# CHAPTER 12 ENVIRONMENTAL STUDY

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## 12.1 Background

The laws and regulations of the Republic of El Salvador require that before implementing any major projects, the project owners shall obtain environmental permits from the Ministry of Environment and Natural Resources (MARN). For this purpose the project owners shall assess the project's eventual impacts on the environment and propose countermeasures for those impacts which may adversely affect the environment to a significant extent. An Environmental Impact Assessment (EIA) Report shall then be submitted to MARN for review and issuance of such environmental permits.

In compliance with the above requirement, CEPA submitted an EIA Report (CEPA 2000) to MARN prior to the design stage. The Report was approved by MARN and an Environmental Permit was issued on December 21,2000 (Resolution MARN-N 400-2000) under the conditions summarized in Table 12.1.1 below.

**Table 12.1.1 MARN-N 400-2000 Permit Conditions**

| Conditions | Remarks |
|---|---|
| 1. Implementation of 14 Mitigation Measures | |
| 2. Payment of ¢16,050,000 as security guarantee | This amount of guarantee was already paid by CEPA |
| 3. Implementation of 18 Permit Conditions | 10 out of 18 Permit Conditions will be fulfilled by the implementation of all Mitigation Measures |
| 4. Audit by MARN during construction period | |

The 14 Mitigation Measures stated in the above table, together with their objective, rationale and main elements as explained in CEPA 2000 are detailed in Table 12.1.2, and the 18 Environmental Permit Conditions, together with their rationale and main elements are detailed in Table 12.1.3.

As noted in the remarks in Table 12.1.1, 10 of the 18 Permit Conditions will be solved when implementing the relevant Mitigation Measures. Their feasibility and justification were discussed by the Study Team with CEPA. Subsequently, to further examine those measures and conditions more detailedly, the Study Team conducted environmental surveys and impact assessment as described in Sub-sections 12.2.

A report titled "The Environmental Management and Monitor Plan" is prepared by the Team, detailing each of the Mitigation Measures and Permit Conditions, and proposing an environmental management and monitoring system to be applied during the project construction and operation stages.

## Table 12.1.2 Original Environmental Mitigation Measures

| MEASURE | OBJECTIVE | RATIONALE | ELEMENTS |
|---|---|---|---|
| **MITIGATION MEASURES** | | | |
| 1. Re-vegetation and wildlife rescue | Plant trees to compensate for losses during the borrow operation. Rescue fauna from the area in which habitat will be lost. | Clearing the borrow site will destroy trees and vegetation, and to compensate, double the area lost should be planted with trees. Planting should be close to the port and on the Conchagua hills. A plan should be developed to rescue the wild fauna from the area and relocate to an area in which they will be able to survive | • Re-vegetate 50 ha with 2,240 trees of species that grow in the area at present;<br>• Implement a plan to rescue wild fauna from the area;<br>• Monitor establishment of vegetation and fauna; |
| 2. Conservation of rocky areas and fauna | Conserve rocky habitat that is relatively rare in the area. | Move rocks in front of Cutuco port and the pillars supporting the existing dock, which are encrusted with marine animals, to an area nearby where the habitat and fauna will survive. | • Move rocks and pillars to another area that will not be affected by future port activities. |
| 3. Environmental management during the borrow operation | Control dust and vehicle emissions, and prevent turbid water entering the bay. | Clearing the borrow area could generate dust so the area should be watered, and drainage and runoff should be collected. A protective fence should be built around the site and vehicles and construction equipment must be properly maintained. | • Water soil 3 times a day in the dry season;<br>• Construct 2,400 m canal with sediment boxes, 2 headers for discharge, and turbidity screens;<br>• Develop program of equipment maintenance;<br>• Construct 1,600 m perimeter fence. |
| 4. Management of waste from borrow works | Dispose of waste from the borrow operation with minimal impacts. | To minimize environmental impacts, vegetation, topsoil and any other waste material from the borrow area should be taken to a disposal site without transporting through La Unión City. | • Recondition the disposal site by compacting an estimated 500,000 $m^3$ of material;<br>• Re-vegetate the site with 1600 trees. |
| 5. Management of dismantling and disposal of existing infrastructure | Avoid accidents and prevent soil, air and water pollution. | Appropriate precautions must be taken when dismantling existing structures at the port, including the jetty, warehouses, tanks and pipelines. Special measures will be needed for asbestos, which is present in the ceiling panels of Warehouse 5. | • Manage asbestos waste, demolish rest of site;<br>• Check and clean existing pipes;<br>• Put signs on pipes from the CORSAIN site which are to be retained intact. |
| 6. Solid waste management | Maintain cleanliness of operating port and avoid soil and water pollution. | Garbage and domestic-type waste will be produced by the operations of the port and by visiting ships, and this will need to be collected and burnt in an incinerator. | • Provide an incinerator to process solid waste from the port and ships;<br>• Provide refuse containers and a garbage truck. |
| 7. Liquid waste management | Prevent accidents that could release hazardous liquids, polluting land and sea. | The terminal in which liquids will be handled in bulk will require infrastructure and equipment to manage the liquids according to international standards and prevent spillage and pollution. | • Construct oil slop tank or mud tank;<br>• API oil-water separator to treat drainage;<br>• Bunds around oil loading and unloading areas;<br>• Vapor collecting tank in truck loading area;<br>• Concrete boxes under jetty to collect spills at pipe connecting points;<br>• Booms, skimmers and absorbent to isolate, collect and dispose of oil spilled into water;<br>• All drainage to feed into oil-water separator;<br>• Oil and grease collector tank of 150$m^3$ capacity |

| MEASURE | OBJECTIVE | RATIONALE | ELEMENTS |
|---|---|---|---|
| 8. Environmental protection during dredging | Limit the production and spread of turbidity produced by the dredging and disposal works. | Dredging will produce around 6.5 million $m^3$ of material, which must be collected and disposed of using procedures that minimize impacts on the marine ecosystem. | • Environmental study of disposal area;<br>• Anti-turbidity curtains in dredging and disposal areas to prevent spread of sediment;<br>• Make workers aware of impacts of dredging;<br>• Place warning signs in disposal area;<br>• Surround disposal area with silt curtains;<br>• Booms and skimmers to deal with oil spills. |
| 9. Sanitary infrastructure for construction site | Avoid water pollution from the inadequate disposal of sewage waste. | Adequate sanitary facilities should be provided for workers on the construction site to prevent sewage entering the surrounding channel water. | • Provide portable latrines for 400 workers;<br>• Treat estimated 36,000 l $day^{-1}$ of sewage via treatment plant, septic tank or irrigation field. |
| 10. Service infrastructure for port workers | Provide recreational areas for workers to comply with occupational safety and hygiene regulations. | This measure proposed by the EIA report was omitted from the Environmental Permit. | |
| 11. Occupational Health and Safety | Prevent accidents harming port workers. | Occupational Health and Safety measures are needed to avoid accidents and protect workers at all times. | • Equip personnel with gloves, masks, ear protection, safety shoes and showers |
| 12. Project Promotion | Reduce socio-economic impacts and disordered growth from increased demand on public service. | The population of La Unión could triple because of workers from ships and container lorries. The impacts of this increase should be studied and a publicity campaign implemented to inform the public and reduce the effects. | • Hold eight meetings with the local community to promote the project;<br>• Conduct an opinion poll to verify acceptance of the project. |
| 13. Port Environmental Unit | Reduce and prevent impacts of the port on the environment | Form a committee of highly qualified persons to be responsible for environmental matters in the operating port, and for enforcing environmental guidelines and regulations. | • Form a committee of qualified environmental experts. |
| 14. Environmental Measures in the Port Operations Manual | Raise awareness of environmental protection in the port. | All ports have a Bulletin or Manual containing instructions regarding procedures that must be followed in the port that is given to ships and other visitors. Environmental measures should be included to prevent visiting ships polluting the bay. | • Add environmental measures to the Port Manual in collaboration with the navy. |
| 15. Solid waste management | Minimize pollution from the handling of solid bulk material, mainly particles. | Equipment installed at the solid bulk terminal should manage the material according to international standards to reduce the emission of dust. | • Handle solids using covered conveyor belts;<br>• Provide towers with dust prevention systems at all direction changes in the conveyors;<br>• Use silos with dust retention mechanisms, including rotating valves;<br>• Use low speed conveyors with collecting trays. |

## Table 12.1.3 Original Environmental Permit Conditions

| CONDITION | RATIONALE | ELEMENTS |
|---|---|---|
| **ADDITIONAL PERMIT CONDITIONS** | | |
| 1. Environmental Management Plan | Execute the Environmental Management Plan according to the program proposed in the EIA report. | This will be fulfilled when Mitigation Measures are included in the port design as stated in the Environmental Management Plan (Section 11.8). |
| 2. Solid Waste Management | Prepare and implement an integrated plan to manage solid waste produced during the construction and operation of the port. | Solid Waste will be managed according to Mitigation Measures 3, 4 and 6. |
| 3. Borrow site Watering/vehicle maintenance | Verify that the watering and vehicle maintenance programs are executed properly during the borrow operation. | Watering and vehicle maintenance will be verified by monitoring associated with Mitigation Measure 3. |
| 4. Effluent analysis by Port Environment Unit | Port Environmental Unit should carry out physical, chemical and microbiological analysis of effluent from the wastewater treatment system, and compare results with national standards. | Port Environmental Unit will monitor effluents, as specified when the Unit is established, so this is included in Mitigation Measure 13. |
| 5. Monitor turbidity during dredging | Turbidity should be analyzed periodically during the dredging. | Turbidity monitoring will be included in the implementation of Mitigation Measure 8. |
| 6. Service infrastructure for port workers | The functioning port should include service infrastructure for workers to comply with Occupational Health and Safety legislation, including green and recreational areas. | Trees will be planted in and around the port as required by Mitigation Measure 1. |
| 7. Environmental Measures in Port Manual | Environmental Measures must be incorporated into the Port Operations Manual to avoid pollution from ships visiting the port. | This is the same as Mitigation Measure 14. |
| 8. Air Quality Monitoring | Dust concentrations must be tested and controlled periodically. | Port Environmental Unit will monitor dust, so this is included in Mitigation Measure 13. |
| 9. Operate liquid treatment system | A technician should be hired to operate the liquid treatment system of the port and monitor the liquid effluent | |
| 10. Maintenance of water sanitation system | The water treatment systems of the port must be maintained by:<br>- Removing sludge from the treatment plant;<br>- Maintaining incinerator, water plant, oil slop tank, separator;<br>- Controlling exploitation of the water well;<br>- Monitoring the quality of industrial and drinking water. | |
| 11. Cleaning drainage channel | Mud should be removed periodically from the channel collecting drainage water from the borrow site. | Drainage channel will be cleaned as part of Mitigation Measure 3. |
| 12. Re-settlement of settlers | Settlers living in the borrow area should be re-settled to housing with at least minimum conditions. | |
| 13. Completion of La Unión bypass | The new La Unión bypass should be completed before construction of the new port begins. | |

| CONDITION | RATIONALE | ELEMENTS |
|---|---|---|
| 14. Prevent rodents entering the port | The new port should have a mechanism to prevent rodents migrating ashore from visiting ships. | |
| 15. Control improvised canteens | In coordination with the competent authorities, CEPA should control the development of improvised canteens outside the site to prevent the generation of solid and liquid waste | |
| 16. Training in wildlife and avoiding snakebites | Venomous snakes are found near the port, so workers should be trained in treatment of snakebites and provided with antiserum. Training should also be provided in wildlife laws and nature conservation (by the Services of Parks and Wildlife Authority). Any apretador crabs (*Menippe frontalis*) found must be given to the local CENDEPESCA office, and MARN should be notified. | |
| 17. Physical and biological survey of disposal site | Physical and biological characteristics of proposed disposal site should be determined. MARN suggest that this should be south of latitude 13° 0' N, at 43m depth , on soft sediment, not rocky bottom. Material must not affect the boundary with the Republic of Nicaragua. The study should be submitted to MARN. | The environmental survey of the disposal site will be carried out and submitted to MARN during the implementation of Mitigation Measure 8. |
| 18. Comply with laws | All laws relevant to this type of project must be complied with. | |

Note :
No further action was taken with respect to Mitigation Measure 10 as this was omitted from the Environmental Permit.
No separate action was taken with respect to Permit Conditions 1-8, 11 and 17 as these all involve actions that will be carried out when Mitigation Measures are implemented.

## 12.2 Environmental Surveys

### 12.2.1 Basis of Survey and Environmental Study

The environmental surveys were aimed primarily at determining how the various conditions of the Environmental Permit would be accommodated within the Project. The work comprised the following:

- Review of the conditions to confirm whether they are justified and feasible;
- Collection of data on the existing environment in the Study area, in addition to those referred to in the EIA;
- Interview survey with artisanal fishermen to determine the fishery activities in the Fonseca Gulf;
- Numerical modeling to predict the dispersion of suspended solids due to dredging, disposal and reclamation works;
- Assessment of the environmental impacts of dredging, disposal and reclamation works;
- Proposal to amend certain conditions of the Environmental Permit;
- Preparation of the Environmental Management and Monitoring Plan for the Project, which describes how the environmental impacts will be mitigated and mitigation measures will be monitored during the construction and operational phases to minimize environmental impacts.

The following additional environmental surveys are conducted to grasp the ecological condition, water quality, etc. required for further examination, as well as numerical simulation of sediment dispersion behavior as a result of the construction works.

1) Ecological survey in the reclamation area (benthos, marine biology)
2) Ecological survey in the borrow area (terrestrial plant and animal)
3) Ecological survey in the offshore dredging area (tidal current, water quality, seabed material, benthos)
4) Ecological survey in the offshore dumping area (water quality, seabed material, benthos)
5) Fishery activities survey
6) Present condition survey (water quality, seabed material, benthos)
7) Air quality observation
8) Water quality for future monitoring purpose (water quality)

Figure 12.2.1 shows the locations of survey stations together with the proposed borrow and reclamation areas, dredging channel, and original and alternative offshore dumping sites.

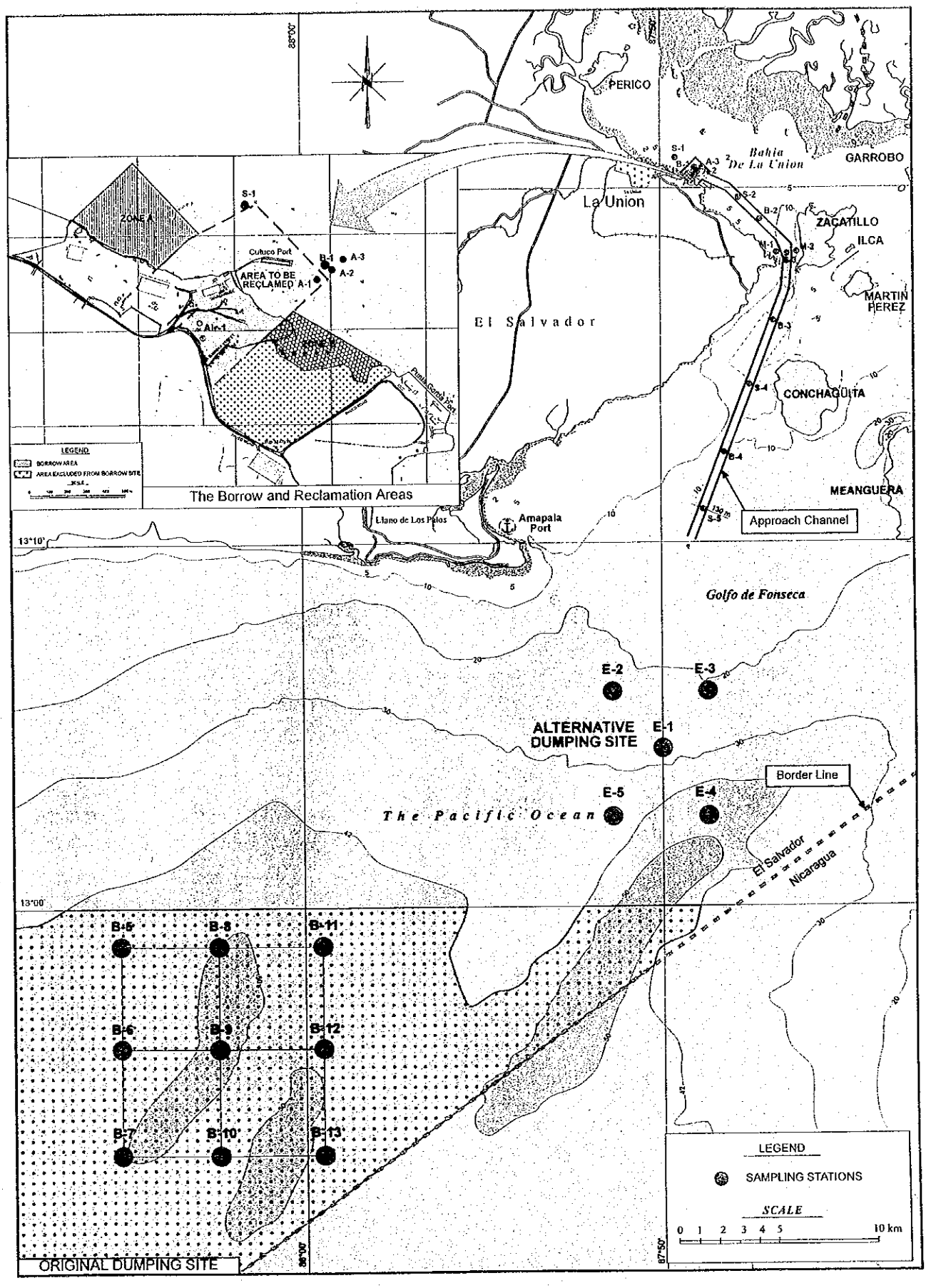



Figure 12.2.1 Locations of Additional Surveys

### 12.2.2 Ecological Survey in Borrow Site

#### (1) Flora

There are 73 species of trees and shrubs in the borrow area; they are grouped into 33 families among which the Leguminosae Family with 19 species is predominant. There are 36 herbaceous species, grouped into 23 families among which the Graminae Family with 9 species is the most abundant, covering much of the vegetated areas, particularly where open to sunlight.

There are two types of flora at the port site:

- The Medium Forest Subcaducifolia, which is the best developed community, being found in most of the areas of natural vegetation inland of the coastal strip. Leguminaceae predominate here, particularly *Enterlobium cyclocarpum* (concaste) and *Pithecellobium* spp (mango). There are also tropical hardwoods, including teak (*Tectona grandis*) and mahogany (*Swietenia humilis*); and
- The Mangrove Forest, which is present in only five small patches, primarily because of the absence of gently sloping mudflat in the intertidal zone. Only a few trees of *Conocarpus erectus*, *Avicennia bicolour*, *Laguncularia racemosa* and *Rhizophora mangle* are present in these areas.

The third community (Irilar), which generally forms a transition between the other two, is virtually absent, with only a few specimens of iril (*Coccoloba floribunda*) present, dispersed within the Medium Forest. The flora in the area includes several species that have become nationally rare, because of the extensive deforestation throughout the country.

#### (2) Fauna

The fauna in the area is relatively diverse, and includes at least 14 reptiles, 43 species of birds (resident and migratory) and 11 mammals, plus numerous insects and other invertebrates. The greater part of animals are present in the more densely vegetated areas, away from human activity.

Table 12.2.1 shows the categories of animals classified based on the official listing of the Ministry of Agriculture and Cattle of El Salvador (MAG Official Listing 1998), and listed in the Appendices to the Agreement on International Trade in Threatened Species of Wild Fauna and Flora (CITES 1998). Both are normally used for classification of the status of endanger by MARN.

MAG official listing was prepared following the IUCN 1996 and 1997 Classification, and issued in 1998 in accordance with Wildlife Conservation Law. MAG classification has only two categories 1) Threaten of Extinct (T); and 2) Endanger of Extinct (DE). (T) is provided for the species of which have decreasing trend constantly by exti nction. (DE) is provided for the species of which face a critical situation to exti nction threater.

A total of 14 species are under the category of "Threaten of Extinct" and 6 species are "Endanger of Extinct". Thus, these species are considered to be nationally rare in accordance with the judgement of MARN. (None of these species is listed in the Red Book of IUCN 2000).

The habitant currently occupied by these animals (the trees, vegetation and soil of the borrow area) will be removed before commencement of construction, a good proportion of the fauna should survive if they are properly collected, transported and released in a similar habitat nearby.

MARN have agreed to the proposal of releasing captured animal into the adjacent undamaged area. CEPA will consult MARN to obtain their assistance in specifying the species and capture method. The operation of capture will start by the indentification of the location of nests and burrows, and carrying capacity of animals at the proposed releasing ground. It will be carried out avoiding the period of breding.

**Table 12.2.1 Rare and Endangered Animals Reported from Borrow Area**

| SCIENTIFIC NAME | COMMON NAME IN EL SALVADOR | COMMON ENGLISH NAME | MAG Listing 1998 | CITES (Appendix No) |
|---|---|---|---|---|
| **Reptiles** | | | | |
| *Lampropeltis triangulum* | False coral | Milk snake | DE | |
| *Micrurus nigrocinctus zunilensis* | Coral | Central American coral snake | T | III |
| *Crotalus durissus* | Cascabel | Rattlesnake | DE | III |
| *Kinosternum scorpioides* | Tortuga candado | Scorpion mud turtle | T | |
| *Iguana iguana* | Iguana verde | Green igana | DE | II |
| *Boa constrictor* | Masacuata | Boa constrictor | T | II |
| *Oxybelis aeneus* | Bejuquilla cafe | Mexican vine snake | T | |
| **Birds** | | | | |
| *Pelecanus erythrorhynchus* | Pelicano blanco | American white pelican | T | |
| *Falco sparverius* | Lilisque | Sparrow kestrel | T | II |
| *Caracara plancus* | Querque | Southern caracara | T | II |
| *Ortalis leucogastra* | Chachalaca | White bellied chachalaca | T | |
| *Aratinga strenua* | Pericón | Pacific parakeet | T | II |
| *Aratinga canicularis* | Chocoyo | Orange fronted parakeet | T | II |
| *Amazon auropaliata* | Lora de nuca amarilla | Yellow headed parrot | DE | II |
| *Contopus cinereus* | Copetón | Tropical pewee | T | |
| *Dendroica petechia erythacorides* | Reinita de manglar | Yellow warbler | T | |
| **Mammals** | | | | |
| *Dasypus novemcinctus fanestratus* | Cuzuco | Nine banded armadillo | T | |
| *Canis latrans dickeyi* | Coyote | Coyote | T | |
| *Agouti paca* | Tepezcuintle | Paca agouti | DE | |
| *Herpailurus yagouaroundi fossata* | Gato zonto | Otter cat | DE | |

### 12.2.3 Ecological Survey in Reclamation Area

The EIA report (CEPA 2000) mentioned that the only notable fauna community in the reclamation area is the one which inhabits the submerged rocks on the beach and in the sublittoral zone immediately seaward of the Cutuco Port facilities. This had been surveyed in detail in the rainy season (September and October 2001), however, because it was later proposed as a result of the Study to dispose of dredged spoil to the onshore dumping areas on either side of the reclamation site, the fauna living on the north-western and south-eastern sides of the Cutuco Port was re-surveyed in the dry season (December 2001 and January 2002).

A series of line transects are laid down on each beach, at the proposed onshore dumping areas 100 m apart, and a 1 $m^2$ quadrat (subdivided by strings into 100 equal 0.01 $m^2$ squares) is used to record the organisms present at between 20 and 50 stations along each transect (depending on the width of the beach). The substrate type and organisms present at each corner of the one hundred 0.01 $m^2$ squares is recorded at each station, and the figures are converted into percentage cover estimates for each station. All stations are sampled during low tide periods, except at the Cutuco site where many of the rocks are in the sublittoral zone, so a scuba diver is used to survey this area underwater.

Table 12.2.2 shows the average percentage cover of rock, sand and biota in the three areas surveyed, together with the number of species recorded, and the average population density (individuals per $m^2$) of the seven most frequently recorded organisms.

**Table 12.2.2 Substrates and Species Recorded on Foreshore and in Sub-littoral Zone of Cutuco Port**

| Percentage Cover | N-W of Port | Reclamation Area | S-E of Port |
|---|---|---|---|
| Rock | 29.1 | 57.9 | 62.0 |
| Sand | 54.2 | 37.7 | 4.4 |
| Biota | 16.7 | 4.4 | 33.6 |
| Total species | 15 | 16 | 17 |
| Pop. density (per $m^2$) | | | |
| Serpulid polychaete | 14.1 | 5.5 | 0.4 |
| Nerita sp | 9.4 | 6.1 | 423 |
| Cerithidea sp | 5.7 | 5.3 | 62 |
| Ostrea iridescens | 5.5 | 20 | 11 |
| Balanus sp | 27.8 | 33 | 5 |
| Menipe frontalis | | 26 | 27 |
| Grapsid crab | | 256 | 205 |

Table 12.2.3 shows a full list of species in the area, comprising 17 species.

**Table 12.2.3 List of Marine Benthos Recorded in the Vicinity of Cutuco Port**

| Taxonomic Group | Scientific name |
|---|---|
| Algae (seaweed) | Bostrychyia moritziana |
| | Bostrychyia sp |
| | Cladophora sp |
| Segmented worms | Serpulid polychaete |
| Gastropod molluscs - snails | Nerita sp |
| | Cerithidea sp |
| Bivalve molluscs – clams | Ostrea iridescens |
| | Mytella guyanensis |
| | Polimesoda solida |
| Crustacea – chitons | Chiton stokesii |
| Crustacea – barnacles | Balanus sp |
| Crustacea – crabs | Menipe frontalis |
| | Grapsid crab |
| Crustacea – hermit crabs | Clibanarius panamensis |
| Sponges | Red sponge |
| | Yellow sponge |
| | White sponge |

The only rare animal is the "apretador" crab *Menipe frontalis*, which has been heavily exploited by artisanal fishermen. It is now nationally threatened with extinction, being found only in the Fonseca Gulf. It is protected under El Salvador law, and capture is illegal. However, it is found from the benthos survey that this species naturally lives in deep water and no dredging work will be carried out in the area of this habitat. Therefore it is not expected that the port construction will further endanger this species.

### 12.2.4 Ecological Survey in Dredging Area

#### (1) Water Quality

Surface water quality is recorded at 13 stations along the proposed channel in the rainy season (September 2001) and in the dry season (December 2001). Parameters recorded and the methods used are shown in Table 12.2.4.

Figure 12.2.2 shows the variation of temperature, pH and salinity throughout the channel. All the three parameters are within the range expected for tropical coastal waters subjected to significant river inputs. Variations observed would have been due to daily fluctuations in air temperature and tidal conditions, natural seasonal differences, as well as the location of each station.

**Table 12.2.4 Water Quality Parameters Measured, and Methods Used**

| Parameter | Method |
|---|---|
| Temperature | Field: mercury in glass thermometer |
| pH | Field: pH meter |
| Salinity | Field: optical refractometer |
| Transparency | Field: Secchi disc |
| Turbidity | Laboratory |
| Total Suspended Solids | Laboratory |
| Chemical Oxygen Demand | Laboratory |
| Total Oil and Grease | Laboratory |

pH was slightly alkaline, as is normal for seawater, and showed only small variations along the channel and in the wet and dry seasons. The slightly higher values recorded in December would have been due to the reduced river inputs in the dry season allowing greater penetration up the channel of seawater, which is more alkaline than freshwater.

Salinity was higher at the stations farther offshore, where the water is more oceanic in nature and there is less influence from the river inputs. Although salinity is slightly lower at the upstream stations in the dry season, the seasonal difference is small and unlikely to be significant, and is probably caused by the December samples being taken on an ebbing tide.

Temperature is also lower during the dry season, and this is probably due to a variety of factors, of which the fact that air temperatures are naturally lower in December than September, is the most important. It is also possible that the river inputs are warmer than the sea as the catchments are large and exposed to high solar radiation, and these inputs are reduced in the dry season.

Figure 12.2.3 shows those parameters related to water turbidity: transparency, turbidity and suspended solids. These show that this is a very high turbidity environment, along the entire length of the approach channel. Light penetration is uniformly low, with the Secchi disc disappearing from view at a depth of around 1 m at all stations in both seasons. Levels of suspended solids are high, at 170-400 mg/ltr in the rainy season and 195 to 220 mg/ltr in the dry season. Except for two values 402 and 379 mg/ltr measured at the stations S-1 (north of the proposed turning basin) and S-5 (near the proposed entrance of channel), the values of suspended solid are within the range of 170-215 mg/ltr and no significant change between dry and rainy season is observed. This is because of the significant amounts of plankton and organic material originating from the extensive mangrove areas on the northern side of La Unión Bay.

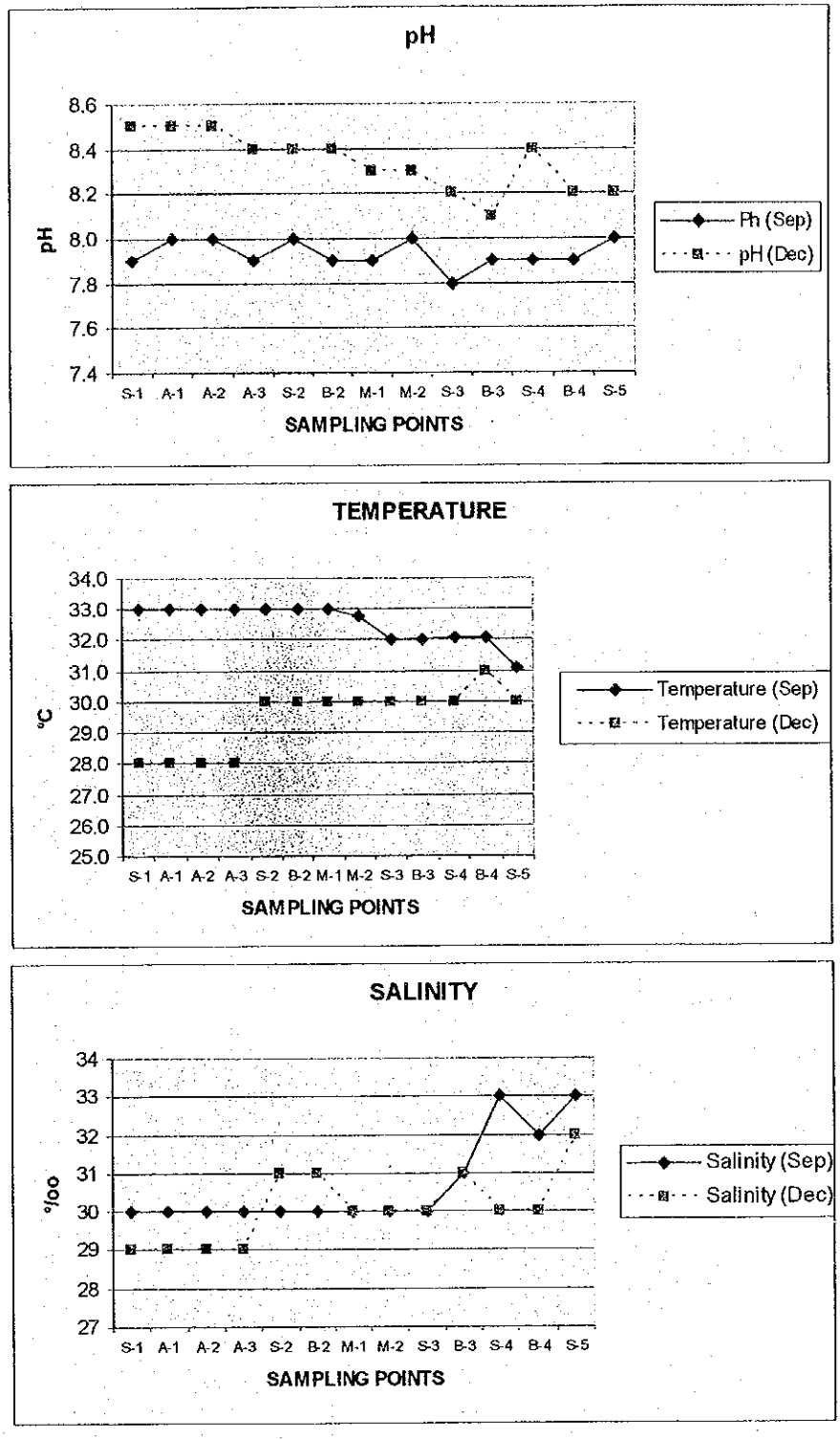
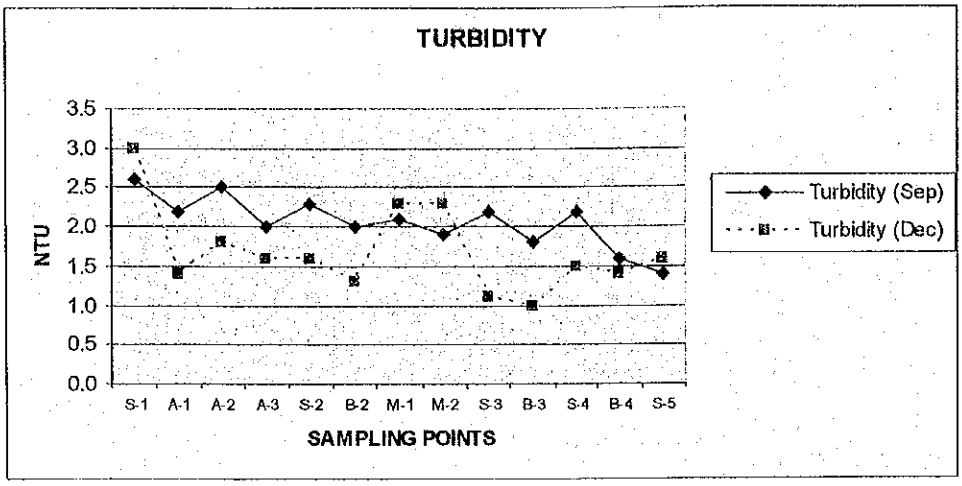
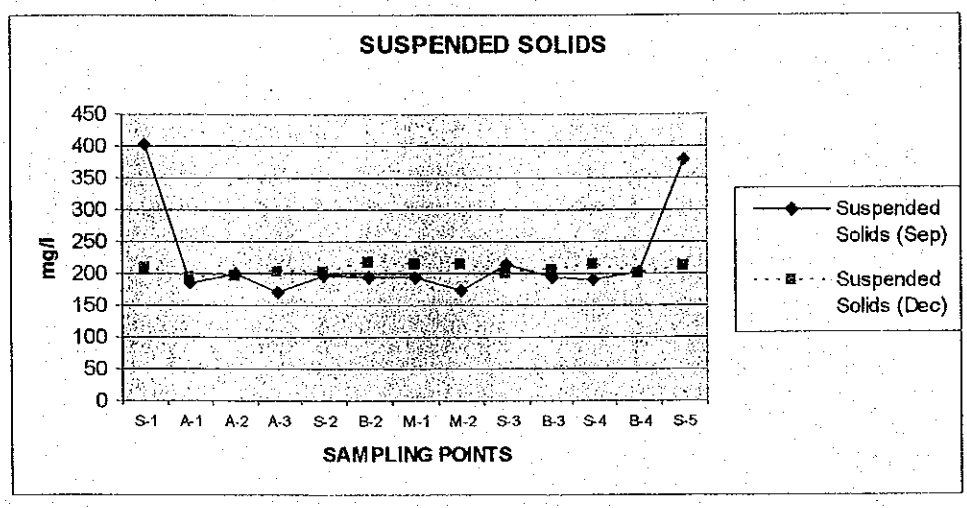



**Figure 12.2.2 Water Quality along Proposed Approach Channel in September and December 2001 (Temperature, pH and Salinity)**



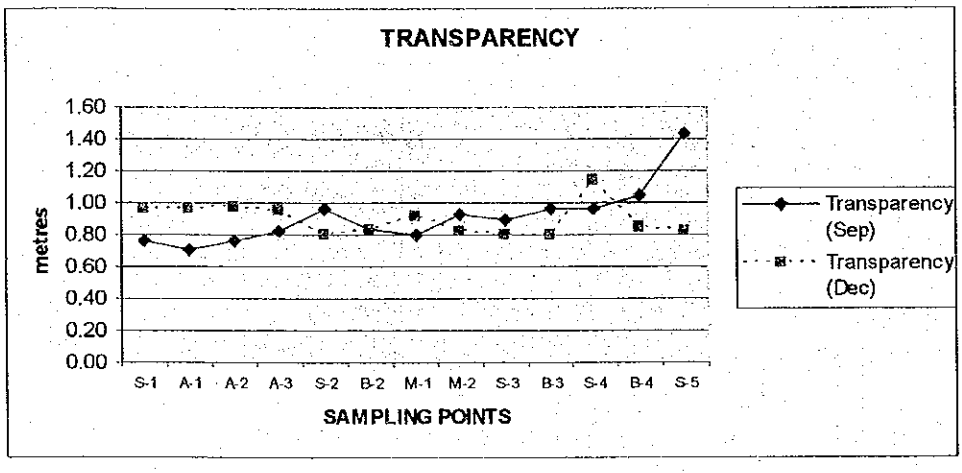




**Figure 12.2.3 Water Quality Along Proposed Approach Channel in September and December 2001 (Transparency, Turbidity and Suspended Solids)**

Figure 12.2.4 shows those parameters that are indicative of pollution levels: COD and total oil and grease. COD is unexpectedly high, varying between 50 and 200 mg/ltr at all stations sampled. Given that coastal waters elsewhere typically exhibit COD values of at least an order of magnitude lower (for example the annual average for Chinese waters is < 1 mg/ltr). In the La Union City, there is no sewage treatment facility . This is one of the main reasons of this high value. Thus, the Government authorities concerned shall take necessary actions to provide appropriate sewage facilities for conserving the environment of the Fonseca Gulf.

Oil and grease are also high in the vicinity of the port (14-30 mg/ltr in both seasons), but much lower elsewhere along the approach channel. This suggests a source of oil pollution in or near the port. The sediment quality survey at one of the points near the port shows high value of oil content as it is.

**(2) Sediment Quality**

Sediment samples are taken at eight stations along the approach channel in the rainy season (October 2001) and three stations adjacent to the proposed reclamation area in the rainy and dry seasons (December 2001). The samples are analyzed in the laboratory for grain size, loss on ignition, COD and total oil and grease, and the results are shown in Figure 12.2.5.

The particle size analyses show that all superficial sediments along the dredging channel are classified as coarse silt/fine sand, with median particle sizes in the 0.06 – 0.08 mm range. The amount of fine sand is fairly consistent between the stations, at 30-60%, and in general the stations in the outer channel had a higher percentage of the finer particles, with 9-46% clay, compared with 10-25% near the port. There is more organic material around the port (5-14%) than in the outer channel (5-9%) because the slower currents in the more protected waters of the bay allow more of this material to settle. The outer channel is also farther from the sources of organic inputs, which have been reported by Rubio Fabián (1994) to include sewage from La Unión City and inhabited areas in the catchments of the rivers, effluents from food processing and beverage factories, waste from the Punta Gorda fishery complex, and waste from shrimp farms in the bay.

COD is higher in the inner channel, and the values are of the order that would be expected for sediments with high organic loads. Oil is below the detection limits of the analytical method at all stations (1 mg/kg) except for the Station A-2 (20 mg/kg) which is near to the proposed Multi-purpose berth. This suggests the existence of oil pollution near this location. According to the Kaiyo Kankyo Chosahou in 1985, normal oil level in offshore area is 1-10 mg/kg while in bay area is 50-1000 mg/kg. Thus the oil observed at the station A-2 is high but it is not extra ordinal level .

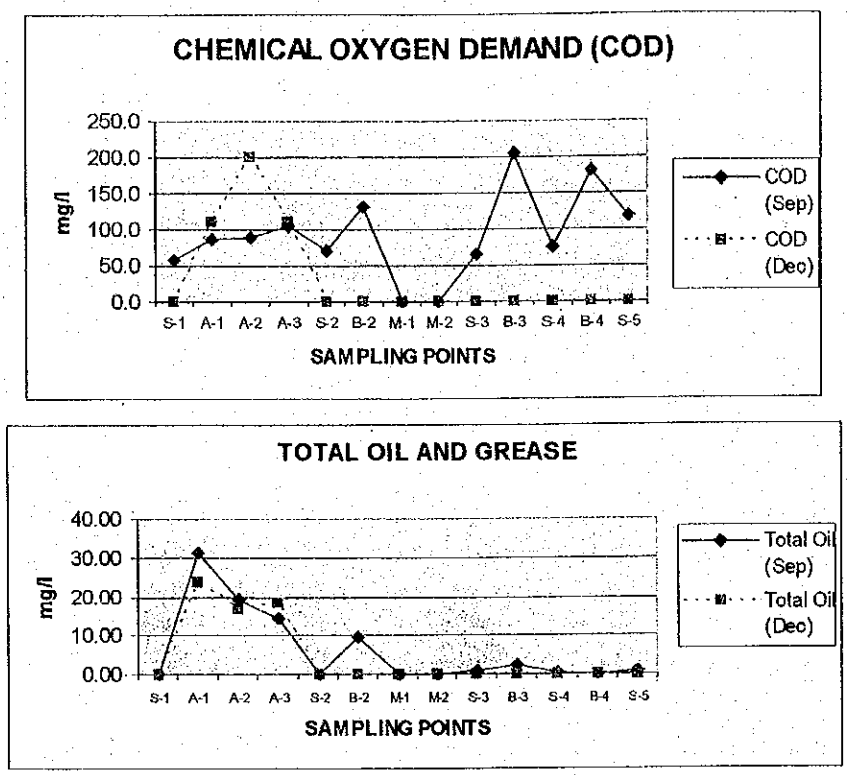



**Figure 12.2.4 Water Quality along Proposed Approach Channel in September and December 2001 (Chemical Oxygen Demand and Total Oil and Grease)**

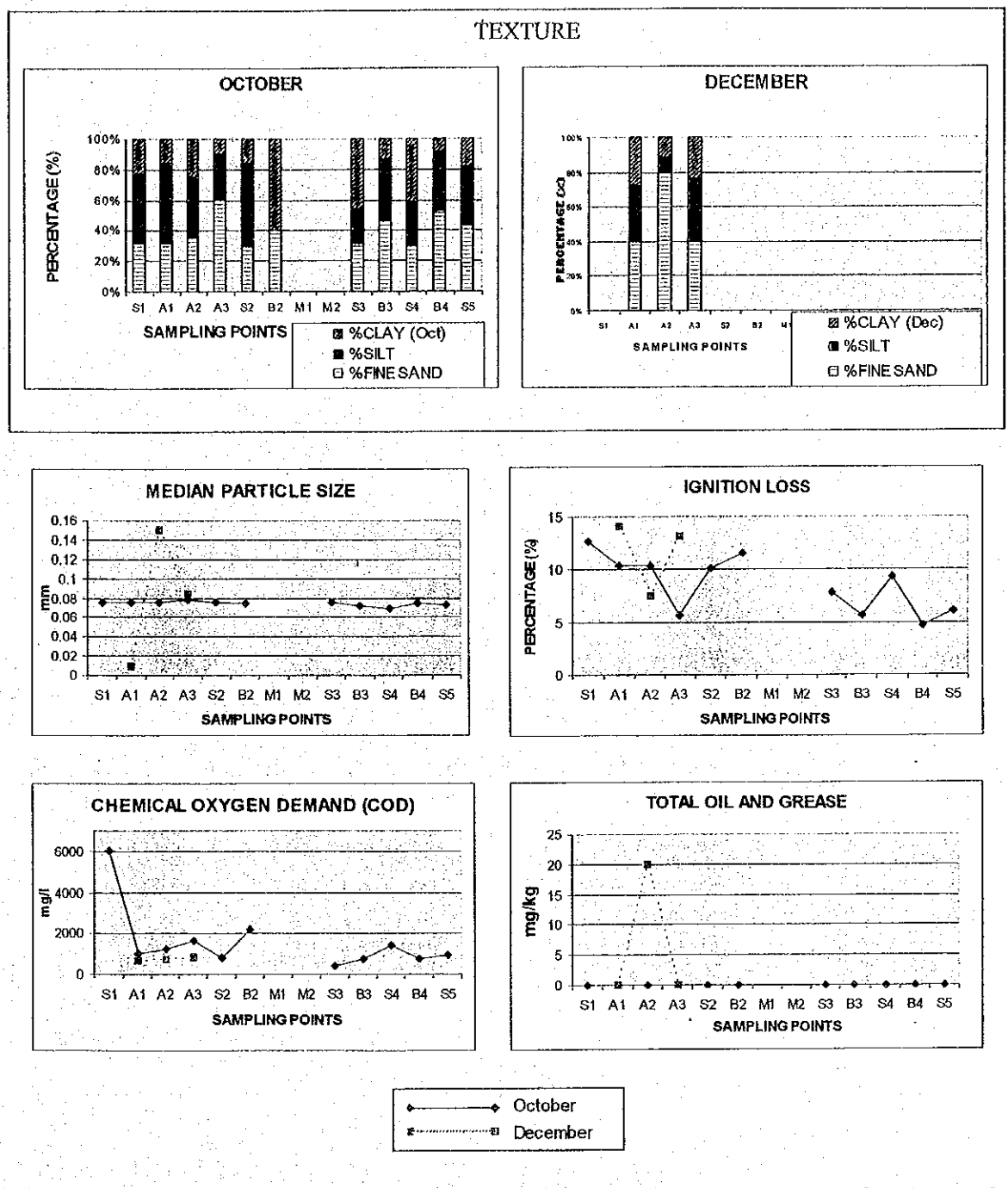



**Figure 12.2.5 Sediment Quality Along the Proposed Approach Channel in October and December 2001**

### (3) Benthos

Sediment samples were taken at 13 stations along the approach channel in the rainy season (September 2001) and at three stations in the vicinity of the port, also in the dry season (December 2001). The sediment was washed through a 0.5 mm sieve and the macrofauna retained was removed and identified. Figure 12.2.6 shows the distribution throughout the channel of the ten most numerous species.

Thirty five species are recorded, and as is generally the case in sublittoral soft-sediment areas, the fauna is dominated by polychaete worms, both in terms of the number of species and the number of individuals. Between 8 and 17 species are recorded at each station, at an average density of 900 individuals/$m^2$. Figure 12.2.6 shows no overall pattern in distribution along the channel, which is not surprising given the absence of major differences in water and sediment quality or sediment type along the channel, and the fact that the depth at the sampled locations varied only 5-10 metres. Most species are found at several stations, and only the molluscs *Mytella guyanensis* and *Anadara grandis* were restricted in distribution (to the inner and outer channel respectively). Station S5 at the outer end of the channel is the poorest in terms of the number of species found (8), and this station and B3 near Conchaguita Island are the poorest in terms of numbers of individuals (557 and 444 respectively).

Most of the polychaetes and some of the other taxa are deposit feeders, reflecting the large organic loading of the area. Taking all sixteen samples into account (i.e. including the three stations sampled in both rainy and dry seasons), then the most numerically dominant organism is the polychaete *Capitella capitata*, which is frequently cited as an indicator of organic pollution.

Six species of commercial importance are present in the samples: the molluscs *M guyanensis* and *A grandis* mentioned above, the shrimps *Penaeus californiensis, P stylirostris* and *P vannamei,* and the apretador crab *Menipe frontalis* (Figure 12.2.7). *P stylirostris* is only found at one station, but the other shrimps and molluscs are distributed more widely and are present at relatively high densities at certain stations. The protected *Menipe frontalis* is present at the two stations near Zacatillo Island, in densities of 29 and 114 individuals per $m^2$.

Therefore, it is not expected that the channel construction will further endanger these species.

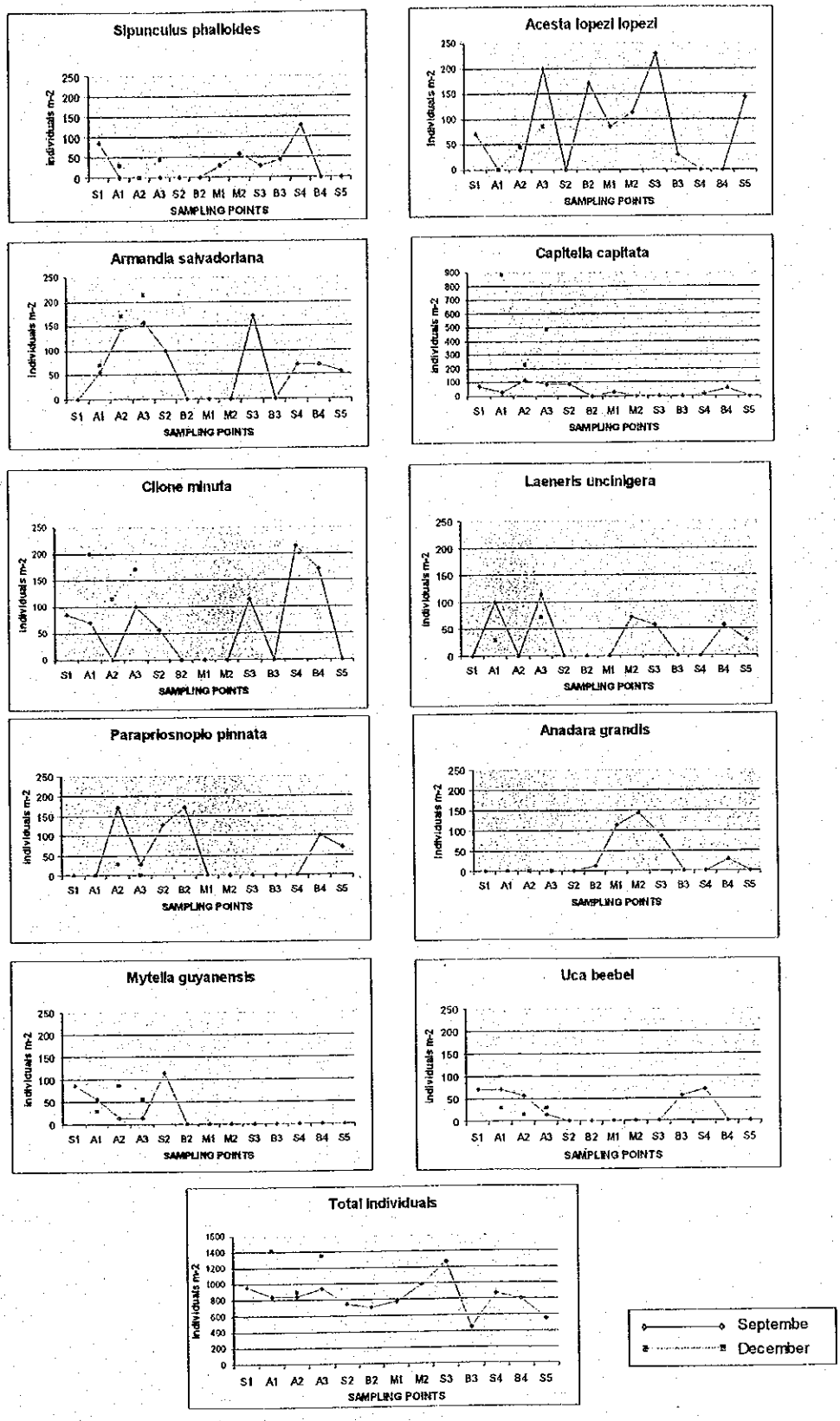



**Figure 12.2.6 Population Density of Total Fauna and the Ten Most Abundant Species Along the Proposed Approach Channel in September and December 2001**

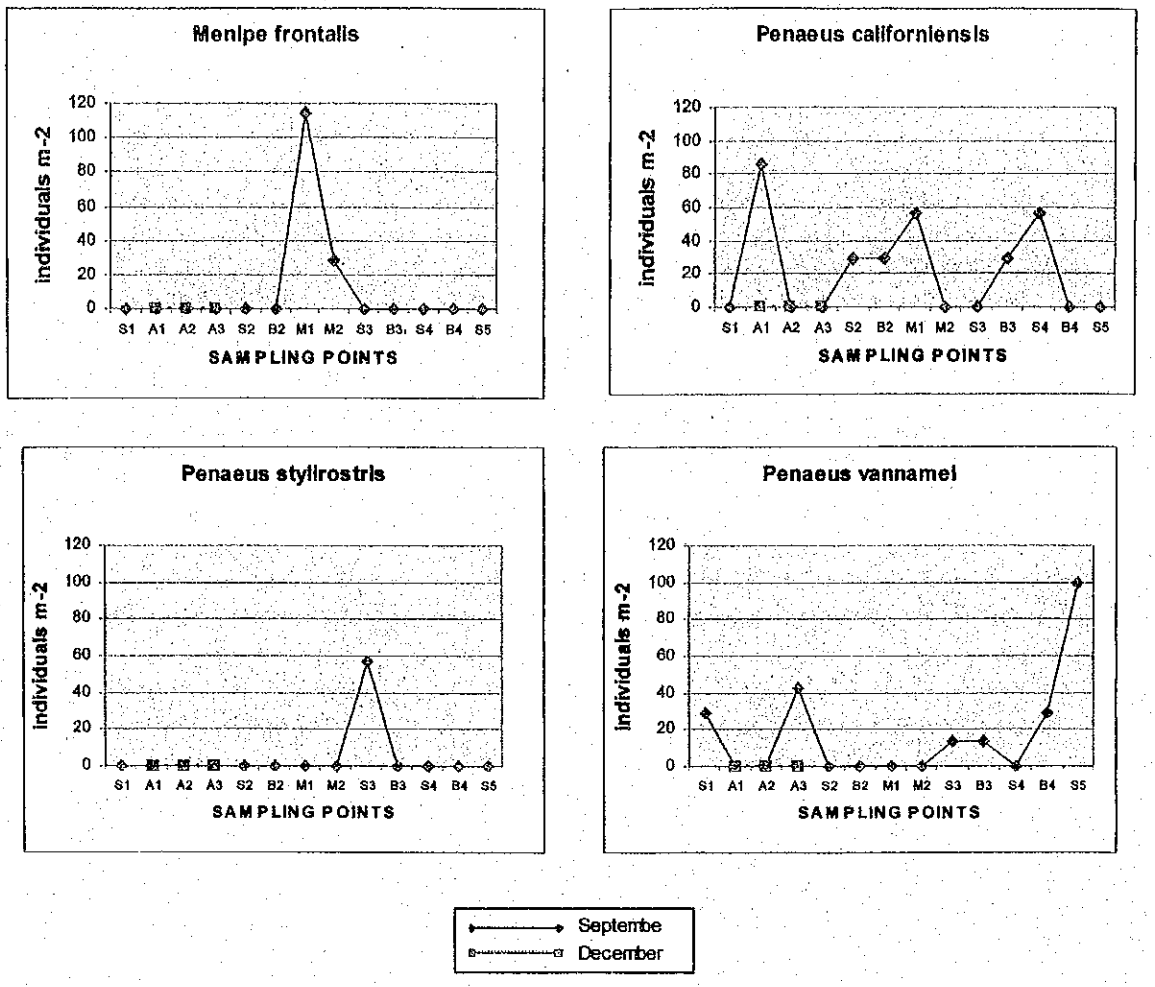



Figure 12.2.7 Population Density of Apretador Crab and Commercially Important Shrimps Along Proposed Approach Channel in September and December 2001.

### 12.2.5 Ecological Survey in Alternative Offshore Dumpsite

#### (1) Water Quality

The alternative dumpsite is located between the 20 and 35 m depth contours south-southwest of the approach channel, and the centre of the area is 12 km from Station S - 5 (Figure 12.2.1). Five stations were visited in December 2001, and surface water quality was measured. The results are shown in Figure 12.2.8.

There are no major variations between the stations. Comparing the results with those recorded along the dredging channel generally show the greater influence of deeper, higher salinity offshore seawater at this site.

Surface water temperature is between 30 and 31 °C, and although this is higher than the temperatures in the channel this would have been because air temperatures are higher on the day that the measurements were taken. Salinity is 33 ‰ at all stations, this being the expected value for deeper water away from the influence of freshwater inputs at the coast.

The Secchi disc to measure transparency disappeared from view at depths of around 9 m throughout, showing the much greater light penetration than the channel waters. Turbidity is correspondingly low, at 0.3 – 0.5 NTU. Suspended solids are however higher than expected (166-176 mg/ltr). COD (62-286 mg/ltr) is also higher than expected, given that this site is a considerable distance from the sources of organic inputs at the coast. Oil and grease are unexpectedly high at all stations. This suggests certain commercial or fishing ships discharged oil or bilge water in this area. As it is discussed below, it is confirmed that the sediment sample taken at the Station E-1 also shows high value of oil and grease.

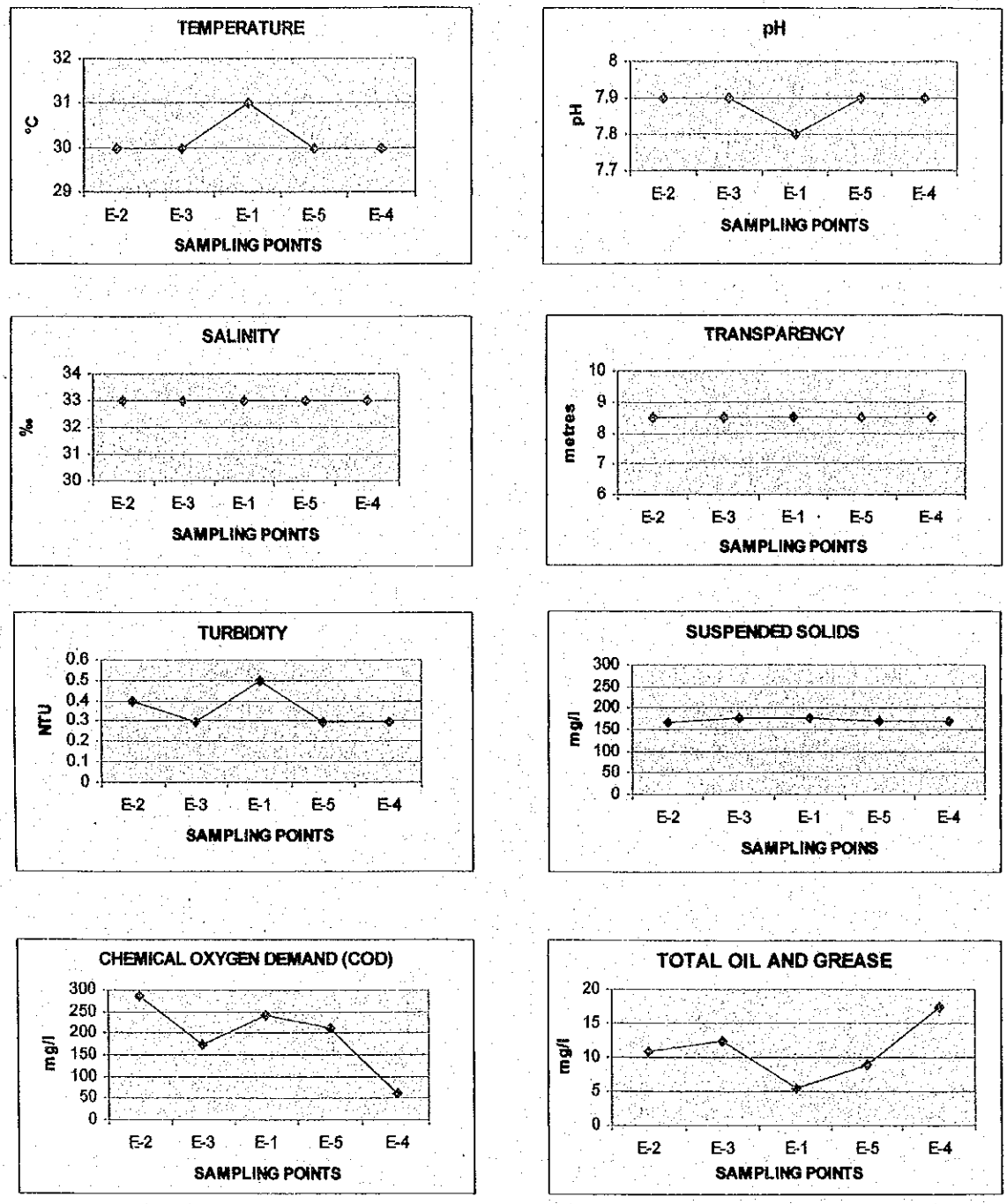



Figure 12.2.8 Water Quality at Alternative Offshore Dumping Site in December 2001.

**(2) Sediment**

A sediment sample was taken from each of the five sites in this area in December 2001, and tested for grain size, loss on ignition, COD and total oil and grease . The results are shown in Figure 12.2.9.

Sediment grain size distribution is remarkably similar across the area, with all stations having median particle sizes between 0.08 and 0.10 mm, containing 60-67% fine sand, 18-25% silt and 14-15% clay. The material is slightly coarser than the deposits in the approach channel, which are closer to the inputs of fine material (the rivers). There is also slightly less organic matter (8-10.6 %).

COD is lower than in the approach channel, again because these sites are farther from the sources of organic inputs. Oil is below the detection limits of the analysis at two stations, but levels of between 5 and 65 mg/kg are recorded at the other three. This high values could be explained if any vessels had washed their oil tanks in this area prior to approaching the port or operating in this offshore area. This practice is contrary to international law, and no ship has been observed doing this, but the level of oil in the sediment indicates a source of oil pollution in this area, so this could be a possible explanation.

**(3) Benthos**

A sample of sediment was taken from each station in December 2001 and washed through a 500 mm sieve, after which the macrofauna retained was removed and identified. The results are plotted in Figure 12.2.10.

Only ten species are recorded, and there are between 6 and 10 species and an average of 409 individuals per station. Although polychaete worms are again dominant in terms of numbers of species (4) and individuals (74% of the total), overall there are significantly fewer species and individuals than in the dredging channel. The species-poor environment, and the significantly higher densities of a single species (the deposit feeding polychaete *Parapriosnopio pinnata*) is indicative of a harsh environment in which few species can survive.

The three penaeid shrimps (*Penaeus vannamei, P californiensis* and *P stylirostris*), are present in this area. It is noted that whereas *P stylirostris* was restricted to a single station in the channel, and the other two species were found more widely and in higher numbers, at the alternative dumpsite *P vannamei* is restricted in distribution and numbers. This suggests that *P vannamei* may inhabit shallower waters closer to land, while *P stylostris* prefers deeper water, and *P californiensis* is able to tolerate more differences in environmental conditions than the others.

Judging from the benthos survey, it is considered that no significant adverse effect is expected in fishing of shrimp.

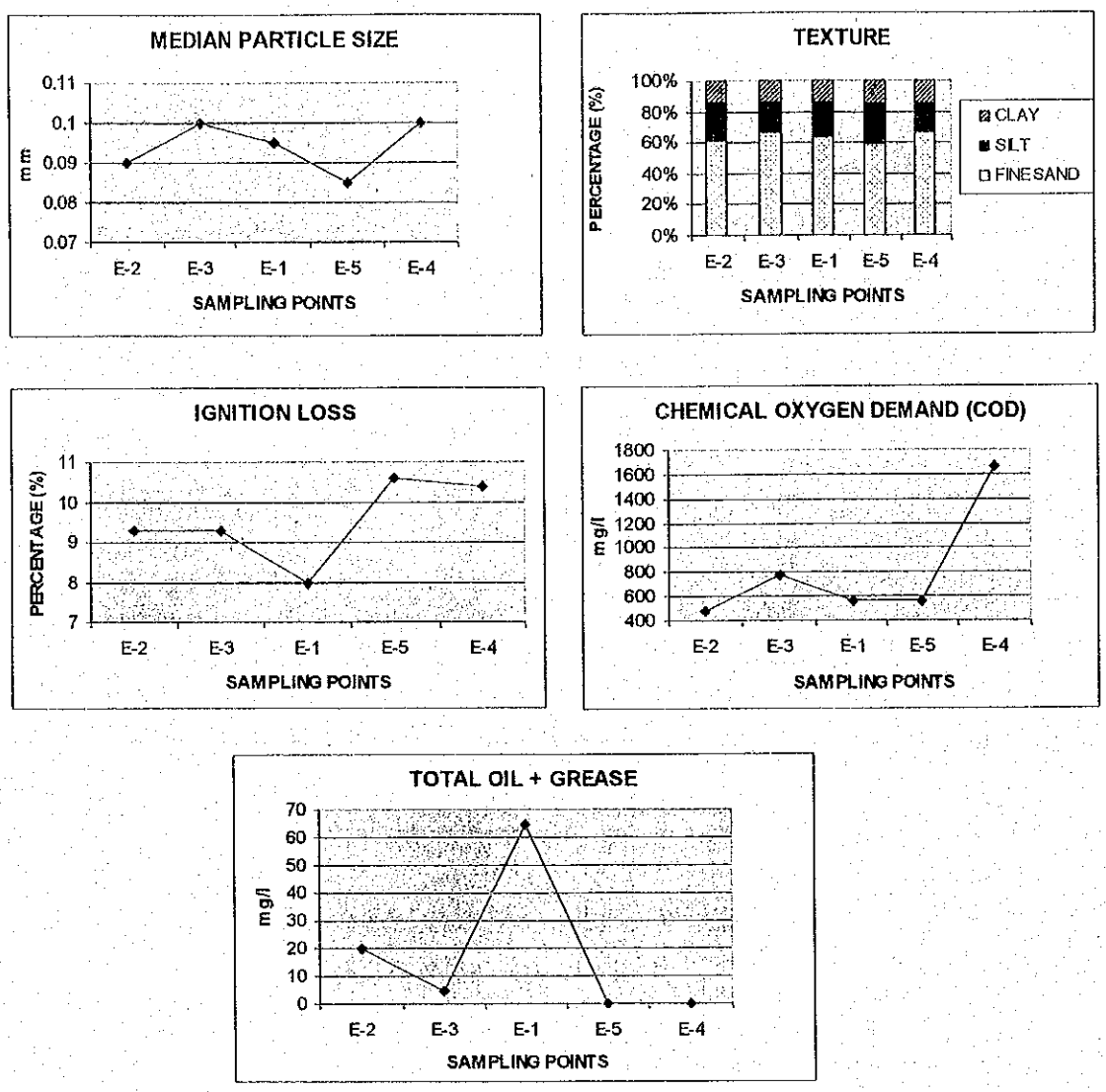



**Figure 12.2.9 Sediment Quality at Alternative Offshore Dumping Site in December 2001**

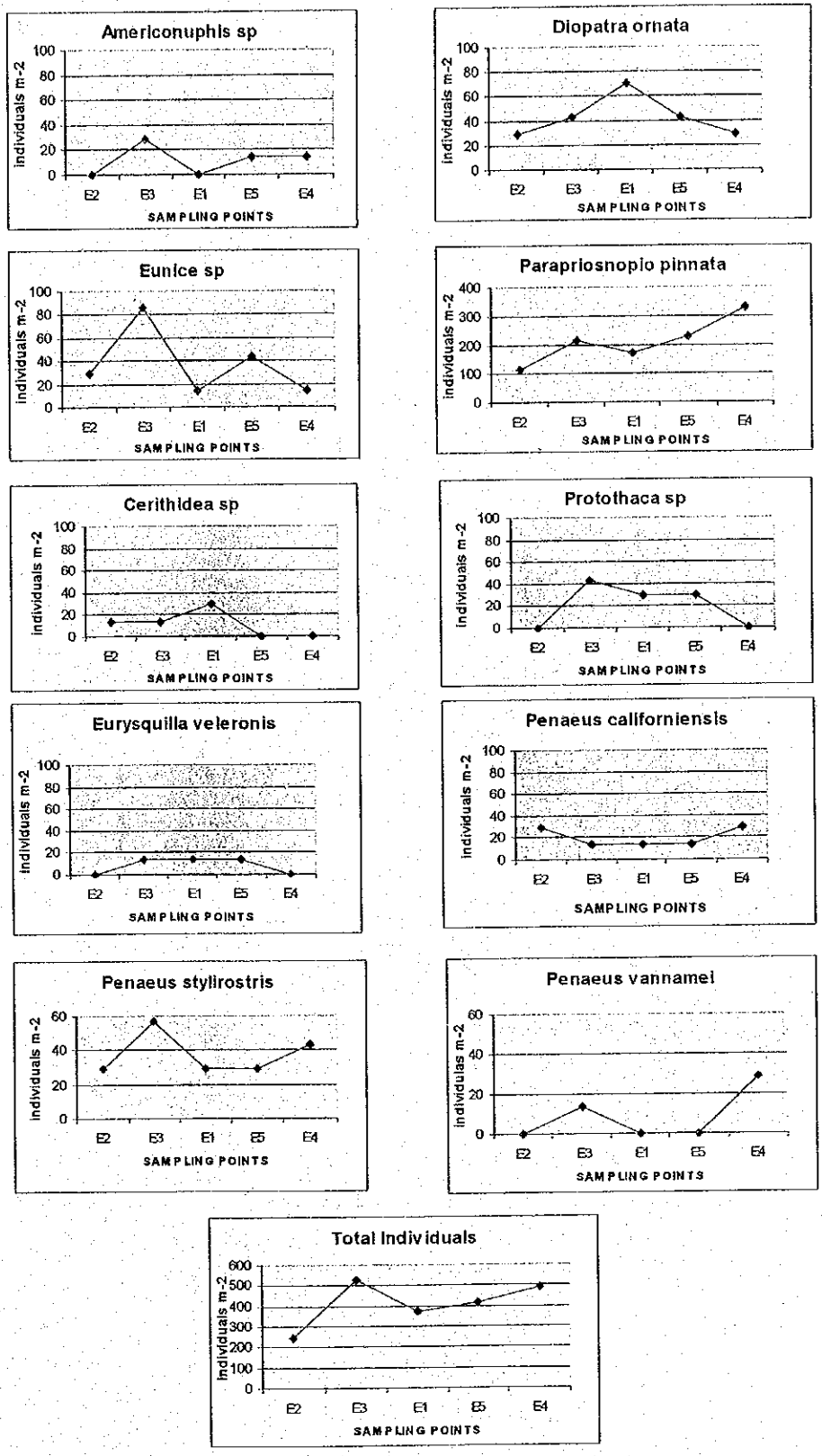



**Figure 12.2.10 Population Density of Total Fauna and of Each Species Present at Alternative Offshore Dumping Site in December 2001**

### 12.2.6 Ecological Survey in Original Offshore Dumpsite

#### (1) Water Quality

The site originally proposed for the disposal of dredged spoil is located 35 km southwest of the outer end of the approach channel, below the 42 m depth contour, west of the international border with Nicaragua. Nine stations in this area were established for surveys in the rainy season (September 2001) and also survey was performed at the three stations (B6, 9 and 12) in the dry season (December 2001). Surface water quality was monitored, and the results are shown in Figure 12.2.11.

Water quality at this site is broadly similar to that of the alternative offshore dumpsite, and because this area is 20 km from the coast and 50 km from the La Unión City, the water is deeper, cooler and more oceanic in nature, and less influenced by the coastal sources of sediment, and organic and other inputs.

Surface temperature is 31-33 °C in the rainy season and 30-31 °C in the dry season, reflecting the cooler air temperatures in December. Temperatures are generally cooler than those recorded closer inland, where the water is shallower and more liable to fluctuations. Salinity is 33-35 ‰, higher than values recorded elsewhere, because of the distance from the river discharges.

The water is clearer here than at any of the other stations (transparency: 12-20 m, turbidity: 0.2-1.5 NTU), but the suspended solids (174-190 mg/ltr) are higher than would be expected.

COD is lower than at the stations closer inland, but at 53-102 mg/ ltr (rainy season) and 58-98 mg/ltr (dry season), values are again much higher than expected, given the distance from the sources of organic matter s.

The reason of these high values of SS and COD is supposed to be an existence of plankton and organic matters related to the shrimp fishing.

Oil is not recorded in the dry season, nor at five of the stations monitored in the rainy season. However there is oil in four of the rainy season samples, at levels of 4-14 mg/ltr, which again might suggest a source of oil pollution, such as the washing of fuel tanks by ships. Since the sediment analysis detected no oil at all stations, the oil contained in the water samples are most likely originated from other area.

#### (2) Sediment Quality

One sediment sample is taken from each of the nine stations during the rainy season (October 2001) and analyzed for grain size, loss on ignition, COD and total oil and grease. The results are shown in Figure 12.2.12.

All stations show a median particle size of 0.07-0.08 mm and the substrate is classified as coarse silt/fine sand. Organic matter is lower than elsewhere, at 5.8-9.6%, which is

consistent with this area being farther from the sources of organic input along the coast. Oil is below the detection limit of 0.1 mg/kg at all stations, indicating a sediment unpolluted with hydrocarbons. The only unusual results are the COD values of 630-1983 mg/kg.

**(3) Benthos**

Further sediment samples were taken from each station in September and October 2001 and washed through a 0.5 mm sieve to reveal the macrofauna, which was removed and identified. The average densities of each species per station are shown in Figure 12.2.13. The stations along the x-axis are arranged according to their relative distance to the coast.

Like the alternative offshore dumpsite this is an area which is poor in terms of both species and population density. Only twelve species are recorded, and the highest density per meter was 25.5 individuals. The graph of total fauna shows that the stations closest to the coast are those with the highest numbers of animals, and in each row of three stations parallel to the coast (B5, B8, B11; B6, B9, B12; B7, B10, B13), the stations with the highest densities of organisms are those farthest to the west (B5, B6, B7).

Like the alternative dumpsite this area differs from the sites closer inshore in that the fauna in not dominated by polychaete worms. Crustaceans are the most numerous taxa in terms of both species (5) and densities, which is typical of certain deeper coastal waters offshore of estuaries and mangrove swamps. *Penaeus californiensis, P stylirostris* and *P vannamei* are again present, albeit at slightly lower densities than recorded at the alternative dumpsite. It is noted that these species are only recorded at the three stations closest to the coast (B5, B8 and B11), which may suggest a habitat/substrate preference, or a depth limit (the average depth recorded here by the divers is 52 m, compared with 54 m at B6, B9 and B12, and 55 m at B7, B10 and B13).

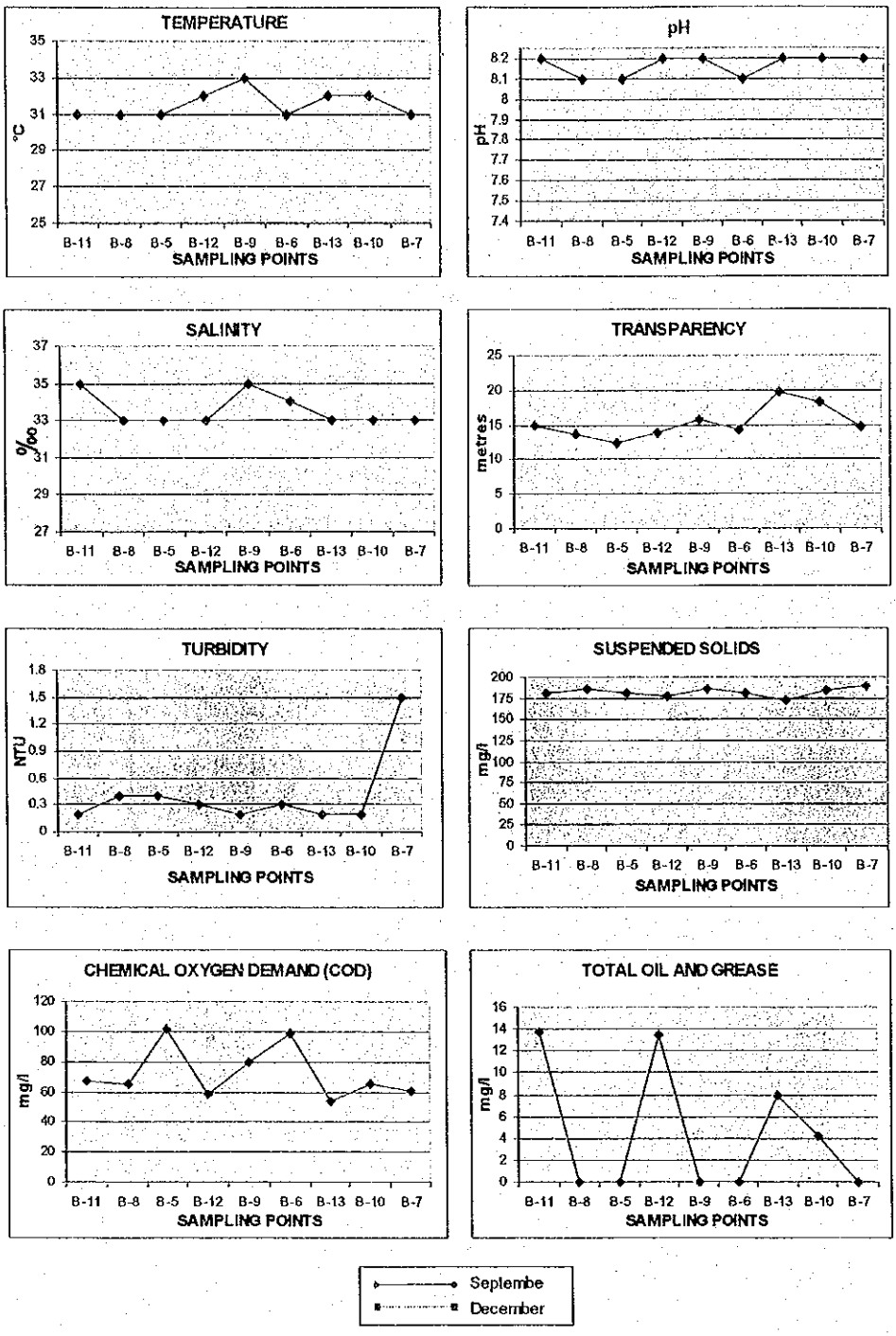
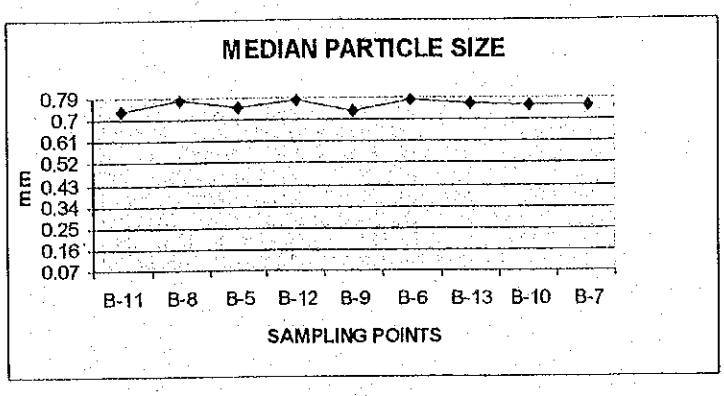
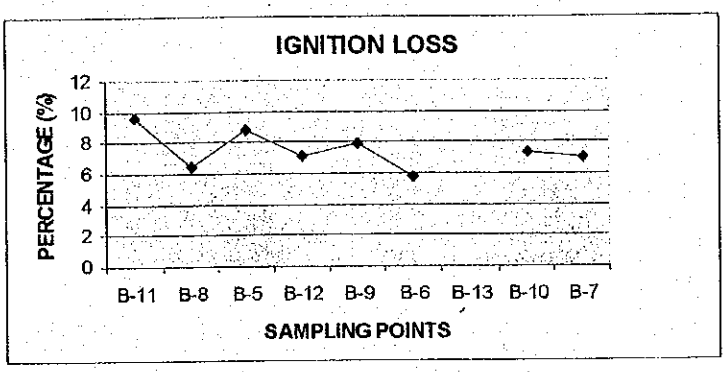
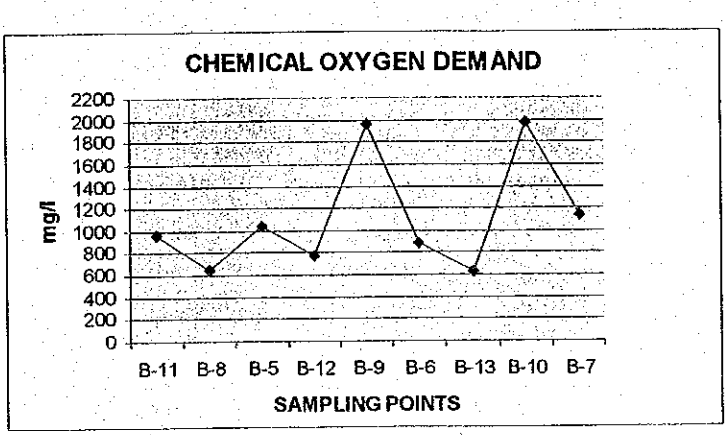



**Figure 12.2.11 Water Quality at Original Offshore Dumping Site in September 2001**



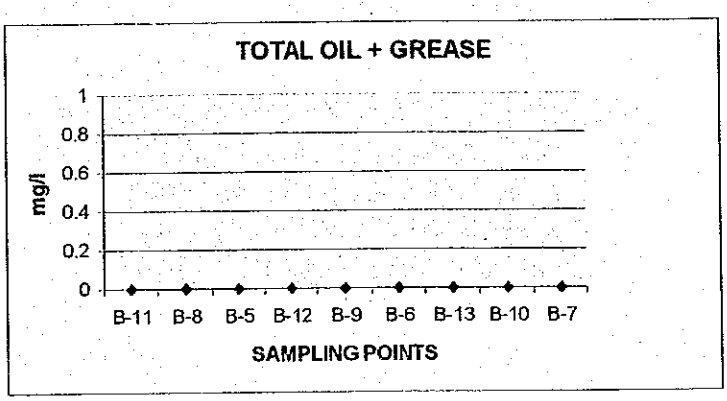




**Figure 12.2.12 Sediment Quality at Original Dumping Site in October 2001**

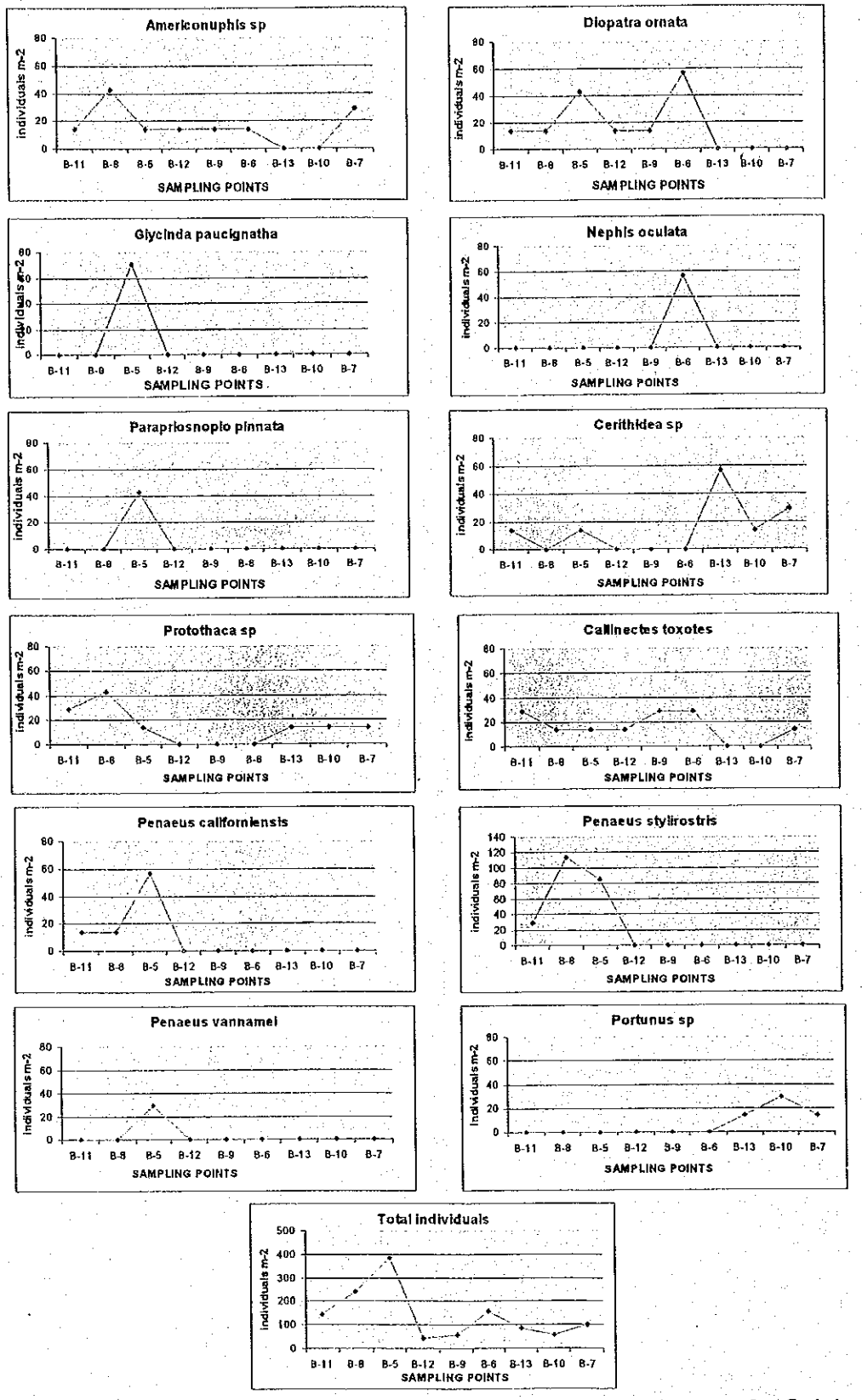



**Figure 12.2.13** **Population Density of Benthic Organisms at the Original Dumping Site in September 2001**

## 12.3 Fisheries Surveys

### 12.3.1 Fishing in Fonseca Gulf

CENDEPESCA data shows that there are four types of fishing in El Salvador:

- Industrial trawling of shrimp for export;
- Artisanal fishing close inshore and in estuaries;
- Artisanal fishing in lakes and enclosed or semi-enclosed lagoons;
- Small-scale aquaculture of fish and shrimps.

Annual catches are currently around 10,000 metric tons per year, having fallen from a peak of 14,500 tons in 1995. The coastal artisanal catch now represents almost 50% of the total, with industrial fishing and artisanal fishing in lakes and lagoons comprising approximately 25% each.

Of the three countries with land bordering the Fonseca Gulf, El Salvador is the only one with an industrial fishing fleet, but this operates in deeper water outside the three nautical mile limit. The only fishing inside the Gulf is allowed for artisanal fishermen, which involves around 8,000 operators, with 3,000 boats, based in nine main fishing villages. Activity is mostly in La Unión Bay, and in 2000 the fishery produced 43% of the total value of the artisanal catch of El Salvador ($2 million), making this the major artisanal fishing area in the country.

Table 12.3.1 shows CENDEPESCA records of annual catch volumes for the past ten years. This indicates that the total fish catch in the year 2000 is similar to what it is in 1991 at around 10,000 metric tons per year. However there has been a gradual decline each year after the catch peaked at 14,500 tons in 1995. Catches by both artisanal and industrial fleets also peaked in the middle of the decade and have since declined to their 1991 levels. The coastal artisanal catch (4,500 tons) now represents almost 50% of the total, mainly because the catch in lakes and lagoons has halved. Aquaculture is not shown because it represents a very small proportion of the total.

**Table 12.3.1 Annual Volume of El Salvador Fish Catch (metric tons) Between 1991 and 2000**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| Industrial Fishing | 2,013 | 2,821 | 4,012 | 4,228 | 4,910 | 6,391 | 4,229 | 4,821 | 2,921 | 2,099 |
| Artisanal Inshore | 4,241 | 4,120 | 3,864 | 5,029 | 5,398 | 4,604 | 4,655 | 3,477 | 4,203 | 4,566 |
| Artisanal: Lakes | 4,345 | 5,136 | 4,461 | 3,818 | 4,325 | 2,966 | 2,809 | 2,443 | 2,653 | 2,830 |
| TOTAL | 10,599 | 12,077 | 12,337 | 13,075 | 14,533 | 13,961 | 11,693 | 10,741 | 9,777 | 9,495 |

The Fonseca Gulf is the body of water inshore of the three islands of Zacate Grande, El Tigre and Meanguera. In the north of the gulf there are two large bays fringed with

extensive mangrove swamps: Cismaya Bay (Honduras) in the east, and La Unión in the west.

Of the three countries with land bordering the Gulf, El Salvador is the only one with an industrial fishing fleet. However this only operates in deeper water outside the three nautical mile territorial limit, and the only fishing inside the Gulf is allowed to artisanal fishermen. On the El Salvador side there are around 300 union fishermen working in the Gulf, and around 8,000 independent operators, with 3,000 boats. Most of these fish in the inner Gulf in La Unión Bay, and there is only minor artisanal fishing further upstream in the estuaries. Boats with outboard motors of 10 HP or more operate at the mouth of the Gulf and along the coast.

Table 12.3.2 shows the main species and the amounts captured by artisanal fishermen in the Gulf between 1990 and 1996, according to CENDEPESCA annual fishing statistics. This shows that shark, red snapper and grouper are the main fin-fish, with mackerel and catfish also prominent. Shrimp are the most important element of the catch, comprising between 140 and 240 tons in all of these years except one. In 2000 the total catch from La Unión Province was 1,596 tons, which amounted to 17% of the fish production of the country, and over 30% of the monetary value, because of the higher value of species like shrimp and lobster.

Although aquaculture does not yet contribute significantly to the annual catch, there are 111 ha used for this practice in La Unión Province, in three areas north and west of the La Unión City. These are in mangrove areas, where saline ponds are used, primarily for the cultivation of shrimp.

**Table 12.3.2 Annual Catch (Metric Tons) of Main Species in Fonseca Gulf (1990-1996)**

| Species | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| Shark | 254.5 | 381.6 | 145.1 | 106.0 | 130.8 | 19.2 | 90.9 |
| Red Snapper | 196.0 | 490.9 | 67.3 | 108.4 | 100.8 | 117.3 | 51.6 |
| Grouper | 155.8 | 250.2 | 89.4 | 114.6 | 87.4 | 56.3 | 85.2 |
| Mackerel | 0.4 | 80.5 | 10.1 | 15.0 | 13.9 | 7.0 | 8.3 |
| Catfish | 0.9 | 178.1 | 0.1 | | 0.17 | 3.0 | 12.2 |
| Other fish | 673.0 | 1853.9 | 104.0 | 135.7 | 143.8 | 154.6 | 129.4 |
| Shrimp | 152.6 | 240.4 | 182.2 | 163.9 | 75.8 | 210.6 | 146.6 |
| Other Crustaceans | 128.1 | 244.1 | 14.9 | 19.9 | 17.2 | 39.9 | 7.2 |
| Molluscs | 405.4 | 521.1 | 4.2 | 4.3 | 2.0 | 6.1 | 1.9 |
| Turtle eggs | 0.1 | | | | | | |
| TOTAL | 3956.8 | 7980.3 | 617.3 | 667.7 | 572.1 | 714.0 | 533.3 |

Figure 12.3.1 shows that the main fishing grounds are near Conchaguita and Meanguera Islands, and to a lesser extent the eastern sides of Zacatillo and Martin Perez Islands, where catches comprise lobster, shrimp and small fish. The second most important grounds are along the coast west of Punta de Amapala, where the catch is mostly of small fish, with larger fish and shrimps being captured offshore by both

artisanal and industrial vessels. Shrimp and small fish are also captured at the head of La Unión Bay around Perico Island, and lobsters are caught close inshore, primarily between Punta Chiquirín and Punta Amapala.

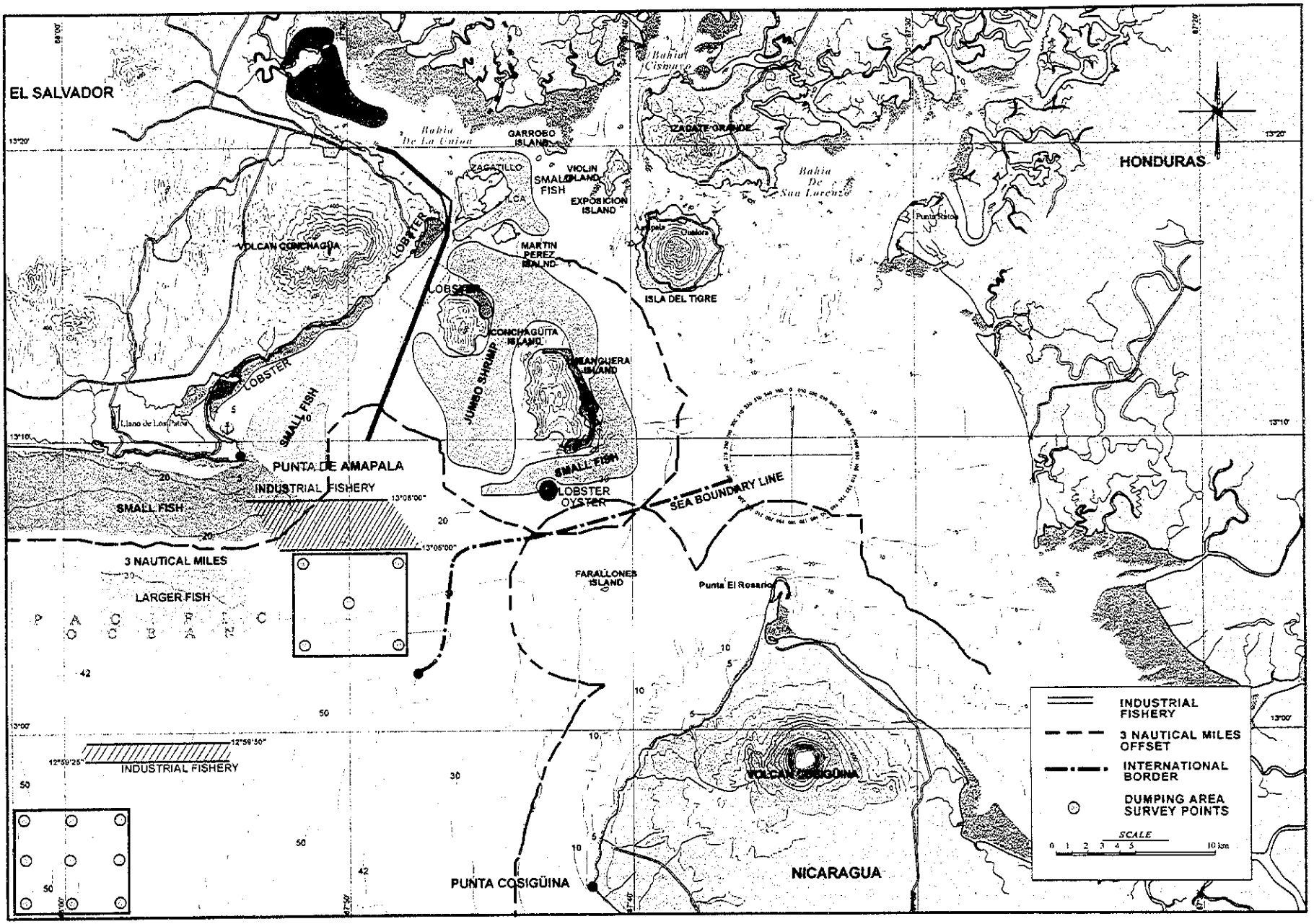



**Figure 12.3.1 MAIN FISHING LOCATIONS IN THE STUDY AREA, FROM INTERVIEWS WITH ARTISANAL FISHERMEN**

Figure 12.2.15 illustrates the main results obtained from the interview survey, conducted in November 2001, of 48 artisanal fishermen operating in the Study area. At least five persons were interviewed from each of the communities.

The interview survey showed that most of the fishing in the Gulf is of a small scale, conducted close to the coast, and consists of trips of 6 - 24 hours. Most of the fishermen work independently, with two or three men operating a single boat. The main vessels are kayaks or fiberglass boats with outboard engines, and most of the fishing is during daylight hours. Half of those interviewed capture fin-fish (55%), with 40% fishing for shrimps, crab and lobster. Seventy percent of the fishermen use nets, and the remainder use simba (long-lines). A wide variety of species are captured including shrimp, lobster, mackerel, shark, eels, corvine, catfish and many others. The main catches are between 2,000 and 50,000 lbs per operation per year, and catches are highest in the dry season.

### 12.3.2 Fishing Communities

The nine fishing villages have a total population of 27,000, of which over 50% are engaged in fishing or related activities. Fishing is thus clearly the mainstay of the local economy and the major method of subsistence, and those involved include women and children as well as men.

Six villages stand out as being the major centers of fishing activity in the area. These are Guisquil and La Unión in the north-west, Conchaguita and Meanguera islands in the south-east, and El Jaguey and El Tamarindo beaches in the south-west. At each of these there are over 100 fishing boats, and at La Unión and Meanguera there are 470 and 1200 respectively.

Kayaks with engines are the main vessels, except at Meanguera where fiberglass boats predominate, presumably because the water is rougher here as this is the island which is farthest offshore. Netting for shrimps and lobsters in the rocky areas around the islands and in the mangroves in the bay are the principal capture methods, with nets for snapper and mackerel being used towards the west along the coast.

### 12.3.3 Fisheries Conservation

There are currently three legal measures in force which are aimed at conserving fish stocks, because of the declines recorded in the catches over the past few years. The first is an international agreement between El Salvador and Nicaragua, signed on 26 August 2001, which prohibits industrial fishing within the Fonseca Gulf, inside a boundary drawn between Punta de Amapala and Punta Consiguina (see Figure 12.3.2). The agreement states that the waters of the Gulf are exclusively reserved for artisanal and sport fishing.

The second measure is a ban implemented by the El Salvador Government on all shrimp fishing in the country in April and May of 2002. This was enforced by CENDEPESCA, and is intended to allow more shrimps to pass through the reproductive phase of the life cycle than is normally the case when large numbers are captured before they have reached maturity.

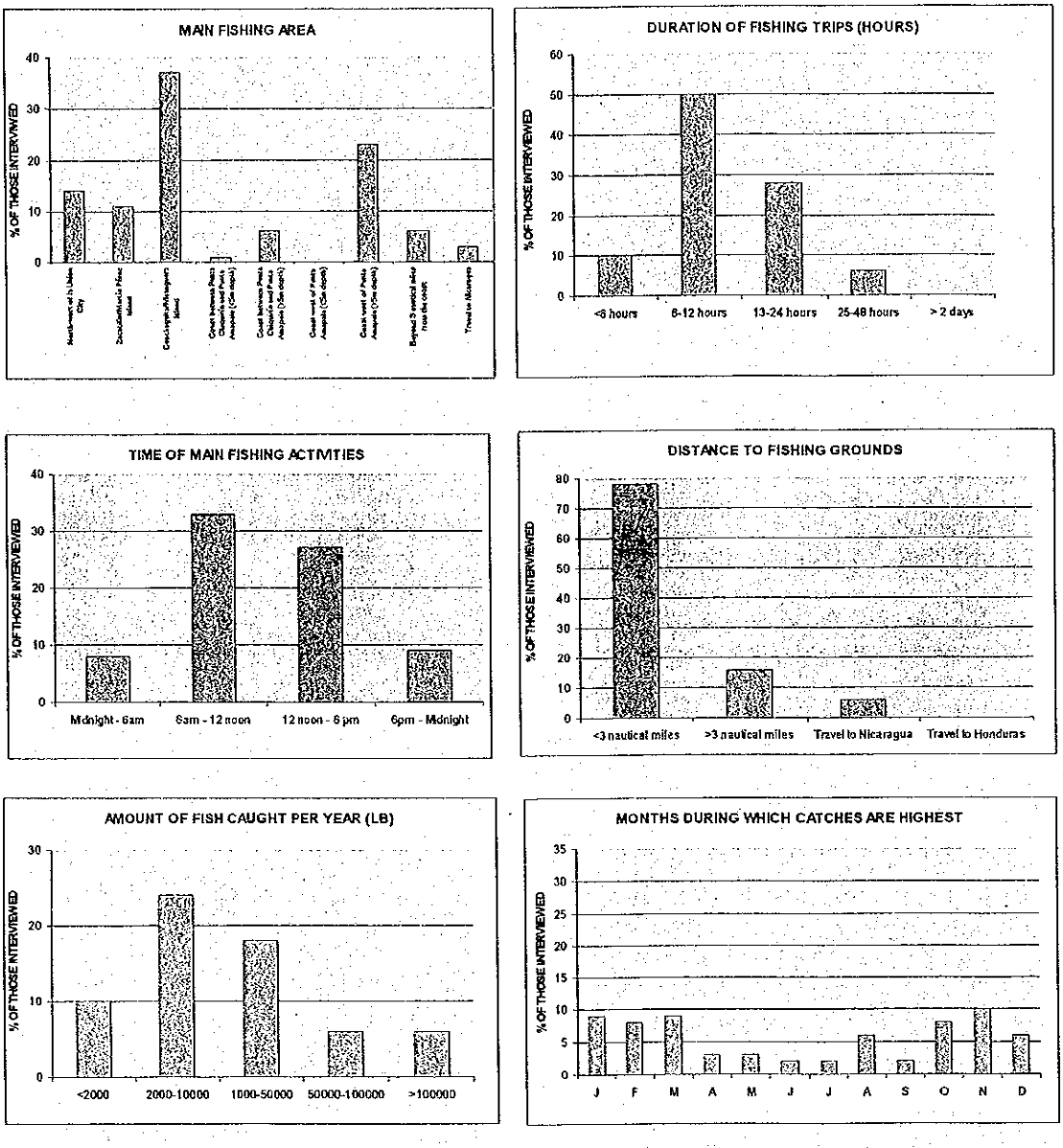



**Figure 12.3.2 Data Obtained form Interviews with Artisanal Fishermen from the Study Area**

A third measure is the ban on the removal and human consumption of oysters, which was brought into force in August 2001 because of the occurrence of a red tide (a population explosion of phytoplankton which are ingested by filter feeding molluscs, and can be toxic to humans if the molluscs are eaten). Although the ban on human consumption has now been lifted, the prohibition on oyster fishing has been kept in force, again to allow the species to pass through the reproductive phase of the life cycle.

### 12.3.4 Conclusion

The results of simulation of sediment dispersion show that the extent of suspended sediment from the alternative offshore dumping site is not significant and it will not move toward the border with Nicaragua.

The alternative offshore dumping site is located at the entrance of the Fonseca Gulf which is a boundary of restricted area for industrial fishing. Some industrial fishing boats are operating within the boundary, but it is illegal.

From the results of the benthos survey at the alternative offshore dumping site s, as discussed in Section 12.2.5, it is concluded that no significant impact on fishing activity is expected by dumping operation.

In the benthos survey along the proposed channel, only protected specie of *Menipe frontalis* was found but this was only found in the narrow part of the channel near Zacatillo Island where the depth is over 14 m and dredging will not be carried out. It is extremely unlikely that any of the organisms present in the channel dredging area will be found only at the location. All of the species have planktonic larvae which will settle after the dredging operation ceases and will grow into adults to re-establish the similar community. Thus the destruction of the species by dredging operation is not ecologically significant.

There are not so many artisanal fishermen operating along the proposed channel and they used to catch high value fish to the east of Zacatillo and Conchaguita Islands or near the shore off Amapala as shown in Figure 12.3.1.

Thus the impact to the artisanal fishery is also not significant.

Through the several meetings with CENDEPESCA it was concluded that the port construction activities are not expected to have significant negative impact on the fisheries industry.

## 12.4 Mathematical Modeling of Sediment Dispersion

### 12.4.1 Dredging in Outer Channel

Mathematical modeling was conducted using the SEDPLUME model of Hydraulics Research Wallingford. For dredging in the channel the model simulated the plumes produced by a trailing suction hopper dredger with a 8,000 $m^3$ capacity and a pump rate of 6 $m^3/s$, which would take roughly 2 hours to fill with overflow, and a further 4 hours for sailing and disposal. The cycle time of dredging and disposal operation was assumed to be about 6 hours in total. It was also assumed that the dredger operates 20 hours per day, thus 3 cycles of dredging and dumping operation will take place per day. The alternative offshore dumping site was considered as the disposal site in this simulation model.

The simulation was carried out under the conditions of spring tide and continuous simulation of sediment dispersion model for the duration of 6 tidal cycles in total .

Figure 12.4.1 shows the predicted increases in suspended sediment in the water at two-hour intervals over a complete spring tide of the 6th tidal cycle for dredging in the outer channel, south-west of Conchaguita Island. The square indicated in the Figure shows the location of the dredged path where the dredging activity is taking place.

Figure 12.4.2 shows the timing of overflow while dredging.

The simulation result shows that:

- The plumes produced by individual periods of dredging tend to remain discrete and oscillate up and down the outer channel with the tide;
- The plumes disperse up to 10 km upstream and downstream of the dredging location;
- The plumes extend along the east coast of Zacatillo and Conchaguita Islands;
- There will be higher levels for short periods in small areas, when increases of 200 mg/ltr above ambient could occur.
- At the dumping site the plumes disperse up to 5 km upstream and downstream of the site and there is evidence of residual current to the west. Within 2-3 km from the dumping site, increases of over 200 mg/ltr above ambient are expected at peak periods.

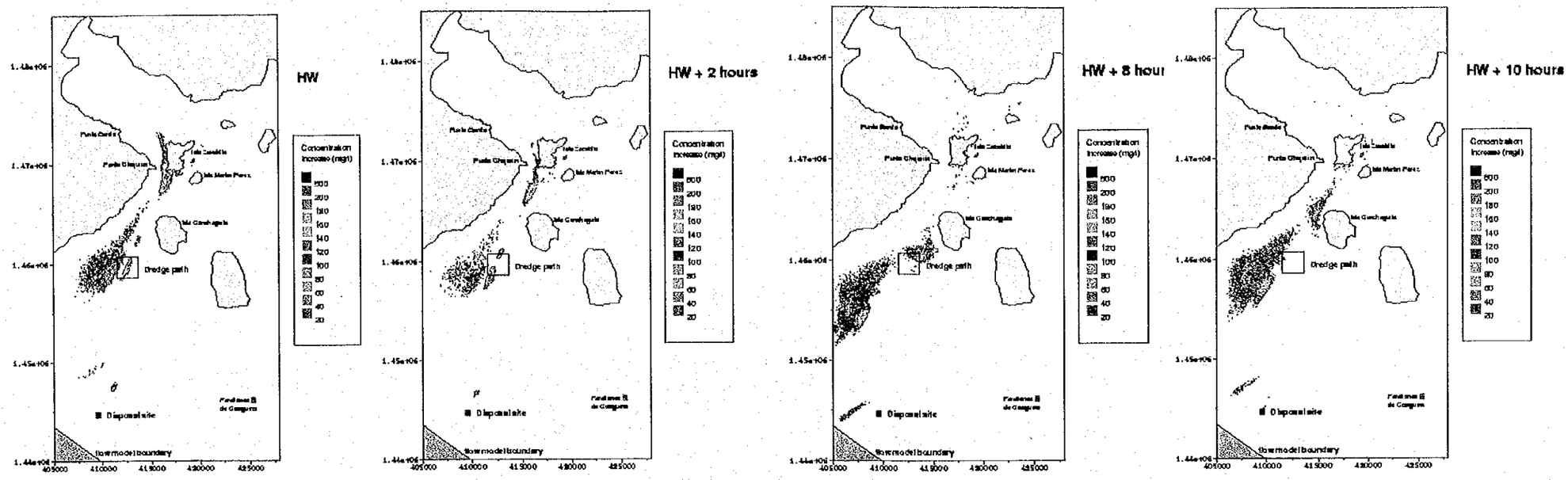



**Figure 12.4.1 Numerical Modeling of Sediment Dispersion from Dredging in Outer Channel with 2 hours Overflow**

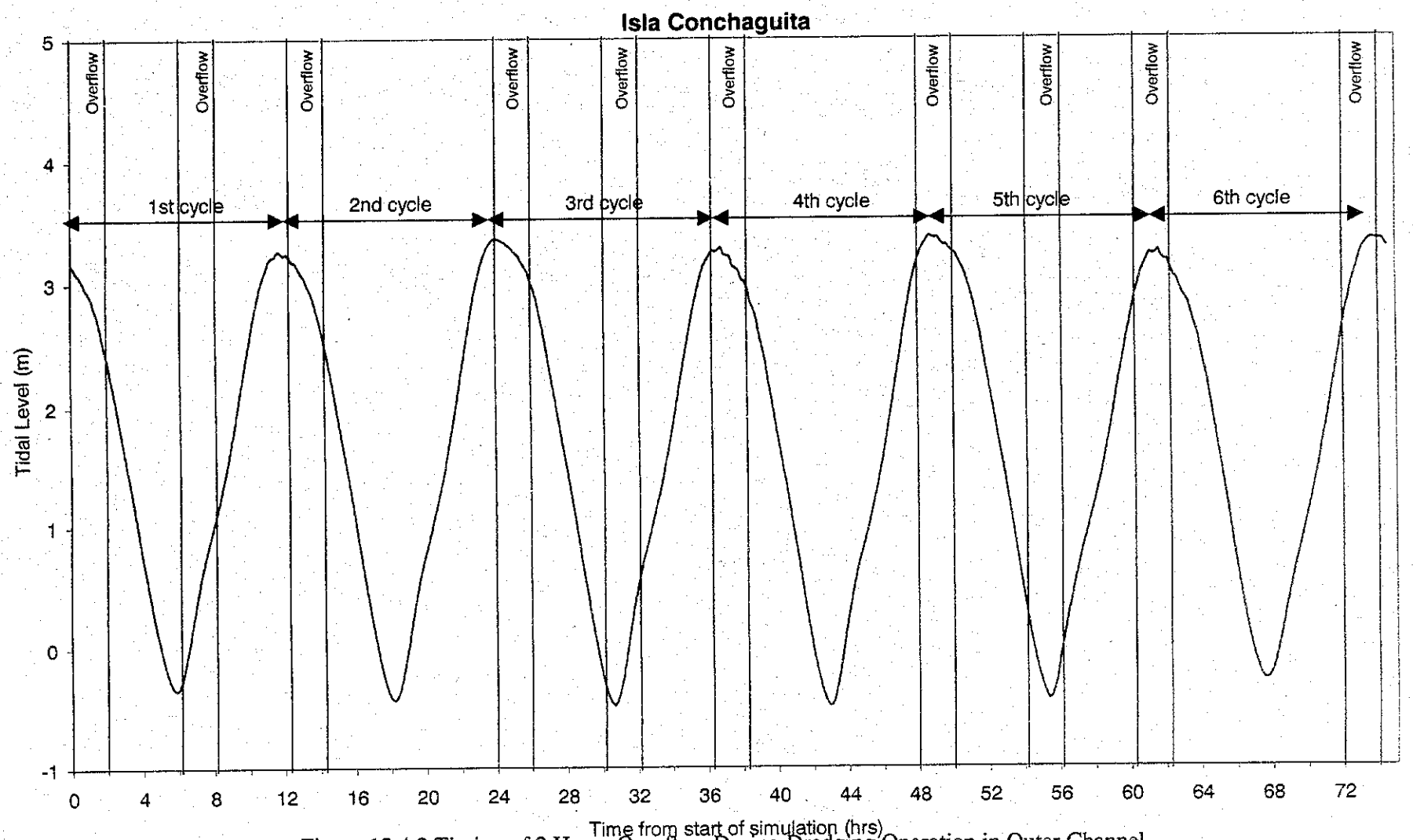



Figure 12.4.2 Timing of 2 Hours Overflow During Dredging Operation in Outer Channel

### 12.4.2 Dredging in Inner Channel

Simulation of the dredger operating in the inner channel was performed. Figure 12. 4.3 shows the model case of dredging in the inner channel at the spring tide, assuming that the dredged soil is directly dumped into the onshore dumping area or the original offshore dumping area. Discharge from the onshore dumping area was not considered in this simulation. This case was simulated with a dredging operation for 2 hours with an overflow period of o ne hour and a sailing and disposal time of 3.3 hours. Assuming the average operation of dredger at 20 hours, the dredging and disposal operation was assumed to be done at four cycles per day. The figure shows the last tidal cycle of the total simulated 6 cycles. The black line shown on the west of Zacatillo Island is the dredging path in this model.

Figure 12.4.4 shows the timing of overflow during dredging operation.

- A single large plume would be formed, extending 10 km upstream and 5-10 km downstream. The high concentrations experienced in the northwest of the bay are caused mainly by re-erosion of deposited material in shallow water ;
- Over a width of roughly 1.5 km and some 10 km upstream and downstream of the dredging area;
- Peak concentration increases of over 200 mg/ltr above ambient are expected. Elsewhere predicted concentration increases are below 100 mg/ltr;
- High concentration would occur near Perico Island around low water.

Simulations were then carried out of the dredger operating with a 1-hour overflow. It shows that:

- The plume would be smaller in area, but it would still extend up to10 km upstream and 3-8 km downstream throughout most of the tidal cycle;
- SS increases would be lower, generally 100 mg/ltr or less, but they could again rise over 200 mg/ltr at the northern part of the bay in peak time.

Since the northern part of the bay is sensitive due to existence of a mangrove area and an important fish nursery area, the dredging in the inner channel shall be performed without overflowing from the dredger.

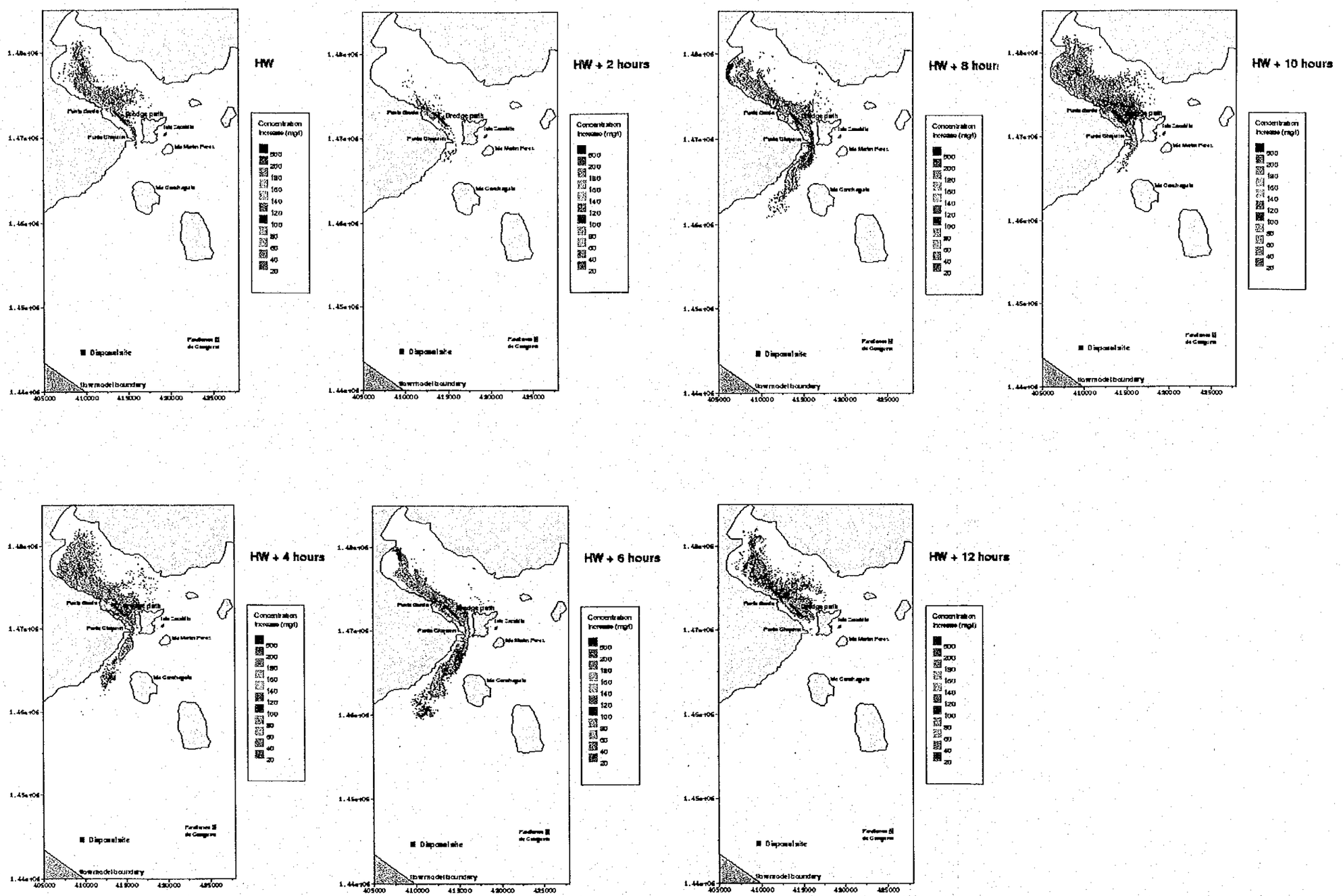



**Figure 12.4.3 Numerical Modeling of Sediment Dispersion from Dredging in Inner Channel with 1 hour Overflow**

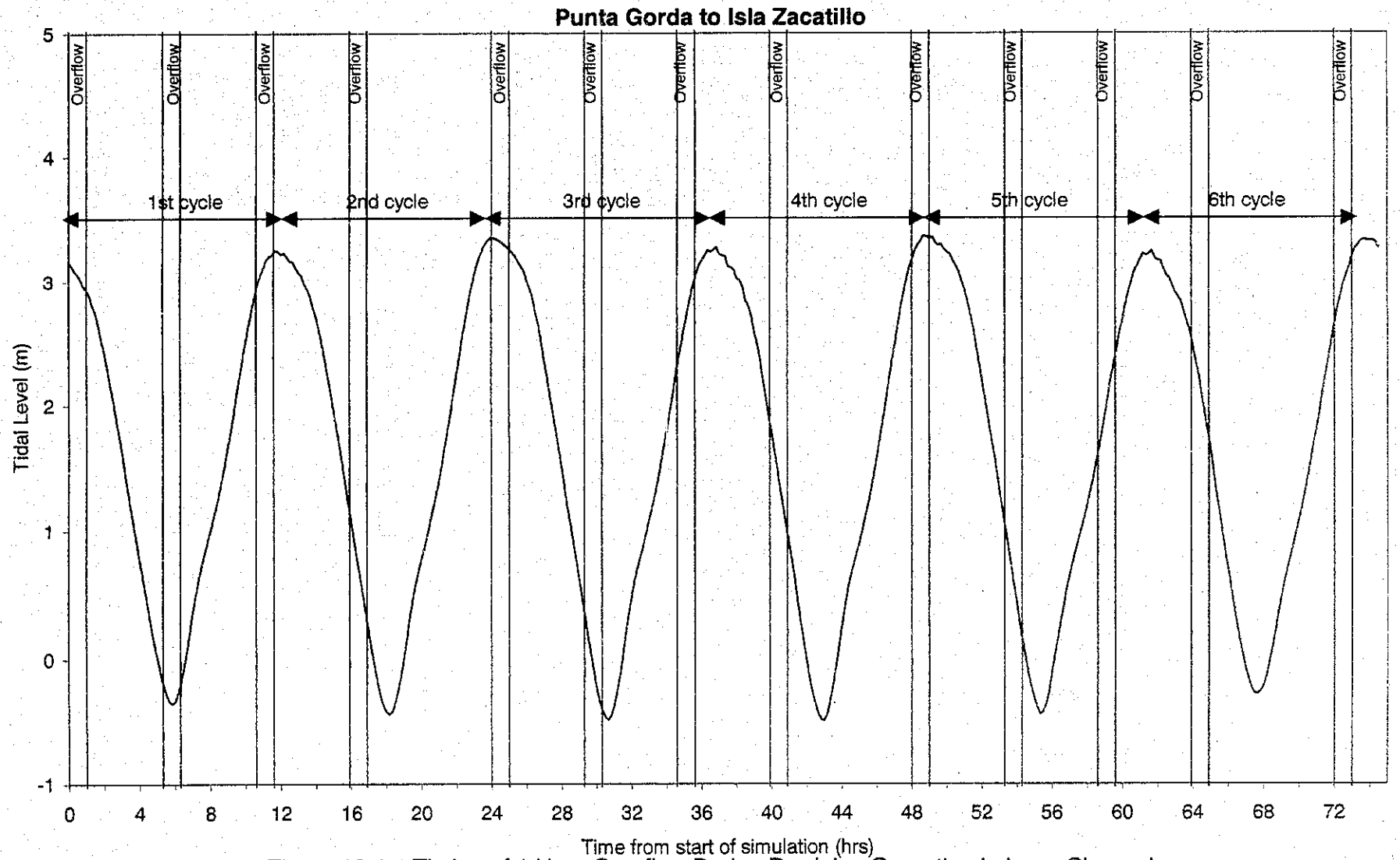



Figure 12.4.4 Timing of 1 Hour Overflow During Dredging Operation in Inner Channel

### 12.4.3 Reclamation

The results of investigations showed that a part of the dredged material is suitable for use in reclamation. Therefore, to minimize the impact of turbid water it was decided to utilize such suitable material. It was also proposed to reclaim additional areas around the port, to dispose of more material. Two such onshore dumping areas were proposed, in which the material would be retained by bunds.

Figure 12.4.5 shows the predicted dispersion of sediment due to the overflow discharges from the reclamation area, produced by directly dumping through discharge pipe of a dredger, assuming a low rate of retention of fine material in the settling lagoon. This figure is one of the numerous simulation cases. This indicates that:

- Plumes are much smaller than those produced by a dredger overflowing, and are confined to the vicinity of the site for much of the high water-ebb tide period;
- The suspended sediment concentration increases to above 500 mg/ltr in the vicinity of the discharge point, and over 200 mg/ltr along a 6 km stretch of coast line north of Punta Gorda;
- The plume extends up to 1.5 km south of Punta Chiquilin, the predicted suspended sediment increase falls to below 20 mg/ltr.

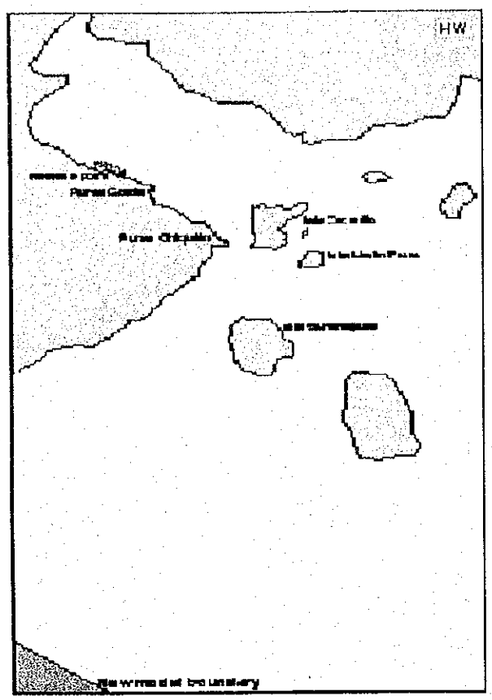
Judging from the results of simulation, no significantly adverse impacts are expected due to the discharge from the reclamation area since the plume from the discharge does not reach the sensitive areas of Perico and Periquito Islands and the mangrove area in the north of the bay. However, the contractor shall plan to construct an appropriate discharge weir in order to reduce the volume of fine material to be released from the settling lagoon.

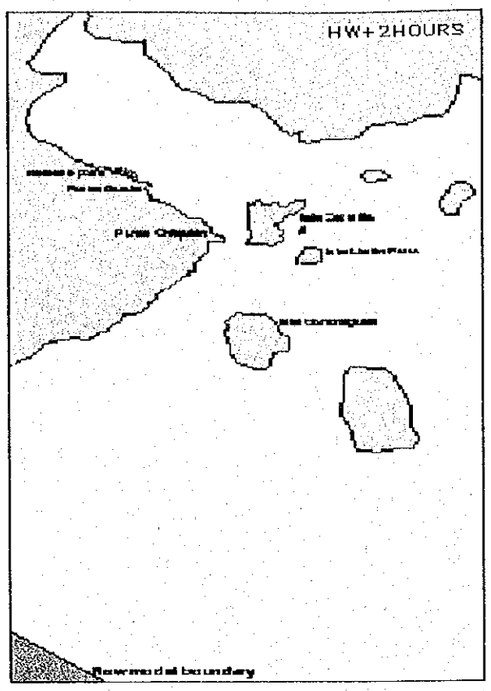
**(4) Disposal at Alternative Offshore Dumping Area**

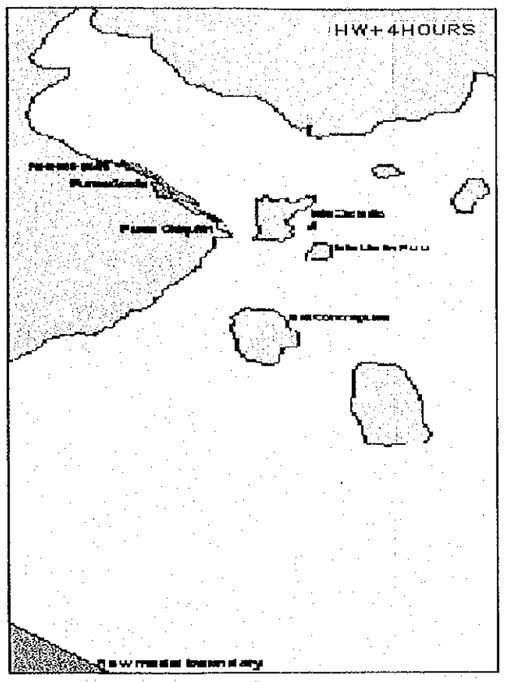
Figure 12.4.1 shows the modeling of plumes produced by dumping dredged material at the alternative disposal site every 5-6 hours. This indicates that:

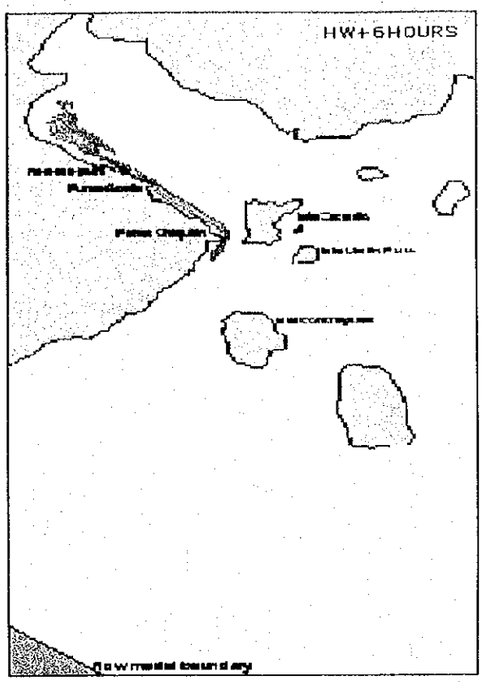
- After dumping, a small plume of increased suspended sediment is formed, extending 1-2 km south-west of the disposal site;
- At the time of dumping SS increases of up to 200 mg/ltr could occur, but only in a very small area; thereafter increases fall to 60 mg/ltr or less;

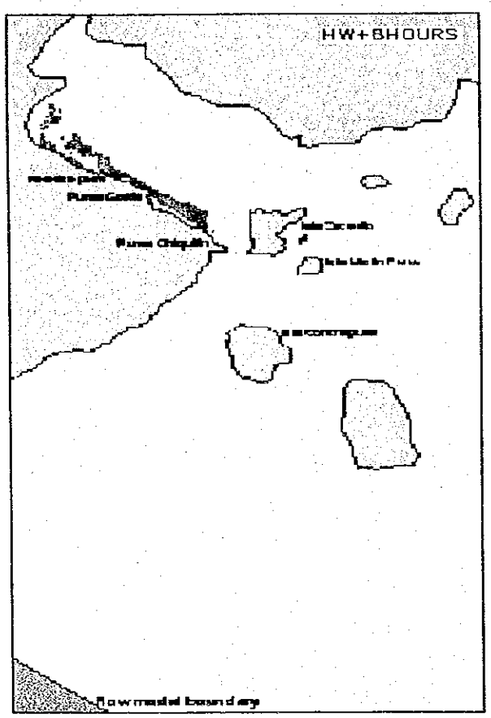
The plume is carried a few km north-westward towards the coast, and it disappears in a few hours as the sediment settles or is dispersed in the water. No significant adverse impact is expected by the dumping operation, thus no special measures are required to be taken. But daily monitoring of water quality at the monitoring stations around the offshore dumping site will be performed to confirm that the level of turbidity will not exceed the Trigger Level and the plume will not expand significantly to the Nicaragua border.

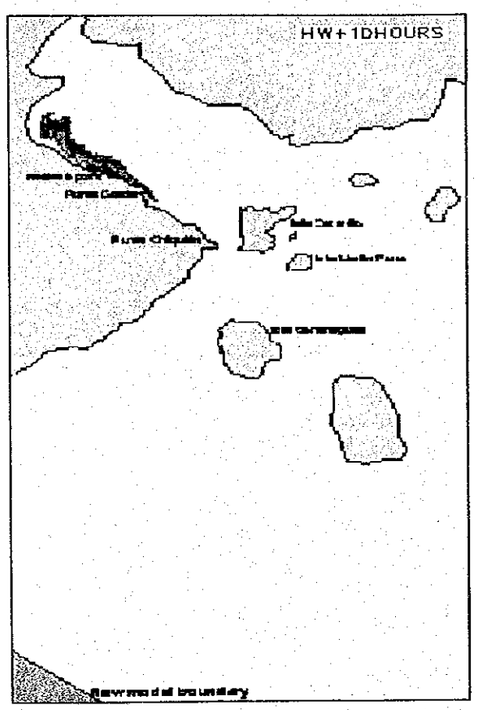


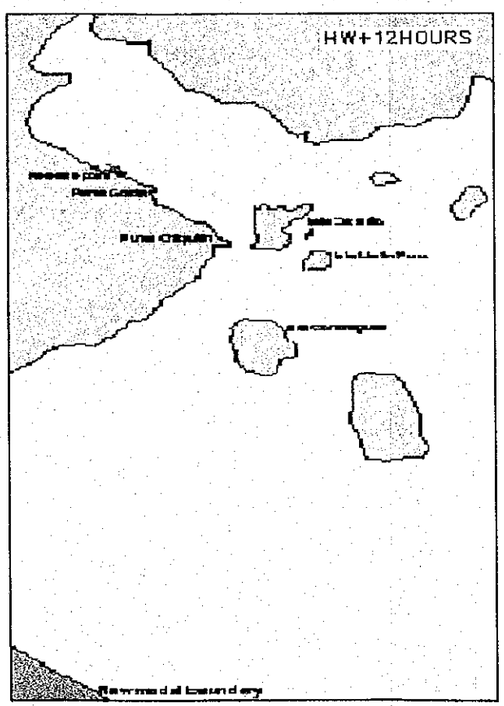



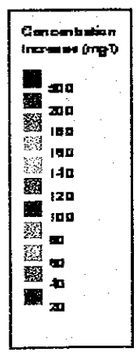




Figure 12.4.5 Numerical Modeling of Sediment Dispersion from Overflow of Water from Reclamation Site

## 12.5 Additional Environmental Impact Assessment

### 12.5.1 Bases of Assessment

Although the environmental assessment for the Project was completed and approved by MARN in 2000, the approach to certain aspects of the Project was amended during the Study. Therefore, the environmental impacts of the following changes were assessed:

- The area of the borrow site was reduced from 28 to 20 ha because it was found to be uneconomical to remove material from the south-eastern side, where there is a high proportion of rock near the surface;
- The dredged material is partly suitable for use in reclamation, so to reduce the spread of turbidity in the inner channel it was decided to use part of the dredged material for reclamation;
- It was also proposed to reclaim two further onshore areas around the port to dispose of more dredged material.

### 12.5.2 Environmental Laws and Regulations

The laws and regulations of El Salvador mainly applied for the Study are listed below:

i) Environmental Law Decree No. 233, May 1998, MARN (Ley del Medio Ambiente).
ii) General Regulations of the Environmental Law, March 2000, MARN (Reglamento General de la Ley del Medio Ambiente).
iii) Special Regulation for Sewage (Discharge) Waters, May 2000, MARN (Reglamento Especial de Aguas Residuales).
iv) Special Regulation for Dangerous Materials, Substances and Residues, May 2000, MARN (Reglamento Especial en Materia de Sustancias, Residuos y Desechos Peligrosos).
v) Integral Management of Solid Waste, May 2000, MARN (Reglamento Especial sobre el Manejo Integral de los Desechos Sólidos).
vi) Technical Norms for Environmental Quality, May 2000, MARN (Reglamento Especial de Normas Técnicas de Calidad Ambiental)

In evaluating the results of environmental surveys in relation with dredging and dumping work, a Cooperation Agreement to safeguard the North Sea (signed by Belgian State and the Flemish Region in 1990 and modified in 2000) was used as reference, since such guideline is not available in El Salvador, Japan and other countries. The dredged materials to be dumped at sea shall meet the sediment quality criteria given below.

| Item | Limit Value |
|---|---|
| Hg | 1.5 ppm |
| Cd | 7 ppm |
| Pb | 350 ppm |
| Zn | 500 ppm |
| Ni | 280 ppm |
| As | 100 ppm |
| Cr | 220 ppm |
| Cu | 100 ppm |
| TBT | 7 ppb |
| Mineral Oil | 36 g/kg |
| PCB | 2 µg/g |

### 12.5.3 Borrow Operation

The only significant change in the borrow operation is that a smaller area will be cleared (20 ha instead of 28 ha). In addition, the ecological survey showed that 40% of this area is covered by CEPA buildings and facilities and contains little or no flora, so in fact only 12 ha of vegetation will be lost.

The affected habitat comprises Medium Forest Subcaducifolia, and includes two stands of *Enterolobium cyclocarpum* (Concaste Negro). Given that the borrow area contains nationally-rare trees, shrubs and herbaceous flora, plus reptiles, birds and mammals, then the 16 ha gain in habitat is a significantly positive impact.

It is reasonable to rescue the wild fauna and to include such nationally-rare trees in re-vegetation in performing the Mitigation Measure No.1.

Because of the changes in the Project it was proposed to amend the Mitigation Measure No.1 as follows:

- Re-vegetate double the area to be lost as a result of the reduction in size of the borrow area (i.e. 24 ha);
- Re-vegetate at the density normally used for such exercises (625 trees per ha, i.e. 15,000 in total);
- Rescue wildlife from the 12 ha area and relocate it to the adjacent land excluded from the borrow site.

### 12.5.4 Reclamation

The change in the approach to reclamation means that less dry terrestrial material will be used as fill, the reclamation area will contain dredged silt/water slurry instead, requiring the release of turbid water back to the environment, and 88.8 ha will be reclaimed including onshore dumping areas, instead of the 26.6 ha required for the port operation. There will also be no turbidity plumes produced by the dredger, which will pump material directly into the reclamation areas.

These changes will have the following effects:

- Turbidity plumes from the overflow from the reclamation areas will be far less extensive than those produced by an overflowing dredger, extending a maximum of 6 km up and down the channel for a 4 hour period after low water only, with maximum SS levels of 100 mg/ltr above ambient or less, in all but the immediate vicinity of the site;
- An additional 62.2 ha of intertidal and nearshore habitat will be lost, and 3 ha of mangroves at the borrow site will die because they will be cut off from the tide. However, these mangrove relicts are located above high water level in a small area.

Turbid water can impede light penetration and reduce phytoplankton productivity, irritate the gills of fish and cause them to avoid such areas, and smother the benthos when the sediment settles on the seabed. However these impacts are unlikely to be significant because:

- This is a location of high current action where phytoplankton populations are constantly replenished from adjacent areas;
- Any avoidance by fish is temporary and results in more fish being available in unaffected areas;
- Benthic organisms in a highly turbid environment are naturally tolerant of settling sediment and respond by burrowing up through the material.

It is not expected that the reclamation work will cause any significant effect except for a small mangrove area. CEPA offers to take charge of planting mangroves in a 6-ha area in the vicinity of the port area.

None of the conditions of the Environmental Permit relates to the use of dredged material for reclamation, because this was only considered in the Study period. To mitigate the negative ecological impacts, it was proposed to:

- Include in the re-vegetation plan, planting of 6 ha of mangroves by CEPA to compensate for the 3 ha that will be lost;
- Monitor turbidity/suspended solids 500 m away from the overflow from the reclamation area, and take action to reduce SS if levels rise to more than 200 mg/ ltr above ambient.

### 12.5.5 Dredging

Figure 12.4.1 shows the dispersion of sediment due to trailer suction dredging in the outer channel. In the inner channel, plumes will be formed when the area is dredged by trailer suction dredger with overflow. Thus the dredger shall operate without overflow or shall dump the dredged material through the discharge pipe directly to the reclamation area, or onshore dumping areas.

The effects of these changes are as follows:

- For most of the period during which the dredger operates in the inner channel, very strict control of turbidity is required ;
- Within the inner channel, SS will be 100 mg/ltr or less above ambient, except at low water level when there could be increases of 500 mg/ltr at the ends of the plume.
- During the year in which the dredger operates in the outer channel, plumes similar to those shown in Figure 12.2.16 will be formed;
- During this time there will be two main plumes, covering areas of 10 x 3-4 km and 5 x 1.2 km, which oscillate down and up the channel with the tide;
- At most locations within the plumes, increases in SS will be 60 mg/ ltr or less;
- There will be higher levels for short periods in small areas, when increases of 200 mg/ltr above ambient could occur within 0.5 $km^2$.

Dredging can cause environmental impacts due to the effects of turbidity plumes as described above, and the removal of animals from the seabed. The destruction of benthos is unlikely to be significant because the animals are all found elsewhere in the Fonseca Gulf and most are also found in other areas along the coast, so the losses will affect a very small proportion of the total population. Although *Menipe frontalis* was found in the channel it was only at two stations near Zacatillo Island, where the seabed is over 14 m deep and thus will not need to be dredged.

The effects of turbidity are also unlikely to be significant. However there is one area where SS increases could cause significant negative impacts, that is in the mangrove swamps in the north of the bay. These are important nursery areas for fish and shrimp, the delicate young stages of which should be protected from environmental stress. There are also beds of mussels and clams between Perico and Periquito Islands, which are exploited by the local community and thus also need to be protected.

To mitigate the impacts of dredging, the Environmental Permit required to apply silt curtains around the dredger. However the use of silt curtains around the dredger was considered:

- Inappropriate, given that this is normally used to protect highly sensitive, clear waters, supporting rich growths of coral, which is not the case in La Unión Bay where the water is highly turbid, and where there is no coral;
- Infeasible for applying silt curtains in the case of trailer-suction dredging, because silt curtains are anchored in the water whereas the dredger moves across an area pumping continuously.

As an alternative to the use of silt curtains, it was proposed to:

- Monitor turbidity and suspended solids at 12 stations throughout the channel for at least a month before dredging, to determine background (average) levels, and the relationship between turbidity and SS;
- Monitor turbidity at the same stations every 24 hours throughout the dredging period, and convert the values to SS;
- Locate monitoring stations at the sensitive parts of the Study area, as shown on Figure 12.5.1. These are:
  - Stations 1 and 2 near the mussel beds of Perico and Periquito Islands;
  - Stations 3, 4, 5 at the southern edge of the fish nursery area;

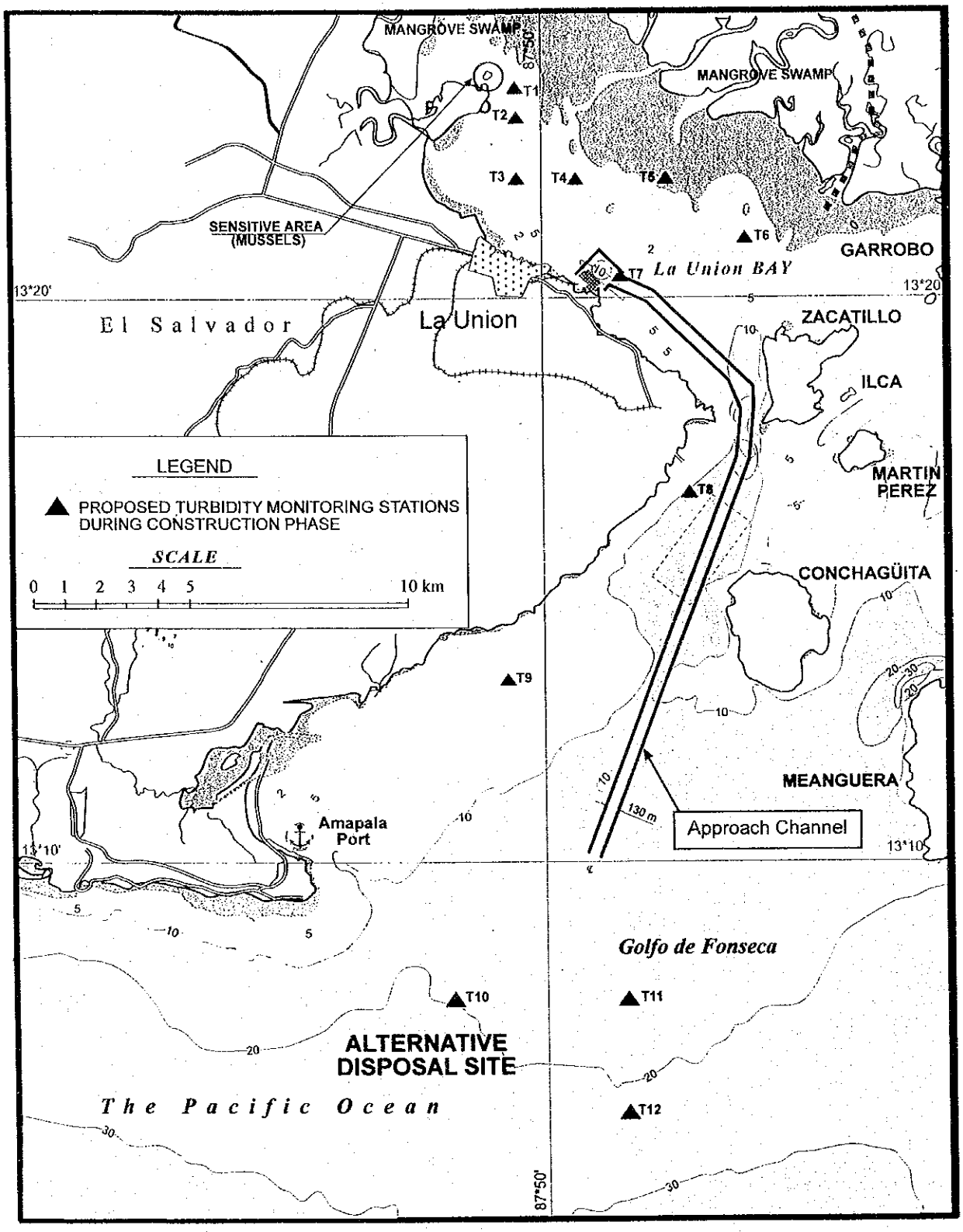



Figure 12.5.1 Map of La Unión Bay Showing Stations Monitored During Design Stage and Proposed Stations for Turbidity Monitoring During Construction Phase.

- Station 6, 2 km north-east of the inner channel to prevent plumes traveling towards the opposite side of the channel;
- Station 7, 500m from the discharge from the reclamation area;
- Stations 8 and 9, 1 and 2 km west of the outer channel to protect the coastal fishery between Punta Amapala and Punta Chiquirin;
- Stations 10, 11 and 12 at the alternative disposal site to prevent plumes drifting towards the coast or offshore towards the international border.

- Set Trigger Levels of increases in SS of 200 mg/ ltr above ambient at Stations 6-12, these being levels which most animals living in a turbid environment should be able to withstand or avoid;
- Set Trigger Levels of 100 mg/ltr above ambient at Stations 3-5 to protect the sensitive juvenile stages;
- Set Trigger Levels of 60 mg/ltr above ambient at Stations 1 and 2 to protect the sensitive filter feeding mollusks, with these triggers being applied if levels at Stations 3, 4 and 5 also rise by 60 mg/ltr or more (when it can be assumed that the increases are produced by the dredging);
- In setting trigger level, it was not provided different figures for dry/wet seasons since the survey results revealed no significant change between two seasons.
- Apply the contingency that if Trigger Levels are exceeded, dredging must cease until values fall below ambient again. Repeated failures would require a reconsideration of the approach to the dredging to determine whether additional remedial measures are needed.

### 12.5.6 Disposal

The changes in the disposal operation mean that 6 million $m^3$ of material will be dumped offshore, from the outer channel, outer part of the inner channel, and the surface layers of the inner channel where the silt is too fine to use for reclamation. This will all be carried to the alternative offshore dumpsite in the hold of the dredger and released approximately. The dispersal of sediment is shown in Figure 12.4.1, which indicates that:

- After dumping a small plume of increased suspended sediment is formed, extending 1-2 km south-west of the disposal site;
- SS increases of up to 200 mg/ltr could occur, but only in a very small area for a short period, after which levels fall to 60 mg/ ltr or less above background;
- The plume is carried a few km north-westward toward the coast, and it disperses within a few hours, well before the release of the next load.

The increases in silt in the water or settling on the seabed are unlikely to cause significant impacts for the reasons explained in Section 12.5.4 above.

Table 12.1.2. shows that there were two measures in the Environmental Permit relating

to disposal of dredging, which required:

- A physical and biological Study of the area, to be submitted to MARN;
- Anti-turbidity curtains around the area to prevent the spread of sediment;
- Warning signs to prevent entry by vessels;
- Material must not affect the boundary with Nicaragua.

According to the Environmental Permit, MARN suggested the original offshore dumpsite south of Latitude 13°N, at a depth of 43 m. However with MARN approval the alternative offshore dumping site was considered to reduce the cost of disposal (as it is closer to the dredging areas), and to protect the environment at the original dumpsite about which MARN was concerned. The results of the surveys showed that the benthos at both sites was neither rare nor in particular needed protection and the seabed of the alternative dumping site is not composed of rock. MARN therefore approved disposal at the alternative site. As far as the permit conditions are concerned:

- The data of physical, biological and environmental characteristics were supplied to MARN;
- Turbidity monitoring at Station 12 and the contingency plan described above will prevent highly turbid plumes from reaching the international border.

The only remaining aspects relate to the use of silt protection curtains, which were omitted for the reasons explained in Section 12.5.5. The impacts of the disposal operation will thus be mitigated by turbidity monitoring at Stations10, 11 and 12 as described above, ceasing disposal if suspended sediment rises more than 200 mg/ltr above ambient.

## 12.6 Changes in the Environmental Permit Conditions

As a result of the review of the Environmental Permit, changes were requested and accepted by MARN in seven Mitigation Measures and one of the Conditions. These include the following:

- Amend **Mitigation Measure 1** to re-vegetate 24 ha of land with 15,000 trees (including 6 ha of mangroves), and rescue wildlife and relocate it into the adjacent undamaged area. This is because only 12 ha of vegetation will now be lost and an 8 ha area will be left intact, and 625 trees/ha is the normal planting density;
- Omit from **Mitigation Measure 2** the relocation of all rocks from the beach at the reclamation site and the pillars supporting the existing dock, as this is not necessary to conserve the fauna. The animals all have planktonic larvae which will colonize under water surfaces of the new port, forming richer populations than are present now.
- Omit from **Mitigation Measure 3** the construction of concrete canals, sediment traps and turbidity screens to treat drainage from watering of soil at the borrow site to reduce dust. Temporary channels dug in the soil would be just as effective, and suspended solids can be reduced by retaining water in the lagoon at the reclamation site. SS monitoring where water is returned to the channel would show whether additional silt reduction measures are required;
- Omit from **Mitigation Measure 6** the incinerator to treat solid waste from the operating port. Waste from ships is dealt with by Shipping Agents and the only waste that is under the responsibility of the Port Authority is that produced by its own activities. There will be a relatively small quantity of office material, which can easily be dealt with by the municipal waste collection service;
- Omit from **Mitigation Measure 7** the aspects relating to controlling pollution from handling liquids in bulk (slop tank and mud tank, bunds around loading areas, vapor collecting tank, concrete boxes to collect spills, oil and grease collector tank) as no bulk liquids will be handled in the port. An oil-water separator will treat drainage from the vehicle maintenance workshop only;
- Omit from **Mitigation Measure 8** the use of silt curtains around the dredger and disposal site as these are normally used only in highly sensitive environments with rich growths of coral, which is not the case in La Unión Bay. Monitor turbidity instead and set Trigger Levels to protect any sensitive areas, with dredging being required to cease if Trigger Levels are reached.

  Also supplement the Measure by establishing turbidity monitoring stations at locations shown in Figure 12.5.1 and setting Trigger Levels of increases in SS of 200 mg/ltr above ambient at Stations 6-12, 100 mg/ltr at Stations 3-5 (to protect the

fish nursery) and 60 mg/ltr at Stations 1 and 2 (to protect the filter-feeding mollusks). Triggers at Stations 1 and 2 would be activated if levels at Stations 3, 4 and 5 also rise by more than 60 mg/ ltr. These values were proposed on the basis of the levels predicted by the modeling for the dredging methods most likely to be used, and levels which animals living in a naturally turbid environment should be able to withstand.

- Add **Mitigation Measure 16** relating to dumping of dredged spoil, which limits reclamation to 27 ha for the port, and 11 and 24 ha onshore dumping sites on the north-western and south-eastern sides.
- Amend **Permit Condition 13** to allow port construction to commence before La Unión bypass has been completed, as the road project has been delayed, which could hinder completion of the port. Instead, determine whether the route of the road can be used by port traffic before the road is finished, to keep heavy traffic out of La Unión City.

No changes were proposed to the remaining Measures (15 of the original 22), which were all reasonable and acceptable.

## 12.7 Environmental Management and Monitoring Plan

The Environmental Management and Monitoring Plan (EMP) was prepared as a separate volume of the report which deals with each of the Mitigation Measures and Environmental Permit Conditions in turn, and describes:

- The measure, its objectives, rationale and main elements (in a table);
- The approach to the measure, that is how it will be engineered;
- Action taken and required in the future, to implement each measure;
- Monitoring to be carried out to ensure that each measure is implemented as specified, and that it protects the environment as intended.

The action taken, and other action required in the future are shown in the EMP, which will be referred to throughout the Project whenever environmental matters are considered.

The main elements of EMP are summarized in Table 12.7.1.

## Table 12.7.1 Summary of the Environmental Management and Monitoring Plan

| MEASURE | ACTION INCLUDED IN CONTRACT | ACTION REQUIRED BY CEPA | MONITORING - Construction | | | Operation | |
|---|---|---|---|---|---|---|---|
| | | | CEPA | Contractor | ECW | PEU | Port Mgr |
| Re-vegetation and wildlife rescue | Retain 5 m strip of vegetation inside port perimeter fence and plant 1 ha of indigenous trees along roads and near buildings | • Identify 23 ha for planting outside port, plus 6 ha of mangroves;<br>• Prepare planting Specification, with MARN assistance;<br>• Appoint qualified Contractor.<br>• Prepare Specification for wildlife capture and release, with MARN help<br>• Appoint qualified Contractor. | Ensure offsite planting, maintenance is as specified<br>Ensure wildlife is captured and released as specified | | Ensure onsite planting is as specified | Check maintenance of onsite vegetation | |
| Conservation of rocky areas/fauna | No action | No action required | | | | | |
| Environmental management of borrow operation | Water soil in dry season. Dig ditches to carry water into reclamation area. Maintain machinery to manufacturers specifications. | No action required | | Record turbidity 500m from reclamation area overflow (see below) | Ensure watering, drainage, vehicle maintenance is as specified | | |
| Management of waste from borrow works | Transport topsoil for use at other project sites identified by La Unión City. Deposit remaining waste in landfill. | • Obtain La Unión City approval to dispose of waste to landfill. | | | Ensure disposal, compaction, re-vegetation is as specified | | |
| Management of dismantling and disposal of existing infrastructure | Remove ceiling panels of Warehouse 5 without breakage and disturbance. Workers to wear appropriate suits. Dispose material in identify location and contents of all pipes on site. | • Liaise with La Unión City to find site for hazardous waste landfill;<br>• Determine location and contents of all pipes on site. | | | Ensure handling and disposal of asbestos, hazardous liquids and other infrastructure is as specified | | |

| MEASURE | ACTION INCLUDED IN CONTRACT | ACTION REQUIRED BY CEPA | MONITORING - Construction | | | Operation | |
|---|---|---|---|---|---|---|---|
| | | | CEPA | Contractor | ECW | PEU | Port Mgr |
| Solid waste management | No action required in construction phase | • Request La Unión City to collect waste from port when operating;<br>• Prepare Port Operations Manual (POM) specifying procedures for all port activities;<br>• Include procedure requiring all port operators to implement a waste management plan;<br>• Prepare waste management plan for port; | | | | | Audit operations of firms in port, to ensure waste is managed according to company and port waste management plans |
| Liquid waste management | Drainage system designed to pass water from vehicle maintenance workshop into oil-water separator. Separator designed to treat water to El Salvador standards. | • Provide equipment required by contingency plan and train staff; | | | | | |
| Environmental protection during dredging | Monitor turbidity daily at 12 stations. Cease dredging if SS rises more than 200 mg/ltr above ambient in channel or dumpsite, 100mg/ltr in mangrove area north of La Unión, or 60 mg/ltr near Perico Island. Develop oilspill contingency plan and carry equipment to deal with spill of any hazardous liquids. | • Give appropriate notice to vessels to avoid dumpsite, reclamation area and dredging area | Review SS results, consult MARN, decide when dredging should cease | Record turbidity as shown in Column 2 | Ensure dredging, disposal, reclamation, monitoring is carried out as specified | | |
| Sanitary infrastructure for construction workers | Provide adequate toilet and washing facilities for construction workers. Dispose of waste according to El Salvador standards | No action required | Review inspection result | Periodical ocular inspection of site | Ensure sanitary facilities are provided and used and waste is removed as specified | | |
| Occupational Health and Safety (OHS) | Prepare OHS Plan describing safety procedures and equipment | • Ensure that OHS Plan of Contractor adequately protects workers;<br>• Prepare Port OHS plan and provide equipment and facilities. | | | Ensure construction carried out as in OHS Plan | | Ensure work in operating port is as in OHS Plan |

| MEASURE | ACTION INCLUDED IN CONTRACT | ACTION REQUIRED BY CEPA | MONITORING - Construction | | | Operation | |
|---|---|---|---|---|---|---|---|
| | | | CEPA | Contractor | ECW | PEU | Port Mgr |
| Project Promotion | No action required by Contractor | • Organize billboard construction;<br>• Hold consultation meetings with local community every 6 months. | | | | | |
| Port Environmental Unit | No action required in construction phase | • Form Port Environmental Unit of qualified Manager, Mechanical Engineer and Water Quality Chemist; | | | | Ambient monitoring periodically | |
| Environmental Measures in Port Operations Manual | No action required in construction phase | • Appoint consultants to develop Port Environmental Management System (EMS);<br>• Require all companies in port to comply with POM and EMS. | | | | Ensure work in operating port complies with POM, EMS. | |
| Solid waste management | No action required in construction phase | • Provide POM, EMS to all bidders for port operations concession;<br>• Use environmental protection as a criterion in evaluating bids;<br>• Ensure that selected bid includes dust prevention measures for bulk solids. | | | | Ensure that solid bulks are handled as specified. | |
| Operate liquid treatment system | Prepare Operation and Maintenance (O&M) Manuals for WWTP and oil/water separator | • Employ Technician to operate WWTP and oil/water separator; | Review monitoring results. | | Ensure that WWTP and oil/water separator are constructed as designed | Ensure that plants are maintained as in O&M Manual. | |
| Maintenance of water sanitation system | Prepare O&M Manual as above | • Determine means of disposing of sludge from WWTP and separator; | | | | Ensure that sludge is disposed of as specified. | |
| Re-settlement of settlers | No action required by Contractor | • Conduct an opinion poll to determine satisfaction of residents with their new accommodation. | Opinion poll as in Column 3 | | | | |
| Completion of La Unión bypass | All road traffic from outside La Unión to use route of the bypass | • Liaise with MOP to monitor progress of road project;<br>• Agree with MOP the arrangement whereby traffic will use bypass route before road is completed. | | | | | |

| MEASURE | ACTION INCLUDED IN CONTRACT | ACTION REQUIRED BY CEPA | MONITORING - Construction | | | Operation | |
|---|---|---|---|---|---|---|---|
| | | | CEPA | Contractor | ECW | PEU | Port Mgr |
| Prevent rodents entering port | No action required in construction phase | • Add procedure to POM for ships to use anti rat discs on mooring ropes;<br>• Employ contractor to produce discs and store near wharf;<br>• Employ contractor to control pests in port | | | | Ensure that all ships use discs on all mooring ropes. Ensure that pests are controlled as specified. | |
| Control improvised canteens | Provide inexpensive canteen for site workers. | • Request La Unión City to pass byelaws forbidding development outside port;<br>• Request La Unión police to patrol area and enforce laws;<br>• Request La Unión City to provide site near port with services and to license establishment of food stalls<br>• Provide low cost canteen in port for workers. | | | Observe outside of port and inform CEPA if any stalls develop | | |
| Training in wildlife and snakebites | Provide training to workforce in avoidance and treatment of snakebites and wildlife conservation, and provide a supply of snakebite antiserum. | • Train workers annually in avoidance and treatment of snakebites<br>• Request MARN to train workers annually in wildlife conservation;<br>• Instruct PEU to prepare POM procedure on treatment of wildlife; | | | Ensure antiserum is provided, plus training in snakebites and treatment of wildlife. | | |
| Comply with laws | Contractor must be conversant with El Salvador law and ensure that all on-site practices comply | • Request Customs and Immigration Officers to operate in port;<br>• CEPA legal dept to ensure that all POM procedures comply with law<br>• Provide POM to all companies and vessels in port. | | | Ensure that construction practices comply with El Salvador law | | Ensure that all practices in operating port comply with POM. Audit firms annually. |

Note:
Contractor = Contractor responsible for constructing the port;
ECW = Environmental Clerk or Works, provided by the Supervising Consultant to supervise environmental matters;
PEU = Port Environmental Unit to be formed by CEPA;
Port Mgr = Port Manager, to be appointed by CEPA.

## 12.8 Conclusions

The Environmental Study carried out during the design stage has examined the Mitigation Measures and other Conditions contained in the Environmental Permit (Resolution MARN-N 400- 2000) for the Project, and determined how they will be put into practice when the port is being built, and when it is operating. Additional data on environmental conditions in the Study area were collected and used, together with predictions of sediment plume behavior produced by numerical modeling, to assess the environmental impacts of changes in the approach to the borrow, reclamation, dredging and disposal operations. Mitigation to reduce the significance of these impacts was proposed, together with amendments to certain of the Permit Conditions, to reflect the increased understanding of the design of the Project and the sensitivity of the environment. An Environmental Management and Monitoring Plan was prepared, describing each measure, how it will be engineered, action taken and required in the future to ensure that it is implemented, and the associated environmental monitoring.

The main conclusions from the Study are as follows:

- La Unión Bay is an area that is naturally high in turbidity from soil eroded due to deforestation in the uplands and brought in by rivers, and from degrading plant material from the extensive mangrove swamps in the north of the bay;
- The area is polluted by organic matter from raw sewage discharged from La Unión City and other inhabited areas drained by the rivers;
- The only area requiring special protection is in the mangrove swamps in the north of the bay, which are likely to be important nursery grounds for fish and shrimp, and where there are populations of clams and mussels that are exploited by the local community. In order to protect such sensitive area of the bay, 12 turbidity monitoring stations shall be established and daily monitoring shall be performed during the operation of dredging and reclamation works. The operation shall be ceased if the turbidity level exceeds the Trigger Levels set up for each station.

Amendments were proposed to seven of the mitigation measures and one of the additional conditions as discussed in Section 12.6.