1,626,000	10.49	17,056,740.00
2)	Armor Rock				
2)-1	Armor Rock (0.5ton/piece, below-4.0m)	m3	928,000	8.31	7,711,680.00
2)-2	Armor Rock (0.5ton/piece, above-4.0m)	m3	272,000	16.64	4,526,080.00
2)-3	Armor Rock (3.0ton/piece below-4.0m)	m3	-	24.56	0.00
2)-4	Armor Rock (3.0ton/piece above-4.0m)	m3	700,000	105.94	74,158,000.00
	Total Fill m3		8,300,000		
2)-5	Armor Rock supply, hauling(6km)	m3	1,900,000	5.88	11,172,000.00
	Subtotal this Sheet				351,719,840.00
	Total-Item No. 11 Breakwater				351,719,840.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
1 2	DIVERSION SCHEME				
(1)	COFFER DAMS FOR DIVERSION				
1)	Coffer Dams E-1-D W-1-D W-3-D W-4-D W-6-D W-7-D E-3-Di				
	Excavation(Haulimg Diatance 5.0km) Shovel(3.0m3), Dump Truck(32t)				
1)-1	Common	m3	147,500	4.77	703,575.00
1)-2	Weathered Rock	m3	147,500	6.68	985,300.00
	Total m3		295,000		
	Embankment(Hauling Distance 5.0km) Shovel(3.0m3), Dump Truck(32t)				
1)-3	Core Material	m3	311,000	11.69	3,635,590.00
1)-4	Filter	m3	330,000	11.70	3,861,000.00
1)-5	Rock	m3	889,000	8.46	7,520,940.00
	Total Volume m3		1,530,000		
2)	Grouting Blanket Grouting				
2)-1	Drilling Grouting Hole	m	11,500	19.99	229,885.00
2)-2	Pressure Grouting	m	11,500	34.07	391,805.00
3)	Concrete Works including forms and etc.				
3)-1	Concrete	m3	3,500	100.00	350,000.00
3)-1	Reinforcing Bars(Deformed)	t	210	804.10	168,861.00
	Subtotal this Sheet				17,846,956.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	Diversion Channels E-1-C W-1-C W-3-C W-4-C W-6-C W-7-C E-3-C				
1)	Dry Excavation(Hauling Distance 0.5km)				
1)-1	Common	m3	5,700,000	1.82	10,374,000.00
1)-2	Weathered Rock	m3	3,420,000	3.03	10,362,600.00
1)-3	Hard Rock	m3	2,280,000	4.72	10,761,600.00
	Total m3		11,400,000		
2)	Dredging(Hauling Distance 2.5km)				
2)-1	Clayey Materials	m3	500,000	2.29	1,145,000.00
2)-2	Weathered Rock	m3	300,000	4.28	1,284,000.00
2)-3	Hard Rock	m3	200,000	70.46	14,092,000.00
	Total m3		1,000,000		
	Subtotal this Sheet				48,019,200.00
	Total-Item No. 12 Diversion Scheme				65,866,156.00

Item No.	Description	Unit	Q'ty	Unit Cost	Amount
				$	$
13	SUPPORTING CONSTRUCTION To be assigned as percentage of Construction Costs	ls	1		421,207,000
	Subtotal this Sheet				421,207,000.00
	Total-Item No. 13 Supporting Construction				421,207,000.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
14	GENERAL CONDITIONS				
(1)	Canal Excavation, (14.3%, Item Total)	ls	1		781,211,000.00
(2)	Placing Area, (14.3%, Item Total)	ls	1		23,606,000.00
(3)	Lock Construction (15.8%, Item Total)	ls	1		68,835,000.00
(4)	Gate Leaves and Related Facilities		-		-inclusive-
(5)	New Dams(to be provided in 2,060)		-		-
(6)	Pump Station		nil		-
(7)	New Parmanent Roads	ls	1		2,430,000.00
(8)	New Canal Crossing		-		-inclusive-
(9)	Navigation Support System(15.8% I.Total)	ls	1		74,538,000.00
(10)	Barrier Dams (14.3%, Item Total)	ls	1		61,742,000.00
(11)	Breakwater (14.3%, Item Total)	ls	1		50,296,000.00
(12)	Diversion Scheme (14.3%, Item Total)	ls	1		9,419,000.00
(13)	Supporting Construction(14.3% I. Total)	ls	1		60,233,000.00
	Subtotal this Sheet				1,132,310,000.00
	Total-Item No.14 General Conditions				1,132,310,000.00

2.4 Bill of Quantities for Case-(e)

(1) Sea Level Canal, Route 10
Single Lane in Zone II
Tidal Gates on Pacific & Atlantic Side
250,000DWT, the Year of 2020

1) Summary

Item No.	Description	Unit	General Cond. $	D. Const. Cost $	Project Costs $
			(II)	(I)	(I)+(II)
	SUMMARY				
I	DIRECT CONSTRUCTION COSTS				
(A)	CIVIL WORKS				
1	Canal Excavation	ls	738,109,000	5,161,598,910	5,899,707,910.00
2	Placing Area	ls	23,606,000	165,076,691	188,682,691.00
3	Gate Construction	ls	58,525,000	370,411,820	428,936,820.00
5	New Dams(to be provided in A.D. 2,060)		-	-	-
6	Pump Station		nil	nil	nil
7	New Permanent Roads	ls	2,430,000	16,989,590	19,419,590.00
8	New Canal Crossing	ls	inclusive	221,936,760	221,936,760.00
10	Barrier Dams	ls	61,742,000	431,760,306	493,502,306.00
11	Breakwater	ls	50,296,000	351,719,840	402,015,840.00
12	Diversion Scheme	ls	9,419,000	65,866,156	75,285,156.00
13	Supporting Construction	ls	60,233,000	421,207,000	481,440,000.00
	Subtotal		1,004,360,000	7,206,567,073	8,210,927,073
(B)	PLANT FORMING A PART OF PERMANENT WORK				
4	Gate Leaves and Related Facilities	ls	inclusive	737,960,800	737,960,800.00
9	Navigation Support System	ls	65,089,000	411,957,333	477,046,333.00
	Subtotal		65,089,000	1,149,918,133	1,215,007,133.00
	CONSTRUCTION COSTS, TOTAL		1,069,449,000	8,356,485,206	9,425,934,206.00
III	INDIRECT COSTS				
1	Administrative Costs(*1)	ls	-	-	96,144,500.00
2	Headquarter's Costs(*1)	ls	-	-	162,857,600.00
3	Construction Supervision(*1)	ls	-	-	182,317,300.00
4	Land Aquisition & Rights	ls	-	-	27,337,175.00
5	Compensation Costs	ls	-	-	13,557,600.00
6	Contingency(10% of Const. Costs)	ls	-	-	942,593,000.00
	Subtotal				1,424,807,175.00
	(*1): to be assigned as percentage of Construction Costs				
	GRAND TOTAL(PROJECT COSTS)				10,850,741,381.00

BILL NO. : 1 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A.D. 2020) 250,000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
					0.00
I	DIRECT CONSTRUCTION COSTS				
1	CANAL EXCAVATION				
(1)	Grubbing & clearing in the Canal Area				
1)-1	ZONE 1	m2	0	0.21	0.00
1)-2	ZONE 2	m2	5,878,000	0.21	1,234,380.00
1)-3	ZONE 3	m2	2,073,000	0.21	435,330.00
1)-4	ZONE 4	m2	11,910,000	0.21	2,501,100.00
1)-5	ZONE 5	m2	0	0.21	0.00
	Grubbing & Clearing Total m2		19,861,000		
(2)	Dry Excavation				
1)	ZONE 1				
	Average hauling distance 0.0km				
1)-1	Common	m3	-		0.00
1)-2	Weathered rock (using ripper)	m3	-		0.00
1)-3	Medium Hard rock (using ripper)	m3	-		0.00
1)-4	Hard rock (using blasting)	m3	-		0.00
2)	ZONE 2				
	Average hauling distance 4.5km				
2)-1	Common	m3	15,755,000	2.42	38,127,100.00
2)-2	Weathered rock (using ripper)	m3	89,409,000	3.51	313,825,590.00
2)-3	Medium Hard rock (using ripper)	m3	46,277,000	3.51	162,432,270.00
2)-4	Hard rock (using blasting)	m3	5,142,000	5.43	27,921,060.00
	Subtotal this Sheet				546,476,830.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3)	ZONE 3				
	Average hauling distance 3.5km				
3)-1	Common	m3	23,229,000	2.12	49,245,480.00
3)-2	Weathered rock (using ripper)	m3	117,992,000	3.14	370,494,880.00
3)-4	Medium Hard rock (using ripper)	m3	54,557,000	3.14	171,308,980.00
3)-5	Hard rock (using blasting)	m3	13,639,000	5.01	68,331,390.00
4)	ZONE 4				
	Average hauling distance 4.0km				
4)-1	Common	m3	41,419,000	2.27	94,021,130.00
4)-2	Weathered rock (using ripper)	m3	370,149,000	3.32	1,228,894,680.00
4)-3	Medium Hard rock (using ripper)	m3	121,103,000	3.32	402,061,960.00
4)-4	Hard rock (using blasting)	m3	51,903,000	5.22	270,933,660.00
5)	ZONE 5				
	Average hauling distance 0.0km				
5)-1	Common	m3	-		0.00
5)-2	Weathered rock (using ripper)	m3	-		0.00
5)-3	Medium Hard rock (using ripper)	m3	-		0.00
5)-4	Hard rock (using blasting)	m3	-		0.00
	Dry Excavation Total m3		950,574,000		
	Subtotal this Sheet				2,655,292,160.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(3)	Dredging				
1)	ZONE 1				
	Average hauling distance 2.5km				
1)-1	Clayey material(clay, silt)	m3	8,857,000	3.91	34,630,870.00
1)-2	Loose material(sand, gravel)	m3	5,163,000	3.61	18,638,430.00
1)-3	Weathered rock	m3	2,242,000	6.94	15,559,480.00
1)-4	Medium Hard rock	m3	0	-	0.00
1)-5	Hard rock (using blasting)	m3	0	-	0.00
2)	ZONE 2				
	Average hauling distance 10.5km				
2)-1	Clayey material(clay, silt)	m3	0	2.39	0.00
2)-2	Loose material(sand, gravel)	m3	18,104,000	2.25	40,734,000.00
2)-3	Weathered rock	m3	28,698,000	4.31	123,688,380.00
2)-4	Medium Hard rock	m3	36,437,000	8.98	327,204,260.00
2)-5	Hard rock (using blasting)	m3	4,049,000	70.53	285,575,970.00
3)	ZONE 3				
	Average hauling distance 2.0km				
3)-1	Clayey material(clay, silt)	m3	7,755,000	2.41	18,689,550.00
3)-2	Loose material(sand, gravel)	m3	6,612,000	2.22	14,678,640.00
3)-3	Weathered rock	m3	10,386,000	4.28	44,452,080.00
3)-4	Medium Hard rock	m3	0	-	0.00
3)-5	Hard rock (using blasting)	m3	0	-	0.00
4)	ZONE 4				
	Average hauling distance 2.5km				
4)-1	Clayey material(clay, silt)	m3	0	2.39	0.00
4)-2	Loose material(sand, gravel)	m3	7,657,000	2.22	16,998,540.00
4)-3	Weathered rock	m3	30,946,000	4.28	132,448,880.00
4)-4	Medium Hard rock	m3	9,785,000	8.95	87,575,750.00
4)-5	Hard rock (using blasting)	m3	4,194,000	70.46	295,509,240.00
5)	ZONE 5				
	Average hauling distance 2.5km				
5)-1	Clayey material(clay, silt)	m3	37,546,000	2.41	90,485,860.00
5)-2	Loose material(sand, gravel)	m3	32,824,000	2.22	72,869,280.00
5)-3	Weathered rock	m3	26,820,000	4.28	114,789,600.00
5)-4	Medium Hard rock	m3	0	-	0.00
5)-5	Hard rock (using blasting)	m3	0	-	0.00
	Wet Excavation Total m3		278,075,000		
	Subtotal this Sheet				1,734,528,810.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(4)	Vegetation(Seeding) of Canal Slope				
1)	ZONE 1	m2	12,000	0.75	9,000.00
2)	ZONE 2	m2	2,687,000	0.75	2,015,250.00
3)	ZONE 3	m2	2,199,000	0.75	1,649,250.00
4)	ZONE 4	m2	7,327,000	0.75	5,495,250.00
5)	ZONE 5	m2	-	0.75	0.00
	Total Area m2		12,225,000		
(5)	Temporary Works				
1)	Access Roads(W=22m, t=1.5m)	m	30,000	1,002.98	30,089,400.00
	Starting from excavating spot in the Canal to main construction road which is lying along the Canal				
2)	Dewatering for Dry Excavation	m3	1,033,572,000	0.18	186,042,960.00
	Subtotal this Sheet				225,301,110.00
	Total-Item No.1 Canal Excavation				5,161,598,910.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
2	Placing Areas for Surplus Material				
(1)	Grubbing & Clearing for Placing Areas				
1)	D-01 Area	m2	2,100,000.0	0.21	441,000.00
2)	D-02 Area	m2	2,200,000.0	0.21	462,000.00
3)	D-03 Area	m2	3,700,000.0	0.21	777,000.00
4)	D-04 Area	m2	200,000.0	0.21	42,000.00
5)	D-05 Area	m2	400,000.0	0.21	84,000.00
6)	D-06 Area	m2	2,200,000.0	0.21	462,000.00
7)	D-07 Area	m2	4,600,000.0	0.21	966,000.00
8)	D-08 Area	m2	2,400,000.0	0.21	504,000.00
9)	D-09 Area	m2	1,600,000.0	0.21	336,000.00
10)	D-10 Area	m2	1,600,000.0	0.21	336,000.00
11)	D-11 Area	m2	2,300,000.0	0.21	483,000.00
12)	D-12 Area	m2	2,100,000.0	0.21	441,000.00
13)	D-13 Area	m2	2,300,000.0	0.21	483,000.00
14)	D-14 Area	m2	2,700,000.0	0.21	567,000.00
15)	D-15 Area	m2	5,300,000.0	0.21	1,113,000.00
16)	D-16 Area	m2	8,300,000.0	0.21	1,743,000.00
17)	D-17 Area	m2	4,700,000.0	0.21	987,000.00
18)	D-18 Area	m2	1,300,000.0	0.21	273,000.00
19)	D-19 Area	m2	1,000,000.0	0.21	210,000.00
	Total Area m2		51,000,000.0		
(2)	Placing Area Preparation Including Surface Drainage(Open Ditch) Vegetation Under Ground Drainage	km2	51.00	2,535,141.00	129,292,191.00
(3)	Access Roads (W = 22m, t=1.5m) Starting from placing area to the main construction road	m	25,000	1002.98	25,074,500.00
	Subtotal this Sheet				165,076,691.00
	Total-Item No.2 Placing Areas for Surplus Material				165,076,691.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3	GATE CONSTRUCTION				
(1)	PACIFIC TIDAL GATE				
1)	Excavation(Hauling Distance 5.0m)				
1)-1	Common	m3	9,000,000	2.57	23,130,000.00
1)-2	Weathered Rock	m3	5,400,000	3.69	19,926,000.00
1)-3	Hard Rock	m3	3,600,000	5.64	20,304,000.00
	Total m3		18,000,000		
1)-4	Dewatering	ls	1	14,470,000.00	14,470,000.00
2)	Backfill	m3	2,200,000	3.85	8,470,000.00
3)	Grouting				
3)-1	Consolidation Groutiong	m	62,600	20.05	1,255,130.00
3)-2	Curtain Groutiong	m	62,600	66.80	4,181,680.00
4)	Concrete including form works, etc	m3	980,000	76.49	74,960,200.00
5)	Reinforcing Bar (Deformed)	t	13,000	804.10	10,453,300.00
	Subtotal this Sheet				177,150,310.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	ATLANTIC TIDAL GATE				
1)	Excavation(Hauling Distance 5.0m)				
1)-1	Common	m3	9,000,000	2.57	23,130,000.00
1)-2	Weathered Rock	m3	5,400,000	3.69	19,926,000.00
1)-3	Hard Rock	m3	3,600,000	5.64	20,304,000.00
	Total m3		18,000,000		
1)-4	Dewatering	ls	1	14,470,000.00	14,470,000.00
2)	Backfill	m3	2,200,000	3.85	8,470,000.00
3)	Grouting				
3)-1	Consolidation Groutiong	m	62,600	20.05	1,255,130.00
3)-2	Curtain Groutiong	m	62,600	66.80	4,181,680.00
4)	Concrete including form works, etc	m3	980,000	92.93	91,071,400.00
5)	Reinforcing Bar (Deformed)	t	13,000	804.10	10,453,300.00
	Subtotal this Sheet				193,261,510.00
	Total-Item No.3 Gate Construction				370,411,820.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
4	GATE LEAVES AND RELATED FACILITIES				
(1)	ATLANTIC TIDAL GATE				
1)	Gate				
1)-1	Gate Leaves	ton	16,922	9,600	162,451,200.00
1)-2	Accessory	set	1	14,621,000	14,621,000.00
2)	Mechanical Equipment				
2)-1	Gate Frames	ton	5,077	11,000	55,847,000.00
2)-2	Gate Hoists	ton	1,692	15,600	26,395,200.00
2)-3	Other Mechanical Component	set	1	53,122,000	53,122,000.00
3)	Electrical Power and Control				
3)-1	Electric Power and Control Equipment (6000KW)	set	1	7,000,000	7,000,000.00
3)-2	Emergency Power Plant	kw	6,000	1,000	6,000,000.00
3)-3	Miscellaneous El. Equipment	set	1	1,000,000	1,000,000.00
4)	Others	set	1	7,437,000	7,437,000.00
	Subtotal this Sheet				333,873,400.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	PACIFIC TIDAL GATE				
1)	Gate				
1)-1	Gate Leaves	ton	21,922	9,600	210,451,200.00
1)-2	Accessory	set	1	18,941,000	18,941,000.00
2)	Mechanical Equipment				
2)-1	Gate Frames	ton	5,077	11,000	55,847,000.00
2)-2	Gate Hoists	ton	1,692	15,600	26,395,200.00
2)-3	Other Mechanical Component	set	1	68,818,000	68,818,000.00
2)-4					
3)	Electrical Power and Control				
3)-1	Electric Power and Control Equipment (6000KW)	set	1	7,000,000	7,000,000.00
3)-2	Emergency Power Plant	kw	6,000	1,000	6,000,000.00
3)-3	Miscellaneous El. Equipment	set	1	1,000,000	1,000,000.00
4)	Others	set	1	9,635,000	9,635,000.00
	Subtotal this Sheet				404,087,400.00
	Total-Item No. 4 Gate Leaves and Related Facilities				737,960,800.00

Item No.	Description	Unit	Q'ty	Unit Cost	Amount
				$	$
5	NEW DAMS				
(1)	UPPER GATUN DAM (H=100M) to be provided in the year of 2,060		-	-	-
	Subtotal this Sheet Total-Item No. 5 New Dams				-

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
6	PUMP STATIONS		nil	-	-
	Subtotal this Sheet				-
	Total-Item No. 6 Pump Stations				-

Item No.	Description	Unit	Q' ty	Unit Cost $	Amount $
7	NEW PERMANENT ROADS				
(1)	ROADS FOR INSPECTION (NEW ROADS) W = 6.8m				
1)	Subgrade, Base Course(t=0.4m)	km	71.0	110,490.00	7,844,790.00
2)	Asphalt Paving(t=70mm)	m2	710,000.0	12.88	9,144,800.00
	Subtotal this Sheet				16,989,590.00
	Total-Item No. 7 New Permanent Roads				16,989,590.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
8	NEW CANAL CROSSINGS				
(1)	BRIDGES OVER THE NEW CANAL				
1)	Bridges Over The Canal on Pacific Side				
1)-1	Cable Stayed Bridge Canal Width 190m Span = L1(Main)+L2+L3=250+90+90=430m Width = 20.5m (Four Lane)	m2	8,815	6,064.00	53,454,160.00
1)-2	Approaching Bridges(Steel Box Girder) Total Length = 600m (One Span 60m) Width = 20.5m (Four Lane)	m2	12,300	2,956.00	36,358,800.00
2)	Bridges Over the Canal at Middle				
2)-1	Cable Stayed Bridge Canal Width 190m Span = L1(Main)+L2+L3=350+140+140=630m Width = 10.0m (Two Lane)	m2	6,300	11,146.00	70,219,800.00
2)-2	Approaching Bridges(Steel Box Girder) Total Length = 600m (One Span 60m) Width = 10.0m (Two Lane)	m2	6,000	2,980.00	17,880,000.00
3)	Bridges Over The Canal on Atlantic Side				
3)-1	Cable Stayed Bridge Canal Width 190m Span = L1(Main)+L2+L3=250+90+90=430m Width = 10.0m (Two Lane)	m2	4,300	6,080.00	26,144,000.00
3)-2	Approaching Bridges(Steel Box Girder) Total Length = 600m (One Span 60m) Width = 10.0m (Two Lane)	m2	6,000	2,980.00	17,880,000.00
	Subtotal this Sheet				221,936,760.00
	Total-Item No. 8 New Canal Crossings				221,936,760.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
9	NAVIGATION SUPPORT SYSTEMS				
	For Two-Way Canal Portion				
(1)	Navigation Lights (Buoys or Beacons) and Leading Channel Range Lights				
1)	Navigation Lights (Buoys or Beacons) 10 w, Lens Type Light Range : Three Nautical miles Power supply : Battery				
1)-1	Pacific Ocean Side Navigation For 30km (interval every 927m) 30,000/927=33 * 2 sides	sets	66	121,506.00	8,019,396.00
1)-2	At turning points, L and M 2 points * 2 sides	sets	4	121,506.00	486,024.00
1)-3	Atlantic Ocean Side Navigation For 3km (interval every 927m) 3,000/927 = 4 * 2 sides	sets	8	121,506.00	972,048.00
	For One-Way Canal Portion				
	Navigation Lights (Beacon, Pole Type) 5w, Lens Type Light Range : One Nautical miles Power supply : by supply				
2)-4	Navigation Lights (Beacon, Pole Type) 55,000m / 152m = 362 * 2 sides	sets	724	46,656.00	33,778,944.00
2)-5	Navigation Lights (Beacon, Pole Type) At turning points, B, C ... K 10 points x 2 sets	sets	20	46,656.00	933,120.00
	Subtotal this Sheet				44,189,532.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
3)	Channel Range Marker(Light)				
3)-1	For One-Way Canal Portion 5 points x 1 lane x 2 sets	sets	10	473,496.00	4,734,960.00
3)-2	For Two-Way Canal Portion 4 points x 2 lanes x 4 sets	sets	32	473,496.00	15,151,872.00
	Subtotal this Sheet				19,886,832.00

BILL NO. : 16 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A.D.- 2020) 250,000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost	Amount
				$	$
(2)	TUG STATION				
1)	Provide Tug Boats, 6,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	10	6,649,286	66,492,860.00
2)	Provide/Supply Tug Boats, 3,000 HP-4,000 HP, (C&F Panama) (maintenance/running Cost not included)	unit	7	4,652,857	32,569,999.00
3)	Launches(for 10 persons) Twin Screw (maintenance/running Cost not included)	unit	10	163,571	1,635,710.00
(3)	EMERGENCY TIE UP STATION (Mooring Dolphin Type)				
1)	Located Near Station B	nos	1	14,043,200	14,043,200.00
2)	Located Near Station C	nos	1	14,043,200	14,043,200.00
3)	Excavation				
	Dry Excavation(Hauling distance 4.0km)				
3)-1	Common	m3	2,000,000	2.27	4,540,000.00
3)-2	Weathered Rock	m3	1,200,000	3.32	3,984,000.00
3)-3	Hard Rock	m3	800,000	5.22	4,176,000.00
	Dredging(Hauling Distance 22km)				
3)-4	Clayey material(clay, silt)	m3	2,000,000	4.79	9,580,000.00
3)-5	Weathered Rock	m3	1,200,000	7.33	8,796,000.00
3)-6	Hard Rock	m3	800,000	100.95	80,760,000.00
	Total Excavation m3		8,000,000		
	Subtotal this Sheet				240,620,969.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(4)	Jetty(10m x 50m)				
	Three(3) Locations for Tug Jetty				
1)	Located Near Station A	nos	2	4,972,000	9,944,000.00
2)	Located Near Station B	nos	1	4,972,000	4,972,000.00
3)	Located Near Station C	nos	2	4,972,000	9,944,000.00
(5)	Mooring Buoy				
1)	Located at Atlantic Entrance (50,000 DWT * 2)	nos	2	20,600,000	41,200,000.00
2)	Located at Pacific Entrance (50,000 DWT * 2)	nos	2	20,600,000	41,200,000.00
	Subtotal this Sheet				107,260,000.00
	Total-Item No. 9 Navigation Support System				411,957,333.00

BILL NO. : 18 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A.D. 2020) 250,000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
1 O	BARRIER DAMS				
(1)	BARRIER DAM 'E'				
1)	Dredging(Hauling distance 10km)				
1)-1	Clayey Material(Clay, Silt)	m3	2,900,000	2.89	8,381,000.00
1)-2	Loose Material(Sand, Gravel)	m3	3,000,000	2.88	8,640,000.00
	Total Excavation m3		5,900,000		
2)	Filling Materials Onland Hauling(10km) Dump Truck(240t), Shovel(30m3)				
2)-1	Core Material	m3	4,300,000	4.52	19,436,000.00
2)-2	Filter Material	m3	3,600,000	4.52	16,272,000.00
2)-3	Sand Material	m3	300,000	4.52	1,356,000.00
2)-4	Rock Material	m3	4,540,000	4.46	20,248,400.00
2)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	260,000	4.46	1,159,600.00
	Total Volume m3		13,000,000		
3)	Filling on Water Operation (Filling Below WL -4.0m)				
3)-1	Core Material	m3	3,700,000	5.67	20,979,000.00
3)-2	Filter Material	m3	3,380,000	6.54	22,105,200.00
3)-3	Sand Material	m3	240,000	5.67	1,360,800.00
3)-4	Rock Material	m3	4,295,000	6.54	28,089,300.00
3)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	120,000	21.58	2,589,600.00
4)	Filling on Water Operation (Filling, Above WL -4.0m)				
4)-1	Core Material	m3	600,000	8.70	5,220,000.00
4)-2	Filter Material	m3	220,000	14.38	3,163,600.00
4)-3	Sand Material	m3	60,000	8.70	522,000.00
4)-4	Rock Material	m3	245,000	14.38	3,523,100.00
4)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	140,000	84.04	11,765,600.00
	Total Filling m3		13,000,000		
	Subtotal this Sheet				174,811,200.00

Item No.	Description	Unit	Q' ty	Unit Cost $	Amount $
5)	Curtain Grouting				
5)-1	Drilling	m	36,000	73.09	2,631,240.00
5)-2	Pressure Grouting(cement 50kg/m)	m	20,000	71.50	1,430,000.00
6)	Excavation for Spillway				
	Dredging				
6)-1	Clayey Material	m3	500,000	2.89	1,445,000.00
6)-2	Weathered Rock	m3	300,000	2.88	864,000.00
6)-3	Hard Rock	m3	200,000	70.53	14,106,000.00
	Toatal m3		1,000,000		
	Dry Excavation(Hauling Distance 0.5km)				
	Shovel(3.0m3), Dump Truck(32t)				
6)-4	Excavation Common	m3	2,150,000	1.82	3,913,000.00
6)-5	Weathered Rock	m3	1,290,000	3.03	3,908,700.00
6)-6	Weathered Rock	m3	860,000	4.72	4,059,200.00
	Toatal m3		4,300,000		
7)	Concrete works including forms, etc.				
7)-1	For Spillway	m3	6,000	100.00	600,000.00
7)-2	Reinforcing Bars(Deformed)	t	360	804.10	289,476.00
8)	Gates				
8)-1	Sliding gates	t	17.0	10,000.00	170,000.00
8)-2	Sliding gates hoists	t	4.0	12,100.00	48,400.00
8)-3	Spare gate	t	6.0	9,300.00	55,800.00
8)-4	Radial gate	t	9.0	12,100.00	108,900.00
8)-5	Radial gate hoist	t	5.0	12,100.00	60,500.00
8)-6	Spare gate	t	9.0	9,300.00	83,700.00
	Subtotal this Sheet				33,773,916.00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	BARRIER DAM 'F'				
	Dredging (Hauling Distance 15km)				
1)-1	Clayey Material(Clay, Silt)	m3	3,000,000	2.91	8,730,000.00
1)-2	Loose Material(Sand, Gravel)	m3	3,500,000	2.90	10,150,000.00
	Total Excavation m3		6,500,000		
2)	Filling Materials Onland Hauling(10km) Dump Truck(240t), Shovel(30m3)				
2)-1	Core Material	m3	4,650,000	4.52	21,018,000.00
2)-2	Filter Material	m3	3,900,000	4.52	17,628,000.00
2)-3	Sand Material	m3	350,000	4.52	1,582,000.00
2)-4	Rock Material	m3	5,040,000	4.46	22,478,400.00
2)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	260,000	4.46	1,159,600.00
	Total Volume m3		14,200,000		
3)	Filling on Water Operation (Filling Below WL -4.0m)				
3)-1	Core Material	m3	4,000,000	5.67	22,680,000.00
3)-2	Filter Material	m3	3,660,000	6.54	23,936,400.00
3)-3	Sand Material	m3	290,000	5.67	1,644,300.00
3)-4	Rock Material	m3	4,760,000	6.54	31,130,400.00
3)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	120,000	21.58	2,589,600.00
4)	Filling on Water Operation (Filling, Above WL -4.0m)				
4)-1	Core Material	m3	650,000	8.74	5,681,000.00
4)-2	Filter Material	m3	240,000	14.38	3,451,200.00
4)-3	Sand Material	m3	60,000	8.74	524,400.00
4)-4	Rock Material	m3	280,000	14.42	4,037,600.00
4)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	140,000	84.04	11,765,600.00
	Total Filling m3		14,200,000		
5)	Curtain Grouting				
4)-1	Drilling	m	38,000	73.09	2,777,420.00
4)-2	Grouting(cement 50kg/m)	m	23,000	71.50	1,644,500.00
	Subtotal this Sheet				194,608,420.00

BILL NO. : 21 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A.D. 2020) 250,000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(3)	BARRIER DAM 'G'				
	Dredging(Hauling Distance 10km)				
1)-1	Clayey Material(Clay, Silt)	m3	500,000	2.89	1,445,000.00
1)-2	Loose Material(Sand, Gravel)	m3	500,000	2.88	1,440,000.00
	Total Excavation m3		1,000,000		
2)	Filling Materials Onland Hauling(10km)				
	Dump Truck(240t), Shovel(30m3)				
2)-1	Core Material	m3	650,000	4.52	2,938,000.00
2)-2	Filter Material	m3	600,000	4.52	2,712,000.00
2)-3	Sand Material	m3	50,000	4.52	226,000.00
2)-4	Rock Material	m3	655,000	4.46	2,921,300.00
2)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	45,000	4.46	200,700.00
	Total Volume m3		2,000,000		
3)	Filling on Water Operation				
	(Filling Below WL -4.0m)				
3)-1	Core Material	m3	540,000	5.67	3,061,800.00
3)-2	Filter Material	m3	560,000	6.54	3,662,400.00
3)-3	Sand Material	m3	40,000	5.67	226,800.00
3)-4	Rock Material	m3	610,000	6.54	3,989,400.00
3)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	20,000	21.58	431,600.00
4)	Filling on Water Operation				
	(Filling, Above WL -4.0m)				
4)-1	Core Material	m3	110,000	8.70	957,000.00
4)-2	Filter Material	m3	40,000	14.38	575,200.00
4)-3	Sand Material	m3	10,000	8.70	87,000.00
4)-4	Rock Material	m3	45,000	14.38	647,100.00
4)-5	Rip Rap Material(2.0t/pc, d=1.0m)	m3	25,000	84.13	2,103,250.00
	Total Filling m3		2,000,000		
5)	Curtain Grouting				
4)-1	Drilling	m	8,000	73.09	584,720.00
4)-2	Grouting(cement 50kg/m)	m	5,000	71.50	357,500.00
	Subtotal this Sheet				28,566,770.00
	Total-Item No.10 Barrier Dams				431,760,306.00

BILL NO. : 22 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A. D. 2020) 250, 000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
1 1	BREAKWATER				
(1)	BREAKWATER AT ATLANTIC OCEAN SIDE				
	East Break Water 3, 000m (M. Depth -17m) West Break Water 3, 400m (M. Depth -17m)				
1)	Core				
1)-1	Core Materials(below -4. 0m)	m3	6, 705, 000	12. 34	82, 739, 700. 00
1)-2	Core Materials(above -4. 0m)	m3	795, 000	13. 54	10, 764, 300. 00
2)	Armor Rock				
2)-1	Armor Rock (0. 5ton/piece, below-4. 0m)	m3	1, 488, 000	15. 31	22, 781, 280. 00
2)-2	Armor Rock (0. 5ton/piece, above-4. 0m)	m3	112, 000	19. 69	2, 205, 280. 00
2)-3	Armor Rock (3. 0ton/piece below-4. 0m)	m3	-	30. 86	0. 00
2)-4	Armor Rock (3. 0ton/piece above-4. 0m)	m3	700, 000	109. 40	76, 580, 000. 00
	Total Fill m3		9, 800, 000		
2)-5	Armor Rock supply, hauling(6km)	m3	2, 300, 000	5. 88	13, 524, 000. 00
(2)	BREAK WATER AT PACIFIC OCEAN SIDE				
	East Breakwater 8, 000m (M. Depth -17m) West Breakwater (nil)				
1)	Core				
1)-1	Core Materials(below-4. 0m)	m3	4, 774, 000	5. 97	28, 500, 780. 00
1)-2	Core Materials(above-4. 0m)	m3	1, 626, 000	10. 49	17, 056, 740. 00
2)	Armor Rock				
2)-1	Armor Rock (0. 5ton/piece, below-4. 0m)	m3	928, 000	8. 31	7, 711, 680. 00
2)-2	Armor Rock (0. 5ton/piece, above-4. 0m)	m3	272, 000	16. 64	4, 526, 080. 00
2)-3	Armor Rock (3. 0ton/piece below-4. 0m)	m3	-	24. 56	0. 00
2)-4	Armor Rock (3. 0ton/piece above-4. 0m)	m3	700, 000	105. 94	74, 158, 000. 00
	Total Fill m3		8, 300, 000		
2)-5	Armor Rock supply, hauling(6km)	m3	1, 900, 000	5. 88	11, 172, 000. 00
	Subtotal this Sheet				351, 719, 840. 00
	Total-Item No. 11 Breakwater				351, 719, 840. 00

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
1 2	DIVERSION SCHEME				
(1)	COFFER DAMS FOR DIVERSION				
1)	Coffer Dams E-1-D W-1-D W-3-D W-4-D W-6-D W-7-D E-3-Di				
	Excavation(Haulimg Diatance 5.0km) Shovel(3.0m3), Dump Truck(32t)				
1)-1	Common	m3	147,500	4.77	703,575.00
1)-2	Weathered Rock	m3	147,500	6.68	985,300.00
	Total m3		295,000		
	Embankment(Hauling Distance 5.0km) Shovel(3.0m3), Dump Truck(32t)				
1)-3	Core Material	m3	311,000	11.69	3,635,590.00
1)-4	Filter	m3	330,000	11.7	3,861,000.00
1)-5	Rock	m3	889,000	8.46	7,520,940.00
	Total Volume m3		1,530,000		
2)	Grouting Blanket Grouting				
2)-1	Drilling Grouting Hole	m	11,500	19.99	229,885.00
2)-2	Pressure Grouting	m	11,500	34.07	391,805.00
3)	Concrete Works including forms and etc.				
3)-1	Concrete	m3	3,500	100.00	350,000.00
3)-1	Reinforcing Bars(Deformed)	t	210	804.10	168,861.00
	Subtotal this Sheet				17,846,956.00

BILL NO. : 24 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A.D. 2020) 250,000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
(2)	Diversion Channels				
	E-1-C				
	W-1-C				
	W-3-C				
	W-4-C				
	W-6-C				
	W-7-C				
	E-3-C				
1)	Dry Excavation(Hauling Distance 0.5km)				
1)-1	Common	m3	5,700,000	1.82	10,374,000.00
1)-2	Weathered Rock	m3	3,420,000	3.03	10,362,600.00
1)-3	Hard Rock	m3	2,280,000	4.72	10,761,600.00
	Total m3		11,400,000		
2)	Dredging (Hauling Distance 2.5km)				
2)-1	Clayey Materials	m3	500,000	2.29	1,145,000.00
2)-2	Weathered Rock	m3	300,000	4.28	1,284,000.00
2)-3	Hard Rock	m3	200,000	70.46	14,092,000.00
	Total m3		1,000,000		
	Subtotal this Sheet				48,019,200.00
	Total-Item No.12 Diversion Channels				65,866,156.00

BILL NO. : 25 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A. D. 2020) 250,000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
13	SUPPORTING CONSTRUCTION to be assigned as percentage of Construction Costs	ls	1		421,207,000.00
	Subtotal this Sheet				421,207,000.00
	Total-Item No. 13 Supporting Construction				421,207,000.00

BILL NO. : 26 SLC, SINGLE LANE IN ZONE II CASE-(e)
(A. D. 2020) 250,000DWT, TIDAL GATE(PACIFIC), TIDAL GATE(ATLANTIC)

Item No.	Description	Unit	Q'ty	Unit Cost $	Amount $
14	GENERAL CONDITIONS				
(1)	Canal Excavation, (14.3%, Item Total)	ls	1		738,109,000.00
(2)	Placing Area, (14.3%, Item Total)	ls	1		23,606,000.00
(3)	Lock Construction (15.8%, Item Total)	ls	1		58,525,000.00
(4)	Gate Leaves and Related Facilities				-inclusive-
(5)	New Dams(to be provided in 2,060)				-
(6)	Pump Station		-nil-		-
(7)	New Parmanent Roads (14.3%, Item Total)	ls	1		2,430,000.00
(8)	New Canal Crossing				-inclusive-
(9)	Navigation Support System(15.8%, I.Total)	ls	1		65,089,000.00
(10)	Barrier Dams (14.3%, Item Total)	ls	1		61,742,000.00
(11)	Breakwater (14.3%, Item Total)	ls	1		50,296,000.00
(12)	Diversion Scheme (14.3%, Item Total)	ls	1		9,419,000.00
(13)	Supporting Construction (14.3%, I.Total)	ls	1		60,233,000.00
	Subtotal this Sheet				1,069,449,000.00
	Total-Item No.14 General Conditions				1,069,449,000.00

PART III COST ESTIMATES

III. Chapter 3 - Project Cost Distribution by Year

3.1 Project Cost Distribution by Year for Case-(5)

(1) High Rise Lock Canal, Single Lane Culebra Cut Option Case-(5), 150,000 DWT, Rise 85' (in year 2020)

Table III.3-1 indicates the project cost distribution for the cases listed below:

3.2 Project Cost Distribution by Year for Case-(6)

(1) High Rise Lock Canal, Single Lane Culebra Cut Option Case-(6), 200,000 DWT, Rise 85' (in year 2020)

Table III.3-2 indicates the project cost distribution for the cases listed below:

3.3 Project Cost Distribution by Year for Case-(d)

(1) Sea Level Canal, Route 10, Single Lane in Tidal Lock on Pacific Side Case-(d), 250,000 DWT (in year 2020)

Table III.3-3 indicates the project cost distribution for the cases listed below:

3.4 Project Cost Distribution by Year for Case-(e)

(1) Sea Level Canal, Route 10, Single Lane in Zone II
Tidal Gates on Pacific & Atlantic Case-(e), 250,000 DWT (in year 2020)

Table III.3-4 indicates the project cost distribution for the cases listed below:

Table III.3-1 Project Cost Distribution by Year
High Rise Lock Canal, Single Lane Culebra Cut Option
Case-(5) : 150,000 DWT, Rise 85' (the Year of 2020)

File:FLOWHRL

	Major Cost Component	Amount	Year of Expenditure (unit:millions of dollars)															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	CONSTRUCTION COSTS																	
(A)	CIVIL WORKS																	
1	Canal Excavation	1,592.90				398.22	298.67	298.67	298.67	298.67								
2	Placing Area	87.79				21.95	16.46	16.46	16.46	16.46								
3	Lock Construction	855.16					213.79	179.58	179.58	179.58	102.62							
5	New Dams	-																
6	Pump Station	-																
7	New Permanent Roads	8.75									5.47	3.28						
8	New Canal Crossing	450.20				112.55	74.28	74.28	74.28	74.28	40.52							
10	Barrier Dams	-																
11	Breakwater	-																
12	Diversion Scheme	-																
13	Supporting Construction	291.24			145.62	145.62												
	Subtotal	3,286.05			145.62	678.34	603.20	569.00	569.00	569.00	148.61	3.28						
(B)	PLANT FORMING A PART OF PERMANENT WORKS																	
4	Gate Leaves and and Related Facilities	888.89						222.22	164.44	164.44	164.44	173.33						
9	Navigation Support System	414.21								207.10	103.55	103.55						
	Subtotal	1,303.10						222.22	164.44	371.55	268.00	276.89						
	CONSTRUCTION COSTS TOTAL	4,589.15			145.62	678.34	603.20	791.22	733.44	940.55	416.60	280.17						
I I	INDIRECT COSTS																	
1	Administrative Costs	56.37	2.82	2.82	5.35	6.48	6.48	6.48	6.48	6.48	6.48	6.48						
2	Headquarter's Costs	96.22	23.09	23.09	23.09	3.85	3.85	3.85	3.85	3.85	3.85	3.85						
3	Construction Supervision	112.86	3.39	3.39	8.92	13.88	13.88	13.88	13.88	13.88	13.88	13.88						
4	Land Aquisition & Rights	-																
5	Compensation Costs	105.00	42.00	42.00	21.00													
6	Contingency	458.92				45.89	45.89	45.89	45.89	91.78	91.78	91.78						
	INDIRECT COSTS TOTAL	829.36	71.30	71.30	58.36	70.10	70.10	70.10	70.10	116.00	116.00	116.00						
	ANNUAL DISTRIBUTION	5,418.50	71.30	71.30	203.98	748.45	673.31	861.32	803.54	1,056.54	532.60	396.16						

Table III.3-2 Project Cost Distribution by Year
High Rise Lock Canal, Single Lane Culebra Cut Option
Case-(6) : 200,000 DWT, Rise 85' (the Year of 2020)

File:FLOWHRL

	Major Cost Component	Amount	Year of Expenditure (unit:millions of dollars)															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	CONSTRUCTION COSTS																	
(A)	CIVIL WORKS																	
1	Canal Excavation	1,893.03				473.26	283.95	283.95	283.95	283.95	283.95							
2	Placing Area	87.79				21.95	13.17	13.17	13.17	13.17	13.17							
3	Lock Construction	970.62				242.66	160.15	160.15	160.15	160.15	87.36							
5	New Dams	237.00				59.25	23.70	38.39	38.39	38.39	38.87							
6	Pump Station	-																
7	New Permanent Roads	8.75									2.19	3.94	2.63					
8	New Canal Crossing	501.19				125.30	93.97	93.97	93.97	93.97								
10	Barrier Dams	-																
11	Breakwater	-																
12	Diversion Scheme	-																
13	Supporting Construction	291.24			116.50	174.75												
	Subtotal	3,989.62			116.50	1,097.15	574.95	589.64	589.64	589.64	425.53	3.94	2.63					
(B)	PLANT FORMING A PART OF PERMANENT WORKS																	
4	Gate Leaves and and Related Facilities	1,011.24						252.81	187.08	187.08	187.08	197.19						
9	Navigation Support System	414.21								165.68	124.26	124.26						
	Subtotal	1,425.45						252.81	187.08	352.76	311.34	321.45						
	CONSTRUCTION COSTS TOTAL	5,415.07			116.50	1,097.15	574.95	842.45	776.72	942.40	736.88	325.39	2.63					
I I	INDIRECT COSTS																	
1	Administrative Costs	66.51	2.99	2.99	5.99	7.32	7.32	7.32	7.32	7.32	7.32	7.32	3.33					
2	Headquarter's Costs	113.54	27.82	27.82	27.82	3.97	3.97	3.97	3.97	3.97	3.97	3.97	2.27					
3	Construction Supervision	133.17	3.66	3.66	10.65	15.31	15.31	15.31	15.31	15.31	15.31	15.31	7.99					
4	Land Aquisition & Rights	-																
5	Compensation Costs	105.00	42.00	42.00	21.00													
6	Contingency	541.51				40.61	40.61	40.61	40.61	108.30	108.30	108.30	54.15					
	INDIRECT COSTS TOTAL	959.72	76.47	76.47	65.46	67.22	67.22	67.22	67.22	134.91	134.91	134.91	67.74					
	ANNUAL DISTRIBUTION	6,374.79	76.47	76.47	181.95	1,164.37	642.17	909.67	843.94	1,077.31	871.78	460.30	70.36					

Table III.3-3 Project Cost Distribution by Year
Sea Level Canal, Route 10
Case : Case-(d) 250,000 DWT (the Year of 2020)

File:FLOESLC

	Major Cost Component	Amount	Year of Expenditure (unit:millions of dollars)															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	CONSTRUCTION COSTS																	
(A)	CIVIL WORKS																	
1	Canal Excavation	6,244.22					1,561.06	437.10	437.10	468.32	468.32	468.32	468.32	468.32	468.32	468.32	530.76	
2	Placing Area	188.68					47.17	18.87	6.60	6.60	6.60	6.60	6.60	6.60	6.60	37.74	38.68	
3	Lock Construction	504.50							252.25	84.08	84.08	84.08						
5	New Dams	-																
6	Pump Station	-																
7	New Permanent Roads	19.42													4.85	8.74	5.83	
8	New Canal Crossing	187.67					46.92	21.58	21.58	21.58	21.58	21.58	21.58	11.26				
10	Barrier Dams	493.50					123.38	81.43	81.43	81.43	81.43	44.42						
11	Breakwater	402.02					100.50	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.36	19.30	
12	Diversion Scheme	75.29					32.75	28.23	14.30									
13	Supporting Construction	481.44				192.58	288.86											
	Subtotal	8,596.74				192.58	2,200.64	618.56	844.62	693.37	693.37	656.35	527.86	517.54	511.13	546.15	594.56	
(B)	PLANT FORMING A PART OF PERMANENT WORKS																	
4	Gate Leaves and and Related Facilities	316.01								79.00	59.25	59.25	59.25	59.25				
9	Navigation Support System	546.30													136.57	202.13	207.59	
	Subtotal	862.30								79.00	59.25	59.25	59.25	59.25	136.57	202.13	207.59	
	CONSTRUCTION COSTS TOTAL	9,459.04				192.58	2,200.64	618.56	844.62	772.37	752.62	715.61	587.11	576.79	647.71	748.28	802.15	
I I	INDIRECT COSTS																	
1	Administrative Costs	96.48	1.45	1.45	5.31	8.68	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	
2	Headquarter's Costs	163.43	40.86	40.86	40.86	21.08	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
3	Construction Supervision	182.96	4.57	4.57	4.57	8.23	14.64	14.64	14.64	14.64	14.64	14.64	14.64	14.64	14.64	14.64	14.64	
4	Land Aquisition & Rights	27.34	10.93	10.93	5.47													
5	Compensation Costs	13.56	5.42	5.42	2.71													
6	Contingency	945.90				42.57	42.57	42.57	42.57	42.57	42.57	42.57	42.57	151.34	151.34	151.34	151.34	
	INDIRECT COSTS TOTAL	1,429.67	63.24	63.24	58.92	80.56	66.24	66.24	66.24	66.24	66.24	66.24	66.24	175.02	175.02	175.02	175.02	
	ANNUAL DISTRIBUTION	10,888.71	63.24	63.24	58.92	273.14	2,266.87	684.80	910.86	838.61	818.86	781.84	653.35	751.80	822.72	923.29	977.17	

Table III.3-4 Project Cost Distribution by Year
Sea Level Canal, Route 10
Case : Case-(e) 250,000 DWT (the Year of 2020)

File:FLOESLC

	Major Cost Component	Amount	Year of Expenditure (unit:millions of dollars)															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	CONSTRUCTION COSTS																	
(A)	CIVIL WORKS																	
1	Canal Excavation	5,899.71					1,474.93	412.98	412.98	442.48	442.48	442.48	442.48	442.48	442.48	442.48	501.48	
2	Placing Area	188.68					47.17	18.87	6.60	6.60	6.60	6.60	6.60	6.60	6.60	37.74	38.68	
3	Lock Construction	428.94					107.23	90.08	90.08	90.08	51.47							
5	New Dams	-																
6	Pump Station	-																
7	New Permanent Roads	19.42													4.85	8.74	5.83	
8	New Canal Crossing	221.94					55.48	25.52	25.52	25.52	25.52	25.52	25.52	13.32				
10	Barrier Dams	493.50					123.38	81.43	81.43	81.43	81.43	44.42						
11	Breakwater	402.02					100.50	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.36	31.36	19.30	
12	Diversion Scheme	75.29					32.75	28.23	14.30									
13	Supporting Construction	481.44				192.58	288.86											
	Subtotal	8,210.93				192.58	2,230.31	688.46	662.27	677.47	638.86	550.38	505.96	493.76	485.29	520.31	565.28	
(B)	PLANT FORMING A PART OF PERMANENT WORKS																	
4	Gate Leaves and and Related Facilities	737.96							184.49	184.49	184.49	184.49						
9	Navigation Support System	477.05													119.26	176.51	181.28	
	Subtotal	1,215.01							184.49	184.49	184.49	184.49			119.26	176.51	181.28	
	CONSTRUCTION COSTS TOTAL	9,425.93				192.58	2,230.31	688.46	846.76	861.96	823.35	734.87	505.96	493.76	604.56	696.82	746.56	
I I	INDIRECT COSTS																	
1	Administrative Costs	96.14	1.44	1.44	5.29	8.65	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	
2	Headquarter's Costs	162.86	40.71	40.71	40.71	21.01	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	
3	Construction Supervision	182.32	4.56	4.56	4.56	8.20	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59	
4	Land Aquisition & Rights	27.34	10.93	10.93	5.47													
5	Compensation Costs	13.56	5.42	5.42	2.71													
6	Contingency	942.59				42.42	42.42	42.42	42.42	42.42	42.42	42.42	42.42	150.81	150.81	150.81	150.81	
	INDIRECT COSTS TOTAL	1,424.81	63.07	63.07	58.74	80.28	66.00	66.00	66.00	66.00	66.00	66.00	66.00	174.40	174.40	174.40	174.40	
	ANNUAL DISTRIBUTION	10,850.74	63.07	63.07	58.74	272.86	2,296.31	754.47	912.77	927.96	889.36	800.87	571.97	668.16	778.96	871.22	920.96	

ATTACHMENTS

Attachment 1

(from Port Engineering - Third Edition, Gulf Publishing Company)

Attachment 1

Reference on the minimum lane width:

Per Bruun "Port Navigation and Hydraulics"
Port Engineering - Third Edition,
Gulf Publishing Company P.86 - 89.

Attachment 2

(from PCC – Directive)

B.1 PCC experience regarding the interface between ship navigation and dredging works:

There are existing restrictions to dredging operations, due to ship transit through the Canal. These restrictions, depending on the location of dredging works, limit the works during certain hours. These restrictions have been established by the Marine Bureau as Marine Directives, taking into consideration the needs of the transiting vessels and their safety.

A copy of this directive is enclosed.

SECTION 6

DREDGING OPERATIONS AND NAVIGATIONAL AIDS

6.1 Dredging Operations

6.2 Dump Scow Movement

6.3 Navigational Aids

6.1 Dredging Operations

a. *Responsibility*

(1) The Canal Operations Unit is responsible for monitoring the condition of the navigational aids, the navigational channels and the terminal harbors and adjacent waters, to ensure that they are properly maintained for the safe movement of ships. Coordinates with the Dredging and/or Engineering Divisions, solutions to problems that may develop in these areas. Notifies immediately to interested parties deviations affecting the safety of transiting ships.

(2) The Dredging Division is responsible for planning and executing the function of dredging and disposal of dredged material in Canal channels and for the maintenance and operation of navigational aids in the Canal.

(3) The Engineering Division is responsible for performing periodic hydrographic surveys, producing hydrographic charts of the navigational waters and terminal harbors, and the timely distribution of these charts to the Canal Operations Unit and the Dredging Division for action.

(4) The Office of Canal Improvements is responsible for, in coordination with the Marine and Engineering and Construction Bureaus, performing feasibility studies for channel improvements to meet projected traffic demand. With the advise of the Marine Bureau, and based on operational demands, establishes priorities in the channel improvements dredging schedule.

b. *Definitions*

(1) *Dredging Cuts:* For the purpose of dredging with Dipper Dredges, the width of the navigational channel is divided in cuts. These cuts are 37.5 feet wide and go from the center line to either side up to the prism lines. The dredging cuts represent the area along which the Dipper Dredges excavate. When dredging, dredges advance along these cuts. Gaillard Cut is divided into 14 individual Cuts (Figure 1), 7 Cuts on each side of the centerline. Cut 7 is 25 feet wide with all other Cuts 37.5 feet wide.

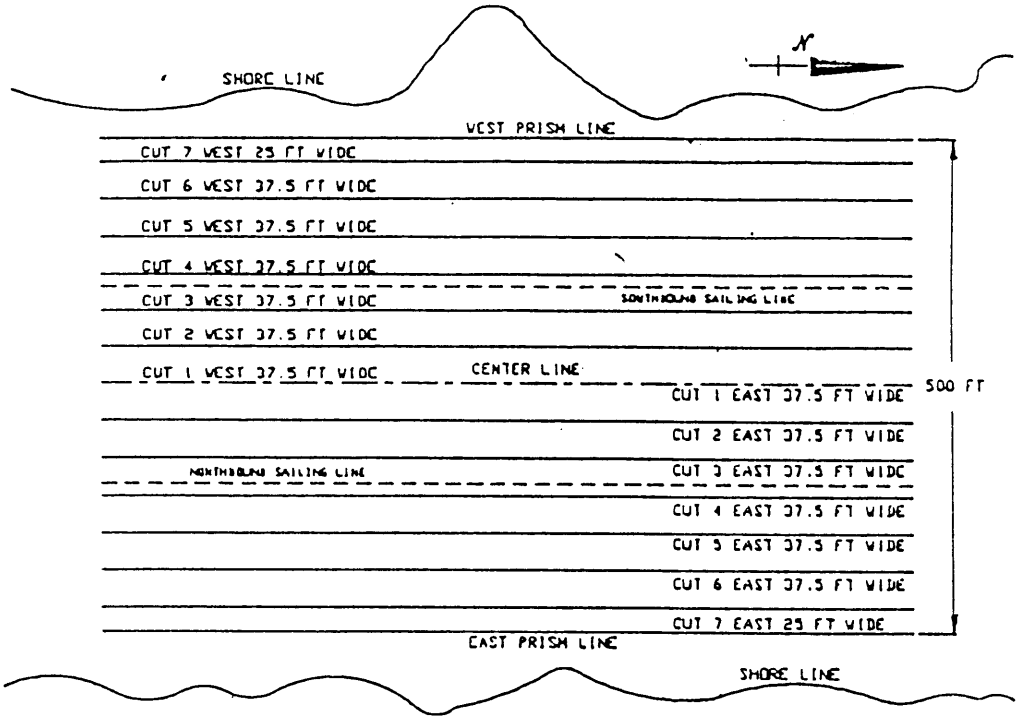

Figure 1 - Dredging Cuts in Gaillard Cut

(2) *Curves:* Curve is a change in direction in the navigational channel of the Canal. For the purpose of dredging, a curve extends 1,000 feet in each direction from the point of intersection (PI) of the channel center line.

(3) Point of intersection in Gaillard Cut are located as follows:

Bas Obispo P.I.	STA. 1665 + 13.4 S.	Lirio P.I.	STA. 1892 + 09.9
Las Cascadas P.I.	STA. 1764 + 43.1	Culebra P.I.	STA. 1970 + 96.9
Cunette P.I.	STA. 1819 + 57.2	Cartagena P.I.	STA. 2035 + 89.7
Empire P.I.	STA. 1842 + 57.4	Paraiso P.I.	STA. 2076 + 06.9

c. *Constraints:* The following constraints will be in effect when dredging equipment is stationed in Gaillard Cut.

(1) *Straight Reaches*

(a) Dredging equipment may operate in Cuts 2-7 at any time, allowing ship traffic to use Cut 1 and all Cuts on the opposite side of the channel centerline. This provides 287 foot channel for one-way ship traffic.

(b) Dredging equipment will operate in Cut 1 only between 1800 - 0600 hours.

(c) A tug will be available at the site to assist ships while work is performed in Cut 1.

(2) *Curves*

(a) Dredging equipment may operate in Cuts 3-7 on the inside of the curves and Cuts 4-7 on the outside of curves without restriction.

(b) Dredging equipment may operate in Cuts 1 and 2 on the inside of the curve and Cuts 1, 2, and 3 on the outside of a curve only between 1800-0600 hours.

(c) A tug will be available at the site to assist ships while work is being performed in Cuts 1, 2, and 3.

d. Transit Controllers should make a log entry whenever Dredging equipment moves on or off the centerline Cuts (Cut 1, 2 and 3).

6.2 Dump Scow Movement

a. This procedure is to provide instructions for dump scow movement in the Gaillard Cut.

b. Movements of loaded scows in the cut will be scheduled, and such scows are not to meet "clear-cut" vessels in the cut at anytime.

c. Empty scows can be moved with limited scheduling and will be permitted to meet (when the movement is necessary) "clear-cut" vessels, except vessels with PD1 and PD2 cargo.

d. Ships which are designated as "clear-cut" on some basis (visibility, ETC.) other than simply a beam in excess of 95 feet will be evaluated on an individual basis as to their suitability for meeting tug-scow combinations in the cut.

e. Before moving empty scows, Dredging Division will report the movement to Marine Traffic Control which will, in turn, notify the pilots of vessels which may meet the scows. Pilots of "clear-cut" vessels will be notified of scow movements in the Cut, when the pilot calls Marine Traffic Control before departing Pedro Miguel northbound, or passing Buoy 62 southbound, or as soon thereafter as a scow movement is planned and agreed to by Marine Traffic Control and Dredging Division.

f. Pusher Type Tugs should be used in pushing mode for scow movements. Scows are not to be lashed side by side during movements in the Cut.

g. Pilots and Tug masters will communicate with each other in order to avoid meetings in the cut between scows and "clear-cut" vessels in curves. (A curve is defined to include 1000 feet each side of the intersection of the adjacent reaches). The tug will yield to the "clear-cut" vessel to avoid such meetings.

h. When there is a dredge working in the Cut, Dredging Division will be provided computer-generated schedules of Canal traffic.

i. All differences in interpretation of rules and regulations or any departures from prescribed operating procedures must be referred to the Canal Operations Captain for resolution.

6.3 Navigational Aids

a. Navigational aids are essential for the safe and expeditious transit of ships through the Canal.

b. *Responsibilities*

(1) The Canal Operations Captain Unit of the Marine Bureau is responsible for establishing the requirements for navigational aids for Canal approach and transit operations.

(2) The Engineering and Construction Bureau is responsible for establishing the requirements for back-channel and branch channel navigational aids. Its Dredging Division is responsible for navigational aids procurement, fabrication, construction, installation, maintenance, improvement and replacement. On site maintenance of navigational aids, is the responsibility of the Repair Branch of the Dredging Division.

c. *Coordination*

Needs and means of improving navigational aids are coordinated between the Marine Bureau and the Engineering and Construction Bureau. This is normally done through the Canal Operations Unit, Dredging Division and Engineering Division.

d. *Reporting Procedures*

Pilots and other personnel navigating in the Canal, shall report to MTC any apparent problem of navigational aids. This includes but is not limited to lights unlit, buoys out of position, damaged ranges and targets and mooring buoys out of position. The report shall be conveyed to the Canal Operations Unit for review and action. Duty Canal Operations Captain shall relay the information via TELEFAX to Dredging Division's Field Office (FAX number 56-6320) and Repair Branch (FAX number 56-6857), and verify if information was received by contacting the Gamboa Field Office using the hot line between the two offices. Information shall include:

(1) *Buoys*: Position number, reach name, ship's transit number (northbound or southbound), and date observed.

(2) *Ranges*: Reach name, ship's transit number (northbound or southbound), date observed, and if upper, middle or lower range. Gaillard Cut range targets shall specify whether it is the Sailing Line or the Center Line.

(3) *Bank Lights*: Reach name, ship's transit number, date observed, if east or west, and if north, middle or south of the reach.

(4) *Mamei Curve*: Mamei Curve is divided in two reaches, namely Juan Grande Reach and Mamei Reach. When reporting outages in this area, pilots should refer to the specific reach, not to the curve.

Attachment 3

(Data from Suez Canal)

Attchment 3: Standard Cross Section of Suez Canal, Phase II

Description	Canal Dimensions					Navigable Ships				Design Conditions		
	Area (m2)	Depth (m)	Width(m)			Size (DW or GT)	Draught (m)	Breadth (m)	Length (m)	Grade of Slope	Area Ratio (Target)	Lane Ratio (Target)
			Surface	-11.0m level	Bottom							
Canal												
East Channel						Around						
Km 0～60	3,510	19.5	258	170	102	150,000DW	16.2	44.0	280.0	1:4	4.8	2.6
Km 60～162	3,416	19.5	236	170	119	(fully laden)	(53′)	(145′)	(920′)	1:3	4.8	2.6
West Channel						Around						
Km 0～60	3,503	15.5	288	200	164	300,000DW (in ballast)	13.0	54.8	341.0	1:4	4.6	2.7
Km 60～162	3,313	15.0	266	200	176	or 50,000DW (container ship)	(43′)	(180′)	(1,120′)	1:3	4.6	2.7
Port Said												
Approach Channel												
East Channel		20.0			max. 700	same as east channel of canal						
West Channel		16.5			max. 840	same as west channel of canal						
Suez												
Entrance Channel												
East Channel		19.5			289	same as east channel of canal						
West Channel		16.0			417	same as west channel of canal						
Great Bitter Lake Channel												
East Channel		18.5			361	same as east channel of canal						
West Channel		14.5			417	same as west channel of canal						

Attachment 4

(Terms of Reference)

Addendum to Terms of Reference (TOR)

Engineering and Cost Estimate

At the 14th Board of Commissioners Meeting and in response to a proposal for the inclusion of a single lane option of both High Rise and Sea level Alternatives, the Commissioners instructed the Secretariat to prepare the implementation plan of this additional task, including proposal of TOR, budget and comletion schedule.

In accordance with above, during the Joint Review Meeting discussion was also made on possible scope of work to cover this additional task. The extent of the further engineering and cost analysis should be that stated in the TOR below and the Yachiyo Engineering Company, Limited (YEC) will prepare a cost and schedule proposal to cover the task specified by this TOR.

1. High Rise Lock Canal Alternative

(1) Cost estimation is to be determined for providing a single lane Culebra Cut zone, namely Zone III and IV as defined in the ECE Draft Final Report. In essence the cost needed is that of deepning the Status Quo Culebra Cut along the portion that will be traversed by the design ship. No widening is deemed necessary. In this Canal configuration, the rest of the canal features remain the same.

The following are the items to be taken into consideration to perform this task:

i) The basis for single lane Culebra Cut consideration should be the same used in calculation of two lanes channel. The base is that Culebra Cut is widened by the PCC to two lanes (approximately 630 feet)

ii) The procedure to be used by YEC for construction scheduling and costing was provided as follows:

a. Should keep one lane of Culebra Cut open for navigation at all times;

b. The Culebra Cut route of the design ships (150,000 DWT and 200,000 DWT, i.e. **Cases 2** and **4**) be deepened to 21 and 22 meters respectively;

c. The navigation channel can be very briefly closed for

traffic only during underwater excavation by blasting, similar to the experience of last decade when the PCC deepened the Culebra Cut;

d. Hauling excavated material by barge should use the working lane (not navigation lane) as much as possible unless this barge needs to pass the work area in which case the barge can use navigational channel traveling not less than 6.5 knots;

e. The proposed 27,000 H.P. dredging equipment may use the navigational channel when it is required of this equipment to make long distance shifts from one site to another;

f. The cost of completing a single lane Culebra Cut should be broken down by year for both zone III and IV which constitute Culebra Cut.

2. Sea Level Alternatives

(1) Tidal Gate Option (**Case b**)

The Atlantic approach channel between the coast line and the Atlantic Tidal Gate for the sea level canal should be estimated as a single lane channel with transition zone over an appropriate length.

(2) Tidal Lock Option (**Case a**)

The single lane (chamber) for the Pacific Locks case is to be costed.

It should be noted that the cost for the later expansion, namely the expansion to two (2) lane approach channel for **Case b** and the expansion to three (3) tidal locks for **Case a**, need not to be estimated.