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Technical Analysis of Gaillard Cut Widening 1-way Post-Panamax Traffic

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GAILLARD CUT WIDENING

1-way Post-Panamax Traffic

1 GENERAL DESCRIPTION OF THE STUDY

The construction of new Post-Panamax locks at the Panama Canal would require improvements to existing Canal navigation channels, which involves deepening and widening work to guarantee the safe and expedite transit of Post-Panamax vessels through the Canal. According to Canal operations preliminary analyses, the currently used semi-convoy traffic mode proved to be more efficient in terms of Post-Panamax and Panamax throughput capacity; therefore, it is foreseen that Gaillard Cut and both Canal entrances would require a 1-way Post-Panamax channel layout, while Gatun Lake would call for a 2-way Post-Panamax configuration.

This study covers the technical analysis to widen Canal internal waterways for 1-way Post-Panamax traffic from the north end of Gamboa Reach to the south end of Paraiso Reach. Although the new locks approach channel intersects the southern area of Cucaracha Reach, it is assumed that Post-Panamax widening would extend to Paraiso Reach, which complies with 2-way Panamax traffic requirements. The 1-way Post-Panamax widening is focused mainly in Gaillard Cut, which represents the Canal's most restricted and narrowest navigation channel, and the greatest challenge to Canal navigation.

As of today, a decision has not been reached for a Post-Panamax draft phase scenario. One of the scenarios contemplates the transit of Post-Panamax traffic at lake elevation of 25.9m (85') PLD; therefore, no additional dredging would be required in Gatun Lake and Gaillard Cut at a channel bottom elevation of 10.4 m (34') PLD. However, if the decision is to augment Gatun Lake water capacity or availability by lowering the lake's minimum operation level to elevation 23.9 m (78.5') PLD, then dredging would be required to reach to a design channel bottom of 8.4 m (27.5') PLD or 9.3 m (30.5') PLD, depending on lake minimum operation level selection. At this conceptual stage, a design channel bottom of elevation 10.4 m PLD for 1-way Post-Panamax widening in Gaillard Cut is being assumed as a first phase. The 2nd phase would be additional dredging to lower the design channel bottom to 8.4 (27.5') PLD.

Gaillard Cut widening for 1-way Post-Panamax traffic calls for massive dry excavation and dredging as well as land and wet drilling and blasting. After several widening layout evaluations, 2 options were selected to optimize Gaillard Cut's existing configuration to the proposed 1-way Post-Panamax layout: Option Contractor's, and Option Gold Hill; each option depicting Gaillard Cut's critical excavation operations.

2 GAILLARD CUT NAVIGATION CHANNEL CONCEPT WIDTH DESIGN FOR 1-WAY POST-PANAMAX TRAFFIC

2.1 Navigation Channel Widening Guidelines

- The ACP used basically two guidelines to determine the effective channel width to allow safe navigation of Post-Panamax vessels:
    - "Approach Channels A Guide for Design" by the joint working group made up by representatives of the Permanent International Association of Navigation Congresses (PIANC), and the International Association of Ports and Harbors (IAPH), in cooperation with the International Maritime Pilots Association (IMPA), and the International Association of Lighthouse Authorities (IALA), June 1997.
    - "Safe Waterways, A Users Guide to the Design, Maintenance and Safe Use of Waterways, Guidelines for the Safe Design of Commercial Shipping Channels" by Fisheries and Oceans, Canada.
- In addition to the previous guidelines, vessel minimum visibility requirements were also implemented to design the proposed Gaillard Cut 1-way Post-Panamax channel as required by the International Maritime Organization (IMO) through the International Convention on Safety of Life at Seas (SOLAS) issued in 1998.
- All the guidelines applicable to Canal waterways were discussed with ACP Maritime Operations personnel, including administrative pilots and the director, to reach to a consensus in selecting the adequate channel design for 1-way Post-Panamax traffic. Also, channel design for 2-way Panamax traffic was discussed, and it was agreed that 1-way Post-Panamax navigation channel shall also meet minimum requirements for 2-way Panamax traffic. Appendix No. 2 includes the memos for the record documenting the results of the meetings with ACP engineering and maritime operations personnel.

2.2 Design ship

- The design ship selected to determine Gaillard Cut's Post-Panamax configuration is the same container with deadweight tonnage of 100,000, and bulk carrier ship with deadweight tonnage between 100,000 and 140,000 used to develop the conceptual Post-Panamax new locks design.
- The design ship's main characteristics used to determine proposed new Canal locks dimensions as well as improved navigation channels are as follows:
    - Length: 385 m (1,265 ft)
    - Beam: 55 m (180 ft)
    - Draft: 15.2 m (50 ft)
- One of the reasons that lead to selecting the container ship as the design ship was the rapid growth of Panamax container ships longer than 274 m (900 ft) transiting through the Canal in the last years as shown in Appendix No. 3. The number of Panamax

container vessel transits through the Canal is expected to continue growing in the following years.

- The number of Post-Panamax container ships entering the maritime transportation industry is also increasing every year, but unfortunately the existing Panama Canal cannot capture the Post-Panamax ship segment due to Canal infrastructure size restrictions.
- According to Canal marketing studies preliminary results, containerized cargo is expected to be the dominant commodity passing through the new proposed locks.

2.3 Channel Design

2.3.1 Line-of-sight visibility requirements

- IMO SOLAS has established that the bridges of all container ships must be designed in such a way that the ship's line of sight shall be two ship lengths from the bow or 500 m, at the least. In other words, the helmsman and all ship officers on board the ship bridge shall be able to see at least 500 m or two ship lengths ahead of the ship's bow as shown in Appendix No. 4.
- This SOLAS line-of-sight visibility requirement was implemented as a result of a tendency by container ships to carry large stacks of containers on deck jeopardizing forward visibility.
- The Gaillard Cut's proposed Post-Panamax channel design included the line of sight requirement for 500 m based on a Post-Panamax container ship sailing in the channel centerline, and its bow in the channel bend point of intersection (PI) as shown in Appendix No. 5.
- Although the ship starts to turn before navigation channel PI, the worst-case scenario was used to determine the 500 m line-of-sight visibility required by a ship for safe navigation, which consists in placing the ship's bow in the PI.

2.3.2 Channel width

- Channel width parameters depend on the following factors:
  - Channel basic maneuvering lane and allowances for wind, currents, waves, bottom surface, waterway depth, etc.
  - Channel bank clearances
  - In the case of bends, additional width known as width of swept track is required, which is determined by ship rudder angle and waterway depth.
  - Additional width for passing distance for 2-way traffic (in the case of 1-way Post-Panamax traffic, this additional width is zero.)
- Based on PIANC and Canada guidelines for the previous factors, the following table presents Gaillard Cut minimum channel width dimensions required for 1-way Post-Panamax traffic:

GAILLARD CUT CHANNEL WIDTH PROPOSED FOR 1-WAY POST-PANAMAX

Recommendations	Straight Leg		Bend	
	Beam	meters	Beam	meters
PIANC	3.10	171	4.30	237
CANADA	4.10	226	5.19	285
Average	3.60	198	4.75	261
Proposed dimensions	4.09	225	4.73	260

Notes:
1. Beam = 55 m

- The proposed channel width was agreed during the meetings with the administrative pilots, taking into consideration their experience navigating ships through Canal waters. Although the experience of Canal pilots is limited to transiting Panamax vessels and smaller, they recommend the proposed dimensions as suitable for Post-Panamax vessels. The proposed width for a 1-way Post-Panamax channel complies with the minimum requirements for 2-way Panamax traffic.
- Under the Canal expansion scenario, it is assumed that Gaillard Cut would be safe for 2-way Panamax and 1-way Post-Panamax traffic.
- For more details on minimum waterway width calculations according to PIANC and Canada recommendations, refer to Appendixes No. 6 and 7.
- Appendix No. 8 shows a PIANC graphic that recommends an additional width for bends. In the case of the Gaillard Cut, at a rudder angle of 20 degrees and a water depth/draught ratio of 1.13, the recommended additional width is 1.2 times the ship's beam, that is, 66 m for 1-way Post-Panamax traffic.

2.3.3 Channel Bend Turning Radius

- The channel bend turning radius as the channel additional bend width goes to serve ship rudder angle and channel depth/draught ratio. This radius is generally expressed in terms of ship length.
- Appendix No. 9 contains a PIANC graph to determine the minimum channel bend radius. In the case of 1-way Post-Panamax traffic, the minimum bend radius is 7.25 times the ship's length, or, 2,800 m.

2.3.4 Channel Distance Between Successive Bends

- Gaillard Cut was initially dug with several bends following the existing riverbed of the Obispo and Grande rivers. According to PIANC, the minimum tangent distance

between successive bends should be greater than 5 ship lengths as shown in Appendix No. 10.

- In the case of a 1-way Post-Panamax navigation channel, 5 ship lengths are equivalent to 1,925 meters. However, proposed Gaillard Cut channel design for 1-way Post-Panamax does not comply with the minimum distance of 1,925 m. The cost of achieving the minimum distance of 5 L is very high, because it would require additional massive excavation.
- The issue of non-compliance with the minimum distance between opposite bends was discussed with ACP Maritime Operations personnel. It was agreed that navigation of Post-Panamax ships in a channel between two curves with widths of 225 m in straight legs and 260 m in bends, and 500 m of line sight would be sufficiently safe to overcome the non-compliance of 1,925 m because proposed channel width and line sight dimension exceed minimum requirements for 1-way Post-Panamax vessel traffic.

2.3.5 Transition from Navigation Channel Straight Sections to Bends

- According to Canada's recommendation, the transition from a straight section to a bend of the channel should be no less than a ratio of 10:1 (length/additional width).
- The transition from the straight section to the increased width of the bend is required to provide a smoother change and compensate for the asymmetric forces exerted by the ship as it enters or exits the channel turn.
- Appendix No. 11 contains a graphic showing proper transition for a parallel-widened channel bend.

2.4 Summary of Gaillard Cut Proposed Channel Design Characteristics for 1-Way Post-Panamax Traffic

- Following is a table summarizing proposed new characteristics to widen Gaillard Cut and part of Gatun Lake's navigational channel to allow for the safe navigation of Post-Panamax vessels in one way:

GAILLARD CUT WIDENING CHANNEL DESIGN PARAMETERS FOR 1-WAY POST-PANAMAX TRAFFIC	
Channel design parameters	**Requirements**
Ship visibility from the bridge:	**2 ship lengths (L) or 500 meters, the least**
Navigation channel minimum width in straight legs:	**225 m (738 ft) in straight legs**
Navigation channel minimum width in bends:	**260 m (853 ft) in bends**
Navigation channel turning radius:	**7.25 L**
Transition zone from straight section to increased width of the bend:	**10 : 1**
Notes:	
1. Requirements based on a design ship of 385 m L, 55 m B, and 15 m T	
2. The requirements were taken from PIANC, "Approach Channels, A Guide for Design"; and Canada Fisheries and Oceans, "Guidelines for the Safe Design of Commercial Shipping Channels.	

2.5 Required Gaillard Cut and Gatun Lake Reaches for 1-way Post-Panamax Widening

- The proposed widening for 1-way Post-Panamax traffic involves the widening to 225 m in straight sections and 260 m in the bends from the north end of Gamboa Reach to the south end of Paraiso Reach, that is, 19.3 km long of navigational channel. Specifically 12.7 km of this channel widening is located in Gaillard Cut, and 6.6 km in Gatun Lake. For simplicity purposes, this report is referring to 1-way Post-Panamax widening as Gaillard Cut widening, although the widening work includes part of Gatun Lake's navigational channel.
- Appendix No. 1 contains a sketch of Gaillard Cut's new proposed configuration for 1-way Post-Panamax traffic, which includes all the recommended parameters shown in the previous table.
- The following table shows the extent of the widening required for Gaillard Cut and Gatun Lake reaches to allow the transit of 1-way Post-Panamax and 2-way Post-Panamax traffic. As mentioned in the introduction, it is assumed that 1-way Post-Panamax widening includes Paraiso Reach, although the new locks approach channel intersects in Cucaracha Reach, north of Paraiso Reach. This report only contains the technical analysis for 1-way Post-Panamax traffic in Gaillard Cut and part of Gatun Lake. The analysis of 2-way traffic navigational channel requirements is presented in a separate report.

PROPOSED DIMENSIONS FOR GATUN LAKE AND GAILLARD CUT NAVIGATION CHANNEL REACHES FOR 1-WAY POST-PANAMAX TRAFFIC

Area	Existing Nominal Distance (m)	Existing Nominal Width (m)	Proposed Widening Scenario	Proposed Nominal Width (m)
Gatun Lake				
Gatun Reach	5,967	305	2-way Post-Panamax	330
Pena Blanca Reach	7,171	305	2-way Post-Panamax	330
Bohio Reach	2,539	305	2-way Post-Panamax	330
Buena Vista Reach	4,540	305	2-way Post-Panamax	330
Tabernilla Reach	4,521	305	2-way Post-Panamax	330
San Pablo Reach	4,299	244	2-way Post-Panamax	330
Mamei Curve	2,557	290	2-way Post-Panamax	330
Juan Grande Reach	908	254	2-way Post-Panamax	330
Gamboa Reach	5,096	198	1-way Post-Panamax	225
Chagres Crossing	1,464	198	1-way Post-Panamax	225
SUB-TOTAL	**39,061**			
Gaillard Cut				
Bas Obispo Reach	2,965	192	1-way Post-Panamax	225
Cascadas Reach	1,705	192	1-way Post-Panamax	225
Cunette Reach	704	192	1-way Post-Panamax	225
Empire Reach	1,501	192	1-way Post-Panamax	225
Culebra Reach	2,520	192	1-way Post-Panamax	225
Cucaracha Reach	1,853	192	1-way Post-Panamax	225
Paraiso Reach	1,464	192	2-way Panamax	225
PM Approach	222	192	2-way Panamax	225
SUB-TOTAL	**12,934**			
Total Channel Dist. for 1-way PPX from Gamboa to Paraiso (m)				**19,271**
Total Channel Dist. for 2-way PPX from Gatun to Juan Grande (m)				**32,502**

Note:
1. The nominal width of bends is not shown in the table.

3 PROPOSED EXECUTION AND DESCRIPTION FOR POST-PANAMAX GAILLARD CUT WIDENING

- Gaillard Cut widening would require the following operations:
  - Dry excavation
  - Land-based drilling and blasting
  - Land-based dredging
  - Underwater drilling and blasting
  - Sub-aquatic dredging
- It is assumed that for the proposed widening, ACP resources will be used to perform underwater drilling and blasting and conventional dredging, while Contractor's will conduct land-based drilling and blasting, dry excavation, and land-based dredging operations. These 5 excavation and dredging processes are shown in Appendix No. 12.
- Dry excavation is the first operation required to widen Gaillard Cut, to remove the loads off Cut slopes and prepare the banks for the following dredging phase. As shown in Appendix No. 13, dry excavation involves the removal of material above elevation 27.5 m PLD. Dry excavation also includes drilling and blasting when required.
- External Contractor's conducted the dry excavation work during the Gaillard Cut Widening Program (GCWP) in the mid 1990's, and would be required to do likewise during Gaillard Cut widening once the Canal Expansion program is approved .
- Once Gaillard Cut banks are at elevation 27.5 m PLD after the dry excavation phase, land-based drilling and blasting operations would follow to fracture the material for its proper removal or dredging. Like on the dry excavation phase, external Contractor's would be required to execute land-based drilling and blasting operations for widening.
- Land-based dredging helps remove wet material from land. This process could be executed via excavator by using draglines or the LIEBHERR 994 excavator, which was used during the Gaillard Cut widening to 630'. Although the ACP carried out land-based dredging operations during the GCWP using the LIEBHERR 994 excavator, it is foreseen that the ACP would contract the services of an external company to perform the Gaillard Cut widening land-based dredging phase. As of today, the ACP is planning to sell the LIEBHERR 994 excavator.
- Underwater drilling and blasting is executed in areas where land-based drilling and blasting cannot reach. After material fragmentation, conventional dredging would follow to remove all material below elevation 27.5 m PLD. As opposed to dry excavation and land-based drilling and blasting, the ACP drill-boat THOR and the new drill-boat that will become part of ACP fleet by the year 2005 would perform underwater drilling and blasting.
- The final phase would be sub-aquatic dredging or the removal of wet material below the water line, which would be performed by ACP floating dredges -- dipper dredge

RIALTO M. CHRISTENSEN (RMC), cutter-suction dredge MINDI, and a new cutter-suction dredge that the ACP is planning to acquire by the year 2005.

- Based on the ACP's recent dry excavation experience to expand Gaillard Cut width from 152 m (500 ft) to 192 m (630'), it was decided that a time horizon of 5 to 6 years would be adequate to complete Gaillard Cut widening.
- As a first stage, the target design channel bottom would be elevation 10.36 m PLD, so drilling and blasting would be required only to elevation 7.92 m PLD. However, the next draft expansion phase could be from 14 m to 15.2 m; therefore, to avoid drilling and blasting equipment mobilization and maximize fragmentation productivity, it is assumed that drilling and blasting operations would be performed to elevation 5.95 m PLD. It is highly recommended that drilling and blasting be conducted beyond initial requirements for future dredging, since it constitutes the critical path for dredging.

4 GAILLARD CUT WIDENING ALTERNATIVES FOR 1-WAY POST-PANAMAX TRAFFIC

4.1 General Description of Alternatives

- After analyzing several options, the ACP selected 2 options to enable the safe transit of 1-way Post-Panamax vessels through Gaillard Cut:
  - Contractor's Hill Option
  - Gold Hill Option
- The existing Gaillard Cut navigational channel configuration of 192 m in straight areas was used to develop Gaillard Cut proposed configuration for 1-way Post-Panamax traffic. However, as of today, the existing configuration will change as the ACP is planning to straighten the Cut to improve the maneuverability of 294m-long Panamax ships, and vessel visibility.
- Sketches of proposed 1-way Post-Panamax widening options are shown in Appendix No. 14. The areas in purple along the Gaillard Cut channel indicate the required extent of the widening, while the areas in brown are proposed disposal sites to accommodate excavation and some dredging material.
- Both widening options provide improvements to Gaillard Cut's points of intersections (PI) especially in Cunette, Empire, and Lirio; and Culebra, in the Gold Hill option. Appendix No. 14 contains a table showing improvements to angles of deviation after the widening.
- The Contractor's Hill option involves massive excavation in the area where Contractor's Hill is located. This hill is located on the west side of Gaillard Cut, between the reaches of Culebra and Cucaracha. Appendix No. 14 and 15 include sketches of the location of Contractor's Hill and Gold Hill.
- The Gold Hill option involves massive excavation in the area where Gold Hill is located. This hill is located on the east side of Gaillard Cut, across from Contractor's Hill. Sketches of this hill are also shown in Appendixes No. 14 and 15.
- Both options are similar from La Pita curve to the north, but differ from the Lirio curve to the south. Therefore, it is proposed that widening be executed first in the areas north of Lirio curve. A proper decision to opt for the widening of either Gold Hill or Contractor's Hill could not be taken until a geotechnical evaluation of the proposed excavation of areas is performed and reviewed by the Geotechnical Advisory Board. The Geotechnical Advisory Board is a group formed by well-known geotechnical, seismological experts, and geologists that advise the ACP on these types of issues.
- Both options represent major geotechnical challenges. As shown in Appendix No. 15, excavating a portion of Gold Hill could affect Culebra east and Cucaracha and produce massive landslides. Gold Hill and Purple Rock act like a wall to contain landslides in Culebra and Cucaracha.

- Excavation in Contractor's Hill could promote major instability and upheaval of the Canal channel bottom in the area of Escobar as shown in Appendix No. 15, close to the construction of the new Centenary bridge , which will join the Panama Canal's east and west sides .

4.2 Gold Hill Option, Advantages and Disadvantages

- Advantages:
  - Required excavation volume for Gold Hill option is less than for the Contractor's Hill option -- therefore, cost are reduced.
  - The Gold Hill option has a better navigation alignment than the Contractor's Hill option, that is, fewer ship rudder angle changes.
  - The excavation of the Gold Hill option would cause almost no critical effects on Contractor's Hill, Escobar Hill, or Culebra landslide areas.
- Disadvantages:
  - The excavation in Gold Hill and Purple Rock could affect the stability of Cucaracha and east Culebra slopes.
  - There is a deficit in the disposal sites' remaining capacity on the east side. Therefore, final disposition of excavation material poses a major problem.

4.3 Contractor's Hill Option, Advantages and Disadvantages

- Advantages:
  - Less excavation would be required on the east side of Gaillard Cut where there is a deficit in disposal sites' remaining capacity.
  - Available disposal sites on the west side of Gaillard Cut have enough remaining capacity to easily accommodate Contractor's Hill excavation material.
  - Excavation of the Contractor's Hill option does not affect Gold Hill, Cucaracha landslide area, or east Culebra landslide area.
- Disadvantages:
  - Greater excavation volume than the Gold Hill option; therefore the Contractor's Hill option would be more expensive.
  - Contractor's Hill navigation alignment involves greater ship rudder angle change.
  - Excavation of Contractor's Hill option could affect Contractor's Hill, Escobar, Model Slope, and west Culebra slide areas as shown in Appendix No. 15.

5 DRY EXCAVATION PHASE

5.1 Dry Excavation Volumes

- The ACP Geotechnical Branch defined proposed Gaillard Cut widening preliminary slope schemes based on the experience gained during the recently completed GCWP. No stability analysis was run for the Contractor's Hill or Gold Hill options. However, the slope schemes were selected in a conservative manner, taking into account the complex geology and topography of Gaillard Cut, guided by previous successful excavation results and experience.
- Using the preliminary slope schemes, the Geotechnical Branch estimated the excavation volume using the civil engineering application software INROADS, and recently updated digital topographic and bathymetric information during the period running from 1999 through 2002. Appendix No. 1 contains graphics of Gaillard Cut with general topographic information. Proposed horizontal alignment of both options is shown in Appendix No. 16.
- As previously mentioned, the proposed draft excavation phase would enable the transit of Post-Panamax ships at a design channel bottom of 10.4 m PLD, with lake minimum operation level at elevation 25.9 m PLD. However, since dry excavation volume was estimated for a design channel bottom of elevation 8.38 m (27.5 ft) PLD, additional dry excavation would not be required for future deepening.
- It was assumed that the dry excavation volume estimate includes all the material above elevation 27.5 m (90') PLD.
- The Contractor's Hill option requires the removal of 29.3 million cubic meters of dry excavation material, while the Gold Hill option requires 23.2 million cubic meters as shown in the following table. The navigational channel layout is the same for both options from Gamboa to La Pita South; therefore, dry excavation volumes would be the same for both areas. However, due to differences in channel layouts, dry excavation volumes from Lirio to the south differ in both options. For detailed information, refer to Appendix No. 17 for the Contractor's Hill option, and No 18 for the Gold Hill option.

GAILLARD CUT WIDENING DRY EXCAVATION VOLUMES FOR 1-WAY POST-PANAMAX

Area	Station	Dry Excavation to 10.36 m PLD (m^3)	
		Contractor Hill Option	Gold Hill Option
Gamboa	44K+940 to 50K+950	316,400	316,400
Obispo y Cascadas	50K+950 to 55K+150	3,850,008	3,850,008
Subtotal		**4,166,408**	**4,166,408**
La Pita Norte	53K+760 to 55K+550	1,739,073	1,739,073
La Pita Sur	55K+550 to 57K+070	3,505,790	3,505,790
Subtotal		**5,244,863**	**5,244,863**
Lirio	56K+440 to 58K+680	5,611,524	5,069,828
Hodges	58K+680 to 60K+020	5,745,528	1,881,112
Contractor y Escobar	60K+020 to 61K+240	6,433,346	1,982,851
Goyo y Cartagena	61K+240 to 63K+440	2,117,505	2,087,594
Gold Hill			2,782,587
Subtotal		**19,907,903**	**13,803,972**
Total		**29,319,174**	**23,215,243**

5.2 Dry Excavation Timeframe Estimate

- Dry excavation for the proposed widening was planned in such a way that it would comply with maximum target timeline of 5 to 6 years to complete the Gaillard Cut widening. This operation also includes the fragmentation of hard material through drilling and blasting, if required, and would be performed by the same Contractor's in charge of the dry excavation process. Local contractors in Panama successfully performed the dry excavation work for the Gaillard Cut Widening Program to 192 m (GCWP) in the 1990's. It would be most likely that the ACP would seek external contractors to conduct the Gaillard Cut widening dry excavation phase.
- According to the geologic condition of the material to be excavated and following excavation experience in Gaillard Cut, the ACP Department of Engineering and Projects, and the Contracting Division estimated the following dry excavation productions based on GCWP experience to complete the widening in 5 to 6 years:
    - Hard material = 75,000 cubic meters per month
    - Medium material = 150,000 cubic meters per month
    - Soft material = 225,000 cubic meters per month
- The following table includes a summary of GCWP excavation production records compiled by the ACP's Contracting Division. Appendix No. 20 and No. 21 include more

information on GCWP excavation records compiled by the Contracting and Dredging divisions, independently.

GAILLARD CUT WIDENING PROGRAM TO 192 M EXCAVATION MATERIAL HISTORICAL RECORDS

Area	Type of Material	Production m^3/month	Season
Obispo	Hard	**90,690**	Summer
Tres Pesos	Hard	**95,926**	Summer
Borinque	Medium hard to harc	**52,000**	Raining
Las Cascadas III	Medium hard	**320,000**	Summer
Las Cascadas I & II	Medium hard	**210,250**	Summer
Central La Pita	Hard	**284,000**	Summer
Central La Pita	Hard	**111,000**	Raining
North La Pita	Hard	**74,750**	Raining
Summit	Medium hard	**196,000**	Summer
Escobar	Hard	**91,000**	Unknown
Cartagena	Medium hard	**137,500**	Unknown
Contractor	Hard	**75,000**	Unknown
Gold Hill	Hard	**68,000**	Unknown

- Gantt Charts were developed to plan the dry excavation phase. As shown on Appendix No. 19, up to 4 excavation fronts would be required simultaneously to comply with the proposed timeline of 5 to 6 years. Also, to maximize excavation productivity, dry excavation contracts should include as minimum 2 summers, if the dry excavation contract or project should last more than 1 year.
- Based on assumed excavation productions and planning a maximum of 4 fronts working simultaneously, the total time of this phase is estimated at 4.75 years for the Contractor's Hill option, and 4.33 years for the Gold Hill option.

5.3 Dry excavation estimated costs

- Historical cost information from the GCWP was used to estimate the dry excavation costs for the Gaillard Cut widening. The following table includes a summary of the different unitary costs, which encompasses drilling and blasting if required, offered by potential vendors who worked for the GCWP, according to the type of project or type of material. The Contractor's Hill and Gold Hill projects were separated due to the high percentage of hard rock found in these areas. The average unitary cost was $4.33 per cubic meter, with an average hauling distance of 3 km. Refer to Appendix No. 20 for more information.

GAILLARD CUT WIDENING PROGRAM TO 192 m (GCWP)
Unclassified Excavation Unit Price Record

Comtract	cu.m.	Government estimate ($/m^3)	Number of offereros	Average unit cost $/m^3
Mandinga	107,900	7.60	6	**7.70**
Obispo	280,000	3.25	10	**3.17**
Elliot	250,000	7.70	10	**5.60**
Eduardo	118,700	5.78	8	**6.42**
Tres Pesos	305,000	7.25	5	**6.04**
Borinquen	345,000	3.88	4	**3.65**
Las Cascadas	1,181,700	2.64	8	**2.69**
Las Cascadas III	2,687,100	1.90	5	**2.35**
North La Pita	680,000	3.62	5	**3.28**
South La Pita I	414,000	3.75	6	**3.22**
South La Pita II	158,000	2.80	6	**3.03**
Central La Pita	2,946,805	1.99	6	**2.74**
Summit	1,620,000	2.19	6	**2.18**
Empire	2,887,500	1.65	3	**2.45**
Hodges	2,208,655	2.10	5	**2.65**
Escobar	1,220,000	2.30	1	**3.33**
Cartagena	2,320,911	3.53	6	**3.42**
			Sub-Total Avg	**3.76**
Note: Projects Gold Hill and Contrators Hill are not included in this analysis since material to be excavated is mostly hard rock. The calculated average price				
is more representative for the unclassified excavation definition of our specs documents				
Gold Hill	1,485,000	4.36	2	**5.64**
Contractors Hill	1,860,000	4.20	4	**4.19**
			Sub-Total Avg	**4.91**
			Total Avg.	**4.33**

- Although GCWP dry excavation unitary cost offered by different contractors was $4.33 per cubic meter, it was decided that an average of $4.50 per cubic meter would reflect an updated Gaillard Cut widening project total cost. Due to a required increase in excavation productivity, and probably increased disposal site hauling distance, the unitary cost for Gaillard Cut widening could be slightly higher than GCWP unitary cost. However, it is known that competitive prices could be found in the construction segment.
- Because of the shortage in the remaining capacity of disposal sites on the east side, it is estimated that the hauling distance on the east site would be 5 km, as opposed to the 3 km estimated for the west side.

- Dry excavation total costs for both Contractor's Hill and Gold Hill options is $131.9 million, and $104.5 million, respectively. The following chart shows the cost per area:

GAILLARD CUT WIDENING DRY EXCAVATION COST				
Project	**Contractor Hill Option**		**Gold Hill Option**	
	Volume (m^3)	**Cost ($)**	**Volume (m^3)**	**Cost ($)**
Unit Cost		4.50		4.50
1. Gamboa	316,400	1,423,800	316,400	1,423,800
2. Obispo & Casc.	3,850,008	17,325,036	3,850,008	17,325,036
3. North La Pita	1,739,073	7,825,827	1,739,073	7,825,827
4. South La Pita	3,505,790	15,776,057	3,505,790	15,776,057
5. Lirio	5,611,524	25,251,858	5,069,828	22,814,227
6. Hodges	5,745,528	25,854,876	1,881,112	8,465,002
7. Contractor	6,433,346	28,950,057	1,982,851	8,922,831
8. Cartagena	2,117,505	9,528,773	2,087,594	9,394,173
9. Gold Hill			2782587.2	12,521,642
Total	**29,319,174**	**131,936,284**	**23,215,243**	**104,468,595**
Notes:				
1. It is assumed that material transportation distances would be 5.0 km for the east side and 3.0 km for the west				

6 LAND-BASED DRILLING AND BLASTING PHASE

6.1 Drilling and Blasting Estimated Volumes

- Drilling and blasting is required to fragment the hard material for its subsequent dredging or excavation. This phase covers the fragmentation of material from elevation 27.50 m (90') PLD to elevation 5.94 m (19.5') PLD, which represents a depth of 21.6 m (70.5') of material fragmentation. Conventional dredging or land-based dredging would be implemented to remove the fragmented material below elevation 27.50 m PLD.
- Using the same templates to estimate dry excavation volumes and proposed horizontal alignment for the Contractor's and Gold Hill options, the ACP Geotechnical Branch estimated drilling and blasting volumes via the civil engineering application software INROADS and digital topographic and bathymetric information updated between 1999 and 2002.
- As previously mentioned, since drilling and blasting constitutes the critical path of any dredging and excavation project, it is advisable to drill and blast up elevation 5.94 m PLD, which is beyond that required for the initial channel bottom design of 10.4 m PLD. Therefore, the underwater channel bottom would be fragmented for other dredging projects or deeper draft channel as shown in Appendix No. 28. Also, costs for drilling and blasting execution in phases is very high -- around 50% cost increase. One phase of the drilling and blasting work is proposed for different draft scenarios.
- Based on GCWP experience, 84% of the total drilling and blasting volume would be performed by land-based equipment. The total volume of drilling and blasting and land-based drilling and blasting in cubic meters is shown in the following table:

GAILLARD CUT WIDENING LAND-BASED DRILLING AND BLASTING VOLUMES

Area	From elevation 27.5 m to 5.94 m PLD			
	Contractor Hill Option		Gold Hill Option	
	Total volume (m^3)	Land-based volume (m^3)	Total volume (m^3)	Land-based volume (m^3)
Gamboa	2,938,208	2,468,095	2,938,208	2,468,095
Obispo & Casc.	5,790,144	4,863,721	5,790,144	4,863,721
North La Pita	1,255,811	1,054,881	1,255,811	1,054,881
South La Pita	1,408,374	1,183,034	1,408,374	1,183,034
Lirio	2,955,476	2,482,600	2,665,557	2,239,068
Hodges	1,767,143	1,484,400	507,045	425,917
Contractor	2,156,532	1,811,487	769,457	646,344
Cartagena	2,111,620	1,773,761	2,089,457	1,755,144
Gold Hill			763,684	641,495
Total	**20,383,308**	**17,121,979**	**18,187,737**	**15,277,699**

Notes:

1. Based on GCWP, it is estimated that 84% of total drilling and blasting volume can be performed with terrestrial equipment.

6.2 Land-based Drilling and Blasting Timeline Estimate

- Just as with the dry excavation, the ACP is planning to contract land-based drilling and blasting services; however, ACP drilling and blasting equipment production during the GCWP was used to estimate material fragmentation timeframe.
- According to the data shown in Appendix No. 21, during GCWP, land-based drilling and blasting operation average production was around 28,343 cubic meters per week, but increased to 32,830 from March 1995 through June 2001 due to later acquisition of other land-drill rigs. At the beginning of the GCWP, only the electrical land-based drill rig P&H was available to perform the land-based drilling and blasting. However, the land-based drill rigs DM-45, 2 TAMROCKS D55 SP, and 2 Rangers 700 were acquired in phases and integrated to the GCWP execution.
- For the Gaillard Cut widening process, it was assumed that 100% of estimated drilling and blasting volume would require fragmentation. Most of the widening material that would be dredged has not been subjected to previous drilling or blasting as opposed to channel deepening. The Gaillard Cut channel bottom has been deepened previously and a percentage of its sub-marine material would not require drilling and blasting for its subsequent dredging.
- The land-based drilling and blasting in GCWP was executed under two different schedules according to program requirements: 2 watches of 10 hours per day, 5 times per week (2W-5D), and 3 watches of 8 hours per day each, 5 times per week (3W-5D).
- Using all 6 land-based drill rigs acquired by the ACP for the GCWP, the Dredging Division estimated that under a mode of 2W-5D and 1 front, land-based drilling and blasting productivity could be of 61,386 cubic meters per week as shown in Appendix No. 24. However, to keep pace with other activities, it is estimated that 54,273 cubic meters per week or 235,000 cubic meters per month would be sufficient to comply with the widening target timeline of 5 to 6 years.
- Producing 235,000 cubic meters per month requires the support of one D-5M tractor, one D-6tractor, a CAT 924 payloader, a CAT 934 payloader, 2 diesel-refueling vehicles, 1 lubricating vehicle, 2 water pumps, 2 4x4 vehicles, one diesel storage tank, 2 portable explosive magazines, and one compressor.
- Producing an average 235,000 cubic meters per month includes equipment preventive maintenance, crew relief, and emergency repairs.
- An average pattern of 176'x200' was used to estimate land-based drilling and blasting productivity. Each pattern would have 16' of spacing and 14' of burden resulting in 14 lines of 11 boreholes each for a total of 154 boreholes. Each borehole has a 6" diameter. According to the type of material found in Gaillard Cut, the pattern size might change to fulfill dredging operation needs.
- As shown in the Gantt Chart, Appendix No. 19, land-based drilling and blasting would follow dry excavation and precede land-based dredging, and it could start as early as 2 months or as late as 25 months after initiating the dry excavation work, depending on the availability of resources, vessel traffic interference or widening execution progress.

Based on the estimated productivity of 235,000 cubic meters per week, the land-based drilling and blasting operation could take about 4 years and 8 months to complete under the Contractor's Hill option, and 4 years and 3 months under the Gold Hill option.

6.3 Estimated Costs for Land-based Drilling and Blasting

- Based on GCWP experience, land-based drilling and blasting operational costs were used to estimate the total cost of fracturing hard material for its later removal. Appendix No. 24 includes the estimate of drilling and blasting unitary cost for different shift schedules and number of equipment front scenarios. Assuming a 2W-5D shift and one front, the unitary cost would be approximately $3.89 per cubic meter. Applying a factor of 1.15 that includes incidentals, contractor's profit, and bonds, then the average unitary cost would be $4.50 per bank cubic meter as shown on the following table.

LAND-BASED DRILLING AND BLASTING APPROXIMATE UNIT COST

Items	Unit Cost ($/bank m^3)
Unit cost	3.89
Incidentals (3%)	0.12
Profit (10%)	0.39
Bonds (2%)	0.08
Total unit cost	4.47

- The estimated cost for land-based drilling and blasting includes the operation of land-based drill rigs P&H, DM-45, 2 TAMROCKS D55 SP, and 2 Rangers 700, as well as support equipment including one D-5M tractor, one D-6 tractor, a CAT 924 payloader, a CAT 934 payloader, 2 diesel refueling vehicles, 1 lubricating vehicle, 2 water pumps, 2 4x4 vehicles, one diesel storage tank, 2 portable explosive magazines, and one compressor.
- The estimated cost also includes labor, equipment maintenance, 12 % of overhead costs, fuel, explosives, and accessories.
- Land-based drilling and blasting total cost would be $60 million and $53.5 million for the Contractor's Hill and Gold Hill options, respectively. The following table shows the costs per area:

GAILLARD CUT STRAIGHTENING LAND-BASED DRILLING AND BLASTING ESTIMATED COST

Project	Contractor Hill Option		Gold Hill Option	
	Volume (m^3)	Cost ($)	Volume (m^3)	Cost ($)
Unit Cost		4.50		4.50
1. Gamboa	2,468,095	11,106,426	2,468,095	11,106,426
2. Obispo & Casc.	4,863,721	21,886,744	4,863,721	21,886,744
3. North La Pita	1,054,881	4,746,966	1,054,881	4,746,966
4. South La Pita	1,183,034	5,323,655	1,183,034	5,323,655
5. Lirio	2,482,600	11,171,699	2,239,068	10,075,805
6. Hodges	1,484,400	6,679,800	425,917	1,916,628
7. Contractor	1,811,487	8,151,691	646,344	2,908,548
8. Cartagena	1,773,761	7,981,924	1,755,144	7,898,148
9. Gold Hill			641494.5264	2,886,725
Total	**17,121,979**	**77,048,906**	**15,277,699**	**68,749,646**

7 LAND-BASED DREDGING PHASE

7.1 Land-based Dredging Estimated Volume

- The land-based dredging phase generally follows land-based drilling and blasting work and precedes underwater drilling and blasting. This phase assists sub-aquatic dredging by removing fragmented material below lake water level along navigational channel banks. While in Gaillard Cut, the dredging excavator usually sits on a bank at elevation of 27.5 m PLD to dredge material using a bucket.
- Using the same templates to estimate dry excavation, and drilling and blasting volumes, the ACP Geotechnical Branch calculated the required dredging volume to achieve the proposed Gaillard Cut 1-way Post-Panamax navigational channel layout for the Contractor's Hill and Gold Hill options. The calculations were performed using civil engineering application software INROADS and digital topographic and bathymetric information updated from 1999 through 2002.
- During the GCWP, about 21% of the total dredging volume was removed by the hydraulic excavator LIEBHERR 994, acquired by the ACP in 1997 to support cutter-suction dredge MINDI and dipper dredge RMC work. For more information on land dredging and the LIEBHERR 994 excavator, refer to Appendixes No. 21 and 22.
- For the 1-way Post-Panamax widening in Gaillard Cut, it was assumed that 30% of the total dredging volume could be removed using land-based dredging equipment. Although this percentage is higher than the one recorded during the GCWP, it still represents an attractive and sufficient volume for external contractors to compensate for land-based dredging initial costs such as land-based equipment mobilization, which should be very high due to the use of land-based dredges and support equipment of larger size than that of the dry excavation equipment.
- The total dredging volume and land-based dredging volume were estimated for a design channel bottom of elevation 10.4 m (34 ft) PLD, including an over-dredging of 0.6 m (2 ft) or to elevation of 9.75 m (32 ft) PLD. The following shows the total dredging volume required to obtain a design channel bottom of 10.4 m PLD, with the corresponding land-based dredging volume for the Contractor's Hill and Gold Hill options. In Gamboa Reach, dredging is required in Santa Cruz Island, located on the west bank. Accessibility to this island would be difficult for contractors, so dredging with ACP resources would result more effective than land-based dredging. Dredging is performed with the help of land-based equipment such as bulldozers that dump the material into the water for its subsequent dredging. Land-based dredging in the Hodges and Contractor's areas under the Contractor's Hill option could delay the dredging phase, extending the widening timeline; therefore, 100% of underwater dredging would be preferable for these areas.

GAILLARD CUT WIDENING TOTAL DREDGING AND LAND-BASED DREDGING VOLUMES

Area	To Channel Botton of 10.4 m PLD			
	Contractor Hill Option		Gold Hill Option	
	Total volume (m^3)	Land dredging volume (m^3)	Total volume (m^3)	Land dredging volume (m^3)
Gamboa	1,994,019	0	1,994,019	0
Obispo & Casc.	4,564,736	1,369,421	4,564,736	1,369,421
North La Pita	1,007,093	302,128	1,007,093	302,128
South La Pita	1,149,836	344,951	1,149,836	344,951
Lirio	2,430,237	729,071	2,190,129	657,039
Hodges	1,452,208	0	409,168	122,750
Contractor	1,772,047	0	630,824	189,247
Cartagena	1,733,010	519,903	1,714,071	514,221
Gold Hill			636,441	190,932
Total	**16,103,185**	**3,265,474**	**14,296,316**	**3,690,689**

Notes:

1. It is estimated that around 30% of total dredging volume could be performed with land dredge equipment.

7.2 Land-based dredging Timeline Estimate

- As with dry excavation and land-based drilling and blasting, the ACP is planning to hire external contractors to conduct the land-based dredging work.
- The ACP Maintenance Division estimated that a dragline production could be around 20,849 bank cubic meters per week, while a hydraulic excavator such as the LIEBHERR 994 could be around 24,329 cubic meters per week under a schedule of 6 days per week and 20 hours per day a as shown in calculations included in Appendix No. 22.
- During the GCWP, the LIEBHERR 994 average production was 17,844 bank cubic meters per week according to the data shown in Appendix No. 21. However, there were factors that hindered the LIEBHERR's maximum productivity, such as its constant mobilization to support dredging operations, longer hauling distance on the east bank, the assigning of excavator 44 cubic yard trucks to the ACP clamshell, and excavator assignation to works other than GCWP dredging.
- After analyzing the LIEBHERR 994's potential capacity based on GCWP experience and theoretical estimates, it was decided that land-based dredging production in the widening program could be around 25,000 bank cubic meters per week.

- The land-based dredging production of 25,000 bank cubic meters per week would require at least 4 off-road hauling trucks similar to those used in the GCWP: 773D Caterpillar trucks. However, the number of trucks would depend on the distance to the dumpsite.
- As shown in the Gantt Chart, Appendix No. 19, land-based dredging follows land-based drilling and blasting and precedes underwater drilling and blasting; and it can start several months after land-basedl drilling and blasting, depending on execution progress and availability of resources. Based on the estimated productivity of 25,000 bank cubic meters per week, land-based dredging could be accomplished in 2 years and 5 months under the Contractor's Hill option, and in 3 years and 1 month under the Gold Hill option.

7.3 Land-based Dredging Cost Estimate

- The cost calculation included in Appendix No. 22 indicates that the unitary cost of a land dredger per se for land-based dredging is around $2.01 per cubic meter for a P&H 2355 dragline, and $1.15 per cubic meter for a hydraulic LIEBHER 994 excavator. Associated costs such as road maintenance, hauling, dredge support, disposal site maintenance, and others, could add up to $6.32 per cubic meter, including a 10% of profit. Following is a table that summarizes the total unitary cost for land-based dredging:

LAND-BASED DREDGING APPROXIMATE UNIT COST

Items	Unit Cost ($/bank m^3)	
Roads maintenance	0.90	
Disposal site maint.& operat.	0.95	
Auxiliary equipment support	0.80	
Overburden (20% of $3.50)	0.70	
3-km Hauling ($0.35/ bcm-km)	1.05	
Supervision, camping	0.50	
Sub-total	**4.90**	
Incidentals (2%)	0.10	
Overhead (15%)	0.74	
Profit (10%)	0.49	
Bonds (2%)	0.10	
Sub-total	**1.42**	
	P&H 2355	**LIEBHERR 994**
Land dredger	**2.01**	
Total unit cost	**8.33**	**7.47**

- The cost estimates are based on a 3 km dumping distance, which was considered average during the previous phase of the GCWP. These estimates would need to be adjusted if the new dump sites require traveling farther, since additional hauling trucks would be needed to keep the excavator busy at all times. Road maintenance costs would also increase.

- An average unitary cost of $8.50 per cubic meter was used to estimate land-based dredging total cost, which is $27.8 million for the Contractor's Hill option, and $31.4 million for the Gold Hill option. The following table includes the cost per area:

GAILLARD CUT WIDENING LAND DREDGING ESTIMATED COST

Project	Contractor Hill Option		Gold Hill Option	
	Volume (m^3)	Cost ($)	Volume (m^3)	Cost ($)
Unit Cost		8.50		8.50
1. Gamboa	0	0	0	0
2. Obispo & Casc.	1,369,421	11,640,077	1,369,421	11,640,077
3. North La Pita	302,128	2,568,087	302,128	2,568,087
4. South La Pita	344,951	2,932,082	344,951	2,932,082
5. Lirio	729,071	6,197,104	657,039	5,584,829
6. Hodges	0	0	122,750	1,043,378
7. Contractor	0	0	189,247	1,608,600
8. Cartagena	519,903	4,419,176	514,221	4,370,881
9. Gold Hill			190,932	1,622,924
Total	**3,265,474**	**27,756,525**	**3,690,689**	**31,370,858**

8 UNDERWATER DRILLING AND BLASTING PHASE

8.1 Underwater drilling and blasting volume estimate

- The underwater drilling and blasting phase follows the land-based dredging phase and assists land-based drilling in areas beyond land reach. According to the GCWP experience, it is estimated that the underwater portion for drilling and blasting would be around 16% of the total drilling and blasting volume required for subsequent dredging.
- The drilling and blasting volume was estimated from elevation 27.50 m to 5.94 m PLD required to widen Gaillard Cut from 192 m to 225 m in straight legs, and from a maximum of 222 m to the proposed width of 260 m in the bends.
- The following table shows the total volume of drilling and blasting and the portion that corresponds to the underwater phase:

GAILLARD CUT WIDENING UNDERWATER DRILLING AND BLASTING ESTIMATED COST

Project	Contractor Hill Option		Gold Hill Option	
	Volume (m^3)	Cost ($)	Volume (m^3)	Cost ($)
Unit Cost		7.60		7.60
1. Gamboa	470,113	3,572,861	470,113	3,572,861
2. Obispo & Casc.	926,423	7,040,815	926,423	7,040,815
3. North La Pita	200,930	1,527,066	200,930	1,527,066
4. South La Pita	225,340	1,712,583	225,340	1,712,583
5. Lirio	472,876	3,593,859	426,489	3,241,317
6. Hodges	282,743	2,148,846	81,127	616,566
7. Contractor	345,045	2,622,343	123,113	935,660
8. Cartagena	337,859	2,567,730	334,313	2,540,780
9. Gold Hill			122,189	928,640
Total	**3,261,329**	**24,786,103**	**2,910,038**	**22,116,288**

8.2 Underwater Drilling and Blasting Timeline Estimate

- It is assumed that either one, the ACP drill-boat THOR, or the new drill-boat would be available to perform the underwater drilling and blasting phase to widen Gaillard Cut. As

of today, the ACP is planning to acquire a new drill-boat during fiscal year 2004, which should be operational by 2005. The new drill-boat should have a higher productivity margin than the THOR; however, the THOR's production was used to estimate the underwater drilling and blasting timeline.

- According to the GCWP, underwater drilling and blasting productivity was just 13,532 cubic meters per week under the 2W-5D mode but during 16 hours per day instead of 20. However, the drill-boat THOR just implemented the 3W-7D mode in May 2003, that is 24 hours per day, 7 days per week to perform the ongoing Gatun Lake and Gaillard Cut deepening to channel bottom elevation 10.4 m PLD. The resulting productivity since May is 24,601 cubic meters per week under an alternated schedule of 3W-7D and 3W-5D, as shown on recent records included in Appendix No. 25. Under a full 3W-7D schedule, it is estimated that the THOR can accomplish 30,000 cubic meters per week.
- In addition to the working schedule change and consequently the addition of working crews, the THOR's increased productivity reflects its hydraulic system improvement implemented in 2002. This improvement should have boosted up THOR's efficiency in 13%.
- The production of 30,000 cubic meters per week for widening the Gaillard Cut is somewhat conservative, since the drill-boat would be drilling and blasting outside navigation channel prism lines; therefore, traffic interruption would be minimum. This production includes emergency repairs, preventive maintenance, and crew relief.
- Using a productivity of 30,000 cubic meters per week, the underwater drilling and blasting phase could be accomplished in 2 years and 10 months, and 2 years and 2 months, including 5 months of overhaul every 5 years, for the Contractor's Hill and Gold Hill options, respectively. As shown in Appendix No. 19, only one front of underwater drilling and blasting would be required to complete the Gaillard Cut widening in 5 to 6 years.

8.3 Underwater Drilling and Blasting Cost Estimate

- The THOR operation costs for fiscal years 1995, 1996, 1997, and 1998, included in Appendix No. 26, were used to estimate underwater drilling and blasting costs. Operation costs include drillboat availability, labor, overhead, and auxiliary equipment support costs. The overhead for the ACP Dredging Division was estimated to be 12%.
- These costs were converted into 2002 dollars by applying the average inflation rate of 1.023 for fiscal years 1995 through 2002 according to the US Corps of Engineers (USACE), as shown in Appendix No. 27.
- The inflation rate was applied to THOR operation costs, except for labor, since labor wage was estimated at the maximum step for each position or man-category wage effective January 3, 1999, and these wages have not been increased since then.
- THOR availability costs were averaged based on 270 days of operation per year with the remaining days of the year used for drill-boat maintenance, overhaul and emergency repairs.

- Following is a table showing THOR operation costs per hour and per week in 2002 dollars:

ACP DRILL-BOAT THOR OPERATION COST	
	Cost per hour ($)
Availability cost	164
Labor cost	517
Overhead cost	62
Fuel cost	54
Auxiliary equipment cost	216
TOTAL COST per hour	**1,013**

- For a productivity of 30,000 cubic meters per week, the underwater drilling and blasting is estimated at $7.60 per cubic meter as shown on the following table and Appendix No. 26:

UNDERWATER DRILLING AND BLASTING UNIT COST ESTIMATE				
Equipment	**Cost per hour ($)**	**Cost per week ($)**	**Estimated production per week (m^3)**	**Unit cost ($/m^3$)**
Drill-boat THOR	1,013	167,894	30,000	**5.60**
Explosives cost				**2.00**
TOTAL UNIT COST				**7.60**

- Using the unitary cost of $7.60 per cubic meter, the total cost of underwater drilling and blasting for the Contractor's Hill and Gold Hill options is $24.8 million and $22.1 million, respectively, as shown on the following table. These costs do not include the initial investment to acquire a new drillboat.

GAILLARD CUT WIDENING UNDERWATER DRILLING AND BLASTING ESTIMATED COST

Project	Contractor Hill Option		Gold Hill Option	
	Volume (m^3)	Cost ($)	Volume (m^3)	Cost ($)
Unit Cost		7.60		7.60
1. Gamboa	470,113	3,572,861	470,113	3,572,861
2. Obispo & Casc.	926,423	7,040,815	926,423	7,040,815
3. North La Pita	200,930	1,527,066	200,930	1,527,066
4. South La Pita	225,340	1,712,583	225,340	1,712,583
5. Lirio	472,876	3,593,859	426,489	3,241,317
6. Hodges	282,743	2,148,846	81,127	616,566
7. Contractor	345,045	2,622,343	123,113	935,660
8. Cartagena	337,859	2,567,730	334,313	2,540,780
9. Gold Hill			122,189	928,640
Total	**3,261,329**	**24,786,103**	**2,910,038**	**22,116,288**

9 SUB-AQUATIC DREDGING PHASE

9.1 Sub-Aquatic Dredging Volume Estimate

- Dredging would be the last phase of the Gaillard Cut Post-Panamax widening and will depend very much of the fragmentation level of the channel bottom and the type of material to be dredged (rock, soil, etc.). There would be areas that require no drilling and blasting, so dredging could be performed at an earlier stage.
- According to the GCWP experience, either the cutter-suction dredge MINDI or the dipper dredge RMC would remove 84% of the overall dredging volume. The RMC is assigned to areas where mostly hard material is found, and the MINDI to areas where the material's unconfined compressive strength is generally below 3,500 psi.
- As pointed out previously, the dredging volume was estimated at elevation 10.4 m PLD using the parameters defined in the section on the land-based dredging phase; however, in this case, 70% of the total volume corresponds to sub-aquatic dredging. The following table contains the estimate of the dredging volume:

GAILLARD CUT WIDENING TOTAL DREDGING AND SUB AQUATIC DREDGING VOLUMES

Area	To Channel Botton of 10.4 m PLD			
	Contractor Hill Option		Gold Hill Option	
	Total volume (m^3)	Dredging volume (m^3)	Total volume (m^3)	Dredging volume (m^3)
Gamboa	1,994,019	1,994,019	1,994,019	1,994,019
Obispo & Casc.	4,564,736	3,195,315	4,564,736	3,195,315
North La Pita	1,007,093	704,965	1,007,093	704,965
South La Pita	1,149,836	804,885	1,149,836	804,885
Lirio	2,430,237	1,701,166	2,190,129	1,533,090
Hodges	1,452,208	1,452,208	409,168	286,417
Contractor	1,772,047	1,772,047	630,824	441,577
Cartagena	1,733,010	1,213,107	1,714,071	1,199,850
Gold Hill			636,441	445,509
Total	**16,103,185**	**12,837,712**	**14,296,316**	**10,605,627**

Notes:

1. It is estimated that around 70% of total dredging volume could be performed w ith sub aquatic dredging equipment.

- Only dredging would be performed in Gamboa Reach under both widening options, and in the Hodges and Contractor's areas under the Contractor's Hill option, for effectiveness and timeline compliance reasons.

9.2 Sub-Aquatic Dredging Timeline Estimate

- To estimate the dredging phase timeline in the Gantt Chart included in Appendix No. 19, it was assumed that 3 dredges would be available to perform the Gaillard Cut widening: RMC, MINDI, and a new cutter-suction dredge that the ACP is planning to acquire by fiscal year 2005.
- According to the data shown on Appendix No. 21, dredging average productivity during GCWP from January 1994 through June 2001 was about 32,167 cubic meters per week, for a maximum hauling distance of 20 km in the case of the RMC, and 3 km of pumping distance for the MINDI. For planning purposes, a productivity of 30,000 cubic meters per week was assumed to dredge the channel bottom to elevation 10.4 m PLD. It was assumed that the new cutter-suction dredge would have the same productivity as the MINDI. The GCWP target design channel bottom was elevation 11.3 m (37 ft) PLD; therefore, theoretically dredging productivity should be less for a deeper channel bottom of 10.4 m PLD.
- The productivity of 32,167 cubic meters per week was achieved under a schedule of 3W-7D, including preventive maintenance, emergency repairs, dredging maintenance, and crew relief. Overhaul maintenance is conducted approximately 6 months every 5 years, and was included in the Gantt Chart for the planning of the Gaillard Cut widening.
- The planning of dredging work includes a maximum of 3 dredging fronts simultaneously as shown on the Gantt Chart included in Appendix No. 19, but it could vary according to widening execution needs. Based on this assumption and a productivity of 30,000 cubic meters per week, the dredging phase could be executed in 4 years and 5 months or in 3 years and 6 months under the Contractor's Hill option and the Gold Hill option, respectively.

9.3 Sub-Aquatic Dredging Cost Estimate

- Operation costs for the RMC and the MINDI during fiscal years 1995, 1996, 1997, and 1998, included in Appendix No. 29 and 30, were used to estimate the dredging cost at a productivity of 30,000 cubic meters per week. The overhead for the ACP dredging Division was estimated at 12%.
- These costs were converted to 2002 dollars by applying the average inflation rate of 1.023 for fiscal years 1995 through 2002, according to USACE, as shown in Appendix No. 27.
- The inflation rate was applied to RMC and MINDI operation costs, except for labor, since labor wage was estimated at the maximum step for each position or man-category wage effective January 3, 1999, and the wages have not been increased since then.

- The RMC and MINDI availability cost was averaged based on 270 days of operation per year, with the remaining days of the year used for drill-boat maintenance, overhaul and emergency repairs.
- It was assumed that 100% of underwater drilling and blasting estimated volume would require drilling and blasting since the area for widening has not been subjected to previous fragmentation process.
- Following is a table showing RMC and MINDI operation costs per hour and per week converted to 2002 dollars:

ACP DREDGES OPERATION COST

	CHRISTENSEN	MINDI
	Transportation distance of 20 km	Pumping distance 3 km
Availability cost ($ per hour)	306	781
Labor cost ($ per hour)	531	624
Overhead cost ($ per hour)	64	75
Fuel cost ($ per hour)	56	233
Auxiliary equipment cost ($ per hour)	888	439
TOTAL COST ($ per hour)	**1,845**	**2,152**
TOTAL COST ($ per week)	**307,545**	**351,866**

- For a productivity of 30,000 cubic meters per week, the dredging is estimated at an average of $11.00 per cubic meter, as shown on the following table and in Appendixes No. 29 and 30:

DREDGING UNIT COST ESTIMATE

Dredge	Cost per hour ($)	Cost per week ($)	Estimated production per week (m^3)	Unit cost ($/m^3$)
Dipper dredge RMC	1,845	307,545	30,000	**10.25**
Cutter-suction dredge MINDI	2152	351866	30,000	**11.73**
AVERAGE UNIT COST				**10.99**

- Using the unitary cost of $11.00 per cubic meter, total dredging costs for the Contractor's Hill and Gold Hill options are $141.2 million and $116.7 million, respectively, as shown

on the following table. These costs do not include the initial investment to acquire a new cutter-suction dredge.

GAILLARD CUT WIDENING DREDGING ESTIMATED COST

Project	Contractor Hill Option		Gold Hill Option	
	Volume (m^3)	Cost ($)	Volume (m^3)	Cost ($)
Unit Cost		11.00		11.00
1. Gamboa	1,994,019	21,934,209	1,994,019	21,934,209
2. Obispo & Casc.	3,195,315	35,148,467	3,195,315	35,148,467
3. North La Pita	704,965	7,754,614	704,965	7,754,614
4. South La Pita	804,885	8,853,737	804,885	8,853,737
5. Lirio	1,701,166	18,712,825	1,533,090	16,863,994
6. Hodges	1,452,208	15,974,285	286,417	3,150,591
7. Contractor	1,772,047	19,492,517	441,577	4,857,342
8. Cartagena	1,213,107	13,344,177	1,199,850	13,198,347
9. Gold Hill			445,509	4,900,595
Total	**12,837,712**	**141,214,832**	**10,605,627**	**116,661,897**

9.4 Additional Dredging to an 8.38 m (27.5 ft) PLD Design Channel Bottom

- If it were decided to deepen the widened areas from elevation 10.4 m to 8.38 m PLD, additional dredging would be required. The dredging material should already be fragmented since drilling and blasting would have been executed to elevation 5.94 m PLD, sufficient to remove material above design navigation channel bottom at elevation 8.38 m PLD.
- The additional dredging volume and costs to achieve a channel bottom at elevation 8.38 m PLD in the straightened portion of Gaillard Cut for the Contractor's Hill option and the Gold Hill option are as follows:

ADDITIONAL DREDGING REQUIRED FOR A DESIGN CHANNEL BOTTOM OF 8.38 m (27.5 ft) PLD				
Additional Dredging	**Design channel bottom from 10.36 m to 8.38 m PLD (m^3)**	**Dredging Tolerance from 8.38 m to 7.77 m PLD (m^3)**	**Total dredging volume (m^3)**	**Total cost at a unit cost of \$11/m^3 (\$)**
Contractor Hill Option	3,001,058	737,839	3,738,897	**41,127,867**
Gold Hill Option	2,802,242	675,608	3,477,850	**38,256,350**

10 DISPOSAL SITES FOR DREDGING AND EXCAVATION MATERIAL

- The total amount of dredging and excavation material from Gaillard Cut 1-way Post-Panamax widening including the 0.61 m of over-dredging for option Contractor's Hill and Gold Hill option is as follows:

GAILLARD CUT 1-WAY POST-PANAMAX WIDENING DRY EXCAVATION AND DREDGING MATERIAL

	Option Contractor Hill (m^3)	Option Gold Hill (m^3)
Dry excavation	29,319,174	23,215,243
Land-based dredging	3,265,474	3,690,689
Dredging	12,837,712	10,605,627

- A total of 32.6 M cubic meters of land-based dredging and dry excavation material would have to be disposed over land surface under the Contractor's Hill option, while 26.8 M cubic meters would have to be disposed upland under the Gold Hill option. Some of the 12.8 M cubic meters or 10.6 M cubic meters of underwater dredging material could also be discharged in upland disposal sites. Appendixes No. 1 and 14 include sketches of ACP designated disposal sites along Gaillard Cut to accommodate excavation and dredging material. At this stage, there are not reliable topography records of disposal sites, so remaining capacity is under evaluation.
- If the Canal Expansion Program is approved, the ACP Geotechnical Branch would proceed to prepare the upland disposal sites dike design to accommodate the excavation and land-based and underwater dredging material, as well as the design for the Gaillard Cut widening.
- Consultant MOFFATT&NICHOL is conducting a study that includes the remaining capacity estimate of some ACP disposal sites located along Gaillard Cut, specifically E2, W3, W5, and the area near of Mandinga and Camacho Rivers on the west bank.
- Regarding dredging material, some 12.8 M cubic meters would have to be disposed of under the Contractor's Hill option, and 10.6 M cubic meters under the Gold Hill option. Cutter- suction dredges would require to pump the dredged material upland in Gaillard Cut designated disposal sites. The dipper dredge RMC would dispose of the dredging material in Gatun Lake. However, if Post-Panamax deepening were implemented first, there would be a deficit in the remaining capacity of lake designated disposal sites. Therefore, assessment of aquatic disposal site issues is recommended before widening execution.

11 SUMMARY

- The following table shows a summary of excavation, dredging, and drilling and blasting volumes, duration, and cost estimates without contingencies for proposed Gaillard Cut widening for 1-way Post-Panamax traffic assuming the existing Gaillard Cut configuration after its widening to 192 m:

GAILLARD CUT WIDENING FOR PROPOSED 1-WAY POST-PANAMAX NAVIGATION CHANNEL
Summary of volume, duration, and cost estimates

Phase	Option Contractor Hill			Option Contractor Hill		
	Volume (m^3)	Duration (y-m years months)	Cost ($)	Volume (m^3)	Duration (y-m years months)	Cost ($)
Dry Excavation	29,139,174	4 y - 9 m	131,936,284	23,215,243	4 y - 4 m	104,468,595
Land D&B	17,121,979	4 y - 8 m	77,048,906	15,277,699	4 y - 3 m	68,749,646
Land dredging	3,265,474	2 y - 5 m	27,756,525	3,690,689	3 y -1 m	31,370,858
Underwater D&B	3,261,329	2 y - 10 m	24,786,103	2,910,038	2 y -2 m	22,116,288
Dredging	12,837,712	4 y - 5 m	141,214,832	10,605,627	3 y - 6 m	116,661,897
TOTAL to elev. 10.4 m PLD		**6 y - 3 m**	**402,742,650**		**5 y - 5 m**	**343,367,284**
Additional Dredging Cost to 8.38 m PLD			**41,127,867**			**38,256,350**
TOTAL COST			**443,870,517**			**381,623,634**

Notes:
1. The volume, duration, and costs were estimated assuming Gaillard Cut existing configuration of 192 m wide in straight legs, and a maximum of 222 m in the bends.

- As of today, the ACP is planning to execute the Gaillard Cut straightening program for 2-way Panamax traffic during fiscal year 2004 to meet SOLAS ship visibility requirements and improve ship maneuverability, especially at the bends. Dredging, excavation, and drilling and blasting volume, duration, and cost estimate for 2-way Panamax traffic at a design channel bottom elevation of 10.4 m PLD with no contingency are as follow:

GAILLARD CUT PROPOSED 2-WAY PANAMAX NAVIGATION CHANNEL AT ELEVATION 10.4 M PLD

Summary of volume, duration, and cost estimates

Phase	Volume (m^3)	Duration (y m years months)	Cost ($)
Dry Excavation	9,141,355	2 y - 3 m	41,136,098
Land D&B	4,997,350	2 y - 5 m	22,488,073
Land dredging	942,356	2 y - 3 m	8,010,022
Underwater D&B	951,876	2 y - 2 m	7,234,258
Dredging	2,477,289	2 y - 8 m	27,250,174
TOTAL		**4 y - 3 m**	**106,118,625**

- Therefore, Gaillard Cut 1-way Post-Panamax layout costs should be as follows after its 2-way Panamax straightening implementation:

GAILLARD CUT WIDENING FOR 1-WAY POST-PANAMAX TRAFFIC AFTER STRAIGHTENING FOR 2-WAY PANAMAX TRAFFIC

Gaillard Cut layout	Options	
	Contracto Hill	Gold Hill
1-way Post-Panamax traffic	402,742,650	343,367,284
2-way Post-Panamax traffic	106,118,625	106,118,625
NET COST to elev. 10.4 m PLD	**296,624,025**	**237,248,659**
Additional Dredging Cost to 8.38 m PLD	**41,127,867**	**38,256,350**
TOTAL COST	**337,751,892**	**275,505,009**

APPENDIX No. 1

Gaillard Cut Widening Sketches

Option Contractor Hill
&
Option Gold Hill

APPENDIX No. 2

Memos for the Records

Meeting between ACP Maritime Operations and Engineering Personnel

AUTORIDAD DEL CANAL DE PANAMÁ

Memorándum

Fecha : 31 de enero de 2003

Conteste a : IPCN

Asunto : Reunión sobre las posibles ampliaciones a los cauces de navegación del Canal

Para : Constancia en el archivo

1. El 30 de enero del 2003, se llevó a cabo una reunión en el salón de conferencias de la División de Proyectos de Capacidad del Canal para discutir el tema en mención.

2. Las siguientes personas estuvieron presentes en la reunión: Agustín Arias (IP), Luis Alfaro (IPI), Capitán Diego Porras (MRTC), Capitán Max Newman (MTRH), Capitán Ricardo Varela (MRXI), Capitán Federico Cockburn (MRTA), Capitán Jacinto Holnes (MRTP), Maximiliano De Puy (IPIG), Carlos Reyes (IPIG), y Yolanda Chin (IPCN).

3. El Ing. Arias explicó las diferentes propuestas para la ampliación de los cauces de navegación para barcos Post-Panamax en una vía y dos vías. Sin embargo, el esfuerzo inicial para identificar los diferentes parámetros en el diseño de la ampliación de los cauces debe ser dirigido al mejoramiento de las curvas en el Corte para el tráfico de barcos Panamax. Con este mejoramiento, el Canal cumple con las regulaciones de la Organización Marítima Internacional sobre visibilidad de los barcos desde la proa.

4. El Ing. Arias informó que la Junta Directiva autorizó la disposición de fondos para la ejecución de trabajos para el mejoramiento de las curvas del Corte para el tránsito de Panamax. Por lo tanto, se requiere de la participación activa del Departamento de Operaciones Marítimas y de Ingeniería y Proyectos para el diseño técnico y estimado de costos de las mejoras requeridas en el Corte.

5. Los participantes de la reunión concordaron que el trabajo solicitado para el mejoramiento de las curvas se realice en dos reuniones semanalmente, específicamente martes y jueves, de dos horas cada uno para llegar a un mutuo acuerdo sobre el diseño final para finales del mes de febrero del presente año. Además se sugirió la grabación de estas reuniones para la documentación apropiada de las discusiones.

6. El Capitán Porras solicitó una copia del resumen ejecutivo del estudio realizado por CAORF sobre el proyecto de ampliación del Corte Gaillard a 630'. Además el Ing. Arias solicitó que se enviara una copia a todos los asistentes sobre los resultados de investigación realizado por la Ing. Chin de las dimensiones de los canales y sus respectivas restricciones en las dimensiones de los barcos para su tránsito.

7. Por último se convocó la próxima reunión para el martes 4 de febrero a las 10:00 a.m. en el edificio 714, 2do piso.

Yolanda M. Chin
Equipo de Cauces de Navegación

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MRTC
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MRXI
MRTA
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AUTORIDAD DEL CANAL DE PANAMÁ

Memorándum

Fecha : 7 de febrero de 2003

Conteste a : IPCN

Asunto : Reunión sobre las posibles ampliaciones a los cauces de navegación del Canal

Para : Constancia en el archivo

1. El 6 de febrero del 2003, se llevó a cabo la tercera reunión en el salón de conferencias de la División de Proyectos de Capacidad del Canal como parte de la agenda para la definición de los parámetros generales en el diseño de las mejoras y ampliación de los cauces de navegación del Canal.

2. Las siguientes personas estuvieron presentes en la reunión: Agustín Arias (IP), Luis Alfaro (IPI), Capitán Diego Porras (MRTC), Capitán Ricardo Varela (MRXI), Capitán Federico Cockburn (MRTA), Maximiliano De Puy (IPIG), José García (IPIG), y Yolanda Chin (IPCN).

3. Se distribuyeron copias del informe de las pruebas de encuentro de barcos Panamax efectuadas en 1999; el informe de PIANC sobre el diseño de los cauces de navegación de 1997 y 1980; "Handbook of Port and Harbor Engineering" de Gregory Tsinker; "International Workshop on Channel Design and Vessel Maneuverability" auspiciado por SNAME, USACE, MARAD y USCG en el 2001; "Guidelines for the Safe Design of Comercial Shipping Channels" de Canada; y un resumen de guías para el diseño de cauces recopilado por el Ing. De Puy.

4. Los participantes discutieron las diferentes opciones para las mejoras de las curvas de la Pita y Lirio. Estas diferentes opciones fueron presentadas por el Ing. García a través de los programas computacionales MICROSTATION e INROADS.

5. Entre las opciones presentadas están la ampliación de la Pita hacia el este, integración de un sólo PI (punto de intersección) en la bordada de Cunette para eliminar esta bordada, desviación de la bordada de Cunette de manera que hubiera una recta entre las bordadas de Empire y Cascadas, y la ampliación total de 260 m desde el norte de la Pita hasta el sur Lirio.

6. El Capitán Porras indicó que la condición de las curvas de la Pita y Lirio eran similares a las de las curvas de Mamei y Juan Grande. Por lo tanto, se debería utilizar el ancho de la recta más estrecho de Mamei como parámetro para la bordada entre las curvas de la Pita y Lirio, es decir, 270 m.

7. Se hicieron varios ejercicios para comparar las dimensiones actuales de los cauces de navegación del Corte y el Lago con aquéllas recomendadas por PIANC y Canada. En el caso de las distancias entre dos curvas sucesivas, PIANC recomienda que estas

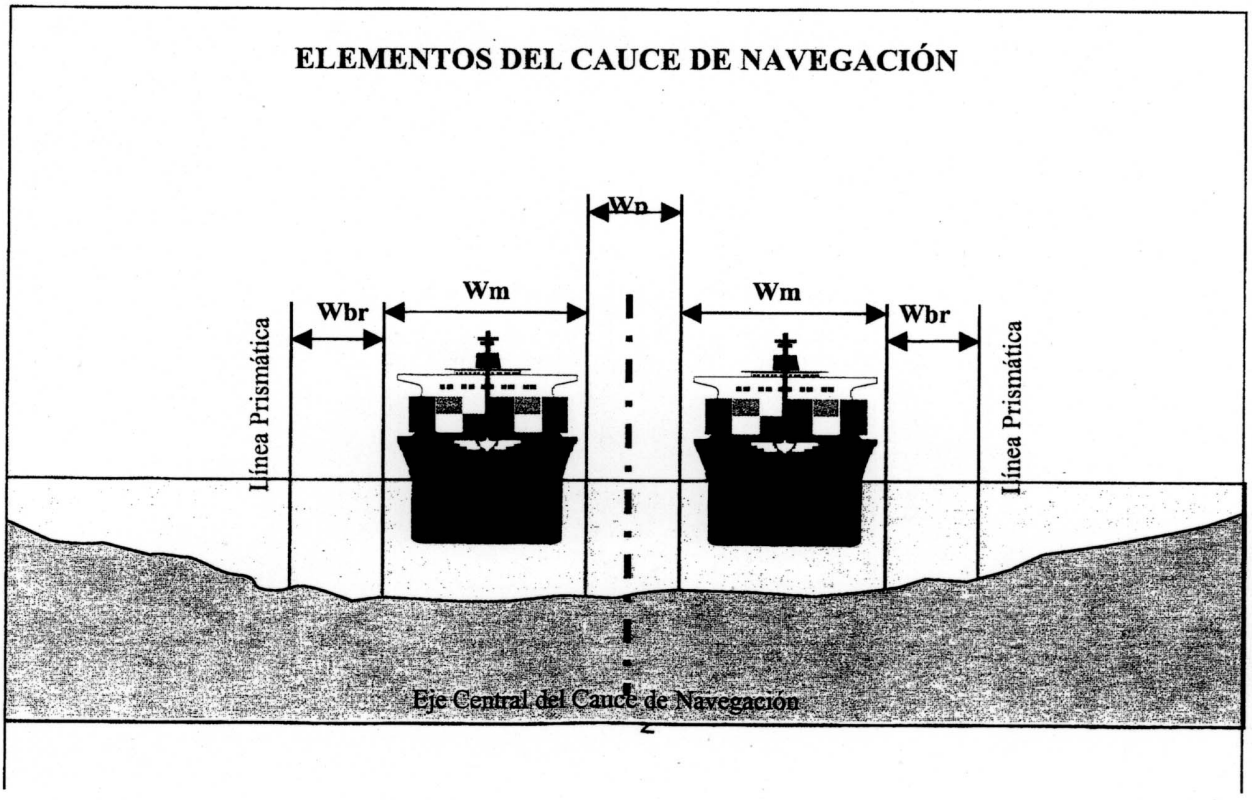
distancias deben ser mayores de 5 veces el largo del barco que el caso del Canal de Panamá es de 1,470 m. La bordada de Cascadas tiene un largo de 1,325 m entre dos curvas, y la bordada de Empire tiene un largo de 1,300 m entre los PI de Empire y Lirio, los cuales no cumplen con la recomendación de PIANC.

8. En el caso de las curvas, dependiendo de la relación de profundidad y calado, PIANC recomienda como mínimo un radio de 7 veces el largo del barco, es decir 2,059 m. Sólo la curva localizada entre las bordadas Bas Obispo y Las Cascadas cumple con este requisito.

9. También se discutieron las recomendaciones del PIANC y Canada sobre el ancho del cauce de acuerdo a las características del Corte Gaillard. Estas recomendaciones están reflejadas en el siguiente cuadro y gráfica:

RECOMENDACIONES DE ANCHO DE LOS CAUCES BASADOS EN LA MANGA DE LOS BARCOS (B)

Guías	Holgura al banco (Wbr)	Vía de maniobra (Wm)	Distancia para rebasar (Wp)	Tipo de fondo de navegación	Relación de profundidad del cauce y calado	TOTAL
PIANC	0.5 B	1.5 B	0.6 B	0.2 B	0.2 B	**6 B**
Canada	1.0 B	1.5 B	0.7 B	0.2 B	0.4 B	**7.6 B**



IPCN, 5 de febrero de 2003
Asunto: Reunión sobre las posibles ampliaciones a los cauces de navegación del Canal

10. Por último se convocó la próxima reunión para el martes 11 de febrero a las 10:00 a.m. en el edificio 714, 2do piso.

Yolanda M. Chin
Equipo de Cauces de Navegación

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MRTA
MRTP

AUTORIDAD DEL CANAL DE PANAMÁ

Memorándum

Fecha : 12 de marzo de 2003

Conteste a : IPCN

Asunto : Presentación de los resultados del análisis de ampliación a 260m desde la curva La Pita hasta la curva de Lirio en en Corte Gaillard

Para : Constancia en el archivo

1. El 28 de febrero del 2003, se llevó a cabo una presentación de los resultados del análisis de la ampliación de un sector del Corte Gaillard desde la curva La Pita hasta la curva de Lirio en el Corte Gaillard, primero con el propósito de cumplir los requisitos de SOLAS sobre la visibilidad de los barcos; segundo para mejorar la navegación de los barcos en las curvas mencionadas; y tercero para permitir el encuentro de 2 barcos Panamax con esloras de 294 m (965').

2. Las siguientes personas estuvieron presentes en la reunión: Director Agustín Arias (IP), Director Jorge Quijano (MR), Luis Alfaro (IPI), Jorge de la Guardia (IPC), Capitán Arcelio Hartley (MRT), Capitán Miguel Rodríguez (MRXI), Capitán Chet Lavalas (MRTP), Capitán Diego Porras (MRTC), Capitán Federico Cockburn (MRTA), Capitán Max Newman (MTRH), Capitán Rogelio Tenturier (MRTC), Maximiliano De Puy (IPIG), José García (IPIG), Capitán Rolando Rivera (IPCN) y Yolanda Chin (IPCN).

3. El Ing. García hizo una presentación de los resultados del análisis de la ampliación a 260 m de ancho del cauce de navegación desde las curvas La Pita hasta Lirio sobre la base de las reuniones efectuadas con el personal de IP y MR efectuadas durante las semanas de los meses de enero y febrero del 2003. En estas reuniones se utilizó las recomendaciones del PIANC en su informe "Approach Channels – A Guide for Design, 1997", y del gobierno de Canadá en el informe "Guidelines for the Safe Design of Comercial Shipping Channels" para el diseño del sector del cauce a ampliar.

4. Las características de la ampliación de las curvas La Pita y Lirio se basó en un barco porta contenedor de 294 m (965 pies) de eslora (L) y 32 m (106 pies) de manga (B). Las siguientes dimensiones se aplicaron en el diseño de la ampliación de las curvas en mención:

- Relación de radio de curvatura y eslora del barco de diseño = 7.25 en la línea central del cauce de navegación
- Línea de visibilidad = 2 L ó 500 m, la menor
- Ancho mínimo = 260 m ó 8.1 B
- Transición de cambio de ancho (192 m a 260 m) = 10:1
- Distancia del tramo recto entre las 2 curvas desde las tangentes = 1,277 m ó 4.35 L

5. Todas las dimensiones mencionadas en el punto anterior cumplen con las recomendaciones del PIANC y Canadá, excepto la distancia del tramo recto entre dos curvas que según estas dos instituciones, se recomienda 5 L, es decir, 1471 m. Sin embargo, es muy difícil alargar este tramo recto ya que implicaría excavaciones en grandes magnitudes que no serían viables financieramente. Se acordó que los 1,277 m en el tramo recto son suficientes para la navegación segura de los barcos ya que 260 m de ancho representa una holgura sustancial para el encuentro de 2 barcos Panamax. Además los 260 m que representan 8.1 B es mucho mayor que el 6.4 B recomendado por PIANC para el encuentro de 2 barcos de 32 m de manga.

5. Además de las características recomendadas por PIANC y Canadá en el diseño de la ampliación de las curvas, se cumple el requisito mínimo de SOLAS de 2 L ó 500 m para la visibilidad adecuada de los buques Panamax en las líneas de navegación. El Ing. García presentó un diagrama del cumplimiento de este requisito con la proa del buque en el punto de intersección (PI) de las curvas que representa la condición más crítica al cambiar el rumbo del barco.

6. Otra ventaja de la ampliación de las curvas La Pita y Lirio es la disminución de los ángulos de desviación de los PI's de las diferentes curvas, y por lo tanto, el enderezamiento relativo de este sector ayudando a la navegación más segura de los barcos.

7. Los participantes hicieron varias observaciones sobre las características utilizadas para la ampliación de las curvas La Pita y Lirio. Entre estas observaciones estaba la utilización de la relación de 1.13 de profundidad del cauce al calado máximo del barco que representa el nivel mínimo de operación del Lago Gatún a 24.8 m (81.5') PLD; sin embargo, la mayor parte del tiempo el lago está a 26 m (85') PLD, por lo tanto, el ancho mínimo del cauce puede ser 6 B en vez de 6.4 B en el tramo recto, y 7.2 B en vez de 7.6 B en las curvas.

8. El Director Arias informó que no sería necesario mover las torres de enfilamiento sur de Bas Obispo para la excavación propuesta. Por ende, el trabajo de ampliación de las curvas La Pita y Lirio no afectaría las pruebas de encuentro de Panamax que están ejecutando los prácticos de la ACP.

9. El Director Quijano informó que MR estaba en proceso de consulta con los prácticos de la ACP para la implementación de iluminación en las cámaras de las esclusas y el aumento de calado. El tema de la ampliación propuesta debería ser consultado con los prácticos en sesiones independientes que se darán a más tardar la primera semana de abril, y que se informaría a IP sobre los resultados de las mismas.

10. El Ing. Arias estimó que la licitación para los trabajos de excavación al sur de la Pita sería en mayo del 2003 después del diseño que realice la Sección de Geotécnica. En

enero del 2004, se iniciarían los trabajos de excavación en el área en mención para aprovechar la estación seca.

11. La presentación del Ing. García se adjunta a este memorándum.

11. Por último se convocó a los miembros del comité de mejoras a los cauces de navegación para la próxima reunión el 13 de marzo en el edificio 714, Paseo El Prado, 2do piso, a las 10:00 a.m.

Yolanda M. Chin
Equipo de Cauces de Navegación

c:
IP
MR
IPI
IPIG
MRTC
MTRH
MRXI
MRTA
MRTP

AUTORIDAD DEL CANAL DE PANAMÁ

Memorándum

Fecha : 28 de marzo de 2003

Conteste a : IPCN

Asunto : Definición de los parámetros de diseño de los canales de navegación.

Para : Constancia en el archivo

1. El 20 de marzo del 2003, se llevó a cabo una reunión como parte de la agenda de homologación de los parámetros de diseño para la ampliación de los cauces de navegación del Canal que permitirá el tránsito de dos barcos Panamax, un barco Post-Panamax y dos barcos Post-Panamax.

2. Las siguientes personas estuvieron presentes en la reunión: Director Agustín Arias (IP), Luis Alfaro (IPI), Capitán Miguel Rodríguez (MRXI), Capitán Chet Lavalas (MRTP), Capitán Diego Porras (MRTC), Maximiliano De Puy (IPIG), José García (IPIG), Yolanda Chin (IPCN), Rolando Rivera (IPCN), Rigoberto Delgado (IPCL) y Gustavo Rivas (IPCN).

3. El Director Arias indicó que los criterios de diseño de las curvas en el Corte Gaillard fueron definidos para el encuentro de barcos Panamax y que se pueden utilizar como punto de partida para el diseño de los cauces Post-Panamax de una y dos vías. En las reuniones previas, se acordó que para la definición de los criterios de diseño se utilizará como referencia las recomendaciones del PIANC-"Approach Channels-A Guide for Design", del gobierno de Canadá en el informe-"Guidelines for the Safe design of Comercial Shipping Channels" y SOLAS (Safety of Life at Sea).

4. Se expuso nuevamente los criterios utilizados para la ampliación del Corte a 260 m (850 pies) desde la curva La Pita hasta la curva Lirio para dos barcos Panamax de 294 metros (965 pies) de eslora y 32 metros (106 pies) de manga cada uno:

- Relación de radio de curvatura y eslora del barco de diseño = 7.25 B (2,130 m) en la línea central del cauce de navegación
- Línea de visibilidad = 2 L ó 500 m, la menor
- Ancho mínimo = 260 m ó 8.1 B
- Transición de cambio de ancho (192 m a 260 m) = 10:1
- Distancia mínimo del tramo recto entre 2 curvas desde las tangentes = 1,77 m ó 4.35 L

5. Para el encuentro de dos barcos Panamax, los participantes acordaron en que los tramos rectos como las Bordadas Bas Obispo y Cascadas del Corte Gaillard tendrían un ancho mínimo de 225 m que excede el promedio de 222 m recomendado por PIANC y Canada. En el Cruce de Chagres, se aplicaría el criterio de un ancho mínimo de 260 m como en las curvas de La Pita y Lirio. Mientras que el tramo recto de la Bordada de Gamboa se mantendría el ancho actual de 198 m ya que 2 barcos Panamax se encuentran sin ningún problema. Sin embargo, el Capitán Lavalas recomienda el

mejoramiento o ampliación del lado este de la Bordada de Gamboa para minimizar el problema de succión de banco.

6. La Ing. Chin presentó un cuadro con los criterios y dimensiones recomendados por PIANC y Canadá para cauces de navegación con una y dos vías Post-Panamax, el cual se adjunta a este memorándum. El barco de diseño utilizado es un barco porta-contenedor Post-Panamax con eslora de 385 metros (1,263 pies), manga de 55 metros (180 pies) y calado de 15 metros (50 pies). Hasta la fecha, estas dimensiones se utilizan como parámetros para el diseño de las esclusas Post-Panamax.

7. Después de varios debates entre el personal de IP y MR y basándose en las recomendaciones de PIANC y Canada, se acordaron las siguientes dimensiones de los cauces para el tránsito seguro de barcos Post-Panamax.

DIMENSIONES PROPUESTOS DE CAUCES PARA BARCOS POST-PANAMAX
Todas las dimensiones en metros

Cauce de Navegación	Una vía Post-Panamax		Dos vías Post-Panamax	
	Tramo Recto	Curva	Tramo Recto	Curva
Ancho	225	260	330	400
Radio de curvatura		2,800		2,800
Línea de visibilidad		500		500
Transición de cambio de ancho	10 : 1		10 : 1	

Barco de diseño: Barco portacontenedor de 385m de eslora, 55 m de manga y 15 m de calado.

8. Las dimensiones propuestas para 2 vías Panamax cumplen las recomendaciones mínimas de PIANC y Canada para 1 vía Post-Panamax; por lo tanto se utilizaron estas mismas dimensiones excepto el radio de curvatura: 2,130 m para el esquema de 2 vías Panamax y 2,800 m para el esquema de una vía Post-Panamax. El Director Arias solicitó al Ing. García cuantificar la diferencia de los dos esquemas de radio de curvatura con el fin de determinar factibilidad de la ejecución de la ampliación de las curvas La Pita y Lirio a 2,800 m en vez del propuesto a 2,130 m.

9. Los criterios presentados en el cuadro anterior se utilizarán para la elaboración de los diseños geométricos; el estimado de volúmenes de dragado, excavación, y perforación y voladura; y la planificación de estas actividades para alcanzar el ancho y profundidad de los cauces 2 vías Panamax, 1 vía Post-Panamax y 2 vías Post-Panamax.

10. Los capitanes Porras, Rodríguez y Lavalas también sugirieron la posibilidad de mejorar las curvas en las bordadas de Bohío y Juan Grande mediante la inclusión de otros PI's (puntos de intersección).

11. Finalmente el Director Arias indicó que una vez concluidos los diseños, cálculos y planificación de la ampliación de los cauces para barcos Post-Panamax, se coordinará la próxima reunión para la presentación de los resultados.

Yolanda M. Chin
Equipo de Cauces de Navegación

c:
IP
IPI
IPIG
MRTC
MRXI
MRTP

AUTORIDAD DEL CANAL DE PANAMÁ

Memorándum

Fecha : 7 de mayo de 2003

Conteste a : IPCN

Asunto : Planificación del programa acelerado de enderezamiento del Corte Gaillard

Para : Constancia en el archivo

1. El 6 de mayo del 2003, se llevó a cabo la tercera reunión de coordinación para planificar el programa acelerado de Enderezamiento del Corte Gaillard.

2. Las siguientes personas estuvieron presentes en la reunión: Director Agustín Arias (IP), Luis Alfaro (IPI), Manuel Alvarado (IPD), Carlos Reyes (IPDI), Gustavo Rivas (IPDL) Efraín Isaza (FMCM), Alvaro Chong (FMCM-LIC1), John Langman (IPII), Luis Paniza (IPIG), Max De Puy (IPIG), José García (IPIG), Rolando Rivera (IPCN), y Yolanda Chin (IPCN).

3. El Director Arias inició la reunión explicando que debido a que no se logró acuerdo con el Sindicato, el proyecto de Ampliación del Atlántico se realizará por contrato, para lo cual se están preparando unos documentos de contratos con el alcance del proyecto que pronto le será entregado a FMC. Igualmente resaltó la preocupación de la Administración por que en los pliegos de licitación se establezcan claramente nuestras necesidades y que el contratista que decida participar en la licitación tenga muy claro el alcance del proyecto, nuestras necesidades en cuanto a la ejecución del mismo y la información necesaria para la correcta estimación del proyecto.

4. FMCM indicó que en este tipo de proyecto y basado en la experiencia anterior del Ensanche del Corte, hay ciertas limitaciones físicas que nos restringen la cantidad de equipo. Igualmente manifestó que la fecha de inicio de la ejecución de cada uno de estos proyectos incidirá directamente en la producción, ya que de acuerdo a la data del proyecto anterior para la estación seca se pueden esperar producciones en la excavación seca por el orden de 400,000 metros cúbicos por mes y que durante la estación lluviosa la misma se reduce a 100,000 metros cúbicos por mes. Otra información que es de vital importancia en este tipo de proyectos, es el de poder proveer al contratista la información geológica disponible del área del proyecto.

5. Seguidamente se presentaron los esquemas preparados de la opción 14 y 15. La opción 14 consiste en el alineamiento del Corte mayormente hacia el lado Oeste del prisma existente cumpliendo con los criterios de radio de curvatura y visibilidad sin afectar "Gold Hill". Tiene un costo de operación (incluye15% imprevisto) estimado en 441 M$ y una duración de aproximadamente 6.7 años. El volumen total de excavación seca, dragado de tierra y dragado subacuático es de aproximadamente 45.4 millones de metros cúbicos.

IPCN, 7 de mayo de 2003
Asunto: Planificación acelerada del programa de Enderezamiento del Corte

La opción 15 con el alineamiento del Corte mayormente hacia el lado Este del prisma existente, cumple con los criterios de radio de curvatura y visibilidad, afectando la excavación las áreas de "Gold Hill", "Purple Rock" y los derrumbes de Cucaracha y Sur Cucaracha. Se ha estimado un costo de operación (incluye15% imprevisto) de 377 M$ y una duración de 5.3 años. El volumen total estimado de excavación seca, dragado de tierra y dragado subacuático es de aproximadamente 37.5 millones de metros cúbicos.

6. El Director Arias indicó que para la planificación acelerada del programa de Enderezamiento del Corte, se debe optimizar la excavación seca de manera que la ejecución de la misma coincida al máximo con los períodos de la estación seca; igualmente puntualizó que debido a la duración de los proyectos de dragado desde tierra, se debe considerar la ejecución de esta actividad bajo un solo contrato, por lo que esta actividad debe considerarse con un solo frente de trabajo.

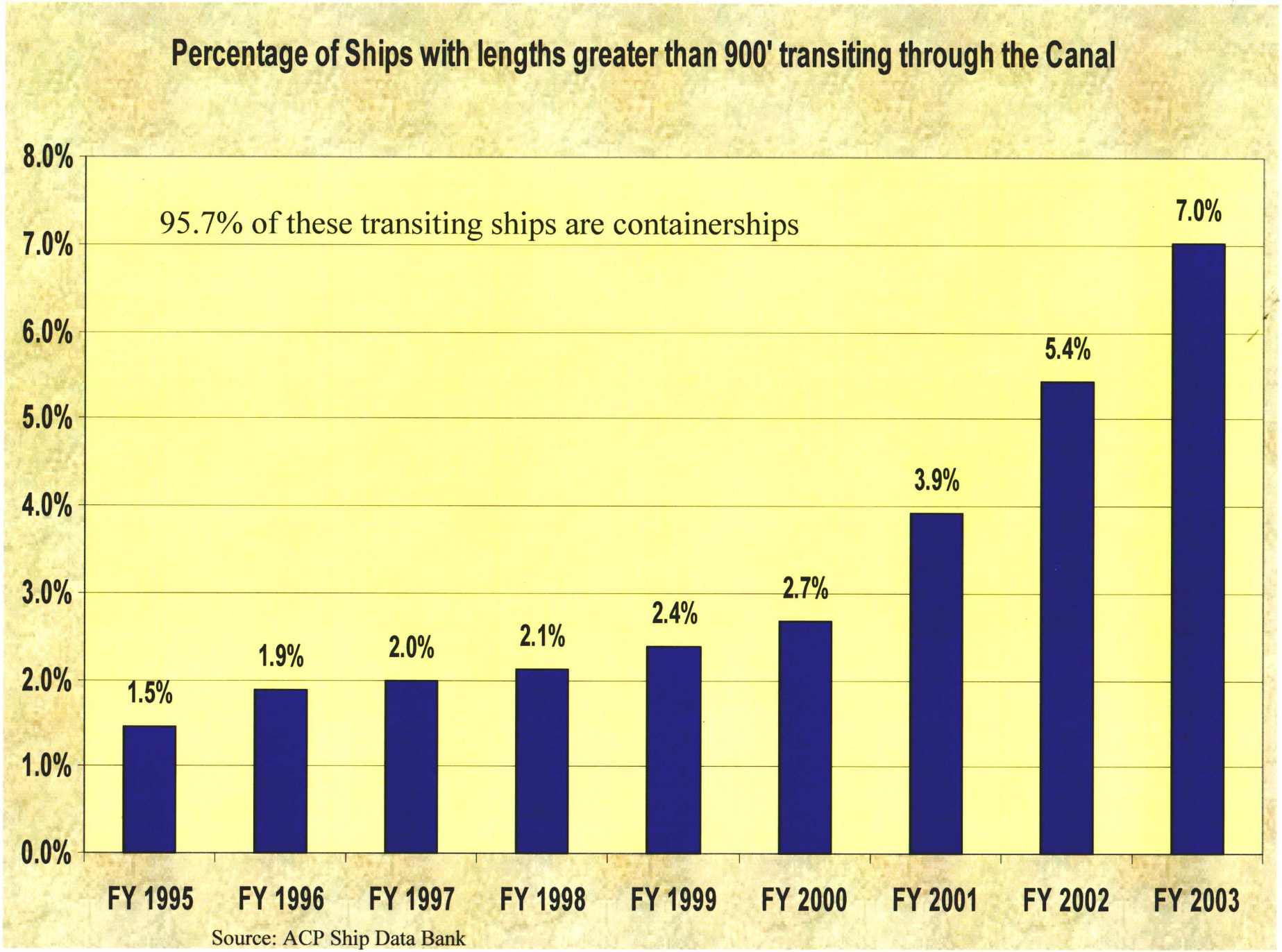
7. El Director Arias solicitó que se preparen para la próxima semana, con base a lo indicado en el punto anterior, las nuevas revisiones de la opción 14 y 15. Igualmente solicitó que se preparen las justificaciones para aquellas actividades que se consideren no deben ser contratadas, para que sean discutidas y analizadas. Igualmente solicitó a los participantes que para la próxima reunión presenten sus comentarios relacionados con la logística requerida para la ejecución del proyecto de Enderezamiento del Corte.

Yolanda M. Chin
Equipo de Cauces de Navegación

c:
participantes

APPENDIX No. 3

Growth Percentage of Ships Greater than 274 m (900 ft) Transiting Through the Canal

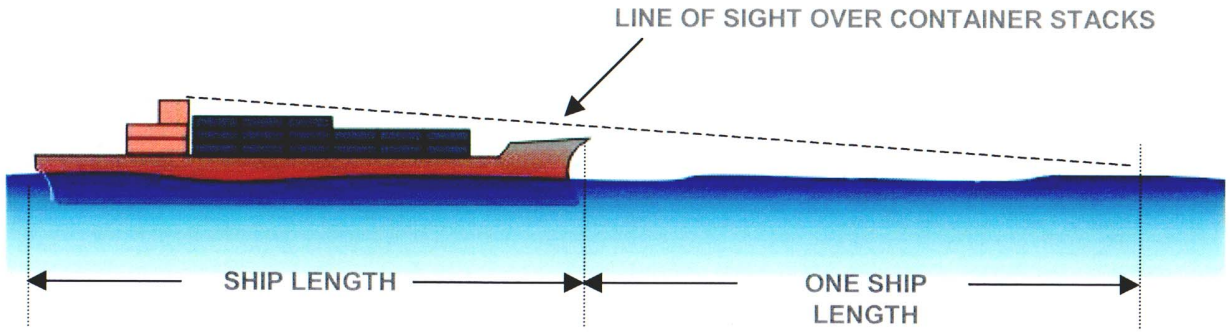

Percentage of Ships with lengths greater than 900' transiting through the Canal
95.7% of these transiting ships are containerships
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
1.5%
1.9%
2.0%
2.1%
2.4%
2.7%
3.9%
5.4%
7.0%
FY 1995
FY 1996
FY 1997
FY 1998
FY 1999
FY 2000
FY 2001
FY 2002
FY 2003
Source: ACP Ship Data Bank

APPENDIX No. 4

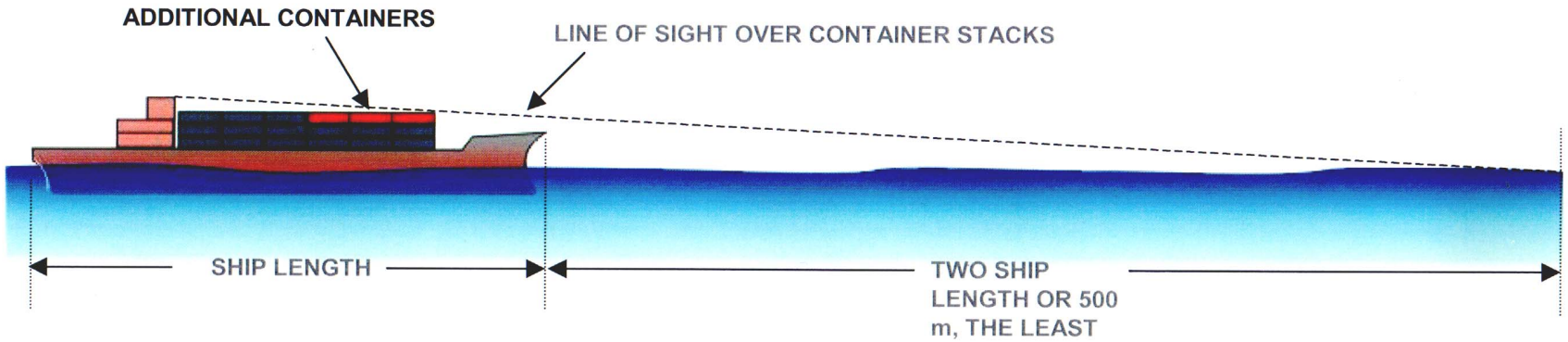
SOLAS Requirement

LINE OF SIGHT

LINE OF SIGHT REQUIREMENTS AS PER SOLAS



Autoridad del Canal de Panamá

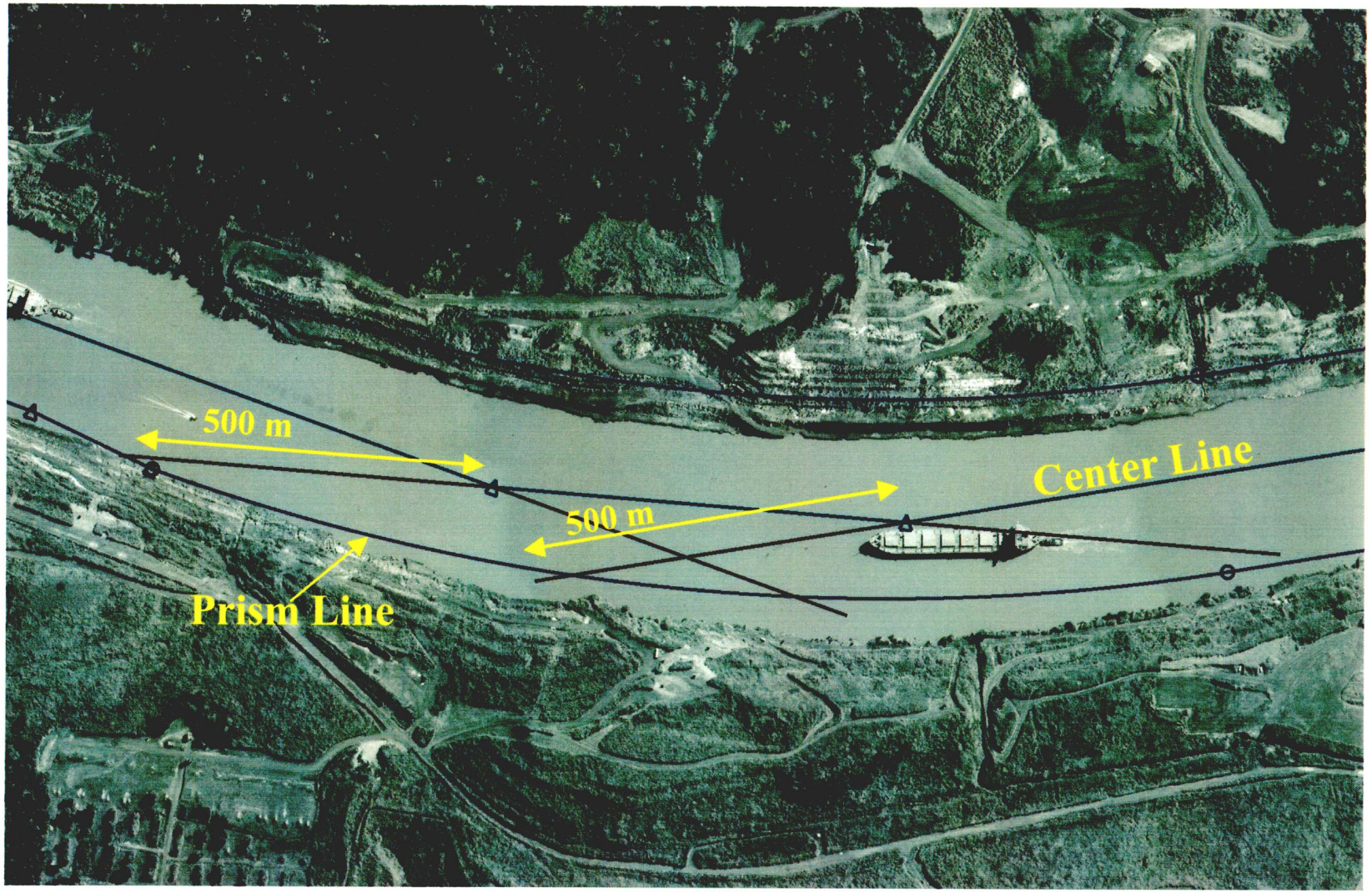


IMO SOLAS CONVENTION

APPENDIX No. 5

Plan View of Line of Sight Requirements in Navigation Channel Centerline

Example of line of visibility requirement in La Pita bend



APPENDIX No. 6

Navigation Channel Width Requirements for 1-way Post-Panamax traffic

Characteristics of the Design Ship

Vessel type	**Container Ship**
Deadweight (tonnes)	125,780
Displacement (metric tonnes)	209,633
Length (meters)	385
Beam (meters)	55
Draft (meters	15
Blockcoefficient	0.66
Depth to draft relation	1.13

	PIANC RECOMMENDATIONS		**CANADA RECOMMENDATIONS**	
Factors affecting Design Channel Width	**GAILLARD CUT One way PPX traffic**		**GAILLARD CUT One way PPX traffic**	
	Straight Reaches	**Bend**	**Straight Reaches**	**Bend**
Basic manoeuvring lane (W_{BM})	**1.50**	**1.50**	**1.50**	**1.50**
Addition for speed	0.00	0.00	0.00	0.00
Addition for cross wind	0.00	0.00	0.00	0.00
Addition for cross current	0.00	0.00	0.00	0.00
Addition for longitudinal current	0.00	0.00		
Addition for waves	0.00	0.00		
Addition for aids to navigation	0.00	0.00	0.00	0.00
Addition for bottom surface	**0.20**	**0.20**	**0.20**	**0.20**
Addition for waterway depth	**0.40**	**0.40**	**0.40**	**0.40**
Addition for cargo hazard	0.00	0.00	0.00	0.00
Bank clearance	**0.50**	**0.50**	**1.00**	**1.00**
Additional passing distance for two way traffic				
Vessel speed (PIANC) Vessel clearance (Canada)	**0.00**	**0.00**	**0.00**	**0.00**
Traffic density	**0.00**	**0.00**	**0.00**	**0.00**
Width of Swept Track		**1.2**		**1.09**
Total channel width (beam)	**3.10**	**4.30**	**4.10**	**5.19**
Total channel width (m)	**171**	**237**	**226**	**285**
Radius of Turn (ship length)		**7.25**		**5.00**
Radius of Turn (m)		**2,791**		**1,925**

APPENDIX No. 7

Navigation Channel Width Requirements for 2-way Panamax traffic

Characteristics of the Design Ship

Vessel type	**Container Ship**
Deadweight (tonnes)	50,000
Displacement (tonnes)	74,977
Length (meters)	294
Beam (meters)	32
Draft (meters	12
Blockcoefficient	1
Depth to draft relation	1.13

CHANNEL WIDTH OF 2-WAY PANAMAX TRAFFIC GUIDELINES

Factors affecting Design Channel Width	PIANC RECOMMENDATIONS				CANADA RECOMMENDATIONS			
	GAILLARD CUT		GATUN LAKE		GAILLARD CUT		GATUN LAKE	
	Straight Reaches	Curves	Straight Reaches	Curves	Straight Reaches	Curves	Straight Reaches	Curves
Basic manoeuvring lane	**1.50**	**1.50**	**1.50**	**1.50**	**1.50**	**1.50**	**1.50**	**1.50**
Addition for speed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Addition for cross wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Addition for cross current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Addition for longitudinal current	0.00	0.00	0.00	0.00				
Addition for waves	0.00	0.00	0.00	0.00				
Addition for aids to navigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Addition for bottom surface	**0.20**	**0.20**	**0.10**	**0.10**	**0.20**	**0.20**	**0.10**	**0.10**
Addition for waterway depth	**0.40**	**0.40**	**0.20**	**0.20**	**0.40**	**0.40**	**0.20**	**0.20**
Addition for cargo hazard	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bank clearance	**0.50**	**0.50**	**0.00**	**0.00**	**1.00**	**1.00**	**0.50**	**0.50**
Additional passing distance for two way traffic								
Vessel speed	**1.00**	**1.00**	**1.40**	**1.40**	**1.00**	**1.00**	**1.00**	**1.00**
Traffic density	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**
Width of Swept Track		**1.2**		**1.2**		**1.2**		**1.2**
Total channel width (beam)	**6.40**	**7.60**	**5.20**	**6.40**	**7.40**	**8.60**	**5.80**	**7.00**
Total channel width (m)	**206**	**245**	**167**	**206**	**238**	**277**	**187**	**225**
Radius of Turn (length)		**7.25**		**7.25**		**5.00**		**5.00**
Radius of Turn (m)		**2,132**		**2,132**		**1,471**		**1,471**

APPENDIX No. 8

Width of Swept Track in a Turn
PIANC recommendation

appendix no.8- swept track (1046x1534x24b jpeg)

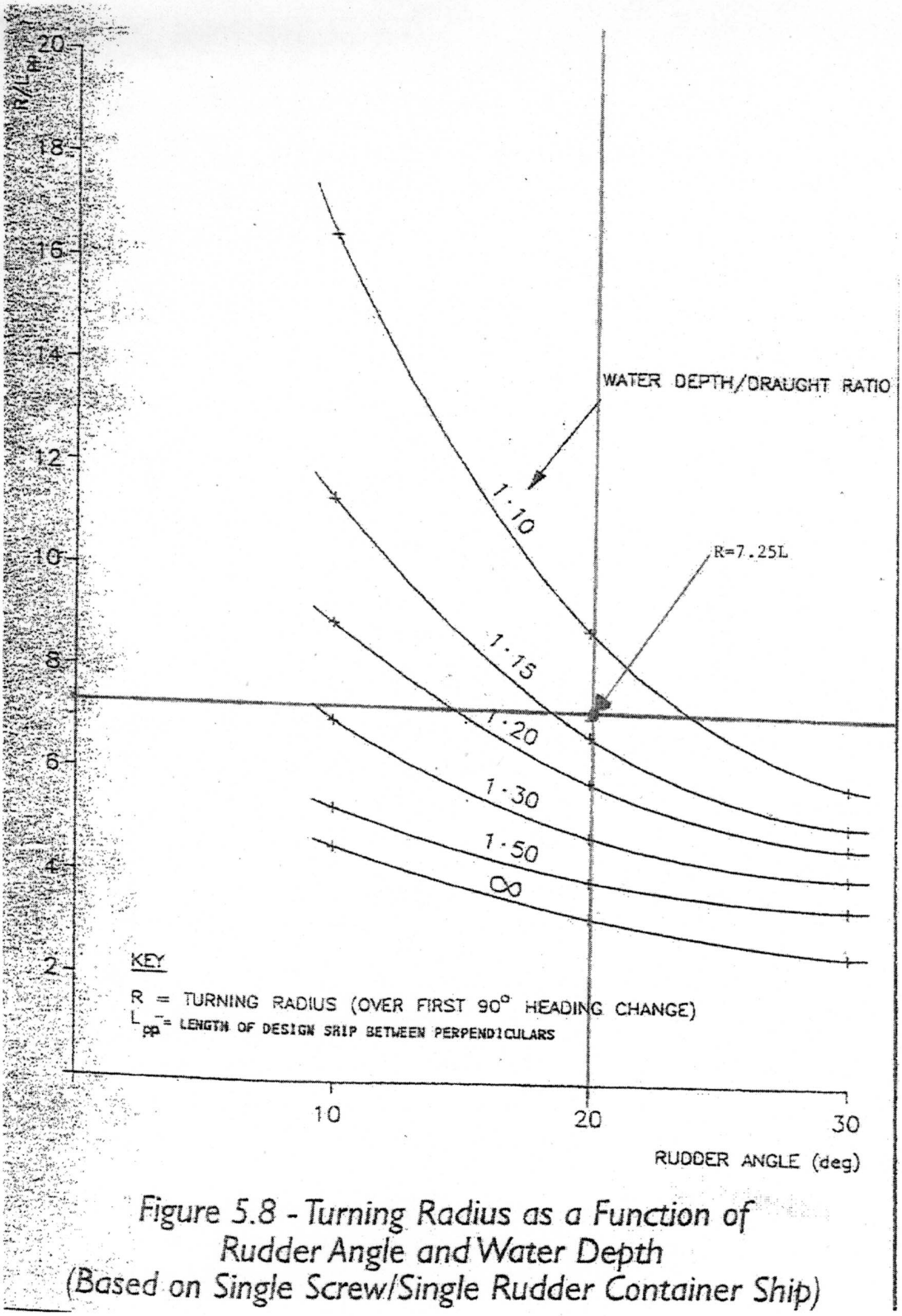


Figure 5.8 - Turning Radius as a Function of Rudder Angle and Water Depth (Based on Single Screw/Single Rudder Container Ship)

APPENDIX No. 9

Channel Turning Radius

appendix no.9- turning radius (1096x1567x24b jpeg)

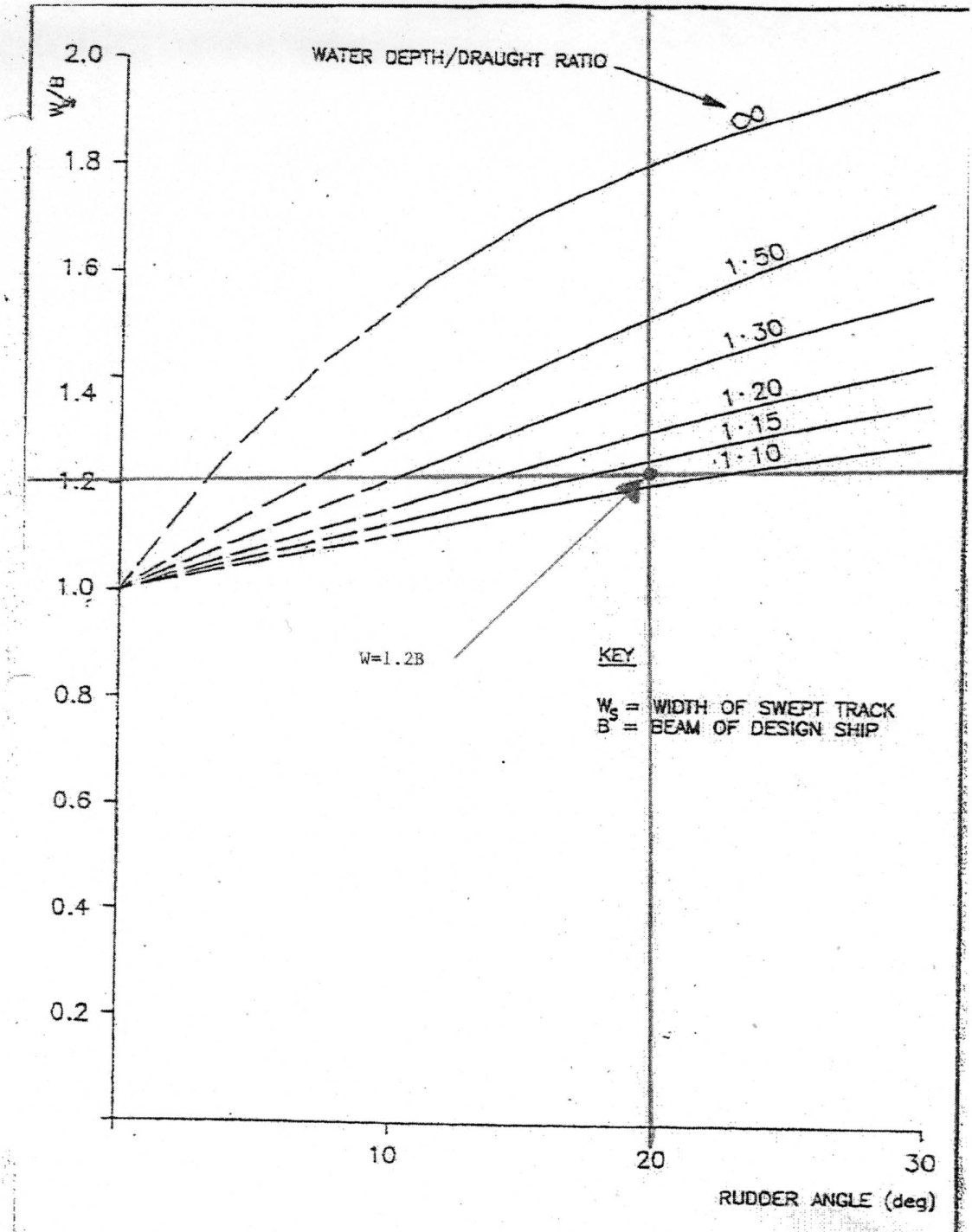


Figure 5.9 - Width of Swept Track in a Turn as a Function of Rudder Angle and Water Depth (Based on Single Screw/Single Rudder Container Ship)

APPENDIX No. 10

Navigation Channel Requirements Between Successive Bends

appendix no.10- successive bends (1012x1507x24b jpeg)

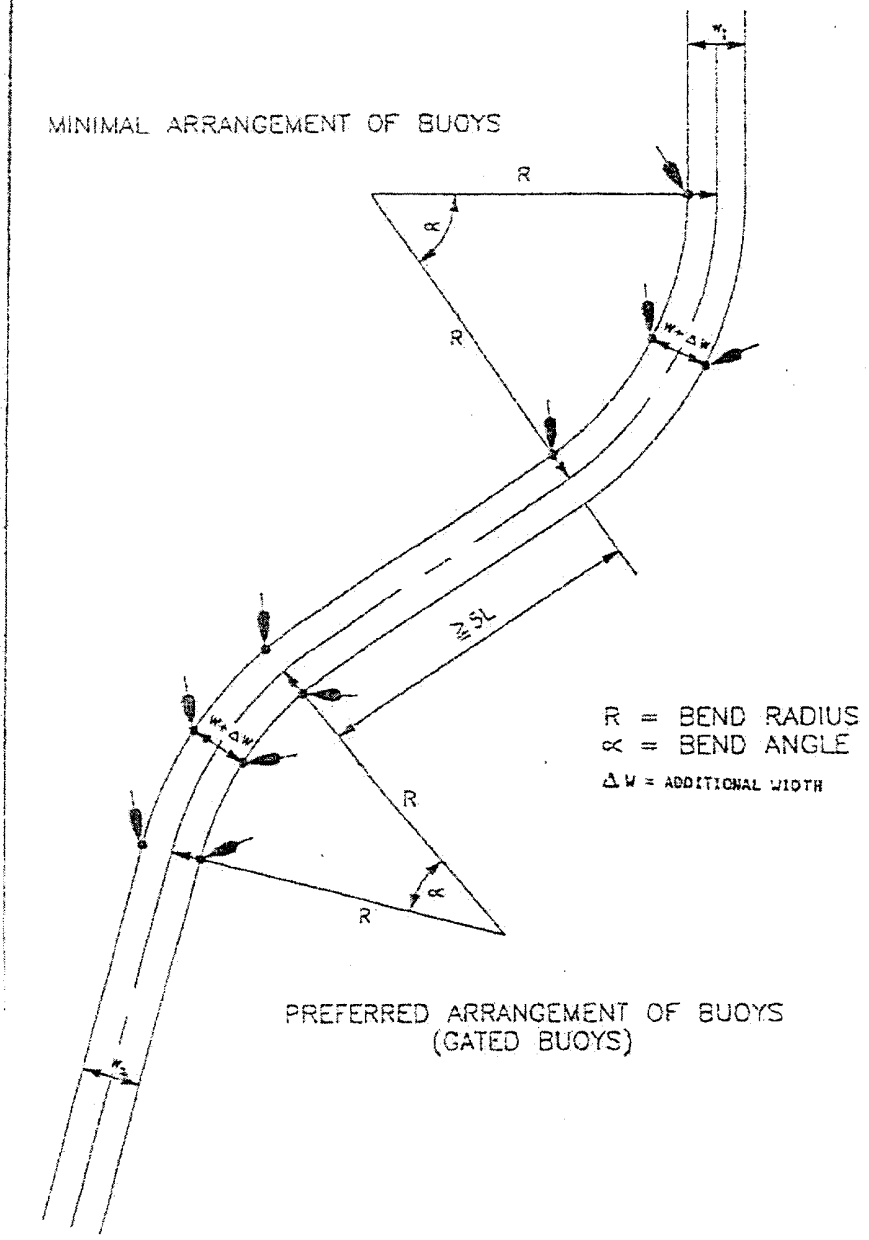


Figure 5.1 - Suggested Bend Markings & Definitions

APPENDIX No. 11

Recommendation on Transition Zone Between Channel Straight Section and Bend

appendix no.11-transition zone (1003x1572x24b jpeg)

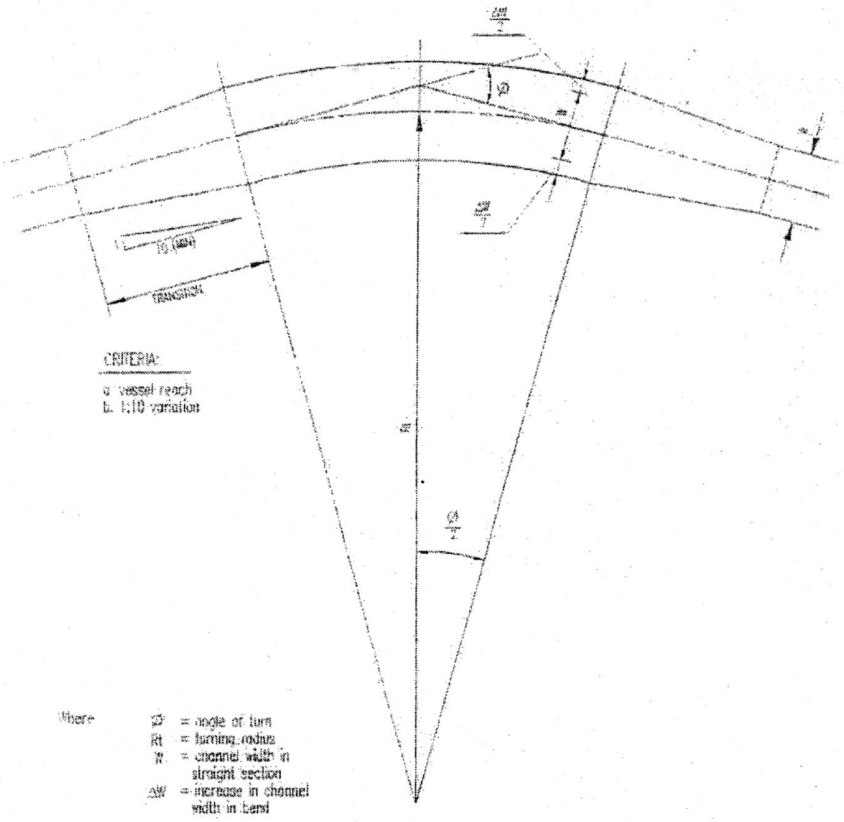
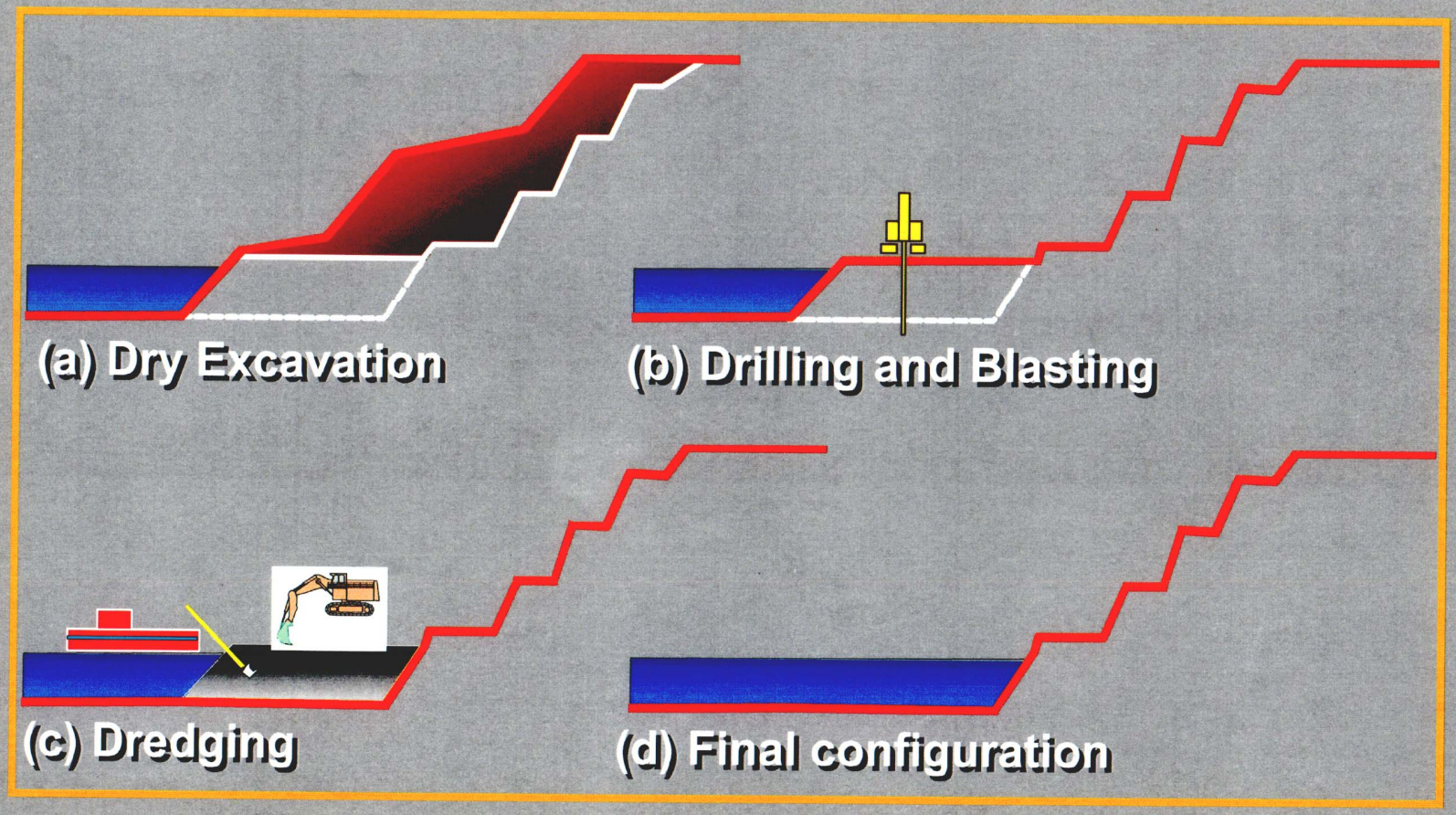


Figure 7: Typical Parallel Widened Curve

APPENDIX No. 12

Gaillard Cut Widening Excavation and Dredging Processes
Processes Sketch

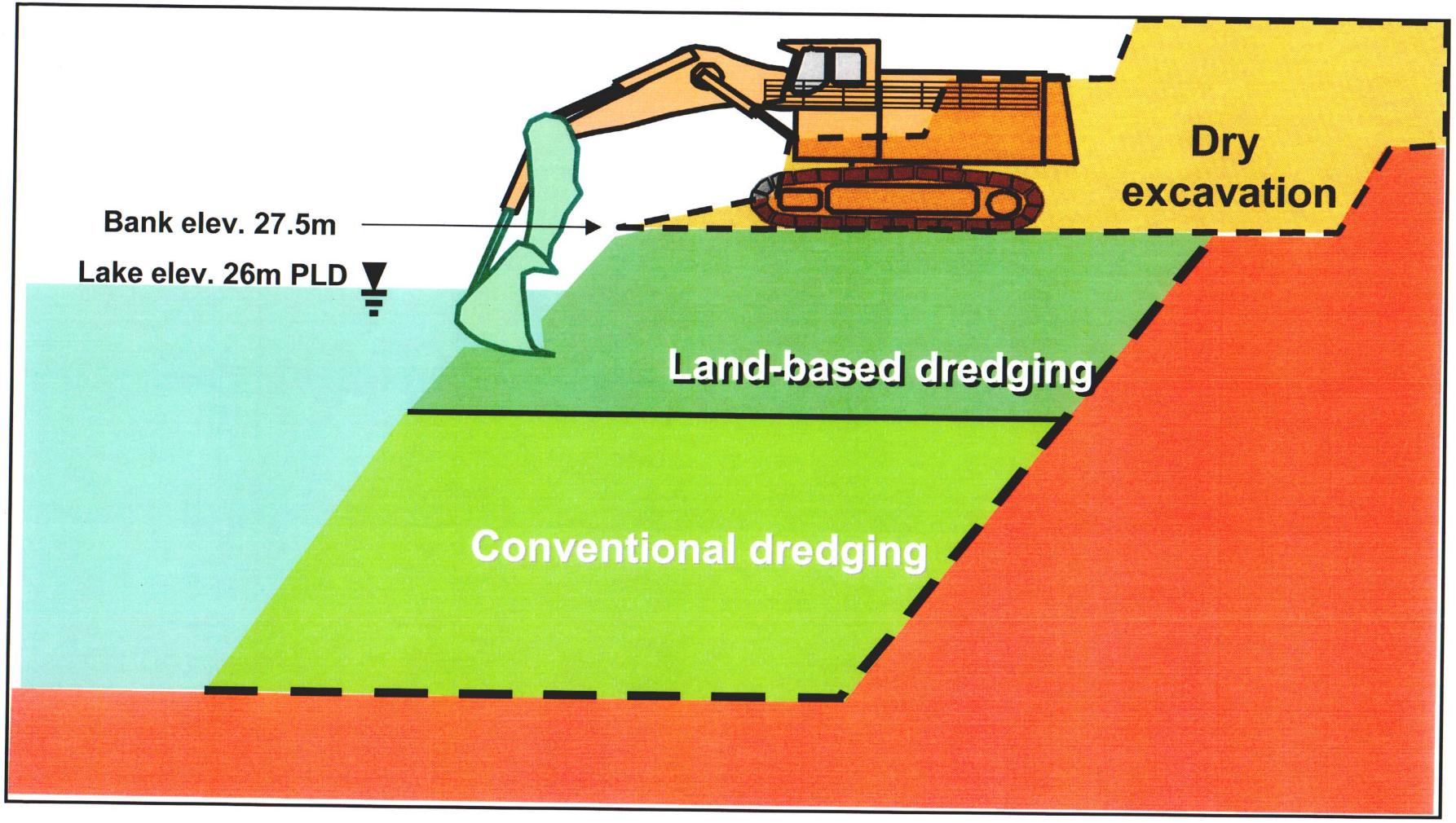
Gaillard Cut Widening
Excavation Processes



APPENDIX No. 13

Gaillard Cut Excavation and Dredging Sketch

DREDGING AND EXCAVATION OPERATIONS



APPENDIX No. 14

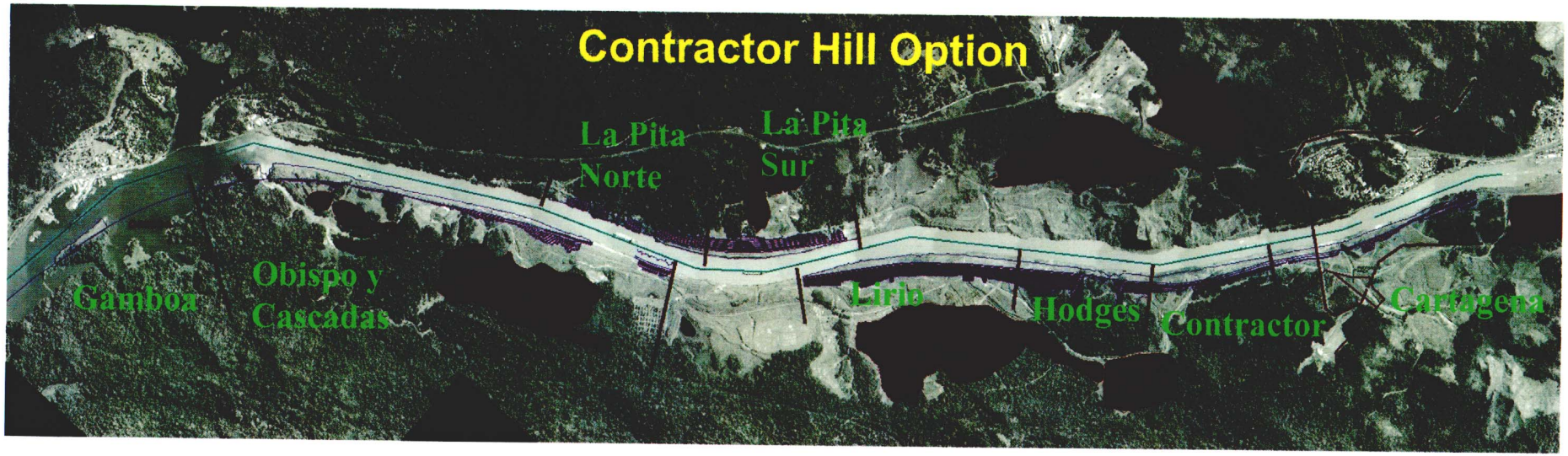
Gaillard Cut Widening Options Sketches
and
Angles of Deviation

GAILLARD CUT ANGLES OF DEVIATION AFTER WIDENING

PI´s o (Bordadas) (grado:min:seg)	Existing (Before GCWP)	After GCWP	GC Widening Contractor Hill (Option No. 14)	CG Widening Gold Hill (Option No. 15)
(Gamboa - Bas Obispo)	51:56:51	51:56:51	51:35:47	51:35:47
		0:00:00	0:21:04	0:21:04
Las Cascadas	9:09:00	8:10:00	7:23:27	7:23:27
		0:59:00	1:45:33	1:45:33
Cunnete	19:05:00	18:06:00	14:48:52	14:48:52
		0:59:00	4:16:08	4:16:08
Empire	17:57:00	16:17:00	13:37:47	13:37:47
		1:40:00	4:19:13	4:19:13
Lirio	22:14:00	20:00:00	13:39:27	12:24:58
		2:14:00	8:34:33	9:49:02
Culebra	17:43:00	17:09:00	15:46:51	13:12:07
		0:34:00	1:56:09	4:30:53
Cartagena	12:07:17	10:21:03	11:51:25	13:11:40
		1:46:14	0:15:52	1:04:22
Paraiso	15:48:19	14:28:00	15:47:03	15:47:03
		1:20:20	0:01:16	0:01:16

Figures in red depict angle of deviation reduction with respect to existing condition.

Gaillard Cut Straightening Alternatives

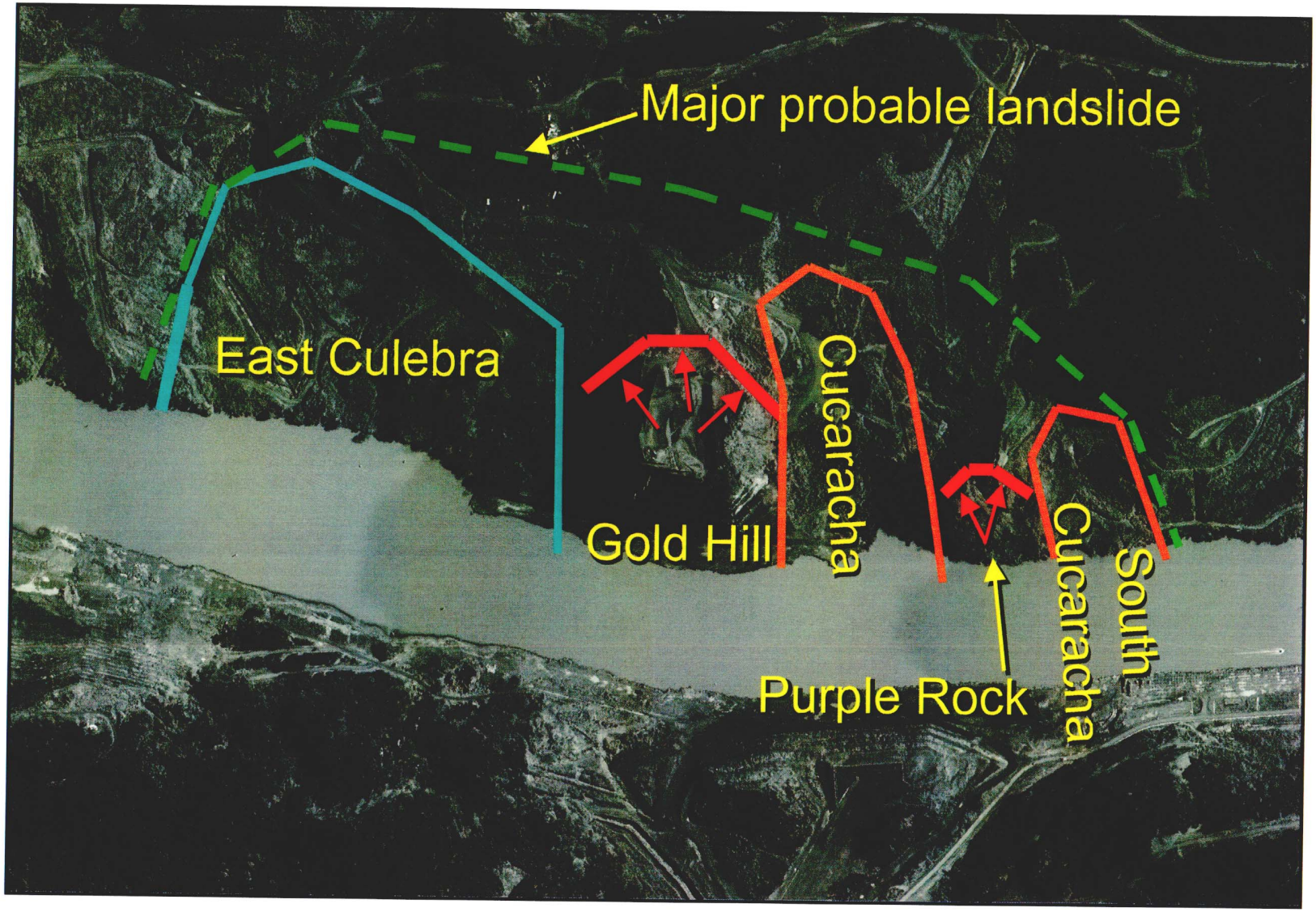


APPENDIX No. 15

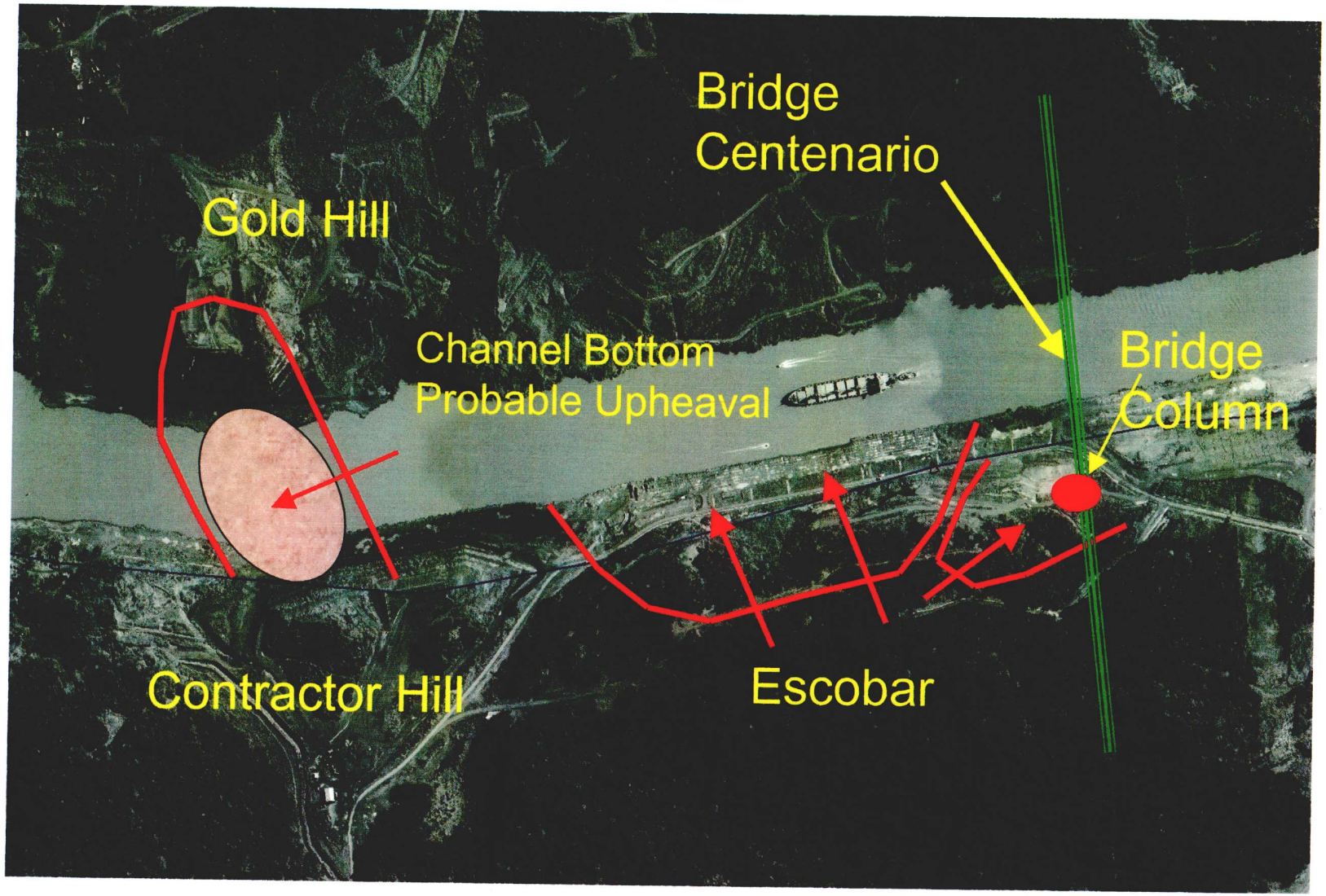
Gaillard Cut Widening
Option Contractor and Option Gold Hill

Instabilities Sketches

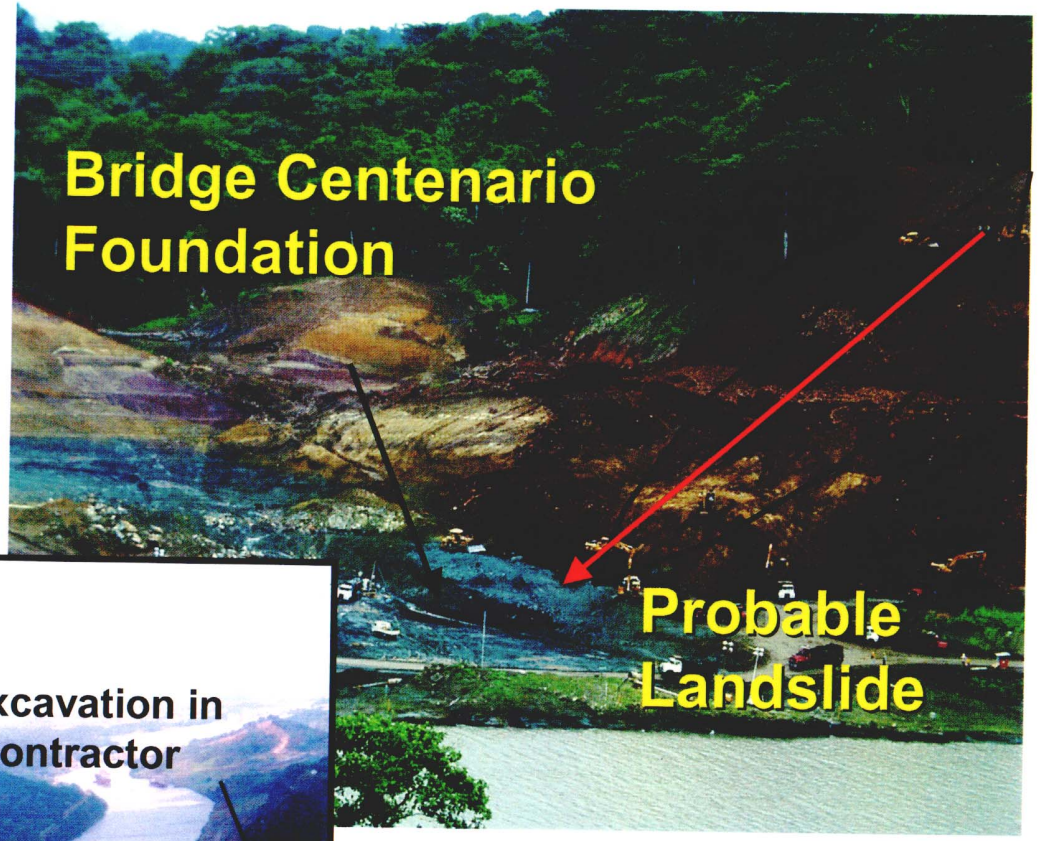
Gold Hill and Purple Rock Excavation Associated Instabilities

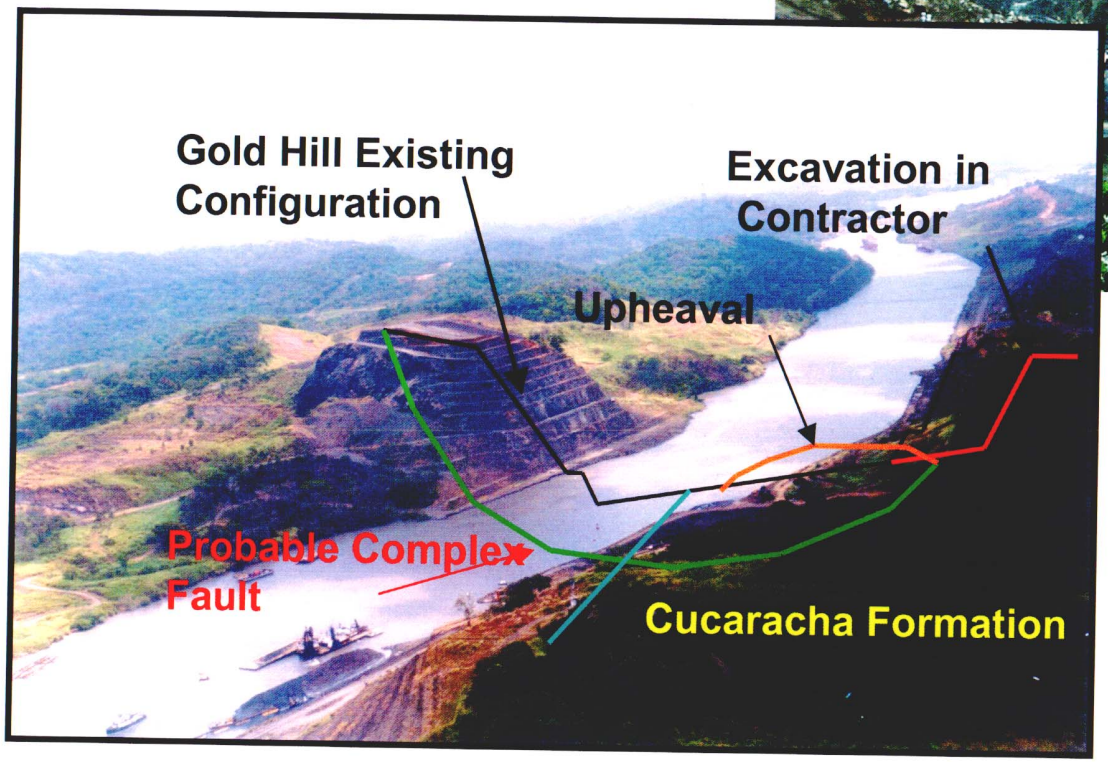


Contractor Hill Excavation Associated Instabilities



Contractor Hill Alternative Probable Associated Instabilities





APPENDIX No. 16

Gaillard Cut Widening 1-Way Post-Panamax

Proposed Horizontal Alignment Information

Project Name: opcion 14
Description:
Horizontal Alignment Name: option 14 CL
Description:
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	-7+116.966	1008361.027	637514.333
PI	( )	-2+339.174	1007595.044	642230.324
Tangent Direction:		S 80^46'27.97" E		
Tangent Length:		4777.792		
Element: Linear				
PI	( )	-2+339.174	1007595.044	642230.324
PI	( )	-1+158.599	1007061.277	643283.343
Tangent Direction:		S 63^07'11.66" E		
Tangent Length:		1180.574		
Element: Linear				
PI	( )	-1+158.599	1007061.277	643283.343
PI	( )	-0+024.261	1006271.788	644097.856
Tangent Direction:		S 45^53'37.67" E		
Tangent Length:		1134.338		
Element: Linear				
PI	( )	-0+024.261	1006271.788	644097.856
PI	( )	2+564.455	1004011.557	645359.919
Tangent Direction:		S 29^10'40.91" E		
Tangent Length:		2588.715		
Element: Linear				
PI	( )	2+564.455	1004011.557	645359.919
PI	( )	3+940.306	1002733.985	645870.580
Tangent Direction:		S 21^47'13.95" E		
Tangent Length:		1375.851		

Element: Linear
PI ( ) 3+940.306 1002733.985 645
870.580
PI ( ) 4+491.493 1002291.492 646
199.226
Tangent Direction: S 36^36'06.27" E
Tangent Length: 551.188

Element: Linear
PI ( ) 4+491.493 1002291.492 646
199.226
PI ( ) 6+200.942 1001197.981 647
513.170
Tangent Direction: S 50^13'53.69" E
Tangent Length: 1709.448

Element: Linear
PI ( ) 6+200.942 1001197.981 647
513.170
PI ( ) 8+707.266 999185.183 649
006.591
Tangent Direction: S 36^34'26.60" E
Tangent Length: 2506.325

Element: Linear
PI ( ) 8+707.266 999185.183 649
006.591
PI ( ) 10+545.359 998062.536 650
462.012
Tangent Direction: S 52^21'17.97" E
Tangent Length: 1838.093

Element: Linear
PI ( ) 10+545.359 998062.536 650
462.012
PI ( ) 12+023.497 997419.482 651
792.941
Tangent Direction: S 64^12'42.96" E
Tangent Length: 1478.138

Element: Linear
PI ( ) 12+023.497 997419.482 651
792.941
POE ( ) 12+268.907 997256.637 651
976.537
Tangent Direction: S 48^25'40.03" E
Tangent Length: 245.410

Project Name: opcion 14
Description:
Horizontal Alignment Name: opt 14 east R=2130
Description:
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	0+000.000	1008458.836	637529.577
PI	( )	3+905.719	1007828.662	641384.123
Tangent Direction:		S 80^42'53.78" E		
Tangent Length:		3905.719		
Element: Linear				
PI	( )	3+905.719	1007828.662	641384.123
PC	( )	4+208.305	1007810.626	641686.171
Tangent Direction:		S 86^34'57.84" E		
Tangent Length:		302.586		

Elements are not collinear

Element: Circular				
PC	( )	4+208.305	1007810.626	641686.171
PI	( )	6+105.427	1007504.497	643558.431
CC	( )		1003932.129	641052.007
PT	( )	7+743.223	1005848.102	644483.326
Radius:		3930.000		
Delta:		51^32'09.03" Right		
Degree of Curvature(Arc):		1^27'28.47"		
Length:		3534.918		
Tangent:		1897.122		
Chord:		3416.954		
Middle Ordinate:		390.790		
External:		433.940		
Tangent Direction:		S 80^42'49.94" E		
Radial Direction:		S 9^17'10.06" W		
Chord Direction:		S 54^56'45.42" E		
Radial Direction:		S 60^49'19.09" W		
Tangent Direction:		S 29^10'40.91" E		

Elements are not collinear

Element: Linear

PT ( )	7+743.223	1005848.102	644.483.326	
PI ( )	7+920.626	1005685.379	644.553.988	
Tangent Direction:	S 23^28'22.02" E			
Tangent Length:	177.403			

Element: Linear

PI ( )	7+920.626	1005685.379	644.553.988	
PI ( )	9+462.397	1004339.299	645.305.738	
Tangent Direction:	S 29^10'56.01" E			
Tangent Length:	1541.771			

Element: Linear

PI ( )	9+462.397	1004339.299	645.305.738	
PI ( )	9+637.277	1004195.921	645.405.867	
Tangent Direction:	S 34^55'43.27" E			
Tangent Length:	174.880			

Element: Linear

PI ( )	9+637.277	1004195.921	645.405.867	
PC ( )	9+638.268	1004195.057	645.406.350	
Tangent Direction:	S 29^10'41.77" E			
Tangent Length:	0.991			

Element: Circular

PC ( )	9+638.268	1004195.057	645.406.350	
PI ( )	9+784.238	1004067.609	645.477.515	
CC ( )		1003093.242	643.433.128	
PT ( )	9+929.804	1003932.065	645.531.693	
Radius:	2260.000			
Delta:	7^23'27.82"	Right		
Degree of Curvature(Arc):	2^32'06.76"			
Length:	291.536			

Tangent:		145.971		
Chord:		291.334		
Middle Ordinate:		4.699		
External:		4.709		
Tangent Direction:	S 29^10'41.77" E			
Radial Direction:	S 60^49'18.23" W			
Chord Direction:	S 25^28'57.86" E			
Radial Direction:	S 68^12'46.05" W			
Tangent Direction:	S 21^47'13.95" E			

Element: Linear				
PT ( )		9+929.804	1003932.065	645
531.693				
PI ( )		9+930.804	1003931.136	645
532.064				
Tangent Direction:	S 21^47'13.95" E			
Tangent Length:		1.000		

Element: Linear				
PI ( )		9+930.804	1003931.136	645
532.064				
PI ( )		10+105.739	1003762.861	645
579.872				
Tangent Direction:	S 15^51'36.69" E			
Tangent Length:		174.935		

Element: Linear				
PI ( )		10+105.739	1003762.861	645
579.872				
PI ( )		10+727.675	1003185.473	645
811.017				
Tangent Direction:	S 21^49'03.38" E			
Tangent Length:		621.936		

Element: Linear				
PI ( )		10+727.675	1003185.473	645
811.017				
PI ( )		10+902.552	1003030.440	645
891.931				
Tangent Direction:	S 27^33'38.88" E			
Tangent Length:		174.878		

Element: Linear				
PI ( )		10+902.552	1003030.440	645
891.931				
PC ( )		10+903.552	1003029.512	645
892.303				
Tangent Direction:	S 21^49'03.38" E			

Tangent Length:		1.000		
Element: Circular				
	PC ( )	10+903.552	1003029.512	645892.303
	PI ( )	11+409.890	1002559.443	646080.484
	CC ( )	.	1003772.818	647749.046
	PT ( )	11+895.387	1002235.546	646469.674
Radius:		2000.000		
Delta:		28^24'50.31" Left		
Degree of Curvature(Arc):		2^51'53.24"		
Length:		991.835		
Tangent:		506.337		
Chord:		981.702		
Middle Ordinate:		61.169		
External:		63.099		
Tangent Direction:		S 21^49'03.38" E		
Radial Direction:		S 68^10'56.62" W		
Chord Direction:		S 36^01'28.53" E		
Radial Direction:		S 39^46'06.31" W		
Tangent Direction:		S 50^13'53.69" E		
Element: Linear				
	PT ( )	11+895.387	1002235.546	646469.674
	PC ( )	13+106.100	1001461.070	647400.271
Tangent Direction:		S 50^13'53.69" E		
Tangent Length:		1210.713		
Element: Circular				
	PC ( )	13+106.100	1001461.070	647400.271
	PI ( )	13+376.740	1001287.945	647608.295
	CC ( )		999723.952	645954.581
	PT ( )	13+644.814	1001070.598	647769.558
Radius:		2260.000		
Delta:		13^39'27.09" Right		
Degree of Curvature(Arc):		2^32'06.76"		
Length:		538.713		
Tangent:		270.639		
Chord:		537.439		

Middle Ordinate:		16.033		
External:		16.147		
Tangent Direction:		S 50^13'53.69" E		
Radial Direction:		S 39^46'06.31" W		
Chord Direction:		S 43^24'10.14" E		
Radial Direction:		S 53^25'33.40" W		
Tangent Direction:		S 36^34'26.60" E		
Element: Linear				
PT	( )	13+644.814	1001070.598	647769.558
PI	( )	13+645.814	1001069.795	647770.154
Tangent Direction:		S 36^34'26.60" E		
Tangent Length:		1.000		
Element: Linear				
PI	( )	13+645.814	1001069.795	647770.154
PI	( )	13+820.691	1000919.630	647859.780
Tangent Direction:		S 30^49'51.10" E		
Tangent Length:		174.878		
Element: Linear				
PI	( )	13+820.691	1000919.630	647859.780
PI	( )	15+426.744	999629.830	648816.764
Tangent Direction:		S 36^34'26.60" E		
Tangent Length:		1606.052		
Element: Linear				
PI	( )	15+426.744	999629.830	648816.764
PI	( )	15+601.621	999500.520	648934.498
Tangent Direction:		S 42^19'02.10" E		
Tangent Length:		174.878		
Element: Linear				
PI	( )	15+601.621	999500.520	648934.498
PC	( )	15+602.621	999499.717	648935.094
Tangent Direction:		S 36^34'26.60" E		
Tangent Length:		1.000		

Element: Circular

PC ( )	15+602.621	999499.717	648 935.094
PI ( )	15+879.805	999277.115	649 100.257
CC ( )		1000691.440	650 541.269
PT ( )	16+153.480	999107.820	649 319.734

Radius:	2000.000
Delta:	15^46'51.38" Left
Degree of Curvature(Arc):	2^51'53.24"
Length:	550.859
Tangent:	277.184
Chord:	549.119
Middle Ordinate:	18.935
External:	19.116
Tangent Direction:	S 36^34'26.60" E
Radial Direction:	S 53^25'33.40" W
Chord Direction:	S 44^27'52.29" E
Radial Direction:	S 37^38'42.03" W
Tangent Direction:	S 52^21'17.97" E

Element: Linear

PT ( )	16+153.480	999107.820	649 319.734
PI ( )	16+155.480	999106.598	649 321.318

Tangent Direction:	S 52^21'17.97" E
Tangent Length:	2.000

Element: Linear

PI ( )	16+155.480	999106.598	649 321.318
PI ( )	16+329.363	998987.079	649 447.612

Tangent Direction:	S 46^34'43.77" E
Tangent Length:	173.883

Element: Linear

PI ( )	16+329.363	998987.079	649 447.612
PI ( )	17+304.186	998391.688	650 219.488

Tangent Direction:	S 52^21'17.97" E
Tangent Length:	974.824

Element: Linear

PI ( )	17+304.186	998391.688	650 219.488	
PC ( )	17+476.960	998300.563	650 366.276	
Tangent Direction:	S 58^10'06.18" E			
Tangent Length:	172.773			

Elements are not collinear

Element: Circular

PC ( )	17+476.960	998300.563	650 366.276	
PI ( )	17+684.644	998173.717	650 530.723	
CC ( )		999884.184	651 587.811	
PT ( )	17+890.845	998083.365	650 717.724	
Radius:	2000.000			
Delta:	11^51'24.99"	Left		
Degree of Curvature(Arc):	2^51'53.24"			
Length:	413.885			
Tangent:	207.684			
Chord:	413.147			
Middle Ordinate:	10.697			
External:	10.754			
Tangent Direction:	S 52^21'17.97" E			
Radial Direction:	S 37^38'42.03" W			
Chord Direction:	S 58^17'00.47" E			
Radial Direction:	S 25^47'17.04" W			
Tangent Direction:	S 64^12'42.96" E			

Elements are not collinear

Element: Linear

PT ( )	17+890.845	998083.365	650 717.724	
PI ( )	18+063.618	997992.830	650 864.877	
Tangent Direction:	S 58^23'54.76" E			
Tangent Length:	172.773			

Element: Linear

PI ( )	18+063.618	997992.830	650 864.877	
PI ( )	19+086.937	997547.642	651 786.283	
Tangent Direction:	S 64^12'42.96" E			

	Tangent Length:	1023.318		
Element: Linear				
	PI ( )	19+086.937	997547.642	651 786.283
	POE ( )	19+396.115	997342.500	652 017.600
	Tangent Direction:	S 48^25'55.23" E		
	Tangent Length:	309.178		

Project Name: opcion 14
Description:
Horizontal Alignment Name: option 14 east
Description:
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	0+000.000	1008458.836	637529.577
PI	( )	3+905.719	1007828.662	641384.123
Tangent Direction:		S 80^42'53.78" E		
Tangent Length:		3905.719		
Element: Linear				
PI	( )	3+905.719	1007828.662	641384.123
PC	( )	4+208.305	1007810.626	641686.171
Tangent Direction:		S 86^34'57.84" E		
Tangent Length:		302.586		

Elements are not collinear

Element: Circular				
PC	( )	4+208.305	1007810.626	641686.171
PI	( )	6+105.427	1007504.497	643558.431
CC	( )		1003932.129	641052.007
PT	( )	7+743.223	1005848.102	644483.326
Radius:		3930.000		
Delta:		51^32'09.03" Right		
Degree of Curvature(Arc):		1^27'28.47"		
Length:		3534.918		
Tangent:		1897.122		
Chord:		3416.954		
Middle Ordinate:		390.790		
External:		433.940		
Tangent Direction:		S 80^42'49.94" E		
Radial Direction:		S 9^17'10.06" W		
Chord Direction:		S 54^56'45.42" E		
Radial Direction:		S 60^49'19.09" W		
Tangent Direction:		S 29^10'40.91" E		

Elements are not collinear

Element: Linear

PT ( )	7+743.223	1005848.102	644	483.326
PI ( )	7+920.626	1005685.379	644	553.988

Tangent Direction: S 23^28'22.02" E
Tangent Length: 177.403

Element: Linear

PI ( )	7+920.626	1005685.379	644	553.988
PI ( )	9+419.013	1004377.177	645	284.584

Tangent Direction: S 29^10'56.01" E
Tangent Length: 1498.387

Element: Linear

PI ( )	9+419.013	1004377.177	645	284.584
PC ( )	9+594.885	1004232.922	645	385.191

Tangent Direction: S 34^53'34.15" E
Tangent Length: 175.873

Elements are not collinear

Element: Circular

PC ( )	9+594.885	1004232.922	645	385.191
PI ( )	9+784.232	1004067.609	645	477.515
CC ( )		1002804.287	642	827.086
PT ( )	9+973.053	1003891.787	645	547.793

Radius: 2930.000
Delta: 7^23'42.06" Right
Degree of Curvature(Arc): 1^57'19.75"
Length: 378.167
Tangent: 189.347
Chord: 377.905
Middle Ordinate: 6.099
External: 6.112
Tangent Direction: S 29^10'56.01" E
Radial Direction: S 60^49'03.99" W

Chord Direction:	S 25^29'04.98" E			
Radial Direction:	S 68^12'46.05" W			
Tangent Direction:	S 21^47'13.95" E			

Elements are not collinear

Element: Linear				
PT ( )	9+973.053	1003891.787	645	547.793
PI ( )	10+148.980	1003722.591	645	595.993
Tangent Direction:	S 15^54'04.59" E			
Tangent Length:	175.927			

Element: Linear				
PI ( )	10+148.980	1003722.591	645	595.993
PI ( )	10+556.917	1003343.875	645	747.604
Tangent Direction:	S 21^49'03.38" E			
Tangent Length:	407.937			

Element: Linear				
PI ( )	10+556.917	1003343.875	645	747.604
PI ( )	10+732.790	1003187.914	645	828.890
Tangent Direction:	S 27^31'41.51" E			
Tangent Length:	175.873			

Element: Linear				
PI ( )	10+732.790	1003187.914	645	828.890
PC ( )	10+733.790	1003186.985	645	829.262
Tangent Direction:	S 21^49'03.38" E			
Tangent Length:	1.000			

Element: Circular				
PC ( )	10+733.790	1003186.985	645	829.262
PI ( )	11+409.750	1002559.443	646	080.484
CC ( )		1004179.299	648	308.014
PT ( )	12+057.889	1002127.040	646	600.052
Radius:	2670.000			

Delta:	28^24'50.31" Left			
Degree of Curvature(Arc):	2^08'45.27"			
Length:	1324.100			
Tangent:	675.960			
Chord:	1310.573			
Middle Ordinate:	81.661			
External:	84.237			
Tangent Direction:	S 21^49'03.38" E			
Radial Direction:	S 68^10'56.62" W			
Chord Direction:	S 36^01'28.53" E			
Radial Direction:	S 39^46'06.31" W			
Tangent Direction:	S 50^13'53.69" E			
Element: Linear				
PT ( )		12+057.889	1002127.040	646 600.052
PC ( )		13+018.745	1001512.394	647 338.601
Tangent Direction:	S 50^13'53.69" E			
Tangent Length:	960.856			
Element: Circular				
PC ( )		13+018.745	1001512.394	647 338.601
PI ( )		13+369.619	1001287.945	647 608.295
CC ( )			999260.290	645 464.320
PT ( )		13+717.166	1001006.163	647 817.366
Radius:	2930.000			
Delta:	13^39'27.09" Right			
Degree of Curvature(Arc):	1^57'19.75"			
Length:	698.421			
Tangent:	350.873			
Chord:	696.768			
Middle Ordinate:	20.786			
External:	20.934			
Tangent Direction:	S 50^13'53.69" E			
Radial Direction:	S 39^46'06.31" W			
Chord Direction:	S 43^24'10.14" E			
Radial Direction:	S 53^25'33.40" W			
Tangent Direction:	S 36^34'26.60" E			
Element: Linear				
PT ( )		13+717.166	1001006.163	647 817.366
PI ( )		13+718.166	1001005.360	647

UNAUTHORIZED USE OR DUPLICATION IS PROHIBITED
PROHIBIDA LA REPRODUCCION SIN AUTORIZACION
DEL AUTOR

CENTRO DE RECURSOS TECNICOS
AUTORIDAD DEL CANAL DE PANAMA

817.962

Tangent Direction: S 36^34'26.60" E
Tangent Length: 1.000

Element: Linear
PI ( ) 13+718.166 1001005.360 647
817.962
PI ( ) 13+893.044 1000855.196 647
907.588
Tangent Direction: S 30^49'51.10" E
Tangent Length: 174.878

Element: Linear
PI ( ) 13+893.044 1000855.196 647
907.588
PI ( ) 15+326.006 999704.402 648
761.435
Tangent Direction: S 36^34'26.60" E
Tangent Length: 1432.962

Element: Linear
PI ( ) 15+326.006 999704.402 648
761.435
PI ( ) 15+500.883 999575.092 648
879.168
Tangent Direction: S 42^19'02.10" E
Tangent Length: 174.878

Element: Linear
PI ( ) 15+500.883 999575.092 648
879.168
PC ( ) 15+501.883 999574.289 648
879.764
Tangent Direction: S 36^34'26.60" E
Tangent Length: 1.000

Element: Circular
PC ( ) 15+501.883 999574.289 648
879.764
PI ( ) 15+871.924 999277.115 649
100.257
CC ( ) 1001165.239 651
024.008
PT ( ) 16+237.280 999051.106 649
393.259
Radius: 2670.000
Delta: 15^46'51.38" Left
Degree of Curvature(Arc): 2^08'45.27"

Length:	735.396
Tangent:	370.040
Chord:	733.074
Middle Ordinate:	25.279
External:	25.520
Tangent Direction:	S 36^34'26.60" E
Radial Direction:	S 53^25'33.40" W
Chord Direction:	S 44^27'52.29" E
Radial Direction:	S 37^38'42.03" W
Tangent Direction:	S 52^21'17.97" E

Element: Linear

PT	( )	16+237.280	999051.106	649 393.259
PI	( )	16+238.280	999050.495	649 394.051

Tangent Direction:	S 52^21'17.97" E
Tangent Length:	1.000

Element: Linear

PI	( )	16+238.280	999050.495	649 394.051
PI	( )	16+414.152	998929.754	649 521.929

Tangent Direction:	S 46^38'39.84" E
Tangent Length:	175.873

Element: Linear

PI	( )	16+414.152	998929.754	649 521.929
PI	( )	17+295.119	998391.688	650 219.488

Tangent Direction:	S 52^21'17.97" E
Tangent Length:	880.967

Element: Linear

PI	( )	17+295.119	998391.688	650 219.488
PC	( )	17+467.893	998300.563	650 366.276

Tangent Direction:	S 58^10'06.18" E
Tangent Length:	172.773

Elements are not collinear

Element: Circular

PC	( )	17+467.893	998300.563	650 366.276

PI ( )	17+675.577	998173.717	650	
530.723				
CC ( )		999884.184	651	
587.811				
PT ( )	17+881.778	998083.365	650	
717.724				

Radius:	2000.000
Delta:	11^51'24.99" Left
Degree of Curvature(Arc):	2^51'53.24"
Length:	413.885
Tangent:	207.684
Chord:	413.147
Middle Ordinate:	10.697
External:	10.754
Tangent Direction:	S 52^21'17.97" E
Radial Direction:	S 37^38'42.03" W
Chord Direction:	S 58^17'00.47" E
Radial Direction:	S 25^47'17.04" W
Tangent Direction:	S 64^12'42.96" E

Elements are not collinear

Element: Linear

PT ( )	17+881.778	998083.365	650	
717.724				
PI ( )	18+054.551	997992.830	650	
864.877				

Tangent Direction:	S 58^23'54.76" E
Tangent Length:	172.773

Element: Linear

PI ( )	18+054.551	997992.830	650	
864.877				
PI ( )	19+077.870	997547.642	651	
786.283				

Tangent Direction:	S 64^12'42.96" E
Tangent Length:	1023.318

Element: Linear

PI ( )	19+077.870	997547.642	651	
786.283				
POE ( )	19+387.048	997342.500	652	
017.600				

Tangent Direction:	S 48^25'55.23" E
Tangent Length:	309.178

Project Name: opcion 14
Description:
Horizontal Alignment Name: opt 14 west R=2130
Description:
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	0+000.000	1008186.400	637703.000
PI	( )	0+684.154	1008126.200	638384.500
Tangent Direction:		S 84^57'06.86" E		
Tangent Length:		684.154		
Element: Linear				
PI	( )	0+684.154	1008126.200	638384.500
PI	( )	3+692.488	1007633.138	641352.153
Tangent Direction:		S 80^34'00.28" E		
Tangent Length:		3008.334		
Element: Linear				
PI	( )	3+692.488	1007633.138	641352.153
PC	( )	3+995.074	1007554.033	641644.216
Tangent Direction:		S 74^50'42.04" E		
Tangent Length:		302.586		

Elements are not collinear

Element: Circular				
PC	( )	3+995.074	1007554.033	641644.216
PI	( )	5+766.687	1007268.157	643392.612
CC	( )		1003932.129	641052.007
PT	( )	7+296.130	1005721.345	644256.317
Radius:		3670.000		
Delta:		51^32'09.03" Right		
Degree of Curvature(Arc):		1^33'40.29"		
Length:		3301.055		
Tangent:		1771.613		

```
                  Chord:          3190.896
         Middle Ordinate:           364.936
                External:           405.232
      Tangent Direction:   S 80^42'49.94" E
       Radial Direction:   S  9^17'10.06" W
        Chord Direction:   S 54^56'45.42" E
       Radial Direction:   S 60^49'19.09" W
      Tangent Direction:   S 29^10'40.91" E

Elements are not collinear

Element: Linear
           PT (        )        7+296.130   1005721.345    644
256.317
           PI (        )        7+471.988   1005577.010    644
356.784
      Tangent Direction:   S 34^50'25.64" E
         Tangent Length:           175.858

Element: Linear
           PI (        )        7+471.988   1005577.010    644
356.784
           PI (        )        9+015.283   1004229.607    645
109.289
      Tangent Direction:   S 29^10'57.76" E
         Tangent Length:          1543.296

Element: Linear
           PI (        )        9+015.283   1004229.607    645
109.289
           PC (        )        9+191.086   1004068.347    645
179.304
      Tangent Direction:   S 23^28'09.27" E
         Tangent Length:           175.803

Elements are not collinear

Element: Circular
           PC (        )        9+191.086   1004068.347    645
179.304
           PI (        )        9+320.333   1003955.505    645
242.323
           CC (        )                    1003093.169    643
433.157
           PT (        )        9+449.221   1003835.490    645
290.294
                Radius:          2000.000
                 Delta:       7^23'42.06" Right
```

Degree of Curvature(Arc):	2^51'53.24"			
Length:	258.135			
Tangent:	129.247			
Chord:	257.956			
Middle Ordinate:	4.163			
External:	4.172			
Tangent Direction:	S 29^10'56.01" E			
Radial Direction:	S 60^49'03.99" W			
Chord Direction:	S 25^29'04.98" E			
Radial Direction:	S 68^12'46.05" W			
Tangent Direction:	S 21^47'13.95" E			

Element: Linear				
PT ( )	9+449.221	1003835.490	645.290.294	
PI ( )	9+450.143	1003834.634	645.290.636	
Tangent Direction:	S 21^47'13.95" E			
Tangent Length:	0.922			

Element: Linear				
PI ( )	9+450.143	1003834.634	645.290.636	
PI ( )	9+624.965	1003679.349	645.370.944	
Tangent Direction:	S 27^20'47.22" E			
Tangent Length:	174.822			

Element: Linear				
PI ( )	9+624.965	1003679.349	645.370.944	
PI ( )	10+247.020	1003101.851	645.602.133	
Tangent Direction:	S 21^49'03.38" E			
Tangent Length:	622.055			

Element: Linear				
PI ( )	10+247.020	1003101.851	645.602.133	
PI ( )	10+421.898	1002933.811	645.650.554	
Tangent Direction:	S 16^04'27.88" E			
Tangent Length:	174.878			

Element: Linear				
PI ( )	10+421.898	1002933.811	645.650.554	
PC ( )	10+422.898	1002932.882	645	

650.926

Tangent Direction: S 21^49'03.38" E
Tangent Length: 1.000

Element: Circular

PC ( )	10+422.898	1002932.882	645	650.926
PI ( )	10+995.059	1002401.704	645	863.571
CC ( )		1003772.818	647	749.046
PT ( )	11+543.671	1002035.700	646	303.355

Radius: 2260.000
Delta: 28^24'50.31" Left
Degree of Curvature(Arc): 2^32'06.76"
Length: 1120.773
Tangent: 572.161
Chord: 1109.324
Middle Ordinate: 69.121
External: 71.302
Tangent Direction: S 21^49'03.38" E
Radial Direction: S 68^10'56.62" W
Chord Direction: S 36^01'28.53" E
Radial Direction: S 39^46'06.31" W
Tangent Direction: S 50^13'53.69" E

Element: Linear

PT ( )	11+543.671	1002035.700	646	303.355
PC ( )	12+754.384	1001261.224	647	233.953

Tangent Direction: S 50^13'53.69" E
Tangent Length: 1210.713

Element: Circular

PC ( )	12+754.384	1001261.224	647	233.953
PI ( )	12+993.888	1001108.017	647	418.044
CC ( )		999723.952	645	954.581
PT ( )	13+231.122	1000915.674	647	560.756

Radius: 2000.000
Delta: 13^39'27.09" Right
Degree of Curvature(Arc): 2^51'53.24"
Length: 476.738

	Tangent:	239.504		
	Chord:	475.610		
	Middle Ordinate:	14.188		
	External:	14.289		
	Tangent Direction:	S 50^13'53.69" E		
	Radial Direction:	S 39^46'06.31" W		
	Chord Direction:	S 43^24'10.14" E		
	Radial Direction:	S 53^25'33.40" W		
	Tangent Direction:	S 36^34'26.60" E		
Element: Linear				
	PT ( )	13+231.122	1000915.674	647 560.756
	PI ( )	13+232.122	1000914.871	647 561.351
	Tangent Direction:	S 36^34'26.60" E		
	Tangent Length:	1.000		
Element: Linear				
	PI ( )	13+232.122	1000914.871	647 561.351
	PI ( )	13+407.000	1000785.562	647 679.085
	Tangent Direction:	S 42^19'02.10" E		
	Tangent Length:	174.878		
Element: Linear				
	PI ( )	13+407.000	1000785.562	647 679.085
	PI ( )	14+767.098	999693.283	648 489.515
	Tangent Direction:	S 36^34'26.60" E		
	Tangent Length:	1360.099		
Element: Linear				
	PI ( )	14+767.098	999693.283	648 489.515
	PI ( )	15+003.268	999490.567	648 610.686
	Tangent Direction:	S 30^52'05.80" E		
	Tangent Length:	236.170		
Element: Linear				
	PI ( )	15+003.268	999490.567	648 610.686
	PI ( )	15+642.121	998981.099	648 996.139
	Tangent Direction:	S 37^06'37.39" E		

```
            Tangent Length:            638.852

Element: Linear
              PI (        )         15+642.121    998981.099    648
996.139
              PI (        )         16+002.468    998761.011    649
281.466
         Tangent Direction:   S 52^21'17.97" E
            Tangent Length:            360.347

Element: Linear
              PI (        )         16+002.468    998761.011    649
281.466
              PI (        )         16+560.234    998465.964    649
754.806
         Tangent Direction:   S 58^03'48.77" E
            Tangent Length:            557.766

Element: Linear
              PI (        )         16+560.234    998465.964    649
754.806
              PI (        )         16+973.539    998213.531    650
082.065
         Tangent Direction:   S 52^21'17.97" E
            Tangent Length:            413.305

Element: Linear
              PI (        )         16+973.539    998213.531    650
082.065
              PC (        )         17+149.411    998092.790    650
209.943
         Tangent Direction:   S 46^38'39.84" E
            Tangent Length:            175.873

Elements are not collinear

Element: Circular
              PC (        )         17+149.411    998092.790    650
209.943
              PI (        )         17+380.980    997951.356    650
393.301
              CC (        )                       999858.527    651
571.954
              PT (        )         17+610.894    997850.614    650
601.807
                    Radius:           2230.000
                     Delta:       11^51'24.99" Left
  Degree of Curvature(Arc):        2^34'09.54"
```

Length:	461.482
Tangent:	231.568
Chord:	460.659
Middle Ordinate:	11.927
External:	11.991
Tangent Direction:	S 52^21'17.97" E
Radial Direction:	S 37^38'42.03" W
Chord Direction:	S 58^17'00.47" E
Radial Direction:	S 25^47'17.04" W
Tangent Direction:	S 64^12'42.96" E

Elements are not collinear

Element: Linear

PT ( )	17+610.894	997850.614	650601.807
PI ( )	17+878.876	997729.785	650841.004

Tangent Direction:	S 63^11'58.74" E
Tangent Length:	267.982

Element: Linear

PI ( )	17+878.876	997729.785	650841.004
PI ( )	18+101.986	997653.226	651050.567

Tangent Direction:	S 69^55'52.73" E
Tangent Length:	223.111

Element: Linear

PI ( )	18+101.986	997653.226	651050.567
PI ( )	18+798.440	997350.238	651677.661

Tangent Direction:	S 64^12'42.96" E
Tangent Length:	696.454

Element: Linear

PI ( )	18+798.440	997350.238	651677.661
PI ( )	18+898.159	997294.639	651760.441

Tangent Direction:	S 56^06'47.37" E
Tangent Length:	99.719

Element: Linear

PI ( )	18+898.159	997294.639	651760.441

PI ( )	19+051.553	997206.306	651 885.848	
Tangent Direction:	S 54^50'24.99" E			
Tangent Length:	153.394			

Element: Linear

PI ( )	19+051.553	997206.306	651 885.848	
POE ( )	19+069.745	997199.832	651 902.849	
Tangent Direction:	S 69^09'04.91" E			
Tangent Length:	18.192			

Project Name: opcion 14
Description:
Horizontal Alignment Name: option 14 west
Description:
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	0+000.000	1008186.400	637703.000
PI	( )	0+684.154	1008126.200	638384.500
Tangent Direction:		S 84^57'06.86" E		
Tangent Length:		684.154		
Element: Linear				
PI	( )	0+684.154	1008126.200	638384.500
PI	( )	3+692.488	1007633.138	641352.153
Tangent Direction:		S 80^34'00.28" E		
Tangent Length:		3008.334		
Element: Linear				
PI	( )	3+692.488	1007633.138	641352.153
PC	( )	3+995.074	1007554.033	641644.216
Tangent Direction:		S 74^50'42.04" E		
Tangent Length:		302.586		

Elements are not collinear

Element: Circular				
PC	( )	3+995.074	1007554.033	641644.216
PI	( )	5+766.687	1007268.157	643392.612
CC	( )		1003932.129	641052.007
PT	( )	7+296.130	1005721.345	644256.317
Radius:		3670.000		
Delta:		51^32'09.03" Right		
Degree of Curvature(Arc):		1^33'40.29"		
Length:		3301.055		
Tangent:		1771.613		

Chord:	3190.896			
Middle Ordinate:	364.936			
External:	405.232			
Tangent Direction:	S 80^42'49.94" E			
Radial Direction:	S 9^17'10.06" W			
Chord Direction:	S 54^56'45.42" E			
Radial Direction:	S 60^49'19.09" W			
Tangent Direction:	S 29^10'40.91" E			

Elements are not collinear

Element: Linear				
PT ( )	7+296.130	1005721.345	644 256.317	
PI ( )	7+471.988	1005577.010	644 356.784	
Tangent Direction:	S 34^50'25.64" E			
Tangent Length:	175.858			

Element: Linear			
PI ( )	7+471.988	1005577.010	644 356.784
PI ( )	8+971.915	1004267.470	645 088.143
Tangent Direction:	S 29^10'57.76" E		
Tangent Length:	1499.928		

Element: Linear			
PI ( )	8+971.915	1004267.470	645 088.143
PC ( )	9+147.788	1004106.149	645 158.192
Tangent Direction:	S 23^28'17.88" E		
Tangent Length:	175.873		

Elements are not collinear

Element: Circular			
PC ( )	9+147.788	1004106.149	645 158.192
PI ( )	9+320.333	1003955.505	645 242.323
CC ( )		1002804.287	642 827.086
PT ( )	9+492.398	1003795.285	645 306.365
Radius:	2670.000		
Delta:	7^23'42.06" Right		

Degree of Curvature(Arc):	2^08'45.27"
Length:	344.610
Tangent:	172.545
Chord:	344.371
Middle Ordinate:	5.558
External:	5.569
Tangent Direction:	S 29^10'56.01" E
Radial Direction:	S 60^49'03.99" W
Chord Direction:	S 25^29'04.98" E
Radial Direction:	S 68^12'46.05" W
Tangent Direction:	S 21^47'13.95" E

Elements are not collinear

Element: Linear

PT	( )	9+492.398	1003795.285	645306.365
PI	( )	9+668.218	1003639.080	645387.065

Tangent Direction:	S 27^19'20.44" E
Tangent Length:	175.820

Element: Linear

PI	( )	9+668.218	1003639.080	645387.065
PI	( )	10+076.274	1003260.253	645538.721

Tangent Direction:	S 21^49'03.38" E
Tangent Length:	408.056

Element: Linear

PI	( )	10+076.274	1003260.253	645538.721
PI	( )	10+252.147	1003091.284	645587.513

Tangent Direction:	S 16^06'25.24" E
Tangent Length:	175.873

Element: Linear

PI	( )	10+252.147	1003091.284	645587.513
PC	( )	10+253.147	1003090.355	645587.885

Tangent Direction:	S 21^49'03.38" E
Tangent Length:	1.000

Element: Circular

PC	( )	10+253.147	1003090.355	645

587.885

PI ( )	10+994.931	1002401.704	645	
863.571				
CC ( )		1004179.299	648	
308.014				
PT ( )	11+706.185	1001927.195	646	
433.734				

Radius:	2930.000
Delta:	28^24'50.31" Left
Degree of Curvature(Arc):	1^57'19.75"
Length:	1453.038
Tangent:	741.784
Chord:	1438.194
Middle Ordinate:	89.613
External:	92.440
Tangent Direction:	S 21^49'03.38" E
Radial Direction:	S 68^10'56.62" W
Chord Direction:	S 36^01'28.53" E
Radial Direction:	S 39^46'06.31" W
Tangent Direction:	S 50^13'53.69" E

Element: Linear

PT ( )	11+706.185	1001927.195	646	
433.734				
PC ( )	12+667.041	1001312.549	647	
172.282				

Tangent Direction:	S 50^13'53.69" E
Tangent Length:	960.856

Element: Circular

PC ( )	12+667.041	1001312.549	647	
172.282				
PI ( )	12+986.779	1001108.017	647	
418.044				
CC ( )		999260.290	645	
464.320				
PT ( )	13+303.486	1000851.239	647	
608.564				

Radius:	2670.000
Delta:	13^39'27.09" Right
Degree of Curvature(Arc):	2^08'45.27"
Length:	636.445
Tangent:	319.738
Chord:	634.939
Middle Ordinate:	18.941
External:	19.076
Tangent Direction:	S 50^13'53.69" E
Radial Direction:	S 39^46'06.31" W

Chord Direction:	S 43^24'10.14" E			
Radial Direction:	S 53^25'33.40" W			
Tangent Direction:	S 36^34'26.60" E			
Element: Linear				
PT ( )	13+303.486	1000851.239	647 608.564	
PI ( )	13+304.486	1000850.436	647 609.160	
Tangent Direction:	S 36^34'26.60" E			
Tangent Length:	1.000			
Element: Linear				
PI ( )	13+304.486	1000850.436	647 609.160	
PI ( )	13+480.358	1000720.324	647 727.489	
Tangent Direction:	S 42^17'04.73" E			
Tangent Length:	175.873			
Element: Linear				
PI ( )	13+480.358	1000720.324	647 727.489	
PI ( )	14+759.223	999693.283	648 489.515	
Tangent Direction:	S 36^34'26.60" E			
Tangent Length:	1278.865			
Element: Linear				
PI ( )	14+759.223	999693.283	648 489.515	
PI ( )	14+995.393	999490.567	648 610.686	
Tangent Direction:	S 30^52'05.80" E			
Tangent Length:	236.170			
Element: Linear				
PI ( )	14+995.393	999490.567	648 610.686	
PI ( )	15+634.246	998981.099	648 996.139	
Tangent Direction:	S 37^06'37.39" E			
Tangent Length:	638.852			
Element: Linear				
PI ( )	15+634.246	998981.099	648 996.139	
PI ( )	15+994.593	998761.011	649	

281.466

Tangent Direction: S 52^21'17.97" E
Tangent Length: 360.347

Element: Linear
PI ( ) 15+994.593 998761.011 649
281.466
PI ( ) 16+552.359 998465.964 649
754.806
Tangent Direction: S 58^03'48.77" E
Tangent Length: 557.766

Element: Linear
PI ( ) 16+552.359 998465.964 649
754.806
PI ( ) 16+965.664 998213.531 650
082.065
Tangent Direction: S 52^21'17.97" E
Tangent Length: 413.305

Element: Linear
PI ( ) 16+965.664 998213.531 650
082.065
PC ( ) 17+141.537 998092.790 650
209.943
Tangent Direction: S 46^38'39.84" E
Tangent Length: 175.873

Elements are not collinear

Element: Circular
PC ( ) 17+141.537 998092.790 650
209.943
PI ( ) 17+373.105 997951.356 650
393.301
CC ( ) 999858.527 651
571.954
PT ( ) 17+603.019 997850.614 650
601.807

Radius: 2230.000
Delta: 11^51'24.99" Left
Degree of Curvature(Arc): 2^34'09.54"
Length: 461.482
Tangent: 231.568
Chord: 460.659
Middle Ordinate: 11.927
External: 11.991
Tangent Direction: S 52^21'17.97" E

```
          Radial Direction:   S 37^38'42.03" W
           Chord Direction:   S 58^17'00.47" E
          Radial Direction:   S 25^47'17.04" W
        Tangent Direction:    S 64^12'42.96" E

Elements are not collinear

Element: Linear
             PT (        )          17+603.019    997850.614    650
601.807
             PI (        )          17+871.001    997729.785    650
841.004
         Tangent Direction:    S 63^11'58.74" E
            Tangent Length:             267.982

Element: Linear
             PI (        )          17+871.001    997729.785    650
841.004
             PI (        )          18+094.111    997653.226    651
050.567
         Tangent Direction:    S 69^55'52.73" E
            Tangent Length:             223.111

Element: Linear
             PI (        )          18+094.111    997653.226    651
050.567
             PI (        )          18+790.565    997350.238    651
677.661
         Tangent Direction:    S 64^12'42.96" E
            Tangent Length:             696.454

Element: Linear
             PI (        )          18+790.565    997350.238    651
677.661
             PI (        )          18+890.284    997294.639    651
760.441
         Tangent Direction:    S 56^06'47.37" E
            Tangent Length:              99.719

Element: Linear
             PI (        )          18+890.284    997294.639    651
760.441
             PI (        )          19+043.678    997206.306    651
885.848
         Tangent Direction:    S 54^50'24.99" E
            Tangent Length:             153.394

Element: Linear
```

PI ( )	19+043.678	997206.306	651 885.848	
POE ( )	19+061.870	997199.832	651 902.849	

Tangent Direction: S 69^09'04.91" E
Tangent Length: 18.192

Opcion 15 -4West Prism con radio de 2130 m

Project Name: opcion 15
Description:
Horizontal Alignment Name: option 15 west R=2130
Description: modificando opt 14 en Gold Hill
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	0+000.000	1008186.400	637703.000
PC	( )	0+581.929	1008135.195	638282.672
Tangent Direction:		S 84^57'06.86" E		
Tangent Length:		581.929		
Element: Circular				
PC	( )	0+581.929	1008135.195	638282.672
PI	( )	0+684.154	1008126.200	638384.500
CC	( )		1005475.551	638047.733
PT	( )	0+786.279	1008109.445	638485.342
Radius:		2670.000		
Delta:		4^23'06.58" Right		
Degree of Curvature(Arc):		2^08'45.27"		
Length:		204.350		
Tangent:		102.225		
Chord:		204.300		
Middle Ordinate:		1.955		
External:		1.956		
Tangent Direction:		S 84^57'06.86" E		
Radial Direction:		S 5^02'53.14" W		
Chord Direction:		S 82^45'33.57" E		
Radial Direction:		S 9^25'59.72" W		
Tangent Direction:		S 80^34'00.28" E		
Element: Linear				
PT	( )	0+786.279	1008109.445	638485.342
PI	( )	3+692.388	1007633.138	641352.153
Tangent Direction:		S 80^34'00.28" E		
Tangent Length:		2906.110		
Element: Linear				

PI ( )	3+692.388	1007633.138	641	352.153
PC ( )	3+994.974	1007554.033	641	644.216
Tangent Direction:	S 74^50'42.04" E			
Tangent Length:	302.586			

Elements are not collinear

Element: Circular

PC ( )	3+994.974	1007554.033	641	644.216
PI ( )	5+766.587	1007268.157	643	392.612
CC ( )		1003932.129	641	052.007
PT ( )	7+296.030	1005721.345	644	256.317
Radius:	3670.000			
Delta:	51^32'09.03" Right			
Degree of Curvature(Arc):	1^33'40.29"			
Length:	3301.055			
Tangent:	1771.613			
Chord:	3190.896			
Middle Ordinate:	364.936			
External:	405.232			
Tangent Direction:	S 80^42'49.94" E			
Radial Direction:	S 9^17'10.06" W			
Chord Direction:	S 54^56'45.42" E			
Radial Direction:	S 60^49'19.09" W			
Tangent Direction:	S 29^10'40.91" E			

Elements are not collinear

Element: Linear

PT ( )	7+296.030	1005721.345	644	256.317
PI ( )	7+471.888	1005577.010	644	356.784
Tangent Direction:	S 34^50'25.64" E			
Tangent Length:	175.858			

Element: Linear

PI ( )	7+471.888	1005577.010	644	356.784
PI ( )	9+015.113	1004229.668	645	109.255
Tangent Direction:	S 29^10'57.76" E			

```
            Tangent Length:            1543.226

Element: Linear
              PI (        )           9+015.113   1004229.668    645
109.255
              PC (        )           9+190.986   1004068.347    645
179.304
         Tangent Direction:   S 23^28'17.45" E
            Tangent Length:             175.873

Elements are not collinear

Element: Circular
              PC (        )           9+190.986   1004068.347    645
179.304
              PI (        )           9+320.233   1003955.505    645
242.323
              CC (        )                       1003093.169    643
433.157
              PT (        )           9+449.121   1003835.490    645
290.294
                    Radius:            2000.000
                     Delta:         7^23'42.06" Right
  Degree of Curvature(Arc):         2^51'53.24"
                    Length:             258.135
                   Tangent:             129.247
                     Chord:             257.956
           Middle Ordinate:               4.163
                  External:               4.172
         Tangent Direction:   S 29^10'56.01" E
          Radial Direction:   S 60^49'03.99" W
           Chord Direction:   S 25^29'04.98" E
          Radial Direction:   S 68^12'46.05" W
         Tangent Direction:   S 21^47'13.95" E

Elements are not collinear

Element: Linear
              PT (        )           9+449.121   1003835.490    645
290.294
              PI (        )           9+624.939   1003679.277    645
370.974
         Tangent Direction:   S 27^18'53.62" E
            Tangent Length:             175.818

Element: Linear
              PI (        )           9+624.939   1003679.277    645
370.974
```

```
              PI (        )          10+246.915   1003101.851    645
602.133
         Tangent Direction:   S 21^49'03.38" E
            Tangent Length:             621.977

Element: Linear
              PI (        )          10+246.915   1003101.851    645
602.133
              PI (        )          10+422.291   1002933.346    645
650.740
         Tangent Direction:   S 16^05'26.73" E
            Tangent Length:             175.375

Element: Linear
              PI (        )          10+422.291   1002933.346    645
650.740
              PC (        )          10+422.791   1002932.882    645
650.926
         Tangent Direction:   S 21^49'03.38" E
            Tangent Length:               0.500

Element: Circular
              PC (        )          10+422.791   1002932.882    645
650.926
              PI (        )          10+994.952   1002401.704    645
863.571
              CC (        )                       1003772.818    647
749.046
              PT (        )          11+543.564   1002035.700    646
303.355
                    Radius:            2260.000
                     Delta:        28^24'50.31" Left
  Degree of Curvature(Arc):         2^32'06.76"
                    Length:            1120.773
                   Tangent:             572.161
                     Chord:            1109.324
           Middle Ordinate:              69.121
                  External:              71.302
         Tangent Direction:   S 21^49'03.38" E
          Radial Direction:   S 68^10'56.62" W
           Chord Direction:   S 36^01'28.53" E
          Radial Direction:   S 39^46'06.31" W
         Tangent Direction:   S 50^13'53.69" E

Element: Linear
              PT (        )          11+543.564   1002035.700    646
303.355
              PC (        )          12+777.655   1001246.269    647
```

251.922

Tangent Direction:	S 50^13'53.69" E			
Tangent Length:	1234.091			

Element: Circular

PC ( )	12+777.655	1001246.269	647	
251.922				
PI ( )	12+995.208	1001107.104	647	
419.141				
CC ( )		999708.997	645	
972.550				
PT ( )	13+211.056	1000935.240	647	
552.527				
Radius:	2000.000			
Delta:	12^24'57.71"	Right		
Degree of Curvature(Arc):	2^51'53.24"			
Length:	433.401			
Tangent:	217.553			
Chord:	432.554			
Middle Ordinate:	11.728			
External:	11.797			
Tangent Direction:	S 50^13'53.69" E			
Radial Direction:	S 39^46'06.31" W			
Chord Direction:	S 44^01'24.83" E			
Radial Direction:	S 52^11'04.02" W			
Tangent Direction:	S 37^48'55.98" E			

Element: Linear

PT ( )	13+211.056	1000935.240	647	
552.527				
PI ( )	13+211.156	1000935.161	647	
552.589				
Tangent Direction:	S 37^48'55.98" E			
Tangent Length:	0.100			

Element: Linear

PI ( )	13+211.156	1000935.161	647	
552.589				
PI ( )	13+386.930	1000807.722	647	
673.648				
Tangent Direction:	S 43^31'45.79" E			
Tangent Length:	175.773			

Element: Linear

PI ( )	13+386.930	1000807.722	647	
673.648				
PI ( )	15+149.765	999415.102	648	
754.481				

Tangent Direction:	S 37^48'55.98" E			
Tangent Length:	1762.835			
Element: Linear				
PI ( )	15+149.765	999415.102	648	
754.481				
PI ( )	15+325.638	999266.124	648	
847.952				
Tangent Direction:	S 32^06'17.84" E			
Tangent Length:	175.873			
Element: Linear				
PI ( )	15+325.638	999266.124	648	
847.952				
PC ( )	15+325.738	999266.045	648	
848.013				
Tangent Direction:	S 37^48'55.98" E			
Tangent Length:	0.100			
Element: Circular				
PC ( )	15+325.738	999266.045	648	
848.013				
PI ( )	15+587.269	999059.438	649	
008.364				
CC ( )		1000651.700	650	
633.388				
PT ( )	15+846.485	998894.913	649	
211.663				
Radius:	2260.000			
Delta:	13^12'07.33" Left			
Degree of Curvature(Arc):	2^32'06.76"			
Length:	520.747			
Tangent:	261.532			
Chord:	519.596			
Middle Ordinate:	14.982			
External:	15.082			
Tangent Direction:	S 37^48'55.98" E			
Radial Direction:	S 52^11'04.02" W			
Chord Direction:	S 44^24'59.64" E			
Radial Direction:	S 38^58'56.69" W			
Tangent Direction:	S 51^01'03.31" E			
Element: Linear				
PT ( )	15+846.485	998894.913	649	
211.663				
PI ( )	16+083.079	998746.076	649	
395.577				
Tangent Direction:	S 51^01'03.31" E			

Tangent Length:		236.595		
Element: Linear				
PI ( )		16+083.079	998746.076	649
395.577				
PI ( )		16+258.952	998649.590	649
542.620				
Tangent Direction:	S 56^43'41.44" E			
Tangent Length:		175.873		
Element: Linear				
PI ( )		16+258.952	998649.590	649
542.620				
PI ( )		16+880.932	998258.314	650
026.109				
Tangent Direction:	S 51^01'03.31" E			
Tangent Length:		621.980		
Element: Linear				
PI ( )		16+880.932	998258.314	650
026.109				
PI ( )		17+056.805	998134.621	650
151.135				
Tangent Direction:	S 45^18'25.17" E			
Tangent Length:		175.873		
Element: Linear				
PI ( )		17+056.805	998134.621	650
151.135				
PC ( )		17+060.274	998132.438	650
153.832				
Tangent Direction:	S 51^01'03.31" E			
Tangent Length:		3.470		
Element: Circular				
PC ( )		17+060.274	998132.438	650
153.832				
PI ( )		17+318.182	997970.193	650
354.314				
CC ( )			999865.905	651
556.684				
PT ( )		17+573.809	997857.992	650
586.537				
Radius:		2230.000		
Delta:		13^11'39.65"	Left	
Degree of Curvature(Arc):		2^34'09.54"		
Length:		513.535		
Tangent:		257.908		

	Chord:	512.401		
	Middle Ordinate:	14.766		
	External:	14.865		
	Tangent Direction:	S 51^01'03.31" E		
	Radial Direction:	S 38^58'56.69" W		
	Chord Direction:	S 57^36'53.14" E		
	Radial Direction:	S 25^47'17.04" W		
	Tangent Direction:	S 64^12'42.96" E		
Element: Linear				
	PT ( )	17+573.809	997857.992	650 586.537
	PI ( )	17+814.036	997753.483	650 802.839
	Tangent Direction:	S 64^12'42.96" E		
	Tangent Length:	240.226		
Element: Linear				
	PI ( )	17+814.036	997753.483	650 802.839
	PI ( )	17+989.909	997693.107	650 968.024
	Tangent Direction:	S 69^55'21.10" E		
	Tangent Length:	175.873		
Element: Linear				
	PI ( )	17+989.909	997693.107	650 968.024
	PI ( )	18+778.035	997350.238	651 677.661
	Tangent Direction:	S 64^12'42.96" E		
	Tangent Length:	788.126		
Element: Linear				
	PI ( )	18+778.035	997350.238	651 677.661
	PI ( )	18+877.754	997294.639	651 760.441
	Tangent Direction:	S 56^06'47.37" E		
	Tangent Length:	99.719		
Element: Linear				
	PI ( )	18+877.754	997294.639	651 760.441
	PI ( )	19+031.148	997206.306	651 885.848
	Tangent Direction:	S 54^50'24.99" E		
	Tangent Length:	153.394		

Opcion 15 -4West Prism con radio de 2130 m

Element: Linear

PI	( )	19+031.148	997206.306	651
885.848				
POE	( )	19+049.340	997199.832	651
902.849				

Tangent Direction: S 69^09'04.91" E

Tangent Length: 18.192

Project Name: opcion 15
Description:
Horizontal Alignment Name: option 15 CL
Description:
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	-7+116.966	1008361.027	637514.333
PI	( )	-2+339.174	1007595.044	642230.324
Tangent Direction:		S 80^46'27.97" E		
Tangent Length:		4777.792		
Element: Linear				
PI	( )	-2+339.174	1007595.044	642230.324
PI	( )	-1+158.599	1007061.277	643283.343
Tangent Direction:		S 63^07'11.66" E		
Tangent Length:		1180.574		
Element: Linear				
PI	( )	-1+158.599	1007061.277	643283.343
PI	( )	-0+024.261	1006271.788	644097.856
Tangent Direction:		S 45^53'37.67" E		
Tangent Length:		1134.338		
Element: Linear				
PI	( )	-0+024.261	1006271.788	644097.856
PI	( )	2+564.455	1004011.557	645359.919
Tangent Direction:		S 29^10'40.91" E		
Tangent Length:		2588.715		
Element: Linear				
PI	( )	2+564.455	1004011.557	645359.919
PI	( )	3+940.306	1002733.985	645870.580
Tangent Direction:		S 21^47'13.95" E		
Tangent Length:		1375.851		

Element: Linear
PI ( ) 3+940.306 1002733.985 645
870.580
PI ( ) 4+491.493 1002291.492 646
199.226
Tangent Direction: S 36^36'06.27" E
Tangent Length: 551.188

Element: Linear
PI ( ) 4+491.493 1002291.492 646
199.226
PI ( ) 6+200.942 1001197.981 647
513.170
Tangent Direction: S 50^13'53.69" E
Tangent Length: 1709.448

Element: Linear
PI ( ) 6+200.942 1001197.981 647
513.170
PI ( ) 8+792.058 999151.028 649
101.839
Tangent Direction: S 37^48'55.98" E
Tangent Length: 2591.117

Element: Linear
PI ( ) 8+792.058 999151.028 649
101.839
PI ( ) 10+493.463 998080.705 650
424.407
Tangent Direction: S 51^01'03.31" E
Tangent Length: 1701.405

Element: Linear
PI ( ) 10+493.463 998080.705 650
424.407
PI ( ) 12+013.365 997419.482 651
792.941
Tangent Direction: S 64^12'42.96" E
Tangent Length: 1519.901

Element: Linear
PI ( ) 12+013.365 997419.482 651
792.941
POE ( ) 12+258.775 997256.637 651
976.537
Tangent Direction: S 48^25'40.03" E
Tangent Length: 245.410

Project Name: opcion 15
Description:
Horizontal Alignment Name: option 15 east R=2130
Description: modificando opt 14 en Gold Hill
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	0+000.000	1008458.836	637529.577
PI	( )	3+905.719	1007828.662	641384.123
Tangent Direction:		S 80^42'53.78" E		
Tangent Length:		3905.719		
Element: Linear				
PI	( )	3+905.719	1007828.662	641384.123
PC	( )	4+208.305	1007810.626	641686.171
Tangent Direction:		S 86^34'57.84" E		
Tangent Length:		302.586		

Elements are not collinear

Element: Circular				
PC	( )	4+208.305	1007810.626	641686.171
PI	( )	6+105.427	1007504.497	643558.431
CC	( )		1003932.129	641052.007
PT	( )	7+743.223	1005848.102	644483.326
Radius:		3930.000		
Delta:		51^32'09.03" Right		
Degree of Curvature(Arc):		1^27'28.47"		
Length:		3534.918		
Tangent:		1897.122		
Chord:		3416.954		
Middle Ordinate:		390.790		
External:		433.940		
Tangent Direction:		S 80^42'49.94" E		
Radial Direction:		S 9^17'10.06" W		
Chord Direction:		S 54^56'45.42" E		
Radial Direction:		S 60^49'19.09" W		
Tangent Direction:		S 29^10'40.91" E		

Elements are not collinear

Element: Linear

PT ( )	7+743.223	1005848.102	644
483.326			
PI ( )	7+920.626	1005685.379	644
553.988			

Tangent Direction: S 23^28'22.02" E
Tangent Length: 177.403

Element: Linear

PI ( )	7+920.626	1005685.379	644
553.988			
PI ( )	9+461.990	1004339.655	645
305.540			

Tangent Direction: S 29^10'56.01" E
Tangent Length: 1541.365

Element: Linear

PI ( )	9+461.990	1004339.655	645
305.540			
PI ( )	9+638.261	1004195.057	645
406.350			

Tangent Direction: S 34^52'59.47" E
Tangent Length: 176.270

Element: Linear

PI ( )	9+638.261	1004195.057	645
406.350			
PC ( )	9+640.198	1004193.365	645
407.294			

Tangent Direction: S 29^10'41.77" E
Tangent Length: 1.938

Element: Circular

PC ( )	9+640.198	1004193.365	645
407.294			
PI ( )	9+784.231	1004067.609	645
477.515			
CC ( )		1003106.176	643
460.266			
PT ( )	9+927.865	1003933.864	645
530.974			

Radius: 2230.000
Delta: 7^23'27.82" Right
Degree of Curvature(Arc): 2^34'09.54"
Length: 287.666

CENTRO DE RECURSOS TECNICOS
AUTORIDAD DEL CANAL DE PANAMA

UNAUTHORIZED USE OR DUPLICATION IS PROHIBITED
PROHIBIDA LA REPRODUCCION SIN AUTORIZACION DEL AUTOR

Tangent:	144.033			
Chord:	287.467			
Middle Ordinate:	4.637			
External:	4.647			
Tangent Direction:	S 29^10'41.77" E			
Radial Direction:	S 60^49'18.23" W			
Chord Direction:	S 25^28'57.86" E			
Radial Direction:	S 68^12'46.05" W			
Tangent Direction:	S 21^47'13.95" E			
Element: Linear				
PT ( )	9+927.865	1003933.864	645	
530.974				
PI ( )	9+930.802	1003931.136	645	
532.064				
Tangent Direction:	S 21^47'13.95" E			
Tangent Length:	2.938			
Element: Linear				
PI ( )	9+930.802	1003931.136	645	
532.064				
PI ( )	10+105.737	1003762.861	645	
579.872				
Tangent Direction:	S 15^51'36.69" E			
Tangent Length:	174.935			
Element: Linear				
PI ( )	10+105.737	1003762.861	645	
579.872				
PI ( )	10+727.573	1003185.566	645	
810.980				
Tangent Direction:	S 21^49'03.38" E			
Tangent Length:	621.836			
Element: Linear				
PI ( )	10+727.573	1003185.566	645	
810.980				
PI ( )	10+903.446	1003029.605	645	
892.265				
Tangent Direction:	S 27^31'41.51" E			
Tangent Length:	175.873			
Element: Linear				
PI ( )	10+903.446	1003029.605	645	
892.265				
PC ( )	10+903.546	1003029.512	645	
892.303				
Tangent Direction:	S 21^49'03.38" E			

Tangent Length:		0.100		
Element: Circular				
PC ( )		10+903.546	1003029.512	645
892.303				
PI ( )		11+409.883	1002559.443	646
080.484				
CC ( )			1003772.818	647
749.046				
PT ( )		11+895.381	1002235.546	646
469.674				
Radius:		2000.000		
Delta:		28^24'50.31"	Left	
Degree of Curvature(Arc):		2^51'53.24"		
Length:		991.835		
Tangent:		506.337		
Chord:		981.702		
Middle Ordinate:		61.169		
External:		63.099		
Tangent Direction:		S 21^49'03.38" E		
Radial Direction:		S 68^10'56.62" W		
Chord Direction:		S 36^01'28.53" E		
Radial Direction:		S 39^46'06.31" W		
Tangent Direction:		S 50^13'53.69" E		
Element: Linear				
PT ( )		11+895.381	1002235.546	646
469.674				
PC ( )		13+129.472	1001446.115	647
418.241				
Tangent Direction:		S 50^13'53.69" E		
Tangent Length:		1234.091		
Element: Circular				
PC ( )		13+129.472	1001446.115	647
418.241				
PI ( )		13+375.306	1001288.858	647
607.198				
CC ( )			999708.997	645
972.550				
PT ( )		13+619.215	1001094.652	647
757.924				
Radius:		2260.000		
Delta:		12^24'57.71"	Right	
Degree of Curvature(Arc):		2^32'06.76"		
Length:		489.743		
Tangent:		245.834		
Chord:		488.786		

Middle Ordinate:		13.253		
External:		13.331		
Tangent Direction:	S 50^13'53.69" E			
Radial Direction:	S 39^46'06.31" W			
Chord Direction:	S 44^01'24.83" E			
Radial Direction:	S 52^11'04.02" W			
Tangent Direction:	S 37^48'55.98" E			
Element: Linear				
PT ( )		13+619.215	1001094.652	647
757.924				
PI ( )		13+619.315	1001094.573	647
757.986				
Tangent Direction:	S 37^48'55.98" E			
Tangent Length:		0.100		
Element: Linear				
PI ( )		13+619.315	1001094.573	647
757.986				
PI ( )		13+795.188	1000945.595	647
851.457				
Tangent Direction:	S 32^06'17.84" E			
Tangent Length:		175.873		
Element: Linear				
PI ( )		13+795.188	1000945.595	647
851.457				
PI ( )		15+557.923	999553.054	648
932.228				
Tangent Direction:	S 37^48'55.98" E			
Tangent Length:		1762.735		
Element: Linear				
PI ( )		15+557.923	999553.054	648
932.228				
PI ( )		15+733.796	999425.536	649
053.349				
Tangent Direction:	S 43^31'34.11" E			
Tangent Length:		175.873		
Element: Linear				
PI ( )		15+733.796	999425.536	649
053.349				
PC ( )		15+733.896	999425.457	649
053.410				
Tangent Direction:	S 37^48'55.98" E			
Tangent Length:		0.100		

```
Element: Circular
              PC (        )          15+733.896    999425.457    649
053.410
              PI (        )          15+965.340    999242.619    649
195.314
              CC (        )                        1000651.700    650
633.388
              PT (        )          16+194.734    999097.021    649
375.224
                     Radius:            2000.000
                      Delta:       13^12'07.33" Left
  Degree of Curvature(Arc):        2^51'53.24"
                     Length:             460.838
                    Tangent:             231.444
                      Chord:             459.819
             Middle Ordinate:              13.259
                   External:              13.347
           Tangent Direction:   S 37^48'55.98" E
            Radial Direction:   S 52^11'04.02" W
             Chord Direction:   S 44^24'59.64" E
            Radial Direction:   S 38^58'56.69" W
           Tangent Direction:   S 51^01'03.31" E

Element: Linear
              PT (        )          16+194.734    999097.021    649
375.224
              PI (        )          16+194.834    999096.958    649
375.302
           Tangent Direction:   S 51^01'03.31" E
              Tangent Length:              0.100

Element: Linear
              PI (        )          16+194.834    999096.958    649
375.302
              PI (        )          16+370.707    998973.266    649
500.327
           Tangent Direction:   S 45^18'25.17" E
              Tangent Length:            175.873

Element: Linear
              PI (        )          16+370.707    998973.266    649
500.327
              PI (        )          17+229.181    998433.215    650
167.653
           Tangent Direction:   S 51^01'03.31" E
              Tangent Length:            858.474

Element: Linear
```

PI ( )	17+229.181	998433.215	650 167.653	
PC ( )	17+405.054	998336.729	650 314.696	

Tangent Direction: S 56^43'41.44" E
Tangent Length: 175.873

Elements are not collinear

Element: Circular

PC ( )	17+405.054	998336.729	650 314.696	
PI ( )	17+636.362	998191.218	650 494.501	
CC ( )		999891.407	651 572.860	
PT ( )	17+865.624	998090.589	650 702.773	

Radius: 2000.000
Delta: 13^11'39.65" Left
Degree of Curvature(Arc): 2^51'53.24"
Length: 460.570
Tangent: 231.308
Chord: 459.553
Middle Ordinate: 13.243
External: 13.331
Tangent Direction: S 51^01'03.31" E
Radial Direction: S 38^58'56.69" W
Chord Direction: S 57^36'53.14" E
Radial Direction: S 25^47'17.04" W
Tangent Direction: S 64^12'42.96" E

Elements are not collinear

Element: Linear

PT ( )	17+865.624	998090.589	650 702.773	
PI ( )	18+041.496	997998.699	650 852.731	

Tangent Direction: S 58^30'04.83" E
Tangent Length: 175.873

Element: Linear

PI ( )	18+041.496	997998.699	650 852.731	
PI ( )	19+078.304	997547.642	651 786.283	

Tangent Direction: S 64^12'42.96" E

	Tangent Length:	1036.808		
Element: Linear				
	PI ( )	19+078.304	997547.642	651 786.283
	POE ( )	19+387.482	997342.500	652 017.600
	Tangent Direction:	S 48^25'55.23" E		
	Tangent Length:	309.178		

Project Name: opcion 15
Description:
Horizontal Alignment Name: option 15 east
Description: modificando opt 14 en Gold Hill
Style: default

	STATION	NORTHING	EASTING
Element: Linear			
POB ( )	0+000.000	1008458.836	637529.577
PI ( )	3+905.719	1007828.662	641384.123
Tangent Direction:	S 80^42'53.78" E		
Tangent Length:	3905.719		
Element: Linear			
PI ( )	3+905.719	1007828.662	641384.123
PC ( )	4+208.305	1007810.626	641686.171
Tangent Direction:	S 86^34'57.84" E		
Tangent Length:	302.586		
Elements are not collinear			
Element: Circular			
PC ( )	4+208.305	1007810.626	641686.171
PI ( )	6+105.427	1007504.497	643558.431
CC ( )		1003932.129	641052.007
PT ( )	7+743.223	1005848.102	644483.326
Radius:	3930.000		
Delta:	51^32'09.03" Right		
Degree of Curvature(Arc):	1^27'28.47"		
Length:	3534.918		
Tangent:	1897.122		
Chord:	3416.954		
Middle Ordinate:	390.790		
External:	433.940		
Tangent Direction:	S 80^42'49.94" E		
Radial Direction:	S 9^17'10.06" W		
Chord Direction:	S 54^56'45.42" E		
Radial Direction:	S 60^49'19.09" W		
Tangent Direction:	S 29^10'40.91" E		

Elements are not collinear

Element: Linear

PT ( )	7+743.223	1005848.102	644483.326
PI ( )	7+920.626	1005685.379	644553.988

Tangent Direction: S 23^28'22.02" E
Tangent Length: 177.403

Element: Linear

PI ( )	7+920.626	1005685.379	644553.988
PI ( )	9+419.013	1004377.177	645284.584

Tangent Direction: S 29^10'56.01" E
Tangent Length: 1498.387

Element: Linear

PI ( )	9+419.013	1004377.177	645284.584
PC ( )	9+594.885	1004232.922	645385.191

Tangent Direction: S 34^53'34.15" E
Tangent Length: 175.873

Elements are not collinear

Element: Circular

PC ( )	9+594.885	1004232.922	645385.191
PI ( )	9+784.232	1004067.609	645477.515
CC ( )		1002804.287	642827.086
PT ( )	9+973.053	1003891.787	645547.793

Radius: 2930.000
Delta: 7^23'42.06" Right
Degree of Curvature(Arc): 1^57'19.75"
Length: 378.167
Tangent: 189.347
Chord: 377.905
Middle Ordinate: 6.099
External: 6.112
Tangent Direction: S 29^10'56.01" E
Radial Direction: S 60^49'03.99" W

```
          Chord Direction:    S 25^29'04.98" E
         Radial Direction:    S 68^12'46.05" W
        Tangent Direction:    S 21^47'13.95" E

Elements are not collinear

Element: Linear
             PT (         )          9+973.053   1003891.787    645
547.793
             PI (         )         10+148.980   1003722.591    645
595.993
        Tangent Direction:    S 15^54'04.59" E
           Tangent Length:             175.927

Element: Linear
             PI (         )         10+148.980   1003722.591    645
595.993
             PI (         )         10+556.917   1003343.875    645
747.604
        Tangent Direction:    S 21^49'03.38" E
           Tangent Length:             407.937

Element: Linear
             PI (         )         10+556.917   1003343.875    645
747.604
             PI (         )         10+732.790   1003187.914    645
828.890
        Tangent Direction:    S 27^31'41.51" E
           Tangent Length:             175.873

Element: Linear
             PI (         )         10+732.790   1003187.914    645
828.890
             PC (         )         10+733.790   1003186.985    645
829.262
        Tangent Direction:    S 21^49'03.38" E
           Tangent Length:               1.000

Element: Circular
             PC (         )         10+733.790   1003186.985    645
829.262
             PI (         )         11+409.750   1002559.443    646
080.484
             CC (         )                      1004179.299    648
308.014
             PT (         )         12+057.889   1002127.040    646
600.052
                   Radius:           2670.000
```

Delta:	28^24'50.31" Left			
Degree of Curvature(Arc):	2^08'45.27"			
Length:	1324.100			
Tangent:	675.960			
Chord:	1310.573			
Middle Ordinate:	81.661			
External:	84.237			
Tangent Direction:	S 21^49'03.38" E			
Radial Direction:	S 68^10'56.62" W			
Chord Direction:	S 36^01'28.53" E			
Radial Direction:	S 39^46'06.31" W			
Tangent Direction:	S 50^13'53.69" E			

Element: Linear

PT ( )	12+057.889	1002127.040	646 600.052	
PC ( )	13+049.477	1001492.735	647 362.222	
Tangent Direction:	S 50^13'53.69" E			
Tangent Length:	991.588			

Element: Circular

PC ( )	13+049.477	1001492.735	647 362.222	
PI ( )	13+368.192	1001288.858	647 607.198	
CC ( )		999240.631	645 487.942	
PT ( )	13+684.410	1001037.077	647 802.609	
Radius:	2930.000			
Delta:	12^24'57.71" Right			
Degree of Curvature(Arc):	1^57'19.75"			
Length:	634.933			
Tangent:	318.715			
Chord:	633.691			
Middle Ordinate:	17.182			
External:	17.283			
Tangent Direction:	S 50^13'53.69" E			
Radial Direction:	S 39^46'06.31" W			
Chord Direction:	S 44^01'24.83" E			
Radial Direction:	S 52^11'04.02" W			
Tangent Direction:	S 37^48'55.98" E			

Elements are not collinear

Element: Linear

PT ( )	13+684.410	1001037.077	647

802.609

PI ( ) 13+860.283 1000888.099 647
896.080

Tangent Direction: S 32^06'17.84" E
Tangent Length: 175.873

Element: Linear

PI ( ) 13+860.283 1000888.099 647
896.080

PI ( ) 15+472.804 999614.226 648
884.752

Tangent Direction: S 37^48'55.98" E
Tangent Length: 1612.521

Element: Linear

PI ( ) 15+472.804 999614.226 648
884.752

PC ( ) 15+648.677 999486.707 649
005.873

Tangent Direction: S 43^31'34.11" E
Tangent Length: 175.873

Elements are not collinear

Element: Circular

PC ( ) 15+648.677 999486.707 649
005.873

PI ( ) 15+957.655 999242.619 649
195.314

CC ( ) 1001123.742 651
115.143

PT ( ) 16+263.896 999048.246 649
435.494

Radius: 2670.000
Delta: 13^12'07.33" Left
Degree of Curvature(Arc): 2^08'45.27"
Length: 615.219
Tangent: 308.978
Chord: 613.859
Middle Ordinate: 17.700
External: 17.818
Tangent Direction: S 37^48'55.98" E
Radial Direction: S 52^11'04.02" W
Chord Direction: S 44^24'59.64" E
Radial Direction: S 38^58'56.69" W
Tangent Direction: S 51^01'03.31" E

Elements are not collinear

```
Element: Linear
             PT (        )          16+263.896    999048.246    649
435.494
             PI (        )          16+439.769    998924.554    649
560.519
          Tangent Direction:    S 45^18'25.17" E
             Tangent Length:             175.873

Element: Linear
             PI (        )          16+439.769    998924.554    649
560.519
             PI (        )          17+220.809    998433.215    650
167.653
          Tangent Direction:    S 51^01'03.31" E
             Tangent Length:             781.041

Element: Linear
             PI (        )          17+220.809    998433.215    650
167.653
             PC (        )          17+396.682    998336.729    650
314.696
          Tangent Direction:    S 56^43'41.44" E
             Tangent Length:             175.873

Elements are not collinear

Element: Circular
             PC (        )          17+396.682    998336.729    650
314.696
             PI (        )          17+627.990    998191.218    650
494.501
             CC (        )                        999891.407    651
572.860
             PT (        )          17+857.252    998090.589    650
702.773
                     Radius:            2000.000
                      Delta:       13^11'39.65" Left
  Degree of Curvature(Arc):         2^51'53.24"
                     Length:             460.570
                    Tangent:             231.308
                      Chord:             459.553
             Middle Ordinate:              13.243
                   External:              13.331
          Tangent Direction:    S 51^01'03.31" E
           Radial Direction:    S 38^58'56.69" W
            Chord Direction:    S 57^36'53.14" E
           Radial Direction:    S 25^47'17.04" W
```

Tangent Direction: S 64^12'42.96" E

Elements are not collinear

Element: Linear

PT ( )	17+857.252	998090.589	650	702.773
PI ( )	18+033.125	997998.699	650	852.731

Tangent Direction: S 58^30'04.83" E
Tangent Length: 175.873

Element: Linear

PI ( )	18+033.125	997998.699	650	852.731
PI ( )	19+069.932	997547.642	651	786.283

Tangent Direction: S 64^12'42.96" E
Tangent Length: 1036.808

Element: Linear

PI ( )	19+069.932	997547.642	651	786.283
POE ( )	19+379.111	997342.500	652	017.600

Tangent Direction: S 48^25'55.23" E
Tangent Length: 309.178

Project Name: opcion 15
Description:
Horizontal Alignment Name: option 15 west
Description: modificando opt 14 en Gold Hill
Style: default

		STATION	NORTHING	EASTING
Element: Linear				
POB	( )	0+000.000	1008186.400	637703.000
PC	( )	0+581.929	1008135.195	638282.672
Tangent Direction:		S 84^57'06.86" E		
Tangent Length:		581.929		
Element: Circular				
PC	( )	0+581.929	1008135.195	638282.672
PI	( )	0+684.154	1008126.200	638384.500
CC	( )		1005475.551	638047.733
PT	( )	0+786.279	1008109.445	638485.342
Radius:		2670.000		
Delta:		4^23'06.58" Right		
Degree of Curvature(Arc):		2^08'45.27"		
Length:		204.350		
Tangent:		102.225		
Chord:		204.300		
Middle Ordinate:		1.955		
External:		1.956		
Tangent Direction:		S 84^57'06.86" E		
Radial Direction:		S 5^02'53.14" W		
Chord Direction:		S 82^45'33.57" E		
Radial Direction:		S 9^25'59.72" W		
Tangent Direction:		S 80^34'00.28" E		
Element: Linear				
PT	( )	0+786.279	1008109.445	638485.342
PI	( )	3+692.388	1007633.138	641352.153
Tangent Direction:		S 80^34'00.28" E		
Tangent Length:		2906.110		
Element: Linear				

PI ( )	3+692.388	1007633.138	641	352.153
PC ( )	3+994.974	1007554.033	641	644.216
Tangent Direction:	S 74^50'42.04" E			
Tangent Length:	302.586			

Elements are not collinear

Element: Circular

PC ( )	3+994.974	1007554.033	641	644.216
PI ( )	5+766.587	1007268.157	643	392.612
CC ( )		1003932.129	641	052.007
PT ( )	7+296.030	1005721.345	644	256.317

Radius:	3670.000
Delta:	51^32'09.03" Right
Degree of Curvature(Arc):	1^33'40.29"
Length:	3301.055
Tangent:	1771.613
Chord:	3190.896
Middle Ordinate:	364.936
External:	405.232
Tangent Direction:	S 80^42'49.94" E
Radial Direction:	S 9^17'10.06" W
Chord Direction:	S 54^56'45.42" E
Radial Direction:	S 60^49'19.09" W
Tangent Direction:	S 29^10'40.91" E

Elements are not collinear

Element: Linear

PT ( )	7+296.030	1005721.345	644	256.317
PI ( )	7+471.888	1005577.010	644	356.784
Tangent Direction:	S 34^50'25.64" E			
Tangent Length:	175.858			

Element: Linear

PI ( )	7+471.888	1005577.010	644	356.784
PI ( )	8+971.816	1004267.470	645	088.143
Tangent Direction:	S 29^10'57.76" E			

```
            Tangent Length:            1499.928

Element: Linear
              PI (        )           8+971.816   1004267.470    645
088.143
              PC (        )           9+147.688   1004106.149    645
158.192
         Tangent Direction:   S 23^28'17.88" E
            Tangent Length:             175.873

Elements are not collinear

Element: Circular
              PC (        )           9+147.688   1004106.149    645
158.192
              PI (        )           9+320.233   1003955.505    645
242.323
              CC (        )                       1002804.287    642
827.086
              PT (        )           9+492.298   1003795.285    645
306.365
                    Radius:            2670.000
                     Delta:         7^23'42.06" Right
  Degree of Curvature(Arc):         2^08'45.27"
                    Length:             344.610
                   Tangent:             172.545
                     Chord:             344.371
           Middle Ordinate:               5.558
                  External:               5.569
         Tangent Direction:   S 29^10'56.01" E
          Radial Direction:   S 60^49'03.99" W
           Chord Direction:   S 25^29'04.98" E
          Radial Direction:   S 68^12'46.05" W
         Tangent Direction:   S 21^47'13.95" E

Elements are not collinear

Element: Linear
              PT (        )           9+492.298   1003795.285    645
306.365
              PI (        )           9+668.118   1003639.080    645
387.065
         Tangent Direction:   S 27^19'20.44" E
            Tangent Length:             175.820

Element: Linear
              PI (        )           9+668.118   1003639.080    645
387.065
```

```
              PI (        )          10+076.174   1003260.253    645
538.721
         Tangent Direction:   S 21^49'03.38" E
            Tangent Length:            408.056

Element: Linear
              PI (        )          10+076.174   1003260.253    645
538.721
              PI (        )          10+252.047   1003091.284    645
587.513
         Tangent Direction:   S 16^06'25.24" E
            Tangent Length:            175.873

Element: Linear
              PI (        )          10+252.047   1003091.284    645
587.513
              PC (        )          10+253.047   1003090.355    645
587.885
         Tangent Direction:   S 21^49'03.38" E
            Tangent Length:              1.000

Element: Circular
              PC (        )          10+253.047   1003090.355    645
587.885
              PI (        )          10+994.831   1002401.704    645
863.571
              CC (        )                       1004179.299    648
308.014
              PT (        )          11+706.085   1001927.195    646
433.734
                    Radius:            2930.000
                     Delta:       28^24'50.31" Left
  Degree of Curvature(Arc):         1^57'19.75"
                    Length:            1453.038
                   Tangent:             741.784
                     Chord:            1438.194
            Middle Ordinate:              89.613
                  External:               92.440
         Tangent Direction:   S 21^49'03.38" E
          Radial Direction:   S 68^10'56.62" W
           Chord Direction:   S 36^01'28.53" E
          Radial Direction:   S 39^46'06.31" W
         Tangent Direction:   S 50^13'53.69" E

Element: Linear
              PT (        )          11+706.085   1001927.195    646
433.734
              PC (        )          12+697.673   1001292.890    647
```

```
195.904
          Tangent Direction:   S 50^13'53.69" E
             Tangent Length:            991.588

Element: Circular
               PC (        )         12+697.673   1001292.890    647
195.904
               PI (        )         12+988.106   1001107.104    647
419.141
               CC (        )                       999240.631    645
487.942
               PT (        )         13+276.264   1000877.665    647
597.212
                     Radius:           2670.000
                      Delta:       12^24'57.71" Right
  Degree of Curvature(Arc):        2^08'45.27"
                     Length:            578.591
                    Tangent:            290.433
                      Chord:            577.459
            Middle Ordinate:             15.657
                   External:             15.750
          Tangent Direction:   S 50^13'53.69" E
           Radial Direction:   S 39^46'06.31" W
            Chord Direction:   S 44^01'24.83" E
           Radial Direction:   S 52^11'04.02" W
          Tangent Direction:   S 37^48'55.98" E

Elements are not collinear

Element: Linear
               PT (        )         13+276.264   1000877.665    647
597.212
               PI (        )         13+452.136   1000750.147    647
718.333
          Tangent Direction:   S 43^31'34.11" E
             Tangent Length:            175.873

Element: Linear
               PI (        )         13+452.136   1000750.147    647
718.333
               PI (        )         15+064.658    999476.273    648
707.004
          Tangent Direction:   S 37^48'55.98" E
             Tangent Length:           1612.521

Element: Linear
               PI (        )         15+064.658    999476.273    648
707.004
```

```
              PC (        )          15+240.531    999327.296    648
800.476
         Tangent Direction:   S 32^06'17.84" E
            Tangent Length:            175.873

Elements are not collinear

Element: Circular
              PC (        )          15+240.531    999327.296    648
800.476
              PI (        )          15+579.596    999059.438    649
008.364
              CC (        )                       1001123.742    651
115.143
              PT (        )          15+915.658    998846.138    649
271.933
                     Radius:           2930.000
                      Delta:       13^12'07.33" Left
  Degree of Curvature(Arc):        1^57'19.75"
                     Length:            675.128
                    Tangent:            339.065
                      Chord:            673.635
             Middle Ordinate:             19.424
                   External:             19.553
         Tangent Direction:   S 37^48'55.98" E
          Radial Direction:   S 52^11'04.02" W
           Chord Direction:   S 44^24'59.64" E
          Radial Direction:   S 38^58'56.69" W
         Tangent Direction:   S 51^01'03.31" E

Element: Linear
              PT (        )          15+915.658    998846.138    649
271.933
              PI (        )          16+074.719    998746.076    649
395.577
         Tangent Direction:   S 51^01'03.31" E
            Tangent Length:            159.061

Element: Linear
              PI (        )          16+074.719    998746.076    649
395.577
              PI (        )          16+250.592    998649.590    649
542.620
         Tangent Direction:   S 56^43'41.44" E
            Tangent Length:            175.873

Element: Linear
              PI (        )          16+250.592    998649.590    649
```

542.620

PI ( ) 16+872.572 998258.314 650
026.109

Tangent Direction: S 51^01'03.31" E
Tangent Length: 621.980

Element: Linear

PI ( ) 16+872.572 998258.314 650
026.109

PI ( ) 17+048.445 998134.621 650
151.135

Tangent Direction: S 45^18'25.17" E
Tangent Length: 175.873

Element: Linear

PI ( ) 17+048.445 998134.621 650
151.135

PC ( ) 17+051.914 998132.438 650
153.832

Tangent Direction: S 51^01'03.31" E
Tangent Length: 3.470

Element: Circular

PC ( ) 17+051.914 998132.438 650
153.832

PI ( ) 17+309.823 997970.193 650
354.314

CC ( ) 999865.905 651
556.684

PT ( ) 17+565.449 997857.992 650
586.537

Radius: 2230.000
Delta: 13^11'39.65" Left
Degree of Curvature(Arc): 2^34'09.54"
Length: 513.535
Tangent: 257.908
Chord: 512.401
Middle Ordinate: 14.766
External: 14.865
Tangent Direction: S 51^01'03.31" E
Radial Direction: S 38^58'56.69" W
Chord Direction: S 57^36'53.14" E
Radial Direction: S 25^47'17.04" W
Tangent Direction: S 64^12'42.96" E

Element: Linear

PT ( ) 17+565.449 997857.992 650
586.537

PI ( )	17+805.676	997753.483	650 802.839	
Tangent Direction:	S 64^12'42.96" E			
Tangent Length:	240.226			
Element: Linear				
PI ( )	17+805.676	997753.483	650 802.839	
PI ( )	17+981.549	997693.107	650 968.024	
Tangent Direction:	S 69^55'21.10" E			
Tangent Length:	175.873			
Element: Linear				
PI ( )	17+981.549	997693.107	650 968.024	
PI ( )	18+769.675	997350.238	651 677.661	
Tangent Direction:	S 64^12'42.96" E			
Tangent Length:	788.126			
Element: Linear				
PI ( )	18+769.675	997350.238	651 677.661	
PI ( )	18+869.394	997294.639	651 760.441	
Tangent Direction:	S 56^06'47.37" E			
Tangent Length:	99.719			
Element: Linear				
PI ( )	18+869.394	997294.639	651 760.441	
PI ( )	19+022.788	997206.306	651 885.848	
Tangent Direction:	S 54^50'24.99" E			
Tangent Length:	153.394			
Element: Linear				
PI ( )	19+022.788	997206.306	651 885.848	
POE ( )	19+040.980	997199.832	651 902.849	
Tangent Direction:	S 69^09'04.91" E			
Tangent Length:	18.192			

APPENDIX No. 17

Option Contractor Hill

Volume, timeline, and cost estimates

GAILLARD CUT STRAIGHTENING

CONTRACTOR'S HILL OPTION - VOLUME CHART

Excavation for Panamax Vessels

Post-Panamax

Area	Station (Align. in use) (m)	Total Excavation (10.36m PLD) (m^3)	Dry Excavation (m^3)	Underwater Excavation (m^3)	Additional Dredging 10.36 - 9.75 (m^3)	Additional Blasting 9.75 - 7.92 (m^3)	Additional Blasting 7.92-5.94 (m^3)	Additional Dredging from 9.75-8.38 (m^3)	Additional Dredging 8.38-7.77 (m^3)
1. Gamboa	44K+940 @ 50K+950	2,158,154	316,400	1,841,754	152,265	453,508	490,681	314,694	151,169
2. Obispo & Cascadas	@ 55K+150	8,216,775	3,850,008	4,366,767	197,969	588,582	636,826	1,389,439	196,194
Sub-total		**10,374,929**	**4,166,408**	**6,208,521**	**350,234**	**1,042,090**	**1,127,507**	**1,704,133**	**347,363**
3. North La Pita	53K+760 @ 55K+550	2,706,344	1,739,073	967,272	39,821	119,463	129,255	126,067	39,821
4. South La Pita	@ 57K+070	4,614,233	3,505,790	1,108,443	41,393	124,180	134,359	126,279	93,965
Sub-total		**7,320,578**	**5,244,863**	**2,075,714**	**81,214**	**243,643**	**263,614**	**252,346**	**133,786**
5. Lirio	56K+440 @ 58K+680	7,920,930	5,611,524	2,309,406	120,831	252,280	272,959	361,015	84,093
6. Hodges	@ 60K+020	7,135,778	5,745,528	1,390,250	61,958	151,268	163,667	184,609	50,422
7 Contractor & Escobar	@ 61K+240	8,125,100	6,433,346	1,691,754	80,293	184,674	199,811	247,441	61,558
8 Goyo & Cartagena	@ 63K+440	3,775,773	2,117,505	1,658,268	74,742	181,852	196,758	251,514	60,617
Sub-total		**26,957,581**	**19,907,903**	**7,049,678**	**337,824**	**770,074**	**833,195**	**1,044,579**	**256,690**
Total		***44,653,087***	***29,319,174***	***15,333,913***	***769,272***	***2,055,807***	***2,224,316***	***3,001,058***	***737,839***

GAILLARD CUT STRAIGHTENING (CONTRACTOR'S HILL OPTION)
PROJECT COST

	Dry Excavation		Land-based Dredging		Underwater Dredging		From elev. 27.5 m to 5.94 m: Land-based Drilling		From elev. 27.5 m to 5.94 m: Underwater Drilling		Total
Project											
U/C West		$4.50		$8.50		$11.00		$4.50		$7.60	
U/C East				$8.50							
1. Gamboa	316,400	$1,423,800	0	$0	1,994,019	$21,934,209	2,468,095	$11,106,426	470,113	$3,572,861	**$38,037,296**
2. Obispo & Casc	3,850,008	$17,325,036	1,369,421	$11,640,077	3,195,315	$35,148,467	4,863,721	$21,886,744	926,423	$7,040,815	**$93,041,139**
3. North La Pita	1,739,073	$7,825,827	302,128	$2,568,087	704,965	$7,754,614	1,054,881	$4,746,966	200,930	$1,527,066	**$24,422,561**
4. South La Pita	3,505,790	$15,776,057	344,951	$2,932,082	804,885	$8,853,737	1,183,034	$5,323,655	225,340	$1,712,583	**$34,598,114**
5. Lirio	5,611,524	$25,251,858	729,071	$6,197,104	1,701,166	$18,712,825	2,482,600	$11,171,699	472,876	$3,593,859	**$64,927,345**
6. Hodges	5,745,528	$25,854,876	0	$0	1,452,208	$15,974,285	1,484,400	$6,679,800	282,743	$2,148,846	**$50,657,806**
7. Contractor	6,433,346	$28,950,057	0	$0	1,772,047	$19,492,517	1,811,487	$8,151,691	345,045	$2,622,343	**$59,216,608**
8. Cartagena	2,117,505	$9,528,773	519,903	$4,419,176	1,213,107	$13,344,177	1,773,761	$7,981,924	337,859	$2,567,730	**$37,841,779**
Total Volume	**29,319,174**		**3,265,474**		**12,837,712**		**17,121,979**		**3,261,329**		***$402,742,649***
Total		**$131,936,284**		**$27,756,525**		**$141,214,832**		**$77,048,906**		**$24,786,103**	***$402,742,649***

Land-based dredging = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD)*0.3
Dredging = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD)*0.7
Land-based drilling = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.84
Underwater drilling = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.16

(a) **$463,154,046**

Notes: It is assumed that material transportation distances would be 5.0 km for the east side and 3.0 km for the west
It is assumed that 30% of the dredging work would be land-based and 70% underwater

(a) Miscellaneous expenses (signaling, preparation of disposal sites) and contingencies

GAILLARD CUT STRAIGHTENING (CONTRACTOR'S HILL OPTION)
SCHEDULE FOR PROJECT ACTIVITIES

											From elev. 27.5 m to 5.94 m					
	Dry excavation	Production	Unit	Time (wks.)	Land-based dredging	Prod (BCM/wks)	Time (wks.)	Underwater dredging	Prod. (BCM/wks.)	Time(wks.)	Land-based drilling	Production (BCM/wks)	Time (wks.)	Underwater drilling	Prod (BCM/wks)	Time (wks.)
Project																
U/C West																
U/C East																
1. Gamboa	316,400	25,000	BCM/sem.	13	0	25,000	0	1,994,019	30,000	66	2,468,095	235,000	45	470,113	30,000	16
2. Obispo & Casc.	3,850,008	150,000	BCM/mes	111	1,369,421	25,000	55	3,195,315	30,000	107	4,863,721	235,000	90	926,423	30,000	31
3. North La Pita	1,739,073	150,000	BCM/mes	50	302,128	25,000	12	704,965	30,000	23	1,054,881	235,000	19	200,930	30,000	7
4. South La Pita	3,505,790	150,000	BCM/mes	101	344,951	25,000	14	804,885	30,000	27	1,183,034	235,000	22	225,340	30,000	8
5. Lirio	5,611,524	225,000	BCM/mes	108	729,071	25,000	29	1,701,166	30,000	57	2,482,600	235,000	46	472,876	30,000	16
6. Hodges	5,745,528	150,000	BCM/mes	166	435,662	25,000	17	1,016,545	30,000	34	1,484,400	235,000	27	282,743	30,000	9
7. Contractor	6,433,346	150,000	BCM/mes	186	531,614	25,000	21	1,240,433	30,000	41	1,811,487	235,000	33	345,045	30,000	12
8. Cartagena	2,117,505	150,000	BCM/mes	61	519,903	25,000	21	1,213,107	30,000	40	1,773,761	235,000	33	337,859	30,000	11
Total Volume	**29,319,174**				**4,232,750**			**11,870,436**			**17,121,979**			**3,261,329**		

Land-based dredging = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD)*0.3
Dredging = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD)*0.7
Land-based drilling = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.84
Underwater drilling = (Underwater excv. from 27.5m to 10.36 m PLD + additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.16

Note: It is assumed that material transportation distances would be 5.0 km for the east side and 3.0 km for the west
It is assumed that 30% of the dredging work would be land-based and 70% underwater

GAILLARD CUT STRAIGHTENING

COST AND ADDITIONAL VOLUMES USING R=2800 M INSTEAD OF R= 2130 M

Area	Station (Align. in use) (m)	Total Excavation (10.36m PLD) (m^3)	Dry Excavation (m^3)	Underwater Excavation (m^3)	Additional Dredging 10.36 - 9.75 (m^3)	Additional Blasting 9.75 - 7.92 (m^3)	Additional Blasting 7.92-5.94 (m^3)
NORTH & SOUTH LA PITA (USING R=2130 M)		6,171,914	4,432,022	1,598,899	65,956	197,869	214,088
DIFFERENCE USING R=2800 M		15.7%	15.5%	23.0%	18.8%	18.8%	18.8%
EMPIRE-CARTAGENA (USING R=2130 M)		26,472,626	19,414,960	6,916,672	335,370	764,312	826,961
DIFFERENCE USING R=2800 M		1.8%	2.5%	1.9%	0.7%	0.7%	0.7%
TOTAL DIFFERENCE		**1,633,618**	**1,305,784**	**609,821**	**17,712**	**51,536**	**55,760**
TOTAL DIFFERENCE(%)		**3.7%**	**4.5%**	**4.0%**	**2.3%**	**2.5%**	**2.5%**

	U/C ($/M^3$)	VOLUME (M^3)	COST ($)
DRY EXCAVATION	4.5	1,305,784	5,876,028
LAND-BASED DREDGIN	8.5	188,260	1,600,209
UNDERWATER DREDGI	11	439,273	4,832,003
LAND DRILL. & BLAST.	4.5	617,256	2,777,654
LAND DRILL. & BLAST.	7.6	117,573	893,552
TOTAL ADDITIONAL COST		**$15,979,446**	

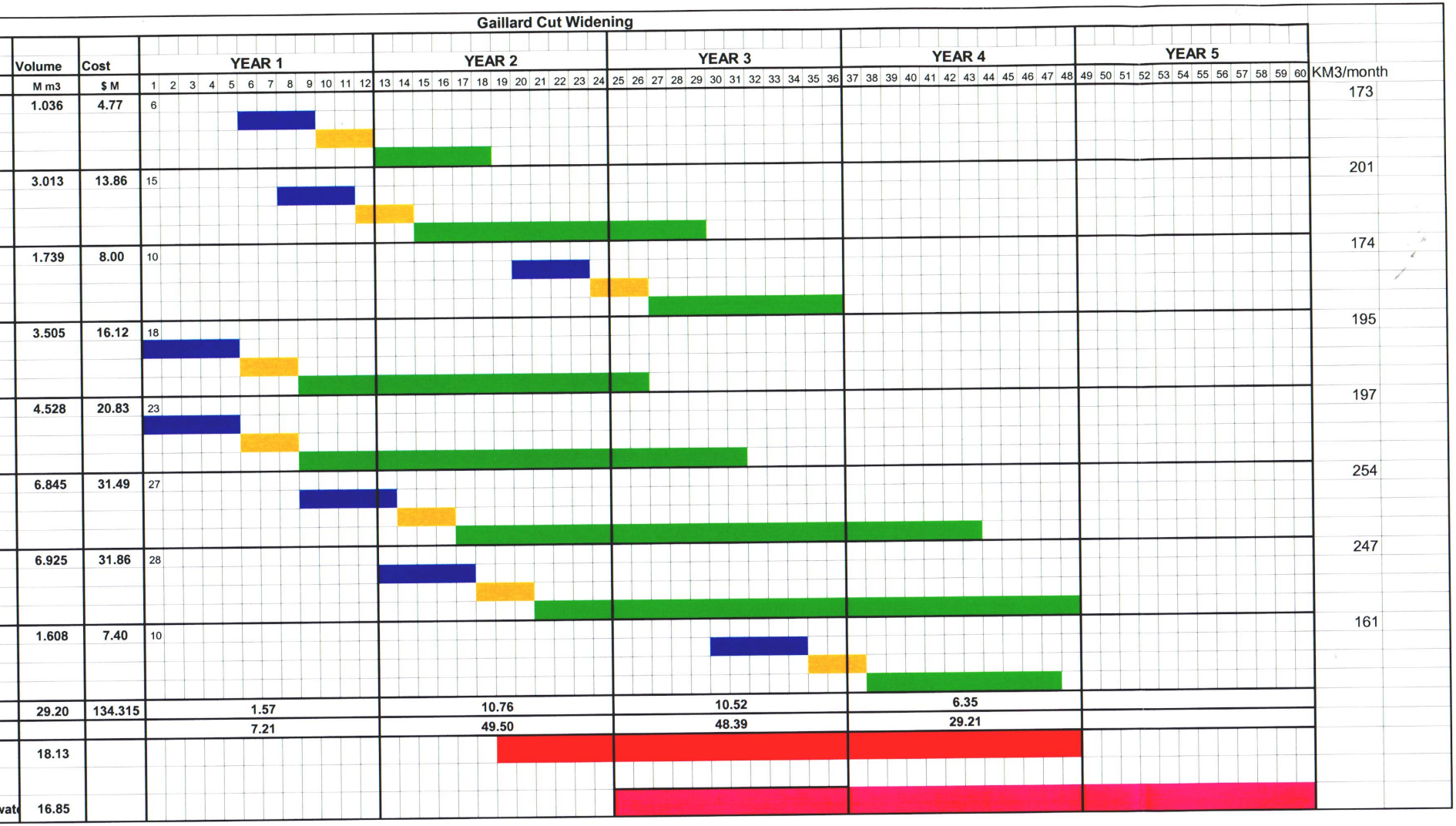
TOTAL PROJECT COST USING R= 2800 M: **$402,742,649**

ADDITIONAL COST: $15,979,446

ADDITIONAL INCREASE: **4.0%**

Gaillard Cut Widening

Project (Contractor's Hill) / Timeframe in months	Volume	Cost	KM3/month
	M m3	$ M	
Gamboa	**1.036**	**4.77**	173
Research and Design			
Bidding process			
Execution			
Obispo and Cascadas	**3.013**	**13.86**	201
Research and Design			
Bidding process			
Execution			
North La Pita	**1.739**	**8.00**	174
Research and Design			
Bidding process			
Execution			
South La Pita	**3.505**	**16.12**	195
Research and Design			
Bidding process			
Execution			
Lirio	**4.528**	**20.83**	197
Research and Design			
Bidding process			
Execution			
Hodges	**6.845**	**31.49**	254
Research and Design			
Bidding process			
Execution			
Contractor-Escobar	**6.925**	**31.86**	247
Research and Design			
Bidding process			
Execution			
Goyo-Cartagena	**1.608**	**7.40**	161
Research and Design			
Bidding process			
Execution			
Annual Dry Excavation (m3)	**29.20**	**134.315**	
Cash Flow (Dry Excv.) $ M			
Drilling and Blasting	**18.13**		
Dredging (land-based & underwat	**16.85**		



AREA SIDE Station	GAMBOA REACH TO CASCADAS REACH WEST Total Excavation (cu.m.)	Dry Excavation (cu.m.)	Underwater Excavation (cu.m.)	Add. dredging (cu.m.)	Add. Blasting 9.75-7.92 (cu.m.)	Add. Blasting 7.92-5.94 (cu.m.)	Total Dredging Post-Panamax 27.5- 8.38 (m^3)	Additional Dredging from 9.75-8.38 (m^3)	Additional Dredging 8.38-7.77 (m^3)
50K+950 to 54k+320 Obispo	6,388,745.36	3,014,178.60	3,374,566.76	124,951.60					
50K+100 to 50K+500 Mandinga	1,121,908	359889.6	762,018.40	32011.8	201721.97	218256.45	1806933		
48K+250 to 48K+920 Island	1252208.8	316400	935,808.80	35917					

APPENDIX No. 18

Option Gold Hill

Volume, timeline, and cost estimates

GAILLARD CUT STRAIGHTENING

GOLD HILL OPTION - VOLUME CHART

Excavation for Panamax vessels

Post-Panamax

Area	Station (Align. in use) (m)	Total Excavation (10.36m PLD) (m^3)	Dry Excv. (27.5m PLD) (m^3)	Underwater Excavation (m^3)	Additional Dredging 10.36 - 9.75 (m^3)	Additional Blasting 9.75 - 7.92 (m^3)	Additional Blasting 7.92-5.94 (m^3)	Additional Dredging from 9.75-8.38 (m^3)	Additional Dredging 8.38-7.77 (m^3)
1. Gamboa	44K+940 @ 50K+950	2,158,154	316,400	1,841,754	152,265	453,508	490,681	314,694	151,169
2. Obispo & Cascadas	@ 55K+150	8,216,775	3,850,008	4,366,767	197,969	588,582	636,826	1,389,439	196,194
Sub-total		**10,374,929**	**4,166,408**	**6,208,521**	**350,234**	**1,042,090**	**1,127,507**	**1,704,133**	**347,363**
3. North La Pita	53K+760 @ 55K+550	2,706,344	1,739,073	967,272	39,821	119,463	129,255	126,067	39,821
4. South La Pita	@ 57K+070	4,614,233	3,505,790	1,108,443	41,393	124,180	134,359	126,279	93,965
Sub-total		**7,320,578**	**5,244,863**	**2,075,714**	**81,214**	**243,643**	**263,614**	**252,346**	**133,786**
5. Lirio	56K+440 @ 58K+680	7,183,839	5,069,828	2,114,011	76,118	228,355	247,073	280,197	76,118
6. Hodges	@ 60K+020	2,274,609	1,881,112	393,497	15,671	47,012	50,865	126,485	15,671
7 Contractor & Escobar	@ 61K+240	2,591,479	1,982,851	608,628	22,196	66,588	72,046	116,936	22,196
8 Goyo & Cartagena	@ 63K+440	3,741,564	2,087,594	1,653,970	60,101	180,304	195,082	228,774	60,101
Sub-total		**15,791,490**	**11,021,385**	**4,770,105**	**174,086**	**522,259**	**565,065**	**752,392**	**174,086**
9.Gold Hill		3,539,385	2,782,587	616,069	20,372	61,117	66,126	93,371	20,372
Total		***37,026,382***	***23,215,243***	***13,670,409***	***625,907***	***1,869,109***	***2,022,312***	***2,802,242***	***675,608***

GAILLARD CUT STRAIGHTENING (GOLD HILL OPTION)
PROJECT COSTS

	Dry Excavation		Land-based Dredging		Underwater Dredging		From elev. 27.5 m to 5.94 m: Land-based Drilling		From elev. 27.5 m to 5.94 m: Underwater Drilling		Total
Project											
U/C West		$4.50		$8.50		$11.00		$4.50		$7.60	
U/C East				$8.50							
1. Gamboa	316,400	$1,423,800	0	$0	1,994,019	$21,934,209	2,468,095	$11,106,426	470,113	$3,572,861	**$38,037,296**
2. Obispo & Casc.	3,850,008	$17,325,036	1,369,421	$11,640,077	3,195,315	$35,148,467	4,863,721	$21,886,744	926,423	$7,040,815	**$93,041,139**
3. North La Pita	1,739,073	$7,825,827	302,128	$2,568,087	704,965	$7,754,614	1,054,881	$4,746,966	200,930	$1,527,066	**$24,422,561**
4. South La Pita	3,505,790	$15,776,057	344,951	$2,932,082	804,885	$8,853,737	1,183,034	$5,323,655	225,340	$1,712,583	**$34,598,114**
5. Lirio	5,069,828	$22,814,227	657,039	$5,584,829	1,533,090	$16,863,994	2,239,068	$10,075,805	426,489	$3,241,317	**$58,580,172**
6. Hodges	1,881,112	$8,465,002	122,750	$1,043,378	286,417	$3,150,591	425,917	$1,916,628	81,127	$616,566	**$15,192,165**
7. Contractor	1,982,851	$8,922,831	189,247	$1,608,600	441,577	$4,857,342	646,344	$2,908,548	123,113	$935,660	**$19,232,980**
8. Cartagena	2,087,594	$9,394,173	514,221	$4,370,881	1,199,850	$13,198,347	1,755,144	$7,898,148	334,313	$2,540,780	**$37,402,329**
9. Gold Hill	2,782,587	$12,521,642	190,932	$1,622,924	445,509	$4,900,595	641,495	$2,886,725	122,189	$928,640	**$22,860,527**
Total Volume	**23,215,243**		**3,690,689**		**10,605,627**		**15,277,699**		**2,910,038**		***$343,367,284***
Total		**$104,468,595**		**$31,370,858**		**$116,661,897**		**$68,749,646**		**$22,116,288**	***$343,367,284***

Land-based dredging = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD)*0.3

Dredging = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD)*0.7

Land-based drilling = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.84

Underwater drilling = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.16

$394,872,377

Note: It is assumed that material transportation distances would be 5.0 km for the East side and 3.0 km for the West
It is assumed that 30% of the dredging work would be land-based and 70% underwater

GAILLARD CUT STRAIGHTENING (GOLD HILL OPTION)
SCHEDULE OF PROJECT ACTIVITIES

											From elev. 27.5 m to 5.94 m					
	Dry excavation	Production	Unit	Time (wks.)	Land-based dredging	Prod (BCM/wks)	Time (wks.)	Underwater dredging	Prod. (BCM/wks)	Time (wks.)	Land-based drilling	Production (BCM/wks)	Time (wks.)	Underwater drilling	Prod (BCM/wks)	Time (wks.)
Project																
1. Gamboa	316,400	25,000	BCM/wks.	13	0	25,000	0	1,994,019	30,000	66	2,468,095	235,000	45	470,113	30,000	16
2. Obispo & Casc.	3,850,008	150,000	BCM/mth	111	1,369,421	25,000	55	3,195,315	30,000	107	4,863,721	235,000	90	926,423	30,000	31
3. North La Pita	1,739,073	150,000	BCM/mth	50	302,128	25,000	12	704,965	30,000	23	1,054,881	235,000	19	200,930	30,000	7
4. South La Pita	3,505,790	150,000	BCM/mth	101	344,951	25,000	14	804,885	30,000	27	1,183,034	235,000	22	225,340	30,000	8
5. Lirio	5,069,828	225,000	BCM/mth	98	657,039	25,000	26	1,533,090	30,000	51	2,239,068	235,000	41	426,489	30,000	14
6. Hodges	1,881,112	150,000	BCM/mth	54	122,750	25,000	5	286,417	30,000	10	425,917	235,000	8	81,127	30,000	3
7. Contractor	1,982,851	150,000	BCM/mth	57	189,247	25,000	8	441,577	30,000	15	646,344	235,000	12	123,113	30,000	4
8. Cartagena	2,087,594	150,000	BCM/mth	60	514,221	25,000	21	1,199,850	30,000	40	1,755,144	235,000	32	334,313	30,000	11
9. Gold Hill	2,782,587	150,000	BCM/mth	80	190,932	25,000	8	445,509	30,000	15	641,495	235,000	12	122,189	30,000	4
Total Volume	**23,215,243**				**3,690,689**			**10,605,627**			**15,277,699**			**2,910,038**		

Land-based dredging = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD)*0.3
Dredging = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD)*0.7
Land-based drilling = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.84
Underwater drilling = (Underwater excv. from 27.5m to 10.36 m PLD + Additional dredging from 10.36 m to 9.75m PLD + Sub-blasting from 9.75 m to 7.92 m PLD)*0.16

Note: It is assumed that material transportation distances would be 5.0 km for the East side and 3.0 km for the West
It is assumed that 30% of the dredging work would be land-based and 70% underwater

GAILLARD CUT STRAIGHTENING (GOLD HILL OPTION)

ADDITIONAL COSTS AND VOLUMES USING R=2800 M INSTEAD OF R= 2130 M

Area	Station (Align. in use (m)	Total Excavation (10.36m PLD) (m^3)	Dry Excavation (m^3)	Underwater Excavation (m^3)	Additional Dredging 10.36 - 9.75 (m^3)	Additional Blasting 9.75 - 7.92 (m^3)	Additional Blasting 7.92-5.94 (m^3)
N. & S. LA PITA (USING R=2130 M)		6,171,914	4,432,022	1,598,899	65,956	197,869	214,088
DIFFERENCE USING R=2800 M		15.7%	15.5%	23.0%	18.8%	18.8%	18.8%
EMPIRE-CARTAGENA (USING R=2130 M)		15,751,226	10,973,694	4,777,532	175,185	525,556	568,632
DIFFERENCE USING R=2800 M		41.6%	44.9%	32.2%	31.8%	31.8%	31.8%
GOLD HILL (USING R=2130 M)		2,939,026	2,574,176	364,850	17,802	53,408	57,786
DIFFERENCE USING R=2800 M		17.0%	7.5%	40.8%	12.6%	12.6%	12.6%
TOTAL DIFFERENCE		**1,789,287**	**1,068,943**	**720,607**	**16,730**	**50,186**	**54,299**
TOTAL DIFFERENCE (%)		**4.0%**	**3.6%**	**4.7%**	**2.2%**	**2.4%**	**2.4%**

	U/C ($/M^3$)	VOLUME (M^3)	COST ($)
DRY EXCAVATION	4.5	1,068,943	4,810,246
LAND-BASED DREDGIN(	8.5	221,201	1,880,210
UNDERWATER DREDGI	11	516,136	5,677,496
LAND DRILL. & BLST	3.5	707,131	2,474,958
LAND DRILL. & BLST	7.6	134,692	1,023,656
TOTAL ADDITIONAL COST		**$15,866,566**	

TOTAL PROJECT COST USING R= 2800 M:

$343,367,284

ADDITIONAL COST: $15,866,566

COMPARED TO PROJECT USING R=2130M

ADDITIONAL INCREASE:

4.6%

APPENDIX No. 19

Gaillard Cut Post-Panamax Widening Program

Gantt Chart

GANT-PROFUNDIZACIÓN & AMPLIACIÓN - Opción 14

CERRO CONTRATISTA

Cash Flow

Proyecto de Profundización de 37' @ 26' PLD	2003	2004	2005	2006	2007	2008	2009	2010	Total
PROYECTO DE AMPLIACIÓN-CERRO CONTRATISTA									
Mantenimiento Thor									
Mantenimiento RMC									
Mantenimiento Draga Mindi									
1)GAMBOA									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA		$1,423,800.00							
PERFORACIÓN Y VOLADURA TIERRA		$8,157,359.47	$2,949,066.53						$1,423,800.00
LICITACIÓN									$11,106,426.00
DRAGADO DESDE TIERRA									
PERFORACIÓN ACUÁTICA (PERF. THOR)			$3,572,861.00						
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)			$8,404,790.09	$13,529,418.92					$3,572,861.00
2-OBISPO Y CASCADAS									$21,934,209.01
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA		$3,233,114.83	$7,915,556.99	$6,176,384.19					
PERFORACIÓN Y VOLADURA TIERRA			$10,830,704.23	$11,256,039.77					$17,325,036.01
LICITACIÓN									$21,886,744.00
DRAGADO DESDE TIERRA				$9,502,103.67	$2,137,973.33				
PERFORACIÓN ACUÁTICA (THOR)				$3,861,092.10	$3,179,722.90				$11,640,077.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NVA.)				$7,581,079.05	$27,567,387.95				$7,040,815.00
DRAGADO Y SEÑALIZACIÓN (MINDI)									$35,148,467.00
3-LA PITA NORTE									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA			$6,126,504.57	$1,699,322.43					
PERFORACIÓN Y VOLADURA TIERRA			$1,142,323.46	$3,604,642.54					$7,825,827.00
LICITACIÓN									$4,746,968.00
DRAGADO DESDE TIERRA				$2,568,087.00					
PERFORACIÓN ACUÁTICA (Perf. Nueva)				$1,527,066.00					$2,568,087.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)				$7,754,614.00					$1,527,066.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)									$7,754,614.00
4-LA PITA SUR									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA		$6,788,651.71	$8,987,405.29						
PERFORACIÓN Y VOLADURA TIERRA			$5,323,655.00						$15,776,057.00
LICITACIÓN									$5,323,655.00
DRAGADO DESDE TIERRA			$1,226,687.37	$1,705,394.63					
PERFORACIÓN ACUÁTICA (PERF. NUEVA)				$1,712,583.00					$2,932,082.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)				$8,853,737.00					$1,712,583.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)									$8,853,737.00
5-LIRIO									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA			$6,173,502.84	$13,202,370.53	$5,875,984.63				
PERFORACIÓN Y VOLADURA TIERRA				$4,638,336.77	$6,533,362.23				$25,251,858.00
LICITACIÓN									$11,171,699.00
DRAGADO DESDE TIERRA					$6,197,104.00				
PERFORACIÓN ACUÁTICA (PERF. NUEVA)					$3,382,612.82	$211,246.18			$6,197,104.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)					$6,112,219.68	$12,600,605.32			$3,593,859.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									$18,712,825.00
6-HODGES									
INVESTIGACIÓN Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA			$1,614,219.77	$9,712,678.29	$9,712,678.29	$4,815,299.66			
PERFORACIÓN Y VOLADURA TIERRA						$6,679,800.00			$25,854,876.01
PERFORACIÓN ACUÁTICA (PERF. NUEVA)						$2,148,846.00			$6,679,800.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)						$1,426,275.54	$14,548,010.46		$2,148,846.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									$15,974,286.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)									
7-CONSTRATISTA - ESCOBAR									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA			$27,571.48	$9,787,876.41	$9,787,876.41	$9,346,732.69			
PERFORACIÓN Y VOLADURA TIERRA						$8,151,691.00			$28,950,056.99
PERFORACIÓN ACUÁTICA (PERF. NUEVA)						$1,623,355.19	$998,987.81		$8,151,691.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)							$19,492,517.00		$2,622,343.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									$19,492,517.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)									
8-GOYO - CARTAGENA									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA				$1,334,028.22	$8,194,744.78				
PERFORACIÓN Y VOLADURA TIERRA					$7,981,924.00				$9,528,773.00
LICITACIÓN									$7,981,924.00
DRAGADO DESDE TIERRA					$2,134,431.95	$2,284,744.05			
PERFORACIÓN ACUÁTICA (PERF. NUEVA)						$2,567,730.00			$4,419,176.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)						$13,344,177.00			$2,567,730.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									$13,344,177.00
Total		$19,602,926.01	$84,094,848.62	$120,006,834.52	$98,798,022.97	$65,200,502.63	$35,039,515.27		$402,742,650.02

GANT-PROFUNDIZACIÓN & AMPLIACIÓN - Opción 15

CERRO ORO

Cash Flow

	2003	2004	2005	2006	2007	2008	2009	2010	Total
Proyecto de Profundización de 37' @ 26' PLD									
PROYECTO DE AMPLIACIÓN-CERRO ORO									
Mantenimiento Thor									
Mantenimiento RMC									
Mantenimiento Mindi									
1)GAMBOA									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA		$1,423,800.00							$1,423,800.00
PERFORACIÓN Y VOLADURA TIERRA		$7,263,250.02	$3,843,175.98						$11,106,426.00
LICITACIÓN									
DRAGADO DESDE TIERRA									
PERFORACIÓN ACUÁTICA (PERF. THOR)			$3,572,861.00						$3,572,861.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)			$8,404,790.09	$13,529,418.92					$21,934,209.01
2-OBISPO Y CASCADAS									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA		$6,388,188.95	$7,915,556.99	$3,021,290.06					$17,325,036.00
PERFORACIÓN Y VOLADURA TIERRA		$660,076.41	$12,333,006.54	$8,893,661.05					$21,886,744.00
LICITACIÓN									
DRAGADO DESDE TIERRA				$7,528,257.59	$4,111,819.41				$11,640,077.00
PERFORACIÓN ACUÁTICA (THOR)					$7,040,815.00				$7,040,815.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)				$1,278,126.07	$32,409,625.42	$1,460,715.51			$35,148,467.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)									
3-LA PITA NORTE									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA			$7,736,388.98	$89,438.02					$7,825,827.00
PERFORACIÓN Y VOLADURA TIERRA			$3,212,232.63	$1,534,733.37					$4,746,966.00
LICITACIÓN									
DRAGADO DESDE TIERRA				$2,568,087.00					$2,568,087.00
PERFORACIÓN ACUÁTICA (Perf. Nueva)				$1,527,066.00					$1,527,066.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)				$7,754,614.00					$7,754,614.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)									
4-LA PITA SUR									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA		$7,200,918.00	$8,575,139.00						$15,776,057.00
PERFORACIÓN Y VOLADURA TIERRA			$5,323,655.00						$5,323,655.00
LICITACIÓN									
DRAGADO DESDE TIERRA			$2,932,082.00						$2,932,082.00
PERFORACIÓN ACUÁTICA (PERF. NUEVA)				$1,712,583.00					$1,712,583.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)				$8,853,737.00					$8,853,737.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)									
5-LIRIO									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA			$5,686,928.30	$11,806,196.19	$5,321,102.51				$22,814,227.00
PERFORACIÓN Y VOLADURA TIERRA				$3,394,528.17	$6,681,276.83				$10,075,805.00
LICITACIÓN									
DRAGADO DESDE TIERRA					$5,584,829.00				$5,584,829.00
PERFORACIÓN ACUÁTICA (PERF. NUEVA)					$3,241,317.00				$3,241,317.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)						$16,863,994.00			$16,863,994.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									
6-HODGES									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA					$4,366,865.08	$4,098,134.92			$8,465,000.00
PERFORACIÓN Y VOLADURA TIERRA						$1,916,628.00			$1,916,628.00
LICITACIÓN									
DRAGADO DESDE TIERRA						$1,043,378.00			$1,043,378.00
PERFORACIÓN ACUÁTICA (PERF. NUEVA)						$616,566.00			$616,566.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)						$3,150,591.00			$3,150,591.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									
7-CONSTRATISTA - ESCOBAR									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA					$7,245,607.13	$1,677,223.87			$8,922,831.00
PERFORACIÓN Y VOLADURA TIERRA						$2,908,548.00			$2,908,548.00
LICITACIÓN									
DRAGADO DESDE TIERRA						$1,608,600.00			$1,608,600.00
PERFORACIÓN ACUÁTICA (PERF. NUEVA)						$935,660.00			$935,660.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)						$4,857,342.00			$4,857,342.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									
8-GOYO - CARTAGENA									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA				$626,278.20	$7,940,312.89	$827,581.91			$9,394,173.00
PERFORACIÓN Y VOLADURA TIERRA					$5,524,825.05	$2,373,322.95			$7,898,148.00
LICITACIÓN									
DRAGADO DESDE TIERRA					$237,871.07	$4,133,009.93			$4,370,881.00
PERFORACIÓN ACUÁTICA (PERF. NUEVA)						$2,540,780.00			$2,540,780.00
DRAGADO Y SEÑALIZACIÓN (DRAGA MINDI)						$12,444,155.74	$754,191.26		$13,198,347.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									
9-Gold Hill									
INVESTIGACION Y DISEÑO									
LICITACIÓN									
EJECUCIÓN DE EXCAVACIÓN SECA				$3,477,305.12	$5,934,823.64	$3,109,513.23			$12,521,641.99
PERFORACIÓN Y VOLADURA TIERRA						$2,886,725.00			$2,886,725.00
LICITACIÓN									
DRAGADO DESDE TIERRA						$1,622,924.00			$1,622,924.00
PERFORACIÓN ACUÁTICA (PERF. NUEVA)						$928,640.00			$928,640.00
DRAGADO Y SEÑALIZACIÓN (DRAGA NUEVA)						$4,900,595.00			$4,900,595.00
DRAGADO Y SEÑALIZACIÓN (DRAGA RMC)									
Total		$22,936,233.38	$69,535,816.51	$77,595,319.76	$95,641,090.03	$76,904,629.06	$754,191.26		$343,367,280.00

APPENDIX No. 20

Gaillard Cut Widening Program to 192 m

Historical Records Compiled
by
ACP Contracting Division

Cut Widening Program
Unclassified Excavation Unit Price Record

OFFERORS													
Comtract	**cu.m.**	**Govmt**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Avr**
Mandinga	107,900	7.60	2.94	12.00	7.00	8.40	9.33	6.55					**7.70**
Obispo	280,000	3.25	4.47	1.99	4.33	2.79	2.17	2.54	3.80	2.76	3.76	3.05	**3.17**
Elliot	250,000	7.70	5.35	3.19	5.67	3.58	7.47	7.50	9.00	3.75	4.73	5.79	**5.60**
Eduardo	118,700	5.78	9.72	4.15	6.30	5.84	7.31	7.59	5.00	5.43			**6.42**
Tres Pesos	305,000	7.25	4.98	7.74	9.00	4.60	3.88						**6.04**
Borinquen	345,000	3.88	3.16	3.95	3.36	4.12							**3.65**
Las Cascadas	1,181,700	2.64	2.95	2.13	2.30	3.18	3.50	2.55	2.83	2.08			**2.69**
Las Cascadas III	2,687,100	1.90	1.99	1.91	3.34	2.57	1.96						**2.35**
North La Pita	680,000	3.62	4.40	2.20	2.70	2.69	4.39						**3.28**
South La Pita I	414,000	3.75	2.50	2.92	4.50	4.95	1.77	2.69					**3.22**
South La Pita II	158,000	2.80	2.70	2.56	3.50	4.95	1.77	2.69					**3.03**
Central La Pita	2,946,805	1.99	1.98	2.50	2.50	3.23	3.50	2.70					**2.74**
Summit	1,620,000	2.19	2.25	1.90	2.55	2.15	1.69	2.55					**2.18**
Empire	2,887,500	1.65	2.80	2.20	2.47	2.33							**2.45**
Hodges	2,208,655	2.10	2.13	0.80	4.95	2.20	2.04	3.80					**2.65**
Escobar	1,220,000	2.30	3.36	3.29									**3.33**
Cartagena	2,320,911	3.53	2.80	2.58	3.81	4.40	3.15	3.79					**3.42**
												Total Avg	**3.76**
Note: Projects Gold Hill and Contrators Hill are not included in this analysis since material to be excavated is mostly hard rock. The calculated avera													
is more representative for the unclassified excavation definition of our specs documents													
Gold Hill	1,485,000	4.36	6.10	5.17									**5.64**
Contractors Hill	1,860,000	4.20	4.82	3.30	3.95	4.67							**4.19**
												Avg	**4.91**

GAILLARD CUT WIDENING PROGRAM TO 192 m (GCWP) EXCAVATION COST

Contract	Contractor	Bid Price ($)	Final Price ($)	Government Estimated ($)	Final-vs-Govt ($)		GCWP Excav. Volume	GCWP Excav. Unit Cost ($)
Obispo	Asfaltos	680,601	806,385	1,021,510	-215,125		297,000	2.72
Eduardo	Asfaltos	561,505	596,691	743,086	-146,395		124,173	4.81
Elliot	Asfaltos	866,440	981,207	2,036,415	-1,055,208		282,628	3.47
Tres Pesos	Asfaltos	1,267,940	1,540,747	2,263,524	-722,777		373,810	4.12
Cascada Phase 1 & II	Asfaltos	2,951,680	2,681,546	3,867,286	-1,185,740		995,360	2.69
South La Pita	Asfaltos	1,181,460	1,160,799	2,156,800	-996,001		560,818	2.07
Central La Pita	Asfaltos	6,191,920	6,534,377	6,117,027	417,350		3,096,893	2.11
Summit	Asfaltos	3,262,442	3,300,048	4,107,724	-807,676		1,626,000	2.03
Atlantic entrance	Asfaltos	1,147,389	1,342,977	1,501,000	-158,023			
Hodges	Asfaltos	5,065,547	7,170,234	5,103,350	2,066,884	1/	2,814,699	2.55
Contractor Hill	Asfaltos	7,044,949	6,956,113	8,950,449	-1,994,336		1,840,643	3.78
Total Asfaltos (11)		**30,221,873**	**33,071,124**	**37,868,171**	**-4,797,047**		**12,012,024**	**2.64**

1/ F. Price: Includes $2.3 mill for Remedial work

Contract	Contractor	Bid Price	Final Price	Government Estimated	Final - Govern		GCWP Excav. Volume	GCWP Excav. Unit Cost ($)
Mandinga	Aoki	1,175,000	1,105,070	1,193,560	-88,490		161,460	6.84
Borinquen	Moore Overseas	1,343,166	1,421,817	1,487,765	-65,948		315,000	4.51
Cascada Phase III	Cusa	5,222,200	4,806,556	5,407,788	-601,232		2,484,589	1.93
North La Pita	Skanska	1,931,000	1,850,430	2,715,480	-865,050		629,505	2.94
Empire	Meco-Santa Fe	7,265,490	6,838,006	5,656,779	1,181,227		2,795,396	2.45
Escobar	Meco-Santa Fe	4,902,081	4,744,168	3,644,781	1,099,387	1/	1,063,848	4.46
Gold Hill	Meco-Santa Fe	9,543,712	10,740,686	7,630,234	3,110,452		1,480,888	7.25
Cartagena	Constructora del Istmo	6,482,140	6,233,552	8,535,901	-2,302,349		2,248,545	2.77
contracts completed (8)		37,864,789	37,740,285	36,272,289	1,467,997		11,179,231	
Subtotal-- Meco-Santa Fe		21,711,283	22,322,860	16,931,794	5,391,066		5,340,132	
1 Final Price : includes claim settlement for $360 k								
Total- Others(8)		**37,864,789**	**37,740,285**	**36,272,289**			**11,179,231**	**3.38**
Total-- 19-- Projects		**68,086,662**	**70,811,409**	**74,140,459**			**23,191,255**	**3.01**

Companies that Worked in Gaillard Cut Widening Program

Companies		Bids- offers		Government estimate			bid vs govt	
Asfaltos	for 11 projects	30,221,873	44%	37,868,171	51%		-7,646,298	Asfaltos
Meco Santa Fe	for 3 projects	21,711,283	32%	16,931,794	23%		**4,779,489**	Meco
Aoki	one project	1,175,000	2%	1,193,560	2%		-18,560	Aoki
Cusa	one project	5,222,200	8%	5,407,788	7%		-185,588	Cusa
Moore Overseas	one project	1,343,166	2%	1,487,765	2%		-144,599	Moore
Skanska	one project	1,931,000	3%	2,715,480	4%		-784,480	Skanska
Constructora del Istmo	one project	6,482,140	10%	8,535,901	12%		-2,053,761	Constructora el Istmo
TOTAL COST		**68,086,662**		**74,140,459**			**-6,053,798**	

ACP Contracting Officer	**Efrain Isaza c**	**69,468,432**	**Total GCWP Cost**
	7/17/03		
		3.00	**Average GCWP unit cost**

CUT WIDENING PROGRAM

UNCLASSIFIED EXCAVATION UNIT PRICE RECORD

			OFFERORS										
Contract	cu.m.	Govmt	1	2	3	4	5	6	7	8	9	10	
Mandinga	107,900	7.60	2.94	12.00	7.00	8.40	9.33	6.55					
Obispo	280,000	3.25	4.47	1.99	4.33	2.79	2.17	2.54	3.80	2.76	3.76	3.05	
Elliot	250,000	7.70	5.35	3.19	5.67	3.58	7.47	7.50	9.00	3.75	4.73	5.79	
Eduardo	118,700	5.78	9.72	4.15	6.30	5.84	7.31	7.59	5.00	5.43			C.
Tres Pesos	305,000	7.25	4.98	7.74	9.00	4.60	3.88						
Borinquen	345,000	3.88	3.16	3.95	3.36	4.12							
Las Cascadas	1,181,700	2.64	2.95	2.13	2.30	3.18	3.50	2.55	2.83	2.08			2.69
Las Cascadas III	2,687,100	1.90	1.99	1.91	3.34	2.57	1.96						
North La Pita	680,000	3.62	4.40	2.20	2.70	2.69	4.39						
South La Pita I	414,000	3.75	2.50	2.92	4.50	4.95	1.77	2.69					
South La Pita II	158,000	2.80	2.70	2.56	3.50	4.95	1.77	2.69					
Central La Pita	2,946,805	1.99	1.98	2.50	2.50	3.23	3.50	2.70					
Summit	1,620,000	2.19	2.25	1.90	2.55	2.15	1.69	2.55					
Empire	2,887,500	1.65	2.80	2.20	2.47	2.33							
Hodges	2,208,655	2.10	2.13	0.80	4.95	2.20	2.04	3.80					
												Total avg	

Note: Projects Gold Hill and Contractors Hill are not included in this analysis since material to be excavated is mostly hard rock
The calculated average price is more representative for the unclassified excavation definition of our specs documents

Gold Hill	1,485,000	4.36	6.10	5.17							5.64
Contractors Hill	1,860,000	4.20	4.82	3.30	3.95	4.67					4.19
										Avg	4.91

← Before Escobar

9/5/47

CONSTRUCTION DIVISION
CUT WIDENING PROGRAM

STATUS REPORT FOR PROJECTS 1-9 May 11, 1995

PROJECT	ACTUAL CONTRACT PRICE $	ESTIMATED VOLUME UNCLASSIFIED EXCAVATION m^3	VOLUME EXCAVATED m^3	EXCAVATION (%) COMPLETED	OVERALL PROJECT PROGRESS (%)	COMMENTS
NO.2 OBISPO	806,385	297,000	297,000	100	100	Work accepted as completed on August 25, 1992.
NO.1 MANDINGA	1,105,070	161,460	161,460	100	100	Work accepted as completed on August 29, 1994.
NO. 4 EDUARDO	596,691	124,173	124,173	100	100	Work accepted as completed on December 30, 1992.
NO. 3 ELLIOT	981,207	282,628	282,628	100	100	Work accepted as completed on May 27, 1993.
NO.5 TRES PESOS	1,540,747	373,810	373,810	100	100	Work accepted as completed on October 15, 1993.
NO. 6 BORINQUEN	1,421,817	315,000	315,000	100	100	Work accepted as completed on June 10, 1994.
NO. 7 CASCADAS REACH PHASES I & II	2,681,546	995,360	995,360	100	100	Work Accepted as completed on January 24, 1995.
NO. 8 NORTH LA PITA	1,850,430	629,505	629,505	100	100	Work accepted as completed on January 27, 1995.
NO. 9 SOUTH LA PITA	1,160,799	560,818	560,818	100	100	Work accepted as completed on March 15, 1995.
TOTAL PROGRAM	12,144,692	3,739,754	3,739,754	92.89		

XED
1/24/03

V Contract Elev.

Mean Lake (+26)

The work in general includes clearing and grubbing; excavation of common and rock material to form new slopes and elevations shown on drawings. Excavation activities require the use of heavy equipment and/or drilling and blasting. The excavated material to be disposed of at specified spoil areas. Other work includes: construction or re-building gravel roads and associated drainage.

PROGRAM OVERVIEW

CONTRACT PROJECT NO.	PROJECT	ORIGINAL CONTRACT PRICE ($)	CONTRACTOR	DATE AWARDED	NOTICE TO PROCEED	MOBILIZATION DATE	SCHEDULED COMPLETION DATE	LIMITS SOUTH NORTH	K BENCH ELEV.
CC-2-904	NO. 2 OBISPO	680,601	ASFALTOS PANAMEÑOS	12/23/91	01/07/92	01/13/92	09/04/92	52+900 52+340	27.13
CC-2-917	NO.1 MANDINGA	1,175,000	AOKI, CO.	01/28/92	02/12/92	03/07/92	09/09/92	50+660 50+320	21
CC-2-962	NO.4 EDUARDO	561,505	ASFALTOS PANAMEÑOS	05/20/92	06/03/92	06/06/92	01/15/93	52+360 51+820	27.5
CC-2-995	NO. 3 ELLIOT	866,440	ASFALTOS PANAMEÑOS	08/05/92	08/16/92	08/24/92	05/11/93	51+820 51+420	27.4
CC-3-023	NO. 5 TRES PESOS	1,267,990	ASFALTOS PANAMEÑOS	09/22/92	10/14/92	11/16/92	07/12/93	51+420 50+940	27.4
CC-3-063	NO. 6 BORINQUEN	1,343,166	MOORE OVERSEAS CONST. COMPANY	02/26/93	04/05/93	04/02/93	02/25/94	53+380 52+800	27.5
CC-3-133	NO. 7 CASCADAS REACH PHASES I & II	2,951,680	ASFALTOS PANAMEÑOS	09/16/93	10/13/93	12/17/93	12/27/94	55+120 53+360	43.0
CC-3-174	NO. 8 NORTH LA PITA	1,931,000	SKANSKA INT. CIVIL ENG. AB.	02/08/94	03/02/94	04/04/94	01/05/95	55+600 54+880	27.5
CC-3-203	NO. 9 SOUTH LA PITA PHASES I & II	1,181,460	ASFALTOS PANAMEÑOS	03/30/94	04/19/94	11/01/94	03/15/95	56+920 56+500	27.5

CONTRACT MANAGEMENT

Cut Widening Report

STATUS REPORT No. 149 ABRIL 25, 2001

PROJECT	ACTUAL CONTRACT PRICE ($)	ESTIMATED VOLUME UNCLASSIFIED EXCAVATION (m3)	VOLUME EXCAVATED (m3)	EXCAVATION COMPLETED (%)	OVERALL PROJECT PROGRESS (%)	COMMENTS
SUB-TOTAL	12,144,692	3,739,754	3,739,754	100	100	Total of projects 1 thru 9, completed.
No. 10 CENTRAL LA PITA	6,534,377	3,096,893	3,096,893	100.00	100	Project accepted as completed on July 22, 1997.
No. 7 LAS CASCADAS PHASE III	4,806,556	2,484,589	2,484,589	100.00	100	Project accepted as completed on August 28, 1997.
No. 11 SUMMIT	3,300,048	1,626,000	1,626,000	100.00	100	Project accepted as completed on September 3, 1997.
No. 12 EMPIRE	6,838,006	2,795,396	2,795,396	100.00	100	Project accepted as completed on May 7, 1998.
No. 13 HODGES	7,170,234	2,814,699	2,814,699	100.00	100	Project accepted as completed on May 24, 1999.
No. 14 GOLD HILL	10,740,686	1,480,888	1,480,888	100.00	100	Project accepted as completed on May 18, 1999.
NO. 15 CONTRACTORS HILL	6,956,113	1,840,643	1,840,643	100.00	100	Project accepted as completed on May 24, 1999.
NO. 16 ESCOBAR	4,744,168	1,063,848	1,063,848	100.00	100	Project accepted as completed on November 6, 1998.
NO. 17 CARTAGENA	6,233,552	2,248,545	2,248,545	100.00	100	Project accepted as completed on April 23, 2001
TOTAL	69,468,432	23,191,255	23,191,255	100.00		
TOTAL PROGRAM		23,191,255	23,191,255	100.00		

CONTRACT MANAGEMENT

Cut Widening Report

Mean Lake (+26)

V Contract Elev

The work in general includes clearing and grubbing, excavation of common and rock material to form new slopes and elevations shown on drawings. Excavation activities require the use of heavy equipment and/or drilling and blasting. The excavated material to be disposed of at specified spoil areas. Other work includes construction or re-building gravel roads and associated drainage.

PROGRAM OVERVIEW

CONTRACT PROJECT No.	PROJECT	ORIGINAL CONTRACT PRICE ($)	CONTRACTOR	AWARD DATE	NOTICE TO PROCEED	MOBILIZATION DATE	SCHEDULED COMPLETION DATE	LIMITS SOUTH NORTH	CONTRACT BENCH ELEVATION
CC-3-248	No. 10 CENTRAL LA PITA PHASE I, II, II	6,191,919	ASFALTOS PANAMEÑOS, S.A.	09/20/94	10/03/94	12/22/94	02/15/97	56+560 55+380	27.50
CC-3-340	No. 7 LAS CASCADAS PHASE III	5,222,200	CONSTRUCTORA URBANA, S.A.	10/02/95	10/31/95	10/31/95	10/20/97	55+540 53+340	27.50
CC-3-341	No. 11 SUMMIT	3,262,422	ASFALTOS PANAMEÑOS, S.A.	10/02/95	11/06/95	12/11/95	04/29/97	57+740 56+800	27.50
CC-3-414	No. 12 EMPIRE	7,265,490	MECO-SANTA FE	08/27/96	09/12/96	10/18/96	04/22/98	58+660 56+740	27.50
CC-3-417	No. 13 HODGES	5,065,546	ASFALTOS PANAMEÑOS, S.A.	09/26/96	10/15/96	12/07/96	03/31/98	60+040 58+440	27.50
CC-3-454	No. 14 GOLD HILL	9,543,712	MECO-SANTA FE	03/21/97	04/07/97	07/14/97	07/21/98	60+260 58+700	27.50
CC-3-461	No. 15 CONTRACTORS HILL	7,044,949	ASFALTOS PANAMEÑOS, S.A.	05/29/97	06/18/97	05/29/97	09/18/98	60+580 60+000	27.50
CC-97-36	No. 16 ESCOBAR	4,902,081	MECO-SANTA FE	09/16/97	11/14/97	01/12/98	11/23/98	62+425 60+450	27.00
CC-99-15	No. 17 CARTAGENA	6,482,140	CONSTRUCTORA DEL ISTMO, S.A.	01/11/00	12/20/99	12/01/99	03/22/01	62+760 63+700	27.00

APPENDIX No. 21

Gaillard Cut Widening Program to 192 m

Historical Records Compiled
by
ACP Dredging Division

DREDGING DIVISION

GAILLARD CUT WIDENING PROGRAM (GCWP)

DRY EXCAVATION CONTROL

STATUS OF THE PROJECT AS OF NOVEMBER 6, 2001

CONTROL SHEET - FINAL

PROJ	SECTOR	NAME	REACH	BANK	CONTRACTOR	LENGTH	EST. BCM	REPORTED BCM	BAL.	% COMP		BID OPEN	AWARD	NOTICE	MOB	COMP	EST. WKS	REP. WKS	BAL.	% COMP.	EST. BCM / WK		REPORTED BCM / WK
1	A	MANDINGA	BAS OBISPO	WEST	AOKI CO.	340	161460	161460	0	100	1	12/20/91	1/28/92	2/12/92	3/7/92	9/9/92	15	26.5	0	100	10764.00		6092.83
5	B	TRES PESOS	BAS OBISPO	WEST	ASFALTOS PAN.	480	373810	373810	0	100	1	8/31/92	9/22/92	10/14/92	11/16/92	7/12/93	33	34	0	100	11327.58		10994.41
3	C	ELLIOT	BAS OBISPO	WEST	ASFALTOS PAN.	390	282628	282628	0	100	1	8/3/92	8/5/92	8/16/92	8/24/92	5/11/93	24	37	0	100	11776.17		7638.59
4	D	EDUARDO	BAS OBISPO	WEST	ASFALTOS PAN.	550	124173	124173	0	100	1	5/11/92	5/20/92	6/3/92	6/6/92	1/15/93	10	20.5	0	100	12417.30	MIN.	6057.22
2	E	OBISPO	BAS OBISPO	WEST	ASFALTOS PAN.	540	297000	297000	0	100	1	12/20/91	12/23/91	1/7/92	1/13/92	9/4/92	26	33	0	100	11423.08		9000.00
6	F	BORINQUEN	BAS OBISPO	WEST	MOORE OVER.	480	315000	315000	0	100	1	1/29/93	2/26/93	4/5/93	4/2/93	2/25/94	30	47	0	100	10500.00		6702.13
7	G	CASCADAS 1&2	CASCADAS	WEST	ASFALTOS PAN.	2120	995360	995360	0	100	1	8/31/93	9/16/93	10/13/93	12/17/93	12/27/94	65	53.5	0	100	15313.23		18604.86
7	G	CASCADAS 3	CASCADAS	WEST	CUSA	2120	2484589	2484589	0	100	1	7/26/95	10/2/95	10/31/95	10/31/95	8/28/97	147	104	0	100	16901.97		23890.28
8	H	N. LA PITA	CASCADAS	EAST	SKANSKA INT.	640	629505	629505	0	100	1	1/21/94	2/8/94	3/2/94	4/4/94	1/5/95	52	39	0	100	12105.87		16141.15
10	I	C. LA PITA	CUNETTE	EAST	ASFALTOS PAN.	980	3096893	3096893	0	100	1	8/17/94	9/20/94	10/3/94	12/22/94	7/22/97	137	113	0	100	22605.06		27406.13
9	J	S. LA PITA	EMPIRE	EAST	ASFALTOS PAN.	420	560818	560818	0	100	1	3/25/94	3/30/94	4/19/94	11/1/94	3/15/95	51	19	0	100	10996.43		29516.74
11	K	SUMMIT	EMPIRE	EAST	ASFALTOS PAN.	830	1626000	1626000	0	100	1	8/28/95	10/2/95	11/6/95	12/11/95	9/3/97	87	62	0	100	18689.66		26225.81
12	L	EMPIRE	EMP./CUL.	WEST	MECO STA. FE	1750	2795396	2795396	0	100	1	8/1/96	8/27/96	9/12/96	10/18/96	5/7/98	88	86	0	100	31765.86		32504.60
13	M	HODGES	CULEBRA	WEST	ASFALTOS PAN.	1050	2814699	2814699	0	100	1	9/16/96	9/26/96	10/15/96	12/7/96	5/24/99	81	83	0	100	34749.37		33912.04
14	N	GOLD HILL	CUCARACHA	EAST	MECO STA. FE	1000	1480888	1480888	0	100	1	3/7/97	3/21/97	4/7/97	7/14/97	5/18/99	126	77	0	100	11753.08		19232.31
15	O	CONTRACTOR	CUCARACHA	WEST	ASFALTOS PAN.	850	1840643	1840643	0	100	1	4/16/97	5/29/97	6/18/97	5/29/97	5/24/99	87	95	0	100	21156.82		19375.19
16	P	ESCOBAR	CUCARACHA	WEST	MECO STA. FE	1900	1063848	1063848	0	100	1	9/3/97	9/16/97	11/14/97	1/12/98	11/23/98	113	45	0	100	9414.58		23641.07
17	R	CARTAGENA	PARAISO	WEST	CONS.DEL ISTMO	800	2248545	2248545	0	100	1	8/13/99	1/11/00	12/20/99	12/1/99	3/17/01	66	63	0	100	34068.86	MAX.	35691.19
18	Q	TIE UP STA.	PARAISO	WEST	ACP	1500			0			ACP				ACP							
							VOLUME:										TIME:						Average=	19,590
							23191255	23,191,255	0	100							1238	1037.5	0	100			

NOTE: ACP PERSONNEL WILL COMPLETE WORK AT THE TIE-UP STATION.

DREDGING DIVISION

GAILLARD CUT WIDENING PROGRAM (GCWP)

LAND-BASED DREDGING CONTROL

STATUS OF THE PROJECT AS OF NOVEMBER 6, 2001

CONTROL SHEET - FINAL

PROJ	SECTOR	NAME	REACH	BANK	ESTIMATED BCM	PRODUCTION PERIOD BCM	CURRT. BCM	BALANCE BCM	% COMP	EST. START. DATE	EST. COMPLETION DATE	EST. WEEKS	CURRT. WEEKS	% COMP WEEK	ESTIMATE BCM / WK	PERIOD BCM / WK	REPORTED BCM / WK
1-6	A-F	MANDINGA	BAS OBISPO	WEST													
7	G	CASCADAS 3	CASCADAS	WEST													
8	H	N. LA PITA	CASCADAS	EAST	55688		55688		100	8/18/97	11/5/97	3.48	8	100	16000	MIN.	6961.00
10	I	C. LA PITA	CUNETTE	EAST	487270		487270		100	11/6/97	5/30/98	30.45	19	100	16000	MAX.	25645.79
9	J	S. LA PITA	EMPIRE	EAST	153152		153152		100	1/15/98	3/27/98	9.57	9	100	16000		17016.89
11	K	SUMMIT	EMPIRE	EAST	233756		233756		100	5/31/98	7/14/98	14.61	10	100	16000		23375.60
12	L	EMPIRE	EMP./CUL.	WEST	540833		540833		100			33.80	30	100	16000		18027.77
13	M	HODGES	CULEBRA	WEST	275912		275912		100	10/1/00	10/15/00	17.24	14	100	16000		19708.00
14	N	GOLD HILL	CUCARACHA	EAST													
15	O	CONTRACTOR	CUCARACHA	WEST	194427		194427		100			12.15	12	100	16000		16202.25
16	P	ESCOBAR	CUCARACHA	WEST	277029		277029		100	2/4/99	7/26/99	17.31	16	100	16000		17314.31
17	R	CARTAGENA	PARAISO	WEST	238388		238388		100	3/30/01	8/23/01	14.90	17	100	16000	0.00	14022.82
18	Q	TIE UP STA.	PARAISO	WEST	80645		80645	0	100	8/27/01	10/30/01	5.04	4	100	16000	0.00	20161.25
																Average=	17,844

Total Dredging Volume= 12,105,450

Ratio Land-based Dredging/Total Dredging	21%

VOLUME:

2,537,100	0	2,537,100	0	100

TIME:

158.57	139.00	100

7/17/039:55 AM

DREDGING DIVISION

GAILLARD CUT WIDENING PROGRAM (GCWP)

UNDERWATER DRILLING AND BLASTING CONTROL

STATUS OF THE PROJECT AS OF NOVEMBER 6, 2001

CONTROL SHEET - FINAL

PROJ	SECTOR	NAME	REACH	BANK	EST. BCM	CURRENT BCM	BALANCE BCM	% COMP	EST. START. DATE	EST. COMPL. DATE	EST. WEEKS	CURRT. WEEKS	% COMPL WEEKS	EST. BCM / WK		REPORTED BCM / WK
1-6	A-F	MANDINGA	BAS OBISPO	WEST	303416	303416		100	11/14/94	12/19/96	18.96	18	100	16000		16856.44
1-6	A-F	MANDINGA	BAS OBISPO	WEST	306971	306971		100	1/28/97	7/14/97	19.19	28	100	16000		10963.25
7	G	CASCADAS 3	CASCADAS	WEST	144577	144577		100	8/11/97	10/3/97	9.04	8	100	16000		18072.13
8	H	N. LA PITA	CASCADAS	EAST	66377	66377		100	10/4/97	11/6/97	4.15	4	100	16000		16594.25
10	I	C. LA PITA	CUNETTE	EAST	120179	120179		100	11/1/97	1/20/98	7.51	8	100	16000		15022.38
9	J	S. LA PITA	EMPIRE	EAST	36636	36636		100	11/24/97	1/20/98	2.29	4	100	16000		9159.00
11	K	SUMMIT	EMPIRE	EAST	59489	59489		100	11/7/97	11/25/97	3.72	4	100	16000		14872.25
12	L	EMPIRE	EMP./CUL.	WEST	99797	99797		100	4/20/98	8/28/98	6.24	6	100	16000		16632.83
13	M	HODGES	CULEBRA	WEST	124490	124490		100	10/26/98	12/13/98	7.78	8	100	16000		15561.25
14	N	GOLD HILL	CUCARACHA	EAST	108933	108933		100	4/3/00	6/24/00	8.00	10	100	16000		10893.30
15	O	CONTRACTOR	CUCARACHA	WEST	60129	60129		100	8/19/99	9/24/99	3.76	5	100	16000		12025.80
16	P	ESCOBAR	CUCARACHA	WEST	201006	201006		100	8/17/98	10/23/98	12.56	11	100	16000	MAX.	18273.27
17	R	CARTAGENA	PARAISO	WEST	61132	61132		100	4/27/01	9/15/01	17.71	25.43	100	16000	MIN.	2403.93
18	Q	TIE UP STA.	PARAISO	WEST	96906	96906		100	2/19/01	8/31/01	4.00	8	100	16000		12113.25
															Average=	13,532

VOLUME:

1790038	1,790,038	0	100.00

TIME:

124.90	147.43	100

*Last production blast: October 29, 2001 (Hodges Project)

DREDGING DIVISION

GAILLARD CUT WIDENING PROGRAM (GCWP)

LAND-BASED DRILLING AND BLASTING CONTROL

STATUS OF THE PROJECT AS OF NOVEMBER 6, 2001

CONTROL SHEET - FINAL

PROJ	SECTOR	NAME	REACH	BANK	EST. BCM	CURRT. DRILLED BCM	BALANCE DRILLED BCM	% COMP. DRILLED	CURRT. BLASTED BCM	BALANCE BLASTED BCM	% COMP. BLASTED	EST. START. DATE	EST. COMP. DATE	EST. WEEKS	ACTUAL WEEKS	% COMP WEEKS	EST. BCM / WK.		REPORTED BCM / WK
1-6	A-F	MANDINGA	BAS OBISPO	WEST	1131937	1131937	0	100	1131937	0	100	3/14/95	8/30/96	37.73	76	100	30000		14893.91
7	G	CASCADAS 3	CASCADAS	WEST	1559586	1559586	0	100	1559586	0	100	2/4/97	7/27/97	77.98	46	100	20000		33904.04
8	H	N. LA PITA	CASCADAS	EAST	291779	291779	0	100	291779	0	100	9/6/96	3/6/97	14.59	30	100	20000	MIN.	9725.97
10	I	C. LA PITA	CUNETTE	EAST	860632	860632	0	100	860632	0	100	10/28/96	12/29/97	43.03	59.5	100	20000		14464.40
9	J	S. LA PITA	EMPIRE	EAST	492496	492496	0	100	492496	0	100	8/25/97	1/16/98	24.62	18	100	20000		27360.89
11	K	SUMMIT	EMPIRE	EAST	439510	439510	0	100	439510	0	100	8/25/97	1/16/98	21.98	16	100	20000		27469.38
12	L	EMPIRE	EMP./CUL.	WEST	1234915	1234915	0	100	1234915	0	100	3/18/98	9/1/98	30.87	31	100	40000		39835.97
13	M	HODGES	CULEBRA	WEST	627029	627029	0	100	627029	0	100	4/1/99	12/16/99	31.35	18	100	20000		34834.94
14	N	GOLD HILL	CUCARACHA	EAST	152149	152149	0	100	152149	0	100	10/6/99	11/2/99	7.61	5	100	20000		30429.80
15	O	CONTRACTOR	CUCARACHA	WEST	643629	643629	0	100	643629	0	100	4/1/99	9/30/99	16.09	14	100	40000	MAX.	45973.50
16	P	ESCOBAR	CUCARACHA	WEST	1233216	1233216	0	100	1233216	0	100	8/31/98	3/30/99	61.66	40	100	20000		30830.40
17	R	CARTAGENA	PARAISO	WEST	390882	390882	0	100	289625	0	100	3/23/01	7/4/01	9.77	8	100	40000		36203.13
18	Q	TIE UP STA.	PARAISO	WEST	22528	22528	0	100	22528	0	100	5/15/01	6/1/01	0.56	1	100	40000		22528.00
																		Average=	28,343

VOLUME:	DRILLED:		BLASTED:		
9,080,288	9,080,288	100	8,979,031	0	100

TIME:		
377.85	362.50	100

Average from Aug. 1997 through June 2001 32829.56

7/17/0310:01 AM

DREDGING DIVISION

GAILLARD CUT WIDENING PROGRAM (GCWP)

UNDERWATER DRILLING AND BLASTING CONTROL VERSUS LAND-BASED DRILLING

STATUS OF THE PROJECT AS OF NOVEMBER 6, 2001

PROJ	SECTOR	NAME	REACH	BANK	EST. BCM	Current UNDW. D & B BCM	Subtotal of Undw. D & B per reach (BCM)	Current Land (D&B) per reach (BCM)	Subtotal of Land (D&B) per reach (BCM)	Subdrilling versus Land D & B ratio by reach (%)
1-6	A-F	MANDINGA	BAS OBISPO	WEST	306971	306971	306971	1131937	1131937	21%
7	G	CASCADAS 3	CASCADAS	WEST	144577	144577	210954	1559586	1851365	10%
8	H	N. LA PITA	CASCADAS	EAST	66377	66377		291779		
10	I	C. LA PITA	CUNETTE	EAST	120179	120179	120179	860632	860632	12%
9	J	S. LA PITA	EMPIRE	EAST	36636	36636	195922	492496	2166921	8%
11	K	SUMMIT	EMPIRE	EAST	59489	59489		439510		
12	L	EMPIRE	EMP./CUL.	WEST	99797	99797		1234915		
13	M	HODGES	CULEBRA	WEST	124490	124490	124490	627029	627029	17%
14	N	GOLD HILL	CUCARACHA	EAST	108933	108933	370068	152149	2028994	15%
15	O	CONTRACTOR	CUCARACHA	WEST	60129	60129		643629		
16	P	ESCOBAR	CUCARACHA	WEST	201006	201006		1233216		
17	R	CARTAGENA	PARAISO	WEST	61132	61132	158038	390882	413410	28%
18	Q	TIE UP STA.	PARAISO	WEST	96906	96906		22528		

VOLUME: 1,486,622

VOLUME: 9,080,288

Average= 16%

*Last production blast: October 29, 2001 (Hodges project)

7/17/0310:02 AM

GAILLARD CUT WIDENING PROGRAM TO 630' BREAKDOWN (CAPITAL)
MINDI INDICATORS IN B.C.M.
INFORMATION FROM JANUARY 1994 UNTIL SEPTEMBER 30, 2000

PROJECT	DATE	PERIOD		STATION		RUN TIME (hrs)	WAT.	RT/WATCH (hrs)	VOLUME (m3)	CM/WATCH (m3)	CM/HR	CM/Week
		FROM	TO	FROM	TO							
OBISPO	AUG.98	16-Aug-98	31-Aug-98	1735+00	1722+00	155.99	48	3.25	27,884	581	179	12,199
	SEP.98	1-Sep-98	2-Sep-98	1718+00	1722+90	28.24	6	4.71	17,817	2,969	631	62,358
TOTAL						**184.23**	**54**	**3.41**	**45,700**	**846**	**248**	**17,772**
BORINQ.	AUG.98	9-Aug-98	15-Aug-98	1735+00	1739+00	34.98	21	1.67	18,015	858	515	18,015
	OCT.98	22-Oct-98	22-Oct-98	1748+00	1751+50	10.58	3	3.53	26,005	8,668	2,458	18,203
	JAN.99	23-Jan-99	31-Jan-99	1736+00	1743+50	75.66	27	2.80	22,298	826	295	17,343
TOTAL						**121.22**	**51**	**2.38**	**66,318**	**1,300**	**547**	**27,308**
CASCADAS	OCT.97	19-Oct-97	31-Oct-97	1749+50	1753+00	139.21	36	3.87	41,338	1,148	297	24,114
	NOV.97	1-Nov-97	30-Nov-97	1753+00	1761+45	356.13	90	3.96	142,593	1,584	400	33,272
	DEC.97	1-Dec-97	31-Dec-97	1761+45	1769+50	361.20	93	3.88	160,008	1,721	443	36,131
	JAN.98	1-Jan-98	31-Jan-98	1769+50	1776+25	345.23	90	3.84	138,634	1,540	402	32,348
	FEB.98	1-Feb-98	28-Feb-98	1749+10	1758+85	320.03	84	3.81	73,229	872	229	18,307
	MAR.98	1-Mar-98	31-Mar-98	1758+85	1770+35	332.19	93	3.57	89,683	964	270	20,251
	APR.98	1-Apr-98	30-Apr-98	1770+35	1790+39	376.92	90	4.19	167,944	1,866	446	39,187
	MAY.98	1-May-98	31-May-98	1784+80	1799+95	368.11	93	3.96	108,213	1,164	294	24,435
	JUN.98	1-Jun-98	26-Jun-98	1790+79	1804+40	351.05	78	4.50	69,148	887	197	18,617
TOTAL						**2950.07**	**747**	**3.95**	**990,791**	**1,326**	**336**	**27,854**
ESCOBAR	APR.99	1-Apr-99	30-Apr-99	2009+45	2023+90	411.06	84	4.89	70,321	837	171	17,580
	MAY.99	1-May-99	23-May-99	1998+20	2024+75	366.51	93	3.94	71,790	772	196	16,211
	JUN.99	1-Jun-99	30-Jun-99	2001+40	2020+20	465.80	90	5.18	127,156	1,413	273	29,670
	JUL.99	1-Jul-99	3-Jul-99	1997+85	2029+78	336.08	93	3.61	57,946	623	172	13,084
	AUG.99	1-Aug-99	31-Aug-99	1990+80	2030+75	340.74	93	3.66	91,289	982	268	20,614
	SEP.99	1-Sep-99	3-Sep-99	1986+60	1990+00	28.50	9	3.17	6,186	687	217	14,434
	OCT.99	18-Oct-99	31-Oct-99	2025+25	2031+35	208.49	42	4.96	62,480	1,488	300	31,240
	NOV.99	1-Nov-99	30-Nov-99	2031+35	2046+40	319.34	90	3.55	71,058	790	223	16,580
	DEC.99	1-Dec-99	4-Dec-99	1989+10	2047+90	292.50	60	4.88	199,825	3,330	683	69,939
	JAN.00	1-Jan-00	8-Jan-00	1981+20	1986+80	86.08	21	4.10	78,730	3,749	915	78,730
	FEB.00	14-Feb-00	29-Feb-00	1895+85	1918+00	215.40	46	4.68	255,783	5,561	1,187	116,771
	MAR.00	1-Mar-00	21-Mar-00	1884+30	1893+25	252.05	63	4.00	119,682	1,900	475	39,894
		31-Mar-00	31-Mar-00									
TOTAL						**3322.55**	**784**	**4.24**	**1,212,246**	**1,546**	**365**	**32,471**
TIE-UP STA	DEC.99	5-Dec-99	8-Dec-99	2047+60	2049+35	99.41	21	4.73	38,516	1,834	387	38,516
		21-Dec-99	23-Dec-99									
TOTAL						**99.41**	**21**	**4.73**	**38,516**	**1,834**	**387**	**38,516**
EMPIRE	FEB.00	14-Feb-00	29-Feb-00	1895+85	1918+00	215.40	46	4.68	255,783	5,561	1,187	116,771
	MAR.00	1-Mar-00	21-Mar-00	1884+30	1893+25	252.05	63	4.00	119,682	1,900	475	39,894
	APR.00	1-Apr-00	30-Apr-00	1869+00	1888+00	276.97	84	3.30	153,182	1,824	553	38,296
	MAY.00	1-May-00	18-May-00	1859+50	1922+90	202.17	45	4.49	36,999	822	183	17,266
TOTAL						**946.59**	**238**	**3.98**	**565,647**	**2,377**	**598**	**49,910**
HODGES	MAY.00	19-May-00	31-May-00	1923+00	1927+05	167.91	39	4.31	54,509	1,398	325	29,351
	JUN.00	1-Jun-00	7-Jun-00	1927+05	1928+55	61.33	15	4.09	19,482	1,299	318	27,274
TOTAL						**229.24**	**54**	**4.25**	**73,991**	**1,370**	**323**	**28,774**

Average/week	**31,801**	**BM³/week**

GAILLARD CUT WIDENING PROJECT BREAKDOWN (CAPITAL)												
CHRISTENSEN INDICATORS IN B.C.M.												
INFORMATION FROM JANUARY 1994 UNTIL SEPTEMBER 30, 2000												
PROJECT	DATE	PERIOD		STATION		RUN TIME (hrs)	WAT.	RT/WATCH (hrs)	VOLUME (m3)	CM/WATCH	CM/HR	CM/week
		FROM	TO	FROM	TO							
MANDINGA	JUN.94	19-Jun-94	30-Jun-94	1642+00	1654+00	203	36	5.63	38,947	1,082	192	22,719
	JUL.94	1-Jul-94	31-Jul-94	1649+00	1662+50	472	84	5.62	100,458	1,196	213	25,115
	AUG.94	1-Aug-94	6-Aug-94	1652+50	1663+08	332	60	5.53	70,321	1,172	212	24,612
		8-Aug-94	11-Aug-94									
		15-Aug-94	17-Aug-94									
		23-Aug-94	24-Aug-94									
		27-Aug-94	31-Aug-94									
	SEP.94	22-Sep-94	30-Sep-94	1656+40	1661+25	39	8	4.83	5,985	748	155	15,710
	OCT.94	3-Oct-94	13-Oct-94	1642+30	1662+40	37	8	4.62	4,183	523	113	10,981
TOTAL						**1,082**	**196**	**5.52**	**219,893**	**1,122**	**203**	**23,560**
TRES P.	AUG.94	8-Aug-94	8-Aug-94	1660+05	1666+50	178	33	5.40	53,985	1,636	303	34,354
		12-Aug-94	14-Aug-94									
		17-Aug-94	22-Aug-94									
		24-Aug-94	26-Aug-94									
	JUL.95	1-Jul-95	25-Jul-94	1667+00	1673+70	375	72	5.21	111,511	1,549	297	32,524
	AUG.95	3-Aug-95	31-Aug-95	1673+00	1682+20	443	85	5.21	130,169	1,531	294	32,159
	SEP.95	1-Sep-95	19-Sep-95	1671+50	1689+55	378	75	5.04	111,206	1,483	294	31,138
		25-Sep-95	30-Sep-95									
	OCT.95	1-Oct-95	14-Oct-95	1679+45	1685+00	217	42	5.16	61,496	1,464	284	30,748
	JUN.96	10-Jun-96	30-Jun-96	1672+65	1680+00	73	15	4.89	18,290	1,219	249	25,606
	JUL.96	9-Jul-96	18-Jul-96	1672+50	1669+00	52	9	5.76	12,611	1,401	243	29,425
TOTAL						**1,716**	**331**	**5.19**	**499,268**	**1,508**	**291**	**31,676**
ELLIOT	JUL.95	26-Jul-95	31-Jul-95	1685+25	1698+80	91	18	5.05	21,191	1,177	233	24,723
	AUG.95	1-Aug-95	1-Aug-95	1698+80	1700+40	12	3	3.89	3,267	1,089	280	22,870
	SEP.95	19-Sep-95	24-Sep-95	1686+85	1689+55	85	15	5.69	22,656	1,510	266	31,719
	JUL.96	22-Jul-96	31-Jul-96	1686+00	1690+00	53	9	5.88	11,847	1,316	224	27,644
	AUG.96	5-Aug-96	24-Aug-96	1683+40	1695+00	251	48	5.23	69,374	1,445	277	30,351
	SEP.96	24-Sep-96	30-Sep-96	1685+00	1695+00	116	21	5.53	21,466	1,022	185	21,466
	OCT.96	1-Oct-96	17-Oct-96	1688+35	1694+15	229	43	5.32	56,061	1,304	245	27,379
	JAN.97	1-Jan-97	15-Jan-97	1693+50	1700+80	205	39	5.26	52,336	1,342	255	28,181
TOTAL						**1,041**	**196**	**5.31**	**258,198**	**1,317**	**248**	**27,664**
EDUARDO	AUG.95	2-Aug-95	3-Aug-95	1700+40	1704+00	25	5	5.02	6,504	1,301	259	27,316
	OCT.96	17-Oct-96	31-Oct-96	1691+95	1720+05	211	39	5.41	60,214	1,544	285	32,423
	NOV.96	10-Nov-96	30-Nov-96	1705+00	1714+50	351	68	5.16	100,702	1,481	287	31,099
	DEC.96	1-Dec-96	23-Dec-96	1700+20	1706+25	401	69	5.82	103,786	1,504	259	31,587
	JAN.97	15-Jan-97	20-Jan-97	1700+55	1719+50	117	22	5.32	36,305	1,650	310	34,655
	JUN.97	11-Jun-97	14-Jun-97	1710+20	1715+20	64	12	5.30	17,069	1,422	268	29,870
TOTAL						**1,169**	**215**	**5.44**	**324,580**	**1,510**	**278**	**31,703**

GAILLARD CUT WIDENING PROJECT BREAKDOWN (CAPITAL)												
CHRISTENSEN INDICATORS IN B.C.M.												
INFORMATION FROM JANUARY 1994 UNTIL SEPTEMBER 30, 2000												
OBISPO	OCT.96	17-Oct-96	18-Oct-96	1717+80	1720+90	26	5	5.15	8,061	1,612	313	33,856
	JAN.97	20-Jan-97	31-Jan-97	1716+00	1724+50	146	27	5.42	47,206	1,748	322	36,716
	FEB.97	1-Feb-97	23-Feb-97	1718+50	1735+80	450	81	5.56	136,977	1,691	304	35,513
		25-Feb-97	28-Feb-97									
	MAR.97	1-Mar-97	9-Mar-97	1728+00	1735+00	173	34	5.09	53,069	1,561	307	32,778
	JUN.97	28-Jun-97	28-Jun-97	1728+80	1769+00	10	3	3.39	1,924	641	189	13,466
TOTAL						**806**	**150**	**5.37**	**247,237**	**1,648**	**307**	**34,613**
BORINQ.	FEB.97	24-Feb-97	24-Feb-97	1735+80	1736+80	15	3	5.09	5,252	1,751	344	36,763
	MAR.97	9-Mar-97	18-Mar-97	1734+00	1740+00	113	21	5.37	33,130	1,578	294	33,130
		30-Mar-97	31-Mar-97									
	APR.97	17-Apr-97	30-Apr-97	1736+75	1749+95	223	42	5.31	56,824	1,353	255	28,412
	MAY.97	1-May-97	19-May-97	1735+80	1750+00	444	83	5.35	121,160	1,460	273	30,655
	JUN.97	1-Jun-97	5-Jun-97	1719+25	1750+00	85	15	5.64	14,321	955	169	20,049
TOTAL						**880**	**164**	**5.36**	**230,687**	**1,407**	**262**	**29,539**
CASCADAS	FEB.98	16-Feb-98	16-Feb-98	1770+00	1781+50	134	27	4.97	43,664	1,617	326	33,961
	MAR.98	1-Mar-98	31-Mar-98	1775+40	1786+50	360	66	5.46	146,137	2,214	406	46,498
	APR.98	1-Apr-98	3-Apr-98	1787+14	1810+30	126	23	5.50	37,374	1,625	295	34,124
	MAY.98	1-May-98	3-May-98	1808+00	1816+00	204	34	5.99	48,489	1,426	238	29,949
	JUN.98	1-Jun-98	30-Jun-98	1808+40	1819+25	415	90	4.61	110,229	1,225	265	25,720
	JUL.98	1-Jul-98	2-Jul-98	1798+75	1805+05	286	51	5.61	68,275	1,339	238	28,113
	AUG.98	1-Aug-98	18-Aug-98	1800+30	1821+00	297	54	5.50	79,053	1,464	266	30,743
TOTAL						**1,823**	**345**	**5.28**	**533,221**	**1,546**	**292**	**32,457**
NORTH LP	MAY.98	9-May-98	13-May-98	1806+40	1815+50	82	15	5.45	22,076	1,472	270	30,907
		22-May-98	26-May-98									
	AUG.98	18-Aug-98	31-Aug-98	1810+20	1820+50	218	39	5.58	56,611	1,452	260	30,483
	SEP.98	1-Sep-98	24-Sep-98	1801+50	1819+85	343	66	5.19	74,382	1,127	217	23,667
	MAY.99	27-May-99	31-May-99	1804+30	1810+00	62	12	5.16	15,115	1,260	244	26,450
	JUN.99	1-Jun-99	9-Jun-99	1810+00	1826+50	91	17	5.37	22,260	1,309	244	27,497
TOTAL						**795**	**149**	**5.34**	**190,443**	**1,278**	**239**	**26,841**
CENT. LP	APR.98	16-Apr-98	26-Apr-98	1830+75	1874+00	158	31	5.08	25,771	831	163	17,458
	MAY.98	4-May-98	8-May-98	1820+00	1848+80	74	14	5.27	15,786	1,128	214	23,679
	SEP.98	25-Sep-98	30-Sep-98	1816+00	1827+00	100	18	5.53	21,069	1,170	212	24,580
	OCT.98	1-Oct-98	31-Oct-98	1820+00	1840+00	423	78	5.43	106,779	1,369	252	28,748
	NOV.98	1-Nov-98	30-Nov-98	1826+25	1842+00	485	86	5.64	132,336	1,539	273	32,315
	DEC.98	1-Dec-98	18-Dec-98	1833+25	1917+50	249	54	4.60	71,298	1,320	287	27,727
	JAN.99	3-Jan-99	23-Jan-99	1837+80	1848+00	311	62	5.02	83,725	1,350	269	28,359
	MAR.99	25-Mar-99	27-Mar-99	1842+10	1853+45	31	9	3.40	8,427	936	276	19,664
	JUN.99	7-Jun-99	30-Jun-99	1813+05	1847+00	370	67	5.52	87,389	1,304	236	27,391
	JUL.99	1-Jul-99	23-Jul-99	1821+00	1852+10	341	67	5.09	95,969	1,432	281	30,080
	AUG.99	16-Aug-99	22-Aug-99	1846+50	1853+20	109	21	5.17	32,183	1,533	297	32,183

GAILLARD CUT WIDENING PROJECT BREAKDOWN (CAPITAL)												
CHRISTENSEN INDICATORS IN B.C.M.												
INFORMATION FROM JANUARY 1994 UNTIL SEPTEMBER 30, 2000												
TOTAL						**2,649**	**507**	**5.23**	**680,733**	**1,343**	**257**	**28,196**
SOUTH LP	APR.98	10-Apr-98	15-Apr-98	1847+00	1865+75	103	18	5.70	21,863	1,215	213	25,506
	MAR.99	5-Mar-99	24-Mar-99	1854+35	1868+25	301	58	5.19	89,282	1,539	296	32,326
	JUL.99	27-Jul-99	31-Jul-99	1861+20	1865+00	84	15	5.58	23,573	1,572	282	33,002
	AUG.99	1-Aug-99	8-Aug-99	1846+35	1864+50	315	60	5.26	96,061	1,601	305	33,621
	SEP.99	1-Sep-99	4-Sep-99	1851+50	1859+75	57	11	5.18	17,679	1,607	310	33,752
TOTAL						**860**	**162**	**5.31**	**248,458**	**1,534**	**289**	**32,208**
EMPIRE	JAN.99	30-Jan-99	31-Jan-00	1883+20	1886+65	36	7	5.14	14,229	2,033	395	42,687
	FEB.99	1-Feb-99	3-Feb-99	1886+65	1889+15	33	6	5.53	11,908	1,985	359	41,679
	APR.99	14-Apr-99	21-Apr-99	1902+20	1910+20	190	42	4.53	85,313	2,031	448	42,656
		24-Apr-99	30-Apr-99	1903+45	1910+40							
	MAY.99	1-May-99	22-May-99	1886+50	1915+00	256	61	4.20	109,771	1,800	429	37,790
	OCT.99	9-Oct-99	31-Oct-99	1907+95	1920+00	310	68	4.56	132,824	1,953	428	41,019
	NOV.99	1-Nov-99	28-Nov-99	1894+35	1910+55	422	84	5.03	177,038	2,108	419	44,260
	MAR.00	22-Mar-00	31-Mar-00	1881+60	1886+50	143	28	5.10	55,573	1,985	389	41,679
	MAY.00	12-May-00	31-May-00	1875+65	1885+30	227	40	5.66	80,672	2,017	356	42,353
TOTAL						**1,617**	**336**	**4.81**	**667,328**	**1,986**	**413**	**41,708**
ESCOBAR	SEP.99	4-Sep-99	30-Sep-99	1985+20	1997+30	394	79	4.98	143,786	1,820	365	38,222
	OCT.99	1-Oct-99	6-Oct-99	1981+25	1983+55	76	16	4.76	24,916	1,557	327	32,702
	JAN.00	16-Jan-00	31-Jan-00	2029+80	2041+00	249	47	5.31	76,885	1,636	308	34,353
	FEB.00	1-Feb-00	15-Feb-00	2018+00	2040+00	222	45	4.94	70,595	1,569	318	32,945
TOTAL						**941**	**187**	**5.03**	**316,183**	**1,691**	**336**	**35,507**
SUMMIT	APR.98	4-Apr-98	9-Apr-98	1865+75	1875+00	66	12	5.47	17,893	1,491	273	31,313
	MAY.98	18-May-98	18-May-98	1968+05	1969+50	6	1	5.67	1,221	1,221	215	25,649
	MAY.99	22-May-99	27-May-99	1866+50	1870+00	71	15	4.74	28,580	1,905	402	40,012
	JUL.99	23-Jul-99	26-Jul-99	1867+85	1871+05	60	11	5.48	16,244	1,477	269	31,012
	OCT.00	8-Oct-00	31-Oct-00	1871+00	1880+25	324	65	4.98	111,298	1,712	344	35,958
TOTAL						**527**	**104**	**5.06**	**175,237**	**1,685**	**333**	**35,384**
GOLD HILL	JUL.98	3-Jul-98	15-Jul-98	1887+75	1976+40	169	30	5.62	22,870	762	136	16,009
	NOV.99	30-Nov-99	30-Nov-99	1960+50	1962+80	16	3	5.36	4,824	1,608	300	33,771
	DEC.99	1-Dec-99	6-Dec-99	1960+85	1968+40	88	16	5.50	16,214	1,013	184	21,281
	FEB.00	16-Feb-00	29-Feb-00	1954+75	2041+50	200	41	4.87	50,595	1,234	253	25,915
	MAR.00	1-Mar-00	8-Mar-00	1961+75	1979+00	154	30	5.13	41,374	1,379	269	28,962
	APR.00	1-Apr-00	30-Apr-00	1960+00	1977+00	477	89	5.36	144,886	1,628	304	34,186
	MAY.00	1-May-00	10-May-00	1955+65	1981+95	141	27	5.21	31,847	1,180	226	24,770
	JUN.00	8-Jun-00	8-Jun-00	1960+95	1982+70	104	20	5.21	17,202	860	165	18,062
TOTAL						**1,179**	**226**	**5.22**	**329,812**	**1,459**	**280**	**30,646**
HODGES	MAR.00	16-Mar-00	21-Mar-00	1943+00	1945+75	78	16	4.86	32,916	2,057	424	43,202
	MAY.00	10-May-00	12-May-00	1940+70	1941+80	34	6	5.64	11,023	1,837	326	38,580

GAILLARD CUT WIDENING PROJECT BREAKDOWN (CAPITAL)												
CHRISTENSEN INDICATORS IN B.C.M.												
INFORMATION FROM JANUARY 1994 UNTIL SEPTEMBER 30, 2000												
	JUN.00	4-Jun-00	5-Jun-00	1939+30	1940+00	17	4	4.31	4,763	1,191	276	25,008
	SEP.00	1-Sep-00	5-Sep-00	1919+00	1943+00	341	65	5.25	110,412	1,699	323	35,672
	DEC.00	1-Dec-00	17-Dec-00	1885+70	1961+25	190	38	4.99	45,252	1,191	239	25,008
TOTAL						**660**	**129**	**5.11**	**204,366**	**1,584**	**310**	**33,269**
CONTRACTOR	JUN.00	17-Jun-00	30-Jun-00	1978+30	1984+50	209	40	5.22	59,695	1,492	286	31,340
	JUL.00	1-Jul-00	31-Jul-00	1967+60	1980+00	488	93	5.25	144,397	1,553	296	32,606
	AUG.00	1-Aug-00	31-Aug-00	1957+60	1989+40	449	83	5.41	139,145	1,676	310	35,205
	SEP.00	1-Sep-00	1-Sep-00	1959+00	1961+30	9	2	4.34	2,382	1,191	275	25,008
TOTAL						**1,155**	**218**	**5.30**	**345,618**	**1,585**	**299**	**33,294**
								Average/week	**31,771**	**BM³/week**		

APPENDIX No. 22

Land Dredge Production and Cost Estimate,

and LIEBHERR 994 Acquisition Information

Land Dredge Project
Key Dates

Date	Event
07-Sep-97	Project's official starting date at North La Pita, east bank
24-Sep-97	Start of two 8-hrs shift
14-Oct-97	Dredge operation halted due to a landslide at Central La Pita
28-Oct-97	Dredge operation reasumed once the landslide was controlled
05-Jan-98	Start of two 10-hrs shift
15-Jul-98	Operation's official completion date at the east bank
08-Aug-98	Crossing of the Liebherr Excavator from east bank to Empire at west bank
03-Feb-99	Land Dredge operation is moved from Empire to Escobar to support Mindi
27-Mar-99	Completion of the support operation for Mindi
22-Apr-99	One haul truck permanently moved from Liebher Excavator to ClamShell
19-Nov-99	Double shift for the ClamShell begins
04-Jan-00	Construction of the pit for Mindi discharge
29-Feb-00	Beginning of the support operation for the Mindi
24-May-00	Support operation halted due to a landslide at Culebra Village
20-Jun-00	Support operation at the pit reasumed once the landslide was controlled
20-Jul-00	Return to the landslide at Culebra Village
28-Jul-00	Construction of Lirio drainage

Land Dredge Project
Key Quantities

F Y	Description	Unit	Estimated	Actual	%
1998	Operation's annual production	BCM	929,866.00	1,104,719.00	118.8%
	Operation's annual cost	U.S.D.	$ 4,751,000.00	$ 4,136,821.00	87.1%
	Unit price	U.S.D. / BCM	$ 5.11	$ 3.74	-1.36
1999	Operation's annual production	BCM	860,505.00	709,106.00	82.4%
	Operation's annual cost	U.S.D.	$ 5,137,215.00	$ 3,967,262.00	77.2%
	Unit price	U.S.D. / BCM	$ 5.97	$ 5.59	-0.38
2000	Operation's annual production	BCM	668,328.00	603,866.00	90.4%
	Operation's annual cost	U.S.D.	$ 5,200,000.00	$ 3,638,870.00	70.0%
	Unit price	U.S.D. / BCM	$ 7.78	$ 6.03	-1.75
2001	Operation's annual production	BCM	408,900.00	568,428.00	139.0%
	Operation's annual cost	U.S.D.	$ 2,770,347.00	$ 1,275,925.00	46.1%
	Unit price	U.S.D. / BCM	$ 6.78	$ 2.24	-4.53
Totals	Overall Production	BCM	2,867,599.00	2,986,119.00	104.1%
	Overall Cost	U.S.D.	$ 17,858,562.00	$ 13,018,878.00	72.9%
	Overall Unit Price	U.S.D. / BCM	$ 6.23	$ 4.36	-1.87

* Production **ONLY** reflects dredged material.

* Double-Handling, slide-control, stone revetment and other excavated volumens are not included within the scope of this report.

Prepared by : V. Mirones

Updated : Jan/17/03

Land Dredge Project
Key Contracts

Liebherr-America

Purchase Details	Total	% of Acq. Cost
Acquisition cost of one (1) Hydraulic Excavator Liebherr R994 Litronic	$ 1,918,900.00	
Approximate assembly cost (EIMO + EID)	$ 120,000.00	
Reinbursement to PCC (Buy Back Option at the end of the 3rd. year)	$ 250,000.00	13%
Reinbursement to PCC (Buy Back Option at the end of the 4th. year)	$ 100,000.00	5%

Contracted Maintenance Details	Total/month	Total/year
Maintenance cost 1st. Year	$ 32,070.00	$ 384,840.00
Maintenance cost 2ndt. Year	$ 58,365.00	$ 700,380.00
Maintenance cost 3rd. Year	$ 91,881.00	$ 1,102,572.00
Maintenance cost 4th. Year	$ 70,071.00	$ 840,852.00

Miscelaneous Contract Terms	
Minimum required 6-weeks average mechanical availability	108 hrs / week or 90%
Pre-scheduled preventive maintenance overhauls	sundays; 1 day/qt.; 2 weeks/year
Penalty for target below required availability	$6,000 / % point / month
Penalty for critical failure (availability below 60%) calculated by formula based on age of equipment at the moment of failure	

Cardoze & Lindo, S.A.

Purchase Details	$/truck	Total	% of Acq. Cost
Acquisition cost of four (4) Off-Road Hauling Trucks Caterpillar 773D	$ 424,300.00	$ 1,697,200.00	
Reinbursement to PCC (Buy Back Option at the end of the 3rd. year)	$ 138,600.00	$ 554,400.00	33%
Reinbursement to PCC (Buy Back Option at the end of the 4th. year)	$ 91,575.00	$ 366,300.00	22%

Contracted Maintenance Details	$/month/truck	$/month	$/year
Maintenance cost 1st. Year	$ 11,960.00	$ 47,840.00	$ 574,080.00
Maintenance cost 2ndt. Year	$ 20,800.00	$ 83,200.00	$ 998,400.00
Maintenance cost 3rd. Year	$ 12,480.00	$ 49,920.00	$ 599,040.00
Maintenance cost 4th. Year	$ 19,240.00	$ 76,960.00	$ 923,520.00

Miscelaneous Contract Terms	
Minimum required 6-weeks average mechanical availability	96 hrs / week or 80%
Pre-scheduled preventive maintenance overhauls	sundays; 1 day/qt.; 2 weeks/year
Penalty for target below required availability	$1,200 / % point / month / truck
Penalty for critical failure (availability below 60%) calculated by formula based on age of equipment at the moment of failure	

Land Dredge Project
Equipment Details

Liebherr Excavator R994 Litronic

Maximum Dimensions	Metric System	International System
Long (from front of track to back of counterweight)	9.58 mts	31.42 ft
Width (from outside to outside of lateral stairs)	6.43 mts	21.08 ft
Height (from bottom of track to top of cabin)	7.11 mts	23.33 ft
Gooseneck	10.82 mts	35.50 ft
Stick	3.99 mts	13.08 ft
Bucket capacity (heaped)	5.69 mts3	7.45 cy
Maximum reach at ground level	17.68 mts	58.00 ft
Maximum dump height	11.58 mts	38.00 ft
Maximum digging depth	10.95 mts	35.92 ft
Maximum digging force	65,018.15 kg	143,300.00 pounds
Maximum breakout force	74,024.50 kg	163,150.00 pounds
Operating weight	229,060.80 kg	504,850.00 pounds
Operating ground pressure	2.07 kg/cm2	29.50 psi
Diesel consumption	32 gals/hour	
Engine (Cummins KTTA38-c 1350, 12 Cyl. V)	1,256 BHp @ 2,100 rpm	
Diesel tank capacity	1,030 gals	
Equipment travel speed	1.60 mph	

Caterpillar 773D Off-Road Hauling Trucks

Maximum Dimensions	Metric System	International System
Long (from front bumper to wagon back tail)	9.21 mts	29.92 ft
Width (wagon)	4.32 mts	14.17 ft
Height (from bottom of wheel to top of wagon)	4.38 mts	14.42 ft
Wagon volume capacity (heaped 2:1)	34.05 cm	44.60 cy
Wagon weight capacity	52.36 mtons	57.70 tons
Operating weight (empty)	92,558.98 kg	204,000.00 pounds
Diesel consumption	12 gals/hour	
Engine (Cat 3412E, 12 Cyl. V)	680 Hp @ 2000 rpm	
Diesel tank capacity	185 gals	
Equipment travel speed (loaded)	65 kph @ 0% slope / 5.0 kph @ 30% slope	
Transmission	7 speeds, automatic	

Land Dredge Project
General Details

Working Schedule

Two ten-hour working shift per day / six days per week	
Day shift	From 07:00 through 17:30
Night shift	From 17:30 through 03:30

Human Resources

Description	Grade	Qty. per group	Total
Three main working groups			
Group Leader	ML-11	1	3
Liebherr excavator Operator	MG-11	1	3
Crawler bulldozer Operator	MG-10	2	6
Motorgrader Operator	MG-10	1	3
Off-Road hauling truck Operator	MG-8	4	12
Helper / Flagman	MG-3	3	9
		Total	36
Three mechanical support groups			
Mechanic	MG-10	1	3
Mechanic Helper	MG-8	1	3
		Total	6
Two fuel & lub groups (partially assigned)			
Fuel Dispenser	MG-6	1	2
Helper	MG-3	1	2
		Total	4
Engineers			
Civil Engineer	NM-11	1	2
		Total	2

Equipment

Description	Quantity	Age (years)
Crawler bulldozer Caterpillar D8R	1	2
Crawler bulldozer Caterpillar D8L-53Y	1	17
Crawler bulldozer Caterpillar D7R LGP	1	3
Motorgrader Caterpillar 140H	1	3
Liebherr Excavator R994 Litronic	1	5
Off-Road Hauling Truck Caterpillar 773D	4	5
Tower floodlights Coleman, 4000 watts	4	5

General Operation

Sustained average production	Production (BCM/week)
During FY-1998	25,500
During FY-1999	16,800
During FY-2000	
During FY-2001	

Prepared by : V. Mirones

Updated : Jan/17/03

Estimated Production April 9-03

	PH 2355	Manitowoc 4600	Liebherr 996	Liebherr 996	Liebherr 994	
Maximum depth	32.7	15.2	10.7	18.3	9.1	m
	107	50	35	60	30	ft
Bucket capacity	13.75	6.1	8.8	8.8	5.7	m3
	18	8	11.5	11.5	7.5	yd3
Filling factor	0.75	0.75	0.95	0.95	0.95	
Operation factor	0.65	0.65	0.65	0.65	0.65	
Ideal depth factor	0.9	0.9	1	1	1	
Equipment availability	0.9	0.9	0.9	0.9	0.9	
Piling factor	1.25	1.25	1.25	1.25	1.25	
Time per cycle	90	60	45	50	45	sec/cycle
Estimated productivity:	174	116	313	282	203	BCM/hr
	227	152	409	368	267	BCY/hr
Days per week	6	6	6	6	6	
Hours/day	20	20	20	20	20	
Weekly production	20849	13874	37560	33804	24329	BCM/week
	27294	18196	49084	44175	32011	BCY/week

Excavation costs:				
Approximate costs per month:				
Equipment:	P&H 2355	Liebherr 996	Liebherr 994	
Depreciation	$ 35,400	$ 57,000	$ 16,700	per month
Lub & Diesel	$ 2,400	$ 35,000	$ 14,000	per month
Electricity	$ 20,900			per month
Maintenance	$ 42,900	$ 80,000	$ 32,000	per month
Sub-total:	$ 101,600	$ 172,000	$ 62,700	per month
Manual labor:				
Operators	$ 12,500	$ 12,500	$ 12,500	per month
Oilers	$ 6,250	$ 6,250	$ 6,250	per month
Sub-total:	$ 18,750	$ 18,750	$ 18,750	per month
Total	$ 120,350	$ 190,750	$ 81,450	per month
Production per week	20849	37560	24329	BCM
Weeks for 2MBCM	96	53	82	weeks
	22	12	19	months
Variable total cost	$ 2,666,212	$ 2,345,758	$ 1,546,385	
Initial movilization	$ 300,000	$ 300,000	$ 120,000	
Demobilization -Expatriation-	$ 150,000	$ 150,000	$ 120,000	
Total excavation	$ 3,116,212	$ 2,795,758	$ 1,786,385	
Incidental expenses (2%)	$ 62,324	$ 55,915	$ 35,728	
Overhead (15%)	$ 467,432	$ 419,364	$ 267,958	
Profit (10%)	$ 311,621	$ 279,576	$ 178,639	
Bonds (2%)	$ 62,324	$ 55,915	$ 35,728	
Total	$ 903,701	$ 810,770	$ 518,052	
Total exc for the project	$ 4,019,913	$ 3,606,528	$ 2,304,437	
Cost/m3	$ 2.01	$ 1.80	$ 1.15	$/BCM

Other costs:			
	Unitary cost		Total
Road maintenance	$ 0.90	per BCM	$ 1,800,000
Dump site operation and maintenance	$ 0.95		$ 1,900,000
Equipment support for excavator	$ 0.80		$ 1,600,000
Overburden excavation (20%) at $3.50	$ 0.70		$ 1,400,000
Material transportation ($0.35/BCM-Km)	$ 1.05		$ 2,100,000
Supervision, camp, etc.	$ 0.50		$ 1,000,000
Total	$ 4.90		$ 9,800,000
Incidental expenses (2%)	$ 0.10		
Overhead (15%)	$ 0.74		$ 1,470,000
Profit (10%)	$ 0.49		$ 980,000
Bonds (2%)	$ 0.10		$ 196,000
Total	$ 1.42		$ 2,842,000
Estimated costs per contract	$ 6.32	per BCM	$ 12,642,000

APPENDIX No. 23

Land-based Drilling and Blasting Gaillard Cut Widening Program to 192 m (630 ft) Productivity Record

PERFORMANCE OF DRILLING AND BLASTING OPERATIONS - GCWP (1997 - 2001)
DRILLING AND BLASTING SECTION - DREDGING DIVISION - ACP

MONTH	YEAR	PROJECTS	BORED HOLES	BLASTING BLOCKS/MONTH	DRILLED FEET	EFFECTIVE HOURS B*	AVERAGE DAYS	VOLUME (M3)	VOLUME (YD3)	UNCONF. STRESS (psi)	STRENGTH	DRILLING RATE (ft./min.)	COST	COST/m3	COST INCLUDING OVERHEAD/m³	NOTES	TOTAL COST
JANUARY	1997	NORTH LA PITA	319	2	10,771	121	20	117,820.82	154,094.71	3700	RH-3/4	1.61	$353,758.24	$2.71	$3.04	cartridges	$357,721.69
FEBRUARY	1997	NORTH LA PITA	259	2	34,530	254	19	93,852.58	122,946.88	4300	RH-3/4	2.58	$287,220.64	$1.72	$1.92		$180,615.59
MARCH	1997	CENTRAL LA PITA	312	2	32,117	203	15	112,853.97	147,838.70	2260	RH-2	3.81	$345,995.52	$1.17	$1.31	1*	$147,422.10
APRIL	1997	CENTRAL LA PITA	293	2	29,062	413	16	104,717.03	137,179.31	1650	RH-2/3	1.59	$324,925.28	$2.84	$3.18	1*	$332,737.50
MAY	1997	CENTRAL LA PITA/CASCADAS	680	5	63,138	723	20	205,928.03	269,765.72	3600	RH-3	1.58	$754,092.80	$3.37	$3.78	1*	$777,506.14
JUNE	1997	CENTRAL LA PITA	408	3	48,788	491	20	149,961.37	196,449.39	4120	RH-3/4	1.79	$452,455.68	$2.44	$2.73	1*	$409,643.59
JULY	1997	CENTRAL LA PITA	347	2	79,237	1,140	23	126,282.86	165,430.55	1840	RH-2/3	1.09	$384,809.12	$4.05	$4.54	1*	$573,174.07
AUGUST	1997	CASCADAS	1,140	8	106,038	1,564	20	476,707.02	624,466.20	3120	RH-3	1.22	$1,264,214.40	$3.14	$3.52	1*	$1,678,019.54
SEPTEMBER	1997	CASCADAS	1,154	8	75,461	1,268	13	440,670.81	577,278.76	2350	RH-2/3	1.65	$1,279,739.84	$2.55	$2.86	1*	$1,258,234.72
OCTOBER	1997	CASCADAS	1,353	9	41,977	679	11	505,250.26	661,877.84	2100	RH-2/3	2.03	$1,500,422.88	$2.12	$2.38	1*	$1,201,166.96
NOVEMBER	1997	SOUTH LA PITA / CASCADAS	1,000	7	15,649	309	8	429,365.31	562,468.56	2300	RH-2/3	2.29	$1,108,960.00	$1.64	$1.83	1*	$767,270.91
DECEMBER	1997	SUMMIT	866	6	22,027	499	9	391,221.28	512,499.88	2200	RH-2/3	1.77	$960,359.36	$2.01	$2.25	1*	$880,600.06
JANUARY	1998	SOUTH LA PITA / SUMMIT	868	6	11,557	249	10	424,696.46	556,352.36	2450	RH-2/3	1.68	$962,577.28	$1.96	$2.20	1*	$932,428.41
FEBRUARY	1998																
MARCH	1998	THERE WERE NO DRILLING OR BLASTING OPERATIONS DURING THIS PERIOD															
APRIL	1998																
MAY	1998	Empire	823	5	54,319	739	20	334,968.23	438,096.04	3060	RH-3	1.33	$912,674.08	$2.98	$3.34		$1,118,179.82
JUNE	1998	Empire	527	4	36,603	757	16	249,598.22	326,442.87	2100	RH-2/3	1.09	$584,421.92	$3.12	$3.49		$870,889.68
JULY	1998	Empire	692	5	38,722	481	18	310,034.41	405,485.76	2950	RH-3	1.53	$767,400.32	$2.35	$2.63		$815,144.87
AUGUST	1998	Empire	295	2	25,215	385	19	134,641.61	176,094.18	3100	RH-3	1.24	$327,143.20	$2.83	$3.17		$427,364.24
SEPTEMBER	1998	Empire/Escobar	769	5	44,070	799	27	318,073.47	415,999.83	2200	RH-2/3	0.74	$852,790.24	$5.27	$5.91		$1,878,366.64
OCTOBER	1998	Escobar	496	3	24,826	580	19	183,071.11	239,433.83	2150	RH-2/3	0.81	$535,660.16	$5.21	$5.84	4*	$1,069,224.77
NOVEMBER	1998	Escobar	270	2	39,120	485	13	111,548.52	145,891.34	720	RH-2	2.24	$291,589.20	$1.69	$1.90	4*	$211,434.49
DECEMBER	1998	Escobar	456	3	27,354	289	15	187,160.55	244,782.30	680	RH-2	2.27	$492,461.76	$1.68	$1.88	4*	$351,678.48

Cost/linear foot with RBD= $19.12
cost/linear foot w/o RBD= $18.62
Linear cost Tie-up Station= $12.58

MONTH	YEAR	PROJECTS	BORED HOLES	BLOCKS/MONTH	DRILLED FEET	EFFECTIVE HOURS	AVERAGE DAYS ,	VOLUME (M3)	VOLUME (YD3)	UNCONF. STRESS (psi)	STRENGTH	DRILLING RATE (ft./min.)	COST	COST/m3	COST INCLUDING OVERHEAD/m3	NOTES	
JANUARY	1999	Escobar	390	3	42,240	554	19	170,032.23	222,380.63	2150	RH-2/3	1.45	$421,184.40	$2.48	$2.78	4", 2*	$472,345.46
FEBRUARY	1999	Escobar	458	3	13,643	170	10	221,923.85	290,248.30	680	RH-2	2.89	$494,621.68	$1.12	$1.25	4", 2*	$277,521.02
MARCH	1999	Escobar/Hodges	647	4	33,575	400	8	312,092.84	408,177.92	6500	RH-2/4	3.79	$698,734.12	$0.86	$0.96	4", 2*	$299,501.80
APRIL	1999	Hodges	483	3	34,471	477	19	248,283.88	324,723.88	720	RH-2	1.37	$521,620.68	$2.22	$2.48	4", 2*	$616,719.86
MAY	1999	Hodges/Escobar	461	3	8,368	219	9	205,981.37	269,397.55	4800	RH-3/4	1.53	$497,861.56	$2.29	$2.56	4", 2*	$527,779.99
JUNE	1999	Contractor/Hodges	235	2	16,585	296	13	139,394.90	182,310.88	4300	RH-3/4	1.56	$253,790.60	$1.70	$1.90	4", 2*	$264,838.40
JULY	1999	Contractor/Hodges	366	2	36,403	718	18	177,567.10	232,235.29	4450	RH-3/4	1.02	$395,265.36	$3.17	$3.55	4", 2*	$631,139.51
AUGUST	1999	Contractor	414	3	26,032	384	11	150,575.78	196,934.06	4250	RH-3/4	2.22	$447,103.44	$1.94	$2.17	4", 2*	$326,872.59
SEPTEMBER	1999	Contractor/Gold Hill	599	4	23,909	459	13	225,320.38	294,690.53	11300	RH-3/5	1.44	$646,896.04	$2.88	$3.23	4", 2*	$727,286.80
OCTOBER	1999	Gold Hill	413	3	17,122	393	16	93,661.92	122,497.93	11450	RH-3/5	0.98	$446,023.48	$7.03	$7.87	*5	$737,029.07
NOVEMBER	1999	Gold Hill	102	1				18,363.25	24,016.81	11300	RH-3/5						
DECEMBER	1999																
JANUARY	2000																
FEBRUARY	2000																
MARCH	2000																
APRIL	2000																
MAY	2000																
JUNE	2000																
JULY	2000	THERE WERE NO DRILLING OR BLASTING OPERATIONS DURING THIS PERIOD															
AUGUST	2000																
SEPTEMBER	2000																
OCTOBER	2000																
NOVEMBER	2000																
DECEMBER	2000																
JANUARY	2001																
FEBRUARY	2001																
MARCH	2001																
APRIL	2001	TIE-UP STATION	666	3	28,407	351.29	13	26,353.24	34,466.70	10400	RH-4	2.24	$251,408.34	$6.16	$6.90	6"	$181,904.24
MAY	2001	Cartagena	819	5	24,021	354.52	14	154,350.89	201,871.42	9800	RH-2/4	1.75	$884,487.24	$4.76	$5.33	3",7*	$822,524.12
JUNE	2001	Cartagena	471	3	22,102	590.91	10	102,605.16	134,194.56	1780	RH-2/3	1.35	$508,661.16	$5.33	$5.97	3", 7*	$612,085.24
JULY	2001	Cartagena	178	1				38,458.06	50,298.27	2100	RH-2/3		$192,232.86	$5.00	$5.60	3", 7*	$215,300.83
			20,079	131	1,185,458	17,793	524	7,693,388.77	10,069,339.75			1.70	$21,403,562.90				$22,971,853.19

7,506,228.22

Pondered average cost per m³= $3.06

Notes:
1. The price of explosives bought in bulk in the years 1997 and 1998 was $0.38/lb
2. The price of explosives bought in bulk in the years 1999/2000 was $0.42/lb
3. The price of explosives bought in bulk in the year 2001 was $0.615/lb
4. The RBD was not called to work after the Empire project
5. Blasting at Gold Hill was designed with bottom loads and column loads with double PVC tubes
6. Cartridges used were 3 3/4"
7. Reflects the influence of logistics on the west bank and the distance

Cell: M4
Comment: RATA DE PERFORACIÓN: Es igual al producto de piés de perforación por hora, multiplicado por un factor de producción y por el factor de conversión a minutos.

DRILLING RATE: Equals the result from drilled feet per hour multiplied by a production factor and the conversion to minutes.

Cell: N4
Comment: COSTO: Es igual al costo por pié lineal del barreno por la cantidad de barrenos por proyecto,y multiplicado por la altura promedio del barreno.

COST: Equals the cost per linear foot of the bored hole by the number of bored holes per project, and multiplied by the average height of the bored hole.

Cell: O4
Comment: COSTO POR METRO CÚBICO: Es igual al costo total del proyecto dividido entre el volumen total, multiplicado por la relación de la rata promedio de perforación entre la rata de perforación del proyecto.

COST PER CUBIC METER: Equals the total cost of the project divided by the total volume, multiplied by the relation between the average drilling rate divided by the project drilling rate.

Cell: P4
Comment: COSTO POR METRO CÚBICO CON OVERHEAD: Es igual al costo unitario por proyecto, multiplicado por el factor de Overhead Divisional.(12%)

COST PER CUBIC METER INCLUDING OVERHEAD: Equals the unitary cost per project, multiplied by the divisional overhead factor (12%).

APPENDIX No. 24

Land-based Drilling and Blasting Cost Estimate

PROYECTO ENDEEZAMIENTO DE CURVAS DEL CORTE GAILLARD
PARAMETROS DE VOLADURAS Y COSTOS POR ESTIMADOS POR BLOQUE

B	C	D	E	F	G	H
Shifts	**1Shift/5 Days**	**1 Shift/5 Days**	**2 Shifts/5 Days**	**2 Shifts/ 5 Days**	**3 Shifts/5 Days**	**3 Shifts/5 Days**
Fronts	1	2	1	2	1	2
Workdays	5	5	5	5	5	5
Shifts	1	1	2	2	3	3
Equipment	2 TR; DM-45; 2 Rangers	2 TR; DM-45; 2 Rangers	2 TR; DM-45; 2 Rangers	2 TR; DM-45; 2 Rangers; P&H	2 TR; DM-45; 2 Rangers	2 TR; DM-45; 2 Rangers; P&H
Average Pattern	14'x16'	15'x17'	14'x16'	15'x17'	14'x16'	15'x17'
Work Level	PLD 90'	PLD 90'	PLD 90'	PLD 90'	PLD 90'	PLD 90'
Project Level	PLD 25.5'	PLD 25.5'	PLD 25.5'	PLD 25.5'	PLD 25.5'	PLD 25.5'
Drilling Depth (PLD-19.5')	70.5	70.5	70.5	70.5	70.5	70.5
Rock (Burden)(feet)	14	15	14	15	14	15
Spacing (feet)	16	17	16	17	16	17
Bored holes per Pattern	150	150	150	150	150	150
Bored holes per Line	11	10	11	10	11	10
Lines per Pattern	14	13	14	13	14	13
Average Length of Pattern (feet)	200	200	200	200	200	200
Bank hight (feet)	64.5	64.5	64.5	64.5	64.5	64.5
Feet of drilling/ pattern	9406	9278	9406	9278	9406	9278
Time of production/pattern (days)	9.1	17.9	4.5	7	4	6
Volume/Pattern (m^3)	55606	62377	55606	62377	55606	62377
Area/Pattern (m^2)	3272	3160	3272	3160	3272	3160
Pre-cut	2.5" h=40' @ 5'	2.5" h=40' @ 5'	2.5" h=40' @ 5'	2.5" h=40' @ 5'	2.5" h=40' @ 5'	2.5" h=40' @ 5'
Diameter of bored hole	6"	6"	6"	6"	6"	6"
Effective area/week (m^2)	1806	1768	3612	4716	4070	5305
Total Volume/week (m^3)	**30693**	**34905**	**61386**	**93080**	**69171**	**104715**
Crews	8 MG-10; 16 MG-08; 1 MS-10; 1MS-11; 4 MG-06;1 MG-11	8 MG-10;16 MG-08; 2 MS-10; 1MS-11; 4 MG-06;1 MG-11	14 MG-10; 20 MG-08; 2 MS-10; 1MS-11; 4 MG-06; MG-11	14 MG-10; 20 MG-08; 2 MS-10; 1MS-11; 4 MG-06; MG-11	18 MG-10; 24MG-08;3 MS-10; 1MS-11; 6 MG-06; 2 MG-11	21 MG-10; 30 MG-08;3 MS-10; 1MS-11; 6 MG-06; 2 MG-11
Support equipment	D-5M Tractor; D-6 Tractor; Payloader Cat 924; Payloader Cat 934; 2 diesel dispensing vehicles; 1 oiler vehicle; 2 water pumps three 4x4 vehicles, 1 oiler vehicle; diesel storage tank ; 2 portable explossives magazines, compressor.					
Explossives (estimated pounds/pattern)	116523.92	123080.88	116523.92	123080.88	116523.92	123080.88
Accesories (estimate/pattern)	Boosters 3 lbs. 286 Boosters 1 lbs. 136	Boosters 3 lbs. 294 Boosters 1 lbs. 140	Boosters 3 lbs. 286 Boosters 1 lbs. 136	Boosters 3 lbs. 294 Boosters 1 lbs. 140	Boosters 3 lbs. 286 Boosters 1 lbs. 136	Boosters 3 lbs. 294 Boosters 1 lbs. 140
Detonators (estimate/pattern)	Dual det. 422 Surface det. 28	Dual det 434 Surface det. 28	Dual det. 422 Surface det. 28	Dual det. 434 Surface det. 28	Dual det. 422 Surface det. 28	Dual det. 434 Surface det. 28
Primer chord/pattern (pre-cut)	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00
Pre-cut explossive	$1,136.70	$1,136.70	$1,136.70	$1,136.70	$1,136.70	$1,136.70
Pre-cut accessories (estimate/pattern)	$180.00	$180.00	$180.00	$180.00	$180.00	$180.00
Estimated cost of explossives/pattern	$75,740.55	$80,002.57	$75,740.55	$80,002.57	$75,740.55	$80,002.57
Cost of detonators and boosters	$5,664.86	$5,821.34	$5,664.86	$5,821.34	$5,664.86	$5,821.34
Shock Tubes/ Lead Lines	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00
Drill bits	$955.89	$942.89	$955.89	$942.89	$1,433.84	$1,414.33
Bars	$191.18	$188.58	$191.18	$188.58	$191.18	$188.58
Gravel #8 (3/8") 200 YD^3	$2,053.13	$2,053.13	$2,053.13	$2,053.13	$2,053.13	$2,053.13
Gravel #6/7 (1/2") 200 YD^3	$1,968.75	$1,968.75	$1,968.75	$1,968.75	$1,968.75	$1,968.75
PVC tubes 6" @ $120.00	$17,520.00	$17,520.00	$17,520.00	$17,520.00	$17,520.00	$17,520.00
Oils/Lubricants/Filters	$685.00	$685.00	$685.00	$685.00	$685.00	$685.00
Diesel	$8,152.62	$8,041.67	$8,152.62	$6,031.25	$10,852.62	$8,041.67
Miscellaneous equipment/Seg./Logistics	$300.00	$300.00	$300.00	$300.00	$300.00	$300.00
Cost of manual labor/pattern	$33,627.19	$35,073.85	$22,143.96	$16,381.96	$26,178.12	$22,468.32
Cost of Equipment/pattern	$35,083.06	$34,605.64	$49,115.71	$36,335.50	$55,027.11	$54,616.18
Total Costs	$183,683.92	$188,945.11	$186,233.34	$169,972.66	$199,356.84	$196,821.56
Total Costs including Logistics and Overhead costs	**$212,425.99**	**$218,318.52**	**$215,281.34**	**$197,069.38**	**$229,979.66**	**$227,140.15**
Estimated cost/volume (m^3)	$3.30	$3.03	$3.35	$2.72	$3.59	$3.16
Logistical launch portion	$0.10	$0.09	$0.10	$0.09	$0.10	$0.09
Survey services	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
Overhead costs	$0.40	$0.36	$0.40	$0.33	$0.43	$0.38
Cost of equipment transfer	$0.02	$0.02	$0.02	$0.02	$0.02	$0.01
Estimated total cost/volume (m^3)	**$3.84**	**$3.50**	**$3.89**	**$3.18**	**$4.16**	**$3.65**

Drilling index (ft./min.) 1.23
Drilling efficiency 67%

Note: (1) Total costs for shift combinations are the result of the drilling time of a pattern, with the indicated geometry, and an efficiency of 67% by the tariffs for the use of equipment calculated by the ACP, and Calculation Charts of Manual Labor and Materials.
(2) Production costs for manual labor and equipment use respond to the amount of patterns produced through every work regime and the number of fronts. For example, in 3 Shifts/5 Days and one front a pattern is drilled in 4 days, in 3 Shifts/5 Days two fronts 2 patterns are produced in 6 days.
(3) Estimated cost of the pattern geometry. A design related to local conditions is required.
(4) Description of crew positions: MG-10 Drill Operator; MG-08 Drill Operator; MS-10 Drilling Supervisor; MS-11 Mechanic Supervisor; MG-10 Heavy Equipment Mechanic; MG-08 Mechanic Helper; MG-06 Explossives Operator; MG-11 Explossives Specialist.

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PROYECTO ENDEEZAMIENTO DE CURVAS DEL CORTE GAILLARD
PARAMETROS DE VOLADURAS Y COSTOS POR ESTIMADOS POR BLOQUE

Cell: B10
Comment: La profundidad de perforación es igual a la diferencia de elevación entre el nivel de trabajo menos el nivel del proyecto, mas los 6' de sobre perforación.

The drilling depth is equal to the difference in elevation divided by the work level minus the level of the project plus the 6' of overdrilling.

Cell: B13
Comment: El número de barrenos dentro del prisma es igual a 10*13=130 barrenos, mas los barrenos del talud subacuático.

The number of bored holes within the prism is equal to 10*13=130 bored holes plus the bored holes of the underwater slope.

Cell: B16
Comment: Este valor es igual al número de líneas multiplicado por el Burden.

This value is equal to the number of lines multiplied by the burden.

Cell: B18
Comment: Este valor es igual a la suma de las perforaciones del patrón(108*G9), mas la suma de los barrenos del talud subacuático:G14*(58'+40'+30').

This value is equal to the addition of pattern drillings (108*G9) plus the addition of the underwater slope bored holes: G14*(58'+40'+30'.)

Cell: B19
Comment: Es igual al producto de pies de perforación por patrón por el número de frentes (total de pies de perforación); dividido entre el producto de la tasa de perforación en pies por hora, por el número de horas efectivas del turno, por el número de turnos, por el número de máquinas y por la eficiencia de perforación.
Se asumió el uso de 3 máquinas perforadoras

Equals the result of drilled feet per pattern by the number of fronts (total drilled feet); divided by the result of the drilling rate in feet per hour, by the number of effective shift hours, by the number of shifts, by the number of rigs and by the drilling efficiency.
The use of 3 drilling rigs was assumed.

Cell: C19
Comment: Se asumió el uso de 3 máquinas perforadoras

The use of three drilling rigs was assumed

Cell: D19
Comment: Se asumió el uso de 3 máquinas perforadoras.

The use of 3 drilling rigs was assumed

Cell: E19
Comment: Se asumió el uso de 3 máquinas perforadoras.

The use of 3 drilling rigs was assumed.

Cell: F19
Comment: Se asumió el uso de 4 máquinas perforadoras.

The use of 4 drilling rigs was assumed.

Cell: G19
Comment: Se asumió el uso de 3 máquinas perforadoras. Se adicionó una unidad al denominador como factor de seguridad.

The use of 3 drilling rigs was assumed. As a security measure, an additional unit was added to the denominator.

Cell: B20
Comment: Es igual al producto de la altura de la perforación por el burden, por el spacing, por el número de líneas por patrón.

Equals the result of the drilling height by the burden by the spacing by the number of pattern lines.

Cell: B21
Comment: Es igual al producto del largo del patrón por el ancho del mismo medido en pies cuadrados, multiplicado por el factor de conversión de pies cuadrados a metros cuadrados.

Equals the result of the pattern length by the pattern width, measured in square feet, multiplied by the conversion factor from square feet to square meters.

Cell: B24
Comment: Es igual a la relación del total de días de trabajo de los frentes en una semana, entre el número de días requeridos para perforar un patrón; multiplicado por el área de un patrón.

Equals the relation of total work days for fronts in one week, divided by the number of days required to drill a pattern, multiplied by a pattern area.

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PROYECTO ENDEEZAMIENTO DE CURVAS DEL CORTE GAILLARD
PARAMETROS DE VOLADURAS Y COSTOS POR ESTIMADOS POR BLOQUE

Cell: B25
Comment: Es igual a la relación del total de días de trabajo de los frentes en una semana, entre el número de días requeridos para perforar un patrón; multiplicado por el volumen de un patrón.

Equals the relation of total work days for the fronts in one week, divided by the number of days required to drill a pattern, multiplied by the volume of a pattern.

Cell: B30
Comment:
explosivos) del talud subacúatico.

The first term represents the pattern load column, which is equal to the depth of the bored hole minus the wad, by the linear load density (lbs/ft), by the amount of bored holes of the pattern. The second and third terms represent the load column (pounds of explossives) of the underwater slope.

Cell: B31
Comment: Cantidad promedio de reforzadores de 3 libras, por patrón.

Average amount of 3-pound boosters per pattern.

Cell: B32
Comment: Cantidad promedio de reforzadores de 1 libras, por patrón.

Average amount of 1-pound boosters per pattern.

Cell: B33
Comment: Cantidad promedio de detonadores duales, por patrón.

Average amount of dual detonators per pattern.

Cell: B34
Comment: Cantidad promedio de detonadores de superficie, por patrón.

Average amount of surface detonators per pattern.

Cell: B35
Comment: Es igual al número de barrenos de precorte por la cantidad de cordón detonante por barreno, más la cantidad de cordón detonante a lo largo del patrón. Se divide entre 1000 para determinar el número de carretes y se multiplica por el precio unitario de un carrete.

Equals the number of pre-cut bored holes by the amount of primer chord per bored hole, plus the amount of primer chord along the pattern. It is divided by 1000 to establish the number of reels and is multiplied by the unitary cost of one reel.

Cell: B36
Comment: Es igual a la cantidad de pies del precorte, dividido entre el largo del explosivo, dividido entre el número de explosivos por caja. Esto se multiplica por el peso de una caja y por el costo unitario del explosivo.

Equals the amount of pre-cut feet, divided by the length of the explossive, divided by the number of explossives per box. This is multiplied by the weight of one box and by the unitary cost of the explossives.

Cell: B38
Comment: Total de libras del explosivo, por el precio unitario por libra del explosivo.

Total pounds of explossives by the unitary cost per pound of explossives.

Cell: B39
Comment: Es igual a la suma de las cantidades de detonadores y reforzadores, por el precio unitario respectivo. Los precios unitarios corresponden a los precios investigados para el estimado de la detonación del área del Puente Centenario-AF2002.

Equals the addition of the amounts of detonators and boosters by their corresponding unitary cost. Unitary costs correspond to the prices investigated for the estimated detonation area for the Centenary Bridge-FY2002.

Cell: B41
Comment: Es igual a la longitud total de perforación, dividido entre la duración promedio esperada de una broca y multiplicado por el precio unitario promedio por broca.

Equals the total drilling length, divided by the average expected duration of a drilling bit, multiplied by the average unitary cost per drilling bit.

Cell: B42
Comment: Es igual a la longitud total de perforación, dividido entre la duración promedio esperada de una barra y multiplicado por el precio unitario promedio por barra.

Equals the total drilling length, divided by the average expected duration of a bar, multiplied by the average unitary price per bar.

Cell: B43
Comment: Es igual a la cantidad de yardas cúbicas por patrón, multiplicada por el costo unitario de una yarda cúbica de gravilla.

Equals the amount of cubic yards per pattern, multiplied by the unitary cost of a cubic yard of gravel.

Ing. Carlos A. Reyes R.
IPDI
7/17/03

PROYECTO ENDEEZAMIENTO DE CURVAS DEL CORTE GAILLARD
PARAMETROS DE VOLADURAS Y COSTOS POR ESTIMADOS POR BLOQUE

Cell: B44
Comment: Es igual a la cantidad de yardas cúbicas por patrón, multiplicada por el costo unitario de una yarda cúbica de gravilla.

Equals the amount of cubic yards per pattern, multiplied by the unitary cost of a cubic yard of gravel.

Cell: B45
Comment: El primer término es igual al producto del número de barrenos del patrón por el costo del tramo de PVC por barreno, mas la suma del número de barrenos del talud subacuático por el costo del tramo de PVC correspondiente.

The first term equals the result from the number of pattern bored holes by the cost of PVC section per bored hole, plus the addition of the number of underwater slope bored holes by the cost of the corresponding PVC section.

Cell: B47
Comment: Es igual al producto de $200 diarios por turno por máquina; multiplicado por el número de turnos, por el número de máquinas y por el tiempo de producción de un patrón. Este resultado es dividido entre el número de frentes.

Equals the result of $200 a day per shift per rig, multiplied by the number of shifts, by the number of rigs and by the time of production of a pattern. This result is then divided by the number of fronts.

Cell: B49
Comment: Es igual al producto del costo total de mano de obra de las cuadrillas listadas por hora, incluyendo prestaciones; multiplicado por el número de horas requeridas para perforar un patrón, entre el número de frentes.

Equals the result from the total cost of manual labor performed by crews listed per hour, including salaries, multiplied by the number of hours required to drill a pattern, divided by the number of fronts.

Cell: B50
Comment: Es igual al producto de la tarifa horaria de uso de equipo, la cual incluye mantenimiento; por el número de horas para perforar un patrón.

Equals the result from the hourly tariff for the use of the equipment, which includes maintenance, by the number of hours required to drill a pattern.

Cell: B52
Comment: Es igual a la suma de los costos totales de producción, mas el costo de apoyo de logística ($5500) y de topografía ($1200) por patrón, mas el overhead del costo de producción.

Equals the addition of total production costs plus the cost for logistics support ($5500) and surveys ($1200) per pattern, plus the overhead of production costs.

Cell: B53
Comment: Es igual al costo de perforación de dos patrones dividido entre el volumen de dos patrones, multiplicado por un factor de seguridad de sobre costo.

Equals the drilling cost for two patterns divided by the volume of two patterns, multiplied by an overhead security factor cost.

Cell: B54
Comment: Costo del apoyo de Logística dividido entre el volumen de un patrón.

Cost of logistics support divided by the pattern volume.

Cell: B55
Comment: Costo del apoyo de Topografía dividido entre el volumen de un patrón.

Cost of survey support divided by the volume of a pattern

Cell: B56
Comment: Corresponde al porcentage de overhead Divisional, del costo de producción de la perforación por metro cúbico.

Corresponds to the percentage of divisional overhead costs, of the production cost for the drilling per cubic meter.

Ing. Carlos A. Reyes R.
IPDI
7/17/03

APPENDIX No. 25

ACP Drill-boat THOR Productivity in Gatun Lake and Gaillard Cut Deepening to Elevation 10.4m PLD

DREDGING, AIDS TO NAVIGATION, AND CRANES DIVISION
DRILLBOAT THOR
WEEKLY PRODUCTION REPORT

WEEK		# OF	W/	HRS.	STATIONED		# OF	BITS		DEPTH		EXPLOSSIVE		PRIME C.	BITS		VOLUME		FACTOR	LOAD	PRIME C.	DEPTH	AVERAGE DEPTH		AVRG. DRILL BIT	
FROM	TO	DAYS	DAYS		FROM	TO	BLAST.	DRILL.	LOAD	FEET	MTS.	LBS.	KGS.	(FEET)	DRAGS	TRICONE	YD³	M³	(LBS/YD³)	(LBS/BIT)	(FT/BIT)	(FT/BIT.)	P/BIT	PER DAY	P/BIT	P/DAY
26/08/02	30/08/02	3	1	8	199900	200000	1	20	20	252	77	1254.00	568.80	1880	0	1	1514.52	1158.00	0.83	62.70	94.00	12.60	251.00	84.00	19.00	6.67
02/09/02	06/09/02	5	1	8	201400	201580	2	96	96	1066	325	6026.80	2733.71	9200	0	1	6406.66	4898.53	0.94	62.78	95.83	11.10	1065.00	213.20	95.00	19.20
09/09/02	13/09/02	3	1	8	201075	201780	3	38	38	505	154	2842.40	1289.29	3144	0	1	3035.05	2320.46	0.94	74.80	82.74	13.29	504.00	168.33	37.00	12.67
16/09/02	20/09/02	5	1	8	199000	201050	3	79	79	848	258	4772.80	2164.91	6725	0	1	5096.48	3896.54	0.94	60.42	85.13	10.73	847.00	169.60	78.00	15.80
23/09/02	27/09/02	5	1	8	198900	199600	3	96	96	222	68	6292.80	2854.37	9730	0	1	6671.11	5100.43	0.94	65.55	101.35	2.31	221.00	44.40	95.00	19.20
30/09/02	04/10/02	5	1	8	199300	200200	4	112	112	1280	390	7265.60	3295.62	11280	0	1	7692.80	5881.57	0.94	64.87	100.71	11.43	1279.00	256.00	111.00	22.40
07/10/02	11/10/02	0																								
14/10/02	18/10/02	4	1	8	199100	199700	4	84	84	936	285	5327.60	2416.56	8280	0	0	5625.36	4300.90	0.95	63.42	98.57	11.14	936.00	234.00	84.00	21.00
21/10/02	25/10/02	5	1	8	200800	201600	0	96	96	1234	376	7128.80	3233.57	9408	0	1	7416.34	5670.20	0.00	0.00	0.00	0.00	1233.00	0.00	95.00	0.00
28/10/02	01/11/02	2	1	8	200440	201450	2	73	73	1101	336	5251.60	2382.09	7190	2	2	5835.71	4461.72	0.90	71.94	98.49	15.08	1097.00	550.50	69.00	36.50
04/11/02	08/11/02	2	1	8	200260	201050	2	85	85	1144	349	5084.40	2306.25	8536	0	0	5571.27	4259.54	0.91	59.82	100.42	13.46	1144.00	572.00	85.00	42.50
11/11/02	15/11/02	3	1	8	198500	200700	3	80	80	1027	313	3690.60	1674.03	7480	0	0	6172.17	4718.96	0.60	46.13	93.50	12.84	1027.00	342.33	80.00	26.67
18/11/02	22/11/02	5	1	8	198000	198800	3	80	80	918	280	5206.00	2361.40	8257	1	2	5519.10	4219.65	0.94	65.08	103.21	11.48	915.00	183.60	77.00	16.00
25/11/02	29/11/02	5	1	8	200900	201700	3	92	92	1229	375	6665.2	3023.28	9250	1	0	7398.58	5656.62	0.90	72.45	100.54	13.36	1228.00	245.80	91.00	18.40
02/12/02	06/12/02	5	1	8	200700	201800	0	112	112	1424	434	8147.2	3695.51	11013	1	0	8572.48	6554.13	0.00	0.00	0.00	0.00	1423.00	0.00	111.00	0.00
09/12/02	13/12/02	5	1	8	201100	202000	3	80	80	1220	372	7045.2	3195.65	8644	1	0	7344.40	5615.20	0.96	88.07	108.05	15.25	1219.00	244.00	79.00	16.00
16/12/02	20/12/02	3	1	8	198100	202000	4	96	96	1267	386	7174.4	3254.25	9557	1	0	7627.34	5831.52	0.94	74.73	99.55	13.20	1266.00	422.33	95.00	32.00
23/12/02	27/12/02	1	1	8	197400	197500	1	24	24	229	70	1261.6	572.25	3411	1	0	1378.58	1054.00	0.92	52.57	142.13	9.54	228.00	229.00	23.00	24.00
30/12/02	03/01/03	3	3	8	197100	198100	6	216	216	2159	658	12068.8	5474.32	20386	1	1	12997.18	9937.06	0.93	55.87	94.38	10.00	2157.00	719.67	214.00	72.00
06/01/03	10/01/03	4	3	8	197500	199000	8	329	329	3543	1080	19039.8	8636.31	29661	0	0	21328.87	16307.09	0.89	57.87	90.16	10.77	3543.00	885.75	329.00	82.25
13/01/03	17/01/03	5	3	8			14	440	440	5030	1533	26460.92	12002.47	39715	0	1	30280.60	23151.18	0.87	60.14	90.26	11.43	5029.00	1006.00	439.00	88.00
20/01/03	24/01/03	2	3	8			5	200	200	3052	930	16975.88	7700.13		0	2	18373.04	14047.20	0.92	84.88	0.00	15.26	3050.00	1526.00	198.00	100.00
27/01/03	31/01/03	1	3	8			1	33	33	194	59	548.44	248.77		0	0	583.94	446.45	0.94	16.62	0.00	5.88	194.00	194.00	33.00	33.00
03/02/03	07/02/03	4	3	8			10	406	406	5558	1694	31707.2	14382.14	33618			33459.16	25581.36	0.95	78.10	82.80	13.69		1389.50		101.50
TOTAL		85	35	184			85	2967	2967	35438		197238.04	89465.68	256365	9	15	215900.74	165067.97	0.91	66.48	86.41	11.94	35414.00	416.92	2943.00	34.91

* THE COLUMN THAT READS " DRILLED FEET" CORRESPONDS TO THE TOTAL DEPTH OF BORE HOLES, AND IS MEASURED FROM THE CURRENT ROCK SURFACE DOWN UNTIL THE DESIGN DEPTH.

Prepared by: Y. DUNCAN

OPERATIONS SECTION
DRILLBOAT THOR
WEEKLY PRODUCTION REPORT PER VOLUME
GAILLARD CUT AND GATUN LAKE DEEPENING PROJECT

CUCARACHA REACH

WEEK		WK.	DAYS	W/DAY	# OF	BORED HOLES		DEPTH		VOLUME		ACCUMULATED	% OF **	TOTL. EST.	BLAST.	EXPLOS.	FACTOR	LOAD	DEPTH	AVRG. DEPTH		AVRG. B. H.	
FROM	TO			(5D/WK)	BLAST.	DRILL.*	LOAD	FT	MTS.	YD³	M³	VOLUME	PROGRESS	VOLUME	PER DAY	PER DAY	(LBS/YD³)	(LBS/B.H.)	(FT/B.H..)	P/BIT	PER DAY	P/BIT	P/DAY
15/09/02	21/09/02	1	3	1	1	79	79	848	258.47	5096.48	3896.77	3896.77	0.31	1241550	0	1590.93	0.94	60.42	10.73	848.00	282.67	79.00	26.33
22/09/02	28/09/02	2	3	1	3	96	96	1110	338.33	6671.11	5100.73	8997.50	0.72	1241550	1	2097.60	0.94	65.55	11.56	1110.00	370.00	96.00	32.00
29/09/02	0510/02	3	4	1	4	112	112	1280	390.15	7692.80	5881.91	14879.41	1.20	1241550	1	1816.40	0.94	64.87	11.43	1280.00	320.00	112.00	28.00
13/10/02	19/10/02	4	4	1	4	84	84	936	285.30	5625.36	4301.15	19180.56	1.54	1241550	1	1331.90	0.95	63.42	11.14	936.00	234.00	84.00	21.00
20/10/02	26/10/02	5	3	1	3	96	96	1234	376.13	7416.34	5670.53	24851.10	2.00	1241550	1	2376.27	0.96	74.26	12.85	1234.00	411.33	96.00	32.00
27/10/02	02/11/02	6	2	1	2	73	73	1101	335.59	5835.71	4461.98	29313.08	2.36	1241550	1	2625.80	0.90	71.94	15.08	275.25	550.50	18.25	36.50
03/11/02	09/11/02	7	2	1	2	85	85	1144	348.70	5571.27	4259.79	33572.87	2.70	1241550	1	2542.20	0.91	59.82	13.46	1144.00	572.00	85.00	42.50
10/11/02	16/11/02	8	2	1	3	80	80	1027	313.03	6182.54	4727.17	38300.05	3.08	1241550	2	2929.80	0.95	73.25	12.84	1027.00	513.50	80.00	40.00
17/11/02	23/11/02	9	3	1	3	80	80	918	279.81	5526.36	4225.45	42525.50	3.43	1241550	1	1735.33	0.94	65.08	11.48	306.00	306.00	26.67	26.67
24/11/02	30/11/02	10	3	1	3	92	92	1229	374.60	7398.58	5656.95	48182.45	3.88	1241550	1	2221.73	0.90	72.45	13.36	1229.00	409.67	92.00	30.67
01/12/02	07/12/02	11	3	1	4	112	112	1424	434.04	8572.48	6554.52	54736.97	4.41	1241550	1	2715.73	0.95	72.74	12.71	1424.00	474.67	112.00	37.33
08/12/02	14/12/02	12	2	1	3	80	80	1220	371.86	7344.40	5615.53	60352.50	4.86	1241550	2	3522.60	0.96	88.07	15.25	1220.00	610.00	80.00	40.00
15/12/02	21/12/02	13	3	1	4	96	96	1267	386.19	7627.34	5831.86	66184.36	5.33	1241550	1	2391.47	0.94	74.73	13.20	1267.00	422.33	96.00	32.00
22/12/02	28/12/02	14	1	3	1	24	24	229	69.80	1369.15	1046.85	67231.22	5.42	1241550	1	1261.60	0.92	52.57	9.54	229.00	229.00	24.00	24.00
29/12/02	04/01/03	15	3	3	6	216	216	2159	658.07	12997.18	9937.64	77168.86	6.22	1241550	2	4022.93	0.93	55.87	10.00	2159.00	719.67	108.00	72.00
05/01/03	11/01/03	16	4	3	8	329	329	3543	1079.92	21328.87	16308.05	93476.91	7.53	1241550	2	4759.95	0.89	57.87	10.77	3543.00	885.75	329.00	82.25
12/01/03	18/01/03	17	5	3	14	440	440	5030	1533.16	30280.60	23152.55	116629.46	9.39	1241550	3	5292.18	0.87	60.14	11.43	5030.00	1006.00	440.00	88.00
19/01/03	25/01/03	18	2	3	5	200	200	3052	930.26	14074.20	10761.13	127390.59	10.26	1241550	3	8487.94	1.21	84.88	15.26	1526.00	1526.00	100.00	100.00
02/02/03	08/02/03	19	4	3	10	406	406	5558	1694.10	33459.16	25582.87	152973.47	12.32	1241550	3	7926.80	0.95	78.10	13.69	5558.00	1389.50	406.00	101.50
09/02/03	15/02/03	20	5	3	13	456	456	6468	1971.47	38937.36	29771.51	182744.97	14.72	1241550	3	7402.40	0.95	81.17	14.18	3234.00	1293.60	228.00	91.20
16/02/03	22/02/03	21	5	3	13	456	456	5964	1817.85	35903.26	27451.63	210196.61	16.93	1241550	3	6805.04	0.95	74.62	13.08	2982.00	1192.80	228.00	91.20
23/02/03	01/03/03	22	5	3	11	424	424	5562	1695.32	25600.10	19573.84	229770.44	18.51	1241550	2	6371.84	1.24	75.14	13.12	2781.00	1112.40	212.00	84.80
02/03/03	08/03/03	23	1	3	3	128	128	1680	512.07	10113.60	7732.86	237503.30	19.13	1241550	3	9773.60	0.97	76.36	13.13	1680.00	1680.00	128.00	128.00
09/03/03	15/03/03	24	0	3	0	0	0	0	0.00	0.00	0.00	237503.30	19.13	1241550	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16/03/03	22/03/03	25	0	3	0	0	0	0	0.00	0.00	0.00	237503.30	19.13	1241550	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23/03/03	29/03/03	26	2	3	3	152	152	1994	607.78	12003.88	9178.17	246681.47	19.87	1241550	2	5703.80	0.95	75.05	13.12	1994.00	997.00	152.00	76.00
30/03/03	05/04/03	27	5	3	11	412	412	5060	1542.31	30461.20	23290.63	260793.94	21.01	1241550	2	5744.08	0.94	69.71	12.28	1265.00	1012.00	103.00	82.40
SUBTOTAL 1			79	55	137	4808	4808	61037	1465.5	353089.33	269972.10	260793.94	21.01	1241550	2	4323.21	0.97	71.03	12.69	1968.94	772.62	155.10	60.86

9998.97

* THE COLUMN THAT READS "DRILLED FEET" CORRESPONDS TO THE TOTAL DEPTH OF BORE HOLES, AND IS MEASURED FROM THE CURRENT ROCK SURFACE DOWN UNTIL THE DESIGN DEPTH.

** THE PERCENTAGE OF PROGRESS WAS CALCULATED BASED ON THE ESTIMATED VOLUME FOR CUCARACHA REACH

OPERATIONS SECTION

DRILLBOAT THOR

WEEKLY PRODUCTION REPORT PER VOLUME

GAILLARD CUT AND GATUN LAKE DEEPENING PROJECT

CUCARACHA REACH

WEEK		WK	DAYS	W/DAY	# OF	BORED HOLES		DEPTH		VOLUME		ACCUMULATED	% OF **	TOT. EST.	BLAST.	EXPLOS.	FACTOR	LOAD	DEPTH	AVRG. DEPTH		AVRG. B.H.	
FROM	TO			(7D/WK)	BLAST.	DRILL.*	LOAD	FT	MTS.	YD³	M³	VOLUME	PROGRESS	VOLUME	PER DAY	PER DAY	(LBS/YD³)	(LBS/B.H.)	(FT/B.H.)	P/BIT	PER DAY	P/BIT	P/DAY
06/04/03	12/04/03	28	5	3 (5D)	12	453	453	5005	1525.54	30130.10	23037.47	283831.41	22.86	1241550	2	5474.53	0.91	60.43	11.05	5005.00	1001.00	453.00	90.60
13/04/03	19/04/03	29	5	3 (5D)	10	370	370	3987	1215.24	24001.50	18351.55	302182.96	24.34	1241550	2	4204.94	0.88	56.82	10.78	3986.96	797.39	0.00	74.00
20/04/03	26/04/03	30	5	3 (5D)	4	256	256	2441	744.03	14694.82	11235.66	313418.62	25.24	1241550	1	2527.52	0.86	49.37	9.54	2441.00	488.20	0.00	51.20
27/04/03	03/05/03	31	7	3	8	408	408	4498	1371.01	27077.96	20703.81	334122.42	26.91	1241550	1	3393.84	0.88	58.23	11.02	562.25	642.57	51.00	58.29
04/05/03	10/05/03	32	7	3	11	471	471	5257	1602.35	31647.14	24197.40	358319.83	28.86	1241550	2	3967.73	0.88	58.97	11.16	1314.25	751.00	117.75	67.29
11/05/03	17/05/03	33	5	3	8	308	308	3618	1102.78	21780.36	16653.26	374973.09	30.20	1241550	2	3827.73	0.88	62.14	11.75	516.86	723.60	44.00	61.60
18/05/03	24/05/03	34	7	3	13	535	535	6193	1887.65	37281.86	28505.71	403478.80	32.50	1241550	2	4671.70	0.88	61.13	11.58	1032.17	884.71	89.17	76.43
25/05/03	31/05/03	35	6	3	13	591	591	7157	2181.48	43085.14	32942.90	436421.70	35.15	1241550	2	6309.27	0.88	64.05	12.11	1789.25	1192.83	147.75	98.50
SUBTOTAL 2			47	69	79	3392	3392	38156	1033.89	229698.88	175627.76	436421.70	35.15	1241550	2	4303.45	0.88	59.63	11.25	1271.87	811.83	113.07	72.17
ACCUMULATED TOTAL		126		216	8200	8200	99193	30234.4		582788.21	445599.86	436421.70	35.15	1241550	2	4315.84	0.93	66.32	12.10	1626.11	787.25	134.43	65.08

* THE COLUMN THAT READS "DRILLED FEET" CORRESPONDS TO THE TOTAL DEPTH OF BORE HOLES, AND IS MEASURED FROM THE CURRENT ROCK SURFACE DOWN TO THE DESIGN DEPTH.

** THE PERCENTAGE OF PROGRESS WAS CALCULATED BASED ON THE ESTIMATED VOLUME FOR CUCARACHA REACH

April '03 = **11,521** m3/wk 3t / 5d

May'03 = **24,601** m3/wk 3t / 7d

Drilling depth	Scheduled volume to date	Total volume (1)	% scheduled to date, regarding volume	% scheduled to date regarding Gantt Chart	% progress to date	% delay to date
26'PLD	783,372.98	5,155,559	15.19%	16.00%	8.47%	6.73%
19.5'PLD	1,036,195.20	16,466,571	6.29%	7.00%	2.65%	3.64%

General percentage of progress regarding Gantt Chart

Dredge + P-V	All Tasks
20%	25%
15%	18%

Total D&B volumes were adjusted by substracting volumes corresponding to reaches: Gamboa,J.Grande,Mamei and S.Pablo.

DRILLBOAT THOR
PRODUCTION REPORT BY AREA
GAILLARD CUT AND GATUN LAKE DEEPENING PROJECT

CUCARACHA REACH

WEEK		WEEK	OFFSET	BANK	W/DAY	# OF	B.H.	DEPTH	EXPLOSIVE	AREA		AREA	AREA **	% OF	AVRG. AREA	B.H.	LBS EXPL.
FROM	TO		(FEET)			PATTERNS	DRILL.	(FEET) *	LBS.	FT^2	M^2	ACCUM.	ESTIM.	PROGRSS	X PATTERN	PER M^3	PER M^2
15/09/02	21/09/02	1	39	E	1	1	32	427	2462.40	3900	362.32	362.32	266,631.00	0.14	362.32	0.09	6.80
22/09/02	28/09/02	2	117	E	1	3	96	1110	6292.80	11700	1086.97	1449.29	266,631.00	0.54	362.32	0.09	5.79
29/09/02	0510/02	3	130	E	1	4	112	1280	7265.60	13000	1207.74	2657.03	266,631.00	1.00	301.93	0.09	6.02
13/10/02	19/10/02	4	104	E	1	4	84	936	5327.60	10400	966.19	3623.22	266,631.00	1.36	241.55	0.09	5.51
20/10/02	26/10/02	5	117	E	1	3	96	1234	7128.80	11700	1086.97	4710.18	266,631.00	1.77	362.32	0.09	6.56
27/10/02	02/11/02	6	106	E	1	2	73	1101	5251.60	10600	984.77	5694.96	266,631.00	2.14	492.39	0.07	5.33
03/11/02	09/11/02	7	91	E	1	2	85	1144	5084.40	9100	845.42	6540.37	266,631.00	2.45	422.71	0.10	6.01
10/11/02	16/11/02	8	91	E	1	3	80	1027	5859.60	9100	845.42	7385.79	266,631.00	2.77	281.81	0.09	6.93
17/11/02	23/11/02	9	91	E	1	3	80	918	5206.00	9100	845.42	8231.21	266,631.00	3.09	281.81	0.09	6.16
24/11/02	30/11/02	10	117	E	1	3	92	1229	6665.20	11700	1086.97	9318.17	266,631.00	3.49	362.32	0.08	6.13
01/12/02	07/12/02	11	130	E	1	4	112	1424	8147.20	13000	1207.74	10525.91	266,631.00	3.95	301.93	0.09	6.75
08/12/02	14/12/02	12	91	E	1	3	80	1220	7045.20	9100	845.42	11371.33	266,631.00	4.26	281.81	0.09	8.33
15/12/02	21/12/02	13	104	E	1	4	96	1267	7174.40	10400	966.19	12337.52	266,631.00	4.63	241.55	0.10	7.43
22/12/02	28/12/02	14	26	E	3	1	24	229	1261.60	2600	241.55	12579.07	266,631.00	4.72	241.55	0.10	5.22
29/12/02	04/01/03	15	273	E	3	6	216	2159	12068.80	27300	2536.25	15115.32	266,631.00	5.67	422.71	0.09	4.76
05/01/03	11/01/03	16	329	E	3	8	329	3543	19039.80	32900	3056.51	18171.83	266,631.00	6.82	382.06	0.11	6.23
12/01/03	18/01/03	17	533	E	3	14	440	5030	26460.92	53300	4951.73	23123.57	266,631.00	8.67	353.70	0.09	5.34
19/01/03	25/01/03	18	260	E	3	5	200	3052	16975.88	26000	2415.48	25539.05	266,631.00	9.58	483.10	0.08	7.03
02/02/03	08/02/03	19	481	E	3	10	406	5558	31707.20	48100	4468.64	30007.68	266,631.00	11.25	446.86	0.09	7.10
09/02/03	15/02/03	20	520	E	3	13	456	6468	37012.00	52000	4830.96	34838.64	266,631.00	13.07	371.61	0.09	7.66
16/02/03	22/02/03	21	572	E	3	13	456	5964	34025.20	57200	5314.05	40152.69	266,631.00	15.06	408.77	0.09	6.40
23/02/03	01/03/03	22	546	E	3	11	424	5562	31859.20	54600	5072.51	45225.20	266,631.00	16.96	461.14	0.08	6.28
02/03/03	08/03/03	23	169	W-E	3	3	128	1680	9773.60	16900	1570.06	46795.26	266,631.00	17.55	523.35	0.08	6.22
09/03/03	15/03/03	24	0	N/A	3	0	0	0	0.00	0	0.00	46795.26	266,631.00	17.55	0.00	0.00	0.00
16/03/03	22/03/03	25	0	N/A	3	0	0	0	0.00	0	0.00	46795.26	266,631.00	17.55	0.00	0.00	0.00
23/03/03	29/03/03	26	208	E	3	3	152	1994	11407.60	20800	1932.38	48727.64	266,631.00	18.28	644.13	0.08	5.90
30/03/03	05/04/03	27	559	E	3	16	412	5060	28720.40	55900	5193.28	53920.92	266,631.00	20.22	324.58	0.08	5.53
06/04/03	12/04/03	28	624	E	3	12	453	5055	27372.64	62400	5797.15	59718.07	266,631.00	22.40	483.10	0.08	4.72
13/04/03	19/04/03	29	494	E	3	10	370	3987	21024.68	49400	4589.41	64307.48	266,631.00	24.12	458.94	0.08	4.58
SUBTOTAL 1					61	164	5584	69,658	387,620.32	692,200	64,307.48	64,307.48	266,631.00	24.12	352.72	0.09	6.03

* THE COLUMN THAT READS "DRILLED FEET" CORRESPONDS TO THE TOTAL DEPTH OF BORE HOLES AND IS MEASURED FROM THE CURRENT ROCK SURFACE DOWN TO THE DESIGN DEPTH.

** THE % OF PROGRESS WAS CALCULATED BASED ON THE ESTIMATED AREA IN PLAN C FOR CUCARACHA REACH

IPDO - YDH
07/21/2003

APPENDIX No. 26

ACP Drill-boat THOR Cost Estimate

DRILLBOAT THOR
PRODUCTION REPORT BY AREA
GAILLARD CUT AND GATUN LAKE DEEPENING PROJECT

CUCARACHA REACH

WEEK FROM	WEEK TO	WK.	OFFSET (FT)	BANK	W/DAY	# OF PATTERNS	B.H. DRILL.	DEPTH (FT) *	EXPLOSIVES LBS.	AREA FT²	AREA M²	ACCUMUL. AREA	ESTIM. ** AREA	% OF PROGRSS	AVRG. AREA X PATTERN	B.H. PER M³	LBS EXPL. PER M³
20/04/03	26/04/03	30	377	E	3	4	256	2441	12637.60	37700	3502.44	67809.93	266,631.00	25.43	875.61	0.07	3.61
27/04/03	03/05/03	31	533	E	3	8	408	4498	23756.90	53300	4951.73	72761.66	266,631.00	27.29	618.97	0.08	4.80
04/05/03	10/05/03	32	624	E	3	11	471	5257	27774.10	62400	5797.15	78558.81	266,631.00	29.46	527.01	0.08	4.79
11/05/03	17/05/03	33	403	E	3	8	308	3618	19138.66	40300	3743.99	82302.80	266,631.00	30.87	468.00	0.08	5.11
18/05/03	24/05/03	34	805	E	3	13	535	6193	32701.92	80500	7478.69	89781.50	266,631.00	33.67	575.28	0.07	4.37
25/05/03	31/05/03	35	481	E	3	13	591	7157	37855.62	48100	4468.64	94250.13	266,631.00	35.35	343.74	0.13	8.47
SUBTOTAL 2					78	57	2569	29,164	153,864.80	322,300	29942.65	94,250.13	266,631.00	35.35		0.09	5.14
TOTAL					139	221	8153	98822	541485.12	1014500	94250.13	94,250.13	266,631.00	35.35	176.36	0.09	5.75

* THE COLUMN THAT READS "DRILLED FEET" CORRESPONDS TO THE TOTAL DEPTH OF BORED HOLES, AND IS MEASURED FROM THE CURRENT ROCK SURFACE DOWN TO THE DESIGN DEPTH.

** THE % OF PROGRESS WAS CALCULATED BASED ON THE ESTIMATED AREA IN PLAN C FOR CUCARACHA REACH

IPDO - YDH
07/21/2003

Updated on July 15, 2002

"THOR" RATES

Inflation conversion factor	**1.023**	
Division Overhead	**12%**	

		Total Costs		Incidental Costs
Hourly Cost for availability	$	164		n.a.
Hourly Cost of Labor		517		517
Incidental Costs applied to Labor		62		62
Average Hourly Cost of Fuel		54 1/		54
Small Tugboat support		112		112
Guard or passenger boat support		99		99
Sub-total for support		216		216
Total	**$**	**1,013**	**$**	**849**
Cost by Shift				
Cost for availabily for 8 hours	$	1,309		n.a.
Cost of Labor for 8 hours		4,632		4,632
Fuel Usage for 6 hours		324 2/		324
Support for 8 hours		1,730		1,730
Total Cost by Shift	**$**	**7,995**		**6,686**
Daily Cost -3 shifts				
Cost for Availability		3,926		n.a.
Cost of Labor		13,896		13,896
Fuel Usage		972		972
Support		5,190		5,190
Total Daily Cost	**$**	**23,985**		**$20,059**
Weekly Cost - 3 shifts/7days				
Cost for Availability		27,484		n.a.
Cost of Labor		97,272		97,272
Fuel Usage		6,806		6,806
Support		36,333		36,333
Total Weekly Cost	**$**	**167,894**		**$140,411**
Weekly Estimate of Drilling and Blasting Volume (Cubic meters in bank)		**30,000**		**37,672**
Cost for one cubic meter in bank without explosives	**$**	**5.60**	**$**	**3.73**
Cost of Explosives for one cubic meter in bank	**$**	**2.00**	**$**	**2.30**
Total Cost of One Cubic Meter	**$**	**7.60**	**$**	**6.03**

Notes:

1/ Average Usage of 48 gallons/hour, $1.10/gallon

2/ It was assumed that the THOR spends an average of 6 hours idle daily; therefore, the barge uses fuel for 18 hours a day, or an average of 6 hours each shift.

Updated on July 15, 2002

Dredging Division - THOR Drilling and Blasting Barge

General Overhead Expenses of the Dredging Division **12%**

	FY 1995	FY 1996	FY 1997	FY 1998	Annual Estimate	
Supplies/Materials (excluding fuel)	$276,104	*	$158,000	$936,000	$ 456,701	
Other Direct Expenses	$ 7,119	*			$ 7,200	
General Maintenance	$103,643	$189,896	$321,000	$416,000	$ 257,635	
Overhaul Expenses	$ -	$ -			$ 320,000	
Maritime Insurance					$ 16,648	
Depreciationn (THOR is fully depreciated)	$ -	$ -	$ 19,861	$ 20,375	$ 20,118	
Indirect Maintenance CC 556		$ 73,080			$ 73,080	1/
Total Expenses	$386,866	$189,896			$ 1,151,383	

Total Annual Expenses		$ 1,151,383
Availability (in days)	÷	300
Daily Cost for Availability without crew (demand)		$ 3,838
Hourly Cost for Availability without crew (demand)		$ 160

		Inter-Divisional	Capital (with division overhead)	Com-mercial (c/RGG)
Hourly Cost for Availability		$ 160	$ 160	$ 217
Hourly Cost of on-call crew	+	$ 86	$ 96	$ 130
Total Hourly Cost for Availability		**$ 245**	**$ 256**	**$ 348**
Hourly Cost for Availability		$ 160	$ 160	$ 217
Hourly Cost of Operations Crew 2 shifts/5 days		$ 449	$ 503	$ 684
Hourly Cost of Operations Crew 3 shifts/5 days		$ 543	$ 608	$ 827
Hourly Cost of Operations Crew 3 shifts/7 days		$ 517	$ 579	$ 787
Hourly Cost of Fuel	+	$ 53 2/	$ 53	$ 72
Hourly Cost of Operations Crew 2 shifts/5 days (without support equipment)		**$ 661**	**$ 715**	**$ 973**
Hourly Cost of Operations Crew 3shifts/5 days (without support equipment)		**$ 756**	**$ 821**	**$ 1,117**
Hourly Cost of Operations Crew 3 shifts/7 days (without support equipment)		**$ 730**	**$ 792**	**$ 1,077**
Small Tugboat Support		$ 106	$ 112	$ 152
Guard or Passenger Boat Support		$ 94	$ 99	$ 135
Hourly Cost of Operations Crew 2 shifts/5 days (with support equipment)		**$ 861**	**$ 927**	**$ 1,260**
Hourly Cost of Operations Crew 3 shifts/5 days (with support equipment)		**$ 956**	**$ 1,033**	**$ 1,404**
Hourly Cost of Operations Crew 3 shifts/7 days (with support equipment)		**$ 930**	**$ 1,003**	**$ 1,364**

Mobilization Rate

Hourly Cost of Pilot (required to move dredge)		$ 45	$ 51	$ 69
Cost of a large tugboat to move dredge		$ 341	$ 365	$ 496
Hour Cost for Availability		$ 160	$ 160	$ 217
Hourly Cost of Operations Crew	+	$ 449	$ 503	$ 684
Total Hourly Rate for Mobilization		**$ 995**	**$ 1,078**	**$ 1,466**

1/ Distribution of support for "other 554" is based on the allocation of 58% of the costs at the cost center. This percentage was determined based on the effort of556 for the 554, according to the JCS report.

2/ Average Usage of 48 gallons/hour, $1.10/gallon

Updated on July 15, 2002

"THOR" DRILLING AND BLASTING BARGE

Employee Benefits	38%
Night Shift Differential	10%
Complementary Sunday	25%
Overtime	50%

DAYTIME CREW

On-deck Department:	Grade	No.	Hourly Rate	Total Hourly Rate
On-deck Department:				
Captain in Charge	FE-16	1	$ 32.02	$ 32.02
Engine Department				
Chief Engineer in Charge	ME-15	1	29.99	29.99
Land-based Support Crew				
Explosives Operator	MG-06	6	6.52	39.12
TOTAL DAYTIME CREW		**8**		**$ 101.13**

ROTATION CREW

On-deck Department				
Officer	FE-14	1	$ 28.15	$ 28.15
Blasting Technician	FE-09	1	22.98	22.98
Engine Department				
Dredge Engineer	ME-14	1	28.15	28.15
Drilling Equipment Operator	MG-10	4	17.56	70.24
Drilling Equipment Operator	MG-08	9	8.25	74.25
Oiler	MG-08	2	8.25	16.5
Explosives Operator	MG-06	1	6.52	6.52
TOTAL ROTATION CREW		**19**		**$ 246.79**

2shifts/5days with no overtime	
Monday to Thursday	$ 427.38
Sunday	534.22
Average Rate - 2shifts/5days	**$ 448.75**
3shifts/5days with overtime	
Monday to Thursday	$ 517.37
Sunday	646.71
Average Rate - 3shifts/5days	**$ 543.23**
3shifts/7days with overtime	
Monday to Thursday	$ 517.37
Saturday	$ 458.63
Sunday	$ 573.29
Average Rate - 3shifts/7days	**$ 516.97**

Note: Seven hours of overtime was estimated for each person, weekly

APPENDIX No. 27

Yearly Cost Indexes for Channels & Canal

And

Consumer Price Index

Updated on Aug. 30, 2002

PERFORATING AND DRILLING BARGE - COST OF EXPLOSIVES

Drilling Pattern 100' x 50', burden 10' x spacing 12.5'
Number of drills for pattern 48 - Depth of drill 11' (37' PLD - 26' PLD)
Effective Area 100' x 60'

	Amount	Total number of detonators	Total number of rolls	$ / lb	$/roll	$/ms	$
Volume of required drilling (m^3)	15,000,508						
Total area of required blasting (m^2)	4,474,243						
Effective area of blasting (100' x 60') (m^2)	557						
Required number of patterns	8,028						
Number of drills per pattern	48						
Total number of drills required	385,320						
Depth of a drill (m)	3.35						
Depth of the lake (m)	16.76						
Explosive Power Factor Required	1.98			0.87			**$ 25,839,876**
Total amount of explosives	29,701,006						
Prime chord							
Required amount of chord (m)	9,219,034						
One roll (m)	305		30,248		97.74		**2,956,375**
Detonator							
17 ms (# / pattern	6	48,165				2.53	**121,858**
25 ms (# / 100 lbs of explosives)	1	297,010				2.53	**751,435**
"NLIL" (# roll/pattern)	1		8,028		25.63		**205,776**
TOTAL							**$ 29,875,319**
COST/UNIT $/cubic meter							**1.99**

YEARLY COST INDEXES FOR CHANNEL & CANALS

SOURCE: U.S. CORPS OF ENGINEERS (USACE)

FISCAL YEARS	YEARLY COSTS	YEARLY PERCENTAGE CHANGE
1995	470.64	
1996	482.90	0.026
1997	492.16	0.019
1998	503.55	0.023
1999	516.11	0.025
2000	526.72	0.021
2001	536.03	0.018
2002 [2]	550.03	0.026
LAST 8-YEAR AVERAGE		**0.023**

Notes:

1. Fiscal year correspond the period from October 1 to September 30
2. Forecasted data developed based on US Office of Management and Budget projections.

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Consumer Price Index (CPI) Conversion Factors to Convert to 2001 Dollars
Using the CPI-U-X1 series, which applies the CPI used starting 1983 to 1950-1982
Should be used when exact comparisons are needed between years during the period since 1950

To convert dollars of a year to 2001 dollars, divide the dollar amount
of that year by the conversion factor (CF) for that year
For example, $1000 dollars of 1953 = $6135 dollars of 2001 ($1000 / 0.163)

Year	CF	Year	CF	Year	CF	Year	CF	Year	CF	Year	CF
1950	0.148	1960	0.182	1970	0.233	1980	0.465	1989	0.700	1999	0.941
1951	0.160	1961	0.184	1971	0.243	1981	0.509	1990	0.738	2000	0.972
1952	0.163	1962	0.185	1972	0.251	1982	0.540	1991	0.769	2001	**1.000**
1953	0.164	1963	0.188	1973	0.267	CPI-U = CPI-U-X1		1992	0.792	2002	1.018
1954	0.165	1964	0.190	1974	0.293	1983	0.562	1993	0.816	2003	1.042
1955	0.164	1965	0.193	1975	0.317	1984	0.587	1994	0.837	2004	1.067
1956	0.167	1966	0.199	1976	0.335	1985	0.608	1995	0.861	2005	1.093
1957	0.172	1967	0.205	1977	0.357	1986	0.619	1996	0.886	2006	1.120
1958	0.177	1968	0.213	1978	0.381	1987	0.641	1997	0.906	2007	1.147
1959	0.178	1969	0.223	1979	0.418	1988	0.668	1998	0.920	2008	1.176

CPI is CPI-U-X1, which applies the post-1982 CPI methods to the period 1950 to 1982.
By definition, CPI-U-X1 equals CPI-U starting in 1983, so the conversion factors are the same.
2000 conversion factors use the final 2000 year-to-year CPI (172.2). Conversion factors for 2001-2008 use the average of inflation estimates by the Office of Management and Budget and the Congressional Budget Office.
It is recommended that numbers be **rounded** to **no more than three decimal places**,
for example, $6135 in the example at the top of this page becomes $6140

Note: To reverse the process, that is, to determine what a 2000-dollar figure would be in the dollars of another year, simply **multiply** the 2001 figure by the conversion factor of that year. For example, $1000 2001 dollars would be $148 in 1950 ($1000 x 0.148 = 148), again rounded to 3 decimal places ($148).

The 1983 changes reduced the inflation rate by changing the way costs of home ownership are measured.
For reference, the following lists yearly inflation rate 1970 to 1985 using the CPI and the CPI-U-X1 series, which applies the 1983 measure to the period 1950 to 1982.

	CPI	CPI-U-X1	CPI Inflation	X1 Inflation	Difference (CPI minus X1)
1970	38.8	41.3	5.7	4.8	0.9
1971	40.5	43.1	4.4	4.4	0.0
1972	41.8	44.4	3.2	3.0	0.2
1973	44.4	47.2	6.2	6.3	-0.1
1974	49.3	51.9	11.0	10.0	1.0
1975	53.8	56.2	9.1	8.3	0.8
1976	56.9	59.4	5.8	5.7	0.1
1977	60.6	63.2	6.5	6.4	0.1
1978	65.2	67.5	7.6	6.8	0.8
1979	72.6	74.0	11.3	9.6	1.7
1980	82.4	82.3	13.5	11.2	2.3
1981	90.9	90.1	10.3	9.5	0.8
1982	96.5	95.6	6.2	6.1	0.0
1983	99.6	99.6	3.2	4.2	-1.0

Starting 1983, CPI = CPI-U-X1, but comparing changes between 1982 and 1983 price levels in CPI and CPI-U-X1 results in different rates of inflation for 1983.

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SOURCE: USACE

TABLE A-2, YEARLY COST INDEXES BY CWBS FEATURE CODE
Base Year 1967 = 100

CWBS - FEATURE CODES	Wt %	FY68 Oct 67 - Sep 68	FY69 Oct 68 - Sep 69	FY70 Oct 69 - Sep 70	FY71 Oct 70 - Sep 71	FY72 Oct 71 - Sep 72	FY73 Oct 72 - Sep 73	FY74 Oct 73 - Sep 74	FY75 Oct 74 - Sep 75	FY76 Oct 75 - Sep 76	FY77 Oct 76 - Sep 77
02 RELOCATIONS	5%	105.52	112.79	118.78	134.70	146.50	153.85	167.31	193.03	206.77	218.70
03 RESERVOIRS	5%	104.95	115.82	126.39	146.60	161.77	167.43	175.64	201.34	215.69	226.15
04 DAMS	15%	104.99	112.21	121.16	132.02	142.58	149.41	165.26	186.45	203.20	214.55
05 LOCKS	2%	104.91	111.93	119.92	132.69	143.03	150.04	167.12	190.30	201.75	213.78
06 FISH & WILDLIFE FACILITIES	5%	104.72	112.28	120.22	132.70	143.52	150.83	171.27	193.50	205.30	216.70
07 POWER PLANT	10%	104.79	111.26	119.72	128.54	135.78	141.26	159.74	185.20	194.61	206.65
08 ROADS, RAILROADS & BRIDGES	10%	105.52	112.79	118.78	134.70	146.50	153.85	167.31	193.03	206.77	218.70
09 CHANNELS & CANALS	3%	105.43	112.16	120.51	132.28	141.12	146.21	161.64	186.46	202.12	212.28
10 BREAKWATER & SEAWALLS	5%	104.83	111.42	118.88	127.05	136.29	141.06	158.76	188.03	201.26	213.56
11 LEVEES & FLOODWALLS	5%	105.31	112.16	120.69	132.30	143.87	149.31	166.79	190.35	204.98	216.62
12 NAVIGATION PORTS & HARBORS	10%	104.36	109.78	116.39	127.54	135.81	143.73	162.24	189.32	204.99	220.93
13 PUMPING PLANT	5%	104.83	112.17	119.75	131.73	141.94	149.36	170.45	190.49	202.61	215.84
14 RECREATION FACILITIES	5%	104.83	112.17	119.75	131.73	141.94	149.36	170.45	190.49	202.61	215.84
15 FLOODWAY CONTROL & DIVERSION STRUCTURE	2%	104.72	112.28	120.22	132.70	143.52	150.83	171.27	193.50	205.30	216.70
16 BANK STABILIZATION	2%	105.08	111.41	118.87	128.79	138.40	143.26	160.28	176.63	190.48	200.18
17 BEACH REPLENISHMENT	2%	106.12	113.34	123.12	136.97	149.55	154.85	167.00	188.41	204.97	214.59
18 CULTURAL RESOURCE PRESERVATION	2%	104.83	112.17	119.75	131.73	141.94	149.36	170.45	190.49	202.61	215.84
19 BUILDINGS, GROUNDS & UTILITIES	5%	104.83	112.17	119.75	131.73	141.94	149.36	170.45	190.49	202.61	215.84
20 PERMANENT OPERATING EQUIPMENT	2%	104.83	112.17	119.75	131.73	141.94	149.36	170.45	190.49	202.61	215.84
COMPOSITE INDEX (WEIGHTED AVERAGE)	100%	104.98	112.09	119.92	132.17	142.49	149.16	166.25	189.80	203.43	215.68
YEARLY PERCENTAGE CHANGE			*6.8%*	*7.0%*	*10.2%*	*7.8%*	*4.7%*	*11.5%*	*14.2%*	*7.2%*	*6.0%*

Note: FY indicates data developed based on OMB projections.*

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TABLE A-2, YEARLY COST INDEXES BY CWBS FEATURE CODE
Base Year 1967 = 100

CWBS - FEATURE CODES	Wt %	FY78 Oct 77 - Sep 78	FY79 Oct 78 - Sep 79	FY80 Oct 79 - Sep 80	FY81 Oct 80 - Sep 81	FY82 Oct 81 - Sep 82	FY83 Oct 82 - Sep 83	FY84 Oct 83 - Sep 84	FY85 Oct 84 - Sep 85	FY86 Oct 85 - Sep 86	FY87 Oct 86 - Sep 87
02 RELOCATIONS	5%	239.50	260.37	280.18	306.16	327.40	340.86	349.51	355.43	358.36	366.32
03 RESERVOIRS	5%	243.39	261.77	285.56	315.28	346.62	365.07	375.29	381.95	386.61	394.55
04 DAMS	15%	234.29	254.47	277.12	302.42	323.67	334.76	344.25	350.47	352.94	358.99
05 LOCKS	2%	233.87	254.13	276.11	301.87	323.21	334.84	343.82	348.28	350.35	356.84
06 FISH & WILDLIFE FACILITIES	5%	238.15	260.08	280.32	304.02	322.75	332.91	342.38	347.18	348.99	354.63
07 POWER PLANT	10%	222.75	241.68	266.35	294.48	314.76	324.11	333.16	337.53	341.85	348.65
08 ROADS, RAILROADS & BRIDGES	10%	239.50	260.37	280.18	306.16	327.40	340.86	349.51	355.43	358.36	366.32
09 CHANNELS & CANALS	3%	230.44	249.44	276.52	306.57	333.45	346.07	354.42	358.24	362.93	371.71
10 BREAKWATER & SEAWALLS	5%	232.34	252.07	280.18	311.09	336.64	347.98	355.31	361.66	366.25	374.63
11 LEVEES & FLOODWALLS	5%	235.94	256.08	280.75	308.97	333.68	346.21	354.99	359.69	362.50	370.28
12 NAVIGATION PORTS & HARBORS	10%	236.08	264.25	312.54	348.37	372.04	369.17	379.93	376.98	369.85	358.99
13 PUMPING PLANT	5%	235.78	257.20	277.60	302.25	320.13	330.82	341.06	346.12	347.33	353.35
14 RECREATION FACILITIES	5%	235.78	257.20	277.60	302.25	320.13	330.82	341.06	346.12	347.33	353.35
15 FLOODWAY CONTROL & DIVERSION STRUCTURE	2%	238.15	260.08	280.32	304.02	322.75	332.91	342.38	347.18	348.99	354.63
16 BANK STABILIZATION	2%	217.80	236.77	262.55	290.13	312.93	324.76	333.55	342.96	349.49	358.71
17 BEACH REPLENISHMENT	2%	231.77	249.67	273.04	299.95	327.10	342.33	351.39	358.74	365.02	373.80
18 CULTURAL RESOURCE PRESERVATION	2%	235.78	257.20	277.60	302.25	320.13	330.82	341.06	346.12	347.33	353.35
19 BUILDINGS, GROUNDS & UTILITIES	5%	235.78	257.20	277.60	302.25	320.13	330.82	341.06	346.12	347.33	353.35
20 PERMANENT OPERATING EQUIPMENT	2%	235.78	257.20	277.60	302.25	320.13	330.82	341.06	346.12	347.33	353.35
COMPOSITE INDEX (WEIGHTED AVERAGE)	100%	234.58	255.68	280.71	308.09	329.87	340.21	349.63	354.31	356.24	361.43
YEARLY PERCENTAGE CHANGE		*8.8%*	*9.0%*	*9.8%*	*9.8%*	*7.1%*	*3.1%*	*2.8%*	*1.3%*	*0.5%*	*1.5%*

Note: FY indicates data developed based on OMB projections.*

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TABLE A-2, YEARLY COST INDEXES BY CWBS FEATURE CODE
Base Year 1967 = 100

CWBS - FEATURE CODES	Wt %	FY88 Oct 87 - Sep 88	FY89 Oct 88 - Sep 89	FY90 Oct 89 - Sep 90	FY91 Oct 90 - Sep 91	FY92 Oct 91 - Sep 92	FY93 Oct 92 - Sep 93	FY94 Oct 93 - Sep 94	FY95 Oct 94 - Sep 95	FY96 Oct 95 - Sep 96	FY97 Oct 96 - Sep 97
02 RELOCATIONS	5%	380.42	394.57	402.95	411.27	422.37	440.44	454.26	463.84	473.27	486.24
03 RESERVOIRS	5%	407.44	420.33	435.31	447.08	457.13	467.07	477.72	490.54	502.77	511.08
04 DAMS	15%	371.82	385.00	393.91	402.98	410.31	422.71	435.37	450.08	460.21	470.29
05 LOCKS	2%	371.05	383.63	390.92	398.73	405.85	418.00	430.98	445.65	454.94	464.50
06 FISH & WILDLIFE FACILITIES	5%	367.96	379.94	386.38	394.22	402.07	416.83	430.89	444.68	454.33	466.15
07 POWER PLANT	10%	360.93	376.54	387.78	398.99	406.50	416.04	425.62	438.32	445.08	451.66
08 ROADS, RAILROADS & BRIDGES	10%	380.42	394.57	402.95	411.27	422.37	440.44	454.26	463.84	473.27	486.24
09 CHANNELS & CANALS	3%	383.49	400.61	415.58	427.22	437.81	449.00	459.60	470.64	482.90	492.16
10 BREAKWATER & SEAWALLS	5%	385.55	405.23	422.20	435.04	446.15	457.62	467.96	478.33	490.36	499.73
11 LEVEES & FLOODWALLS	5%	384.15	400.02	410.71	419.99	429.95	441.84	453.83	467.41	477.68	486.21
12 NAVIGATION PORTS & HARBORS	10%	367.45	381.27	396.89	401.41	407.73	419.08	422.73	434.64	451.45	463.22
13 PUMPING PLANT	5%	369.45	383.14	386.75	392.35	399.07	410.63	424.91	439.72	445.58	454.99
14 RECREATION FACILITIES	5%	369.45	383.14	386.75	392.35	399.07	410.63	424.91	439.72	445.58	454.99
15 FLOODWAY CONTROL & DIVERSION STRUCTURE	2%	367.96	379.94	386.38	394.22	402.07	416.83	430.89	444.68	454.33	466.15
16 BANK STABILIZATION	2%	368.75	380.82	392.20	402.54	412.09	423.49	433.89	446.05	457.20	465.43
17 BEACH REPLENISHMENT	2%	383.51	399.48	414.03	425.67	438.77	451.27	460.91	474.09	487.28	495.55
18 CULTURAL RESOURCE PRESERVATION	2%	369.45	383.14	386.75	392.35	399.07	410.63	424.91	439.72	445.58	454.99
19 BUILDINGS, GROUNDS & UTILITIES	5%	369.45	383.14	386.75	392.35	399.07	410.63	424.91	439.72	445.58	454.99
20 PERMANENT OPERATING EQUIPMENT	2%	369.45	383.14	386.75	392.35	399.07	410.63	424.91	439.72	445.58	454.99
COMPOSITE INDEX (WEIGHTED AVERAGE)	100%	374.45	388.68	398.34	406.78	415.22	427.83	439.45	452.31	462.16	472.17
YEARLY PERCENTAGE CHANGE			3.6%	3.8%	2.5%	2.1%	2.1%	3.0%	2.7%	2.9%	2.2%	2.2%

Note: FY indicates data developed based on OMB projections.*

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TABLE A-2, YEARLY COST INDEXES BY CWBS FEATURE CODE
Base Year 1967 = 100

CWBS - FEATURE CODES	Wt %	FY98 Oct 97 - Sep 98	FY99 Oct 98 - Sep 99	FY00 Oct 99 - Sep 00	FY01 Oct 00 - Sep 01	FY02* Oct 01 - Sep 02	FY03* Oct 02 - Sep 03	FY04* Oct 03 - Sep 04	FY05* Oct 04 - Sep 05	FY06* Oct 05 - Sep 06	FY07* Oct 06 - Sep 07
02 RELOCATIONS	5%	490.26	501.14	507.97	513.30	526.95	541.17	555.79	570.79	586.20	602.03
03 RESERVOIRS	5%	521.42	540.51	552.38	568.09	583.83	599.60	615.79	632.41	649.49	667.02
04 DAMS	15%	479.06	488.39	496.78	503.96	515.89	529.82	544.12	558.81	573.90	589.40
05 LOCKS	2%	472.47	480.10	488.88	495.43	507.88	521.59	535.68	550.14	564.99	580.25
06 FISH & WILDLIFE FACILITIES	5%	472.75	481.62	488.90	494.06	506.03	519.69	533.72	548.13	562.93	578.13
07 POWER PLANT	10%	458.96	465.38	472.73	479.63	489.52	502.74	516.31	530.25	544.57	559.27
08 ROADS, RAILROADS & BRIDGES	10%	490.26	501.14	507.97	513.30	526.95	541.17	555.79	570.79	586.20	602.03
09 CHANNELS & CANALS	3%	503.55	516.11	526.72	536.03	550.39	565.25	580.51	596.18	612.28	628.81
10 BREAKWATER & SEAWALLS	5%	510.50	520.83	527.86	534.68	548.77	563.59	578.80	594.43	610.48	626.96
11 LEVEES & FLOODWALLS	5%	495.99	503.35	512.62	518.66	532.71	547.10	561.87	577.04	592.62	608.62
12 NAVIGATION PORTS & HARBORS	10%	457.55	465.45	500.23	504.84	504.07	517.67	531.65	546.01	560.75	575.89
13 PUMPING PLANT	5%	459.40	460.16	468.05	472.18	483.50	496.55	509.96	523.73	537.87	552.39
14 RECREATION FACILITIES	5%	459.40	460.16	468.05	472.18	483.50	496.55	509.96	523.73	537.87	552.39
15 FLOODWAY CONTROL & DIVERSION STRUCTURE	2%	472.75	481.62	488.90	494.06	506.03	519.69	533.72	548.13	562.93	578.13
16 BANK STABILIZATION	2%	476.48	489.61	501.50	513.00	527.35	541.59	556.21	571.23	586.65	602.49
17 BEACH REPLENISHMENT	2%	507.09	521.89	532.71	543.21	562.57	577.76	593.36	609.38	625.83	642.73
18 CULTURAL RESOURCE PRESERVATION	2%	459.40	460.16	468.05	472.18	483.50	496.55	509.96	523.73	537.87	552.39
19 BUILDINGS, GROUNDS & UTILITIES	5%	459.40	460.16	468.05	472.18	483.50	496.55	509.96	523.73	537.87	552.39
20 PERMANENT OPERATING EQUIPMENT	2%	462.01	460.16	468.05	472.18	483.50	496.55	509.96	523.73	537.87	552.39
COMPOSITE INDEX (WEIGHTED AVERAGE)	100%	478.10	486.21	497.07	503.52	514.80	528.70	542.98	557.64	572.69	588.16
YEARLY PERCENTAGE CHANGE			1.3%	1.7%	2.2%	1.3%	2.2%	2.7%	2.7%	2.7%	2.7%

Note: FY indicates data developed based on OMB projections.*

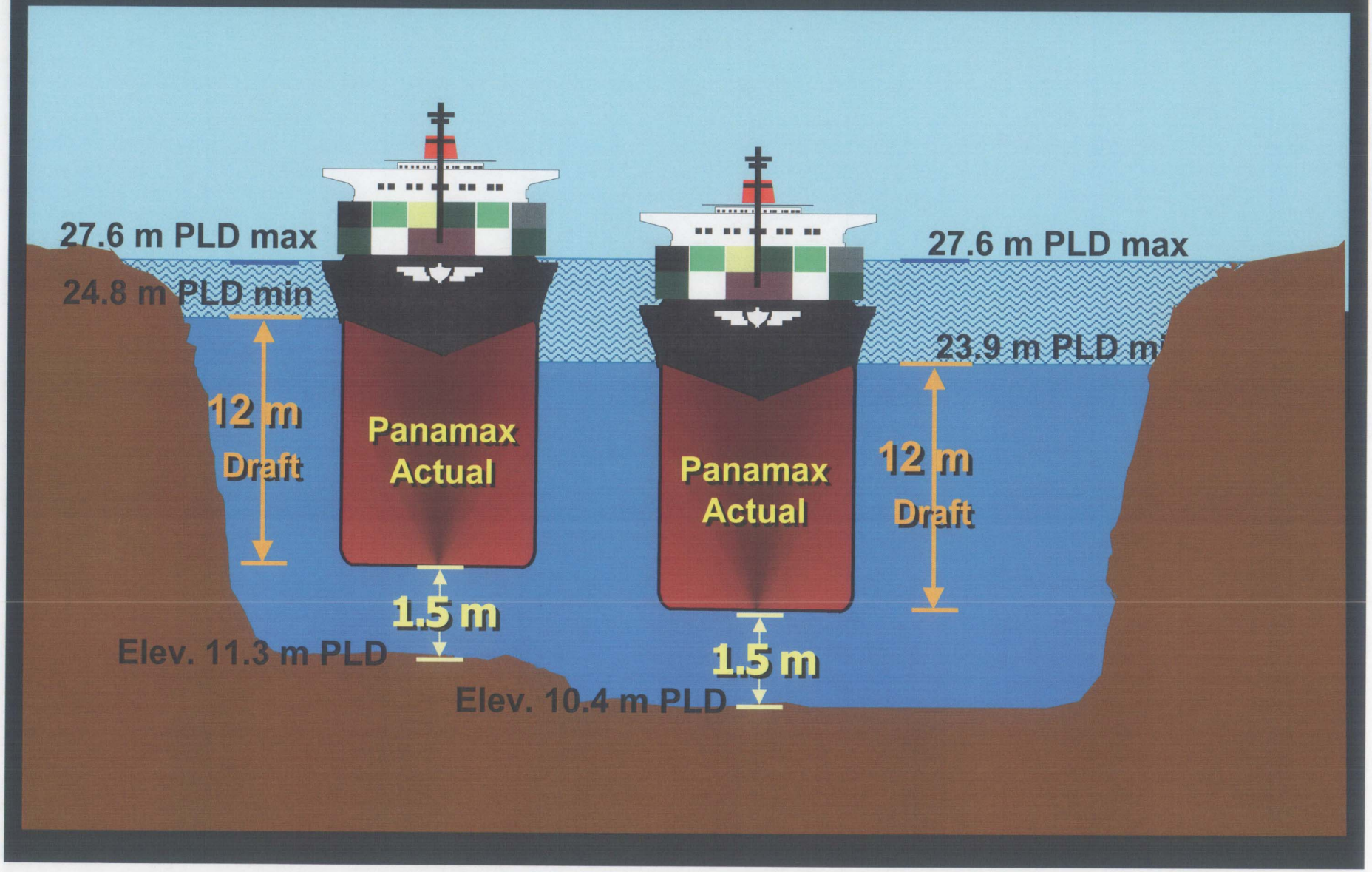
6th page (2544x3448x256 jpeg)

APPENDIX No. 28

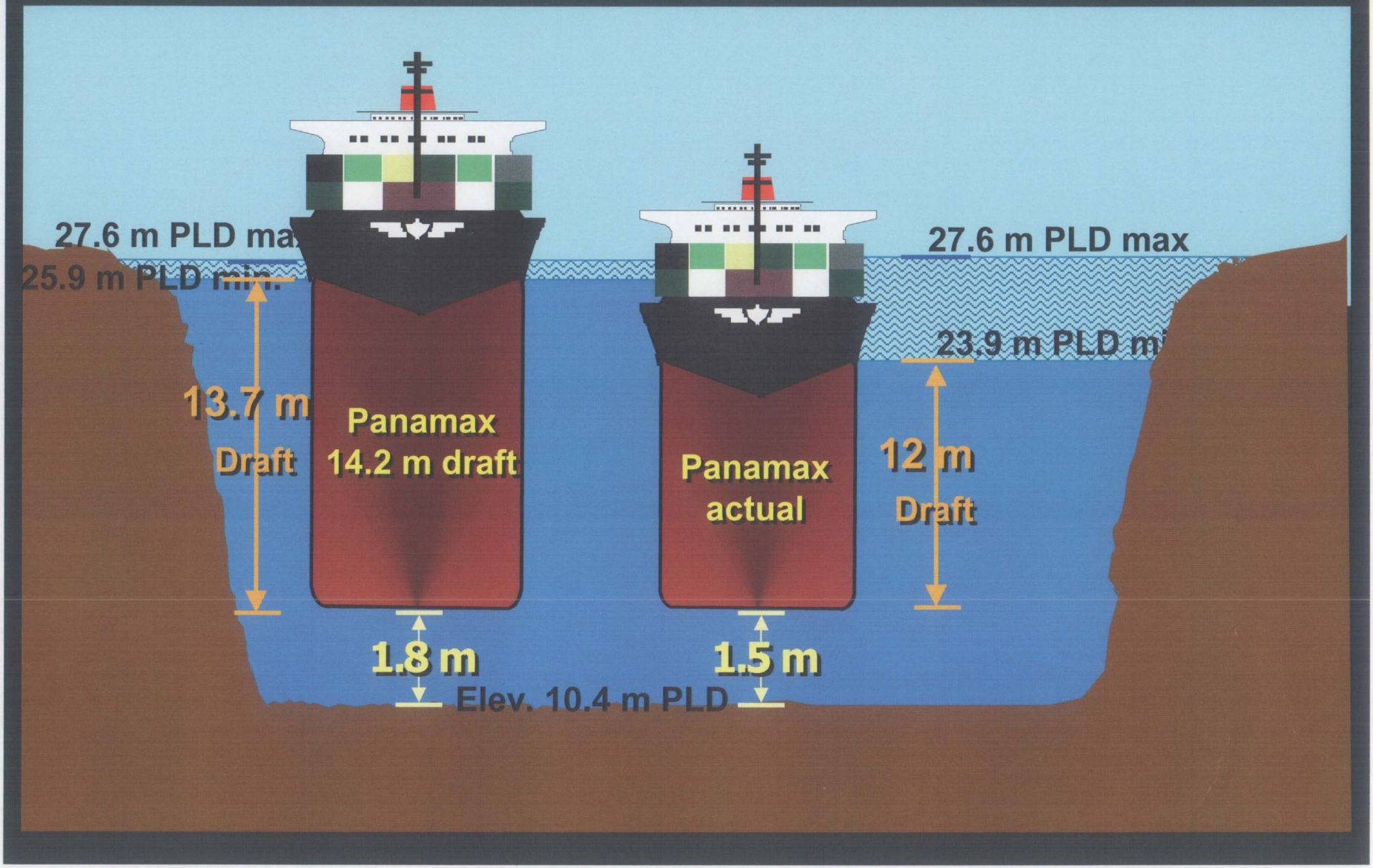
Proposed Canal Expansion Draft Phases

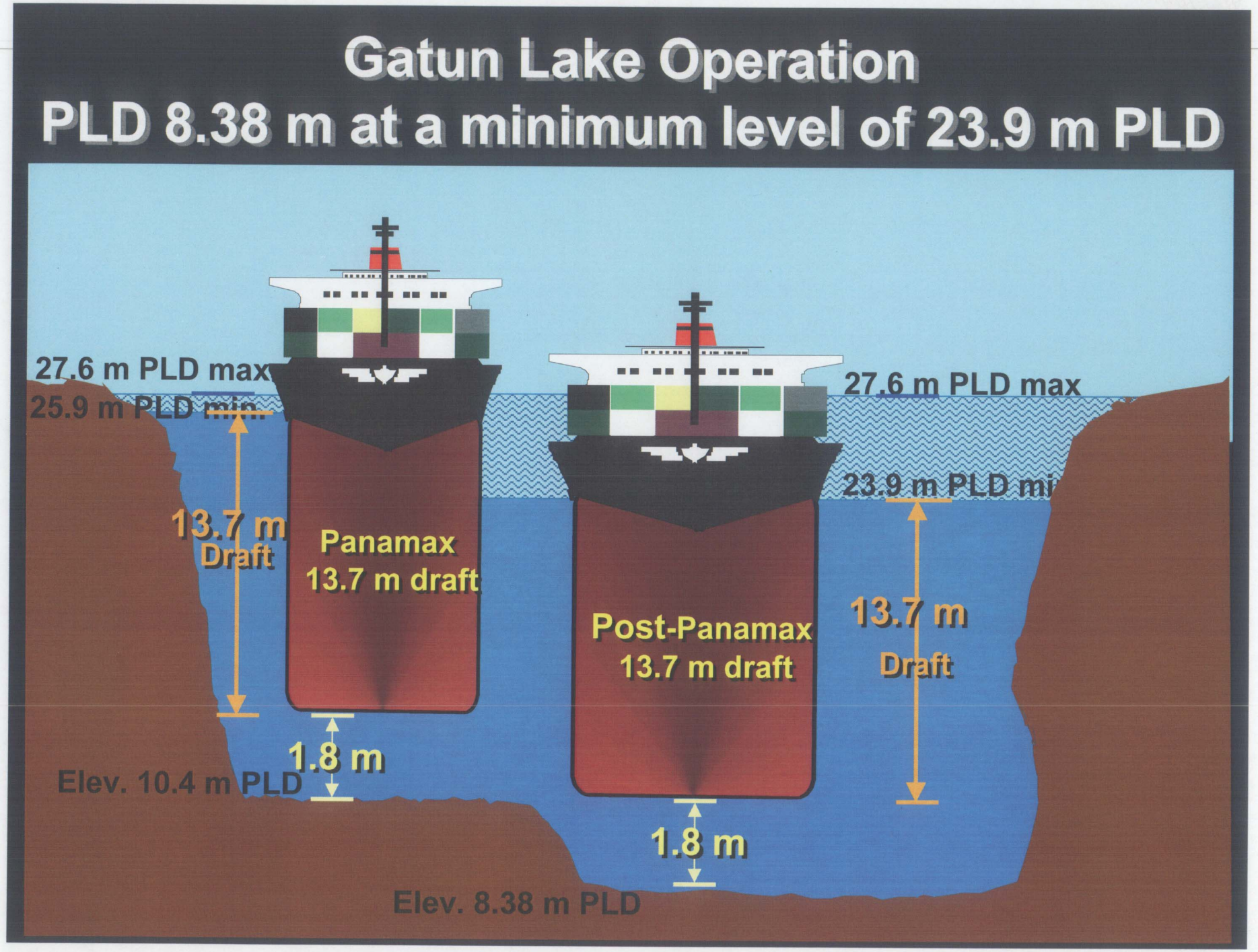
Sketches

Gatun Lake Operation to a minimum level of 24 m PLD



Gatun Lake Operation to a minimum level of 25.9 m




Gatun Lake Operation
PLD 8.38 m at a minimum level of 23.9 m PLD
27.6 m PLD max
25.9 m PLD min
13.7 m
Draft
Panamax
13.7 m draft
1.8 m
Elev. 10.4 m PLD
27.6 m PLD max
23.9 m PLD mi
Post-Panamax
13.7 m draft
13.7 m
Draft
1.8 m
Elev. 8.38 m PLD

APPENDIX No. 29

Cutter Suction Dredge MINDI

Operation Cost

Updated on Dec. 2, 2002

DREDGING RATE FOR THE "CHRISTENSEN" FOR A HAULING DISTANCE OF UP TO 20 KMS.

Inflation Conversion Factor 1.023

Division Overhead 12%

		Total Costs		Incidental Costs
Hourly Cost for Availability	$	306		n.a.
Hourly cost of labor		531		531
Indirect Costs related to labor		64		64
Average Hourly Cost of Fuel		56 /1		56
Large tugboat Support		373		373
Mid-size tugboat Support		222		222
Small tugboat Support		115		115
Guard or Passenger Boat Support		75		75
Launch Support for Disposal Sites		89		89
Launch Support for Hydrographies		14		14
Support Subtotal		888		888
Total	**$**	**1,845**	**$**	**1,539**
Cost by Shift				
Cost for Availability for 8 hours	$	2,445		n.a.
Cost of Labor for 8 hours		4,758		4,758
Fuel Consumption for 6 hours		338 /2		338
Support for 8 hours		7,105		7,105
Total Cost by Shift	**$**	**14,645**		**12,200**
Daily Cost				
Cost for Availability		7,335		n.a.
Cost of Labor		14,274		14,274
Fuel Consumption		1,013		1,013
Support		21,314		21,314
Total Cost per Day	**$**	**43,935**		**$36,600**
Weekly Cost				
Cost for Availability		51,345		n.a.
Cost of Labor		99,915		99,915
Fuel Consumption		7,089		7,089
Support		149,195		149,195
Total Cost per Week	**$**	**307,545**		**$256,200**

Estimated Weekly Volume of Excavation (Cubic Meters in Bank)			
Productivity a		**30,000**	
Productivity b		**28,000**	
Cost of Cubic Meter in Bank			
Productivity a	**$**	**10.25**	**$8.54**
Productivity b	**$**	**10.98**	**$9.15**

1/ Average Consumption of 50 gallons/hour, $1.10/gallon

2/ It was assumed that the CHRISTENSEN would have an average of 6 idle hours a day; therefore, the dredge would be consuming fuel for 18 hours daily, or an average of 6 hours each shift.

Updated on Dec. 2, 2002

"CHRISTENSEN" DREDGE

Overhead	12%
Employee Benefits	38%
Night Shift Differential	10%
Complementary Sunday	25%
Overtime	50%

DAY CREW

On-deck Department:	Grado	No.	Tarifa por hora	Tarifa total por hora	Annual Rate	With Benefits Annually	Ten hours/each of 2 weeks with benefits annually	Eight hours overtime weekly with benefits annually
Captain in Charge	FE-17	1	$ 34.21	$ 34.21	$ 71,157	$ 98,211	$ 18,414	$ 29,463
Welder	MG-10	1	17.56	17.56	36,525	50,412	9,452	15,123
Laborer	MG-03	1	5.75	5.75	11,960	16,507	3,095	4,952
Seaman	MG-07	2	6.96	13.92	28,954	39,962	7,493	11,989
Subtotal		**5**		**$ 71.44**	**148,595**	**205,091**	**38,455**	**61,527**
Engine Department:								
Chief Engineer	ME-16	1	$ 32.02	$ 32.02	$ 66,602	$ 91,924	$ 17,236	$ 27,577
Deputy Chief Engineer	ME-15	1	29.99	29.99	62,379	86,096	16,143	25,829
Electrician	FE-11	1	24.35	24.35	50,648	69,904	13,107	20,971
Machinist	MG-10	1	17.56	17.56	36,525	50,412	9,452	15,123
Nautical Equipment Mechanic	MG-10	1	17.56	17.56	36,525	50,412	9,452	15,123
Electrical Equipment Repairer	MG-09	1	11.12	11.12	23,130	31,923	5,986	9,577
Subtotal		**6**		**132.60**	**275,808**	**380,670**	**71,376**	**114,201**
TOTAL- DAY CREW		**11**		**$ 204.04**	**424,403**	**585,761**	**109,830**	**175,728**
ROTATION CREW								
On-deck Department:								
Dredge Operator	FE-14	1	$ 28.15	$ 28.15	$ 58,552	$ 80,813	$ 15,153	$ 24,244
Dredge Officer	FE-11	1	24.35	24.35	50,648	69,904	13,107	20,971
First Dredge Seaman	ML-08	1	9.74	9.74	20,259	27,962	5,243	8,389
Winch Operator	MG-08	1	8.25	8.25	17,160	23,684	4,441	7,105
Dredge Seaman	MG-07	4	6.96	27.84	57,907	79,924	14,986	23,977
Subtotal		**8**		**$ 98.33**	**204,526**	**282,287**	**52,929**	**84,686**
Engine Department:								
Dredge Engineer	ME-14	1	$ 28.15	$ 28.15	$ 58,552	$ 80,813	$ 15,153	$ 24,244
Oiler	MG-08	2	8.25	16.50	34,320	47,368	8,882	14,211
Subtotal		**3**		**$ 44.65**	**92,872**	**128,182**	**24,034**	**38,455**
SUBTOTAL- ROTATION CREW		**11**		**$ 142.98**	**297,398**	**410,469**	**76,963**	**123,141**
BARGE STATION								
On-deck Department:								
Dredge Seaman Leader	ML-08	1	$ 9.74	$ 9.74	$ 20,259	$ 27,962	$ 5,243	$ 8,389
Dredge Seaman	MG-07	2	6.96	13.92	28,954	39,962	7,493	11,989
Engine Department:								
Repairers	MG-09	5	$ 11.12	$ 55.60	$ 115,648	$ 159,617	$ 29,928	$ 47,885
SUBTOTAL- ROTATING CREW		**8**		**$ 79.26**	**164,861**	**227,541**	**42,664**	**68,262**
TOTAL - ROTATING CREW		**19**		**$ 222.24**	**462,259**	**638,010**	**119,627**	**191,403**
TOTAL - 4 ROTATING CREWS					**1,849,037**	**2,552,041**	**588,338**	**941,341**
TOTAL - 5 ROTATING CREWS					**2,311,296**	**3,190,051**		
TOTAL WITH 4 CREWS, 1 DAY AND OVERTIME							**3,835,970**	**4,254,871**
							438	**486**
TOTAL WITH 5 CREWS, 1 DAY, AND NO OVERTIME						**3,775,812**		
						431		

Total Average Rate with cargo - 4 rotating crews and 8 hours overtime per week for each crew

Monday to Friday	547.37	
Saturday	425.34	
Sunday	531.68	
Total Average Rate per hour	**$ 527.70**	**4,622,632**

Total Average Rate with cargo - 5 rotating crews and 1 hour overtime per week

Monday to Friday	542.93	
Saturday	445.53	
Sunday	556.92	
Total Average Rate per hour	**$ 531.01**	**4,651,659**

1/ There are 5 steps in each hourly wage grade, and the rate of the last step was used.

2/ Employee benefits were figured at 38.02% of the average hourly wages

3/ Included in the average hourly wages were 10% for night differential, 25% for complementary Sunday and 50% for overtime.

4/ Eight hours of overtime a week were included for each crew.

APPENDIX No. 30

Dipper Dredge RMC

Operation Cost

Updated on Dec. 2, 2002

Dredging Division - Christensen Dipper Dredge-

Div Ovh 12%

Expenses	FY 1995 Actual	FY 1996 Actual	FY 1997 Actual	FY 1998 Actual	Estimated Annual	
Labor	$ -	$ -			$ -	
Materials/Supplies (excluding fuel)	286,583	407,158	1,031,000	835,000	639,935	1/
Other Direct Expenses	9,352	270,295			139,823	
General Maintenance	96,786	197,600	331,000	593,000	304,597	
Indirect Maintenance CC 556					79,200	2/
Overhaul Expenses	16,375	596,588			306,482	
Maritime Insurance					39,020	3/
Depreciation	442,720	432,317	417,209	415,198	426,861	4/
Total	$851,816	$1,903,958	$1,779,209	$ 1,843,198	$ 1,935,918	

Annual Estimate	$ 1,935,918
Number of available days	270
Daily Cost for Availability without crew (demand)	$ 7,170
Hourly Cost for Availability without crew (demand)	**$ 299**

	Inter-Divisional	Capital (includes Division Overhead)	Com-mercial (w/RGG)
Hourly Cost for Availability	$ 299	$ 299	$ 406
On-Call Crew - Hourly Cost	$ 204	$ 229	$ 311
Total Hourly Cost for Availability	**$ 503**	**$ 527**	**$ 717**
Hourly Cost for Availability	$ 299	$ 299	$ 406
Operations Crew - hourly cost	$ 531	$ 595	$ 809
Hourly Cost of fuel	$ 55 5/	$ 55	$ 75
Hourly Cost of operation (excluding support equipment)	**$ 885**	**$ 948**	**$ 1,290**
Large Tug Support	$ 341	$ 365	$ 496
Small Tug Support	$ 106	$ 112	$ 152
Mid-size Tug Support	$ 202	$ 217	$ 295
Guard or Passenger Support Boat	$ 68	$ 74	$ 100
Launch Support for disposal of dredged material	$ 77	$ 87	$ 118
Hydrography Services Suport (2 days a week - day shift)	$ 13	$ 14	$ 18
Hourly Cost of operation (including support equipment)	**$ 1,692**	**$ 1,817**	**$ 2,470**

Mobilization Rate

Hourly Cost for Availability (without crew)	$ 299	$ 299	$ 406
Hourly Cost of Operations Crew	$ 531	$ 595	$ 809
Hourly Cost for Pilot (required to mobilize dredge)	$ 45	$ 51	$ 69
Cost of a large tug to move dredge	$ 341	$ 365	$ 496
Cost of a small tug to move dredge	$ 106	$ 112	$ 152
Cost of a mid-size tug to move dredge	$ 202	$ 217	$ 295
Total Hourly Mobilization Rate	**$ 1,525**	**$ 1,639**	**$ 2,228**

1/ Approximately 8.5% of the purchase of supplies and materials are for the barges.

2/ Support Distribution of "other 554" is based on an assignment of 58% of the costs of the costs center. This percentage was determined for 554, based on the effort of 556 in accordance with the JCS report.

3/ The cost of the maritime insurance paid by ACP in 2002 was proportionately allotted to all insured floating equipment.

4/ The depreciation includes the dredge and its improvements, as well as the 5 barges for disposal of dredged material. Sixty-four percent of the depreciation is allotted to the 5 barges.

5/ Average consumption of 50 gallons an hour at $1.10 a gallon.

Updated on Nov 19, 2002

DREDGING RATES OF THE "MINDI"

Inflation Factor Conversion 1.023

Division Overhead 12%

		Total Costs		Marginal Costs
Hourly Cost for Availability	$	781		n.a.
Hourly Cost for Labor		624		624
Indirect Costs relating to Labor		75		75
Average Hourly Cost of Fuel		233		233
Support for 3 small tugboats		344 /1		344
Guard or Passenger Boat Support		81 /1		81
Hydrographic Launches Support (5 days a week - day shift)		15		
Sub-total for Support		439		439
Total	**$**	**2,153**	**$**	**1,371**
Cost by Shift				
Cost for Availability for 8 hours	$	6,251		n.a.
Cost of Labor for 8 hours		5,591		5,591
Fuel Consumption for 8 hours		1,399		1,399
Support for 8 hours		3,514		3,514
Total Cost by Shift	**$**	**16,756**		**10,504**
Daily Cost				
Cost for Availability		18,754		n.a.
Labor Cost		16,774		16,774
Fuel Consumption		4,196		4,196
Support		10,542		10,542
Total Daily Cost	**$**	**50,267**		**$31,512**
Weekly Cost				
Cost for Availability		131,281		n.a.
Labor Cost		117,421		117,421
Fuel Consumption		29,370		29,370
Support		73,794		73,794
Total Weekly Cost	**$**	**351,866**		**$220,585**

Estimated Excavated Volumes by Week (Cubic Meters in Bank)		
Productivity a	**36,000**	
Productivity b	**30,000**	
Productivity c	**24,000**	
Productivity d	**60,000**	
Cost of Cubic Meter in Bank		
Productivity a	**$9.77**	**$6.13**
Productivity b	**$11.73**	**$7.35**
Productivity c	**$14.66**	**$9.19**
Productivity d	**$5.86**	**$3.68**

Updated on Feb. 12, 2001

"MINDI" DREDGE

Overhead	12%
Employee Benefits	38%
Night Shift Differential	10%
Complementary Sunday	25%
Overtime	50%

DAY SHIFT

On Deck Department:	Grade	No.	Hourly Rate	Total Hourly Rate	Annual Rate	With Benefits Annually	5 hours weekly with benefits annually	8 hours overtime weekly with benefits annually
Captain in charge	FE-17	1	$ 34.21	$ 34.21	$ 71,157	$ 98,211	$ 18,414	$ 29,463
Welder	MG-10	3	17.56	52.68	109,574	151,235	28,356	45,370
Seaman	MG-07	1	6.96	6.96	14,477	19,981	3,746	5,994
Laborer	MG-03	1	5.75	5.75	11,960	16,507	3,095	4,952
Subtotal		**6**		**$ 99.60**	**207,168**	**285,933**	**53,612**	**85,780**
Engine Department:								
Chief Engineer	ME-16	1	$ 32.02	$ 32.02	$ 66,602	$ 91,924	$ 17,236	$ 27,577
Deputy Chief Engineer	ME-15	1	29.99	29.99	62,379	86,096	16,143	25,829
Engineer	ME-14	1	28.15	28.15	58,552	80,813	15,153	24,244
Electrician	FE-11	1	24.35	24.35	50,648	69,904	13,107	20,971
Machinist	MG-10	1	17.56	17.56	36,525	50,412	9,452	15,123
Nautical engine mechanic	MG-10	2	17.56	35.12	73,050	100,823	18,904	30,247
Electrical Equipment Repairer	MG-09	1	11.12	11.12	23,130	31,923	5,986	9,577
Subtotal		**8**		**178.31**	**370,885**	**511,895**	**95,980**	**153,569**
Staff at Dredged Material Disposal Sites								
Leader	ML-10	1	$ 19.31	$ 19.31	$ 40,165	$ 55,435	$ 10,394	$ 16,631
Helpers	MG-05	2	6.23	12.46	25,917	35,770	6,707	10,731
Subtotal		**3**		**31.77**	**66,081.60**	**91,205.82**	**17,101.09**	**27,361.75**
TOTAL- DAY SHIFT CREW		**14**		**$ 309.68**	**644,134**	**889,034**	**166,694**	**266,710**
ROTATION CREW								
On-deck Department:								
Dredge Operator	FE-14	1	$ 28.15	$ 28.15	$ 58,552	$ 80,813	$ 15,153	$ 24,244
Dredge Officer	FE-11	1	24.35	24.35	50,648	69,904	13,107	20,971
Dredge Seaman Leader	ML-08	1	9.74	9.74	20,259	27,962	5,243	8,389
Winch Operator	MG-08	2	8.25	16.50	34,320	47,368	8,882	14,211
Dredge Seaman	MG-07	7	6.96	48.72	101,338	139,866	26,225	41,960
Subtotal		**12**		**$ 127.46**	**265,117**	**365,914**	**68,609**	**109,774**
Engine Department:								
Dredge Engineer	ME-14	1	$ 28.15	$ 28.15	$ 58,552	$ 80,813	$ 15,153	$ 24,244
Dredge Engineer	ME-11	1	$ 24.35	24.35	50,648	69,904	13,107	20,971
Oiler	MG-08	2	8.25	16.50	34,320	47,368	8,882	14,211
Subtotal		**4**		**$ 69.00**	**143,520**	**198,086**	**37,141**	**59,426**
Staff at Dredged Material Disposal Sites								
Tractor Operators	MG-10	2	$ 17.56	$ 35.12	$ 73,050	$ 100,823	$ 18,904	$ 30,247
Helper	MG-08	2	8.25	16.50	34,320	47,368	8,882	14,211
Subtotal				**$ 51.62**	**107,370**	**148,192**	**27,786**	**44,457**
TOTAL- ROTATION CREW		**16**		**$ 248.08**	**516,006**	**712,192**	**133,536**	**213,658**
TOTAL - 4 ROTATION CREWS					**2,064,026**	**2,848,768**	**534,144**	**854,630**
TOTAL - 5 ROTATION CREWS					**2,580,032**	**3,560,960**		
TOTAL WITH 4 CREWS, 1 DAY SHIFT AND OVERTIME							**3,904,496**	**4,859,143**
							446	**555**
TOTAL WITH 5 CREWS 1 DAY SHIFT AND NO OVERTIME						**4,449,994**		
						508		

Total Average Rate with cargo - 4 rotation crews and 8 hours of overtime weekly for each crew

Monday to Friday	660.01	
Saturday	474.79	
Sunday	593.49	
Total Average Hourly Rate	**$ 624.05**	**5,466,664**

Total Average Rate with cargo - 5 rotation crews and 1 hour of overtime weekly

Monday to Friday	645.15	
Saturday	497.34	
Sunday	621.67	
Total Average Hourly Rate	**$ 620.68**	**5,437,166**

1/ There are 5 steps in the hourly wage grade, and the last step was used.

2/ Employee benefits were included at 38.02% of the average hourly wages

3/ Included in the average hourly wages were 10% for night differential, 25% for complementary Sunday, and 50% for overtime.

4/ Eight hours of weekly overtime were included for each crew.

Updated on March 20, 2001

Dredging Division - Mindi Suction Dredge

12% Division Overhead (applied to labor)

Costs	FY 1995 Actual	FY 1996 Actual	FY 1997 Actual	FY 1998 Actual	Yearly Estimate	
Labor	$ -	$ -	$ -	$ -	-	
Supplies/Materials (excluding fuel)	905,333	676,442	1,232,400	1,038,000	963,044	
Supplies/Materials for Disposal Sites			58,000	313,000	185,500	
Other Direct Expenses	1,328,672	1,612,966			1,470,819	
General Maintenance	531,943	310,300	1,180,000	852,000	718,561	
Indirect Maintenance CC 556					79,200	1/
Equipment Maintenance at Disposal Sites			32,000	88,000	60,000	
Overhaul Expenses	328,029	691,217	1,571,000		863,415	
Depreciation	508,597	491,390	544,654	601,226	536,467	2/
Maintenance at Disposal Sites						
Maritime Insurance					72,837	3/
Total	$3,602,574	$ 3,782,315	$ 4,618,054	$2,892,226	$ 4,949,842	
Total Annual Estimate					$ 4,949,842	
Number of Available Days					270	
Daily Cost for Availability without crew (demand)					$ 18,333	
Hourly Cost for Availability without crew (demand)					$ 764	

	Inter-Divisional	Capital (with Division overhead)	Commercial (w/RGG)
Hourly Cost for Availability	$ 764	$ 764	$ 1,039
Stand-by or day crew, hourly	$ 310	$ 347	$ 472
Total Hourly Cost for Availability	**$ 1,074**	**$ 1,111**	**$ 1,511**
Hourly Cost for Availability	$ 764	$ 764	$ 1,039
Operations Crew - hourly cost	$ 624	$ 699	$ 951
Hourly Cost of Fuel	$ 228 4/	$ 228	$ 310
Hourly Cost of Operation (without support equipment)	**$ 1,616**	**$ 1,691**	**$ 2,299**
Support of 3 small tugboats	$ 319 5/	$ 336	$ 457
Guard or Passenger Support Boat	$ 73	$ 79	$ 107
Hydrography Support Launches (5 days a week - day shift)	$ 14	$ 15	$ 20
Hourly Cost of Operation (with support equipment)	**$ 2,022**	**$ 2,120**	**$ 2,883**

Rate for Mobilization

Hourly Cost for Availability (without crew)	$ 764	$ 764	$ 1,039
Hourly Cost of Operations Crew	$ 624	$ 699	$ 951
Hourly Cost of Pilot (required to move dredge)	$ 45	$ 51	$ 69
Cost of a large tugboat to move the dredge	$ 332	$ 354	$ 482
Cost of a small tugboat to move the dredge	$ 106	$ 112	$ 152
Cost of a mid-size tugboat to move pipes and pontoons	$ 202	$ 217	$ 295
Cost of a small tugboat to move pipes and pontoons	$ 106	$ 112	$ 152
Total Hourly Rate for Mobilization	**$ 2,180**	**$ 2,309**	**$ 3,140**

1/ Distribution of Support of "other 550" of 556 was based on the equitable assignment of the 5 largest equipment of the central cost system.

2/ The depreciation includes the dredge and its improvements, its auxiliary equipment, the discharge pipes and pontoons, as well a 4 tractors.

3/ The cost of maritime insurance paid by ACP in 2000 was proportionately allocated to all insured floating equipment.

4/ Usage of 290 gallons/hour, 42 gallons/barrel, $33/barrel.

5/ One CHAME class and two ULUA types.