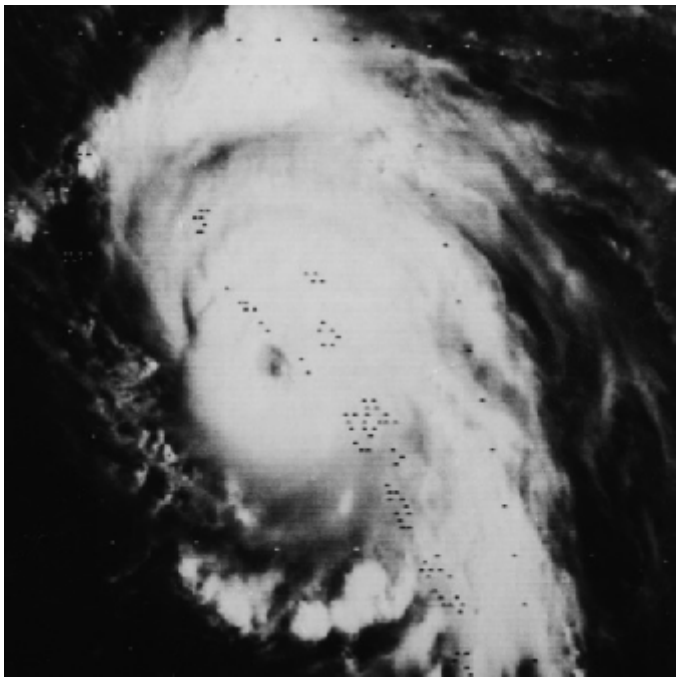
ORGANIZATION OF AMERICAN STATES
UNIT FOR SUSTAINABLE DEVELOPMENT AND THE ENVIRONMENT

Revised Report on:

Needs Assessment for CDCM Training Program



Selpeco Westmar

in association with

SMITH WARNER INTERNATIONAL

80083
February 2001

ORGANIZATION OF AMERICAN STATES
UNIT FOR SUSTAINABLE DEVELOPMENT AND THE ENVIRONMENT

Revised Report on:

Needs Assessment for CDCM Training Program

80083
February 2001

Selpeco Westmar

TABLE OF CONTENTS

1 Introduction 1

1.1 General 1
1.2 Description of Hurricane Lenny 2
1.3 Consultant's Scope of Work 2

2 Evaluation of Capacity for CDCM 4

2.1 Development of Questionnaire 4
2.2 Agencies/Companies Contacted 11
2.3 Summary of Responses 11
2.4 Possible Attendees at Courses 13

3 Meetings Conducted 14

3.1 University of the West Indies 14
3.2 Caribbean Development Bank 18
3.3 Tony Gibbs/CEP 19

4 Outline of Training Program/Short Courses 20

4.1 Overall Objective of Program 20
4.2 Optimum CDCM Training Program Structure 20

5 Role of a US-Based University in Training Program 22

5.1 Criteria for Selecting a US-Based University 22
5.2 Development of a Short-List of Suitable US-Based Universities 22
5.3 Role of an Industry Partner 23

6 Preliminary Schedule for Program Implementation 25

7 Summary and Recommendations 26

7.1 Summary 26
7.2 Summary of Key CDCM Issues 27
7.3 Outline of Recommendations for Training 28

APPENDIX A Figures
APPENDIX B Photographs
APPENDIX C Questionnaire Including Covering Letter from Jan Vermeiren
APPENDIX D Lists of Contacts and Additional Possible Attendees
APPENDIX E Proposed Course Outline
APPENDIX F Letters to US-based Universities
APPENDIX G Norman Allyn Meetings with Engineering and Hydrographic Surveying Companies on December 19, 2000

1 Introduction

1.1 General

In November 1999, Hurricane Lenny formed just south of Jamaica and traveled on a northeast track through the Leeward Islands. A review of all tropical storm and hurricane tracks dating back to 1871 reveals that Lenny was one of perhaps two systems over the past 129 years that has moved on an easterly or northeasterly track in this area. Hurricane Lenny became a Category 4 hurricane with sustained wind speeds of over 150 mph which, combined with its unusual track, resulted in high waves pounding the usually sheltered west coasts of the islands. Physical damage estimates are in the order of $269 million to coastal infrastructure, coastal communities and businesses. Much of the damage occurred in the small island economies of the four Eastern Caribbean countries of Antigua and Barbuda, Dominica, St. Lucia and Grenada, which are located as shown in *Figure 1* in *Appendix A.*

In response to the damage inflicted by Hurricane Lenny, the US Agency for International Development (USAID) has designed a Special Objective (SpO) project for these four countries to assist in their recovery. The SpO has four objectives or Intermediate Results (IR), as follows:

- IR1: Reconstruction of key defense systems and selected sections of coastal roads.
- IR2: Training of key personnel in specialized areas.
- IR3: Development of coastal management plans in selected areas.
- IR4: Reactivate economic activities.

This document addresses IR2, and provides the needs assessment and planning for a Coastal Infrastructure Design, Construction and Maintenance (CDCM) Training Program that will be conducted by the University of the West Indies in Trinidad and a US-Based University.

The preparation of this report was carried out by Selpeco Westmar Consultants, L.L.C., based in Kirkland, Washington, USA, and Smith Warner International Limited, based in Kingston, Jamaica and Barbados.

1.2 Description of Hurricane Lenny

The track of Hurricane Lenny is shown in *Figure 2 in Appendix A.*

The hurricane was a late season storm that formed in the western Caribbean, south of the Cayman Islands. It began moving in a northeasterly direction towards Jamaica, but then veered to the southeast. It subsequently resumed a northeasterly track traveling towards the islands of Anguilla and Antigua. South of the US Virgin Island of St. Croix, it increased in strength to a Category 4 hurricane (November 17, 1999). The eye of the hurricane tracked between Anguilla and Antigua, dropping in intensity to a Category 3 storm between November 18 and 19, 1999.

The National Oceanic and Atmospheric Administration hurricane forecasters describe Category 4 as follows:

Category 4: Winds 130 mph to 155 mph. Extensive curtain wall failures with some complete roof structure failures on small residences. Major erosion of beach areas. Major damage to lower floors of structures near the shore. Terrain continuously lower than 10 ft. above sea level may be flooded requiring massive evacuation of residential areas inland as far as 6 miles.

Hurricane Lenny traveled from west to east, which is opposite to the normal direction of Caribbean hurricanes. The track exposed the leeward sides of the Eastern Caribbean Islands to high waves and storm surge.

1.3 Consultant's Scope of Work

The four tasks that are being undertaken and that comprise the Scope of Works are as follows:

Task 1: Establish contacts in Eastern Caribbean countries to obtain input on the existing and desired capacity for CDCM.

Task 2: Establish contacts and prepare recommendations on US-Based Universities that could partner with the University of the West Indies (UWI) in Trinidad and Tobago.

Task 3: Meet with the UWI Faculty of Engineering to obtain input on the training program. In addition, meet with the Caribbean Development Bank and Consulting Engineers Partnership (CEP) in Barbados after the meetings in Trinidad.

Task 4: Prepare a report giving recommendations on the training program.

2 Evaluation of Capacity for CDCM

2.1 Development of Questionnaire

In the development of the questionnaire, a first-principles approach was taken, in which it is recognized that the primary source of risk to coastal infrastructure is from hurricanes, with impacts arising primarily from hurricane waves, beach erosion/scour and storm surge. This approach resulted in the identification of five primary requirement areas where training may be needed, in order to lead to the facilitation of CDCM. The five areas are outlined in the following sub-sections.

CDCM Requirement No. 1 - Understanding of hurricane trends in the Leeward and Windward Islands (The cause of disaster). This includes the following:

- Knowledge of the National Hurricane Center database of storms dating back to 1876, with the recognition that the quality of the database has improved over the last half century.

- Proper hindcasting of hurricane waves arranged probably on a sector-by-sector basis. The hindcast could be a detailed 2-dimensional, or it could be a parametric hindcast.

- Transformation of the hurricane wave climate from deep water to a nearshore climate.

- External analysis of the hindcast wave climate so that a design wave can be extracted.

Suggested Questions:

1. Does the Department of Public Works or Planning, on each island, have a recognized design criteria that it requires, or uses, in the approval of the design and construction of coastal infrastructure?

2. Has a Coastal Zone Management Plan been developed for the island, such that nearshore design wave climates are known on an island-wide basis? If not, how is nearshore design wave data generated for coastal infrastructure?

Anticipated Training Needs:

1. Review of hurricane statistics for each sector of the Eastern Caribbean under consideration.

2. Methods for estimating design waves in the nearshore area, given that no wave hindcasting or transformation capabilities may exist.

CDCM Requirement No. 2 - Mapping of Coastal Infrastructure (What can be affected by the disaster). This includes the following:

- The location, extent and condition of coastal infrastructure either on an island-wide basis, or on the east or west coast. This will depend on the extent of existing development and on proposals for future development that may be a part of a land use plan.

- Representation of the data on digital mapping is desirable, or at least, on 1:2500 scale mapping.

- Knowledge of the types of coastal infrastructure.

- Coastal infrastructure could be main roads adjacent to the shoreline, tourism infrastructure, beach areas, or residential and commercial buildings.

Suggested Questions:

1. Does mapping exist for the coastline of the island, in digital format?

2. If not, are there survey maps at a scale of 1:2500?

3. Has mapping of coastal infrastructure been carried out, such that the length of roadways adjacent to the shoreline is known? What is the extent of tourism infrastructure and beach areas?

4. Are there development plans in existence that indicate the possible future uses for the coastline?

Anticipated Training Needs:

1. Interpretation of aerial photography and ground truthing of data.

2. Methods of estimating the condition of coastal infrastructure, specifically seawalls and revetments.

CDCM Requirement No. 3 - Knowledge of coastal processes that result in damage to coastal infrastructure and/or shorelines (How damage is caused). These include an understanding of:

- Sediment types and transport characteristics.
- Benthic substrates in the relevant nearshore areas.
- Nearshore wave climates for design and, perhaps, day-to-day conditions.
- Tidal fluctuations and storm surge estimates.
- Effect of existing and proposed sea defenses on shoreline processes.

Suggested Questions:

1. Is there an inventory of nearshore wave climate data?

2. Is there knowledge of benthic substrates?

3. Have tides been measured for a long-term period? Are there operating tide gauges? If yes, has this data been analyzed by a harmonic analysis?

4. Are there any estimates of storm surge for extreme events such as hurricanes?

5. Has the OAS/USAID model TAOS been used for predicting storm surge?

6. Are there any estimates of global sea level rise that are applicable to the islands in question?

7. What information is known on coastal processes such as sediment transport characteristics?

8. Are Environmental Impact Assessment (EIA) procedures used or called for in the design and construction of coastal infrastructure?

9. Are set-backs used as a form of coastal protection? If so, what are these and how were they derived?

Anticipated Training Needs:

1. Identification of benthic substrate types, with longer term training in identification of threatened ecosystems.

2. Updating of the deployment locations and data base collections of Caribbean Planning for Adaption to Global Climate Change (CPACC) gauges throughout the Caribbean. Training in the downloading of data from the CPACC website.

3. The use of TAOS to give generalized, or island-wide predictions of storm surge. The use of 1-line modeling, such as sBEACH, for the prediction of the wave set-up component of storm surges at specific locations.

4. Provision of reasonable estimates of global sea level rise for these islands.

5. Methods of estimating coastal process characteristics such as sediment transport directions and order of magnitude rates.

6. Procedures and methods for the carrying out of EIA's of coastal/marine infrastructure.

7. Methods of estimating and applying setback distances as a means of coastal protection.

CDCM Requirement No. 4 - Design and Construction of Coastal Defense Works (Implementing protection against disasters). This process includes the following:

- Topographic surveys.

- Bathymetric surveys and/or wading shots.

- Soil investigations.

- Use of the previously determined design nearshore wave climate to develop preliminary engineering design requirements of shore protection. Shore protection structures could be: revetments; seawalls; groynes; breakwaters; beach nourishment; or application of computed setback distances.

- Preliminary costing of works, which will require a knowledge of:
  - Quarry production capabilities, including production rates as a function of stone sizes mined.
  - Geotechnical properties of quarry products.
  - Contractor capabilities in each island.
  - Equipment type and availability.
- Preparation of a list of advantages and disadvantages of candidates for sea defenses, including cost and effect on environment.
- Final design of works, that may include selection of a preferred option, detailed coastal engineering design, physical model testing, and hydrodynamic modeling.
- Preparation of contract documents: Technical Specifications; Construction Drawings; use of an approved contract.
- Tendering of the contract to an approved list of contractors.
- Evaluation of the tenders and award of a contract.
- Construction of the works, and the quality control and assurance procedures that will ensure that the design requirements are met and that specified environmental guidelines are followed.

Suggested Questions:

1. Are there qualified surveyors that can carry out shoreline surveys?
2. Who does bathymetric surveying for coastal projects? What sort of equipment is used?
3. In the past, who has designed coastal protection works? How have these performed? What are the most common forms of coastal protection/sea defenses that have been used?

4. Is there a list of approved quarries? If so, have these operators presented material testing information for both aggregate and armour stone? Where were these tests carried out?

5. Are there known local reserves of sand that may be used for beach nourishment? What are the sources of sand that have been used in the past (Barbuda, Guyana, etc.)? Are the characteristics of this sand known (sieve analysis, percentage fines, etc.)?

6. Is there a list of approved contractors that have known capability in the construction of sea defense works? Do these contractors have marine equipment?

7. If there is a need for physical modeling? Where is this usually carried out? What is the capability for numerical modeling of processes?

8. What form of contract is usually used?

9. Who usually ensures compliance with environmental requirements during construction?

Anticipated Training Needs:

1. The carrying out of bathymetric surveys and/or in the interpretation of such data.

2. Design of coastal protection structures and/or strategies.

3. Instruction in the acceptable ranges of material specifications, for varying types of protection options.

4. Design and specification of sand for beach nourishment.

5. Appropriate techniques for construction supervision of coastal and sea defense works.

6. Monitoring and ensuring compliance of the construction with environmental requirements.

CDCM Requirement No. 5 - Maintenance of coastal defense works (Ensuring longevity of sea defense investment). Issues to be considered include:

- Monitoring of shoreline movement or change, on a regular basis.
- Evaluation of effectiveness of sea defense works.
- Estimation of the residual life of works, and of the need to do repairs to works.
- Evaluation of long-term impacts, if any, on the adjacent shoreline, and the need to modify works to minimize any identified impacts.

Suggested Questions:

1. Is there any follow up action taken after sea defense works are constructed?
2. What is the mandate of a Coastal Zone Management Unit if existing?
3. Are developers required to submit follow up monitoring reports after coastal works have been constructed?
4. Does the Public Works Department carry out routine inspection and maintenance of coastal works?
5. When sea defense works are designed either in the public or private sector, are estimates of "life of structure" made and included as a part of the design?

Training Needs:

1. Proper procedures for estimating the condition of coastal structures and the need for remedial action.
2. Development of maintenance manual for structures and/or coastal works.

2.2 Agencies/Companies Contacted

To provide input into the needs assessment, the project team prepared a questionnaire based on the above requirements. The questionnaire is included in *Appendix C* to this report, along with a covering letter prepared by Jan Vermeiren of Organization of American States.

Selpeco Westmar and Smith Warner International assembled a list of about 100 possible contacts from their existing data bases and various directories available on the Internet and in the Yellow Pages. From this information a short-list of 51 contacts was developed, to which the questionnaire was sent by fax and e-mail. Follow-up telephone, e-mail and fax communications were utilized to obtain the maximum number of responses to the questionnaire.

The long and short-lists of contacts are included in *Appendix D,* together with an additional list of possible attendees to the courses that were identified during the contact process.

2.3 Summary of Responses

Based on the representative sampling of returned questionnaires, and augmented by the local/regional experience of SWI/Selpeco Westmar, the following trends are apparent:

- Candidates for training will be both engineers and non-engineers.
- CZM Planning should be encouraged in the islands. Of the four considered, only St. Lucia has a Coastal Zone Management Plan (CZMP) in place and only for its northwest shoreline, although this is presently being extended. One is presently being prepared in Antigua at the northwest shoreline.
- Good digital mapping appears to exist throughout most of the islands.
- There is a need for benthic substrate mapping to develop a baseline "picture", with the possible exception of Trinidad. In St. Lucia, benthic substrate mapping has been carried out for the northwest shoreline.
- The EIA process is widely used throughout the islands, although enforcement associated with this is limited.

- Design standards need to be more widely developed. No general standard is used in Trinidad, for example, while the 1 in 50 Year event is used in Dominica and Grenada. In St. Lucia, the 1 in 10 up to the 1 in 50 Year events are used for design.

- There may be a need for upgrading of enforcement legislation in planning offices.

- Need to dovetail with CPACC regarding regional network of tide gauges.

- Need to identify existing regional bathymetric surveyors and to encourage training.

- Of structures used in the coastal zone, gabions have the poorest performance.

- Inspection and maintenance of built structures may be carried out, but is sketchy and irregular.

- Need to incorporate more widespread use of TAOS, but should be accompanied by local "ground truthing" at each island.

- Civil Engineering Consulting firms usually design coastal protection works.

- Material testing labs exist in some of the islands, with more extensive facilities occurring in Trinidad.

- The FIDIC contract is widely used throughout the region.

- Set backs are widely used throughout the islands, however the technical basis for these is often unclear.

- There is a good regional pool of contractors who are capable of constructing works in the coastal zone.

- More esoteric computer and/or hydraulic modeling of coastal phenomena is usually undertaken by a handful of regional specialist consultants, and largely by foreign firms.

2.4 Possible Attendees at Courses

Targeted participants include the long list of contacts and the list of possible additional attendees identified as a result of the contact process, as provided in *Appendix D*.

It is recommended that the UWI establish attendance at the sessions by advertising the courses in the participating countries and other islands in the region several months in advance of the courses.

The UWI should contact the potential participants identified in *Appendix D* individually by phone, mail, e-mail or in person well in advance of the course sessions.

3 Meetings Conducted

3.1 University of the West Indies

Meetings were conducted at the OAS offices in Port of Spain, Trinidad on December 15 and 16, 2000 with representatives of the University of the West Indies (UWI) in Trinidad. The purpose of the meetings was as follows:

- Review the preliminary needs assessment.
- Develop the CDCM Training Program objectives, course content, location and target participants.
- Define the role of the UWI in organizing and administering the courses and preparation of course materials.
- Develop the criteria for a US-Based University to partner with UWI.
- Develop a short-list of US-Based Universities.
- Define the role of industry participation in presenting the courses.

The participants at the meetings are given in *Table 3.1* below:

TABLE 3.1: Participants at the Needs Assessment Meetings in Trinidad on December 15 and 16, 2000

Name	Affiliation	e-mail address
Mr. Jan Vermeiren	OAS	jvermeiren@oas.org
Mr. Mansfield Blackwood (1st day only)	USAID	mblackwood@usaid.gov
Mr. Compton Deane	Consultant to OAS	cdeane@cablenett.net
Mr. Norman Allyn	Selpeco Westmar	nallyn@westmar.com
Dr. David Smith	Smith Warner International	daysmith@infochan.com
Mr. Raymond Charles	UWI	rcharles@eng.uwi.tt
Dr. Derek Gay	UWI	dgay@wow.net
Dr. G. Shrivastava	UWI	gshrivastave@eng.uwi.tt
Mr. Vincent Cooper	UWI	vcooper@eng.uwi.tt
Mr. N. S. Aru	UWI	nsaru@eng.uwi.tt

The main points that were presented for discussion are summarized as follows:

- Hurricanes normally go from east to west; Hurricane Lenny was one of perhaps only two Tropical Cyclones in approximately 130 years for which tracks of Tropical Cyclones are available, to go from west to east across the Lesser Antilles. Norman Allyn noted that a similar event occurred in 1984 when Hurricane Klaus, while still a Tropical Storm, proceeded from southwest to northeast past the east coast of Puerto Rico (refer to Tropical Cyclones of the North Atlantic Ocean, 1871 - 1998, NOAA). In general, Tropical Cyclones originating in the Caribbean Sea cross the Greater Antilles on northeast tracks more frequently than cyclones originating in the Atlantic Ocean. Examples of these include tropical storm and hurricane events in 1905, 1909, 1912, 1932, 1939, 1949, 1955, 1981, 1991, 1994, and 1996.

- Hurricane Lenny was briefly a Category 4 Hurricane and not only inflicted significant damage to the four participating countries, but to other islands in the region, including Trinidad and Tobago. In Trinidad, boats at anchor in Chaguaramas were damaged. In Tobago, the breakwater at the Coco Reef Hotel was destroyed.

- Norman Allyn and David Smith provided a Power Point presentation illustrating the preliminary needs assessment. The presentation included the track of Hurricane Lenny as shown in *Figure 2* in *Appendix A*, and the damage inflicted on the coastal infrastructure of the four participating countries as illustrated in *Photograph Nos. 1 through 10* in *Appendix B*. Additional photographs and figures were presented to illustrate designs that suffered no damage from Hurricane Lenny.

- Jan Vermeiren presented the results of the TAOS model runs for the region and for individual islands. By analyzing 116 years of historical hurricane data, but not including Hurricane Lenny, Watson Technical Services produced plots of the maximum expected wind speeds, storm surge and wave heights for 10, 25, 50 and 100 year return periods. Plots of the 1 in 100 year return period wind speeds, wave heights and storm surge for the Eastern Caribbean Basin are provided in *Figures 3, 4 and 5* in *Appendix A*. The wind, surge and wave heights generated by Hurricane Lenny are shown in *Figures 6 to 11* in *Appendix A*, which indicate that the storm surge and wave heights from Hurricane Lenny exceed the 1 in 100 year return period for the four participating countries.

- TAOS is installed on a super computer and is used for live forecasting. It has been tested using NOAA wave buoys, with the predicted waves using TAOS found to be within 10% of the NOAA recorded waves for 80% of the data points.

- Jan Vermeiren noted that another source of information that could be used in the training program is the Caribbean Planning for Adaptation to Global Climate Change (CPACC).

- Coastal Zone Planning (CZP) is currently not widely instituted in any of the four participating countries. Barbados is the only country in the region that has CZP for its entire shoreline. In St. Lucia, a Coastal Zone Management Plan (CZMP) has been prepared for the northwest coast. Presently, this is to be expanded to include the Gros Islet area, and also, a CZMP is to be prepared for the south coast town of Soufriere. Finally, a CZMP is also underway for the northwest coast of Antigua.

- Environmental Impact Assessments (EIA) and CZP require education, political will, enforcement and codes. Setbacks and the effect of structures on the environment will be discussed in the Training Programs.

- The Caribbean Uniform Building Code (CUBIC) was discussed. Coastal structures are not part of the Code, which is a major deficiency. Compton Deane was of the opinion that standards for coastal infrastructure should be included in CUBIC. Applicable Codes for coastal structures will be presented in the Training Programs.

- The concept of risk and return period should be addressed in the courses.

- Monitoring and maintenance will be presented in the Training Programs.

- The needs assessment program will focus on its completion over the next nine months, and the requirements of the participating countries.

- The objective is to train 30 to 100 people from the four islands. Participation from other islands will be encouraged, with some cost associated with their attendance.

- The UWI has a contract with OAS to conduct the course. The UWI has experienced teachers within and outside the Eastern Caribbean region.

- The CDCM Training Program Advisory Group consists of the individuals in *Table 3.1*, with the exception of Mr. Blackwood.

- The course outline was developed and is provided in *Appendix E*.

- Bathymetric surveying is taught by the UWI as a part of its Land Surveying course, under Civil Engineering.

- The UWI is to introduce into its curricula, a Graduate Program called "Natural Hazards Engineering".

- It was agreed that the UWI would contact the following three US-Based Universities for interest in participating in the training program, and to determine their competencies:

    - Massachusetts Institute of Technology (MIT), contact Dale Morgan. MIT has a strong ocean engineering program and existing links to UWI.

    - Texas A&M University, contact Billy Edge. Texas A&M has an existing outreach program with the US Army Corps of Engineers Water Engineering Station (WES) at Vicksburg, Mississippi.

    - University of Florida (UF), contact Bob Deane. Florida is "in the region", and so UF personnel will likely have a good understanding of the design issues involved.

- The UWI will rank the universities.

- A copy of the letter to the US-Based Universities is attached in *Appendix F*.

- Norman Allyn and David Smith will review these universities and other Florida Universities to determine if there are any other qualified universities in Florida that should also be invited to bid.

- Industry participation in the training of practicing engineers in the region was discussed. Smith Warner International, with offices in Jamaica and Barbados, will lecture on practical design issues at the course modules to be conducted at the participating islands. Selpeco Westmar has designed a number of piers and sea walls in the region and will lecture on codes and design issues at the course module to be conducted in Trinidad.

- The schedule discussed requires that the final module be conducted no later than about September 2001. The first three modules will be conducted in the period of May through August 2001.

- Norman Allyn arranged with Compton Deane to jointly meet with several prominent engineering and hydrographic surveying companies to obtain additional completed questionnaires while Mr. Allyn was in Trinidad. These meetings were conducted on December 19, 2000 and are summarized in *Appendix G*.

3.2 Caribbean Development Bank

A meeting was held at the Caribbean Development Bank (CDB), with Ms. Cheryl Dixon and Mr. Clairvair Squires. The points that came out of this meeting are summarized as follows:

- EIA's are required for all projects that are funded by the Bank.

- There is a perceived need for more long-term climatological data for use in the design of coastal infrastructure. In general, there should be proper data collection and information gathering, in order to manage the environment.

- The CDB has tried to influence the planning process in order to get issues such as set-back adequately applied. These attempts have not met with much success, largely due to political influence.

- The CDB is familiar with TAOS, but has not employed its use directly.

- The CDB sees a lack of human resources in the area of Land Use and/or Coastal Zone Planning, and for the collection, interpretation and application of coastal data.

- There is a perceived problem related to the separation between Integrated Coastal Zone Management and the general planning function.

- There has been little or no follow up data on the issues raised by the Small Island Developing States (SIDS) Conference.

- There is little or no monitoring of coastal infrastructure and there is a lack of "teeth" in the enforcement of legislation related to it.

- Ms. Dixon suggested that the target audience for Training Module 1 be made less broad. Focus only on those who can make a difference in their organizations.

3.3 Tony Gibbs/CEP

Mr. Tony Gibbs was interviewed regarding his experience in the field of CDCM. The following points emerged from this interview, in summary format.

- Mr. Gibbs is concerned that there has been a lack of focus on Coastal Engineering in the Caribbean. In his opinion, this should be an area of excellence for engineers, both within the region and internationally, since these are issues that are dealt with on a day-to-day basis.

- There is a need to have the UWI filling this requirement.

- There is a need for proper collection and analysis of data throughout the islands.

- The community does not take Coastal Engineering issues seriously enough. In addition, the public sector does not demand sufficiently detailed information from practicing engineers.

- There is a need to have someone with some coastal engineering knowledge in each island.

- To date, the experience of Mr. Gibbs has been that economic considerations very often drive the design to a 1 in 20 year event.

4 Outline of Training Program/Short Courses

4.1 Overall Objective of Program

The overall goal of the Special Objective (SpO) is to provide immediate assistance to participating countries that suffered from Hurricane Lenny, and to achieve a faster recovery from future hurricane disasters through training.

Intermediate Result 2 (IR2), the focus of the present study, will train key personnel from the participating countries and other islands in the region, in specialized areas. An additional benefit of preparing and presenting a series of short courses on CDCM in conjunction with a US-Based University, is that the course content can be modified and used in the establishment of a Coastal Engineering course at the UWI in Trinidad.

In order to offer the course content to as wide an audience as possible, it is proposed that each module will be held in a different island. This is considered to be important, as there are specific areas of CDCM that may be more developed in any one island, as compared to another. For example, the concept of Coastal Zone Planning and the derivation and application of design standards may be more used in St. Lucia than in the other three islands, simply because they have a partial Coastal Zone Management Plan. In Dominica and Grenada, however, extensive designs have been developed for sea defense works, so there is already an awareness in the public and private sectors of the planning and design process that must accompany this type of infrastructure.

4.2 Optimum CDCM Training Program Structure

The optimum training program structure was discussed at the meeting in Trinidad on December 15 and 16, 2000 and resulted in the course outline attached in *Appendix E*. The following points summarize the requirements for an optimal CDCM training program:

- The training program should be completed in the year 2001.
- The training program should address the needs of the individual islands and the region.
- The training program should offer general courses appealing to a broad spectrum of stakeholders in each of the four participating countries.

- The training program should have a more in-depth coastal engineering course, to be conducted in St. Lucia.

- The training program should have a more in-depth course on monitoring and maintenance, to be conducted in Grenada.

- The training program should have a detailed course on design for engineers from each of the four participating countries and other islands in the region, to be presented in Trinidad.

- The training program should have classroom and field components.

5 Role of a US-Based University in Training Program

5.1 Criteria for Selecting a US-Based University

The criteria for selecting a US-Based University to partner with the UWI was discussed at the meeting held with the UWI in Trinidad. The agreed criteria are presented as follows:

- Complements the UWI in providing coastal, planning and environmental engineering expertise that could be employed to augment the existing teaching staff, engineering expertise and facilities at the UWI.
- Familiar with the coastal issues of small islands.
- Interest in reaching out.
- Cost considerations should be taken into account. The OAS and UWI want the best deal in terms of value, which is a balance of cost and the above three criteria.

5.2 Development of a Short-List of Suitable US-Based Universities

Based on the criteria outlined in the previous section, the following universities have been selected as potential candidates for the task. As a result of the meetings in Trinidad with the faculty of the UWI, an initial three US-Based Universities were selected by the UWI. Subsequently, this initial listing of three was expanded to five, these being listed below:

- Texas A&M University (TAMU)
- Massachusetts Institute of Technology (MIT)
- University of Florida (UF)
- Florida Institute of Technology (FIT)
- Old Dominion University (ODU)

In evaluating these five universities, the following points were noted:

- TAMU has the experience in setting up a one-year coastal engineering education reach-out program for the US Army Corps of Engineers in 1989.

- The coastal and ocean engineering program in TAMU has a faculty team that provides courses for a wide range of coastal engineering topics including ocean wave mechanics, coastal structures, coastal sediment process, as well as offshore structures and hydrodynamics.

- UF has a strong faculty and coastal program that provide many coastal related courses. These courses include port and harbor engineering, hydrodynamics of coastal and ocean structures, coastal and offshore structures, coastal process, and coastal sediment transport.

- At MIT, the ocean engineering / naval architecture and marine engineering program has a talented faculty that specializes in ocean science, marine hydrodynamics, turbulent marine flow and design of ocean systems. The course information in the Department of Ocean Engineering at MIT indicates that most courses are related to theoretical background, numerical modeling and marine hydrodynamics. Courses for coastal engineering at MIT are limited.

- FIT's ocean engineering program has a relatively small faculty team in which only two faculty members are identified as specializing in coastal structures, beach erosion control, inlet and harbor dynamics, marine instrumentation, water waves, coastal monitoring and beach processes.

- ODU has a one-person faculty team in the area of Coastal Engineering. Topics covered include: coastal hydrodynamics; coastal processes/structures; computational hydraulics/turbulence; dredging engineering; estuary hydrodynamics; and water wave dynamics.

The preceding preliminary evaluation of potential university candidates indicates that TAMU and UF are the better choices as partners to carry out the course development activities in UWI. The final selection, however, will be made once the responses are received and evaluated.

5.3 Role of an Industry Partner

In addition to having a US University partner with the UWI to prepare and present the training course modules, it is recommended that the inclusion of an industry partner would be beneficial to the development of Coastal Engineering expertise in the Caribbean. To this end, it is suggested that Smith Warner International and Selpeco Westmar continue their involvement in the training process. Specifically, it is envisioned that SWI will work with UWI final year Civil Engineering students, to investigate research topics that are of primary relevance to the region. Through this interaction, it is anticipated that a strong linkage will develop between the course curriculum and the needs of industry.

It is recommended that Norman Allyn of Selpeco Westmar, and David Smith of Smith Warner International, be involved in the preparation and presentation of course material. In particular, the presentation by Selpeco Westmar will focus on the design of coastal and marine structures, while the SWI presentation will focus on the relevant coastal processes.

6 Preliminary Schedule for Program Implementation

A preliminary schedule for the implementation of the CDCM Training Program follows:

- The courses should be advertised well in advance of the sessions, commencing before about March 1, 2001.

- Module 1, on Coastal Zone/Island Systems Management, for a broad range of participants numbering in the order of 15 per island, could be conducted during the month of May 2001, with the following proposed one week sessions in each country:

    - May 7 to 11, 2001 on Antigua
    - May 14 to 18, 2001 on Dominica
    - May 21 to 25, 2001 on St. Lucia
    - May 28 to June 1, 2001 on Grenada

- Module 2, on Coastal Defense Systems, could be conducted in one week sessions on St. Lucia and Dominica with the following proposed schedule:

    - June 18 to 22, 2001 on St. Lucia for what is anticipated to be a large audience of planners and engineers numbering approximately 20 to 30 participants.

    - July 16 to 20, 2001 on Dominica for what is anticipated to be a smaller audience of public and private engineers, and will include classroom and field portions.

- Module 3, on Monitoring and Maintenance, could be conducted on Grenada around August 13 to 17, 2001 for approximately 20 to 30 participants. Classroom and field portions will be included in this module.

- Module 4, on Design of Marine Structures, could be conducted on Trinidad around September 24 to 28, 2001 for approximately 20 participants of public and private sector engineers.

This preliminary schedule allows for preparation and set-up between modules. The final schedule developed by the UWI and the US-Based University should account for the availability of personnel and facilities.

7 Summary and Recommendations

7.1 Summary

The following points summarize the work that was performed in this project:

- A questionnaire was developed and issued to determine the needs for each of the participating countries and the region in general.
- A meeting was held at the Caribbean Development Bank (CDB) between personnel from their Planning Department and Smith Warner International personnel. Follow up interviews with the head of the CDB's Engineering Department, were also conducted.
- A meeting was conducted in Trinidad with OAS, USAID, UWI, Selpeco Westmar and Smith Warner International personnel in attendance. The meeting accomplished the following:
  - Selpeco Westmar and Smith Warner International presented the preliminary needs assessment.
  - The CDCM Training Program objectives, course content, location and target participants were developed.
  - The role of the UWI in organizing and administering the courses, and preparing course material, was defined.
  - The criteria for a US-Based University to partner with UWI were developed.
  - A short-list of US-Based Universities was developed.
  - The role of industry participation in presenting the courses was defined.
- Contacts with a short-list of four US-Based Universities were made by the UWI shortly after the Needs Assessment meetings in Trinidad.

7.2 Summary of Key CDCM Issues

Of the responses to the questionnaires that were received, approximately 55% were from the private sector, 35% from Government agencies and the remaining 10% from the contracting sector. Based on the responses received, and augmented by the regional experience of Smith Warner International and Selpeco Westmar, the following trends can be seen to emerge.

- Coastal Zone Management Planning is only now being actively achieved in these islands, and should be encouraged as much as possible. Of the four islands considered, only St. Lucia has a CZMP in place, and this is only for the northwest shoreline. Plans are presently under development for other areas in St. Lucia and for the northwest coastline of Antigua. In addition, a Coastal Zone Management Unit is being implemented in Dominica.

- Good detailed mapping is available throughout the islands.

- There is a need for sound data collection, analysis and interpretation procedures. These should include oceanographic data and marine biological data. Synergy with ongoing programs such as CPACC should be encouraged.

- The EIA process has been widely adopted for use in the islands. This should be encouraged and perhaps extended so that development is required to initiate post-construction monitoring of projects.

- Design standards need to be more widely developed, accepted and applied throughout the islands, in the design of coastal infrastructure.

- The University of the West Indies has been including bathymetric surveying in its curriculum. This is to be encouraged and continued/expanded.

- Experience gained in the performance of structures used in the coastal zone has shown that gabions do not perform well.

- The inspection and maintenance of coastal structure is not a procedure that is widely carried out in these islands. Dominica appears to be the only one of the four where this occurs. Perhaps aspects of this side of the design and construction cycle could be introduced into the Engineering curriculum at the UWI.

- There is relatively good material testing laboratory support within the region.
- There are good quarry reserves throughout the islands.
- There is a very good pool of qualified contractors throughout the region for this type of work.

These results and trends show clearly that there is a general lack of knowledge and information in the following topics:

- Coastal Zone Management Planning.
- The need for data collection, analysis and interpretation and its place in the design cycle.
- Proper design procedures for coastal structures and infrastructure.
- Proper maintenance methods for coastal structures.

This lack of knowledge presently exists among practicing engineers, in both private and public sectors. Any remedial courses should therefore be aimed initially at this target audience, along with Planners and Architects. Follow-on courses could then be targeted at the undergraduate level, so that future generations of Caribbean engineers will be well versed in the design of structures in the marine environment, an area that is extremely important to the economies and social well-being of its people.

7.3 Outline of Recommendations for Training

As discussed in *Section 7.2* preceding, training should be at two levels. This should be initially to the practicing engineering community and then at the undergraduate level. Lessons learned from the former approach could then be used to fine-tune the latter.

The following recommendations are provided for achieving a successful initial Training Program:

- The UWI should establish attendance at the sessions by the following methods:

- Advertise the courses in the participating countries and other islands in the region several months in advance of the courses. Advertisement could be in newspapers, and through local and/or regional engineering associations.

- The potential participants identified in *Section 2.4* should be individually contacted by phone, e-mail or in person.

- The UWI should evaluate the US-Based Universities using the criteria described in *Section 5.1*, and circulate the results to the CDCM Advisory Committee.

- Industry participation by engineers who have designed coastal infrastructure that have successfully withstood hurricanes, including Hurricane Lenny, should present course material to provide a practical perspective in the course modules.

- The course content should be developed, once the US-Based University is selected, and then circulated to the CDCM Advisory Committee for comment and input.

Following the successful completion of this round of courses, a core lecture series should be extracted and used in the undergraduate final year Civil Engineering course.