ACP

AUTORIDAD DEL CANAL DE PANAMA
Oficina de Proyectos de Capacidad del Canal

THE PANAMA CANAL

Work Order No. 1
EVALUATION OF LOCK CHANNEL ALIGNMENTS

CONTRACT NO. CC-5-536

Summary Report
Part 1 of 4

August 2000

HARZA Engineering Company, Inc.
In association with
TAMS Consultants, Inc.

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS

PART 1 – SUMMARY REPORT

TABLE OF CONTENTS

CHAPTER PAGE

FOREWARD 1

1.0 INTRODUCTION 2
1.1 Background 2
1.2 Work Plan 4
1.3 Quality Control 5
2.0 REVIEW OF EXISTING INFORMATION 6
2.1 Establish Data Transfer Procedures 6
2.2 Review of Geotechnical Information 6
2.2.1 Cut Slopes 7
2.2.2 Boring Data 7
2.2.3 Other Information 8
2.3 Preparation of 3-D Digital Models 8
2.4 Review of Existing Site Conditions 8
3.0 REVIEW OF EXCAVATION METHODOLOGIES 9
4.0 DEVELOPMENT OF EVALUATION CRITERIA 11
4.1 Evaluation Criteria 11
4.2 Importance Coefficients 11
4.3 Evaluation Procedure 12
4.4 Ranking 12
5.0 INITIAL EVALUATION OF LOCK CHANNEL ALIGNMENTS 13
5.1 Review of Design Parameters 13
5.2 Preliminary Quantity Takeoffs 15
5.3 Scoring Assignments for Each Alignment 15
5.3.1 Atlantic Entrance Alignments 15

5.3.2 Pacific Entrance Alignments 16
5.4 Conclusions 16
6.0 FINAL EVALUATION OF LOCK CHANNEL ALIGNMENTS 19
6.1 Preliminary Lock Layouts 20
6.1.1 General Criteria 20
6.1.2 Atlantic Entrance Layouts 21
6.1.3 Pacific Entrance Layouts 22
6.2 Quantity Takeoffs 22
6.2.1 One Way Traffic Excavation Quantities 22
6.3 Refined Alignment Screening 24
6.3.1 Atlantic Entrance Alignments 25
6.3.2 Pacific Entrance Alignments 25
6.4 Preliminary Excavation Cost Estimate 26
6.5 Construction Sequence Analysis 27
6.6 Conclusions 28
7.0 OPTIMIZATION OF LAYOUTS 30
7.1 Preparation of Standard Layouts 30
7.2 Preparation of Site Specific Layouts 30
7.2.1 Introduction 30
7.2.2 Water Saving Basins 31
7.2.3 Location of the Ship Lift 31
7.2.4 Atlantic Entrance 31
7.2.5 Pacific Entrance 32
7.3 Comparison of Excavation Quantities for Various Parameters 32
7.4 Conclusion 33

TABLES

No.	Title	Page
1	Comparison of Excavation Equipment	9
2	Summary of Initial Design Parameters	14
3	Kepner-Tregoe Ranking for Atlantic Entrance	17
4	Kepner-Tregoe Ranking for Pacific Entrance	17
5	Summary of Alignment Numbers	19
6	Summary of Excavation Quantities - Atlantic Entrance Alignments	22
7	Summary of Excavation Quantities - Atlantic Entrance Alignments	23
8	Final Kepner-Tregoe Ranking	24
9	Preliminary Excavation Cost Estimates	27
10	Summary of Construction Duration	28

EXHIBITS

Exhibit	Title
1	Location Map
2	Detailed Location Map
3	Atlantic Entrance Study Area
4	Pacific Entrance Study Area
5	Acronym and Abbreviation List
6	Alignment A1 – Through 1939 Third Locks Excavation
7	Alignment A2 – East of Existing Gatun Locks
8	Alignment A3 – Through the French Canal and Gatun Dam
9	Alignment P1 – Far West Bypass
10	Alignment P2 – Near West Bypass
11	Alignment P3 – Dual Lock East of Existing Locks
12	Alignment P4 – Dual Lock West of Existing Locks
13	Alignment P5 – Dual Lock Using 1939 Excavation
14	Summary of Navigation Times

APPENDICES

Appendix	Title
A	Work Plan for Evaluation of Lock Channel Alignments
B	Quality Control Documentation

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS

PART 2 – INITIAL EVALUATION OF LOCK CHANNEL ALIGNMENTS

TABLE OF CONTENTS

CHAPTER

1.0 SUMMARY
2.0 REVIEW OF DESIGN PARAMETERS
3.0 PRELIMINARY QUANTITY TAKEOFFS
4.0 SCORING ASSIGNMENTS FOR EACH ALIGNMENT
  4.1 Atlantic Entrance Alignments
  4.2 Pacific Entrance Alignments
5.0 CONCLUSIONS

APPENDICES

Appendix	Title
A	Review of Existing Material
B	Development of Evaluation Criteria
C	Design Criteria
D	Excavation Quantity Comparison for Pacific Entrance
E	Kepner-Tregoe Evaluation of Alignments
F	References

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS

PART 3 – FINAL EVALUATION AND OPTIMIZATION

TABLE OF CONTENTS

CHAPTER

1.0 FINAL EVALUATION OF LOCK CHANNEL ALIGNMENTS
- 1.1 Introduction
- 1.2 Preliminary Lock Layouts
- 1.3 Quantity Takeoffs
- 1.4 Refined Alignment Screening
- 1.5 Construction Sequence Analysis
- 1.6 Conclusions

2.0 OPTIMIZATION OF LAYOUTS
- 2.1 Preparation of Standard Layouts
- 2.2 Preparation of Site Specific Layouts
- 2.3 Location of the Ship Lift
- 2.4 Excavation Quantity and Cost Comparison

APPENDICES

Appendix	Title
A	Preliminary Excavation Cost Estimates
B	Summary of Excavation Quantities
C	Excavation Quantities for Phased Construction Approach
C	References

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS

PART 4 – REVIEW OF EXCAVATION METHODOLOGIES

TABLE OF CONTENTS

CHAPTER

1.0 INTRODUCTION
2.0 REVIEW OF EXISTING APPLICATIONS AND METHODS
- 2.1 Wet Excavation Techniques
- 2.2 Dry Excavation Techniques
- 2.3 ACP Excavation Experience in Panama
- 2.4 Disposal Methodologies

3.0 SURVEY OF FUTURE TRENDS
- 3.1 Wet Excavation Techniques
- 3.2 Dry Excavation Techniques

4.0 EVALUATION OF METHODOLOGIES
- 4.1 Wet Excavation Techniques
- 4.2 Dry Excavation Techniques

5.0 CONCLUSIONS AND RECOMMENDATIONS

APPENDICES

Appendix	Title
A	Wet Excavation Equipment
B	Dry Excavation Equipment
C	Global Positioning System Equipment
D	References

FOREWARD

Authorization

This study was authorized by the Panama Canal Authority under Contract No. CC-5-536 and completed under Harza project number 15593, Task Order No. 1.

Scope

The purpose of this study is to evaluate alternative alignments for a new lock channel at the Pacific and Atlantic entrances of the Panama Canal. The alignments are recommended sites for the construction of new sets of locks and a ship-lift. The work area is within the immediate vicinity of the locks and does not include canal entrance channels.

Acknowledgments

This report was prepared for Cesar Kiamco, Project Manager, Canal Capacity Projects Office, Panama Canal Authority. The report was prepared by Harza Engineering Company, Inc. under the supervision of Michael Newbery, P.E., Project Manager, and Nicholas Pansic, P.E., Task Order Manager in association with Tams Consultants, Inc., Jean-Pierre Minios, Project Manager. Harza wishes to thank CCPO staff for their assistance and guidance in preparing the report. In particular, Harza thanks Mr. Betto Arias, Manager of the Canal Capacity Projects Office and John Gribar, P.E., consultant to the CCPO. Special thanks also go to the locks team: Rigoberto Delgado, Project Engineer, Boris Moreno, and Juan Wong.

1.0 INTRODUCTION

1.1 Background

The Panama Canal has operated since its opening in 1914 using two lanes of three-lift locks to transport vessels between the Atlantic and Pacific Oceans. (See Exhibits 1-4) During the past 86 years, three developments have brought the canal to its present full capacity condition. First, the existing water supply has become insufficient to reliably accommodate the number of lock passages each year. Second, the size of ocean-going ships has grown steadily and surpassed the maximum size able to pass the current locks, known as Panamax. Third, steadily increasing ship traffic has reached canal capacity and led to delays in transiting the canal. Delays result from lock closures during regular maintenance of the nearly 90 year old structures. To date, the delays have been addressed by removing the bottlenecks from the Canal. Currently, the Gaillard Cut is being widened to allow two-way traffic of Panamax vessels through the entire Canal. When the Gaillard Cut widening is completed by mid 2001, the locks capacity and water supply will become the limiting factors for increasing Canal traffic. This study addresses measures to relieve the locks capacity limitations.

Until now, the canal has operated efficiently with two lanes of locks. Though regular maintenance occasionally takes one lane out of service, traffic has flowed with little interruption. However, when the widened Gaillard Cut begins allowing two-way Panamax traffic throughout the canal, the two lanes alone will not be able to lock a sufficient number of ships through to meet canal demand. The canal risks losing traffic to other ocean routes or alternative cross-continental transportation. Further, an increasing percentage of new ocean-going vessels recently constructed or under construction are too large to pass through the existing locks (Post-Panamax). Thus, the Panama Canal risks losing traffic and revenue because of its limitations on both vessel size and traffic volume.

To address Canal expansion issues the Panama Canal Authority (ACP) and other international organizations have undertaken several studies. The most recent ones include the 1993 Canal Alternatives Study (CAS) and the 1997 Concepts Study for Canal Alternatives (See Part 2, Appendix F for a complete list of references).

In 1993, the Commission for the Study of Alternatives to the Panama Canal concluded their study, the CAS. The Commission was created under a joint effort of the governments of Panama, Japan and the United States. This study was a comprehensive review of a broad range of options to meet the traffic demands of the world trade. These options included:

- raising Gatun Lake level to El 27.4 m (PLD) from the current level at El 25.9 m;
- lowering Gatun Lake level to El 16.5 m (Miraflores Lake level) or to El 9.0 m;
- several options of a sea-level canal;
- consideration of larger size vessels (Post-Panamax) up to 250,000 DWT.

The CAS concluded that a canal capable of accommodating vessels larger than 65,000 DWT (Panamax) was needed. It recommended further study of a modified high rise lock channel to accommodate vessels of 150,000 to 200,000 DWT. It also recommended further study of water supply issues, toll structures, and monitoring of canal traffic to determine the timing for expansion.

In 1997, the Panama Canal Commission (predecessor to the ACP) funded the Concepts Study for Canal Alternatives, which was conducted by a broad-based multi-specialized team with representation from the U.S. Army Corps of Engineers, other U.S. Government agencies and other entities. The report updated and focused the CAS, and introduced several options and concepts to be further evaluated including the shiplift for vessels up to 30,000 DWT. This report also recommended that a sea-level Canal or a separate locks type Canal at another location not be further considered until water supplies for the existing project are exhausted.

In 1998, in order to synthesize the findings of these studies and to address the issues related to canal capacity, both traffic volume and vessel size, the ACP created the Canal Capacity Projects Office (OPCC) to oversee canal capacity studies. The OPCC began studying expanding canal capacity with a reconnaissance study to recommend location and capacity of potential canal water supply in the western watershed area. Additional water supply is a key factor to canal expansion since each passage of a ship through the canal discharges approximately 210 million liters (55 million gallons) of fresh water into the sea. Current studies show that soon water supply will become the limiting factor in increasing canal capacity.

Based on the previous studies the OPCC concluded that the next evaluation should consider alignments that would use the Gatun Lake at the current level (El. 25.9 m PLD). If an increase in vessel size (Post-Panamax) was to be considered, it would be for vessels of approximately 150,000 DWT. Any new locks would be in the vicinity of the existing facilities in order to make use of the rest of the canal without long bypass channels.

The OPCC then began considering the expansion of canal capacity by constructing a third (and possibly a fourth) lane of locks. Twenty new lock channel alignment concepts (six at the Atlantic Entrance and 14 at the Pacific Entrance) were identified for study. The OPCC directed this study of these alignments to identify the two best alignments at each entrance.

1.2 Work Plan

Prior to commissioning this study, the OPCC performed preliminary investigations based on map studies and prepared several alternative alignments at the Atlantic and Pacific entrances to the Canal. This study uses more detailed topographic and geotechnical information to further evaluate the OPCC alignments. Additional alignments are also proposed and analyzed. The alignments were studied to achieve the ultimate aim of providing a third and fourth lane of locks, and ship lift for smaller vessels and water-saving features. The addition of the third and fourth lane of locks may take place simultaneously, or performed in stages.

The work was performed based on the following breakdown of tasks:

Task 1 – Review of Existing Information
Task 2 – Development of Evaluation Criteria
Task 3 – Initial Evaluation of Lock Channel Alignments
Task 4 – Final Evaluation of Lock Channel Alignments
Task 5 – Optimization of Layout
Task 6 – Review of Excavation Methodologies
Task 7 – Preliminary Cost Estimates for Lock Channel Alignments
Task 8 – Preparation of Draft and Final Reports
Task 9 – Technology Transfer and Training
Task 10 – Project Management

A detailed breakdown of the work and sub-tasks together with the deliverables and milestones is included in Appendix A.

1.3 Quality Control

The quality control plan follows the guidelines put forth in Harza's QA/QC manual for feasibility level studies. The main components of the plan call for specialist review for critical tasks, and clear, organized and checked documentation of computations. The quality control plan and documentation are included in Appendix B.

2.0 REVIEW OF EXISTING INFORMATION

The evaluation of lock channel alignments began with a review and documentation of existing information available for the study. This included geotechnical and geological data as well as topography for the Gatun, Miraflores and Pedro Miguel lock sites and surrounding areas. During this phase, a data transfer procedure was developed and tested to see that information could flow freely between Harza and the OPCC throughout the study.

2.1 Establish Data Transfer Procedures

In order to verify that the systems and electronic file transfer protocols for information sharing between Harza and the ACP were compatible, Harza sent a preliminary summary memo (in Microsoft (MS) Word format) via e-mail. Harza attached several different file types to verify that the system could handle a variety of file types. Hard copies of these files were also included as an attachment. The ACP was able to open, manipulate and produce hard copies that matched provided hard copies for these files.

Harza created a directory on Harza's File Transfer Protocol (FTP) site for specific use on this project. Appendix A in Part 2 contains information on the location of the FTP site and instructions for up/downloading information from the project directory.

2.2 Review of Geotechnical Information

During the initial site visit to the ACP offices, Harza met with staff from the Geology and Geotechnical Sections and received copies of several boring location maps. Copies of the geotechnical summary sheets in electronic format and the Third Locks geological exploration drawings for Pedro Miguel and Gatun were also received. Appendix A of Part 2 lists information that was provided by the ACP. This also included data on the predicted cut slopes. There was also extensive boring data from the 1939 Third Locks Project partially in hard copy and partially in electronic format. Finally, other geological and geotechnical data was uncovered from the 1939 Third Locks Project. This included documents from the Army Corps of Engineers and the American Society of Civil Engineers.

2.2.1 Cut Slopes

The ACP directed Harza to use the five slope types provided in the 1993 Canal Alternatives Study (CAS). The CAS report presents slope criteria for five types of geological conditions that could be encountered along the proposed canal and lock routes. It was assumed that, in general, these excavation criteria are suitable for planning purposes in the canal area provided that they are applied judiciously. It was also assumed that, during later phases of engineering activity, cut slope design for individual features and excavations would be adjusted on a case by case basis depending on actual conditions.

Of the five slope categories, Types 3, 4, and 5 have been identified for the Pacific Entrance layouts and Type 5 for the Atlantic Entrance layouts except for the alignments using the 1939 cut, where the slope recommended by the 1939 design was used. They were used in screening studies and in the preparation of drawings and excavation quantity estimates. In principal, this approach is appropriate for this level and stage of study.

2.2.2 Boring Data

The ACP supplied a summary containing records from approximately 1000 borings completed as part of the 1939 Third Locks Project. The summary was available in hardcopy and also partially in electronic copy. The borings generally listed the elevation of top of sound rock, top of weathered rock and ground surface as well as a general description of the rock type. Many of the typed log entries were inconsistent with the electronic copies. In several cases, the top of rock was listed at an elevation above the ground surface. Where the top of rock was found above the existing ground, the top of rock elevation was changed to be the same as the existing ground.

Once the boring logs were entered in electronic format and corrected, geologic models of the boring areas were constructed in gINT for the Atlantic Entrance and GEMCOM for the Pacific Entrance. For the Atlantic entrance, the boring data offered sufficient coverage to create a comprehensive model for the proposed alignment areas. For the Pacific entrance, the boring data was limited to the site of the proposed locks for the 1939 project. In particular, there were no borings east of the existing locks. It was not possible to construct a comprehensive GEMCOM model to cover the entire investigation area. See Part 3, Section 1.3 for a discussion of how quantities of sound rock, weathered rock and overburden were estimated for the Pacific entrance.

2.2.3 Other Information

Additional records were obtained from the 1939 Third Locks project. Among these were color maps showing the general distribution of rock type in the Pedro Miguel-Miraflores area. These maps were used to plot general foundation conditions for the proposed new locks and barrier dam as part of the Final Evaluation of Alignments (Part 3). Photographs of the 1939 excavation were also located and used to substantiate assumptions made about the use of the CAS slope types in the locks area.

2.3 Preparation of 3-D Digital Models

Electronic copies of the topographic and hydrographic survey ASCii data were obtained in order to create digital models and provide quantity takeoffs. Attachment A-2 lists the information requested and received. In the Final Evaluation IFSAR data from the 1993 USACE Mobile District survey was used to construct a Digital Terrain Model (DTM) and perform quantity takeoffs. The models were limited by the accuracy of the IFSAR data and thus should not be construed as providing more than a basis of comparing the alignment alternatives.

2.4 Review of Existing Site Conditions

As part of this task, existing site conditions were reviewed to ascertain the likely impacts to the proposed channel alignments. Aerial photos, nautical charts, and maps were obtained and examined to identify potential construction or operational obstacles and to optimize layouts. This information was used throughout the evaluation.

3.0 REVIEW OF EXCAVATION METHODOLOGIES

A variety of excavation techniques may be employed in the construction of the proposed new alignments. In general, all alignments would require a combination of both dry and wet excavation. The type of equipment employed will depend on the final quantity and character of the materials to be excavated. Table 1 below summarizes the relative efficiencies of wet and dry excavation equipment for the proposed alignments.

Table 1

Comparison of Excavation Equipment

Rating	1	2	3
Efficiency	Best-Suited	Suitable	Not Appropriate

Equipment	Soil Type				
	Sound Rock*	Weathered Rock*	Blasted Rock	Compacted Soils	Loose Soils
Wet Excavation					
Mechanical					
Dipper Dredge	1	1	1	1	1
Backhoe Dredge	1	1	1	1	1
Clamshell Dredge	3	3	2	2	1
Land-based Backhoe	2	1	1	1	1
Hydraulic					
Suction Dredge	3	3	3	3	1
Cutter Suction Dredge	2	1	1	1	1
Trailing Suction Dredge	3	3	3	2	1
Dry Excavation					
Excavation					
Scraper	3	3	3	1	1
Holland Loader	3	3	3	1	1
Hydraulic Shovel	2	1	1	1	1
Wheel Loader	1	1	1	1	1
Transport					
On Road Truck	3	3	3	1	1
Off Road Truck	1	1	1	1	1
Conveyor	3	3	3	1	1

*In dry conditions, rock must be ripped by a tractor prior to excavation.
Up to 40Mpa (5,800 psi).

Both dry and wet excavation in the proposed alignments will benefit from improved technology. Real time kinematic GPS technology now allows excavation to proceed with great precision in both dry and wet situations. Larger land-based and floating equipment offer greater efficiency and lower costs on massive excavations such as that required for the new locks.

The Gaillard Cut widening program offers evidence that contracting out dry excavation is both cost-effective and efficient for the ACP. If contracts are grouped into larger quantities, economies of scale could reduce the unit prices. A multimillion cubic meter excavation contract would warrant the purchase or lease of larger, more efficient equipment for excavation and hauling.

A similar approach could reduce the cost of underwater excavation as well. Grouping wet excavation into a few large dredging contracts could reduce unit costs and attract the world's most efficient equipment. In particular, large cutter suction and backhoe dredges currently available could offer competitive costs and attractive schedules when compared with use of ACP equipment only.

Finally, spoil from both wet and dry excavation has many potentially beneficial uses. Spoil may be used within the project as fill for dams or to create platforms for new ancillary structures. High quality rock will also provide aggregate for the new concrete guidewalls and locks. Excavated rock could be used to reinforce and expand the Amador Causeway. Local contractors and developers may purchase spoil for fill or aggregate. Also, after environmental evaluation, the overburden may be useful for filling in low-lying areas or to create wetlands habitats.

4.0 DEVELOPMENT OF EVALUATION CRITERIA

The evaluation procedure of Kepner and Tregoe (1981) was adopted to perform the initial alignment evaluations. The three basic steps of the Kepner and Tregoe approach are:

1. Identification of relevant evaluation criteria (or attributes) and an assessment of the relative importance of each attribute (importance coefficient).
2. Determination of appropriate quantitative measures for each of the evaluation criteria.
3. Measurement or assessment of quantities or qualities of each alternative with respect to each evaluation attribute, and the assignment of a score. Weighted scores are then derived from the product of the score and importance coefficient. The sums of the weighted scores for each alternative serve as a guide to identify the most favorable alternative(s).

4.1 Evaluation Criteria

Harza and ACP team members worked closely to develop appropriate evaluation criteria during a meeting in Panama on October 22, 1999. Each of the sixteen evaluation criteria has been assigned to one of the following five evaluation categories: Technical, Operational, Constructibility, Economic and Other Impacts. Appendix B of Part 2 describes how the scores were awarded to each alignment for each evaluation criterion.

4.2 Importance Coefficients

Team members assigned importance coefficients to each of the criteria in the range 10 (most important) to 1 (least important). Composite importance coefficients were developed based on the average of each individual assessment, and were then normalized to employ the full range of possible scores from 1 to 10. Normalization respects the ranking of the coefficients while providing a numerical means of differentiating among alignments. Appendix B of Part 2 shows the development of the importance coefficients.

4.3 Evaluation Procedure

The scoring procedure involved the assignment of a numerical value to each alignment for each criterion. The assigned values were in the range 5 (most favorable) to 1 (least favorable). Weighted scores, which are the product of the raw score and the importance coefficient were then determined. A worksheet developed to record the evaluations and the rationale behind each of the assigned scores for each of the alignments is provided in Appendix B of Part 2.

4.4 Ranking

The alignments were ranked based on the sum of the weighted scores. Initially two ranking systems are proposed. The first approach was to sum all of the weighted scores and rank the alignments on the basis of the gross score. A second approach was to combine the weighted scores from each evaluation category into a single value, and then to assign a weighting factor to each of the categories. An example of each approach is provided in Appendix B of Part 2. The ACP determined that the first approach provided the best results and would be applied to ranking the top alignments for each entrance.

5.0 INITIAL EVALUATION OF LOCK CHANNEL ALIGNMENTS

The Initial Evaluation of Lock Channel Alignments used the data and information collected in the Review of Existing Information, and the methodology established in the Development of Evaluation Criteria to perform preliminary evaluations of alternative channel alignments for a new third lane of Panama Canal locks. As part of the task, two new alternative alignments were proposed on both the Atlantic (Alignments 31 and 32) and the Pacific (Alignments 41 and 42) entrances. These alignments were analyzed along with twenty ACP proposed alignments. This task was designed to screen the large number of alternative alignments to identify the most favorable concepts to carry forward for further, more detailed analysis. The end result of the analysis was a narrowing from twenty-four alignment choices to eight: three at the Atlantic entrance and five at the Pacific entrance.

Based on the results of this analysis, the OPCC decided to carry forward Alignments 5, 6 and 18 on the Atlantic entrance and Alignments 3, 7, 8, 11 and 42 on the Pacific entrance for further analysis. For the Atlantic entrance, from the eight alternatives evaluated, the two most viable alignments are located on the east bank, thereby avoiding the added difficulty of building the locks through the Gatun Dam. Alignment 5 allows integration with the operation of the existing Gatun Locks but will significantly interfere with their operations during construction. Alignment 6 takes advantage of the 1939 excavation and its construction does not disrupt the Canal operation, however it cannot be easily integrated with the current operation. Alignment 18, which is on the west bank, allows integration with the existing locks and minimizes the interference during construction. The scheme, however, requires construction through the Gatun Dam. The five Pacific alignments represent the best concepts presented for evaluation. Among the five carried forward are two bypass alignments that provide the operational simplicity of a single lock complex as well as operational balance with the Gatun locks. The other three Pacific alignments offer the advantages of integration with existing operations and make maximum use of the existing Lake Miraflores.

5.1 Review of Design Parameters

Each alignment was evaluated for a post-Panamax design vessel and lock. Some of the ACP proposed alignments provided showed features such as water saving basins and recycling ponds that others did not include. In the Final Evaluation of Lock Channel

Alignments (Section 5.0), a layout is presented for each of the eight preferred alignments including a third and fourth lane and other ancillary structures such as water saving basins. As part of the Optimization of Layouts (Section 6.0) various lock sizes and design vessels are analyzed for the two recommended alignments at each entrance.

Table 2 below provides the design parameters applied to the alignments. Many of these criteria were established in and taken from the 1993 CAS and the 1997 Concepts Study for Canal Alternatives. These parameters were applied universally to each alignment with the exception of the Pacific entrance alignments that passed immediately adjacent to the existing locks. For those alignments, bottom widths were slightly modified to account for the special condition of the existing locks.

Table 2

Summary of Initial Design Parameters

	Parameter	Dimension	Comments/ Source
VESSEL	Vessel Dimensions Small Panamax Post-Panamax	Length x Draft x Beam 183 m x 8.7 m x 24.0 m 294 m x 12.0 m x 32.3 m 350 m x 14.0 m x 46 m	Concepts Study for Canal Alternatives (1997) pp. ii-iii.
	Design Vessel	350 m x 14.0 m x 46 m	Post-Panamax
CHANNEL	Channel Bottom Width	276 Meters	October 22, 1999 Meeting Between PCC and Harza; Six x design ship beam
	Channel Depth	16.76 Meters (55 feet)	Concepts Study for Canal Alternatives (1997), p. ii.
	Side Slopes Type 1 Unaltered Volcanic Rock Type 2 Intact Sedimentary Rock Type 3 Soft Volcanic Rock Type 4 Highly Weathered Rock Type 5 Unconsolidated Deposits	Underwater / Above Water 2H:3V / 2H:3V 1H:1V / 1H:1V 1H:2V / 1H:1V 1H:2V / 2H:1V 2.5H:1V / 10H:1V	Canal Alternatives Study Volume IV (1993) pp. I.3-26 – I.3-28
LOCK	Lock Dimensions Small Panamax Post-Panamax	Length x Depth x Width 198 m x 10.1 m x 26.5 m 325 m x 13 m x 33 m 381 m x 17 m x 49 m	Scope of Work; p. 5. Design Beam = 24.0 m Design Beam = 32.3 m Design Beam = 46.0 m
	Design Lock	381 m x 17 m x 49 m	Concepts Study for Canal Alternatives, p. iii. Depth over sills

5.2 Preliminary Quantity Takeoffs

Comparative manual quantity takeoffs were performed on selected alignments as part of the Initial Evaluation of Lock Channel Alignments. Quantity variations for the Atlantic entrance alignments were generally obvious by inspection. Therefore, simple hand calculations were sufficient to differentiate and score the "Excavation Cost" and "Construction Period" criteria for the Atlantic entrance alignments. The Pacific entrance alignments required additional analysis. Manual quantity takeoffs were performed on eight proposed Pacific alignments: 1, 3, 7, 8, 11, 14, 41, and 42. Initially, the quantities were calculated manually in order to provide a comparison with the quantities calculated with an InRoads Digital Terrain Model (DTM) during the Final Evaluation. Quantities were not calculated on the other Pacific alignments because they either were unnecessary by inspection, or they were similar enough to other alignments that another alignment's quantity would apply to them.

5.3 Scoring Assignments for Each Alignment

The alignments were first analyzed and scored using the scoring criteria and the evaluation worksheet developed in Section 4.3. One worksheet was completed for each alignment and the scores were then transferred to the matrix of raw scores. From these raw scores and the importance coefficients developed in Section 4.2, weighted scores were calculated and tabulated.

The alignments were ranked based on the sum of the weighted scores. Category weighting was used to perform sensitivity analysis. The sensitivity analysis used a variety of category weightings to highlight the strengths and weaknesses of each alignment. A variety of category weightings were tested to verify that no alignment was being improperly disqualified. Any alignments that appeared more than once in the top five for the various category weightings were reexamined and reevaluated.

5.3.1 Atlantic Entrance Alignments

For the Atlantic entrance, the ACP had identified six basic alignments. Three were placed on the east bank of the Gatun Locks (4, 5 and 6), and three were on the west bank (17, 18 and 19). Two additional alignments were developed for this initial evaluation, alignments 31 and 32. Both were placed on the west bank to address the issue of traffic congestion in the approach to the Gatun Locks. The description and scoring of each alignment is detailed in Part 2.

5.3.2 Pacific Entrance Alignments

For the Pacific entrance, the ACP proposed two basic alignment types. The bypass type consists of a single lock complex that bypasses or divide Lake Miraflores (Alignments 2, 7, 8, 9, 10, 12, 14, 15, 16 and 20). The conventional type utilizes two lock complexes and the existing Lake Miraflores (Alignments 1, 3, 11, 13, 41 and 42), similar to the existing situation.

All alignments transit beneath the site of the formerly proposed Van Dam Bridge. The ACP is considering different bridge alignments that may be affected or adjusted by both the third and fourth lanes of the lock alignments. The location and clearance of this bridge are significant considerations for long-term planning of canal expansion. However, for the initial evaluation of the alignments, only existing infrastructure was considered in comparing the alignments. The description and scoring of each alignment is detailed in Part 2.

5.4 Conclusions

The initial evaluation of lock channel alignments concluded that three Atlantic entrance schemes and five Pacific entrance schemes warrant further evaluation:

Atlantic:	Alignments 5, 6, and 18.
Pacific:	Alignments 3, 7, 8, 11, and 42.

Part 2 provides details of the Kepner-Tregoe evaluation and scoring. The final overall rankings are listed in Tables 3 and 4 on the next page.

Table 3

Kepner-Tregoe Ranking for Atlantic Entrance

Alignment No.	Score	Rank	Carried Forward	Remarks
4	253	4	No	Combined with Alignment No. 5.
5	272	2	Yes	
6	309	1	Yes	Ranks first among east bank alternatives.
17	236	5	No	
18	258	3	Yes	Ranks first among west bank alternatives.
19	223	6	No	
31	217	7	No	
32	195	8	No	

Table 4

Kepner-Tregoe Ranking for Pacific Entrance

Alignment No.	Score	Rank	Carried Forward	Remarks
1	218	11	No	
2	199	16	No	
3	276	1	Yes	Highest ranking dual lock alternative.
7	238	3	Yes	Highest ranking bypass alternative.
8	225	9	Yes	Bypass alternative, to be optimized with Alignment 14.
9	220	10	No	
10	206	14	No	
11	232	4	Yes	
12	213	13	No	
13	229	7	No	
14	231	5	Yes	
15	218	12	Yes	Bypass alternative, to be optimized with Alignment 7
16	206	14	No	
20	231	5	No	
41	226	8	No	
42	253	2	Yes	

The Initial Evaluation eliminated some of the less desirable alignments while highlighting the good features of all alignments. For the Atlantic entrance, the Final Evaluation addresses in detail the pros and cons of the concentration of canal operation, as would occur with Alternative 5. This advantage will be balanced against the disruption of the canal operation during construction that would be avoided with Alternatives 6 and 18.

The five Pacific alignments carried forward allow for optimization of both of the general alignment schemes presented by the ACP: one lock complex bypass alignments and conventional two-lock complex alignments. In addition, both east and west bank alignments are preserved. The Final Evaluation of Lock Channel Alignments includes detailed quantity takeoffs for the remaining five Pacific alignments. The development of standard lock structures and features will also help discriminate among the five.

6.0 FINAL EVALUATION OF LOCK CHANNEL ALIGNMENTS

This task takes the results of the Initial Evaluation and refines them to recommend two final alignments to carry forward for the Atlantic Entrance and two for the Pacific Entrance. In the Initial Evaluation, concepts were identified for the eight alignments to carry forward. Because these concepts represented combinations and optimizations of the original proposed alignments, new numbers have been assigned to each alignment. The new numbers are summarized in Table 5 below.

Table 5

Summary of Alignment Numbers

New Alignment Number	Old Alignment Number
A1	6
A2	4,5
A3	18
P1	8, 14
P2	3, 7, 15
P3	42
P4	3
P5	11

This report section details the steps taken in final evaluation of the proposed lock channel alignments. The first step was preparation of standard footprints for typical lock complexes. For the Atlantic entrance, a single three-lift lock was laid out for all three alignments analyzed. For the Pacific entrance, a three-lift complex was laid out similar to the Atlantic layout for use with the bypass alternatives. In addition a single-lift lock and a double-lift lock, mirroring the current lock complexes, were laid out. The single-lift footprint would be used for the new third lane at Pedro Miguel under the dual lock complex scenarios. The double-lift footprint would be used at Miraflores under the same scenarios.

Next, the eight channel alignments were laid out with the standard lock features. At this stage the alignments were partially optimized. Once laid out, quantity calculations were performed for each alignment. Then, using the layouts, a construction sequence was developed for each alignment. Finally, with the results of these analyses, the alignments were re-evaluated and the final recommendations of which alignments to carry forward were made.

Excavation cost estimates were also performed as part of this task. They are summarized in Section 6.4 and provided in detail in Part 3, Appendix A.

6.1 Preliminary Lock Layouts

6.1.1 General Criteria

In order to evaluate and compare the eight alignments carried forward from the Initial Evaluation, a preliminary standard lock layout was developed. The three Atlantic and five Pacific alignments were evaluated using variations on the preliminary standard layout. On the Atlantic side, a three-lift lock was applied to each of the three remaining alignments. For the Pacific Entrance, the bypass alignments were evaluated with a similar three-lift lock while the dual lock complex alignments were evaluated with a standard two-lift complex at Miraflores and a one-lift lock at Pedro Miguel. Plan views and cross-sections of the proposed lock complex layouts are provided in Part 3. In developing the standard lock layouts, the following eight criteria were used.

1. Locomotives will continue to be used for vessel guidance on the new third and fourth lanes.

2. The proposed third and fourth lane will both be constructed with Post-Panamax dimensions. The new design vessel dimensions are 350 meters long, 46 meters in beam and 14 m in draft. Accordingly, each new lock chamber will measure 381 meters long, 49 meters wide and 17 meters deep (over the sills).

3. New guide walls will be 450 m long and approximately 18 m wide on both the upstream and downstream sides. That length is 120% of the chamber length. This is consistent with the existing guide walls that are 365 m long, or 120% the length of existing chambers. Guard walls are placed at the outside approach to each lock complex. Guard walls are 100 m long and taper out at a 1:4 ratio.

4. The right of way for the approach highways and bridges over the Miraflores and Gatun locks will be maintained. New swing bridges would be required over the third and fourth lock lanes at both Miraflores and Gatun. The costs of the new roads or bridges were not considered in this analysis.

5. Each water saving basin is laid out with a footprint of 58 m x 400 m. This is an area of approximately 120% of a new individual lock chamber. Three basins are required for each lock chamber. Thus a total of nine basins are required for a three-lift lock complex. For alignments A1, P1 and P2, the basins are constructed on three levels and laid out in a staircase arrangement with the top of each basin open to facilitate maintenance. The nine basins required for each three-lift lock would require a total of 21 hectares. For all other alignments, the three levels of basins are stacked one on top of another and supported by internal columns. Thus, they require only one third of the land area of the "staircase" structures. The basins will be founded on rock or on driven piles.

6. Where feasible, water saving basins will be placed between the existing second lane of locks and the proposed third lane. They will be shallow structures and will be situated far enough from the existing lock wall that excavation for their construction will not require anchoring of the existing lock wall. It may be possible to integrate the basins into the existing second lane operations. This would require additional culverts and concrete work in the existing lock wall during annual maintenance periods.

7. The alignment excavation will assume an initial width of four times the design vessel beam (184 m) with future expansion to six times the design vessel beam (276 m).

8. The third and fourth lane lock complexes are completely separate structures divided by 30 m. It may be possible to construct the outside third lane wall such that it could be integrated as the inside wall of a fourth lane later. However, as the dimensions of the fourth lock are not set, a shared center wall between the third and fourth lanes has not been considered at this stage.

6.1.2 Atlantic Entrance Layouts

For the Atlantic Entrance, three alignments were evaluated. The layouts are shown on Exhibits 6 through 8. Detailed descriptions of the Atlantic entrance layouts are included in Part 3.

6.1.3 Pacific Entrance Layouts

For the Pacific entrance, five alignments were evaluated. The two bypass alignments are shown on Exhibits 9 and 10, and the three dual lock alignments are shown on Exhibits 11 through 13. Detailed descriptions of the Pacific entrance layouts are included in Part 3.

6.2 Quantity Takeoffs

6.2.1 One Way Traffic Excavation Quantities

Excavation quantities were estimated for the Atlantic and Pacific entrance alignments using mapping and radar imagery (IFSAR) provided by the ACP. For both entrances, the data was used to construct a Digital Terrain Model (DTM).

For the Atlantic entrance the digital topographic data was limited to the IFSAR model. Other information used to create the DTM includes approximately 500 boreholes performed prior to the 1939 Third Lane Excavation and design drawings of the excavation. The DTM was created with AutoCAD 2000 and the associated software LANDDEVELOPMENT. A summary of the excavation quantities for the Atlantic Entrance is given in Table 6 below.

Table 6

Summary of Excavation Quantities - Atlantic Entrance Alignments

Alignment	Approx. Length (km)	Approx. Volume (million m^3)
A1 - East Bank Alignment Through 1939 Excavation	5.4	12.4
A2 - East Bank Alignment Adjacent to Existing Locks	4.4	12.1
A3 - West Bank Alignment Through the French Canal and Gatun Dam	4.0	14.0

For the Pacific entrance, detailed excavation takeoffs were performed using an InRoads DTM constructed from 3-D contours provided by the ACP. The DTM was created from the ASCii and DTM data from the 1993 Mobile District USACE survey and bathymetric data provided by the ACP's Engineering division. Once constructed, the DTM was used to calculate excavation quantities for each alignment. The spreadsheets used to calculate the excavation quantities are included in Part 3. A summary of the excavation quantities for the Pacific entrance is given in Table 7 below.

Table 7

Summary of Excavation Quantities - Pacific Entrance Alignments

Alignment	Approx. Length (km)	Approx. Volume (million m^3)
P1 - Far West Bypass	9.3	70
P2 - Near West Bypass	9.5	37
P3 - Dual Lock East of Existing Locks	8.2	36
P4 - Dual Lock West of Existing Locks	6.9	38
P5 - Dual Lock Using 1939 Excavation	9.5	43

In addition to calculating gross excavation volumes for each of the alignments, approximations of the quantity of rock and overburden to be excavated were made. These calculations were based on geotechnical data provided by the ACP. Most of the boring logs provided were from the 1939 Third Locks Excavation Project and thus focused on the sites of the new locks proposed for each entrance in 1939. For the Atlantic Entrance, these borings provided sufficient information to estimate rock and overburden quantities for each alignment station. However, for the Pacific Entrance, the borings provided did not sufficiently cover all of the alignment areas to provide a breakdown of rock and overburden for each station. Instead, for the two alignments with the best data, Alignments P1 and P2, an analysis was made of the percentage of sound rock, weathered rock and overburden over the entire length of the two alignments. These percentages, 20% overburden, 15% weathered rock and 60% sound rock were then applied equally to all five Pacific alignments. The percentages were applied for comparative purposes based on the best boring data available at the time. Any alignments being further considered will require additional boring data to better determine the quantities of sound rock, weathered rock, and overburden.

6.3 Refined Alignment Screening

The refined screening of the alignments included both quantitative and qualitative elements. In an attempt to quantify the final evaluation of the alignments, the scoring by the Kepner-Tregoe method was reviewed. For the Atlantic Entrance, the alignments had undergone little modification between the initial and final evaluations. Thus the scores changed little. For the Pacific Entrance, the partial optimization of alignments P1 and P2 raised their scores and left them in the top two positions. Table 8 below provides a summary of the revised weighted scores and ranking for the final evaluation.

Table 8

Final Kepner-Tregoe Ranking

Alignment No.	Score	Rank	Carried Forward	Remarks
A1	315	1	Yes	Carried forward for Optimization.
A2	287	2	Yes	Carried forward for Optimization.
A3	261	3	No	
P1	261	1	Yes	Carried forward for Optimization.
P2	260	2	Yes	Carried forward for Optimization.
P3	241	5	No	
P4	248	4	No	
P5	249	3	No	

Following the revised quantitative analysis, a qualitative analysis of the eight alignment alternatives was conducted to identify the two most desirable alternatives for each entrance. The qualitative screening used the five categories introduced in the Development of Evaluation Criteria:

- Technical;
- Operational;
- Constructablity;
- Economic; and
- Other Impacts.

6.3.1 Atlantic Entrance Alignments

Alignments A1, A2 and A3 were analyzed on the Atlantic entrance. The detailed screening of the Atlantic entrance alignments can be found in Part 3. The principal factors leading to the selection of Alignments A1 and A2 are identified below.

Alignment A1, the furthest East avoids the disruption of the existing facilities operation and takes maximum advantage of the 1939 excavation, however it requires new ancillary facilities and equipment for the operation of the third lane. Alignment A2 is closest to existing locks, avoids Gatun Dam and reduces the need to duplicate facilities at Gatun, however it interferes with the Canal operation during construction. Alignment A3 presents some of the same advantages as A2 and also minimizes the interference with the traffic during construction, however the construction of the locks through the existing Gatun Dam adds a significant risk to the integrity of the Canal. If this scheme is at all possible it is likely that the costs associated with the preservation of the dam would be extremely high.

6.3.2 Pacific Entrance Alignments

For the Pacific entrance Alignments P1, P2, P3, P4 and P5 were further analyzed. The first two, P1 and P2, are bypass alignments that utilize a single three-lift lock complex to raise vessels from tidewater to Gatun Lake level. The other three, P3, P4, and P5, are dual lock complex alignments. They utilize two separate lock complexes and the existing Miraflores Lake. In general, the bypass alignments offer a substantial time saving over the dual lock complex alignments. Exhibit 14 shows the estimated navigation periods for five proposed Pacific lock channel alignments.

The ACP directed that a 184 m bottom width be considered to create a one way channel for the third lane expansion stage. Expansion would take place incrementally. Construction of the new third lane of locks and the 184 m approach channels would be followed later by a widening of the approach channels to 276 m allowing two way traffic as demand increased. Finally, when warranted by vessel traffic, a fourth lane of locks would be added.

The detailed screening of the Pacific entrance alignments can be found in Part 3.

6.4 Preliminary Excavation Cost Estimate

In order to help distinguish among the eight alignments subjected to final evaluation, preliminary cost estimates were performed for the excavation of each alignment. These costs include the blasting (where appropriate), excavation, hauling and disposal of the soil and rock inside the proposed 184 m wide channel prism. They also include mobilization and demobilization of excavation equipment and the construction of barrier dams and cofferdams as indicated. Finally, a 20% pre-feasibility contingency was added. These comparative excavation cost offer a sense of which alternatives will be less expensive than the others and provide an order of magnitude of the overall excavation cost. However, they do not provide the entire project cost and should not be represented as such. The excavation volume is subject to change based on further study of the temporary and permanent excavation slopes and the results of a more accurate survey of the ground condition. More boreholes will be required to more accurately determine the quantity and character of the insitu soil and rock to accurately reflect its excavation cost. Finally, the cost of constructing locks and auxiliary structures has not been considered in this cost estimate. Details on the cost estimate and supporting information are found in Part 3, Appendix A. The results are summarized in Table 9 on the next page.

Table 9

Preliminary Excavation Cost Estimates

Alignment No.	Overall Cost ($ millions)	Remarks
A1	120	
A2	180	
A3	70	Least Costly Atlantic Entrance Alternative
P1	660	Least Costly Bypass Alternative.
P2	830	
P3	540	
P4	370	Least Costly Dual-Lock Complex Alternative.
P5	630	

6.5 Construction Sequence Analysis

For each of the eight alignments, a construction sequence was developed and mapped. Since the project start date is unsure, the sequence is laid out as sequential years. The plans were developed in Microsoft Project 98. While attempts were made to give rough approximations of construction periods for each alignment, the focus was on the sequencing of operations. For each sequence, assumptions were made about the number of independent work crews and their capacity. In general dry excavation production was estimated at 500,000 m^3 per month per work crew. Wet excavation production was assumed as 120,000 m^3 per month in rock and 550,000 m^3 per month in overburden for each dredging plant. These estimates were based on historical data for similar scale projects under similar conditions and are explained in greater detail in Part 4. The construction sequences are detailed in Part 3. A summary of the overall preliminary construction periods is provided in Table 10.

Table 10

Summary of Construction Duration (years)

Alignment	Prelim. Phase	Construction Phase	Total Duration
A1 - Alignment Through 1939 Excavation	2.25	4.5	6.75
A2 - Alignment Adjacent to Exist. Locks	2.25	5.0	7.25
A3 - Alignment Through the Gatun Dam	2.25	4.5	6.75
P1 – Far West Bypass	2.25	6.5	8.75
P2 – Near West Bypass	2.25	5.5	7.75
P3 – Dual Lock East of Existing Locks	2.25	4.5	6.75
P4 – Dual Lock West of Existing Locks	2.25	4.25	6.5
P5 – Dual Lock Using 1939 Excavation	2.25	5.0	7.5

6.6 Conclusions

For the Atlantic entrance the final evaluation of the proposed alignments shows significant differences between the three alignments. Technically, Alignment A1 and Alignment A2 are generally equal. Alignment A1 presents the advantage of separating Post-Panamax traffic from existing smaller traffic. Alignment A3 has an added technical risk because the construction goes through the Gatun Dam. Regarding future expansion, Alignment A2 is the most suitable for a fourth lane. A fourth lane does not appear to be feasible for Alignment A3. The expansion of Alignment A1 to a fourth lane is likely to involve a large quantity of rock excavation and would possibly require the relocation of the Panama Railroad Concession. All three alignments have similar excavation quantities. However, cofferdams and dredging may add significant cost to Alignments A2 and A3. Operationally, Alignment A2 has the advantage of allowing a combined control center, and sharing of the tug boat fleet. Alignment A1 will require the relocation of the anchorage basin. Alignment A2 will have the most impact on the operation during construction with the potential for delays particularly during the canal dredging operations.

For the Pacific entrance, the final evaluation of the proposed alignments highlighted the long-term benefit of bypassing Lake Miraflores with a single lifting operation. As shown on Exhibit 14, having a single three-lift lock instead of two separate lock complexes significantly reduces navigation time through the new locks. Further separation of the Post-Panamax vessels that would be the primary users of the new locks from the smaller vessels using the additional locks would simplify operations. Both the new and existing locks would become specialized for their respective vessel types, allowing them to use the most efficient schedule and equipment.

In conclusion, for the Atlantic Entrance, Alignments A1 and A2 should be carried forward for optimization, as these alignments are the present the overall best opportunity for third and fourth lane expansion. For the Pacific Entrance, the results of the final evaluation combined with the initial evaluation indicate that the two bypass alignments, Alignments P1 and P2 should be carried forward for optimization. These two will offer the most efficient operations combined with potential for future expansion to a fourth lane and beyond. They both utilize the area west of the existing locks that offers sufficient open land for staging, construction and expansion.

7.0 OPTIMIZATION OF LAYOUTS

The final phase of the Evaluation of Lock Channel Alignments was the optimization of the layouts for the two recommended alignments at each entrance. This phase involved a standard layout for lock complexes at each entrance and an examination of the possible sites for the lock complexes.

7.1 Preparation of Standard Layouts

New lock layouts were developed for the three lock sizes being considered for the third and fourth lanes. Each size of locks was laid out two ways. First, it is shown with a third lane and fourth lane constructed simultaneously. In this case, the third and fourth lane shares the center guide wall similarly to the way the guide wall is shared by the existing locks. The second set of layouts assumes that the third and fourth lanes are built in stages. While a combined center wall might be feasible in this case as well, the layout is shown with completely separate lock structures for the third and fourth lane. The lanes are separated by 30 m. This layout lessens the chance of interfering with third lane operations during construction of a fourth lane. It also lowers the first cost of the third lane since the third lane lock wall closest to the proposed fourth lane can be constructed smaller and with fewer culverts and valves than if the wall were to later service a fourth lane.

The dimensions of the new lock complexes were developed from the design criteria developed in the Initial and Final Evaluation sections. In general, the existing two lanes of lock were used as a guide in developing the dimensions for the new lanes.

7.2 Preparation of Site Specific Layouts

7.2.1 Introduction

Based on traffic projections, the ACP will select the size and type of structure that will best meet the demand. The size could be either Panamax or Post-Panamax; to address the traffic of these vessels, the expansion could consist of a third lane or a third and fourth lanes. A greater demand in Panamax size vessels could also be addressed by building a smaller-than-Panamax size passage such as a ship-lift, which would free some space for Panamax size vessel in the existing locks.

7.2.2 Water Saving Basins

Increased canal capacity will increase the demand for water in the canal system. The proposed new alignments incorporate water saving basins so that some of the water used in each lock filling/emptying cycle can be recycled. In general, there are two possible arrangements for the basins, stacked or stepped. If the basins are stacked, the land requirement is less, but maintenance of the structures can be hindered by the low clearance between the basins. Utilizing a stepped design requires a greater land requirement. Use of water saving basins can increases the time required to complete a lock filling/emptying cycle since the head differential driving the filling/emptying is reduced.

7.2.3 Location of the Ship Lift

Consideration was given to the most appropriate location for the proposed shiplift, in relation to the parallel lock structures. Siting the ship lift within the new channel alignment adjacent to the locks has several advantages. First, the amount of additional excavation is minimized, since no separate approach channels are required. Second, at the Pacific entrance, utilizing the proposed bypass channel will reduce transit time for the ship lift traffic, since the entire lift between the Pacific Ocean and Lake Gatun is completed at one time. Locating the ship lift and the locks together will also allow streamlined operation and maintenance. If a fourth lane of locks is required in the future, the ship lift can be relocated, and the additional lock complex can be sited parallel to the third lane. Alternatively on the Atlantic side, as the approach channels are shorter, one could consider locating the third lane on one of preferred alignments (A1 or A2) and the ship-lift on the other. That solution would provide a greater flexibility for later expansion with the fourth lane.

7.2.4 Atlantic Entrance

The two best alignments of the Atlantic entrance are located to the east of the existing Gatun Locks. The most eastern alignment, A1, would use the 1939 Third Locks Project Excavation. As such, the location of a new lock complex should be adjusted along the alignment to best use the geological conditions and the level of excavation previously achieved. For the other alignment, A2, which is adjacent and parallel to the existing Gatun locks, the location of the complex along the alignment will mostly be selected as a function of the canal operation to accommodate traffic (including vehicular), maintenance and access to utilities.

7.2.5 Pacific Entrance

At the Pacific Entrance to the canal, both of the best alignments feature a bypass of the existing Lake Miraflores and the proposed lock complexes comprise three adjacent lifts of locks. In general, locating the lock complex as far downstream (towards the Pacific) as possible reduces the overall volume of material to be excavated. The main limiting factors are geology and navigational safety. This report assumes that new lock complexes would be founded on sound rock, and there should be sufficient maneuvering space for large vessels to enter and exit the entrance channel safely. Another consideration is whether or not a given location for the lock complex gives rise to additional cost or complexity of the construction.

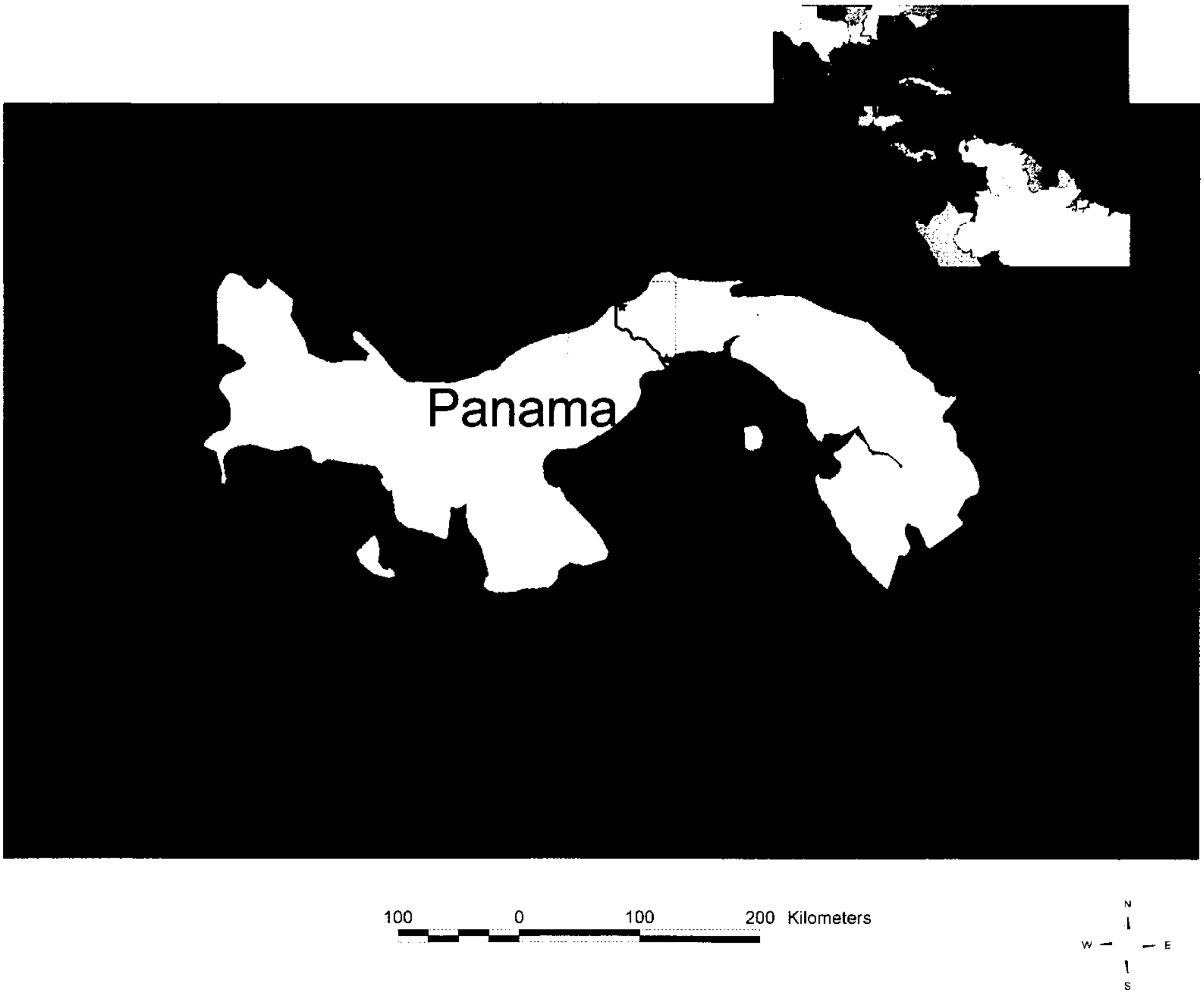
7.3 Comparison of Excavation Quantities for Various Parameters

Different channel design parameters were investigated at the request of the ACP in order to determine the relative difference of excavation quantities for the scenarios. First, the different excavation quantities required for construction of various approach channel widths for the new alignments were examined. For the Atlantic Entrance, there is little difference between the two alignments for a 138 m or 184 m Post-Panamax channel. However, Alignment A1 requires significantly greater excavation for a 276 m channel width (the two-way traffic case). For the Pacific Entrance, the excavation quantity difference for the two alignments remains roughly proportional for each of the channel widths studied.

Next, the comparative excavation quantities to maintain a 16 m deep channel at various levels of Gatun Lake were studied. A 16.76 m deep channel was also studied for Gatun Lake at historic low water level. For each of these comparative estimates, a 184 m wide channel was used. For both the Atlantic and Pacific Entrances, the quantity takeoffs indicate that the channel deepening to accommodate traffic during low water periods would not require vast additional excavation for the new approach channels. Details of these takeoffs are provided in Part 3.

7.4 Conclusion

The Optimization of Alignments presented several different layout scenarios for the two best alignments at the Atlantic and Pacific entrances. For the Atlantic entrance, the final siting of Alignment A1 will be a function of a detailed study of the geology at the 1939 Third Locks Excavation site. Alignment A2's final site will be a function of navigation issues and access for operations and maintenance facilities. For the Pacific entrance, both best alignments feature a bypass of Lake Miraflores. For Alignment P1, excavation cost may be reduced by siting the locks closer to the Pacific entrance channel. Alignment P2's final site (like that of Alignment A1) will be a function of the existing excavation from the 1939 Project.

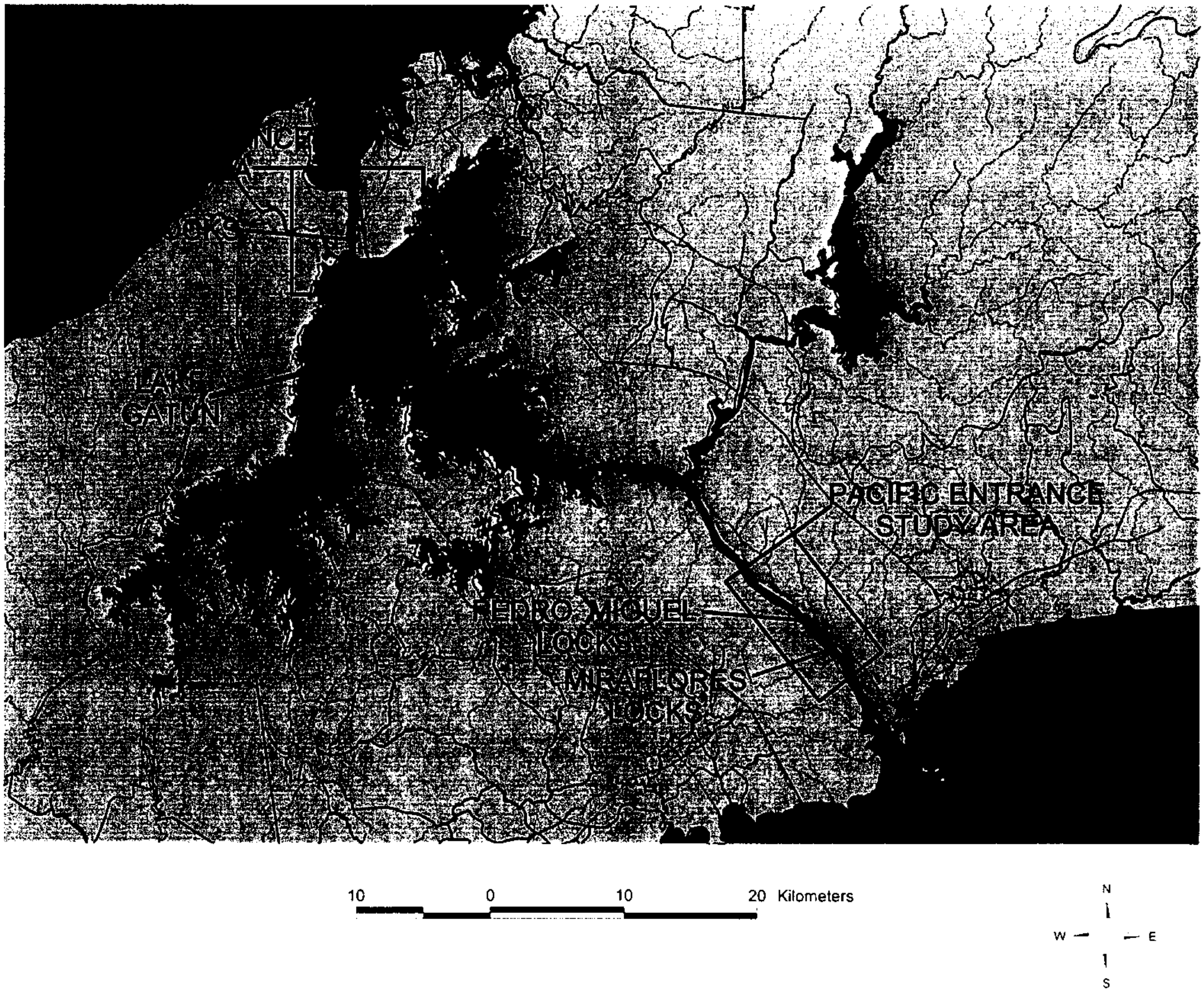


AUTORIDAD DEL CANAL DE PANAMA
Oficina de Proyectos de Capacidad del Canal

CONTRACT NO. CC-5-536
EVALUATION OF LOCK CHANNEL ALIGNMENTS
Location Map

HARZA TAMS | August 2000 | Exhibit 1

O:\ProjectNumber\15593\Task Order 1\Reports\Final Report\Part 1\Ex1

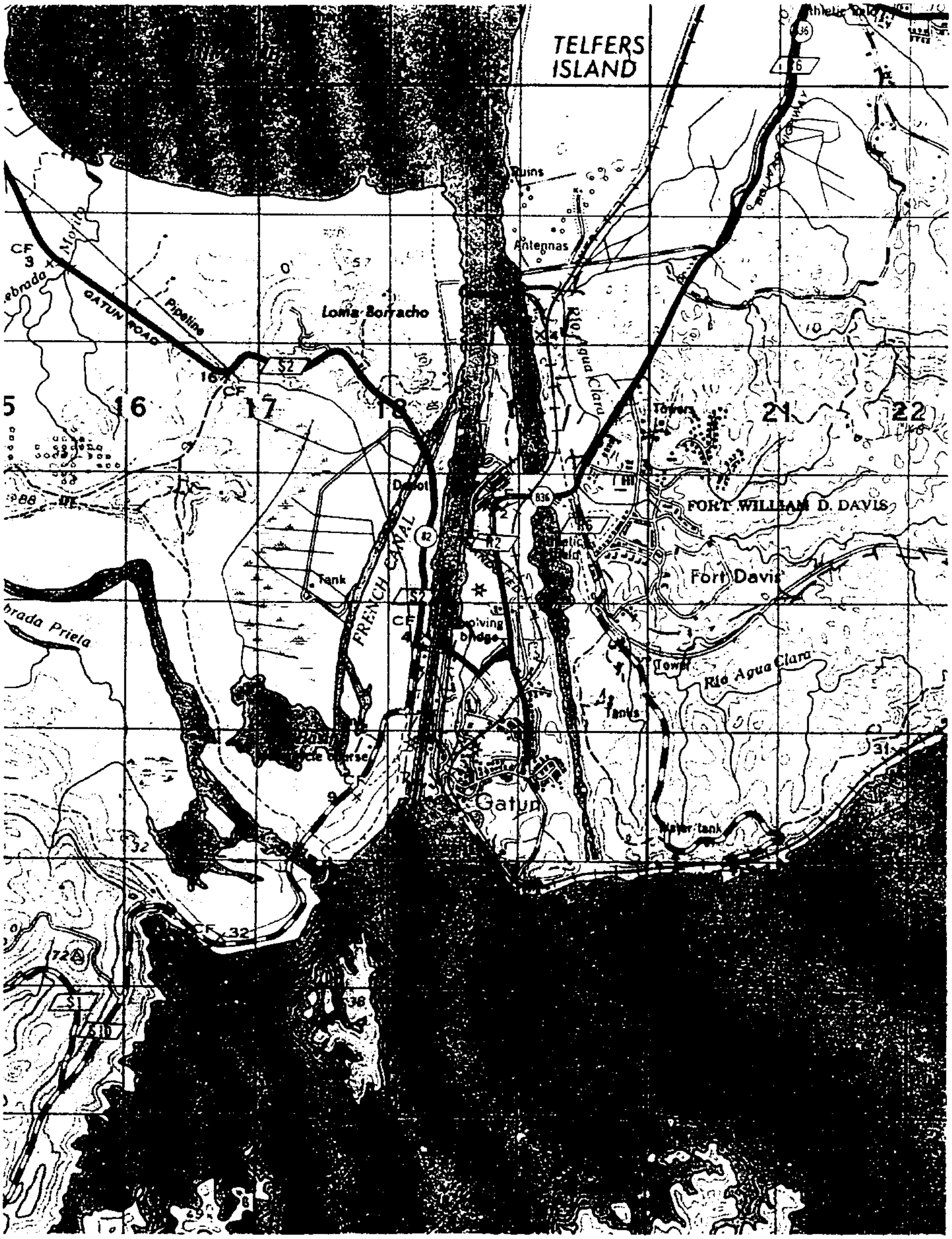


AUTORIDAD DEL CANAL DE PANAMA
Oficina de Proyectos de Capacidad del Canal

CONTRACT NO. CC-5-536
EVALUATION OF LOCK CHANNEL ALIGNMENTS
Detailed Location Map

HARZA TAMS	August 2000	Exhibit 2

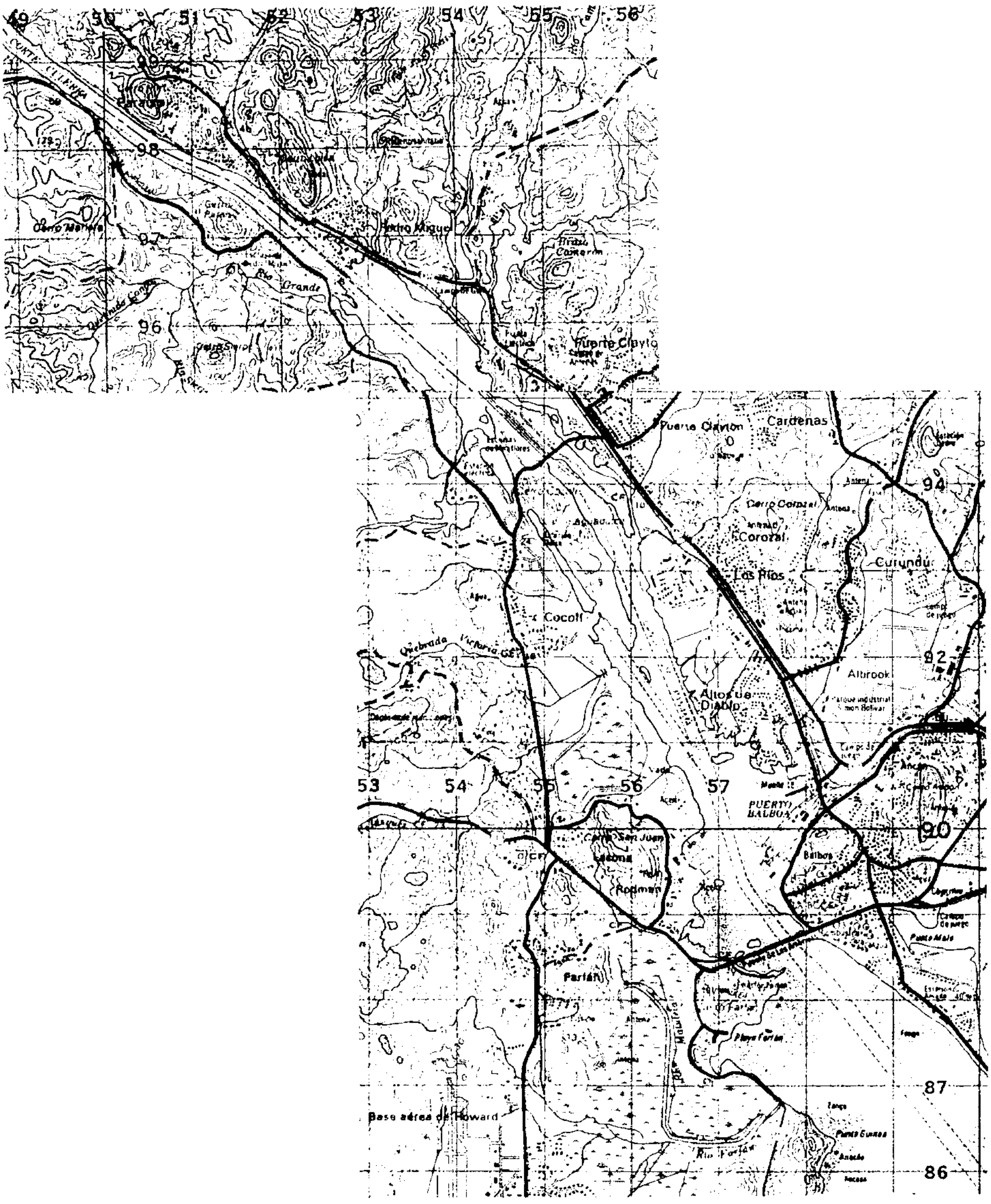
O:\ProjectNumber\15593\Task Order 1\Reports\Final Report\Part 1\Ex2



AUTORIDAD DEL CANAL DE PANAMA
Oficina de Proyectos de Capacidad del Canal

CONTRACT NO. CC-5-536
EVALUATION OF LOCK CHANNEL ALIGNMENTS
Atlantic Entrance Study Area

HARZA TAMS	August 2000	Exhibit 3



AUTORIDAD DEL CANAL DE PANAMA
Oficina de Proyectos de Capacidad del Canal

CONTRACT NO. CC-5-536
EVALUATION OF LOCK CHANNEL ALIGNMENTS
Pacific Entrance Study Area

HARZA TAMS	August 2000	Exhibit 4

ACRONYM AND ABBREVIATION LIST

ACP	Autoridad del Canal de Panama (formerly Panama Canal Commission)
Alt.	Alternative
CAS	Canal Alternatives Study
CCPO	Canal Capacity Projects Office
CLAS	Center for Latin American Studies
DWT	Dead Weight Tons
DTM	Digital Terrain Model
Harza	Harza Engineering Company, Inc.
IASA	Ingenieria Avanzada, S.A.
IFSAR	Interferometric Synthetic Aperture Radar
MF	Miraflores
MLW	Mean Low Water
MLWS	Mean Low Water Spring
OPCC	Oficina de Proyectos de Capicidad del Canal
Panamax	The largest vessel that can pass through the current Panama Canal locks
PCA	Panama Canal Authority (See ACP)
PCC	Panama Canal Commission
PLD	Precise Level Datum
PM	Pedro Miguel
QTO	Quantity Take-off
TAMS	TAMS Consultants, Inc.
Tecnilab	Tecnilab, S.A.
USACE	United States Army Corps of Engineers

MEASUREMENT UNITS

A-F	Acre foot
cm	Centimeters
m^3	Cubic Meter
Ha	Hectare
Hp	Horsepower
kg	Kilogram
kW	Kilowatt
m	Meters
mm	Millimeter

Autoridad del Canal de Panama

Oficina de Proyectos de Capacidad del Canal

Final Evaluation of Lock Channel Alignments

Summary of Navigation Times

Alignment	Approach from Pacific			Miraflores Lock Passage	Transit Lake Miraflores			Pedro Miguel Lock Passage	Merge with Gaillard Cut			Total Time (min)
	Speed (knots)	Distance (m)	Time (min)	Time (min)	Speed (knots)	Distance (m)	Sail Time (min)	Time (min)	Speed (knots)	Distance (m)	Time (min)	
P1 - Far West Bypass Alignment	6	3,110	17	130 *	-	-	-	-	6	6,150	33	180
P2 - Near West Bypass Alignment	6	3,400	18	130 *	-	-	-	-	6	6,860	37	185
P3 - Dual - Lock Alignment East of Existing	6	4,900	26	95 **	2	1,210	20	70 ***	6	3,610	19	231
P4 - Dual - Lock Alignment West of Existing	6	4,300	23	95 **	2	1,230	20	70 ***	6	3,490	19	227
P5 - Dual - Lock Alignment Using 1939 Excavation	6	3,580	19	95 **	2	1,850	30	70 ***	6	3,480	19	233

Notes:

All information provided by ACP Marine Traffic Control.

Total Time from ACP Sta 2400 (N889650, E657155) to ACP Sta 2000 (N998723, E649685)

* Lock passage time at Gatun Locks (3 lift)

** Lock passage time at Miraflores Locks (2 lift)

*** Lock passage time at Pedro Miguel Locks (1 lift)

AUTORIDAD DEL CANAL DE PANAMA
Oficina de Proyectos de Capacidad del Canal

CONTRACT NO. CC-5-536
EVALUATION OF LOCK CHANNEL ALIGNMENTS
Summary of Navigation Times

HARZA TAMS | August 2000 | Exhibit 14

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS
PART 1 – SUMMARY REPORT

APPENDIX A

WORK PLAN FOR EVALUATION OF LOCK CHANNEL ALIGNMENTS

PANAMA CANAL COMMISSION
CANAL CAPACITY PROJECT OFFICE

Work Plan for
Evaluation of Lock Channel Alignments

OCTOBER 14, 1999

HARZA *Consulting Engineers and Scientists*

WORK PLAN

Evaluation of Lock Channel Alignments

October 14, 1999

General Description of Work

The work to be performed under this delivery order shall be inclusive of all labor, material, travel, and incidental services as necessary for evaluating alternative channel alignments at the Pacific and Atlantic entrances of the Panama Canal. The alignments shall be at the location of the best site for the construction of new sets of locks and a ship-lift. The work area shall be that area within the immediate vicinity of the locks and not include entrance channels to the Canal. This work will be performed as follows:

The contractor shall review 19 alternative channel alignments that have been developed by PCC from previous studies of Canal expansions and newly identified options. The contractor shall develop new or modified alignments; a minimum of 3 at each entrance to the Canal, based on the evaluation criteria developed to provide enhanced options.

The Canal Capacity Project Office (CCPO) has performed preliminary investigations based on map studies and prepared several alternative alignments at the Atlantic and Pacific entrances to the Canal. (Alignment plan sheets are provided in the Appendix to this Work Plan.) Harza will bring in more detailed, available topographic and geotechnical information to further evaluate the CCPO alignments. Harza will also develop and analyze additional preferred schemes and report back to the CCPO on the most desirable alignments, construction techniques and sequences.

Harza will study alignments that achieve the ultimate aim of providing a third and fourth line of locks, a ship lift for smaller vessels and water-saving features. The addition of the third and fourth lane of locks may take place simultaneously, or be performed in stages.

Task Breakdown

The work will be performed based on the following breakdown of tasks:

Task 1 – Review of Existing Information
Task 2 – Development of Evaluation Criteria

Task 3 – Initial Evaluation of Lock Channel Alignments
Task 4 – Final Evaluation of Lock Channel Alignments
Task 5 – Optimization of Layout
Task 6 – Review of Excavation Methodologies
Task 7 – Preliminary Cost Estimates for Lock Channel Alignments
Task 8 – Preparation of Draft and Final Reports
Task 9 – Technology Transfer and Training
Task 10 – Project Management

A detailed breakdown of the work and sub-tasks together with the estimated level of effort, deliverables and milestones follows.

Task 1 – Review of Existing Information

The work performed by Harza under this task will establish the basic information to be used throughout the lock channel alignment study to provide efficient and reliable information transfer between Harza and the PCC. The purpose of this task is to collect relevant data and information for the preliminary evaluation. While Task 1 will identify the data sources and set up the means for exploring them, some sources may not actually be addressed until Task 4. However, it is essential to determine what is available upfront as well as how it can be accessed. Harza will not collect any new field data as part of this work order, but will rely on data currently available through the PCC.

Task 1.1 - Establish Data Transfer Procedures. To verify that the systems and electronic file transfer protocols for information sharing between Harza and the PCC are compatible, Harza proposes to make a test transfer of files in each of the five software programs (MS Word, MS Excel, Microstation, MS PowerPoint, and ArcInfo). This will enable us to verify that the PCC can open, manipulate and produce hard-copy versions of future Harza submittals. As part of this task, Harza's Information Technology group will create a File Transfer Protocol (FTP) site, and share information regarding plotters and pen tables for use with Microstation drawings.

Harza has acquired the Gemcom software package to enable us to work directly with the PCC's extensive geotechnical exploration database in a compatible format.

Task 1.2 - Review of Geotechnical Information. The PCC will supply Harza with the required geotechnical information to perform the work. No new boreholes will be drilled as part of this work order. Harza will provide maps showing the areas where geotechnical information is required. Harza will work with the PCC to perform an initial screening of the available data. The preferred boreholes will be those on or immediately adjacent to the proposed alignments, those with the most laboratory test data, and generally the deepest borings with the most rock information. Electronic data that can be imported to Microstation will be utilized to the extent possible. It is anticipated that Harza will work closely with the PCC geologist to extract the required top-of-rock information from the PCC's Gemcom database system in an ASCII format containing x-, y- and z-coordinates.

Task 1.3 - Preparation of 3-D Digital Models. Using the topography supplied by the PCC and the inferred top-of-rock elevations from the PCC-supplied Gemcom database, Harza will prepare 3-D digital terrain models (DTMs) for the proposed alignments that will include the ground surface and the top-of-rock surface. It is assumed that the available 3-D Microstation format topography has adequate detail; in particular that the digitized contours are available with no more than five (5) meter intervals over the entire project area. For those alignments that pass through existing excavations or navigation channels, the PCC will supply hydrographic survey data which will be merged with the topographic data. These DTMs will then be used in conjunction with Gemcom, Geopak, or InRoads to prepare cross sections and excavation quantities for use in later tasks.

Task 1.4 – Review of Existing Site Conditions. Harza will perform a review of existing site conditions to ascertain the likely impacts to the proposed channel alignments. It is anticipated that the PCC will supply as-built drawings of their facilities and other known infrastructure components potentially impacted by any of the alignments. This information will be collected during the initial site visit (see Task 10.2).

Deliverables

Harza will prepare and submit a Task 1 Summary Memo, which will include an electronic copy of digital terrain model(s) with soil/rock horizons. A summary of the geotechnical information will be included as an Appendix.

Milestones

Work related to Task 1 has started and will be completed by November 1, 1999.

Task 2 – Development of Evaluation Criteria

The contractor shall hold discussions with PCC personnel to develop evaluation criteria and methodology using the elements outlined in this scope of work and others that the consultant may recommend for incorporation into the evaluation criteria. Evaluation criteria shall be developed in conjunction with PCC staff using their experience in Canal operations and formal approval of the criteria is required before initiating the evaluation of alternative alignments.

Harza proposes to adopt the evaluation procedure of Kepner and Tregoe (1981) for use in performing the alignment evaluations. This approach is rational, simple and flexible. The three basic steps required are:

1. Identification of relevant evaluation criteria (or attributes) and an assessment of the relative importance of each attribute (importance coefficient).
2. Determination of appropriate quantitative measures for each of the evaluation criteria.
3. Measurement or assessment of quantities or qualities of each alternative with respect to each evaluation attribute, and the assignment of a "score". Weighted scores are then derived from the product of the score and importance coefficient. The sums of the weighted scores for each alternative serve as a guide to identify the most favorable alternative(s).

Harza and PCC team members will work closely in the development of appropriate evaluation criteria and parameters.

Task 2.1 – Attribute Identification and Importance Assessment. The PCC has supplied a list of 13 evaluation criteria (attributes) for the lock channel alignments. Harza will review the attributes, suggest additional attributes if required and, together with the PCC, perform an assessment of the relative importance of each attribute.

Harza recommends that the relative importance assessment be performed "by committee" with input from both Harza and PCC team members. Reaching early consensus on the importance assessment will expedite the evaluation of the alignments. Formal agreement on the criteria and the importance coefficients with the PCC will be obtained before Harza proceeds with the evaluation.

Task 2.2 - Determination of Relevant Quantitative Measures. Harza, in conjunction with the PCC, will develop quantitative measures for each of the evaluation criteria to be used as a guide for the assignment of scores. For example, accessibility of water and electrical power will be measured in terms of distance from the lock complex to the nearest suitable source(s) of water and power.

Deliverables

Harza will prepare and submit a Task 2 Summary Memo, which will include a tabulation of the evaluation criteria, the relative importance and the selected quantitative measure.

Milestones

Work related to Task 2 will start on October 18, 1999 and be completed by November 1, 1999.

Task 3 – Initial Evaluation of Lock Channel Alignments

The contractor shall perform an initial evaluation of all the alternative channel alignments identified using the evaluation criteria approved by PCC. Preliminary results of evaluation shall be presented to PCC for review before the final evaluation is initiated. Based on coordinated discussion, new or modified alignments may be identified.

This task will use the results of Tasks 1 and 2 to perform the initial evaluation of canal alignment alternatives. A description of the alignment alternatives to be evaluated, provided by the PCC, is attached. The key objective of this Task will be to eliminate non-feasible or inadequate alternatives in order to focus on the further evaluation of viable alternatives.

Task 3.1 – Review of Design Parameters. The PCC will provide general design parameters including channel widths, channel bottom elevation, berthing requirements, and channel side slopes. Harza will review the data provided, and document the design criteria to be used for the evaluation.

Task 3.2 – Preliminary Excavation QTOs. Harza will prepare preliminary excavation quantity take-offs (QTOs) for each of the alignments. Harza will utilize 3-D CADD techniques (Gemcom, Geopak, or InRoads) and the digital terrain models developed in Task 1. The quantities will be prepared using cross sections taken at 300m intervals using the average end area method for cut and fill volumes. Quantities will be calculated for overburden excavation and rock excavation for both "in-the-wet" and in-the-dry" construction methodologies.

Task 3.3 – Assignment of Scores to each Alignment. Harza will study each PCC alignment and develop the appropriate measurements in order to assign a "score" for each of the evaluation criteria. Weighted scores will then be derived from the product of the scores and the importance coefficients. A ranking of the alternatives based on the scores will be made.

Task 3.4 – Identification of Alternate Alignments. In concurrence with the PCC's requirements, Harza will prepare three (3) alternate alignments at each of the Atlantic and Pacific entrances. It is anticipated that the new alignments will be primarily variations on the alignments prepared by the PCC. The new alignments will be evaluated using the methodology of Task 3.3.

Task 3.5 – Presentation of Draft Findings to PCC. Harza will provide the PCC with preliminary findings of the initial evaluations performed in Tasks 3.3 and 3.4 for review before proceeding with the final evaluations. This presentation will be made to PCC staff in Harza's Chicago office. The number of proposed alignments to be evaluated and the number of alignments to be carried forward to the final evaluation is shown below:

No. of Alignments	Atlantic	Pacific
Proposed	10 (7+3new)	18 (15+3 new)
Carried Forward	4	4

Deliverables

Harza will prepare and submit a Task 3 Summary Memo, which will include a tabulation of the evaluation criteria, quantitative measurements and weighted scores for each alternative alignment. The Summary Memo will include recommendations for which alignments to carry forward to the next level of analysis.

Milestones

Work related to Task 3 will start on October 18, 1999 and be completed by December 1, 1999. A meeting in Chicago is proposed for December 1, 1999 to present the initial evaluation results and agree on the alignments to carry forward.

Task 4 – Final Evaluation of Lock Channel Alignments

The final evaluation of the selected alignments shall consider refinements and recommendations of the screened alignments and development of these options to provide cost estimates and construction methodology. The contractor shall conduct a screening to identify the best alignments at each Canal entrance and present the reasons for their selection.

Task 4.1 – Prepare Preliminary Layouts. In order to refine the evaluations of the preferred alignments (4 at the Atlantic entrance and 4 at the Pacific entrance), Harza will prepare preliminary layouts of the lock channel alignments showing the location of the third and fourth lanes of locks, and a typical footprint for all other ancillary structures. At this level of study, only one size of lock will be assumed for all alignments. During the optimization of layouts (Task 5), Harza will study each of the three potential lock sizes.

Task 4.2 - Construction Sequence Analysis. For each of the proposed alignments, Harza will prepare a conceptual level construction sequence and schematic schedule. The sequences will consider two development scenarios; one in which both lanes of locks are constructed together, and a second in which the construction is staged.

Task 4.3 – Determination of Excavation Unit Rates. Harza will prepare preliminary unit costs for the excavation of overburden and rock assuming both "in-the-wet" and "in-the-dry" construction methodologies.

Task 4.4 - Quantity Take-Offs. Harza will prepare refined excavation quantity take-offs (QTOs) for each of the preferred alignments. Harza will utilize 3-D CADD techniques (Gemcom, Geopak, or InRoads) and the digital terrain models developed in Task 1. The quantities will be prepared using cross sections taken at 150m intervals using the average end area method for cut and fill volumes. Quantities will be calculated for overburden excavation and rock excavation.

Task 4.5 – Preliminary Cost Estimates for Lock Channel Alignments. Harza will develop preliminary excavation cost estimates for each of the preferred alignments for use in the final evaluation process. The estimated level of effort for this activity is provided under Task 7.

Task 4.6 – Screening of Preferred Alignments. Harza will refine the evaluation procedures of Task 4 and screen the preferred alignments to select the best 2 alignments at each entrance. Harza will provide the PCC with preliminary findings of the final evaluations performed in Task 4 for review before proceeding with the layout optimizations. The number of proposed alignments to be evaluated and the number of alignments to be carried forward to the optimization is shown below:

No. of Alignments	Atlantic	Pacific
Preferred Alignments	4	4
"Best" Alignments	2	2

Deliverables

Harza will prepare and submit a Task 4 Summary Memo. The Summary Memo will include recommendations for which two alignments at each entrance should be carried forward to the next level of analysis.

Milestones

Work related to Task 4 will start on December 1, 1999 and be completed by January 31, 2000.

Task 5 – Optimization of Layouts

The contractor shall optimize the layout design for best alignments based on technical discussions with PCC and consideration of different lock sizes and the proposed ship-lift.

This task will focus on the operating characteristics ("impacts") of a particular alternative, which may not necessarily affect capacity, but may affect the feasibility and desirability of specific alternatives. The proposed approach is to develop standard layouts for each size of lock and then apply these to the specific site conditions of the best alignments. The aim is to address issues relating to the different lock sizes (size of water-saving basins, area required for support services, approach conditions) first and, having developed suitable layouts for each lock size, the impacts of the site specific conditions can be addressed.

Task 5.1 – Preparation of Standard Layouts. For each lock size, Harza will prepare two standard layouts showing:

A: Two new lanes of locks to be constructed concurrently, and

B: A third lane of locks with provisions for a fourth lane to be added in a subsequent construction phase.

In addition to the lanes of new locks, each of the standard layouts will include water-saving basins, one ship lift, and the footprint of ancillary structures and services to support PCC operations. The standard layouts will be developed based on the third and forth lanes of locks being the same size.

Task 5.2 – Preparation of Site-Specific Layouts. For the two best alignments at each entrance, Harza will prepare layouts based on the standard layouts prepared in Task 5.1. Adjustments will be made to match the specific site conditions at each location. The site-specific layouts will be prepared for a single lock size, based on discussions with the PCC.

Deliverables

The results of the optimization process performed in Task 5 will be incorporated into the draft and final reports.

Milestones

Work related to Task 5 will start on January 1, 2000 and be completed by February 15, 2000.

Task 6 – Review of Excavation Methodologies

The Contractor shall conduct a search of existing or proposed excavation methodologies worldwide, provide their description, and identify potential alternatives for their application to the excavation of proposed alignments.

Task 6.1 – Review of Existing Methodologies. Harza will perform a review of the most recently applied excavation methodologies at large earthwork sites worldwide. Among the sites analyzed will be the Eastside Reservoir project, which is currently the largest earthwork site in the US, where Harza is the construction manager. Harza will also study the PCC's current Gaillard Cut widening project to develop benchmark costs for excavation work in Panama. It is anticipated that all relevant studies of the Gaillard Cut will be available from prior studies. Results of preceding studies shall be reviewed constructively to understand the characteristics of each methodology studied. As part of this task, Harza will examine both "wet" and "dry" excavation techniques.

Task 6.2 – Survey of Future Trends. Harza will contact equipment manufacturers and specialty contractors to collect information regarding promising new technologies that may have potential for use at the Panama Canal.

Task 6.3 – Evaluation of Methodologies. Harza will perform an evaluation of the applicability to the Panama Canal of the methodologies described in Tasks 6.1 and 6.2. Harza will take into consideration the suitability of using each of the methodologies for excavating the different soil and rock materials likely to be encountered along the proposed alignments.

Deliverables

Harza will prepare and submit a Task 6 Summary Memo documenting the findings of this Task.

Milestones

Work related to Task 6 will start on November 1, 1999 and be completed by December 15, 1999.

Task 7 – Preliminary Cost Estimates for Lock Channel Alignments

The Contractor shall provide preliminary cost estimates for the excavation of the channel and lock alignments and recommend excavation methodology. Cost estimates for new features, locks, ship-lifts, and water saving basins are not required to be provided.

Using the quantities developed in Task 4, Harza will prepare preliminary excavation cost estimates for each of the preferred alignments. The cost estimates will be at a pre-feasibility level of detail, sufficient to distinguish those projects that warrant further and more detailed study. Since there is uncertainty with respect to the QTOs, labor costs, and material and equipment costs, a contingency will be shown with all of the estimates. Typically for pre-feasibility studies the contingency will be in the range of 20 to 30%.

Preparation of the preliminary estimates will consider the quantity, type and methodology of material to be excavated, dewatering requirements (if any), disposal or possible reuse of the material as fill or aggregate, the source and cost of labor and equipment, and the likely construction schedule.

Deliverables

Harza will prepare and submit a Task 7 Summary Memo.

Milestones

Work related to Task 7 will start on December 15, 1999 and be completed by January 14, 1999.

Task 8 – Preparation of Draft and Final Reports

The Contractor shall prepare a draft and a final report presenting the most desirable alignments. The report shall consist of a) Tabulated results and color graphical displays of the alternatives considered; b) evaluation analysis, assumptions and evaluative parameters used in the analysis; and c) conclusions based on the findings and evaluation criteria or reasons for alternative selection. This report shall present the most desirable alignments, construction techniques, and sequences.

The merits of recommended alternatives based on conclusions of the study shall be explained in the report. Recommendation of additional work, if needed, shall be made.

Task 8.1 - Preparation of Draft Report. Harza will prepare and submit a draft report, which will primarily be a compilation of the Task Summary Memos prepared as part of Tasks 1 through 7. The main text and exhibits of the report will be drawn from Summary Memos 1 through 5.

Four appendices are anticipated: Geotechnical Information (Task 1), Construction Methods (Task 6), Construction Costs (Task 7) and IT Protocols (Task 1).

Task 8.2 - Presentation of Draft Report. Harza proposes that the Task Order Manager and a Principal Engineer present the Draft Report to the PCC in Panama. Harza estimates that the trip will include a minimum of three days in the PCC offices. Harza has used the 14-day advance booking airfare rate to prepare the budget for this task.

Task 8.3 - Preparation of Final Report. Based on discussions with the PCC, and review of comments received, Harza will finalize the report.

Deliverables

We anticipate that 5 copies of the draft report, and 10 copies of the final report, will be provided together with copies of the electronic files. The draft report will be hand-carried to Panama by the Task Order Manager, with a summary presentation made to PCC staff as appropriate.

Milestones

The draft report will be submitted on February 15, 2000 and the final report will be submitted on April 14, 2000.

Task 9 – Technology Transfer and Training

Under this technology transfer, designated PCC personnel will be provided with programs and training to create in-house capability for similar future studies or to further investigate any particular detail.

The contractor shall provide suitable office space at his offices for two PCC engineers who would work along with the Contractor's engineers for training and to expedite conduct of the work.

Harza will accommodate up to two PCC engineers in our Chicago office for the 4-month primary duration of the studies. We anticipate providing each with a fully equipped workstation with PC, CADD, and e-mail capability so that the engineers can fully participate in the project.

Deliverables

Harza will develop a training program for the PCC engineers, and provide certificates of completion at the conclusion of their tenure in our office.

Task 10 – Project Management

During each phase of the study, important results will be sent to the project officials in the form of written/electronic interim reports as soon as the information is available. This will enable project personnel to interact with

the Contractor's engineers during the course of study and make modifications to the plan, if necessary.

Task 10.1 - Work Plan Preparation and Finalization. Following the submittal of Harza's draft work plan to the PCC, Harza will review the plan with the PCC team. We will finalize the Work Plan, and present it in Panama as part of our initial site visit.

Task 10.2 - Work Plan Presentation and Site Visits. Harza proposes that the Task Order Manager, a Principal Engineer and a Senior Engineer present the Work Plan to the PCC in Panama in conjunction with site visits to both the Atlantic and Pacific entrances. Harza estimates that the trip will include a minimum of one day at each entrance and three days in the PCC offices. Harza has used the 14-day advance booking airfare rate to prepare the budget for this task.

Task 10.3 - Project Tracking and Budget Status Reports. In order to keep the PCC informed regarding the status of the Task Order budget, the Project Manager will prepare and submit monthly updates indicating the hours expended for the previous month and the totals to date. Also included will be an estimate of the anticipated level of effort for the upcoming month. Expected activities for the coming month will be documented.

Task 10.4 - Subcontractor Oversight. Harza will maintain regular communication with all subcontractors to verify diligent performance of work tasks. All communication with the PCC shall be through Harza. Harza is aware of the critical nature of this study to the overall Canal Capacity Project. As such, timely completion of study tasks and delivery of draft and final reports is mandatory. The approach discussed below reflects Harza's plan to accomplish the tasks so that the study deliverables to the PCC are complete and timely.

Task 10.5 - Project Management. Harza's Project Manager and Task Order Manager will supervise all of the work to verify adherence to the project schedule and communicate regularly with the PCC. They will also be responsible for adherence to Harza's established QA/QC procedures, including the preparation of a Project Manager's Memorandum, and regular reporting of progress and budget.

Deliverables

Harza will prepare and submit a draft and final report. Monthly progress reports will also be submitted.

Milestones

The draft report will be submitted on February 15, 2000 and the final report will be submitted on April 14, 2000. Monthly progress reports will be submitted within five (5) working days of the end of each month.

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS
PART 1 – SUMMARY REPORT

APPENDIX B

QUALITY CONTROL DOCUMENTATION

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS
PART 1 – SUMMARY REPORT

APPENDIX B
QUALITY CONTROL DOCUMENTATION

TABLE OF CONTENTS

Quality Control Verification Sheet

ACP Review Comments

Civil/Hydraulic Senior Review Comments – E. Cole

Geotechnical Senior Review Comments – P. Dickson

Civil Senior Review Comments – J. Lindell

THE PANAMA CANAL
EVALUATION OF LOCK CHANNEL ALIGNMENTS

HARZA Engineering Company

Project Team

Studied

Structural Engineer:	M. Calvino	Mark Calvino
Civil Engineer:	J. Halloran	Jonathan Halloran
Construction/Cost Engineer:	T. Brown	Thomas M. Brown
Project/Hydraulic Engineer:	J. P. Minois	
Task Order Manager:	N. Pansic	N. Pansic

Reviewed

Civil:	J. Lindell	
Civil/Hydraulic:	E. Cole	E. Cole
Geotechnical:	P. Dickson	

Approved

Project Manager:	M. Newbery	M. Newbery

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
1	The Final Report draft is well organized and presented. It follows a chronological sequence of the different tasks done to complete the scope of work requested by the Canal Capacity Projects Office.	No action.

	Volume 1	
2	Page ES-3, Fourth paragraph: Use "best alignments" instead of "most promising". At the following paragraph, third line, use East side instead of "east bank". At the last line, use Southern end, North of Cerro Paraíso instead of "Pacific entrance just beyond".	This will be changed in the final report.
3	Page ES-4: Under Review of Existing Information, third line, use Engineering Division instead of "dredging division".	This will be changed in the final report.
4	Page ES-6, first paragraph: "including four new alignments developed by Harza".	This will be changed in the final report.
5	Page ES-7: Under Final Evaluation, after qualitative elements, add: based on more fully developed alignments.	This will be changed in the final report.
6	Page ES-9: Alignment A2 will allow "ready integration of new operations with existing ones", but will most certainly create inconveniences on access to existing facilities.	The text will be revised to read, "ready integration of new operations with existing ones, but will create inconveniences on access to existing facilities."
7	The executive summary is too sketchy without enough supporting data. You are forced to read the four volumes in order to reach the conclusions on page	The executive summary will be rewritten and resubmitted prior to submission of the final report.
8	Page 2, third line: Use Canal Area instead of Canal Zone.	This will be changed in the final report.
9	Page 4, third line: Add "specially at the Pacific entrance tidal area." In the last paragraph, add the need to evaluate mangrove habitats by our environmental group.	This will be added to the text in the final report.
	Chapter 4.0 Initial Evaluation of Lock Channel Alignments	
10	Page 8, Table 2 should be titled "Summary of Initial Design Parameters".	This will be changed in the final report.
11	Page 9: "Lack of electronic data" can not be the reason for doing manual calculations. We gave Harza enough electronic files needed for all the initial QTOs.	This will be changed in the final report.

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
12	Page 10: "formerly proposed Van Dam Bridge". Should also mention somewhere that the ACP is considering different bridge alignments that may be affected or adjusted by the locks alignments (third and fourth lanes).	This will be changed in the final report.
13	Page 13: At the end of 1st paragraph, Table 5 instead of 3.	This will be changed in the final report.
14	5. Page 17: We have some concerns in regards with volumes for A1 compared to A2 alignment. Please check.	The quantities have been checked, and will be further checked to address this comments: we would welcome any specific concern.
15	6. Page 22: For A1, consider the RR location and the space limitations imposed by the RR and Fort Davis.	The exhibit will incorporate information regarding the location of the railroad and Fort Davis.
	Chapter 5.0 Final Evaluation of Lock Channel Alignments	
16	Page 18: Harza established some percentages for sound rock, weathered rock, and overburden from the only boring holes data they had from the 1939 excavation (Alignments P1 and P2). These percentages were then applied to the other Pacific side alignments to determine the excavation costs. This seems to be an assumption that could lead to incorrect results if it is not later verified.	A note will be added to the text regarding the limitations of geotechnical data, particularly at the Pacific entrance. The note will contain a recommendation for further geotech study as part of the alignment feasibility report.
	Chapter 6.0 Optimization of Layouts	
17	1. Page 25: We do not agree with placing a shiplift temporarily in the fourth lane alignment for later dismantling. A shiplift can not be built close to the existing locks. We should look at alternate locations for shiplift such as: (a)	A text section will be added listing alternative shiplift locations with respective advantages and disadvantages. The appropriate exhibits will also show the center lines of alternative shiplift locations. The
18	2. Exhibits 2-4: As in the Pacific side alignments, the centerline of the 4B channel should coincide with the centerline of the third lane centerwall.	The alignments will be adjusted in the final report.

	Comment	Response
	Volume 2 **4.0 Scoring Assignments for each Alignment**	
19	1. In the introductory paragraphs, it should be emphasized that these are initial rankings that were later reviewed. If the report is not read in a	We will address this throughout the report.
20	2. Page 4: Is it the 1991 or 1993 USACE/Mobile survey. It is mentioned in volume I as he 1993 survey. Are these two surveys or is it an inconsistency in the write-up?	We are only aware of one survey. The text will be changed accordingly.

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
21	3. Page 12, Alignment 3: Eliminate the statement "Overall, it scored the highest of all alignments". Although initially true, it may lead to confusion in the future.	We will clarify the section to indicate that the scoring refers to the initial evaluation only.
	Appendix A	
22	1. Page A-2, second paragraph: Canal Zone does not exist anymore.	We will address this throughout the report.
23	2. Page A-2.4: Number 14 though 17 are empty? Also, No. 25 has some "????". What is missing?	This will be corrected in the final report.
24	3. Page A-2.6: No. 66 is blank?	This will be corrected in the final report.
	Appendix B	
25	1. Page B-3: Change "(four at the Atlantic entrance, four at the Pacific entrance)" to "(three at the Atlantic entrance, five at the Pacific entrance)".	This will be corrected in the final report.
26	2. Exhibit B-6 is an incomplete table. Please use a watermark to indicate that Tables 5, 6, and 7 are sample tables.	We will add the watermark.
	Appendix C	
27	1. Exhibit C-2, 3: As requested, the design channel bottom elevation at the Atlantic should be at –16.88 m and +7.16 m at Gatun Lake.	Harza will await final direction from the ACP on this item.
28	2. Exhibit C-4, 5, 6, 7: As requested, the design channel bottom elevation at Gatun Lake should be at +7.16 m.	Harza will await final direction from the ACP on this item.
29	3. Exhibit C-8: Two way schematic is not to scale.	It will be corrected
30	4. Exhibit C-9: Underwater grade slope is missing in Type 3 and Type 4.	It will be corrected
	Appendix E	
31	Exhibit E-4: What can we conclude from sensitivity analysis? There is no discussion. How about the Atlantic side Volume Sensitivity Analysis?	The sensitivity analysis is discussed on page 5 of volume 2. A sensitivity analysis table will developed for the Atlantic alignments.

	Volume 3 **Chapter 1. Final Evaluation of Lock Channel Alignments**	
32	1. Page 5: The report states that the construction of alignment A2 "will not interfere with vessel traffic through the existing locks". At some point in time, it will create inconveniences (building the required cellular type cofferdam in the southern end) with traffic and with access to the existing locks.	We agree. The text will be adjusted to incorporate the comment similar to that stated in the conclusions of the final evaluation (page 22, Volume 1). The text will reflect the inconviences that will be created to accessing the existing locks.

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
33	2. Page 12: Harza complied with ACP's directions for scenario planing for several scenarios for the channel design parameters (Gatun Lake elevations: 85 ft., 81.5 ft., and 78.5 ft.). Additionally, ACP gave directions for the QTOs with Gatun Lake bottom elevation of +7.16 m. The results presented in page 13, Table 5, make reference to a +7.9 m elevation (which results from the required 16 m channel depth at a lake elevation of 23.9 m or 78.5 ft.). This Table must be adjusted to accommodate ACP's directions for scenario planning.	Harza will await final direction from the ACP on this item.
34	3. Page 13: To complete the information requested and presented in Table 5, the excavation costs for each option showed in the table should be included in the Final Report.	Cost estimates will be provided for the eight alignments examined in the final evaluation. A note will be provided in the text explaining that the cost estimates are preliminary and that the cost difference between alignments with little change in excavation volume is minimal.
35	4. Page 30 states that alignment A2 "is the most suitable for a fourth lane". The reasons were not clearly stated. Our understanding is that Harza concludes this because of the larger excavation costs for a fourth lane at alignment A1. But excavation costs cannot be the only determining factor in this decision.	The discussion will be expanded to address all issues.
36	5. Page 34, first paragraph: "free some space capacity for Panamax size vessel"	This will be corrected in the final report.
37	6. Page 34, last paragraph: "approximately double the filling/emptying time" use might increase. Water savings basins can be designed for whatever filling and emptying times are required. This is done by varying the number and diameter of conduits and by smoothing and rounding entrances, outlets, and bends.	The text will be changed from,"Preliminary calculations suggest that the use of three water saving basins could approximately double the filling/emptying time," to read, "The use of three water saving basins per lock will increase filling and emptying time. They require further study to determine whether or not the time increase will be significant."
38	7. Page 38 last paragraph: "that a 17 m clearance" and "constructed 0.75 m deeper than the sills." Please revise these values.	As discussed on June 1, 2000, these figures will remain the same.
39	8. Exhibit 27: Revise floor elevations.	Harza will await final direction from the ACP on this item.

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
40	9. Exhibit 31: Shiplift is not good at fourth lane, channel bottom elevation and existing lock walls are not compatible. It is better to put the shiplift in the 1939 excavation instead of using it as spoil disposal area. The A2 alignment forces you to go with stacked water saving basins instead of stepped or staggered basins.	The exhibits will be altered to show various optional alignments for a shiplift. The alternate shiplift alignments will be shown as a centerline on the exhibit. The exhibit will be resubmitted for comment prior to integration in the final report.
	Chapter 2. Optimization of Layouts	
41	1. Page 35: The argument for the location of the Atlantic Ship Lift (in the alignment not selected for the third locks) will require an additional access channel. We should be consistent with the idea used for the Pacific that calls for shared access channels, minimizing the excavation costs. At the Atlantic side the existing excavation is good, some additional excavation/dredging is required.	The text will be adjusted to explain the differing issues at the Atlantic and Pacific entrances and thus the solutions may not be the same. In particular, the channel are much shorter on the Atlantic side: if for example a solution as shown on Exhibit 32 were to be selected, the excavation for the shiplift in the 1939 cut would be only 3.3 million cubic meters: it might be an attractive solution.
42	2. Page 39: We must give great importance to the assessment that if alignment P2 is constructed, some length of the barrier dam will be founded in Cucaracha formation.	We will expand the discussion of this issue.
43	3. Page 40: Exhibit 38 is referred to as having the upstream end at Station 6+500. Might it not be Exhibit 37?	We will change the text to read "Exhibit 37."
44	4. Exhibit 13: The reference elevation for Gatun Lake should be 24.8 m, not 25.9 m.	Harza will await final direction from the ACP on this item.
45	5. Exhibit 27 and 28: The proposed navigable bottom at the Atlantic should be at elevation – 16.88 m, not –16.4 m. Gatun Lake navigable bottom should be at elevation +7.16 m, not +9.9 m. Minimum Gatun Lake +24.8 m should be used instead of the mean.	Harza will await final direction from the ACP on this item.
46	6. Exhibit 33-36: The proposed navigable bottom at the Pacific should be at elevation – 19.00 m, not –18.3 m. Gatun Lake navigable bottom should be	Harza will await final direction from the ACP on this item.
47	7. Please explain how did Harza considered the excavation volumes at lock sites. There shall be an estimated width of the excavation to compare with other alignments.	During the initial evaluation, Harza used the 4B channel width and proposed channel depths through the various lock sites. As part of the optimization of the two best alignments, the excavations templates at the locks were refined to more closely reflect the proposed locks. The changes in excavation volume based on these refinements were small compared to the overall quantity.

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
48	8. On the Atlantic side, the excavation for alignment A1 is very restricted by the railroad. Construction area might be small because of limitations imposed by the railroad. It might be necessary to expand (fourth lane) towards the West of the new lock. Show restrictions imposed by the RR and former Fort Davis town.	The exhibit will show Ft. Davis and the existing railroad. The relocation of the railroad to accommodate the new locks will also be shown.
49	9. Are the A1 alignment locks located at the 1939 excavation? Moving the lock North or South will change the cost (fill or excavation). The approach channels are shown with straight lines at both banks. An effort must be made to interpolate some elevations and show a more realistic contour.	The locks have been located to minimize excavation as well as to use sound rock for concrete foundation based on the geological profile shown on Exhibit 27. Some conservatism has been built in the location with regards to the location of existing excavation: if the rock is as anticipated the complex could be some built 100 to 200 meters to the North to marginally minimize the excavation. The top of the excavation will be shown on the channel and near the locks.
50	10. Disposal sites on the Atlantic need to be studied in more detail. Filling the 1939 excavation is not a good idea. Disposal areas E5 and E6 are not good because the town of Fort Davis is located there. Because of shortages of wet disposal areas all of the dry and wet excavation material shall be placed at E3 and E4 (these areas are on land)	As requested, we will revise. Disposal areas E-5 and E-6 will be removed.
51	11. For the wet excavation, it is possible to use suction dredges and pump directly to E3 and E4. The material deposited there could be used in the future for fill or land reclamation in the vicinity.	See previous comment.
52	12. Exhibit 33: Elevations are incorrect. At the upstream navigational bottom, the elevation shall be 7.16 m, and at the downstream end, elevation shall be	Harza will await final direction from the ACP on this item.
53	13. If we use P1, the existing excavation could be used to place a shiplift or as a fill area. Exhibit 37 could be modified to place the shiplift East of the new locks, at the existing excavation.	The final report will show alternatives for possible shiplift alignments. The alternative alignments will be indicated by a centerline. The exhibit will be resubmitted prior to integration in the final report.
54	14. At the Pacific end, Attachment 2 (Appendix A, Volume 3 of 4), the Barrier Dam cost estimate shall be better evaluated. Items described are not applicable to any of the scenarios described in Exhibit 14. A more detailed	The barrier dam will be reevaluated. Exhibit 14 will be changed to show a a 10 m diameter cofferdam with rip rap protection as the preferred dam. A cost estimate will be developed for this scenario.

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
55	15. For a barrier dam, the backfill type is preferred. The backfill slopes at both sides will prevent ships from hitting the core (steel or concrete cells). A technical discussion on the barrier dam is necessary to clarify how Harza arrived to the features and prices considered (engineering and cost estimate).	See previous comment.
	Appendix A	
56	1. Appendix page A-3: Use of interest rate of 8%, too low? ACP currently is using 14%?	A 14% Rate of Return for the overall project is appropriate. However, we believe the 8% interest rate reflects the current rate of interest for the loan or lease of the plant specified.
57	2. Annual fixed maintenance is first cost divided by useful life? A more expensive alternative may have lower or higher maintenance cost?	The method of determining annual maintenance was chosen because it could be applied uniformly to the various equipment being proposed. A more detailed study of each equipment rate would be necessary for the next level of study. We would be pleased to incorporate a different methodology you may suggest.
58	3. Page A-4: "Liehburr 996" should be Liebherr	This will be corrected in the final report.
59	4. Page A-8 Table 5: Are these rates per m3 or hourly? Need to specify it.	The rates are per m^3. This will be clarified in the final report.
60	5. Attachment 2: The Kentucky Lock permanent cofferdam is smaller than what we need. Some of the items described are not applicable for the scenarios described. Need to use an example in a closer size range. At Olmsted, IL (Ohio River Mile 964.4), the USACE used a 1310 meter long temporary cofferdam finished in late 1995 at a cost of $60-million.	See Comment 14, Chapter 2, Volume 3.
61	6. Page A-9: Should read Appendix B of Volume 3, not Volume 2.	This will be corrected in the final report.
	7. Attachment A-1, Page 6: Basic Labor Costs	
62	a. The Tug Master costs are closer to $ 30.00/ hour	The rate will be adjusted to $30/hour.
63	b. Both Laborers costs seem to reflect ACP costs instead of local contractors wages.	We offered these rates as a conservative estimate. If you prefer different rates, we would be pleased to incorporate them.
64	8. Attachment A-3: E1 and E2 should not be used as disposal site. Better for third locks or shiplift.	Please see above.
65	9. Attachment A-5: W1 site is over the area with contaminated UXO's. The map does not show existing structures. UXO areas should be avoided for	The UXO area will not be used for any alignment excavation. However, it will be used for spoil disposal.

RESPONSES TO COMMENTS – DRAFT FINAL REPORT (Second Draft)
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 12, 2000

	Comment	Response
66	10. E5 and E6 are former Fort Davis. Where are the townsite and existing structures in this drawing? It should be easy to overlay the maps and indicate the existing infrastructure.	Disposal areas E5 and E6 will be removed.
	Appendix B	
67	No reference is made to the design channel bottoms used for the information presented. Similar summaries should be presented for all the requested Gatun Lake elevations and the design channel bottoms. Specify the channel bottom elevations used for computations.	We will add the channel template information to the summaries. As with the cost estimates, complete summaries will be provided for the eight alignments that were examined as part of the final evaluation.
68	Appendix B: Alignment [volume] calculations were done by one person and verified by somebody else?	The calculations were done using an InRoads model and separately checked manually by a civil engineer. The initials of the person who calculated and checked the quantities will be added to each sheet.

	Volume 4 **Chapter 4.0 Review of Existing Applications and Methods**	
69	1. If we compare the production numbers presented from several projects and contractors and Dredging Division's production, the latter ranks low. It should be noted that they have to operate under several operational, navigational and time restrictions that hamper their productivity.	We believe that we have taken into account lower productivity in the estimate by providing relatively low time efficiencies for the various dredging plant. Please note that the proposed plant is significantly higher capacity than the ACP dredges. The proposed cutter suction dredge has approximately two times the *Mindi's* total installed power. The proposed backhoe dredge uses a bucket approximately 70% larger than the *Christensen's*. This will be documented in the report.
70	2. Page 6: Obtain blasting data from ACP. We have a good program and safety record in the cut widening.	We would be pleased to include any additional blasting information that you may provide.
71	3. Exhibit 2: No volumes indicated for disposal sites.	Disposal capacities will be added to the exhibit.
72	4. Drill boat Thor was not mentioned? How about the land blasting drill we presently use?	Please provide information on the *Thor* and land based drill so that we may include it in the final report.
73	5. A narrative section of several pages about the disposal areas shall be introduced in the report discussing the availability and use of land for wet and dry disposal.	Disposal areas will be further discussed in the final report.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 16, 2000
Comments by E. Cole

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
1.	General	It would be useful to include the title of each volume on the cover.	EC	A title will be added to each volume.
2.	General	Is the Executive summary meant to be a stand-alone document for high level non-technical personnel? If so it needs to be lengthened and a few drawings added. If not perhaps it should be shortened and re-designated as Summary and Recommendations, say 3 or 4 pages.	EC	The Executive Summary will be re-written.
3.	General	Volume 1 should contain an overall view of the Panama Canal.	EC	Location maps are currently being produced and will be incorporated in Volume 1.
4.	General	The final evaluation given in the Executive Summary (pages ES-7, 8 and 9) appears to be weak. It is not explained why excavation costs were included in the final evaluation. The lowest excavation cost solutions; A3, P3 and P4 have all been rejected anyway, incidentally on the grounds that locks would be costly for these solutions. Obviously Kepner-Tregoe evaluations have been given more importance in the selection, and these evaluations do include cost criteria. The text should indicate this.	EC	The text will be revised.
5.	General	TAMS and Harza drawings should be made consistent	EC	The TAMS exhibits will be changed.

HARZA

O:\ProjectNumber\15593\Task Order 1\Technical Review\Reply to EC comments.doc

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 16, 2000
Comments by E. Cole

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
6.	Volume 1, page ES-3	Second para.: When will water supply become the limiting factor in increasing canal capacity?	EC	The Reconnaissance Study indicates that the reliability of water supply decrease below the 99.6% target starting in 2000.
7.	Volume 1, Page ES-9	One disadvantage with A3 is the construction through the Gatun Dam. This should be mentioned	EC	The text will be revised.
8.	Volume 1, page ES-9	Optimization: What about the Atlantic Entrance?	EC	A description will be incorporated.
9.	Volume 1, page 7	Second para.: it should be mentioned that the advantage of Alignment No.6 is that it avoids interference with existing locks and make maximum use of the 1939 excavation. The advantage of Alignment No.5 is that it enables maximum integration with existing locks. The advantage of Alignment No.17 is that it maximizes use of the French Canal while minimizing impact on the Gatun Dam.	EC	The text will be revised.
10.	Volume 1, pages 10 and 11	Conclusions – Perhaps the above discussion and some of the material included under 4.0 should really appear under 4.4. In other words a brief description of the particular advantages of the 8 chosen alignments should be given.	EC	The text will be revised.
11.	Volume 1, page 18	Explain significance of 3B, 4B and 6B.	EC	An explanation will be provided

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 16, 2000
Comments by E. Cole

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
12.	Volume 1, page 19	Why did the score for Alignments P3 and P4 drop so dramatically?	EC	The scores for P3 were lowered upon further evaluation because of concerns over the operational disadvantages of having two sets of locks instead of a single lock at Miraflores. The sharp azimuth change at the Pacific (south) approach was also considered to be a serious limitation on the capacity of this alignment. Finally, the excavation necessary to construct a fourth lane at Pedro Miguel was considered to be extraordinarily high. Alignment P4's score was lowered because of similar operational concerns during the final evaluation. It also suffered from high excavation quantities in order to construct the fourth lock lanes at both Miraflores and Pedro Miguel.
13.	Volume 1, page 19	Sec. 5.3.1 - A description of the screening for the Atlantic side should be added	EC	The text will be revised.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 16, 2000
Comments by E. Cole

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
14.	Volume 2, page 1	Summary – the second paragraph should be revised. Alignment 18 does not parallel the existing locks. This paragraph should stress the following: • three alignments have been selected Nos. 5, 6 and 18; • No.5 is closest to existing locks, avoids Gatun dam and reduces the need to duplicate facilities at Gatun; • No.6 is further East eliminating disruption of existing facilities and taking maximum advantage of the 1939 excavation; • No.18 is the best of the alignment on the West side.	EC	The text will be revised.
15.	Volume 2, page 2	Improve the last two sentences in light of the above comments.	EC	The text will be revised.
16.	Volume 2, page 13	What are wicket gates on the emergency dam?	EC	The emergency dam was dropped from design of the final alignments as an unnecessary redundancy.
17.	Appendix D	Why not something similar for the Atlantic side.	EC	During the initial evaluation, the only available topography on the Atlantic side had 20 meter contour intervals; therefore no quantity calculation was performed only gross estimates were used in the initial ranking.

HARZA

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
18.	Volume 3, page 13 Table 5	There seems to be inconsistencies for the Pacific entrance quantities: • P2 with bottom El 8.8: individual quantities don't add up to the total; • P1 the overburden quantities increase and the rock quantities decrease as the bottom is lowered from El 9.9 to El 8.8	EC	The table will be corrected for the final report.
19.	Volume 3, page 18, Table 7	Why has the economic and environmental scoring of P3 and P4 dropped so much from the initial evaluation?	EC	During the final evaluation, the scores for each alignment in each category were reviewed. As a result the environmental scores of alignments P3 and P4 were lowered to reflect a greater than first assumed impact. Similarly, the "cost of locks and special features category" scores for each one were lowered since the cost of the two separate locks for these alignments was viewed as a relative disadvantage over alignments P1 and P2 that called for only a single lock each.
20.	Volume 3, page 28, 29 & 30	It would be useful to note the critical construction items: • A1 and A2: lock construction and gate installation • A3: gate fabrication and installation • P1: channel excavation • P2 lock construction and gate installation • P3, P4 and P5 Miraflores lock construction and gate installation	EC	They will be identified in the text.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 16, 2000
Comments by E. Cole

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
21.	Volume 3, page 16 to 23	What is the rationale in gate fabrication time being shorter for a two-lock option such as P4 compared to single lock option such as P1?	EC	The gate fabrication time for the two lock complex alternatives (P3, P4, and P5) will be changed to show the additional time required to manufacture the additional gates.
22.	Volume 3, page 16 to 23	Does the fabrication time include design and if so has sufficient time been allowed?	EC	Yes, the fabrication time includes the design. A period of 21 months (455 days) has been allowed for design and fabrication of the first sets (one on the Pacific side and one on the Atlantic side). It is estimated that two sets can be delivered every three months thereafter. A total of seven sets for the Pacific side and six sets for the Atlantic side is required.
23.	Volume 3, page 16 to 23	For alternative P2 the construction schedule is based on a temporary sheet pile structure with the barrier dam construction in the dry. The construction schedule assumes that the area to the West can be dewatered prior to permanent barrier dam construction? If not will the barrier dam construction become a critical path item?	EC	The barrier dam design has changed to one with concrete filled sheetpile cells protected with rip rap. The schedule will be updated to show that dewatering may not take place prior to the placement of rip rap support on the west side of the dam.
24.	Volume 3, Section 2.2.3	Why not illustrate with a figure?	EC	The axis of the ship-lift possible location will be shown on the appropriate exhibits
25.	Volume 3, Section 2.2.4	Sub-section should be re-numbered.	EC	It will be corrected.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
June 16, 2000
Comments by E. Cole

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
26.	Volume 3, Section 2.2.4.2	End of second paragraph, what does "or fill" refers to?	EC	The general description of the geological formation (Undivided Holocene sediments) is alluvium or fill.
27.	Volume 3, Section 2.2.4.4	Last paragraph: Exhibit 31 shows only a third lane but the text refers to a third and forth lane. We should really compare Exhibit 29 with Exhibit 31 and Exhibit 30 with Exhibit 32. There should be more comparative analysis given generally in Section 2.2.4	EC	The text will be revised.
28.	Exhibits 29, 30, 31 and 32.	They could be enlarged and cover only the new works area similar to Exhibits 37, 38 and 39.	EC	New drawings will be prepared

END OF TABLE

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 16, 2000
Comments by P. A. Dickson

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
1	Vol. 1, p. 1	There is no documentation provided of the review of geological/ geotechnical information provided. Is it provided elsewhere? If so, provide cross reference information.	PAD	A description of the various types of information that were examined as part of this study, including comments on the quality and utility of the data will be provided. Also will include a brief description of how the information was used by Harza in the performance of this study, i.e. development of parameters or criteria for layouts, constructibility assessment, and construction costing. Cross-references will be provided in cases where such information is provided elsewhere.
2	Vol. 1, p. 20	There is no discussion of the basis for developing cost estimating criteria. This section should reference the source and description of the quantity take-offs.	PAD	A short summary statement will be provided with appropriate cross references to studies that establish top of rock, limits of common excavation, and other categories of excavation (hard rock, soft rock, etc.) that were done in preparation for the cost estimate.
3	Vol. 1, pp. 24-26	There is no discussion of the geological or geotechnical considerations or implications in developing the layout criteria – not evaluation criteria.	PAD	A discussion of the criteria will be provided in the final report.
4	Vol. 2, Appendix A, p. A-1.	The same comments apply as in Comment 1.	PAD	Discussions will be provided as indicated in Comment Response 1.

HARZA

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 16, 2000
Comments by P. A. Dickson

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
5	Vol. 2, Appendix A, p. A-2.	Though a lot of geological and geotechnical data are listed, there is no explanation of how the data was used in the report.	PAD	A discussion of the use of the provided data will be included in the final report.
6	Vol. 3, Exhibits 27, 28, 34, 35,36.	How were the exhibits prepared? What data are they based upon? Who prepared them? How were they used in the study?	PAD	Appropriate notes will be added to the Exhibits - providing credits if the section was not prepared by Harza (e.g. Section taken from .....), origin of data (data from drill hole information provided by ACP), and method of preparation (e.g. using GEMCOM 3-D geologic model).

END OF TABLE

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
1.	General	The Exhibits prepared by Harza and those prepared by TAMS have a different appearance. Could these be made to look more consistent for final submittals to the Client?	JEL	The TAMS exhibits will be changed to look more like the Harza exhibits.
2.	General	In Volume 1, Exhibits 2-4 do not indicate the CAS excavation slope Type as the other exhibits do and only the bottom widths are shown on the exhibits. I realize by reading the text that there is only one slope type being used to evaluate the Atlantic entrance alignments, but it would be more consistent to develop the level of detail to the same point on all of the exhibits.	JEL	The exhibits will be changed to add the slope types.
3.	General	In my copy of Volume 2, some of the Exhibits are missing and/or out of order.	JEL	The final report will be thoroughly reviewed to see that the error does not occur again. Each copy will be individually reviewed.
4.	Alignment A-1 (Exhibit 2)	There are no obvious problems with space for construction or interruption of operations.	JEL	No action.
5.		The alignment is sufficiently remote from the existing alignment that there should be minimal impact on the existing operation during construction.	JEL	No action.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
6.	Alignment A-1 (Exhibit 2)	Where is the spoil area for the excavated material? Alignment A-2 shows the 1939 excavation as a spoil area.	JEL	The spoil areas are shown on Attachment A-3 of Volume 3, Appendix A. Exhibit A-2 will not show any spoil area in the final report.
7.	Alignment A-1 (Exhibit 2)	Will the Water Saving Basins disrupt any existing infrastructure?	JEL	Yes, the construction of the water saving basins will require the removal of several small buildings and the rerouting of a road.
8.	Alignment A-1 (Exhibit 2)	Is the 1939 excavation flooded? Will cofferdams be required to construct the new lock walls in the dry?	JEL	Yes, the excavation is currently flooded. Water will be pumped out prior to the excavation operation and construction of the new locks will be done in the dry. It is anticipated that a cofferdam (earthfill) will be built at Sta. 1+200 to excavate, in the dry, the existing natural plug and the approach channel between Sta. 1+200 and Sta. 2+400.
9.	Alignment A-2 (Exhibit 3)	The approach from the Atlantic side will be congested, both during construction and when the facility is in operation. Excavation of the widened approach channel will impact the operation of the existing locks.	JEL	Concur
10.	Alignment A-2 (Exhibit 3)	Will cofferdams be required to construct the new lock walls on the Atlantic side? They appear to be on land but close to the existing shoreline.	JEL	It is anticipated that the new lock walls can be built without a cofferdam by delaying excavation of that approach after construction of the walls have been completed. The wall is approximately 50 meters from the shoreline. At worse, a single line of sheetpile could be driven to protect the construction area if investigations reveal that the material at that location is backfill from previous construction and it could become unstable.

HARZA

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
11.		The lock walls of the third lane and proposed fourth lane extend into Gatun Lake in an area indicated as an anchorage basin. Will relocation of the anchorage basin be required?	JEL	Yes. This will be stated in the report.
12.		There appears to be some housing, streets, etc. on the east side of the lock. Will this alignment require much infrastructure to be relocated?	JEL	The infrastructure, housing, etc. located between the existing locks and the 1939 cut belong to the ACP and are said to be of minor importance and can be relocated. Further east, on the other side of the 1939 cut, the ACP has indicated that Fort Davis cannot be relocated and therefore cannot be used as proposed for disposal of spoil excavation; the railroad, however, on the east of the 1939 cut could be relocated if needed.
13.		Was any consideration given to designing the third lane lock wall so that it could be incorporated into a fourth lane lock in the future, in a manner similar to the existing locks?	JEL	Yes. The consensus opinion was that for planning purposes it is better to show the third and fourth lane separated with separate guidewalls for two reasons. First, this requires a maximum amount of land usage. It is possible that later refinements could reduce the amount of land usage and possibly the cost. The opposite scenario with more land (and greater cost) being proposed at a later stage of study was not desirable. Second, the fourth lane would presumably be constructed in the distant future (~50 years or more). Any modifications necessary to later accommodate a fourth lane would have virtually no net present value because of the long time horizon.
14.		There would appear to be some advantage to having the new lock facilities adjacent to the existing lock.	JEL	While there are operational advantages to siting a new lock adjacent to existing ones, the potential construction impact on existing operations outweighs the potential benefits.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
15.	Alignment A-3 (Exhibit 4)	This alignment would have less congestion on the Atlantic side than Alignment A-2.	JEL	No action.
16.	Alignment A-3 (Exhibit 4)	The permanent cofferdam that appears to act as an extension to the lock walls would appear to interfere with the entrance to the existing locks on the Gatun Lake side both during the construction phase and for future operation. This is further aggravated by the angle of the axes of the two lanes. This causes the permanent cofferdam to extend almost in front of the existing lock, which would appear to have a negative impact on traffic approaching both lanes. There does not appear to be enough space for large vessels to approach the existing lanes and the third lane.	JEL	The eastern portion of the cofferdam (the part closer to the existing locks and channel) will be changed from a permanent structure to a temporary one to be removed after construction of the locks. Construction activities will, to the extent possible, be staged from the west side of this new structure to avoid interference with existing operations.
17.	Alignment A-3 (Exhibit 4)	This alignment cuts the existing Gatun Dam embankment. There is clearly more construction risk without an obvious offsetting technical advantage. Costs appear to be significantly lower. Are additional risks reflected in the costs?	JEL	The costs shown in the report are costs of excavation. They do not reflect the additional risk of construction of the locks, foundation treatment or special measures to be implemented to preserve the integrity of the dam. A statement to that effect will be incorporated in the text.
18.	Alignment P-1 (Exhibit 5)	The labeling of channel widths on the exhibits for the Pacific alignments is not consistent with the exhibits for the Atlantic side alignments.	JEL	The Atlantic Entrance alignments channel width labels will be changed to a function of the design vessel width ("B") as shown on the Pacific Alignments.

HARZA

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
19.	Alignment P-1 (Exhibit 5)	What does the shading indicate? Appears to be two shades, maybe darker one for existing inundated area. Lighter shade along new alignment does not seem to match contours. Other inundated areas shown with dot pattern. There is no legend to explain what is shown.	JEL	A legend will be added to the drawings to indicate that the dark shading is existing water, the light shading is new channel and the dotted areas are low-lying areas that may be flooded if saddle dams are not constructed.
20.	Alignment P-1 (Exhibit 5)	Space for water saving basins is shown but not labeled.	JEL	The water saving basins will be labeled on all exhibits.
21.	Alignment P-1 (Exhibit 5)	Levees (low embankment dams) are shown along the east bank of Alignment P-1. How high are these levees? They would be constructed in the dry, but apparently would be subject to the Gatun Lake level (i.e., some constant differential head) when the new lane is flooded. How much head will there be on these and how are they intended to be designed?	JEL	The levees would be constructed in the dry as the channel is excavated. They will consist of spoil from the channel both earth and rock and will support up to 9 m of head in places.
22.		Alignment P-1 can be constructed with minimal impact to the operation of the existing locks.	JEL	No action.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
23.	Alignment P-2 (Exhibit 6)	The activity for construction of the barrier dam in Miraflores Lake will be close to the existing channel. The 75 meter separation should be sufficient, depending on the type of equipment used and on the discipline of the contractor but does not allow a lot of room to work. Will the wake from the large vessels passing through the existing lanes interfere with the construction of the barrier dam?	JEL	According to the ACP, vessel speed through Lake Miraflores averages 2-4 knots. A Panamax vessel travelling at this speed could cause a disruptive wake. Vessel speed restrictions may be required in the construction area. To the extent possible, construction would be staged from the west side of the proposed dam.
24.	Alignment P-2 (Exhibit 6)	The barrier dam construction, which involves work in the water, increases the risk of this alignment over alignment P-1, both in terms of construction risk and interference with operation of the existing locks.	JEL	This comment will be added to the discussion of Alignment P2.
25.	Alignment P-3 (Exhibit 6)	The approach from the Pacific into the new Miraflores lock has a curve that looks rather sharp for Post-Panamax sized vessels with only about a ship-length of straight alignment before entering the guide walls. Is this alignment really feasible?	JEL	The azimuth change is nearly 34°. This sharp turn and short approach would make entering and exiting the locks difficult. If this alignment is further studied, the turn could be split into two azimuths and/or the excavation of the east bank of the channel south of the Miraflores locks could be widened to lengthen the approach.
26.	Alignment P-3 (Exhibit 7)	How much excavation work is actually required in Miraflores Lake to make the new lane? There is no separation between the new lane and existing lanes.	JEL	As indicated in Appendix B of Volume 3, nearly 8 million m3 must be excavated in the wet in Lake Miraflores. The new and existing lanes would more or less overlap.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
27.		How will access to the existing Miraflores and Pedro Miguel locks be maintained during the construction of the new locks? Existing utilities will have to be relocated. This alignment has the potential for major impact on the existing operations.	JEL	The alignment requires removal of the existing Miraflores spillway and construction of a new spillway through the 1939 Third Locks excavation. Before construction of the new locks begins, operational facilities would be moved from the east side of the existing locks to the west side. Appropriate access would also be constructed from the west side.
28.		Are water saving basins required?	JEL	Water saving basins are required and are located on the west side of the new third lane.
29.	Alignment P-4 (Exhibit 8)	There are some deep cuts required. Will the spoil be disposed near-by, perhaps in the 1939 excavation area?	JEL	The spoil disposal sites are shown on Attachment A-5, Appendix A, Volume 3.
30.		Are water saving basins required?	JEL	Water saving basins are required and shown on the east side of the new locks.
31.		The North arrow is missing from the exhibit.	JEL	The north arrow will be added.

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
32.	Alignment P-5 (Exhibit 9)	This alignment is similar to Alignment P-4 but takes advantage of the 1939 excavation.	JEL	No action.
33.	Alignment P-5 (Exhibit 9)	It appears to be constructable with minimal interference to existing operations.	JEL	No action.
34.	Alignment P-5 (Exhibit 9)	More excavation is required in Miraflores Lake and near the Pedro Miguel locks. Where will the spoil be disposed?	JEL	The spoil disposal sites are shown on Attachment A-5, Appendix A, Volume 3.
35.	**The Barrier Dam** Exhibit 13 & Exhibit 14	How will the grout curtain be installed with each type of dam, especially Type 1 and Type 4, to assure good contact?	JEL	The grout curtain will be installed by drilling a 3 inch hole and filling with concrete.
36.		The toe of the backfill section of the Type 1 dam will extend between 45 and 50 meters from the axis of the dam toward the existing lane. There is a 75 meter separation shown between the dam axis and the existing traffic lane. Construction activities will compete for right-of-way with the lock traffic.	JEL	Rip rap will be placed from on top of the dam. Only limited marine equipment will be required during rip rap placement.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
37.		The Precast sections (Type 1) appear to be notched into rock, but are installed in the wet. This will be done in about 16m of water. How will the notch be excavated and how will the contact between the precast sections and the rock be prepared?	JEL	The Precast section (Type 1) is no longer under consideration. Type 1 will now include a concrete filled cellular sheetpile structure.
38.	**Final Layouts** Alignment A-1	Comments on preliminary layout apply.	JEL	The changes made to the preliminary layout will also be made on the final layout.
39.		The intermediate stage provides minimal effect on existing operation during construction.	JEL	No action.
40.		If the final stage is constructed, there will be impacts on both the existing lane and the new third lane, as the ship lift will have to be relocated. However, impacts are minimal in the intermediate stage.	JEL	No action.
41.	Alignment A-2	The intermediate stage shows spoil disposal in the 1939 excavation. The final stage shows the ship lift being relocated to the 1939 excavation. Will the spoil be placed and later removed?	JEL	Spoil will not be placed in the 1939 excavation.

HARZA

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
42.		For final stage, was consideration given to constructing the forth lane in the 1939 excavation to avoid interference with the existing facilities, third lane and ship lift during the expansion? Also, was any consideration given to putting the ship lift in the 1939 excavation in the intermediate stage? From an operational standpoint, these options may not be practical, but they might have some merit for minimizing disruption during development of the final stage.	JEL	In the final report, several ship lift alignment alternatives will be provided.
43.	Alignment P-1	The final layout adds a ship lift as an intermediate development in the alignment of the future forth lane. Service of the ship lift would be lost when (if) the forth lane is constructed in the future. Would the ship lift be relocated?	JEL	The ship lift is assumed to have a useful life of 50-75 years. A new lift could be constructed if demand warranted when the fourth lane is constructed.
44.		Are there guide walls leading into the ship lift? No detail on the exhibit.	JEL	The shiplift has a retaining wall to separate it from the third lane. This reinforced concrete wall would simultaneously serve as a guide wall.
45.		Exhibit 38 shows an alternative in which the lock complex would be located further upstream. It appears that this would result in less excavation in the lock area, which would be an advantage. Functionally, the alternatives are equal.	JEL	No action.

RESPONSES TO SENIOR REVIEW COMMENTS – DRAFT FINAL REPORT
PANAMA CANAL AUTHORITY – EVALUATION OF LOCK CHANNEL ALIGNMENTS
May 10, 2000
Comments by J. E. Lindell

COMMENT NO.	REPORT SECTION	COMMENT	BY	HARZA'S REPLY/RESOLUTION
46.	Alignment P-2	Lock and ship lift layout is essentially the same as in P-1. No additional comments.	JEL	No action.

END OF TABLE