SUPPORTING REPORT E

ENVIRONMENTAL ASPECTS

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1. OBJECTIVE OF THE ENVIRONMENTAL STUDY

The objectives of the Environmental Study with respect to the Master Plan and Feasibility Study on Flood Control and Landslide Prevention in the Metropolitan Area of Tegucigalpa are:

(1) to define the baseline environmental condition of the Target Area of the Master Plan with emphasis on riverine environment,

(2) to review the relevant environmental laws, regulations and standards concerned to flood control and landslide prevention including urban river riverine environment,

(3) to conduct Initial Environmental Examination (IEE) for the Master Plan Projects and,

(4) to conduct Environmental Impact Assessment (EIA) for the urgent and Priority Project(s) of the Feasibility Study

2. BASELINE ENVIRONMENTAL CONDITION

2.1 INTRODUCTION

The reverine urban environment of Tegucigalpa is severely and visibly deteriorated. The rivers in the city reaches are essentially black in color and emanates offensive odor. Moreover, illegal dumping of garbage both in river waters and also along the riverbanks seems to be widely prevalent.

The rivers of the city, similar to those of other Latin American cities, serve as open sewers for the discharging of untreated wastewaters resulting from all types of urban uses of domestic, institutional, commercial and industrial origin. Unless this very intended use of rivers as open sewers is eliminated, no significant long-term improvement in riverine environmental condition could be achieved. Also this continued disposal of untreated wastewaters in the rivers has resulted in the pollution of riverbeds as well with the surface of riverbeds being virtually formed with wastewater sludge rather than natural soil, in particular in those river reaches with low flow velocity. In effect the rivers in the city are essentially ecologically dead with no beneficial uses other than as open sewers for the discharge of untreated wastewaters.

2.2 ENVIRONMENTAL QUALITY

The overall baseline (existing) environmental quality of Tegucigalpa city, in particular that of riverine environmental quality having much relevance to this Study on flood control and land slide prevention, is assessed as very significantly deteriorated as also pointed out in the foregone section. The highly polluted nature of the urban river reaches of the city, though visually discernable, is quantified by the available recent water quality data. The recent available data on river water quality in the city river reaches as well as the surrounding suburbanized ones, as obtained from SANNA and CESCCO, are shown in *Table E.2.1* and *Table E.2.2*.

These available data clearly demonstrates the high bacterial and biological pollution in the urban river reaches of Tegucigalpa as evident from the high measured values of fecal coliform and BOD levels thereby confirming the ecologically dead status of the city river reaches.

2.3 ENVIRONMENTAL ISSUES

The most significant and important environmental issues concerned to the riverine urban environment of Tegucigalpa could be discerned from the descriptions given in the above sections. The issue finally comes to degraded water quality and aesthetics of rivers in urban reaches of the city due to inadequate urban environmental infrastructure of wastewater treatment and solid waste management.

It is emphasized that the current environmental issues of the city is very complex in terms of the remedial measures, the cost of such remedial measures and the relevant responsible authorities. Still the remedial measures of urban and industrial pollution control including that of improved solid waste management are well beyond the scope of this Master Plan and be addressed independently as separate plans and projects as recommended in the following section.

2.4 ENVIRONMENTAL IMPROVEMENT

Improved management of all wastes, both liquid and solid, arising from the miscellaneous anthropogenic activities in the city is indispensable for the restoration of the aquatic ecology of the rivers in the city of Tegucigalpa.

The required important action programme of environmental improvement, which are projects independent of this Master Plan and Feasibility Study, are summarized below;

1. Improved solid waste collection service provision in combination with community awareness enhancement program on the importance of not disposing garbage in riverbanks and rivers by the Municipality of Tegucigalpa (AMDC). The community awareness enhancement program shall focus on the aesthetic nuisance as well as the potential flood hazard due to interference to free flow of rivers during high flows caused by accumulated garbage. In this respect it is noted that in 1999 JICA conducted a master plan study on the improvement of solid waste management in the metropolitan area of Tegucigalpa.

2. Regulation of industrial effluents by SERNA so as to ensure pretreatment of wastewater by relevant industries so as to control the discharge of heavy metals, pesticides and other pollutants that are not easily biodegradable and hence tend to accumulate in the receiving water environment.

3. Provision of sewage treatment plants by SANAA to treat all collected wastewater in the city to at least to a minimum of conventional secondary treatment level to achieve a treated effluent quality of 20 mg/l as BOD. Accordingly the current out-falls that discharge untreated wastewater into rivers will be eliminated. Since such a program would involve high cost it is recommended to conduct a master plan study so that the sewage treatment programme for the city could be prioritized and implemented on a stepwise basis and hence would be financially viable.

3. ENVIRONMENTAL INSTITUTIONS, LAWS AND REGULATIONS

3.1 ENVIRONMENTAL INSTITUTIONS

The Ministry of Natural Resources and Environment (SERNA) is the principal environmental institution at national level. In particular, the Vice-ministry of Environment of SERNA has two important environmental units responsible for environmental management/pollution control, the

CESCCO (Center for Studies and Control of Pollutants), and environmental impact assessment, DECA (Directorate of Environmental Evaluation and Control).

CESCCO basically conducts environmental pollution control projects and studies and also deals with environmental pollution issues. It has the necessary professional and laboratory capability to measure environmental contaminants in all environmental elements of water, air, soil, sediments and others. DECA is responsible for issuing environmental licensing of new project and other facilities as required, which may include conduct of environmental impact assessment (EIA) as the prior requirement for the issuance of environmental license.

SANAA (National Service Authority for Water Supply and Sewerage) is the institution responsible for the supply of potable water as well as the management of wastewater at national level in all over the country, including Tegucigalpa, except the city of San Pedro Sula. Accordingly it is the most important institution for the provision of the most significant urban environmental infrastructure of sanitation and water pollution control.

AMDC (Municipality of the Central District), the jurisdiction of which covers the entire metropolitan area of Tegucigalpa, is the institution responsible for the provision of solid waste management service for the city. The solid waste collection, transport and final disposal is a service that is indispensable for the sustainability of an urban environment.

Based on the above discussion it is evident that the most significant environmental institutions for the Tegucigalpa metropolitan area are SERNA, SANAA and AMDC.

3.2 ENVIRONMENTAL LAWS, REGULATIONS AND STANDARDS

3.2.1 ENVIRONMENTAL LAWS AND REGULATIONS

(1) General Law of the Environment (June 1993)

The Art 5 of this general environmental law establishes that the projects, industrial installations or any other public or private activity, susceptible of contaminating or degrading the environment, natural resources or the nation's historic-cultural patrimony, shall be preceded by an Environmental Impact Evaluation, which allows to mitigate potential adverse environmental effects. Accordingly, consequent to these evaluations, it is mandatory to carry out the environment and natural resources protective measures in the execution phase and during the life span of works and installations.

Basically concerning disaster mitigation, as per the Art. 28, the Executive Power, by means of the Secretary of State in the Office of the Environment and the other Secretaries of State and competent decentralized institutions, is responsible for the following:

1. The prevention and control of disasters, emergencies and other environmental contingencies that impact negatively in a part or in the whole national territory;
2. The classification of the hydrographic basins;
3. The implementation of the National System of Basins, considering the natural resources in general

Moreover, the Art. 48 stipulate that the lands of the national territory should be used in a rational and compatible way with their natural vocation and the Art. 50 declare that the soils that are located in steep slopes lands, which use may lead to erosion or landslides, will stay with permanent vegetative cover.

It is enunciated in the Art. 51 that the use of the urban land will be object of planning by the respective municipalities. This planning will include the regulation of the construction and the development of housing programs, the appropriate localization of the public services and the roads of urban communication, the localization of green areas and the forestation of the public roads.

The Art. 65 specifies that stone and sand extraction will be conditioned to technical norms of conservation, which are established by the respective regulation of the present law, to mitigate adverse impacts these activities can induce to the environment.

The Art. 66 describes that solid and organic residuals arising from domestic, industrial or agricultural sources, cattle raising, mining, public and other uses, will be technically treated to avoid alterations in soils, rivers, lakes, lagoons and in general in the marine and terrestrial waters, as well as to avoid atmospheric pollution.

The Art. 78 stipulates that natural or juridical, public or private people who want to carry out any work or susceptible activity that might alter or seriously deteriorate the environment, including the natural resources, are obligated to inform to the competent authority on the matter and to formulate an Environmental impact assessment (EIA) in accordance with the Art. 5 of this Law. Within these activities are urban developments and human settlements.

The Art. 101 establishes that Territorial Classification Plans will be developed for appropriate land use of forest, agricultural, cattlemen and coastal lands to guarantee sustainable development, conservation, protection and appropriate use of the national territory. The Secretary of Environment and Natural Resources will be responsible for preparation of these plans.

The Art. 103 set down the right of population to be informed on environmental conditions and about the operations and actions undertaken in this field, by governmental institutions and the municipalities.

(2) General Regulation of the Law of the Environment (December 1993)

The Art. 7 of this regulation declare that public interest be integral in the classification of the national territory, considering environmental aspects and the economic, demographic and social factors. To this effect, integral land use classification will be formulated, establishing the guidelines, approaches, methodologies and priorities for the use of forest, agriculture, pasture, mangrove and coastal lands in order to guarantee sustainable development, conservation, protection and restoration of the environment and the natural resources.

The Art. 10 recognizes as a right and duty citizens are entitled to participate in all the activities that might be developed by the State and its agencies to protect, conserve and restore the environment and the natural resources. State and its agencies will also be entitled to report on the status of environment and the natural resources.

The Art. 13 set down the functions of the Secretary of the Environment. The main functions are:

1. To collaborate with the competent institutions in the prevention and control of disasters, plagues, emergencies and other environmental contingencies that might affect the national territory.
2. To provide technical collaboration to all state or private agencies, for the execution of activities aimed to preserve, to conserve and to restore the environment and the natural resources.

3. To dictate and execute all necessary measures to preserve, conserve and restore the Environment and the natural resources.

The Art. 78 determine the obligation of the Secretary of the Environment to participate jointly with COPECO'S Permanent Commission of Contingencies, on natural disasters plans for its prevention, mitigation, attention and rehabilitation. Moreover, Art. 80 establishes that the Secretary of the Environment, in coordination with the National Emergency Committee (COPECO) and other related institutions, will identify the country's most critical and vulnerable areas to disasters, in order to formulate disaster mitigation measures.

(3) Code of Health (June 1991)

Responsibilities of the Secretary of Health for disasters and emergencies are established in Article 185, and these are:

To carry out an immediate survey to preliminarily define the magnitude of damage to health, establishing the number of deaths, wounded and sick people;

To establish a simple and fast system of notification about the occurrence of deaths, based on the characteristics of the disaster or emergency;

To verify that affected and displaced people are located in appropriate places and are provided with shields, food and safe drinking water;

To determine the causes of the disaster and to evaluate their possible repetition and/or complications;

To identify additional risks in the area that could complicate the situation of those affected and displaced people; and,

To design with a multisectoral team, the integral restoration of damages.

The Art. 186 establishes that representatives of public or private agencies in charge of public services will analyze the vulnerability of the facilities or people under their dependence, towards the different types of disasters that can occur in their influence areas. The National Permanent Commission of Contingencies (COPECO) will point out other special cases in which it is necessary to carry out vulnerability analysis.

According to the Art. 187, besides the functions established in the Decree 9-90-E (Dec. 1991) the COPECO, is responsible for the coordination of actions delegated to other agencies for intervention during the occurrence of emergencies and disasters. In each Department and Municipalities, Emergency Committees will be constituted with the integration, competition and attributions that COPECO determines. Within all the committees there must be a representative of the Secretary of Public Health.

It is established in Art. 188 that COPECO, in coordination with the national competent authorities, will establish information systems and teams for diagnosis and risks prevention measures originated by disasters.

The Art. 192 specifies that the Secretary of Health will coordinate training programs for contingency plans in sanitary aspects linked to urgencies or disasters. COPECO, will oversee and manage the relevant training exercises.

The Art. 193 establish that all alarm systems used as mechanisms of emergency warning and disasters will complete the requirements and norms that COPECO sets up.

The Art. 194 enunciate that during the evaluation of measures for emergencies and disaster prevention, priority will be given to health and environmental sanitation.

(4) Law of Municipalities (November 1990)

The Law of Municipalities, grants to the Municipal Corporation (Art. 25) the faculty that under certain circumstances and conditions, it may declare Public Emergency or Calamity Status in its own jurisdiction, when necessary and to order appropriate measures.

The Law of Municipalities through the Ordinance No. 134-90 grant to the municipalities autonomy and abilities for the creation of instances to support the municipal administration, as that they assure community participation in the solution of municipal problems. In this respect, Art. No.25, chapter III related to the Municipal Corporation and its functioning, confers the ability to create, terminate, modify and/or transfer administrative units; as well as to create and terminate companies, foundations and associations in a combined form for the provision of municipal services.

(5) Temporary Law for Uninhabitable Areas (December 1998)

The Art. 1 of this Law prohibits the construction of housings, residence buildings and industrial plants in the areas located in the river or creek beds and in areas with geologic faults, undercuts, landslides, hillsides with unstable soils and contention borders that were affected by the Hurricane Mitch. The respective Municipality should elaborate in three (3) months, starting from the validation date of the present Law, a complete study to define its uninhabitable areas. This study has to be done by qualified specialists.

The municipalities will finance the costs of these studies. Those municipal corporations with not enough financial capacity shall request assistance to the Central Government and other Institutions to fulfill their responsibility. Also the Art. 2 establishes that the State could use donations from friendly state to cover the expenses to execute municipal studies referred in the above Art. 1.

(6) Law of Contingencies (December 1990)

The COPECO will be ruled by its Organic Law and its regulation, which is constituted by the following titles:

Title I: Which refers to the Conceptualization.
Title II: Which refers to the Permanent Commission of Contingencies, creation, headquarters, and goals.
Title III: Of its Organization and Functions.
Title IV: Of the National Commissioner.
Title V: Which refers to the patrimony of the COPECO.
And two Titles VI and VII: Referred to the General Dispositions

COPECO will also be ruled by its respective regulations and by other laws of the country. In the Chapter 1, Art. 1, - it is referred that the COPECO is the organ responsible for coordinating the efforts of the public and private sectors to plan, organize, direct, to execute and control the actions guided to prevent and to offer aid to population sectors threatened which are victims of the problems caused by the alteration of natural phenomenon in the country, or order agents, those

that in accordance with its magnitude are qualified as emergencies, disasters or calamities.

Also, COPECO will have as its fundamental purpose in the adoption of policies, strategies and overwhelming measures to channel financial, human and material resources, guided to assist the population affected by the incidence of natural phenomenon and other agents.

(7) Forest Law (November 1971)

The Art. 42 establishes that in the protected forest areas no acts will be allowed that can change the vegetation, the wild life, the landscape, the soil, or the reduction of the waters etc. The State's Forest Administration will give priority in its work programs to the mitigation against fires etc.

In the Art. 45 the acts prohibited in all the public forest areas, in the private forest areas of special regime and in the declared "Fire Danger Areas" are listed; these are:

Clearings
Bush burns
Shepherding
The cut, timber, barking of any kind of vegetation
The obtaining of resins, rubbers and other vegetable extracts
The use and extraction of wood or other forest products.

The Art. 49 enunciates that the municipalities that are in Fire Danger Areas will be forced to contribute people (man power) for the protection against forest fires.

(8) General Forest Regulation (April 1984)

The Art. 48 establishes the considerations for the creation of protected forest areas; one of these considerations is:

The mountainous terrain where runoffs that put in danger towns, agricultural crops, industrial facilities, communication roads and other similar ones originate.

3.2.2 ENVIRONMENTAL STANDARDS

A draft water quality standards, formulated by the Ministry of Health based on intended beneficial use of water, which is applicable to all types of fresh waters including surface waters of rivers and streams, is available. As per this draft standards the water quality requirement is specified for five (5) categories of intended beneficial water use, namely, source of potable water supply, agriculture and livestock use, aquaculture use, flora and fauna conservation (basic water quality) and recreational use. The relevant standards for each of these 5 beneficial use categories are given in APPENDIX E.1.

It is noted that for the urban river reaches of Tegucigalpa, rivers in the Target Area of this Master Plan, as the minimum water quality requirement to conform to this standards, the basic water quality for the conservation of flora and fauna could be considered as applicable. Accordingly the water quality in the urban river reaches of the city of Tegucigalpa needs to have a BOD level that would not exceed 15 mg/l so that aquatic fauna and flora could survive and hence the rivers are not ecologically dead, their current status as illustrated in the foregone Chapter 2.

The river stream water quality requirement of 15 mg/l, could be realized if the direct discharging of untreated wastewater into the rivers is eliminated and instead the wastewater being treated in wastewater treatment plants to a minimum of secondary treatment level prior to their discharge

into rivers as noted in Item 3 of foregone Section 2.4.

4. INITIAL ENVIRONMENTAL EXAMINATION (IEE)

4.1 MASTER PLAN

The Master Plan is essentially aimed at disaster mitigation in the metropolitan area of Tegucigalpa, a very important basic need to ensure the sustainability of an urban environment. The Target Area of this disaster mitigation Master Plan is the core of the existing and developing core of the city center and its vicinity covering an area of 105 km2. Accordingly, it could be visualized that the Master Plan is aimed at long-term environmental enhancement of the urban area of Tegucigalpa resulting in overall improvement in safety and security of the urban environment in comparison to the baseline (existing) environmental condition.

The disaster mitigation measures of the Master Plan are composed of both structural and nonstructural measures of flood control and landslide prevention. The formation of a hazard map that would delineate potentially vulnerable areas prone to flooding and landslide disaster would be the basic component of the nonstructural measure of disaster mitigation. Still structural measures within the context of financial viability are planned for important areas of the city.

4.2 INITIAL ENVIRONMENTAL EXAMINATION (IEE)

This IEE is confined to those areas targeted for structural measures of flood control and landslide prevention as per this Master Plan. The significant areas targeted for flood control structural measures are the Choluteca River reaches between C27 and C98 and at Point C-150, and outlet of the Pescado Lake. The significant areas targeted for landslide prevention structural measures are the sloping terrains of Berrinche, Bambu and Reparto.

(1) Structural Facilities of Landslide Prevention

The structural facilities of landslide prevention are simple and could be flexibly provided in the intended area to be protected. Accordingly potential adverse environmental effects of such facility installation are considered as insignificant even on a short-term basis in the vicinity of the areas targeted for such facility provision. The structural facilities of landslide prevention, in total, are basically composed of the following simple structural elements;

- Earth works
- Gabion walls (mat gabions)
- Drainage wells
- Drainage canals

The drainage wells and canals are aimed at lowering the groundwater table thereby mitigating the formation of saturated soil condition in the surface layer of a sloping terrain during heavy rainfall, the major causative condition for a potential slope failure. Earth work helps to stabilize the slopes. Gabion wall protects slopes from failure. Provision of these facilities do not require extensive land area and hence normally would not require significant land acquisition or housing compensation due to resettlement of population except for several houses in Reparto.

Accordingly any potential adverse environmental effects due to the provision of structural

facilities of landslide prevention is considered as not very significant irrespective of the facilities provided and their location.

(2) Structural Facilities of Flood Control

In contrast to landslide prevention structures the structural facilities of flood control are of large scale with potential adverse environmental effects and hence duly assessed so as to minimize adverse environmental effects. The structural facilities (measures) of flood control, in total, are basically composed of the following;

- River improvement works of deepening and widening of the target river reaches
- Revetment construction in the target river reaches
- Reconstruction of bridges in the target river reaches

It is noted that river widening works is limited to the Berrinche area only and would not require any significant land acquisition, housing compensation or resettlement of population.

The deepening works of rivers may result in the removal of potentially contaminated sediments of the riverbed that may not be amenable to uncontrolled disposal. It is noted that at least the surface layers of the riverbed in the city reaches may be potentially contaminated as the rivers have been functioning as open sewers and are also severely polluted.

The above two aspects of land acquisition cum housing compensation of landslide prevention works and management requirement of potentially contaminated sediments derived from the river beds due to river deepening works are identified as the most significant environmental concerns that need to be addressed in the subsequent environmental impact assessment (EIA) study for the Feasibility Projects of this Master Plan. It is considered that with emphasis on these two environmental concerns during the subsequent EIA study potential adverse environmental effects of the Feasibility Projects could be mitigated.

Finally screening and scoping of IEE for the Master Plan are given respectively in *Table E.4.1* and *Table E.4.2*.

5. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

5.1 INTRODUCTION

Environmental Impact Assessment (EIA) study was conducted for the Priority Projects of flood control and landslide prevention as identified by the Master Plan, for the adoption of structural measures. These Priority Projects identified by the Master Plan are targeted for Feasibility Study (F/S). The EIA study was conducted conforming the relevant regulations and guidance of DECA (Directorate of Environmental Evaluation and Control) of SERNA (The Ministry of Natural Resources and Environment).

The F/S Projects of EIA study are as follows;

(1) Flood control projects

1) River improvement in about 2 km river reaches of the Choluteca River in Berinche area and its upstream (the reaches in between C40 and C65)

2) Outlet improvement of the Pescado Lake (Laguna de Pescado)

(2) Landslide prevention projects

1) Landslide prevention structures in Berinche Area
2) Landslide prevention structures in Bambu Area
3) Landslide prevention structures in Reparto Area

The EIA study was aimed at determining the impact on natural, physical and social environment of the project areas and their surrounding, to identify measures to minimize adverse environmental effects and also to enhance beneficial effects so that the project's suitability for its environment is enhanced. The EIA study was conducted by a multi-disciplinary team of Honduras Experts composed of Team Leader/Environmental Engineer, Biologist, Environmental/Water Quality Specialist, Sociologist and Archeologist, in tandem with the Feasibility Study (F/S) during September – November 2001.

5.2 STUDY METHODOLOGY

5.2.1 DATA COLLECTION

(1) Secondary Data

Due to the limited available effective time of only 2 months to the conduct of the EIA study, available secondary data, in particular with respect to river water quality and biota (fauna and flora), in conjunction with judicial field verification were principally used to determine the overall current environmental status of the project areas of F/S and their vicinity.

(2) Primary Data

1) River Environment

Riverbed material quality sampling and analysis work in a total of five (5) locations of the Grande-Choluteca River reaches was conducted as the most significant primary data collection work. The 5 sampling locations were distributed along the river reaches as follows:

Location No.1 (P1) in Malalaja located at about 5 km downstream of Concepcion Dam of the Grande River as the control representative of clean riverbed (sediment) material quality,

Locations Nos. 2, 3 and 4 (P2, P3 and P4) in the planned river improvement, and hence river bed material excavation and removal, reaches of the Choluteca River (C40-C65) by the Berinche area flood control project, namely, Baileys/Juan Ramon Molina Bridge (P2), Soberania Bridge (P3) and El Chile Bridge (P4),

Location No. 5 (P5) behind the CADECA chicken farms, the planned spoil-bank area for the disposal of excavated river bed material, at further downstream of the Choluteca River along the boundary of the Target Area of this Master Plan.

The 4 sampling locations of P2-P5 located within the targeted river improvement reaches (P2-P4) and spoil-bank area (P5) of the Choluteca River are shown in *Fig. E.5.1*.

This riverbed material quality survey was aimed at determining the potential contamination of excavated material from riverbed due to river improvement works and hence to determine the appropriateness of the spoil bank area for the disposal of excavated riverbed material.

The sediment quality parameters analyzed in laboratory for all 5 samples comprised of the following;

Parameters; Water content (WC), Ignition load/ash remains (IL), Total organic carbon (TOC), Chemical oxygen demand (COD), Total nitrogen (T-N), Total phosphorus (T-P) and 8 heavy metals of Cr (chromium), Ni (nickel), Cu (copper), Zn (zinc), Cd (cadmium), Hg (mercury), Pb (lead) and As (arsenic).

The results of analysis of riverbed material quality are shown below in *Table E.5.1*.

Table E.5.1 Results of physical, organic (A) and heavy metal (B) contents measured in Choluteca and Grande River bed sediments

Physical and organic parameters (% DW)						A
Location	**WC**	**IL**	**TOC**	**T-N**	**T-P**	**COD**
P1 (Malalaja)	21.62	82.45	1.49	0.04	0.01	1.22
P2 (Juan Ramon Molina bridge)	24.52	80.33	1.74	0.04	0.02	1.38
P3 (Soberania bridge)	24.13	75.35	1.48	0.03	0.02	1.06
P4 (El Chile bridge)	40.05	62.79	2.55	0.10	0.04	4.27
P5 (CADECA)	21.88	78.89	3.03	0.08	0.05	0.73

Heavy metals (mg/Kg DW)								B
Location	**Hg**	**As**	**Zn**	**Cr**	**Ni**	**Cu**	**Cd**	**Pb**
P1	*	0.4	8.0	1.0	5.0	1.0	*	1.0
P2	*	0.5	5.0	*	20.0	2.0	*	2.0
P3	*	1.0	10.0	1.0	10.0	*	*	1.0
P4	*	1.0	2.0	*	30.0	1.0	*	2.0
P5	*	4.0	2.0	1.0	20.0	*	*	2.0

* = not detected DW= dry weight

The riverbed material quality results of above indicate no significant variation in overall quality of riverbed material throughout the 5 sampling locations, including the control (representative of clean riverbed) location of P1 (Malalaja in River Grande).

Notable spatial variation in physical and organic quality of riverbed is only with respect to WC (range of about 22-40%) and COD (range of about 0.7-4.3%). Concerning heavy metallic elements, which are most significant indicators of accumulative and persistent pollution level of sediments (riverbed material), in fact the elements of Cd and Hg were not detected. Of the remaining 6 measured elements, significant spatial variation in heavy metallic quality was noted with respect to the 3 elements of As (range of about 0.4-4 mg/kg), Zn (range of about 2-10 mg/kg) and Ni (range of about 5-30 mg/kg).

Still, all heavy metallic elements measured in all 5 locations of sediment (riverbed material) sampling fell within the reference level, indicating the maximum limit of naturally existing level, of dredged material quality standards of Netherlands as reported in World Bank Technical Paper No. 126 (1990) and also well within the standards of US EPA. Accordingly, the riverbed material of the Choluteca River is assessed as uncontaminated.

2) Social Environment

Land/home ownership, housing condition, population composition and social condition (occupation, income, utilities etc) survey of those people living in the project areas were

conducted as the means of determining the social impacts, and hence the required impact mitigation measures, due to inevitable land acquisition and housing relocation/compensation, if any, consequent to the implementation of the project facilities.

The social environmental survey identified a maximum of 31 houses would require resettlement consequent to the project implementation. These houses are located in Berrinche area (19 houses) and Reparto area (12 houses). Moreover, of these 31 households requiring resettlement, all 19 in Berrinche area and 3 in Reparto area (a total of 22 houses) are identified as low-income households.

5.2.2 STUDY MANAGEMENT

The EIA study team, including the JICA Environment Expert, held weekly progress meeting at the office of Environment Unit of SOPTRAVI, the principal agency representing the project implementing organization. In these meetings the progress of work and other relevant issues concerning the conduct of the EIA study were discussed so that the EIA report would be formulated to the satisfaction of important stakeholders. The other organizations represented in these meetings in addition to the Environment Unit of SOPTRAVI are SERNA and SANAA.

5.3 REPORTING OF EIA STUDY

The EIA Report was organized as a separate document in both English and Spanish and composed of following 7 chapters with significant contents in each chapter.

(1) Introduction (Chapter 1)

1) The objective and scope of the study
2) The regulations used in the EIA study
3) EIA implementing organization and specialists

(2) Used methodology (Chapter 2)

1) Field investigation
2) Interviews
3) Environmental analysis
4) Methodology for sediment analysis

(3) Institutional and legal frame enforced in Honduras in the Study Area (Chapter 3)

1) Institutional frame
2) Legal frame
3) Technical frame

(4) Baseline description (Chapter 4)

1) Physical resource
2) Biological resource
3) Social environment

(5) Project description (Chapter 5)

1) Project relevance

2) Description of flood control and landslide prevention works
3) Execution schedule and project cost

(6) Environmental impact assessment (Chapter 6)

1) Environmental sensibility analysis
2) Environmental impacts during construction phase
3) Environmental impacts during post-construction phase

(7) Mitigation measures of environmental impacts (Chapter 7)

1) Description of mitigation and compensation measures
2) Mitigation measures of environmental impacts

5.4 FINDINGS OF EIA STUDY

In overall, implementation of the project facilities of Flood Control and Landslide Prevention in Tegucigalpa would lead to long-term environmental and social benefits. Most of the potential adverse environmental effects, that are inevitable, are confined to the construction stage of the project and identified as not that significant and manageable. In this respect the environmental impacts and their mitigation measures identified are illustrated in APPENDIX E.2. The most significant aspects on the findings of the EIA study are itemized below.

1. The riverbed material along the river reaches of the Choluteca River is found to be not contaminated with heavy metals (ref. Section 5.2.1) and hence disposal of dredged material, consequent to the river improvement and deepening works in the target river reaches of the Choluteca River, at further down stream behind the CADECA chicken farm area of the Choluteca River would not cause any significant long-term adverse environmental effects.

2. Requirement of resettlement of 31 houses, as the maximum, is an important social adverse effect of this project implementation and be given due consideration by the relevant authorities of SOPTRAVI and AMDC, and be solved amicably with the affected households. In this respect since 22 of the identified households are of low income, provision of improved housing at alternative locations for these low-income households, instead of monetary compensation, is recommended. Still since the houses slated for resettlement are of low in numbers it is considered as manageable.

5.5 CONCLUSION AND RECOMMENDATIONS

5.5.1 CONCLUSION

It is concluded that the implementation of the planned project facilities would lead to long-term overall environmental improvement of the urban metropolitan area of Tegucigalpa. In fact based on its very aim of disaster mitigation the project could be classified as an environmental improvement project.

5.5.2 RECOMMENDATIONS

An effective replantation/reforestation of areas temporarily affected by the implementation of construction works of the project facilities is recommended to be undertaken promptly following the completion of construction works.

It is further emphasized that the current poor environmental status of river water environment of Tegucigalpa requires due attention so as to realize long-term riverine ecological improvement of Tegucigalpa. The required environment improvement measures as summarized in Section 2.4 essentially involve improved management of all wastes, both liquid and solid, arising from the miscellaneous anthropogenic activities in the city of Tegucigalpa. The required projects and programs to improve waste management of Tegucigalpa city are recommended to be initiated.

Table E.2.1 Bacteriological and Chemical Characteristics of Surface Water in the Tegucigalpa Metropolitan Area

No.	Name of the Source/Location	Date of Analysis	Fecal Colli Col./100 ml	BOD_5	COD	NO_2 (mg/l)	NO_3 (mg/l)	$N\text{-}NH_3$ (mg/l)	Sus-S.	Sed.-S.	Conduct. Microsiem/cm	Total Phosphorus mg/l	Oils and Greases mg/l
1	Choluteca R., under Germania Br., Col. Loarque	Feb/22/00	22,400	27.32	133.40	0.050	2.280	0.210	300.000	0.800	420.00	13.20	866.30
2	Qda. Grande del Sur, under CAMOSA Br.	Feb/22/00	378,200	69.30	319.80	0.010	0.390	9.400	10.000	0.200	530.00	42.50	14.70
3	Qda. Agua Salada, under Miraflores Br.	Feb/22/00	135,000	133.65	339.20	0.010	2.060	10.500	30.000	0.200	1000.00	89.10	36.90
4	Choluteca R., under TOYOTA Co. Br	Feb/22/00	146,400	59.40	263.30	0.010	0.550	10.700	10.000	0.200	680.00	63.10	35.80
5	Guacerique R., by Guacerique Shell gas station	Feb/22/00	109,800	87.12	301.10	0.000	0.000	10.400	10.000	0.000	690.00	61.80	8.30
6	Choluteca R., under Mallol Br.	Feb/22/00	854,000	55.80	229.10	0.000	0.860	11.300	60.000	0.100	810.00	70.02	50.10
7	Qda. Seca, under Morazan Br.	Feb/22/00	82,000	133.65	323.50	0.000	6.000	9.900	20.000	0.200	1300.00	91.70	39.00
8	Chiquito R., under C.P. Br.	Feb/22/00	488,000	68.31	346.50	0.000	2.160	9.300	20.000	0.400	1100.00	75.00	154.90
9	Qda. El Sapo, under Cemetery Br.	Feb/22/00	196,100	297.00	677.60	0.050	3.950	15.100	250.000	5.600	1060.00	143.74	75.30
10	Choluteca R., under El Chile Br.	Feb/22/00	305,000	103.95	314.30	0.050	3.250	10.400	30.000	0.200	870.00	77.50	9.70

No.	Name of the Source/Location	Date of Analysis	Fecal Colli Col./100 ml	BOD_5	COD	NO_2 (mg/l)	NO_3 (mg/l)	$N\text{-}NH_3$ (mg/l)	Sus-S.	Sed.-S.	Conduct. Microsiem/cm	Total Phosphorus mg/l	Oils and Greases mg/l
1	Choluteca R., under Germania Br., Col. Loarque	Apr/05/00	17,800	37.44	297.60	0.000	2.270	0.540	1660.00	80.600	600.00	41.11	0.27
2	Qda. Grande del Sur, under CAMOSA Br.	Apr/05/00	0	344.40	640.70	0.010	5.450	1.220	440.000	8.000	600.00	23.65	11.50
3	Qda. Agua Salada, under Miraflores Br.	Apr/05/00	3,172,000	146.50	333.00	0.010	1.870	30.900	230.000	2.200	1050.00	14.20	11.94
4	Choluteca R., under TOYOTA Co. Br	Apr/05/00	0	61.60	141.90	0.010	1.900	26.600	84.000	1.500	890.00	26.16	24.84
5	Guacerique R., by Guacerique Shell gas station	Apr/05/00	366,000	69.20	263.93	0.010	3.080	22.050	110.000	1.800	880.00	16.10	24.80
6	Choluteca R., under Mallol Br.	Apr/05/00	1,600	91.40	303.61	0.000	1.090	28.100	112.000	2.000	880.00	17.21	16.80
7	Qda. Seca, under Morazan Br.	Apr/05/00	14,200	150.00	410.54	0.000	0.890	15.600	250.000	1.500	2150.00	183.50	50.60
8	Chiquito R., under C.P. Br.	Apr/05/00	2,928,000	126.15	363.16	0.000	0.530	33.000	370.000	3.500	1250.00	105.85	157.00
9	Qda. El Sapo, under Cemetery Br.	Apr/05/00	3,416,000	192.40	616.18	0.010	2.210	26.900	150.000	5.000	920.00	31.00	40.46
10	Choluteca R., under El Chile Br.	Apr/05/00	2,684,000	177.60	601.76	0.010	0.840	22.600	270.000	1.700	1050.00	18.70	1018.10

No.	Name of the Source/Location	Date of Analysis	Fecal Colli Col./100 ml	BOD_5	COD	NO_2 (mg/l)	NO_3 (mg/l)	$N\text{-}NH_3$ (mg/l)	Tot-S.	Dis.-S.	Conduct. Microsiem/cm	Turbidity NTU	pH
1	Sabacuante R., near Santa Rosa village	Jun/30/00	920	0.00	51.20	0.020	2.460	0.560	132.000	130.000	260.00	2.10	8.39
2	Guacerique R., near Las Tapias village, Mateo	Jul/21/00	1,760	3.00	10.00	0.030	1.830	0.096	95.000	54.000	190.00	7.80	7.51
3	Choluteca R., near Barrio El Chile	Sep/18/00	30,500	13.00	100.00	0.080	3.000	0.620	560.000	82.500	165.00	130.00	7.06

Col. = Number of colonies
BOD_5 = Biochemical Oxygen Demand 5 days
COD = Chemical Oxygen Demand
NO_2 = Nitrite
PH = Potential Hydrogen
Tot-S = Total Solids
Dis-S = Dissolved Solids
Conduct. = Conductivity
NO_3 = Nitrate
Sed-S = Sedimented Solids
Sus-S = Suspended Solids
$N\text{-}NH_3$ = Ammonia Nitrogen
NTU = Turbidity Nephelometric Unit

Source: Water Quality Department; SANAA

Supporting-E : Environmental Aspects

Table E.2.2 (1) Chemical Characteristics of Surface Water in Tegucigalpa Metropolitan Area (Laboratory Analysis Results)

No.	Name of the Source/Location	Date of Analysis	BOD_5 (mg/l)	COD (mg/l)	NO_2 (mg/l)	NO_3 (mg/l)	$N\text{-}NH_3$ (mg/l)	Sed-S (ml/l/h)	Ortho – Phosphates (mg/l)	Alkalinity (mg/l) $CaCO_3$	Turbidity (NTU)	pH
1	Choluteca R., under Mallol bridge	Dec/08/	107	133	<0.01	7.04	21	0.1	1.9	22	89	7.3
2	Choluteca R., under Soberania bridge	Dec/08/	1293	1293	N.D.	4.4	92	D.N.S.	1.4	21	91	7.3
3	Chiquito R., near C.P., Barrio La Hoya	Dec/09/	1187	1492	0.23	5.3	239	0.2	2.6	29	129	7.7
4	Choluteca R., 20 m after the dike	Dec/09/	116	316	N.D.	3.5	26.5	D.N.S.	1.26	21.3	58	7.1
5	Guacerique R., at confluence with Choluteca R.	Dec/09/	331	379	N.D.	4.8	20	1.5	2.2	17	123	7.4

Table E.2.2 (2) Characteristics of Surface Water in Tegucigalpa Metropolitan Area (Field Analysis Results)

No.	Name of the source/Location	Date of Analysis	Depth (m)	Sampling depth (m)	Temperature °C	Dissolved Oxygen mg/l
1	Choluteca River, under Mallol bridge	Dec/08/98	2.5	1.0	24.1	0.31
				Surface	24.5	0.38
2	Choluteca River, under Soberania bridge	Dec/08/98	3.5	1.5	24.5	0.35
				Surface	25.0	0.46
3	Chiquito River, near C.P., Barrio La Hoya	Dec/09/98	0.3 – 0.4	Surface	21.5	5.36
4	Choluteca River, 20 m after the dike	Dec/09/98	0.5	Surface	22.2	1.42
5	Guacerique R., at confluence with Choluteca R.	Dec/09/98	1.0 approx.	Surface	22.5	1.46

*N.D. = Not Detectable

**D.N.S. = Did Not Sediment

Source: SERNA, CESCCO *{Center for the Study and Control of Pollutants}*

Table E.4.1 Screening (Flood Control and Landslide Prevention)

Environmental Item			Description	Evaluation	Remarks（reason）
Social Environment	1	Resettlement	Resettlement due to land occupancy (transfer of rights of residence/land ownership)	Y	Reparto landslide prevention
	2	Economic Activities	Loss of base of economic activities, such as land, and change of economic structure	N	
	3	Traffic and Public Facilities	Impacts on schools, hospitals and present traffic conditions, such as the increase of traffic congestion and accidents	Y	Traffic for civil works
	4	Split of Communities	Community split due to interruption of area traffic	N	
	5	Cultural Properties	Damage to or loss of value of churches, temples, shrines, archeological remaining or other cultural assets	Y	Mallol Bridge
	6	Water Rights and Rights of Common	Obstruction of fishing rights, water rights, rights of common	N	
	7	Public Health Condition	Worsening of public health and sanitation conditions due to the generation of garbage and the increase of vermin	N	
	8	Waste	Generation of construction waste, debris and logs	Y	Civil works
	9	Hazard(risk)	Increase in danger from ground failures, caverns, etc.	N	
Natural environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation or filling work	N	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and deforestation	N	
	12	Groundwater	Lowering of the groundwater table due to over drafting and turbid water caused by construction work	Y	Drainage works
	13	Hydrological Situation	Changes of river discharge, flow velocity and riverbeds condition due to filling work and diversion channel	Y	Riverbed excavation
	14	Coastal Zone	Coastal erosion and change of vegetation due to coastal reclamation and coastal changes	N	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to change of habitat conditions	Not known	
	16	Meteorology	Changes of temperature, rainfall, wind, etc, due to large-scale reclamation and building construction	N	
	17	Landscape	Changes of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	N	
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles or factories	Y	Traffic of civil work
	19	Water Pollution	Pollution caused by the decrease of discharge or the inflow of sediment	Y	Riverbed excavation
	20	Soil Contamination	Contamination caused by discharge of diffusion of sewage or toxic substances	Not known	Riverbed excavation
	21	Noise and Vibration	Noise and vibrations generated by vehicles and pumping operations	Y	By civil works
	22	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	N	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	N	

Table E.4.2 Scoping

Environmental item			Evaluation	Reason
Social environment	1	Resettlement	B	Five houses to be resettled in Cacao River improvement
	2	Economic Activities	D	No effect
	3	Traffic and Public Facilities	D	No effect
	4	Split of Communities	D	No effect
	5	Cultural Properties	A	Historical structures in Centro and Comayaguela near the Choluteca River
	6	Water Rights and Rights of Common	D	No effect
	7	Public Health Condition	D	No effect
	8	Waste	B	Produced by civil works
	9	Hazard(risk)	D	No effect
Natural environment	10	Topography and Geology	D	No effect
	11	Soil Erosion	D	No effect
	12	Groundwater	D	Drainage work will lower the groundwater table
	13	Hydrological Situation	D	No effect
	14	Coastal Zone	D	No effect
	15	Fauna and Flora	C	To be checked in the field reconnaissance
	16	Meteorology	D	No effect
	17	Landscape	D	No effect
Pollution	18	Air Pollution	C	By civil works
	19	Water Pollution	B	By civil works
	20	Soil Contamination	C	To be checked in sampling and testing
	21	Noise and Vibration	B	By civil works
	22	Land Subsidence	D	No effect
	23	Offensive Odor	D	No effect

Note 1; evaluation categories:

A: serious impact is expected
B: some impact is expected
C: extent of impact is unknown(examination is needed. Impact may become clear as study progresses.)
D: no impact is expected. IEE/EIA is not necessary

Note 2; evaluation should be made with reference to the “explanation of item”

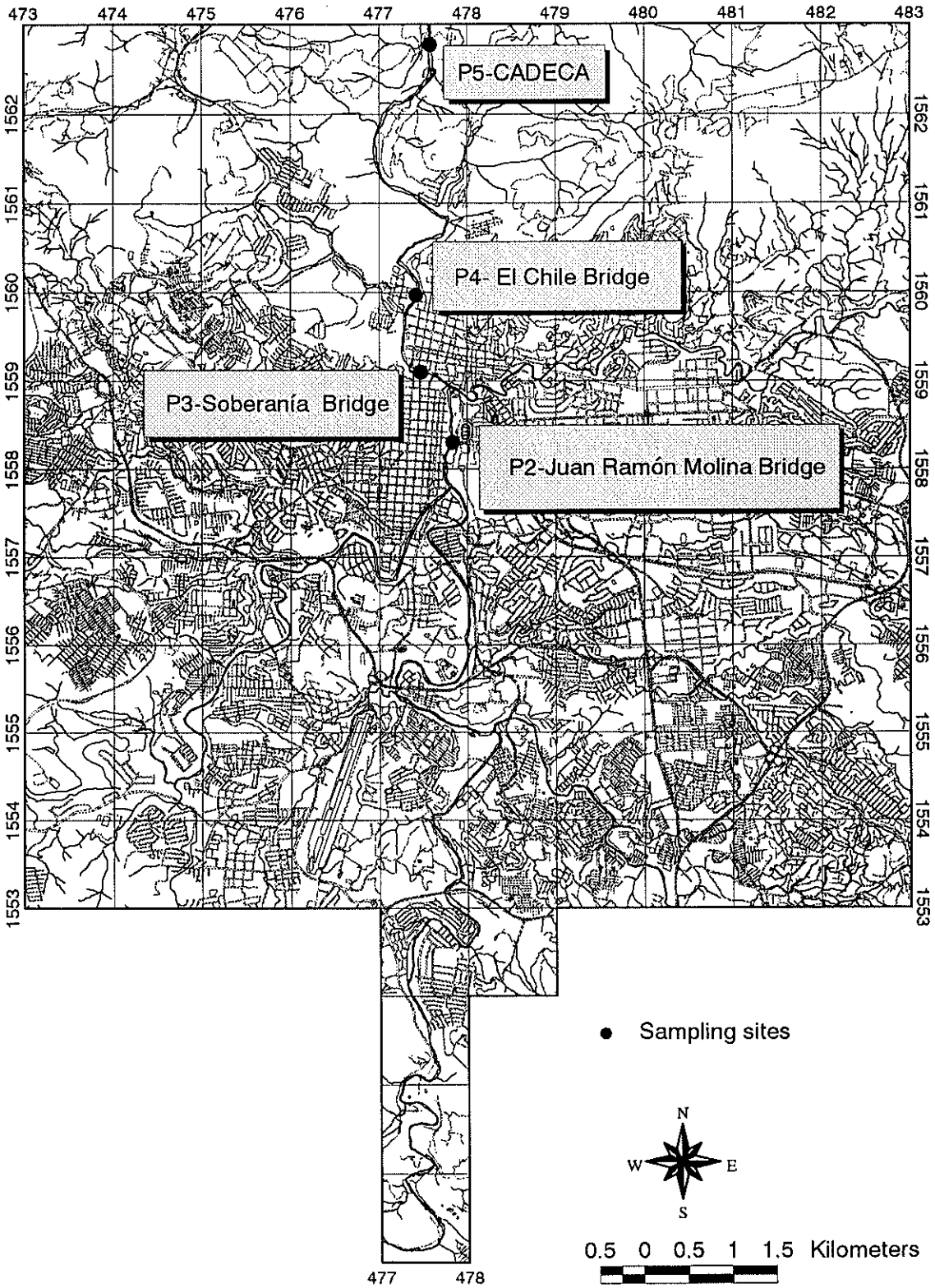

Figure E.5.1	Location of Sampling Sites of Riverbed Sediments

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SUPPORTING REPORT E

APPENDIX E

APPENDIX E.1

BENEFICIAL USE BASED WATER QUALITY STANDARDS

(DRAFT)

MINISTRY OF HEALTH

National Technical Standard for Potable Water Supply
Table # 1

Parameter	Category A: Disinfection Permissible Maximum Value mg/l	Category B: Conventional Treatment Permissible Maximum Value mg/l
Turbidity **(NTU)**	15.00	600.00
Color **(uc)**	15.00	800.00
pH	6.5-8.5	6.0-9.0
Conductivity **(µs/cm)**	1600.00	1600.00
Dissolved Solids	1000.00	1000.00
Dissolved Oxygen	5.00	4.00
BOD	3.00	6.0
COD	10.00	20.00
Ammonia Nitrogen	0.50	1.00
Nitrate	50.00	50.00
Nitrite	3.00	3.00
Ortho-Phosphates	0.10	0.50
Sulfate	250.00	400.00
Chloride	600.00	600.00
Aluminum	0.20	0.20
Iron	0.30	1.00
Manganese	0.50	1.00
Zinc	3.00	3.00
Copper	1.00	1.00
Nickel	0.02	0.02
Silver	0.05	0.05
Lead	0.01	0.05
Mercury	0.001	0.001
Cadmium	0.003	0.003
Total Chromium	0.05	0.05
Arsenic	0.01	0.05
Cyanide	0.07	0.07
Antimony	0.005	0.005
Fluoride	0.70	0.70
Selenium	0.01	0.01
Sodium	200.00	200.00
Hydrocarbon	0.05	0.05
Phenol	0.002	0.002
Total Coliforms **(MPN/100ml)**	500	10,000
Fecal Coliforms **(MPN/100ml)**	100	2,000
Alpha Activity **(Bq/l)**	0.1	0.1
Beta Activity **(Bq/l)**	1.0	1.0

Pesticides (For both categories, expressed in micrograms per liter)

Alacloro	20
Aldicarb	10
Aldrin/Dieldrin	0.03
Atrazin	2
Bentazon	30
Carnofuran	5
Clordan	0.20
DDT	2
1.2 – dibromo – 3.3 cloroprano	1
2.4 – D	30
1.2 – dicloropropano	20
1.3 – dicloropropano	20
Heptacloro and Heptacloepoxido	0.03
Isoproturon	9
Lindano	2
MCPA	2
Metoxicloro	20
Metolacloro	10
Molinato	6
Pendimetalina	20
Pentaclorofenol	9
Permitrina	20
Propanil	20
Pyridato	100
Simazina	2
Trifluralina	20
Dicloroprop	100
2, 4 – DB	100
2, 4, 5 – T	9
Siilvex	9
Mecroprop	10

National Technical Standard for Agricultural and Livestock Water Use

Table # 2

	Category A: Irrigation Water for Vegetables Eaten Raw mg/l	**Category B: Irrigation Water for other Type of Cultivation mg/l**	**Category C: Water for the Consumption of Minor and Major Livestock mg/l**
pH	6.0 – 9.0	6.0 – 9.0	6.0 – 9.0
Conductivity **(µs/cm)**	3000.00	3000.00	3000.00
Dissolved Solids	2000.00	2000.00	2000.00
Floating Material			Absent
Dissolved Oxygen	3.00	3.00	
BOD	50.00		
COD	150.00		
Nitrate	100.00		200.00
Nitrite			6.0
Aluminum	1.00	1.00	2.00
Iron	3.00	3.00	
Manganese	0.50	0.50	0.50
Zinc	3.00	3.00	3.00
Copper	0.20	0.20	0.50
Nickel	0.20	0.20	0.50
Silver	0.05	0.05	
Lead	0.10	0.10	0.10
Mercury	0.01	0.01	0.01
Cadmium	0.005	0.005	0.02
Total Chromium	0.05	0.05	0.10
Arsenic	0.10	0.10	0.10
Cyanide	0.20	0.20	0.20
Fluoride	0.70	0.70	0.70
Selenium	0.02	0.02	0.02
Berillium	0.10	0.10	
Cobalt	0.05	0.05	
Lithium	2.50	2.50	
Vanadium	0.10	0.10	
Boron	1.00	1.00	
Total Coliform **(MPN/100ml)**	5,000	10,000	5,000
Fecal Coliform **(MPN/100ml)**	1,000	2,000	1,000
Helmint eggs **(100ml)**	1	2	
Alpha Activity **(Bq/l)**	0.1	0.1	0.1
Beta Activity **(Bq/l)**	1.0	1.0	1.0

National Technical Standard for Aquaculture Water Use
Table # 3

Parameter	Permissible Maximum Value (mg/l)
pH	6.0 – 9.0
Dissolved Oxygen	3.00
Nitrite	0.50
Ammonia Nitrogen	0.50
Turbidity **(secchi – cm)**	45.00
Suspended Solids	80.00
Sulfurous Acid	0.019
Alkalinity	300.00
Total Hardness	300.00
Manganese	0.50
Zinc	0.50
Copper	0.05
Nickel	0.02
Lead	0.01
Mercury	0.001
Cadmium	0.003
Total Chromium	0.05
Arsenic	0.01
Cyanide	0.01
Fluorides	0.70
Boron	5.00
Phenol	0.002
Total Coliform **(MPN/100ml)**	5,000
Fecal Coliform **(MPN/100ml)**	1,000 per fish ponds
Fecal Coliform **(MPN/100ml)**	65 mollusks and oysters
Alpha Activity **(Bq/l)**	0.1
Beta Activity **(Bq/l)**	1.0
Organic-chlorated Pesticides	0.20
Organic-phosphorated Pesticides	0.10

National Technical Standard for Flora and Fauna Conservation (basic water quality)

Table # 4

Parameter	Permissible maximum Value mg/l
pH	4.5 – 9.5
Floating Material	Absent
Dissolved oxygen	3.00
BOD	15.00
COD	50.00
Ammonia Nitrogen	2.00
Nitrate	50.00
Nitrite	3.00
Sulfate	400.00
Manganese	0.50
Zinc	3.00
Copper	0.20
Nickel	0.20
Lead	0.10
Mercury	0.001
Cadmium	0.005
Total Chromium	0.05
Arsenic	0.05
Cyanide	0.07
Fluoride	0.70
Selenium	0.02
Hydrocarbon	0.20
Total Coliform **(MPN/100ml)**	25,000
Fecal Coliform **(MPN/100ml)**	5,000
Alpha Activity **(Bq/l)**	0.1
Beta Activity **(Bq/l)**	1.0
Organic-chlorated Pesticides	0.2
Organic-phosphorated Pesticides	1.0

Note: Recommended Standards for Urban River Reaches of Tegucigalpa

National Technical Standard for Recreational Water Use through Direct Contact and Indirect Contact
Table # 5

Parameter	Direct Contact Permissible Maximum Value mg/l	Indirect Contact Permissible Maximum Value mg/l
pH	6.0 – 9.0	5.5 – 9.5
Dissolved Oxygen	4.00	3.00
BOD	10.00	15.00
COD	30.00	50.00
Phenol	0.002	0.005
Total Coliforms **(MPN/100ml)**	5,000	10,000
Fecal Coliforms **(MPN/100ml)**	1,000	2,000
Salmonella **(/10,000 ml)**	0	
Fecal Streptococcus **(/100 ml)**	100	
Alpha Activity **(Bq/l)**	0.1	0.1
Beta Activity **(Bq/l)**	1.0	1.0

ANALYSIS METHODS
Table # 6

Parameter	**Analysis Method**
Turbidity	Nephelometric
Conductivity	Wheastone bridge
Total Dissolved Solids	Gravimetric
Suspended Solids	Gravimetric
pH	Potentiometer
Temperature	Visual with Thermometer
Color	Spectro-photometric Colorimetric
Floating Material	Visual with Specific screen
Dissolved Oxygen	Winkler Electrometric
BOD	5 day analysis at 20° C
COD	Colorimetry closed ebb Trimetric valoration closed ebb
Ammonia Nitrogen	Kjeldahhl Nesslerization Colorimetric (Diazotization)
Nitrite	Colorimetric (Cadmium reduction)
Nitrate	Ascorbic Acid
Ortho-Phosphates	Stannous chlorine Blue Metilene colorimetric
Sulfure	Iodimetric (Titrimetric) Turbidimeric
Sulfate	Gravimetrical with B clay chlorine
Chloride	Argentometric
Hydrocarbon	Gas chromatography
Fluoride	Spectro-photometric (spands)
Cyanide	Volumetric
Boron	Volumetric
Alkalinity	Volumetric
Total Hardness	Volumetric
Organic-chlorated Pesticides	Gas chromatography
Organic-phosphorated Pesticides	Gas chromatography

APPENDIX E.2

MITIGATION MEASURES OF ENVIRONMENTAL IMPACTS

Activities in the Choluteca River

Environmental Impacts	Mitigation Measures	Monitoring program		
		Frequency	**Indicator**	**Responsible**
Physical environment				
- Increase turbidity of the Choluteca River water - Air alteration as a result of dust and gas production due to combustion - Soil contamination due to leachates generated by extracted sediments from the riverbed - Noise and vibration due to heavy equipment mobilization	- Deviation and channeling of river - Control sediment and solid waste barriers - Heavy vehicle mobilization road in an orderly fashion - Security measures for the project personnel - Preventive maintenance measures of construction equipment - Supervision in environmental and construction works	- Continually during the project construction stage	- Detour and contention infrastructure built - Approved installation retention program of temporary sediments - Circulation program approved and implemented - Signed contract with the transportation companies and training of employees - Accident occurrence reduction - Monitoring maintenance plan for vehicles and equipment	- Employer - Environmental Engineer supervision

Environmental Impacts	Mitigation Measures	**Monitoring program**		
		Frequency	**Indicator**	**Responsible**
Biological Environment				
- Plant removal of the Choluteca river banks - Plague proliferation associated with stagnant waters - Damage to the aquatic and terrestrial ecosystems	- Reforestation and natural regeneration - Land leveling of working zone - Solid waste removal that store water, probable plague reproductive habitat - Periodic pesticide application - Reforestation of native plants in the schrub area destined as the dredged sediment deposit - Use of the bush of genus *Ulex sp.*, as heavy metal fixing plants in the midterm - Restore the river bed with its original rocky substrate giving regeneration habitat	- After the project - Continually during the project's construction phase	- Replanting of 9 Km of river bank - Implemented plague control program - Implemented reforestation program of the deposit area - 200 *Ulex sp* plants planted and removed incinerated in an annual term - Replacement of the river rocky substrate	- Employer

Environmental Impacts	Mitigation Measures	Monitoring program		
		Frequency	**Indicator**	**Responsible**
Social environment				
- Involuntary displacement of security areas - Affected public health due to dust and gas atmospheric emissions - Generation of construction wastes - Vehicle and pedestrian traffic obstructed - Urban landscape affected - Employment of local human resources - Indirect and temporal job opportunities	- Identification of relocation sites - Relocation and/or indemnization of affected families - Vehicle maintenance and supervision - Compactation of heavy equipment roads and ways - Preventive hygiene measures - Inclusion of security measures in: plastic lining over piled materials and its transportation in trucks. - Mask use for the personnel - Identification of waste material deposit sites and its convenient disposal - Vehicle and pedestrian circulation control, signaling and right of way control - Close working areas with fences having adequate signs - Ads in the media: radio, press and television - Job offering ads with preference for local intensive working human resources - Food hygiene and sanitary condition control in the project direct influence area	- During all the project construction stage	- Identified sites and approved of the affected ones - Negotiated indemnization amount - Vehicle maintenance plan approved - Frequent compaction program with access and circulation ways - Contracting of transport services providers - Industrial security plan for project workers - Way circulation reordering plan - Assignment of traffic authorities involved - Announcements before works begin - Laboral recruiting plan with divulged profile definition - Reduction of respiratory diseases in workers	- Employer, SOPTRAVI, MUNICIPALIDAD, MSP, Traffic General Direction

Environmental Impacts	Mitigation Measures	**Monitoring program**		
		Frequency	**Indicator**	**Responsible**
Cultural environment				
- Structural modification of historical monuments - Affectation of Historical landscape - Affectation of cultural monuments (El Calvario church)	- Technical study to be done by specialized institutions in the intervention areas of the project - To obtain authorization and get supervision from the IHAH, in the areas located within the Historical center of Tegucigalpa and Comayagüela. - Structural measures implementation to avoid damages of cultural monuments. - To define a security belt between the intervention areas in the riverbed and the existing cultural monuments - Use of construction materials with texture and rose color to get harmony with the traditional architecture of Tegucigalpa.	At the beginning of the construction phase and during the construction of works.	Technical study performed	- ICOMOS, Man Foundation (Institution from Tegucigalpa). - IHAH. - Project promoter - Contractor

Activities in the Riverine areas

Environmental Impacts	Mitigation Measures	Monitoring program		
		Frequency	**Indicator**	**Responsible**
Physical environment				
- Silted water caused by construction works - Alteration of air quality by dust and combustion gases production - Land contamination by leaching generated by mud extracted from the river bed - Noise and vibration	- Deviation and channeling of the river or lagoon discharge - Plan retention screens for sediments - Superficial drainage control of access and vehicle circulation ways - Slope stability in hillsides for access ways - Install accident prevention strips especially for children - Circulation plan for heavy vehicles - Identified piling yard with erosion control - Security measures for works personnel, vehicles and pedestrians - Preventive maintenance of construction equipment	- Continually during the project construction stage	- Deviation and contention works constructed - Circulation plan approved and implemented - Signed commitment and training of sediment transport contractors - Accident reduction - Monitoring plan of vehicle and equipment maintenance	- Contractor - Environmental Engineer Supervision
Biological environment				
- Removal of vegetal cover in road and deposit zones - Plague proliferation associated to stagnant waters - Damages to aquatic and terrestrial ecosystem	- Planting and regeneration with native species from the affected ecosystems - Leveling of work zones - Collection of solid wastes that are water storers - Periodic fumigations - Native plants reforestation in the underbrush zone used as a deposition zone of excavated material	- After works - During all the project construction stage	- Reforestation plan of a 500 m^2 area and a part of the way of approximately 100 m long and 4 wide - Plague prevention plan implemented - Fumigation plan implemented - Reforestation plan of the deposition zone implemented	Employer

Environmental Impacts	Mitigation Measures	Monitoring program		
		Frequency	**Indicator**	**Responsible**
Social environment				
- Involuntary displacement of security areas - Affected public health due to dust and gas atmospheric emissions - Generation of construction wastes - Vehicle and pedestrian traffic obstructed - Urban landscape affected - Employment of local human resources - Indirect and temporal job opportunities	- Identification of relocation sites - Relocation and/or indemnization of affected families - Vehicle maintenance and supervision - Compactation of heavy equipment roads and ways - Preventive hygiene measures - Inclusion of security measures in: plastic lining over piled materials and its transportation in trucks. - Mask use for the personnel - Identification of waste material deposit sites and its convenient disposal - Vehicle and pedestrian circulation control, signaling and right of way control - Close working areas with fences having adequate signs - Ads in the media: radio, press and television - Job offering ads with preference for local intensive working human resources - Food hygiene and sanitary condition control in the project direct influence area	- During all the project construction stage	- Identified sites and approved of the affected ones - Negotiated indemnization amount - Vehicle maintenance plan approved - Frequent compaction program with access and circulation ways - Contracting of transport services providers - Industrial security plan for project workers - Way circulation reordering plan - Assignment of traffic authorities involved - Announcements before works begin - Laboral recruiting plan with divulged profile definition - Reduction of respiratory diseases in workers	- Employer, SOPTRAVI, MUNICIPALIDAD, MSP, Transit General Direction

Activities in the landslide sites

Environmental Impacts	Mitigation Measures	Monitoring program		
		Frequency	**Indicator**	**Responsible**
Physical environment				
- Alteration of the phreatic level by pumping excess and sited water caused by the construction works - Alteration of air quality by dust and combustion gases emission - Noise and vibration by heavy machinery movement	- Excavation control for daily yield in short construction phases - Control of phreatic water by pumping to places where erosions can be avoided - Provision of construction materials in place and time for open trench - Temporary stabilizing of land cuts with temporary retention structures - Warning system and industrial security plan for working personnel if explosive use - Temporary sanitary units for personnel Construction equipment in good conditions for excavation and hauling soils process - Cover sheets for trucks - Signal routes for trucks circulation - Transit Guards for circulation control - Signals for potential landslide areas	- Continually during the project construction stage	- Working Plan adopted and approved - Auxiliary channels built and final discharge place identified - Energy Disperser and flow deviation contemplated for non expected flows - Plan for temporary retention structures and sheet piling - Inspection and maintenance plan for equipment and vehicles adopted - Training truck drivers for careful mobilization Temporary sanitary units for working crew - Contingency plan approved for unexpected landslides	- Employer - Environmental Engineer Supervision
Biological environment				
- Reforestation in slide areas for erosion control - Species proliferation associated to stagnant waters - Damages to aquatic and terrestrial ecosystem	- Planting and regeneration with native species from the ecosystems characterized by deep roots that compact soil - Leveling of work zones - Collection of solid wastes that store water - Periodical fumigations	- After works - During all the project construction stage	- Reforestation plan of slide areas in Berrinche and Reparto and margins of Bambu - Plan prevention plan implemented - Fumigation plan implemented	- Employer - Eco-Bambu

Environmental Impacts	Mitigation Measures	**Monitoring program**		
		Frequency	**Indicator**	**Responsible**
Social Environment				
- Involuntary displacement of security areas - Effects on public health by dust emission and noises - Effects on landscape - Generation of construction wastes - Obstruction of vehicular and pedestrian traffic - Contracting of local work resources - Effects on existing infrastructure (potable water system, sewerage, etc.) - Temporal and indirect job opportunities	- Identification of resettling locations - Relocation and/or indemnization of affected families - Compactation of heavy machinery circulation ways - Hygiene preventive measures - Inclusion of security measures in: use of plastic linings in land blocks extracted and their transport in trucks - Mask use for the personnel - Identification of waste construction material deposit and their convenient final disposal - Vehicle and pedestrian circulation control, signaling, way control - Close work zones with fences and works signs with emphasis in children - Ads in mass media: radio, press and television - Ads of job offerings and preference for intensive local human resources - Food hygiene and sanitary conditions control in the project influence zones - In Reparto and Berrinche slide areas, the construction of areas for recreation is proposed: sport fields, amusement parks, children games with adequate illumination	During all the project construction stage - After works	- Identified sites and approved of the affected ones - Negotiated indemnization amount - Vehicle maintenance plan approved - Frequent compaction program with access and circulation ways - Contracting of transport services providers - Industrial security plan for project workers - Way circulation reordering plan - Assignment of traffic authorities involved - Announcements before works begin - Laboral recruiting plan with divulged profile definition - Reduction of respiratory diseases in workers - Improvement of life quality of the nearby population	- Employer, SOPTRAVI, MUNICIPALIDAD, MSP, Transit General Direction