

THE STUDY OF MANAGEMENT ON SANITATION ENVIRONMENT IN THE COAST OF QUINTANA ROO STATE IN THE UNITED MEXICAN STATES

Final Report
Volume II
MAIN REPORT

OCTOBER 2004

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PREFACE

In response to a request from the Government of the United Mexican States, the Government of Japan decided to conduct a development study on Management on Sanitation Environment in the Coast of Quintana Roo State and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected a study team headed by Mr. Hiroshi Kato of KOKUSAI KOGYO CO., LTD. and dispatched the team to Mexico four times between March 2003 and August 2004.

In addition, JICA set up an advisory committee headed by Mr. Kenichi Tanaka, a senior advisor of the Institute for International Cooperation, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Mexico and conducted field surveys in the study area. Upon returning to Japan, the team prepared this final report.

I hope that this report will contribute to the implementation of this plan and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the United Mexican States for their close cooperation extended to the study.

October, 2004

Etsuo KITAHARA
Vice President
Japan International Cooperation Agency

October 2004

Mr. Etsuo KITAHARA
Vice President
Japan International Cooperation Agency

Letter of Transmittal

Dear Mrs. OGATA,

We are pleased to submit the report of the Study of Management on Sanitation Environment in the Coast of Quintana Roo State in the United Mexican States.

The report consists of three components: a study on the present practices of environmental sanitation management in three southern municipalities in the State of Quintana Roo on the Yucatan Peninsula; formulation of the environmental sanitation master plan until the year 2015; and model projects drawn from measures listed in the master plan.

Due to the peculiar geological characteristic – karstic formation – of the Yucatan Peninsula, rainfall percolates into the ground and forms veins consisting of cenotes and caves, which nurture the rich coastal aquatic environment such as mangrove forests and the second largest Mesoamerican Coral Reef in the world. Then, from the viewpoint of environmental sanitation, it was clarified through the study on present practices that the groundwater is considerably vulnerable to the rapid urbanization being continued in the study area.

The master plan was formulated aiming at controlling pollution loads from sewage and solid waste, with the principal objective of preserving the coastal aquatic environment. In order to achieve the principal objective, technical, legal, organization and financial systems have been formulated.

Furthermore, nine model projects, which were urgent measures listed in the master plan, were carried out within the study period; one in the field of wastewater management, six in solid waste management, one in groundwater management and one in environmental education that encompasses the previous three fields. These model projects have been continued and expanded by the Mexican side. Thus, the master plan has already been implemented and the study is actually yielding fruitful results.

We would like to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, the Ministry of Land, Infrastructure and Transport, and the Ministry of Environment of Japan. We would also like to extend our deep appreciation to the Government of Mexico, the Embassy of Japan and the JICA office in Mexico for their vital cooperation during the implementation of the study in Mexico.

Last but not least, we hope that the output of the study presented here will contribute to the sustainable development not only in the study area but also the State of Quintana Roo and the Yucatan Peninsula.

Respectfully,

Hiroshi KATO
Team Leader
The Study of Management on Sanitation
Environment in the Coast of Quintana Roo State in
the United Mexican States

The Study of Management on Sanitation Environment in the Coast of Quintana Roo State in the United Mexican States

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This is the Main Report

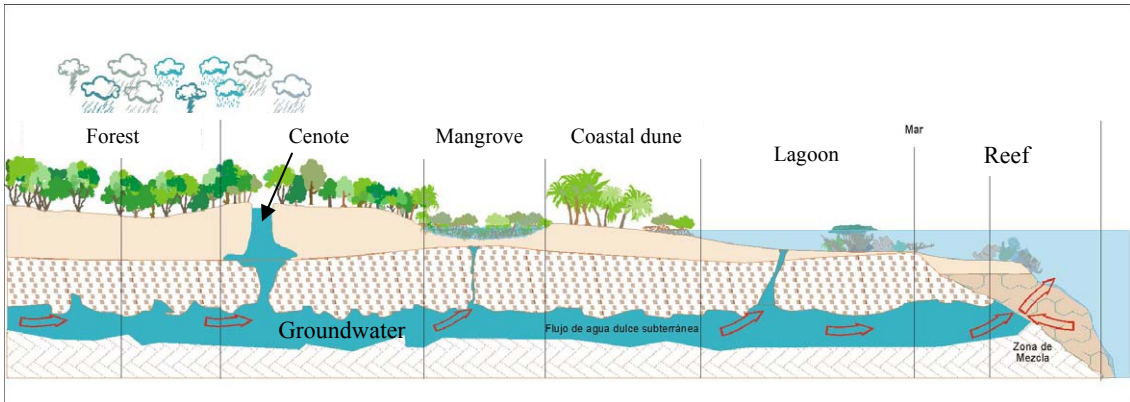
In this report, the project cost is estimated by using the November 2003 price and an exchange rate of US\$1.00 = 11.00 Mexican pesos = JP¥ 110.

STUDY AREA



Plate 1 Features of the Study Area

The Peninsula of Yucatan is a geologic unit composed mainly of limestone which is highly permeable and soluble. Dissolution of the rock has created a karst topography with cenotes and caves. The underground stream is connected to lagoons and reefs, then nurtures rich aquatic environment in the Study Area



Lagoon (Laguna Bacalar)



A beach in Costa Maya

It is feared that inadequate management of wastewater and solid waste would pollute the groundwater, then, deteriorate the aquatic environment. The Master Plan proposed in the Study aims to control pollution load from wastewater and solid waste as shown in the following figure.

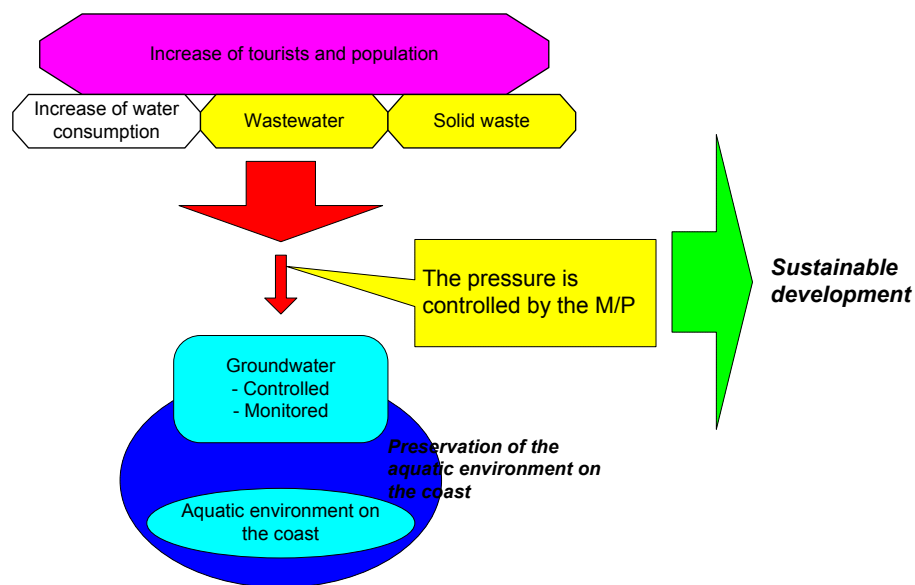


Plate 2 Meetings and Seminars

Meetings and seminars were held aiming at interchanging information and technology among the Mexican Counterpart, the JICA Study Team and other institutions concerned.

Periodical Meeting



Meetings between the Mexican Counterpart and the JICA Study Team were held every two weeks periodically. This was the principal tool for the technology transfer and consensus building.

Seminars



Seminars were held from time to time during the Study, presentations were basically made by the Mexican Counterpart. They explained what they were doing at the time and/or announced what they were going to do after the time.



Not only adults but also children participated in the seminars, who experienced classes that were conducted as one of components of Environmental Education and Recycling Activity Model Project.

Plate 3 Model Project “Urban Type Wastewater Treatment”

Model Project of Urban Type Wastewater Treatment was carried out in Playa del Carmen, Solidaridad Municipality, with purposes of investigating hydrogeological conditions and groundwater quality at the site.

Geophysical Survey



A geophysical survey by transient electromagnetic method (TEM) was carried out. The primary objective of the survey was to determine the composition and distribution of limestone aquifers as well as fresh-saline water interface in the study area.

Monitoring Well



Based on the geophysical survey, the monitoring wells were constructed at different depths in order to confirm lithology of aquifers, distribution of fractures, presence of cavity, fresh water-saltwater interface and water quality.

Water Quality Analysis



Groundwater was sampled from the monitoring wells and its quality was analyzed to verify contamination.

Plate 4 Model Project “Village Type Wastewater Treatment”

Model Project of Village Type Wastewater Treatment was carried out in Subteniente Lopez in Othon P Blanco Municipality, with purposes of verifying a new wastewater treatment plant for a small community and encouraging residents to connect their domestic wastewater with the public sewer.

Wastewater Treatment Plant



CAPA developed a small scale treatment plant to cope with problems regarding wastewater in small communities. The JICA Study Team made some suggestions and training regarding operation and maintenance of the plant.

Explanation to Residents



Several meetings were held for bringing importance of groundwater conservation to the residents' attention and for encouraging them to connect to the public sewer.

In-house Connection



A fund to financially help residents connect to the public sewer was established. And about 100 households made the connection.

Plate 5 Model Project “Establishment of an Integral Solid Waste Management Information System” and “Capacity Building of Executing Agency in Othon P Blanco”

Model Project of Establishment of an Integral Solid Waste Management Information System aimed at setting up a framework where institutions concerned could interchange information, then strengthen coordination among them. Use of the system will lead to monitoring implementation of the Master Plan formulated in the Study.

Model Project of Capacity Building of Executing Agency in Othon P Blanco aimed at establishing a manner of calculation and control of the cost of solid waste management in a routine way by introducing software.

Some computers were equipped to offices of the Mexican Counterpart with required software and training for carrying out the Model Projects.



SEDUMA (Ministry of Urban Development and Environment,
Government of Quintana Roo State)



Municipality of Othon P Blanco



Municipality of Felipe C Puerto

Plate 6 Model Project “Improvement of the Existing Disposal Site in Othon P Blanco”

Model Project of Improvement of the Existing Disposal Site in Othon P Blanco was carried out having the following components:

- improvement of the existing disposal site by constructing dikes, compacting waste, covering waste with soil and installing gas removal pipes,
- technology transfer of proper landfilling with an operation manual, and
- introduction of an incoming waste weighing system with installation of a weighbridge.

Site Improvement



Before Improvement

The site showed intolerably unsanitary conditions, such as waste was scattered, the access road was inundated, and a great number of flies and birds was observed.



Under Improvement

Waste was compiled and compacted, then covered with soil.



After Improvement

Sanitary conditions and workability of the site were well improved. The site was ready for daily operation.

Weighbridge Installation

A weighbridge was installed and a manner how to record data of incoming waste was established. To know waste amount is crucial for entire Solid Waste Management, which gives information necessary for planning and operation in both technical and financial aspects.



A weighbridge was installed at the entrance of the site. A rule how to get on it, e.g., crews except driver shall get off, vehicles shall slowly get on and off the weighbridge, was established.



A computer was installed. That is connected to the weighbridge and records data. Some personnel were trained about how to use it.



A gate was installed at the entrance of the site. It can avoid entry of unauthorized vehicles and persons.

Plate 8 Model Project “Collection Service Improvement in Othon P Blanco” and “Collection Service Improvement in Felipe C Puerto”

Model Project of Collection Service Improvement in Othon P Blanco was carried out in Chetumal City. The principal objective was to improve efficiency of waste collection works, which led to cost reduction.

Model Project of Collection Service improvement in Felipe C Puerto was conducted in Felipe C Puerto City. It also aimed at improving efficiency. In addition, remaining capacity caused by the improvement of efficiency was turned to expansion of collection service area.

Diagnosis of the Current Situation



First, the current situation of collection works was investigated by following vehicles.

Data Analysis and Planning



Data collected during the diagnosis was analyzed, and new collection routes and work schedule were planned based on the analysis.

Improvement of Collection Works



New collection routes and work schedule were practiced. Explanation and training of the new routes and schedule were out to collection crews on the streets.

Plate 9 Model Project “Establishment of Solid Waste Management System in Costa Maya”

Model Project of Establishment of Solid Waste Management System in Costa Maya was carried out in Mahahual, Othon P Blanco Municipality, aiming at introducing a minimization culture.

Solid Waste Management Committee



A committee on Solid Waste Management was created in Mahahual, then, it was acknowledged by the Municipality of Othon P Blanco.

Beach Cleaning



Recycling



Several stations for separate collection of waste were installed. Collected bottles and cans were sorted again and temporary stored, then, sold to traders.

Plate 10 Model Project “Environmental Education and Recycling Activities”

Model Project of Environmental Education and Recycling Activities was carried out over the Study Area aiming at providing an education program that can make children be acquainted with importance of resource conservation and recycling through harmonized coordination of different institutions.

Workshops



First, a workshop was held targeting the Mexican Counterpart, where a method of environmental education was established through discussion and experimental trials. Second, the Counterpart held several workshop inviting teachers to transfer the education method.

Environmental Education in Schools



Teachers having participated in the workshops went back to their schools and had classes regarding environmental conservation and recycling.

Recycling



Children actually participated in a paper recycling activity and visited a paper recycling company.

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Abbreviations

AMSLM	Average Mean Sea Level Meters
AC	Civil Association
APAS	Potable Water, Sewerage and Sanitation
B/C	Benefit Cost
BANOBRAS	National Bank of Public Works and Services (<i>Banco Nacional de Obras y Servicios Públicos</i>)
BOD	Biochemical Oxygen Demand
C/P	Counterpart
CAPA	Commission of Potable Water and Sewerage (<i>Comisión de Agua Potable y Alcantarillado</i>)
CECADESU	Training Center for Sustainable Development
CEPIS	Panamerican Center for Sanitary Engineering and Environmental Sciences (<i>Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente</i>)
CNA	National Committee of Water (<i>Comisión Nacional del Agua</i>)
CNANP	National Committee of Natural Protected Areas (<i>Comision Nacional de Aguas Naturales Protegidas</i>)
COD	Chemical Oxygen Demand
COESPO	State Council of Population
CONAPO	National Council of Population
COSEPRE	Cost of Services Provided
DF/R	Draft Final Report
EAP	Economic Activity Population
EC	Electric Conductivity
ECLAC	Economic Commission for Latin America and the Caribbean
ECOSE	Ecology and Business Commitment
ECOSUR	College of the Southern Border (<i>El Colegio de la Frontera Sur</i>)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EM	Electro Magnetic
F/R	Final Report
F/S	Feasibility Study
FCP	Felipe Carrillo Puerto
FIDECARIBE	Caribbean Trusteeship, State Tourism Agency
FONATUR	Tourism National Found (<i>Fondo Nacional para el Turismo</i>)
GDP	Gross Domestic Product
GIS	Geographic Information System
GNI	Gross National Income
GNP	Gross National Product
GWM	Ground Water Management
HDI	Human Development Index
IC/R	Inception Report
IEE	Initial Environmental Examination
IIRA	Institute of Environmental Impact and Risk
IMSS	Mexican Institute for Health Insurance
IMTA	Mexican Institute of Water Technology
INE	National Ecology Institute
INEGI	General Census of Population and Housing (<i>Instituto Nacional de Estadística, Geografía e Informática</i>)
INI	National Institute for Indigenous People

ISSTE	Health Insurance Institute for State Workers
It/R	Interim Report
JICA	Japan International Cooperation Agency
LEEPA	Regulation of the Environment Balance and Protection of Quintana Roo State
LGEEPA	General Law of Ecological Balance and Environmental Protection
LGPGIR	General Law for the Prevention and Integral Management of Waste
M/M	Minutes of Meetings
M/P	Master Plan
MBPS	Municipal Bureau of Public Services
MLSS	Mixed-Liquor Volatile Suspended Solids
Mo/P	Model Project
MPNISP	Model of National and International Practices in Public Service
NA	Not Available
NGO	Non-Governmental Organization
NPV	Net Present Value
O&M	Operating and Maintenance
OD	Oxygen Demand
OPB	Othón Pompeyo Blanco
P/R	Progress Report
PDSO	Phased Disposal Site Development
PEDI	Integral Development Strategic Plan
PEDU	State Program of Urban Development (<i>Programa Estatal de Desarrollo Urbano</i>)
PEMEX	Oil Mexican Company
PMDU	Urban Development Municipality Programs
PND	National Development Plan
PNDU	National Program of Urban Development
POET	Program of Territorial and Ecological Ordinance
PROFEPA	Federal Environmental Protection Agency
SARH	Secretariat of Agricultural and Hydraulic Resources
SEANAP	System Estate of Natural Protected Areas
SECTUR	Ministry of Tourism
SEDEMAR	Navy
SEDENA	National Army Secretariat
SEDESOL	Ministry of Social Development (<i>Secretaría de Desarrollo Social</i>)
SEDUE	Secretariat of Urban Development and Ecology
SEDUMA	Ministry of Urban Development and Environment, Government of Quintana Roo State (<i>Secretaría de Desarrollo Urbano y Medio Ambiente, Gobierno del Estado de Quintana Roo</i>)
SEMARNAT	Ministry of Environment and Natural Resources (<i>Secretaría de Medio Ambiente y Recursos Naturales</i>)
SEPLADER	Secretariat of Regional Planning and Development
SIGIR	Information System for the Integral Management of Waste
SOL	Solidaridad
SS	Suspended Solids
SSA	Secretariat of Health and Assistance
SVI	Sludge Volume Index
SW	Solid Waste
SWM	Solid Waste Management
TDEM	Time-Domain Electromagnetic Method
TDS	Total Dissolved Solid
TEM	Transient Electromagnetic Method

TS	Total Solid
TSS	Total Suspended Solids
UNEP	United Nation Environment Program
UNESCO	United Nation Educational, Scientific, and Cultural Organization
USAID	United States Agency for International Development
USMN	Unit of the Meteorological National Service
VES	Vertical Electric Sounding
VSS	Volatile Suspended Solids
WTP	Water Treatment Plant
WWM	Wastewater Management

Part I

Outline of the Study

Chapter 1

Outline of the Study

1 Outline of the Study

1.1 Background of the Study

The State of Quintana Roo in Mexico has an area of around 50,800 km², and a population of 870,000, of which 400,000 live in Cancun in year 2000. Within the State of Quintana Roo, the eastern coast stretches over approximately 500km, being an area of rich natural environment, inhabited by numerous tribal people who live off the abundant natural resources. Historical ruins are also plentiful, giving rise to tourism promoted at the national level as a source of hard currency.

However, tourism development without sufficient environmental considerations, coupled with explosive population growth, has exposed the difficulty facing many cities and towns to keep up with the necessary social infrastructure concerning wastewater and solid waste disposal. The result has been the deterioration of the natural environment of the area in recent years. The central and regional governments of Mexico have faced the situation with legislative and administrative countermeasures. However, insufficient and slow results call attention to the adverse effects on the coastal environment and the living environment of the residents.

In March 2001, JICA dispatched a joint Japanese-American Project Formation Study Team, and clarified the high priority of aid for the environmental preservation of the said coastal area. In July 2002, JICA implemented a preliminary study, and confirmed the urgency of aid concerning sewage and solid waste disposal, which have adverse effects on the coastal environment. Subsequently, in October 2002, JICA sent a Preparatory Mission which signed the S/W of the Study, and selected Kokusai Kogyo Co., Ltd. as the consulting firm for the implementation of the Study.

1.2 Objectives of the Study

- 1) Preparation of Environmental Sanitation Management Master Plan integrating wastewater and solid waste management, with the objective of preserving the aquatic environment along the eastern coast of Quintana Roo State, setting 2015 as the target year.
- 2) Implementation of feasibility study on priority projects (model projects) to be selected on the basis of the above mentioned Environmental Sanitation Management Master Plan.
- 3) Technology transfer to Mexican counterpart (C/P) during the implementation of the Study.

1.3 Study Area

The Study Area was composed of three Municipalities (Othón P. Blanco, Felipe C. Puerto, Solidaridad) along the eastern coast of Quintana Roo State (See “Map of the Study Area”).

1.4 Study Schedule

The Study commenced in March 2003 based on the Scope of Works agreed by the Government of Mexico and the Government of Japan. And all works in Mexico were completed in August 2004.

The term of the Study was basically divided in four phase as follows.

- Phase I: Basic Study (Investigation of the current situation), March – July 2003
- Phase II: Formulation of Environmental Sanitation Management Master Plan, August – October 2003
- Phase III: Implementation of Model Projects, November 2003 – May 2004
- Phase IV: Evaluation of Model Projects, June – August 2004

1.5 Organization for Study Implementation

The Study was carried out jointly by the Study Team and Mexican Counterpart Team, following the guidance and advice given by the Steering Committee, composed of representatives from related Mexican agencies, and the Advisory Committee set up by JICA in Japan.

1.5.1 Study Organization

The Study organization will have the following relationship.

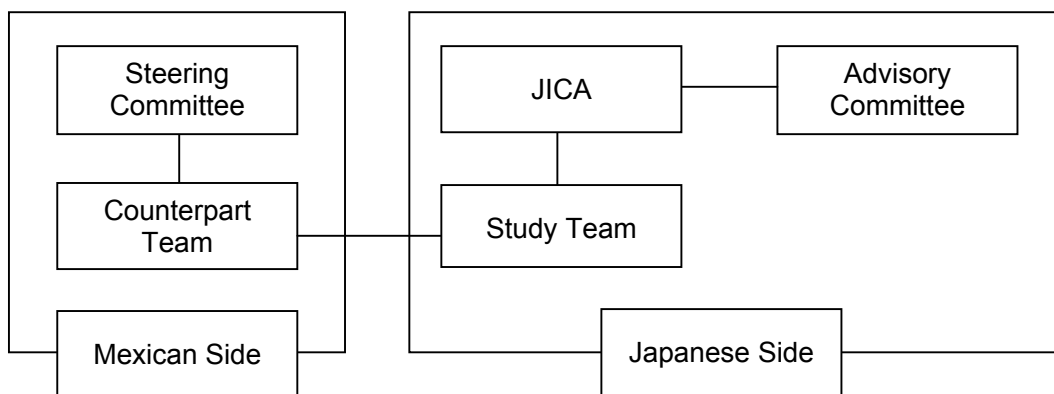


Figure 1-1: Organization Chart of the Study

1.5.2 Study Team

The Study Team is composed of 15 members was shown in the table below

Responsibility	Name
Leader/Environmental Sanitation Management/Wastewater Management (1)	Hiroshi Kato
Wastewater Management (2) / Hydrogeology / Groundwater Analysis / Electromagnetic Exploration	Akira Kamata
Planning & Design of Wastewater Treatment Facilities	Osamu Nahata
Sub-Leader/Solid Waste Management Plan	Ikuo Mori
Planning & Design of Solid Waste Management Facilities	Ximena Alegria
Organization/Legal Structure/Social Survey	Victor Ojeda
Economic & Financial Analyses	Masaru Obara
Initial Environmental Examination	Shinya Kawada
Regional Planning	Toshiro Hamada
Community Participation/Environmental Education	Masaharu Kina
Model Projects	Ichiro Kono
Well Data Processing	Mario Valle
Water Balance Analysis	Peifeng Lei
Administrative Coordinator (1)	Hiroyuki Nakai
Administrative Coordinator (2)	Ikuko Kunitsuka

1.5.3 Advisory Committee

In order to provide the necessary advice to the Study Team, JICA has set up an Advisory Committee composed as follows.

Responsibility	Name	Agency
Committee Leader	Kenichi Tanaka	Institute for International Cooperation, JICA
Committee Member	Takeshi Yahashi	Japan Education Center of Environmental Sanitation

1.5.4 Counterpart Team

Counterparts who jointly worked with the Study Team are shown in the table below.

Name	Institution	Responsibility
1. Environmental Sanitation Management		
Lic. Francisco Hernández Franco	SEMARNAT-QR	Sub delegate of Planning
Lic. Gustavo Hidalgo Sánchez	SEMARNAT-QR	Department of Planning and Foreign Affairs
Ing. Gustavo Olivaris Alanis	SEMARNAT-QR	Chief of Planning and Environment Policy Office
2. Hydrology		
Ing. Iván Gamboa Rosas	CNA- Regional Office	Regional Manager
Ing. Carlos Fernando Chable Mendicuti	CNA- Regional Office	In charge of the Technical Area
Ing. Catherine Magnum Burnier	CNA- Regional Office	In Charge of Basin Council Program
Ing. José Luis Acosta Rodríguez	CNA- Regional Office	Technical-Regional Sub Manager
Ing. Anselmo Ordaz Ayala	CNA-México	CNA México
Ing. Eliseo Vázquez	CNA-México	Specialist on Hydraulic
Tte. Roberto Flores Rodríguez	SEDEMAR	Chief of the Sea Contamination Program
3. Electromagnetic Sounding Analysis		
Ing. Guillermo Cuevas Landeros	CNA- Regional Office	Specialist on Hydraulic
Ing. Artemio Araujo Mendieta	CNA-México	Specialist on Hydraulic
4. Sewerage System Plannin		
Ing. Juventino Castillo Pinzón	CAPA	Coordinator of Planning and Development
Ing. Jaime Quiñones Baas	CAPA	Chief of Projects

Name	Institution	Responsibility
5. Waste Water Treatment Engineering		
Ing. Roberto Chim Iterián	CAPA	Head of Operations
M.C. Miguel Angel García Salgado	CONANP	Monitoring Coordinator of the XI Region of CONANP
6. Solid Waste Management		
Biól. Adolfin Bertha Villalobos	SEMARNAT-QR	Chief of the Department of Environmental Impact and Risk
Ing. Carlos Acosta Loría	SEDUMA	Director of Prevention and Pollution Control
José Guerrero	SEDUMA	In Charge of the Department of Monitoring Environment
Ing. Mónica Chargoy Rosas	Municipality of OPB	Specialist on Solid Waste Management
José Méndez García	Municipality of OPB	Chief of the Collection Department
Ing. Eduardo Escalante Rodríguez	Municipality of FCP	Director of Public Works
Manuel Góngora Reyes	Municipality of FCP	Assistant
Biól. Juan Antonio Huerta Illescas	Municipality of Solidaridad	Director of Environment
7. Solid Waste Management Facilities		
Ing. Carlos Acosta Loría	SEDUMA	Director of Prevention and Pollution Control
MVZ. Rodrigo Camín Cardín	Municipality of OPB	Specialist on Solid Waste Management
José Tut Uan	Municipality of OPB	Director of Public Image
Ing. Eduardo Escalante Rodríguez	Municipality of FCP	Director of Public Works
Biól. Juan Antonio Huerta Illescas	Municipality of Solidaridad	Director of Environment
8. Organization, Institution and Legal System		
Lic. Rosa Elena Carbajal Valiente	SEMARNAT-QR	Chief of Legal Affair
9. Financial and Economic Analysis		
Ing. Gilberto Mena Rivero	CAPA	Director of Project Assessment Area
Arq. Héctor Morín Lázaro	Municipality of OPB	Director of Urban Development and Ecology.
10. Environment Assessment		
Biól. Carlos Llorens Cruset	SEMARNAT-QR	Sub delegate of Environment Protection
Lic. Adrián Neftalí Pérez Zaldivar	Municipality of Solidaridad	Sub-Director of Environmental Norms
Ing Giovanni Contreras Rivero	SEDUMA	Director of Environmental Protection
Biól. Tomás Sánchez Cabrera	Municipality of OPB	Chief of the Department of Ecology
11. Regional Development Planning/Social Survey		
Ing. Gustavo Olivaris Alanis	SEMARNAT-QR	Chief of the Planning and Environment Policy Area
Biól. Cedrela Median Gasca	SEDUMA	Director of Planning and Environmental Policy
Ing. Juventino Cartillo Pinzón	CAPA	Coordinator of Planning and Development
Arq. Roger Alvarado Rivero	Municipality of OPB	Department of Urban Development
12. Community Participation and Environmental Education		
Biól. Teresa Jiménez Almaraz	SEMARNAT-QR	Chief of the Department of Environmental Education
M.C. Bárbara Reveles González	CONANP	Sub director of Chinchorro Shoal Biosphere Reservation and X'calak Reef National Park
Ing. Jorge Jiménez Alvarado	CAPA	Coordinator of Social Participation Area
Ing. Miguel Acopa	CAPA	Chief of Department of Social Participation
Lic. Salim Chamlati	CAPA	Professional Analyst
Biól. Manuel Hernández	SEDUMA	Director of Natural Protection Area, Sanctuary of the Manatee
Ing. José Gabriel McLiberty Pacheco	SEDUMA	Sub Secretary of the Environment Sub Secretary
Ing. Abigail Hernández Santiago	SEDUMA	Responsible of the Environmental Education Program
Alvaro Gorocica Polanco	SEDUMA	Assistant of the Environmental Education Program
Biól. Gonzalo Vidaña Espejo	Municipality of OPB	Director of Ecology
Biól. Lilibeth Arjona Pérez	Municipality of OPB	Chief of Projects and Environmental Office
Ing. Eduardo Escalante Rodríguez	Municipality of FCP	Director of Public Works
Biól. Juan Antonio Huerta Illescas	Municipality of Solidaridad	Director of Environment

1.5.5 Steering Committee

Members of the steering committee who made important decisions are listed below.

Name	Institution	Responsibility
Ing. José de Jesús Infante de Alba	SEMARNAT	Delegate of Quintana Roo
Lic. Francisco Hernández Franco	SEMARNAT	
Ing. Jorge Mariano Morales Calzada	SEDUMA	Ministry
Ing. Juan Manuel Herrera	Commission of Ecology, Forestry and Fishery	President
Ministro Gerardo Lozano	Ministry of Foreign Affairs	Director of technical cooperation
Ing. Francisco Aranguré Monroy	CNA	Delegate in Quintana Roo
Biól. Alfredo Arellano Guillermo	CONANP	Coordinator
Ing. Andrés Ruiz Morcillo	CAPA	General Director
Lic. Eduardo Espinosa Abuxapqui	Municipality of Othón P Blanco	Municipal President
Prof. Francisco Novelo Ordoñez	Municipality of Felipe Carrillo Puerto	Municipal President
C.P. Gabriel Mendicuti Díaz	Municipality de Solidaridad	Municipal President
Ar. Baltasar Linares Díaz	BANOBRAS	Delegate of Quintana Roo
Ing. María Antonia Hernández Rivas	FONATUR	Coordinator

1.6 Reports

The following reports were prepared and submitted to the Mexican side, followed by explanations and discussions.

Report	Language	
Inception Report	English, Spanish	
Progress Report (1)	English, Spanish	
Interim Report	English, Spanish	
Progress Report (2)	English, Spanish	
Draft Final Report	Summary	English, Spanish, Japanese
	Main Report	English, Spanish
	Supporting Report	English, Spanish
Final Report	Summary	English, Spanish, Japanese
	Main Report	English, Spanish
	Supporting Report	English, Spanish

1.7 Technology Transfer

The following technology transfers were carried out during the Study period.

Technology Transfer	Target	Content	Frequency
On-the-job Training	Counterpart	Study method; analysis & evaluation of study results; problem identification; countermeasures; formulation & implementation of projects; formulation, implementation & evaluation of model projects, etc.	As needed during the Study period
Technical Discussions	Counterpart	Study policy & schedule, progress & results; plan formulation method; thinking for alternative plan formulation; selection method of the most appropriate plan; project evaluation method; presentation of sewerage treatment & solid waste management in Japan and other countries, etc.	Every other week
Explanation of Reports	Counterpart and Members of Steering Committee	Policy & results at each stage of the Study; problems & countermeasures, etc.	Five times: IC/R, P/R(1), IT/R, P/R(2), DF/R
Technology Transfer Seminar	Counterpart, Members of Steering Committee, NGOs, International Organizations, etc.	Knowledge & recommendations resulting from the Study	Three times, coinciding with DF/R explanation
Counterpart Training	Counterpart	Visit of facilities related with environmental sanitation management in Japan, increasing awareness on management methods and possible problems	Twice

Part II

Present Situation of Environmental Sanitation in the Study Area

Chapter 2

Profile of the Study Area

2 Profile of the Study Area

2.1 Profile of the Country

2.1.1 Socioeconomic Conditions

Total population of Mexico was 97,361,711 according to the year 2000 census (Source; INEGI census book “Estados Unidos Mexicanos” XII Censo General de Poblacion y Vivienda 2000, Resultados Preliminares). INEGI data indicated that the gross domestic product (GDP) of Mexico in the year 2000 was 4,974,464 Million Pesos at current prices. As the 2000 Census indicated a total population of 97,361,711, the per capita GDP in the year 2000 would be estimated as about 51,000 Pesos. At the exchange rate of 9.57 Pesos per US dollar at the end of December 2000, the 2000 GDP would be approximately USD520,000 Million, and the equivalent per capita GDP would be around USD5,300.

According to INEGI data, the Mexican GDP valued at 1993 prices was 1,155,132 Million Pesos in 1993 and 1,474,726 Million Pesos in 2000, implying a yearly growth rate of 3.55% between 1993 and 2000. Sector performance differed, as the yearly growth rate was lower for the agriculture sector (1.58%), while higher for the industrial sector (4.56%) and the service sector (3.31%). According to the data, Mexico is a predominantly service economy, with the service sector accounting for around two-thirds of GDP, followed by the industry sector with a little over one-fourth of GDP, while the agriculture sector comprised less than 10% of GDP.

Table 2-1: Gross Domestic Product (GDP) of Mexico

Sector	GDP 1993 (Million Pesos)	GDP 2000 (Million Pesos)	1993 Sector Share (%)	2000 Sector Share (%)	1993-2000 Growth Rates (%)
Total GDP	1,155,132	1,474,726	100.0	100.0	3.55
Agriculture	72,703	81,129	6.3	5.5	1.58
Industry	308,897	423,466	26.8	28.7	4.56
Service	772,532	970,131	66.9	65.8	3.31

Source: Anuario Estadístico 2002, Quintana Roo, INEGI
Sistema de Cuentas Nacionales de Mexico 1993-2000, INEGI

The exchange rate of Mexican Pesos per US dollar showed the following monthly variations between 1997 and 2001.

Table 2-2: Exchange Rate – Monthly Average Pesos per US Dollar

	1997	1998	1999	2000	2001
Yearly Average	7.9185	9.1357	9.5605	9.4556	9.2592
End of December	8.0833	9.8650	9.5143	9.5722	9.1423

Source: Anuario Estadístico de los Estados Unidos Mexicanos, Edición 2002, INEGI

The following table shows some examples of interest rates between 1997 and 2001, all types of interest rates went down between 2000 and 2001.

Table 2-3: Interest Rate (%)

	1997	1998	1999	2000	2001
Savings Deposit	7.65	6.85	5.69	3.84	2.46
Inter-bank rate (a)	20.41	36.60	18.67	18.39	7.96
Fixed-term Deposit					
30 days	12.82	16.10	7.60	6.79	2.85
90 days	12.47	16.34	7.88	7.17	3.20
180 days	12.43	16.13	8.04	7.37	3.52
(a) TIIP, determined by the Bank of Mexico					

Source: Anuario Estadístico de los Estados Unidos Mexicanos, Edición 2002, INEGI

The inflation rate in Mexico at the end of December 2002 stood at 4.7%. And, during the first week of July 2003, the inflation accumulated for the past 12 months was estimated at the same rate, that is, 4.7%. In Chetumal, the general inflation rate between January and December 2001 was estimated at 5.04%. The latest data on public debt up to May 2003 indicated the total foreign debt of the public sector of Mexico to be USD77,400 Million. An abbreviated version of the financial situation of the Federal Government between 1997 and 2001 is shown in the following table.

Table 2-4: Financial Situation of the Federal Government (Million Pesos)

Item	1997	1998	1999	2000	2001
INCOME	503,555	545,175	674,349	868,267	939,114
Tax Income	312,116	404,224	521,683	581,703	654,870
Income tax	135,101	169,476	216,123	258,754	285,523
Value added tax	97,742	119,871	151,184	189,606	208,408
Tax on production & service	45,351	76,598	106,704	81,544	110,689
Import tax	18,103	21,488	27,303	32,861	28,902
Others	15,819	16,791	20,369	18,938	21,348
Non-tax Income	191,439	140,951	152,666	286,564	284,244
EXPENDITURES	546,726	612,476	754,389	952,083	996,950
Programmable	327,481	392,695	469,240	589,402	631,529
Current expenditures	267,092	329,580	399,256	507,610	539,373
Personnel	45,123	56,084	67,536	86,480	93,132
Other expenses	23,828	18,798	19,925	44,331	29,960
Aid, subsidy, transfers	198,141	254,698	311,795	376,799	416,281
Capital expenditures	60,389	63,115	69,984	81,792	92,156
Non-Programmable	219,245	219,781	285,149	362,681	365,421
Financial cost	114,224	95,711	144,834	176,461	166,826
Participations	94,573	113,665	140,671	178,136	196,931
Others	10,448	10,405	-356	8,084	1,664
BALANCE	-43,171	-67,301	-80,040	-83,816	-57,836

Source: Anuario Estadístico de los Estados Unidos Mexicanos, Edición 2002, INEGI

2.1.2 Environment Policy

2.1.2.1 General Review

The right to propose and set up laws at a federal level belongs to the President of the Republic, Deputies and Senators of the Congress of the Union, as well as to the legislative chambers of the respective states. The laws issued by the Congress of the Union have supremacy over the state-level legislation.

The governing body of the sector is the Secretariat of Environment and Natural Resources (SEMARNAT), with several decentralized entities: the National Water Commission (CNA); the Federal Environmental Protection Agency (PROFEPA); the National Ecology Institute (INE); the Mexican Institute of Water Technology (IMTA) and the National Commission of Natural Protected Areas (CNANP). The SEMARNAT has an agency in the state of Quintana Roo, and so has the CNA.

The implementation of legal instruments for the environmental sector at a federal level is as follows: the Political Constitution of the United Mexican States; the General Law of Ecological Balance and Environment Protection (LGEEPA); the Law on Domestic Waters; the Federal Law on Water Rights and the Mexican Official Standards. These are briefly described below.

a. Political Constitution of the United Mexican States

The Political Constitution regards the following articles with respect to environmental issues: 4th, 25th, 27th and 115th.

On individual rights

The article hereby guarantees two of the fundamental human rights: Every person is entitled to a suitable environment for his/her development and well-being, and, Every person is entitled to the protection of his/her health.

Article No. 5

With respect to the provision of public services, the Constitution refers to specific secondary laws to be legislated. As to public services, they will be mandatory only under the terms set out by the corresponding laws.

Article No. 25

With the purpose of strengthening the Nation's sovereignty and its democratic system, the Government is responsible for directing the national development. Under social justice and productiveness criteria, enterprises of the economy's social and private sectors will be

supported and impelled, being these entities subject to the modalities issued by the public interest and to the utilization of the productive resources for general benefit, while caring for their conservation and the environment.

Article 27

This article states the Nation's ownership and rights over the land and waters within the national territory, and outlines the conditions on private property in this matter.

The Nation, at all times, will have the right to impose the methods issued by the public interest onto the private property, as well as to regulate the exploitation of those natural resources susceptible to appropriation, for the social benefit, in order to conduct a fair distribution of public wealth, to watch over their conservation, to achieve the country's balanced development and to improve the living conditions of rural and urban populations.

Article 115

The Constitution outlines the public services under the responsibility of municipalities and city halls' powers to issue police and good government edicts. The municipalities will have the following functions and public services under their responsibility: Potable water, sewer systems, drainage, treatment and disposal of wastewater; Cleansing, collection, haulage, treatment and final disposal of wastes.

b. General Law of Ecological Balance and Environmental Protection (LGEEPA)

In 1988, the Congress of the Union issues the General Law of Ecological Balance and Environment Protection (LGEEPA) with the participation of the three governmental hierarchies: Federal, State and Municipal levels. The latter set the foundations for Mexico's current environmental policy.

The LGEEPA regulates the constitutional provisions in respect of the preservation and restoring of ecological balance and environmental protection; its clauses belong to public order and social interest matters and have the purpose of propitiating a sustainable development.

c. Law on Domestic Waters

This law establishes the rules as per Article 27th of the Political Constitution in the field of domestic waters. Purpose of the Law is to regulate the exploitation, utilization or right of use of such waters, their distribution and control; as well as to preserve their sufficiency and quality so as to achieve their integral and sustainable development.

d. Federal Law on Water Fees

It sets out the fees to be disbursed for the use or exploitation of the Nation's public property goods, as well for the services being rendered by the Government.

e. Regulations Currently in Force

**MEXICAN OFFICIAL STANDARDS (NOM) RELATED TO THE STUDY
Potable and Waste Waters**

Standard	Objective
NOM-001-ECOL-96	Permissible boundaries of contaminants when discharging waste waters in domestic waters and national property
NOM-002-ECOL-96	Permissible boundaries of contaminants when discharging waste waters in urban or municipal drainage/sewerage systems
NOM-003-ECOL-97	Maximum permissible boundaries of contaminants in treated waste waters to be reutilized in public services
Amendment NOM-127-SSA1-1994	Environmental health – Water for human use and consumption – Permissible quality boundaries and treatment that water must undergo to become potable
NOM-179-SSA1-98	Vigilance and assessment of quality and control of water for human use and consumption and distributed by public supply systems
NOM-003-CNA-1996	Requirements during the construction of water extraction wells to prevent the pollution of aquifers
NOM-004-CNA-1996	Requirements for the protection of aquifers during maintenance and rehabilitation of water extraction wells and for the closure of wells in general
ANTEPROY-NOM-000-CNA-00 00 PRELIMINARY DRAFT	Requirements for the disposal of surface and groundwater
ANTEPROY-NOM-000-CNA-00 00 PRELIMINARY DRAFT	Requirements for the artificial recharge of aquifers
PROY-NOM-004-ECOL-2001 IN THE WORKS	Environmental protection – sludge and bio-solids – specs and maximum permissible boundaries of contaminants for their utilization and final disposal
SLUDGE ANALYSIS	Determine the presence of helminthes eggs – test procedure
SLUDGE ANALYSIS	Determine the presence of coliform in feces – test procedure
SLUDGE ANALYSIS	Determine the presence of heavy metals – test procedure

**MEXICAN OFFICIAL STANDARDS (NOM)
Municipal and Biological Infectious Solid Wastes**

Standard	Objective
NOM-052-ECOL-93	Outlines the features of hazardous wastes, a list of them and the boundaries that turn a waste into a hazardous one due to its toxicity to the environment
NOM-053-ECOL-93	Establishes the procedure to carry out the extraction test to determine the constituents that turn a waste into a hazardous one due to its toxicity to the environment
NOM-054-ECOL-1993	Establishes the procedure to determine incompatibility between two or more wastes regarded as hazardous by the Mexican Official Standard NOM-052-ECOL-1993
NOM-055-ECOL-1993	Outlines the requirements to be met by the locations devoted to the controlled containment of hazardous wastes, except radioactive residues
NOM-056-ECOL-1993	Establishes the requirements for the plotting and construction of complementary of a controlled containment for hazardous wastes
NOM-057-ECOL-1993	Establishes the requirements to be observed in the plotting, construction and operation of cells of a controlled containment for hazardous wastes
NOM-058-ECOL-1993	Outlines the requirements for the operation of a controlled containment for hazardous wastes

Standard	Objective
NOM-083-ECOL-1996	Establishes the conditions to be met by the sites devoted to the final disposal of municipal solid wastes (Clarification dated March 7 th , 1997)
Mexican Official Standard Draft NOM-084-ECOL-1997	Outlines the requirements for the plotting, construction, operation and monitoring of a sanitary landfill, and provides the basic guidelines for the specific design of the sanitary landfill, its pollutant control works and complementary works, as well as construction and operative specs to suitably run the landfill and the establishment of an on-site environmental monitoring program
NOM-087-ECOL-1995	Establishes the requirements for the segregation, , packing, storage, collection, haulage, treatment and final disposal of hazardous, biologically infectious generated at the medical attention facilities (Clarification June 12 th , 1996)
NOM-133-ECOL-2000	Environmental protection – polychlorinated biphenyls (PCBs) – handling specs
Mexican Standard NMX-AA-15-1985	Protection of the environment – soil pollution – Municipal solid wastes – volume reduction method. It establishes the volume reduction method for municipal solid wastes and obtaining of specimens for laboratory analyses
Mexican Standard NMX-AA-19-1985	Protection of the environment – soil pollution – municipal solid wastes – bulk density. It outlines a method to determine bulk density of municipal solid wastes at the location where the volume reduction operation took place
Mexican Standard NMX-AA-22-1985	Protection of the environment – soil pollution – municipal solid wastes – selection and quantification of by-products. It establishes the selection criteria and methods for the quantification of by-products in municipal solid wastes
Mexican Standard NMX-AA-061-1985	Protection of the environment – soil pollution – municipal solid wastes – Generation. It outlines the techniques to develop the calculation of the generation of wastes by the population to be served
Mexican Standard NMX-AA-91-1985	Protection of the environment – soil pollution – municipal solid wastes – Terminology. Support for the understanding of the concepts employed within the standards referred above.

2.1.2.2 Organization Concerned

a. Secretariat of Environment and Natural Resources (SEMARNAT)

Its fundamental purpose is to build a governmental policy on environment protection that revert the ecological deterioration trends and sets the ground for a sustainable development of the country.

Its core activities comprise the formulation, conduction and evaluation of national policies on environment and natural resources; also, to promote and encourage the sustainable development of natural resources, to oversee the compliance with environmental codes, halt and revert deterioration of the environment.

b. National Water Commission (CNA)

Created by Presidential decree in January 1989 as a decentralized administrative body of the former Secretariat of Agriculture and Hydraulic Resources as the instance in charge of the integral management of water. Currently the CNA is found within SEMARNAT structure.

The CNA expects Mexico to be a nation with a safe supply of water required for its development, to efficiently use this resource, to acknowledge the strategic and economic value of water, to protect water bodies and to preserve the environment for future generations.

In order to fulfill this national purpose, the CNA has the vision of being a regulative body with technical excellence and promoter of society participation and users duly organized for water administration; it also has the mission to manage and preserve domestic waters with the participation of the society, so as to achieve a sustainable use of water.

c. Mexican Institute of Water Technology (IMTA)

Created by presidential Decree on August 7th, 1986, as a decentralized body of the Secretariat of Agriculture and Hydraulic Resources, with the purpose of developing technology and raising the required and qualified human resources to ensure a rational and integral utilization and management of water. Currently this institute lies within SEMARNAT's administrative structure.

d. National Ecology Institute (INE)

Its vision is to become a leading public body in applied environmental research, developing and promoting scientific cooperation projects that effectively solve Mexico's acute environmental issues and support the conservation and restoring of the environment throughout the country.

e. Federal Environmental Protection Agency (PROFEPA)

Its mission is to strive for environmental justice through the strict compliance with the law, driving away impunity, corruption, apathy and authority voids, involving all sectors of the society in this fight and the three governmental levels, under the purest principles of fairness and justice.

2.1.2.3 Environmental Impact Evaluation Process in the Country

The federal procedures are outlined in the LGEEPA, articles 28th through 35th bis 3 and in the codes of the Law on Ecological Balance and Environmental Protection in Environmental Impact Assessment Matters.

At a state level, the code in force is the Law of Ecological Balance and Environment Protection of the state of Quintana Roo, articles 24th through 39th.

Within the boundaries of the study herein, the following are the works that demand authorization as environmental impact is concerned, according to the LGEEPA regulations:

- Federal level (SEMARNAT): waste water treatment facilities that discharge liquids or sludge in bodies that belong to national property;
- State level (SEDUMA): Non hazardous, solid waste management and disposal systems.

2.2 Profile of the Study Area

2.2.1 Topography and Climate

The State is located in the Southeastern part of the Federation between the following coordinates: 21°37' and 17°53' latitude north, and 86°42' and 89°20' longitude west. Quintana Roo borders to the north with Yucatan State and the Gulf of Mexico; to the east with the Caribbean Sea; to the south with the Chetumal Bay and Belize; to the west with Campeche and Yucatan State. ¹

The State is composed of flat regions which follow the Yucatan Peninsula coastline; these areas extend further inland. However, some elevated areas are found in the middle of the Yucatan Peninsula; consequently, the highest points in the State are found along the border with the Campeche State and the northwestern part of the State in the border with Yucatan State. The highest points are Cerro El Charro (230 meters above sea level/masl), Cerro Nuevo Bécar (180 masl), and Cerro El Pavo (120 masl).

From the physiographical perspective, Quintana Roo can be classified in three sub-regions: Yucatecan Carso (limestone plateau) which covers 50% of the State surface, Campeche Carso (limestone plateau) and Lomeríos (hilly area) which covers 32% of the State surface, and Low Coastline of Quintana Roo which covers 18% of the State.²

According to INEGI, the climate in the Study Area is classified as hot sub-humid and/or hot humid. The average temperature is 25.5 C°.

Table 2-5: Average Temperature in the Study Area

Units: °C

Municipality	Meses												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Solidaridad	22.3	22.5	24.1	25.4	26.5	27.0	26.7	26.6	26.5	25.2	23.9	22.5	24.9
FCP	23.4	24.1	25.3	26.8	27.6	27.8	27.6	27.5	27.4	26.3	24.8	23.8	26.0
OPB	22.7	23.4	25.1	26.7	27.8	27.7	27.4	27.6	27.4	26.4	24.7	23.3	25.8
Benito Juárez	23	23	25	26	27.6	27.9	28.1	28.1	27.6	26.3	25	23	25.9
Lázaro Cárdenas	22	22	24	25	26.6	26.9	26.9	26.8	26.6	25.5	24	22	24.9
José Ma. Morelos	23	23	26	27	28.5	28.3	27.8	27.8	27.4	26.4	25	24	26.1
State Average	22.6	23.1	24.5	26.1	27.2	27.5	27.4	27.4	27.1	25.9	24.4	23.1	25.5

Source: elaborated by the S/T with data from CNA

The rainy season can be considered to last between 6 and 7 months (from May to October/November) and the dry season can be considered to last between 6 and 5 months (from November/December to April). The average precipitation in Quintana Roo State is approximately 500 mm higher than the national average (772 mm).

Table 2-6: Rainfall Values in the Ten States with Highest Rainfall (1941-2001)

Unit: mm

Federative Entity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Quintana Roo	66	38	31	34	100	175	121	140	209	165	95	82	1 256
National	26	18	15	19	40	103	138	137	141	74	32	29	772

Source: Estadísticas del Agua en México, Edición 2003, SEMARNAT/CNA

2.2.2 Hydrogeology

a. Regional Hydrogeology

The Peninsula of Yucatan is a geologic unit composed mainly of limestone intercalating evaporites, such as dolomite, gypsum and halite. These carbonate rocks are highly permeable and soluble. Dissolution of these rocks has created a karst topography with sinkholes (*Cenote*) that are generally found along fractures accompanied by regional north-northeast trending faults.

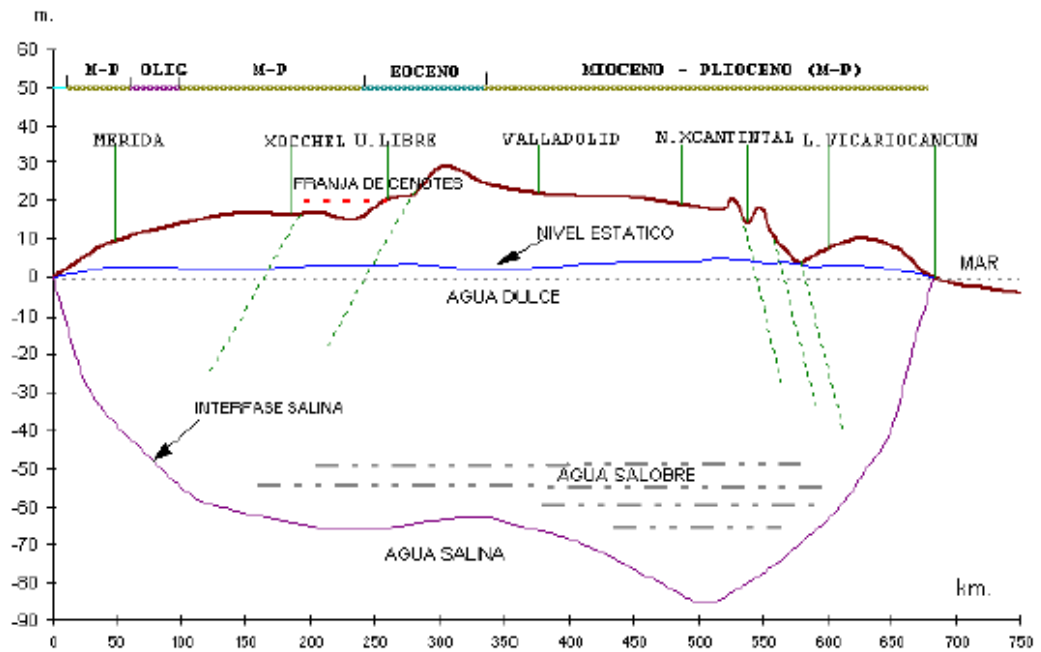
High precipitation in the rainy season directly infiltrates to the underground through fractures and sinkholes. Infiltrated water is stored in the soil, fracture and sinkholes, and mostly extracted to the air through evapo-transpiration. The rest of water reaches to the water table of limestone aquifer, then flows through the porous and fractured media and finally discharged to the sea.

According to the structural geologic analysis, at least two aquifer regions are identified in the Quintana Roo State. The first one is an aquifer composed of carbonate rocks of Paleocene and Eocene ages, which is distributed in the southern part of the state. The second aquifer is composed of the carbonate rocks of Miocene and Pliocene ages and distributed mainly in eastern part along the coast and the northern part of the state.

Groundwater of these aquifers can be divided into three groups from salinity point of view. They are fresh water, brackish water and seawater. A fresh water lens, resulting from the infiltration of rainwater, lies above a brackish water zone, which overlies seawater. Content of salts dissolved in the groundwater increases with depth and its ionic concentration pattern finally becomes very similar to those presented in the seawater.

Figure 2-1 shows a schematic hydrogeology cross section in northern Yucatan Peninsula from Cancun to Mérida. As shown in the figure, the saturated thickness of fresh water grows toward inland. Thickness of fresh water lens is smaller than 30 m in width of 20 Km from the coast and 30 to 50 m in the rest of the plains. In thickest area, it reaches nearly 100 m.

¹ Geostatistical Framework, INEGI, 2000



Fuente: CNA

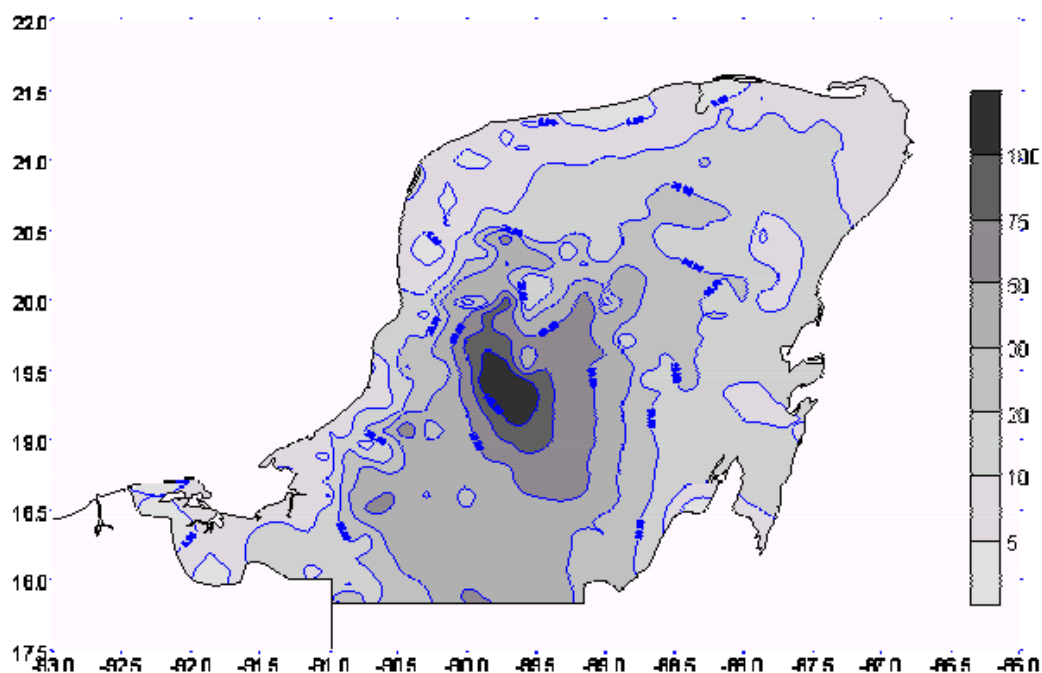
Figure 2-1: Schematic Hydrogeological Cross Section in Northern Yucatan Peninsula

b. Hydrogeologic Conditions

b.1 Depth of the static water level

Information of groundwater levels in the study area is very scarce. Although it is an old data, INEGI conducted a field measurement and made a contour map of the depth of the static water level in 1984. Figure 2-2 shows this map. According to the map, the smallest depths are located in the coastal area in the peninsula. It generally ranges from 5 m to 10 m. The depth increases toward inland. It ranges from 10 to 20m. In the central part of the peninsula, the depth exceeds 30 m to 50 m. particularly, in the southern center of the peninsula; groundwater exists in deeper zone between 70 and 150 m depth. However, the perched water body can be found locally in these areas at a depth from 5 to 10 m.

² INEGI, Physiographical Map 1:1 000 000



FUENTE: INEGI, 1984.

Figure 2-2: Depth of the Static Water Level

b.2 Elevations of the static level

As groundwater leveling has not been carried out since 1980's, elevation of static water levels is not well known at present. However, INEGI presented an elevation contour map of the Quintana Roo State in year 2002.³ According to the map, contour lines of 1 m to 10 m are distributed almost in parallel with the coast and in width of approximately 45 to 50 km. This means that the hydraulic gradient of the water table is very small. It is merely about 1/5,000.

On the other hand, groundwater level in southwestern part of the state shows 15 m to 30 m. The hydraulic gradient is slightly become high; however, it is about 3/5,000

Groundwater flow perpendicular to equi-potential line (elevation contour line). Therefore, in most of the state, groundwater flows toward the coast. In the southwestern part of the state, it flows in the direction of northeast to the Yucatan State and east to the sea. In Cancun and Kantnilikin areas, groundwater flows toward east and north. There are several municipalities' CAPA well fields in the area. Depression of water levels might have occurred, however, no such indication is found in the present contour map.

³ ESTUDIO HIDROLOGICO DEL ESTADO DE QUINTANA ROO, INEGI 2002

b.3 Water level change

Continuous water leveling data, which is recorded such as automatic water level gauge, does not exist in the state. Recently CNA installed 30 monitoring wells in the northern part of the state, Cancun-Tulum. Figure 2-3 shows the location of the monitoring wells and Table 2-1 also shows the static water levels in November 2002 and April 2003. The stations are periodically visited for leveling, however, the data is only available at 6 months interval at present.

Comparing with November 2002 and April 2003, groundwater levels slightly declined in April. This may be caused by 6 months dry period between end of rainy season (November) and beginning of dry season (April).

Although the change is small, it may result in decrease of freshwater lens thickness according to Ghyben-Herzberg Law. For instance, 10 cm of decline becomes approximately 4.0 m of decrease of freshwater lens. Therefore, it is very important to observe the water level changes continuously, particularly, in the coastal area.

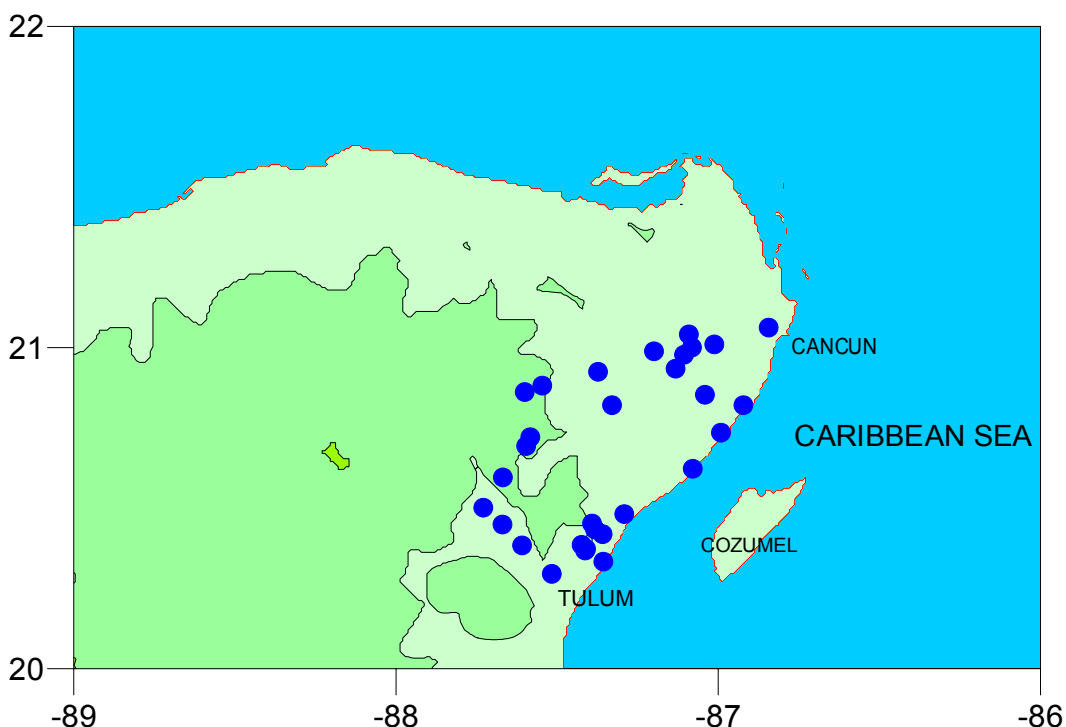


Figure 2-3: Location of Monitoring Wells in Cancun-Tulum

b.4 Groundwater extraction

The aquifers of the Peninsula of Yucatan are exploited by means of thousands of wells. As shown in Table 2-7, 1,685 production wells are registered in CNA. Most of the well water is used for agricultural purpose and urban water supply purpose stands the second.

Table 2-7: Number of Production and Injection Wells Registered in CNA

Item	Production Well				Injection Well			
	OPB	FCP	SOL	Total	OPB	FCP	SOL	Total
Agriculture	658	336	35	1,029	0	0	0	0
Domestic	65	1	11	77	0	0	0	0
Industry	19	1	11	31	6	1	10	17
Multiple	0	0	1	1	0	0	3	3
Livestock	95	33	8	136	0	16	0	16
Public Urban	147	74	26	247	3	1	2	6
Recreation	0	0	1	1	0	0	0	0
Service	29	4	129	162	82	3	169	254
Total	1,014	449	222	1,685	91	21	184	296

FCP: Felipe Carrillo Puerto, OPB: Othón P. Blanco SOL: Solidaridad

b.5 Groundwater Quality

Groundwater quality of the state is investigated by CNA. Figure 2-4 shows the distribution of hardness and chloride in groundwater. In the southwestern part of the state the concentration of both chloride and hardness is high, which is showing more than 500 mg/l. High concentration belt is also extending in northeast direction, which is concordant with the regional faults direction.

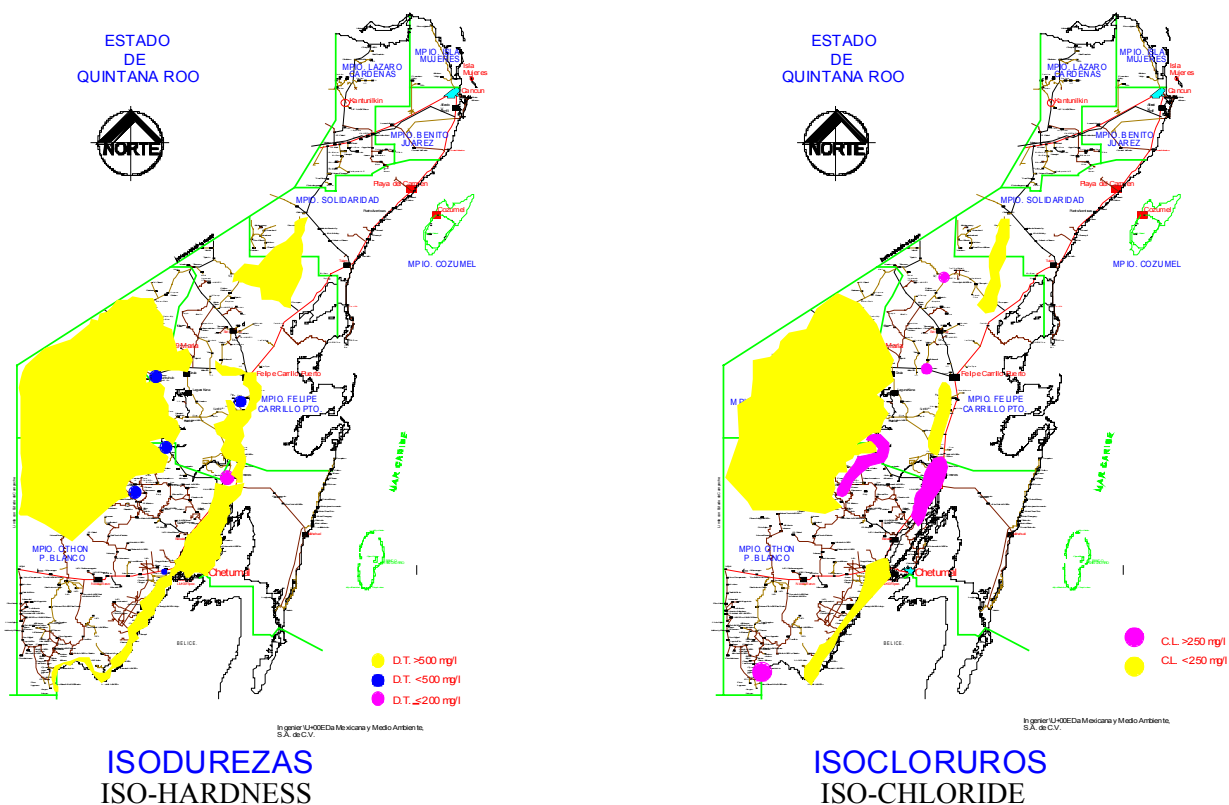


Figure 2-4: Distribution of Hardness and Chloride (After CNA)

b.6 Groundwater Balance of the Study Area

According to CNA (1989)⁴, a groundwater balance calculation is presented as shown in Table 2-8. On the other hand, based on the surface water balance presented in the same report, the Quintana Roo State receives 60,000 Mm³/year of precipitation and about 80% of this amount returns to the air through evapotranspiration. An estimated amount of recharge is 13,350 Mm³/year. Most of this groundwater amount flows out to Caribbean Sea and only 2.6% of the recharge was extracted by pumping in 1989.

Table 2-8: Groundwater Balance in the Quintana Roo State

(Quantity in Million m³/Year)

REVENUE	Quintana Roo State	Cozumel Island
Recharge	13,350	144
Total	13,350	144
EXPENDITURE		
Evapotranspiration	6,300	710
Discharge to sea	4,500	
Discharge to other area	1,350	
Discharge to Rio Hondo	850	
Pumping extraction	350	
Total	13,350	

⁴ SINOPSIS GEOHIDROLOGICA DEL ESTADO DE QUINTANA ROO, SECRETARIA DE AGRICULTURA Y RECURSOS HIDRAULICOS, COMISION NACIONAL DEL AGUA (1989)

2.2.3 Socioeconomic Conditions

2.2.3.1 Population

a. Population

The population of Quintana Roo state and of each municipality in 2000 are as following table:

Table 2-9: Population of Quintana Roo State 2000

		Total	Male	Female	M/F %
Quintana Roo State		874,963	448,308	426,655	105.1
Municipality	Benito Juarez	419,815	215,352	204,463	105.3
	Cozumel	60,091	31,060	29,031	107.0
	Felipe Carrillo Puerto	60,365	30,682	29,683	103.4
	Isla Mujeres	11,313	5,930	5,383	110.2
	Jose Maria Morelos	31,052	16,023	15,029	106.6
	Lazaro Cardenas	20,411	10,537	9,874	106.7
	Othón P. Blanco	208,164	104,314	103,850	100.4
	Solidaridad	63,752	34,410	29,342	117.3

Source; INEGI, 2000, XII Censo General de Población y Vivienda

An important characteristic of Quintana Roo population is of its distribution pattern. Populations are dispersed in many small rural communities. It is vital to understand this population distribution structure for planning appropriate sanitation systems for respective communities. The communities are classified in three categories according to the population size. This division of urban, semi urban and rural is in accordance with SEDUMA's information which is based on INEGI's data. Population line of 2,500 is also used by CAPA for the classification of urban and rural areas.

Table 2-10: Communities and population – 2

Municipality	Population based on community size			Total
	Rural (1 – 2,499)	Semi urban (2,500 – 14,999)	Urban (15,000 -)	
Othón P. Blanco	63,307	23,225	121,602	208,134
Felipe Carrillo P.	33,657	8,163	18,545	60,365
Solidaridad	13,406	6,733	43,613	63,732
Number of Communities	1,245	8	3	1,256
Total Population	110,370	38,121	183,760	332,251
Percentage	33%	12%	55%	100%

Source; INEGI, 2000, XII Censo General de Población y Vivienda

Population tends to concentrate in urban areas where a rapid population growth takes place like in Playa del Carmen, where people can find jobs related with urban developments and tourism developments. Population growth of the study area in the past 20 years is as follows;

Table 2-11: Population Growth (1970 – 1990)

	1970	1980	1990
Quintana Roo	88,150	225,985	493,277
Felipe C Puerto	32,134	32,506	47,234
Othón P Blanco	36,347	97,999	172,563
Solidaridad/Cozumel*	12,622	32,270	44,903

Source; INEGI, * Solidaridad was together with Cozumel until 1994. Population of 1970, 1980, and 1990 includes Cozumel and Solidaridad. After 1994 Solidaridad was an independent municipality.

b. Tourists

Quintana Roo state has abundant tropical forests, lagoons, bays, as well as culture and history, however, in spite of the multi efforts of the state, tourism has been promoted for activities of sun and beach so far. Unfortunately or fortunately historical and archeological heritages of tourism resources are secondary. According to the state ministry of tourism number of incoming tourists is as follows;

Table 2-12: Number of incoming tourist in Quintana Roo

	1999	2000	2001	2002
Cancun	2,818,326	3,044,682	2,987,841	2,827,406
Cozumel	398,737	421,541	455,620	383,676
Chetumal	157,821	207,582	205,216	204,371
Isla Mujeres	140,534	144,793	141,785	141,548
Riviera Maya	767,541	1,184,249	1,504,052	1,793,864
Total	4,282,959	5,002,847	5,294,514	5,350,865

Source; State Ministry of Tourism, Quintana Roo

2.2.3.2 Regional Economy

a. State of Quintana Roo

INEGI data indicated that the gross regional product (GRP) of Quintana Roo State in the year 2000 was 69,474 Million Pesos at current prices. As the 2000 Census indicated a population of 873,804, the per capita GRP in the year 2000 would be estimated as about 79,500 Pesos. At the exchange rate of 9.57 Pesos per US dollar at the end of December 2000, the 2000 GRP would be approximately USD7,260 Million, and the equivalent per capita GRP would be around USD8,300. This indicates that the per capita GRP of Quintana Roo State in 2000 was higher than the country as a whole. Tourism development in Quintana Roo State during the past 30 years has had the effect of greatly improving the GRP of the State, as one-third of tourism income of Mexico is estimated to be generated in Quintana Roo. Tourism induced development, however, has not taken place in a balanced manner among regions of the State, as tourism benefits have been concentrated mostly in the northern region of the State on the

Caribbean Sea. This situation seems to be changing, as new tourism development is planned and taking place in other coastal regions of the State.

According to INEGI data, the GRP of Quintana Roo State valued at 1993 prices was 14,847 Million Pesos in 1993 and 19,555 Million Pesos in 2000, implying a yearly growth rate of 4.0% between 1993 and 2000. This growth rate was slightly higher than the country as a whole during the same period. Sector performance differed, as the yearly growth rate was negative for the agriculture sector (-6.0%), while positive for the industrial sector (1.8%) and the service sector (4.3%). The same data also indicated the increasing share of the service sector and the declining shares of the agriculture and the industrial sectors in the Quintana Roo State GRP between 1993 and 2000, as indicated in the following table.

Table 2-13: Gross Regional Product (GRP) of Quintana Roo State

Sector	GRP 1993 (Million Pesos)	GRP 2000 (Million Pesos)	1993 Sector Share (%)	2000 Sector Share (%)	1993-2000 Growth Rates (%)
Total GDP	14,847	19,555	100.0	100.0	4.0
Agriculture	275	178	1.8	0.9	-6.0
Industry	1,021	1,160	6.9	5.9	1.8
Service	13,551	18,217	91.3	93.2	4.3

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

The 2000 GRP broken down into activities indicated the service sector comprising more than 90%, the most important activities being “commerce, restaurant, hotel” comprising around 54% of GRP, followed by “communal, social, personal services” with some 16%, “financial service, insurance, real estate” with 14%, “transport, storage, communications” with 9%, “manufacturing” with 3%, “construction” with 2%, and around 2% combined for “agriculture”, “mining” and “electricity, gas, water”.

In terms of the number of the economically active population employed in diverse activities in Quintana Roo in February 2000, “hotel and restaurant” accounted for around 18%, “commerce” 17%, “agriculture” 10%, “construction” 8%, “manufacturing” 7%, and “transportation and storage” 6%. Available data on yearly income by activity in Quintana Roo refers to 1998, indicating the following.

Table 2-14: Estimated Yearly Income in Quintana Roo State

Activity	Yearly Income in 1998 (Pesos)
Agriculture	4,000
Manufacturing	19,000
Retail commerce	18,000
Transportation & storage	43,000
Financial & insurance service	38,000
Professional service	76,000
Hotel & restaurant	34,000

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

b. Municipalities

b.1 Othon P Blanco

Of 348,750 economically active population (EAP) of Quintana Roo State in the year 2000, Othón P. Blanco Municipality accounted for 74,223 or 21% of the State. Judging from the sector distribution of EAP, the structure of the economy in Othón P. Blanco Municipality had a more active agriculture sector and less active service sector than Quintana Roo State as a whole. In fact, EAP in the agriculture sector comprised 20% in Othón P. Blanco, while only 10% in the State. EAP in the industrial sector was even at 16% both in Othón P. Blanco Municipality and the State. Conversely, EAP in the service sector was higher at 73% in Quintana Roo State, and 64% in Othón P. Blanco Municipality.

Located in Othón P. Blanco Municipality is Chetumal, the main city of the Municipality and the capital city of Quintana Roo State. Government offices are located in Chetumal, implying the need for government workers to live in the city, thereby increasing the EAP in the service sector. Despite inadequate soil, agriculture has been traditionally important within Othón P. Blanco Municipality, with extensive sugarcane plantations (19,800 ha harvested in 2001) and a sugar processing plant in the area. Industrial development is yet to take place, as indicated by the 16% of EAP employed in this sector. Except for the sugar processing plant, manufacturing consists of small scale processing of agricultural products. One tourism development plan that is being implemented targets cruise ships, with considerable investments already made in the Costa Maya area, specifically Mahahual. Recent investments of more than USD20 Million in the Mahahual dock for cruise ships and supporting facilities (duty free shops, open air theatre) have brought in already more than 140 cruise ships and more than 305,000 passengers, thereby quickly becoming one of the main cruise ship destination in Mexico. Hence, future expectations for tourism development are high on the basis of servicing cruise ship passengers, ecotourism and such attraction as the largest coral reef in the northern hemisphere, Banco Chinchorro, off the coast of Mahahual.

b.2 Felipe C Puerto

Of 348,750 economically active population (EAP) of Quintana Roo State, Felipe Carrillo Puerto Municipality accounted for 17,595 in 2000, and the EAP in the city of Felipe Carrillo Puerto was estimated at around 2,500. Judging from the sector distribution of EAP, the structure of the economy in Felipe Carrillo Puerto Municipality was quite different from that of Quintana Roo State as a whole. In fact, EAP in the agriculture sector comprised 50% in Felipe Carrillo Puerto Municipality, while only 10% in the State. EAP in the industrial sector was 12% in Felipe Carrillo Puerto Municipality and 16% for the State. EAP in the service

sector was lopsided in Quintana Roo State at 73%, but only 38% in Felipe Carrillo Puerto Municipality.

Within Felipe Carrillo Puerto Municipality, agriculture was the main economic activity, but in the city of Felipe Carrillo Puerto, commerce and service were the most important economic activities. The industrial sector is rather weak, as indicated by the 12% of EAP employed in this sector. Tourism is not developed yet, but as the Sian Ka'an biosphere reserve was declared a World Heritage site by UNESCO in 1987, potential development in the future may be based on ecology related attractions.

b.3 Solidaridad

Of 348,750 economically active populations (EAP) of Quintana Roo State, Solidaridad Municipality accounted for 28,604, or around 8% of the State in 2000. Judging from the sector distribution of EAP, the structure of the economy in Solidaridad Municipality was more similar to that of Quintana Roo State as a whole, although with a smaller share of the agriculture sector, and slightly higher shares of industry and service sectors than the State as a whole. In fact, EAP in the agriculture sector comprised 5% in Solidaridad Municipality and 10% in the State, while EAP in the industrial sector was 19% in Solidaridad Municipality and 16% in the State, and EAP in the service sector was 76% in Solidaridad Municipality and 73% in Quintana Roo State.

Within Solidaridad Municipality, tourism is the main economic activity, blessed with such tourist attractions as Playa del Carmen and Tulum, which are visited by approximately one million tourists a year. The industrial sector is not well developed as indicated by the 19% of EAP employed in this sector. The service sector was unquestionably the most important with 76% of EAP in 2000. Hotels & restaurants concentrated around 34% of EAP, followed by commerce with around 14%. Known as Riviera Maya, 132 hotels are estimated to operate in the area, and the huge inflow of tourists has required people of different skills to service the visitors, thereby giving rise to the highest population growth rate registered in Latin America.

2.2.3.3 Municipal Administration Structure

a. Othon P Blanco

The city government is composed of the Mayor, one Vice Mayor, 9 representatives elected by relative majority and 6 representatives elected by proportional representation; substitutes are also elected for the Vice Mayor and the representatives.

The residents can get organized in town governments, delegations and subdelegations to manage their interests in accordance to the number of inhabitants in each locality.

The Municipality through its Bureau of Urban Development and Ecology is in charge of the administration of urban development and the Bureau of Municipal Public Services has the responsibility for solid waste management (cleansing/sweeping and collection).

The cleansing and collection service can be contracted out to the private sector, or can be done in association between the Municipality and the State, and/or the Federation; municipal public services are subjects to tariffs approved by the Municipal Government and the respective Commission.

b. Felipe C Puerto

The Municipal government is composed of the Mayor, one Vice Mayor, six representatives elected by relative majority and three representatives elected by proportional representation; substitutes are also elected for the Vice Mayor and the representatives.

Organisms representing the municipal authority were created to support the Mayor, including town governments, which are decentralized collegiate organisms in charge of cleansing and solid waste collection, among other services.

The cleansing service is provided by the Bureau of Municipal Public Services, which coordinate their activities directly with the Mayor. Drinking water supply and sewer services are responsibility of CAPA.

c. Solidaridad

The Municipal government is composed of a Mayor, in addition to one Vice Mayor, six representatives elected by relative majority and three representatives elected by proportional representation, all with their substitutes. The executive structure is composed of the Mayor, General Secretary, Treasurer and the administrator.

As support to administration, there are the Bureaus of Planning and Development, Public Works, Urban Development and Ecology, and Municipal Public Services. The last one has the responsibility for the cleansing service. The administration has 6 delegations and 10 subdelegations.

2.2.3.4 Education

a. Othon P Blanco

The Municipality of Othón P. Blanco is the one that more wide educational covering offers in the whole state. The municipality has 6 schools of initial education, 8 of special education, 168 of elementary education, 223 of primary education, 97 of secondary education, 2 of middle professional education, 32 of middle-high education, 1 of normal education and 7 of

college education. The index of the population's literacy of 15 years old was of approximately 89.0% in 1995, percentage, which stays as the same level up to the 2,000.

b. Felipe C Puerto

The municipality has 17 schools of formal pre-school education and 41 schools of indigenous pre-school education. There are 44 formal primary schools and 32 indigenous primary schools. At secondary level there are 5 high schools and 33 tele-secondary schools. At higher education level it has 6 colleges, the Regional Center of Pre-school Formal Education and the High Technological Institute.

c. Solidaridad

This municipality has an educational system from the elementary up to middle-higher education. There are 2 schools of special education, 29 of elementary education, 39 of primary education, 11 of secondary and only 2 of middle-high education.

The lack of opportunities in higher education levels has forced the youths to go other vicinity municipalities, especially Cozumel and Benito Juarez. In the case of higher education level, the students change their residence place toward Chetumal or Yucatan.

2.2.3.5 Poverty Conditions

The table below shows poverty conditions of the Study Area. As the Poverty Index shows, proportion of population under poverty in FCP is considerably higher than the average of the state. Also, Solidaridad is high although its economy has been growing rapidly due to tourism.

Table 2-15: Poverty Index in Quintana Roo (Year 2000)

Municipality	Poverty index	Population under poverty	Percentage of population
Quintana Roo	1.00	88,330	12.6
Othón P. Blanco	0.92	23,363	11.6
Felipe Carrillo Puerto	1.66	11,719	20.9
Solidaridad	1.72	6,221	21.6

Source: Information provided by SEDUMA based on INEGI statistic data

2.2.4 Land Use and Development Plan

2.2.4.1 Land Use

a. State of Quintana Roo

Vast area of the territory is covered with forest and jungle, and vast area is not highly utilized. Only tiny portion of the state is intensively utilized. According to the official figure of the

Quintana Roo government the state area is 50,843Km², in which the area inhabited by more than 2,500 populations, is only 9,832ha (0.2%).

a.1 Land use control

The land use was used to be controlled mainly by Federal (SEMARNAT), State (SEDUMA), and partially by Municipality. However, this system of land use control was altered in 2000, giving much power to Municipal government. Therefore, developers who intend to make a development should approach to the corresponding municipality (Department of Urban Development and Ecology). Then the municipal government will guide the developer to consult with the federal or/and state government according to the location, scale, and kind of development.

a.1.1 POET

Roughly speaking most of coastal areas are controlled according to POET (Programa de Ordenamiento Ecológico), and rest of the areas are controlled according to PEOT. Quintana Roo State government designated areas of urban development control or nature conservation areas by issuing the ordinance of land use zoning with maps and tables (POET). The detailed land use and restrictions are illustrated in POET, which includes;

- Designated areas
- Policy on the areas, e.g. conservation area, protection area, economic activity area, etc.)
- Land use
 - Dominant land use, e.g. low density tourism area
 - Suitable land use, e.g. flora and fauna management
 - Restricted use, e.g. tourism
 - Prohibited use, e.g. agriculture, timber industry
- Detail criteria, e.g. allowable building area, number of rooms per ha

This land use control will be adjusted every 5 years. For instance, even though the allowable number of rooms are 1 room per hectare at present, later it may be changed to 2 rooms per hectare. The following figure shows the location of areas covered by each POET and the covered area by PEOT & ANP(National Protected Area).

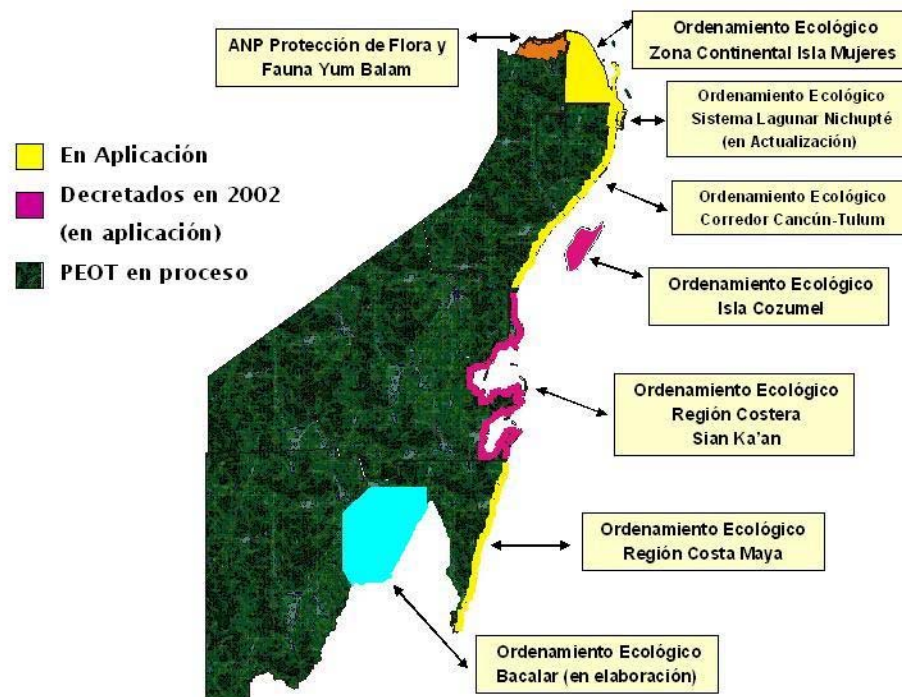


Figure 2-5: Location of POET area and PEOT coverage

POET Bacalar is currently in process. Other 6 POETs are already enacted. However, POET Sistema Lagunar Nichupte is in process of revising. In the Study area there are following three POETs.

1. Costa Maya area (6 oct. 2000)
2. Sian Ka'an Biosphere Reservation area (14 May 2002)
3. Cancun –Tulum Corridor (16 Nov.2001)

a.1.2 Nature protection area

Besides above there are 10 areas of nature protection and conservation controlled by the federal government. These 10 areas cover 981,172ha. Among 10 there are following 5 areas within the Study area.

Table 2-16: Natural Protection Area under Federal Control in Study Area

	Category	Location	Date of Decree	Area (ha)
1	Archeological monument in Tulum (National Tulum Park)	Solidaridad	23 April 1981	664
2	Biosphere reservation of Sian Ka'an	Felipe C Puerto, Solidaridad	20 Jan. 1986	528,147
3	Coral reef reservation of Sian Ka'an	Felipe C Puerto, Solidaridad	2 Feb. 1998	34,927
4	Flora and fauna protection area in Uaymil	Felipe C Puerto, Othón P Blanco	17 Nov. 1994	95,415
5	Biosphere reservation of Chinchorro coral reef	Othón P Blanco	19 Jul. 1996	144,360
Total				803,513

Source: Gobierno del Estado de Quintana Roo

Quintana Roo state by itself decided 6 areas of natural protection, covering 284,548ha in total. Among those the following 2 areas are in the Study area.

Table 2-17: Natural Protection Area under State Control

	Category	Location	Date of Decree	Area (ha)
1	Ecological conservation zone, Sea turtle sanctuary	Xcacec-Xcacecilito Solidaridad	21 Feb 1998	362
2	Ecological conservation zone, Manatee sanctuary	Chetumal bay Othón P Blanco	24 Oct 1996	281,320
Total				281,682

Source: Gobierno del Estado de Quintana Roo

b. Municipalities

b.1 Othon P Blanco

The municipal area of Othón P Blanco is 18,760 km². There are 759 localities in the municipality. Among these urban localities are 7 according to PEDU by SEDUMA, which are Chetumal, Bacalar, Carderitas, Nicolas Bravo, Ingenio Alvaro Obregón, Alvaro Obregón, and Sergio Butron Casas. While rural localities are 752. The area of urban localities is 2,773ha, which is about 0.15% of the total municipal area.

As for the area of Coast Maya a land use zoning map and related documents are prepared by the state of Quintana Roo in order to control the development in Costa Maya. This is Program of Ecological Land Development for Cost Maya Region (POET, 6 Oct. 2000). This ordinance consists of tables and zoning maps, and describes the detail rules of land use. The map covers approx. 120km long area of Costa Maya.

b.2 Felipe C Puerto

The municipal area of Felipe Carrillo Puerto is 13,806km². There are 213 localities in the municipality. Among these urban localities are three, which are Felipe Carrillo Puerto, Chunhuhub, and Tihosuco. While rural localities are 210. The total area of urban localities is 930ha, which is only 0.067% of the total municipal area.

The federal government designated Sian ka'an as a special reservation area of the country in 1986. In order to control developments in Sian Ka'an area Quintana Roo state made an ordinance, Program of Ecological land Development for Sian Ka'an Biosphere Reservation (POET, 14 May 2002). This development control ordinance consists of tables and zoning maps, describing the detail control of land use. In fact Sian Ka'an area is strictly protected by law. Practically it is quite difficult to begin a development in this area.

c. Solidaridad

The municipal area of the Solidaridad is 4,419 Km². There are 284 localities in the municipality. Among these urban localities are only 2, which are Playa del Carmen and Tulum, while rural localities are 282. Urban localities have an area of 257ha, which is 0.057% of the total municipal area.

2.2.4.2 Development Plan

a. State of Quintana Roo

There have been many development plans prepared not only by the state level, but also by federal level and municipal level. There are general plans and sector plans. They are not always integrated. The relationship and hierarchy are not always clear. There are some duplications and some vacuums. Related plans and programs are as follows.

Table 2-18: Development Plans

Plan	Description
Plan Nacional de Desarrollo 2001-2005 (PND)	This sets the basic policy of the development of the country. Some of sector programs are yet in course of preparation.
Programa Nacional de Desarrollo Urbano (PNDU)	This is one of the sector programs of the above "Plan Nacional de Desarrollo 2001-2005. This program sets the guide lines for the federal policy on urban development; it is also the reference to state and municipal levels of urban development and human settlements.
Programa Estatal de Desarrollo Urbano de Quintana Roo 2000-2025 (PEDU)	This is a state level development program following to (PNDU). This sets the urban development policy for the whole state in general. SEDUMA is the main body to prepare this Program. In this development plan SEDUMA forecasts the influx of population and the resulting urban expansion will continue in the tourist areas, but in the rest of area the population increase will be within the natural increase. The magnitude of population increase is remarkable in the tourist oriented coastal area.
Programa de Ordenamiento Ecologico Territorial (POET)	These ordinances of programs focus on rapidly developing areas where the conservation of ecology is necessary in the state.
Programa Estatal de Ordenamiento Territorial (PEOT)	This covers the entire state of Quintana Roo, specially those areas which are not covered by any (POET). This is the tool for protecting natural resources in the state. This focuses on two perspectives; <ul style="list-style-type: none"> To control natural protected areas until more precise management program (POET) will be prepared. To control any activity based on the framework of the ecological ordinance
Plan Estrategico de Desarrollo Integral de Quintana Roo 2000-2025 (PEDI)	Quintana Roo prepared this long term plan by the initiative of the governor. In order to develop Quintana Roo state the following four points are mentioned; <ul style="list-style-type: none"> To achieve the state development on the bases of the tourism development To achieve the development balance among the communities To achieve a sustainable development To link Quintana Roo state to the global world
Plan Estrategico de los Sevicios de Agua Potable, Alcantarillado y Saneamiento 2001-2025	This is one of the sector plans of above PEDI
Plan Basico de Gobierno (2000-2006)	This is made every 6 years for a new governor's term. This is prepared by the coordination of SEPLADER (Secretario de Planeacion y Desarrollo Regional). This plan forms the base of the state policy.
Programas Municipales de Desarrollo Urbano (PMDU)	This is municipal level urban development plan subordinating to PND, PEDU and other federal and state level plans. This plan is of 3 year plan.

b. Municipalities

b.1 Othon P Blanco

The municipality of Othón P Blanco has three year development plan, "Programa de Desarrollo Urbano del Municipio de Othón P Blanco" The ambitious but desirable scenario, based on this state development plan, states the following forecasts;

- Mahahual would grow to 60,000 inhabitants in 2010 and 100,000 in 2025
- Bacalar would accommodate 17,428 inhabitants in 2010 and 30,000 in 2025
- Limones would have 13,127 inhabitants in 2010 and 30,000 in 2025
- Chetumal would have 149,665 inhabitants in 2010 and 190,498 in 2025
- Xahuachol would accommodate 12,000 inhabitants in 2010 and 30,000 in 2025

b.2 Felipe C Puerto

Felipe Carrillo Puerto prepared “Programa de Desarrollo Urbano del Centro de Poblacion de Felipe Carrillo Puerto, Quintana Roo” in order to define and establish the strategies, approaches and actions for the economic, tourism, ecological, and urban integral development. This three year plan has been prepared in coordination with the state government basic plan 1999-2005.

c. Solidaridad

The municipality of Solidaridad has its own three year development plan, “PLAN DE DESARROLLO MUNICIPAL DE SOLIDARIDAD, 2002-2005”. The Plan sets strategies for the development like follows;

- To regulate the urban development by establishing the bases for improvement and conservation.
- To define the land use and to regulate the expanding area in order to achieve the sustainable development
- To improve the level of people’s life

2.2.5 Financial Conditions

a. State of Quintana Roo

a.1 Income and Expenditures

The income and expenditures of Quintana Roo State in the year 2000 amounted to 5,105 Million Pesos. On the other hand, the income and expenditures of all Municipalities in the State in the year 2000 amounted to 1,350 Million Pesos.

“Transfers” and “Federal Participation” comprised around 85% of Quintana Roo State income, and 50% of Municipal income. “Taxes” and “Fees” are relatively more important in the Municipal income. On the expenditures side, “Transfer payment” was the largest component for the State at 69% (composed of 55% subsidy, 13% participation and 1% aid). The largest expenditure of all Municipalities was “Administrative expenses” with 62%.

The below table shows details of income and expenditures of Quintana Roo State and of all Municipalities of the State in the year 2000.

Income and Expenditures at the State and Municipal levels suggest that a large component of income consists of funds transferred from the immediately higher level government, and these funds are spent as transfer payments on the immediately lower level government. In other words, the State government receives funds from the Federal Government and transfers them to Municipal governments. These transfers reportedly take place at a 80:20 ratio, that is, the Federal Government keeps 80% of income and transfers 20% to States. A State, in turn, keeps 80% of the transfer received from the Federal Government and transfers 20% to Municipalities. This allocation ratio appears to be the subject of some debate, as local governments, especially those with large tourist inflows, apparently would like a revision toward a higher share in the federal income.

Table 2-19: Income and Expenditures of Quintana Roo State & Municipalities in 2000

Income and Expenditures	Monetary Value (Million Pesos)		Percentage		
	Q. Roo State	Municipalities	Q. Roo State	Munic.	Mun/State
INCOME	5,105.10	1,350.38	1.0000	1.0000	0.2645
Income during 2000	4,865.59	1,307.70	0.9531	0.9684	0.2688
Taxes	250.79	229.84	0.0491	0.1702	0.9165
Federal share	1,810.73	470.97	0.3547	0.3488	0.2601
Improvements	0.00	0.55	0.0000	0.0004	
Fees	124.43	155.56	0.0244	0.1152	1.2502
Products	83.99	20.02	0.0165	0.0148	0.2384
Exploitation	46.04	93.00	0.0090	0.0689	2.0200
Public debt	0.00	31.69	0.0000	0.0235	
Third party	62.38	0.00	0.0122	0.0000	0.0000
Transfer	2,487.23	232.80	0.4872	0.1724	0.0936
Other Income	0.00	73.27	0.0000	0.0543	
Funds from Previous Year	239.51	42.68	0.0469	0.0316	0.1782
EXPENDITURES	5,105.10	1,350.38	1.0000	1.0000	0.2645
Administrative Expenses	774.65	833.76	0.1517	0.6174	1.0763
Administrative office	409.59	502.83	0.0802	0.3724	1.2276
Public security	13.82	0.00	0.0027	0.0000	0.0000
Public education	1.60	0.00	0.0003	0.0000	0.0000
Miscellaneous	349.64	330.93	0.0685	0.2451	0.9465
Public Works & Promotion	550.55	290.96	0.1078	0.2155	0.5285
Public works	295.19	246.18	0.0578	0.1823	0.8340
Promotion & acquisition	255.36	44.78	0.0500	0.0332	0.1754
Transfer Payments	3,505.54	141.84	0.6867	0.1050	0.0405
Subsidy	2,771.90	3.08	0.5430	0.0023	0.0011
Aid	56.10	37.28	0.0110	0.0276	0.6645
Participation & pay back	677.54	101.48	0.1327	0.0751	0.1498
Public Debt	55.79	54.58	0.0109	0.0404	0.9783
Available Funds (Disponibilidades)	26.67	26.88	0.0052	0.0199	1.0079
Third Party	186.93	1.49	0.0366	0.0011	0.0080
Other Expenses	4.97	0.87	0.0010	0.0006	0.1751

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

a.2 Public Investment

Public investment in Quintana Roo State in 2001 amounted to 885.09 Million Pesos, with varied financing sources as indicated below.

Table 2-20: Public Investment by Sector in Quintana Roo in 2001

Sector	Monetary Value (Million Pesos)				
	Total	Federal	State	Municipal	Credit
Total	885.09	230.71	354.49	295.37	4.52
Education	299.05	84.90	162.04	52.11	0.00
Urban Development	218.31	66.78	39.30	110.09	2.14
Communication & Transport	69.50	35.15	25.11	7.71	1.53
Administration & Finance	60.32	2.29	20.43	36.96	0.64
Agriculture & Forestry	57.50	13.33	42.44	1.73	0.00
Drinking Water	46.05	16.46	27.18	2.20	0.21
Social Welfare	27.68	0.00	7.27	20.41	0.00
Electricity	23.47	0.95	2.98	19.54	0.00
Ecology	18.33	0.29	17.44	0.60	0.00
Security	17.02	0.00	0.00	17.02	0.00
Sport	16.68	0.98	0.34	15.36	0.00
Culture	10.56	0.00	7.08	3.48	0.00
Tourism	9.57	9.47	0.10	0.00	0.00
Health	4.09	0.00	0.00	4.09	0.00
Housing	3.95	0.11	0.11	3.73	0.00
Trade & Supply	2.74	0.00	2.43	0.31	0.00
Fishing	0.27	0.00	0.24	0.03	0.00

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

The above table shows that public investment during 2001 in specific sectors amounted to 46.1 Million Pesos in the Drinking Water, 18.3 Million Pesos in Ecology, 9.6 Million Pesos in Tourism, and 4.1 Million Pesos in Health.

Federal funds financed mostly Education, Urban/Social Development, and Communications & Transportation Sectors. State funds were concentrated in financing Education, Agriculture & Forestry, and Urban/Social Development Sectors. Municipal funds financed Urban/Social Development, Education and Administration & Finance Sectors. Credit financed Urban/Social Development, Communication & Transportation, and Administration & Finance Sectors. These sectors amounted to 70% or more of each financing source.

b. Municipalities

b.1 Public Finance

b.1.1 Othon P Blanco

The income and expenditures of Othón P. Blanco Municipality in the year 2000 amounted to 200.1 Million Pesos, equivalent to 14.8% of the budget of all Municipalities in Quintana Roo State. The most important income source was “Federal participation” or “Federal share” with

79.3 Million Pesos (39.6%), followed by Transfers with 68.8 Million Pesos (34.4%), Taxes with 11.7 Million Pesos (5.9%), Public Debt at 11.33 Million Pesos (5.7%), and Fees with 10.6 Million Pesos (5.3%). Income as Taxes and Fees in Othón P. Blanco Municipality was lower than the average of all Municipalities in the State, while Federal Participation and Transfers were quite a bit higher.

On the expenditure side, Administrative Expenses amounted to 112.1 Million Pesos (56%), followed by Public Works & Promotion with 66.6 Million Pesos (33.3%), and Transfer Payments with 16.4 Million Pesos (8.2%). Expenditures on Public Works & Promotion in Othón P. Blanco Municipality were considerably higher than the average of all Municipalities in the State.

Table 2-21: Income & Expenditures of Othón P. Blanco in 2000

Income & Expenditures	All Municipalities (Million Pesos)	Othón P. Blanco (Million Pesos)
INCOME	1,350.38	200.13
Income during 2000	1,307.70	200.13
Taxes	229.84	11.74
Federal share	470.97	79.26
Improvements	0.55	0.00
Fees	155.56	10.60
Products	20.02	3.37
Exploitation	93.00	6.11
Public debt	31.69	11.33
Third party	0.00	0.00
Transfer	232.80	68.84
Other Income	73.27	8.88
Funds from Previous Year	42.68	0.00
EXPENDITURES	1,350.38	200.13
Administrative Expenses	833.76	112.10
Public Works & Promotion	290.96	66.60
Transfer Payments	141.84	16.39
Public Debt	54.58	5.01
Available Funds (Disponibilidades)	26.88	0.00
Third Party	1.49	0.00
Other Expenses	0.87	0.03

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

b.1.2 Felipe C Puerto

The budget of Felipe Carrillo Puerto Municipality in the year 2000 amounted to 73.2 Million Pesos, equivalent to 5.4% of the budget of all Municipalities in Quintana Roo State. The most important income source was “Federal participation” or “Federal share” with 38.6 Million Pesos (52.7%), followed by Transfer Payments with 26.4 Million Pesos (36.1%), Public Debt at 3.8 Million Pesos (5.2%), while Taxes with 0.56 Million Pesos comprised only 0.77% of income, and Fees with 0.49 Million Pesos comprised only 0.67% of income. It appears that some 90% to 95% of municipal income in Felipe Carrillo Puerto came from federal sources

as “Participaciones” (Federal participation or share) and “Fondo de Aportaciones Federales” (Federal contribution or transfer). On the other hand, Taxes (“Impuestos”) and Fees (“Derechos”) comprised less than 1% of municipal income.

On the expenditure side, Administrative Expenses amounted to 41.7 Million Pesos (56.9%), followed by Transfer Payments with 20.6 Million Pesos (28.1%), and Public Works & Promotion with 10.8 Million Pesos (14.7%). Administrative Expenses, which include Personnel, Materials & Supplies, and General Services, comprised around 55% of total expenses. Public Works & Promotion as an expenditure item, jumped from around 15% of total expenditure in 2000 to around 40% in 2002. On the other hand, Transfer Payments decreased from around 28% in 2000 to 4% in 2002. A new expenditure item in 2002 was Municipal Strengthening with about 1% of total expenditures.

The budget of Felipe Carrillo Puerto Municipality in the year 2000 was balanced, but the 2002 results, just published in newspapers on June 24th 2003, indicated an income shortfall of 1.59 Million Pesos. The deficit was reportedly caused by an unexpected decline in federal funds foreseen as income in the budget.

A comparison of budgets of all Municipalities in Quintana Roo State and that of Felipe Carrillo Puerto Municipality is shown in the following table.

Table 2-22: Municipal Budget of Felipe Carrillo Puerto in 2000

Budget	All Municipalities (Million Pesos)	F. Carrillo Puerto (Million Pesos)
INCOME	1,350.38	73.20
Income during 2000	1,307.70	71.92
Taxes	229.84	0.56
Federal share	470.97	38.56
Improvements	0.55	0.00
Fees	155.56	0.49
Products	20.02	0.96
Exploitation	93.00	1.02
Public debt	31.69	3.80
Third party	0.00	0.00
Transfer	232.80	26.39
Other Income	73.27	0.14
Funds from Previous Year	42.68	1.28
EXPENDITURES	1,350.38	73.20
Administrative Expenses	833.76	41.69
Public Works & Promotion	290.96	10.77
Transfer Payments	141.84	20.60
Public Debt	54.58	0.00
Available Funds (Disponibilidades)	26.88	0.00
Third Party	1.49	0.00
Other Expenses	0.87	0.14

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

b.1.3 Solidaridad

The budget of Solidaridad Municipality in the year 2000 amounted to 190.4 Million Pesos, equivalent to 14.1% of the budget of all Municipalities in Quintana Roo State. The most important income source was Taxes with 64.7 Million Pesos (34%), followed by “Federal participation” or “Federal share” with 47.1 Million Pesos (24.7%), Exploitation with 24.0 Million Pesos (12.6%), Fees with 20.2 Million Pesos (10.6%), Public Debt with 16.5 Million Pesos (8.6%), and Transfers with 14.1 Million Pesos (7.4%). The effect of tourism development can be seen in the income structure of Solidaridad Municipality, as taxes comprised a significant share of the total income, around twice of the average of all Municipalities. On the other hand, income as Transfers was considerably lower, less than half of the average of all Municipalities of the State, thereby suggesting that tourism development in Solidaridad have created income sources that make public finance of this Municipality less dependent on transfers from the higher levels of government.

On the expenditure side, Administrative Expenses amounted to 119.7 Million Pesos (62.9%), followed by Public Works & Promotion with 39.7 Million Pesos (20.9%), Transfer Payments with 18.7 Million Pesos (9.8%), and Public Debt with 12.2 Million Pesos (6.4%). This expenditure structure is in line with the average of all Municipalities in the State.

Table 2-23: Municipal Budget of Solidaridad in 2000

Budget	All Municipalities (Million Pesos)	Solidaridad (Million Pesos)
INCOME		
INCOME	1,350.38	190.40
Income during 2000	1,307.70	190.40
Taxes	229.84	64.67
Federal share	470.97	47.05
Improvements	0.55	0.00
Fees	155.56	20.19
Products	20.02	1.82
Exploitation	93.00	24.04
Public debt	31.69	16.45
Third party	0.00	0.00
Transfer	232.80	14.07
Other Income	73.27	2.11
Funds from Previous Year	42.68	0.00
EXPENDITURES		
EXPENDITURES	1,350.38	190.40
Administrative Expenses	833.76	119.73
Public Works & Promotion	290.96	39.71
Transfer Payments	141.84	18.67
Public Debt	54.58	12.19
Available Funds (Disponibilidades)	26.88	0.00
Third Party	1.49	0.00
Other Expenses	0.87	0.10

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

b.2 Taxation System

b.2.1 Othon P Blanco

Taxes are applied at the Federal, State and Municipal levels.

The term “Fiscal Federalism” (*Federalismo Fiscal*) is used to describe an arrangement that turns over to the Federal Government some tax functions of Federal Entities. Under this arrangement, the Federal Government coordinates and receives from taxpayers most of the taxes, and then allocates the collected taxes in pursuance of distributive justice and administrative efficiency.

The “National System of Fiscal Coordination” (*Sistema Nacional de Coordinacion Fiscal*) encompasses the legal bases on the distribution mechanism of participations, on the possibility of making agreements on fiscal matters and administrative cooperation. The objectives of this system are to clarify the tax roles and eliminate double taxing among the three levels of government, in order to make the best use of each income source.

Known as “Ramo 28” is the federal participation, or money that the Federal Government returns to States and Municipalities to compensate for the income forgone upon implementation of the National System of Fiscal Coordination. The sources of federal income for this participation are income tax, value added tax, special tax on production and services, fees on petroleum and mining, amounting to around 880,000 Million Pesos in 2002.

b.2.2 Felipe C Puerto

In general, the taxation system is similar to that described under Othón P. Blanco Municipality.

Land tax is the most important tax in Felipe Carrillo Puerto Municipality. Still the share of taxes in the municipal income is quite low, as federal funds comprised 90% or more of total income.

b.2.3 Solidaridad

In general, the taxation system is similar to that described under Othón P. Blanco Municipality.

Compared with other municipalities in the study area, a clear difference in the case of Solidaridad Municipality was the large share of taxes, around 34% of total income in the year 2000. Likewise, fees accounted for almost 11% of total income, and “aprovechamientos” for around 13%. These data indicate that, in Solidaridad Municipality, own sources of income accounted for a larger share of total income than federal funds, as participations comprised

around 25%, and contributions about 7%. In other words, Solidaridad Municipality is financially more self-supporting, making it clear the benefits of tourism on tax collection under the same tax system.

2.2.6 Environment Policy

2.2.6.1 General Review

a. Institutional Hierarchy in Environmental Issues

At a state level, the right to propose laws and decrees is vested in the Governor of the State, Deputies of the local legislative term and the Municipal Councils.

At a state level, the main legal devices are as follows: the Political Constitution of the Free and Sovereign State of Quintana Roo; Law of Ecological Balance and Environment Protection of the state of Quintana Roo; Law on Potable Water and Sewerage of the state of Quintana Roo.

b. Brief Summary on Environmental Legislation

b.1 Political Constitution of the Free and Sovereign State of Quintana Roo

Regarding health matters, the Political Constitution of the State of Quintana Roo makes reference to the constitutional right of entitlement to health. No reference is made to environmental matters. The State Government guarantees legal equality for all of its dwellers: every person is entitled to the protection of their health.

The Constitution of the State is extensive in reference to the legislation involving the municipalities. The municipal liability regarding the rendering of the solid waste management service is set forth. Potable water and sewerage services will be provided by the municipalities under an agreement with the Committee of Potable Water and Sewerage (CAPA).

The municipalities are empowered to formulate, approve and manage municipal urban development zoning and plans. Likewise, they will be in charge of public functions and services: cleaning, collection, haulage, treatment and final disposal of wastes; potable water, drainage, sewerage, treatment and final disposal of its wastewaters.

b.2 Law of Ecological Balance and Environment Protection of the State of Quintana Roo

The law herein has the purpose of encouraging the sustainable development and regulating the actions related to the preservation and restoring of the ecological balance, as well as to the protection of the environment in the state of Quintana Roo.

The State Government, by means of the Secretariat of Urban Development and Environment, has the following obligations, among others:

- Formulation, execution and evaluation of the state's environmental policy
- The enforcement of policy instruments
- Regulation of the collection, haulage, storage, handling, treatment and final disposal systems of non hazardous wastes.
- Regulation of sustainable utilization and prevention and control of pollution in the state's jurisdictional waters, as well as of the domestic waters assigned to it
- Overseeing the compliance with Mexican Official Standards
- Assessment of environmental impacts arising from the works or activities not expressly reserved to the Federal Government.

b.3 Law on Potable Water and Sewerage of the State of Quintana Roo

The law herein sets the foundations for the rendering of potable water and sewerage systems throughout the state; thus, its provisions have a public order and social interest feature and are of general observance. The attributions will be coordinately executed between the State and the municipalities through the Committee of Potable Water and Sewerage (CAPA) and the operative entities. The way of executing such public services will be ruled by the demographic features of the place, the need for such services and the urban issues.

In article 36th it is established that the owners or proprietors of improved and mercantile/industrial property and of any other facility that, given its nature, use potable water are also obligated to connecting to the sewerage network system at those places where such service exists, within the stipulated terms. Where the obligation of connecting to the sewerage network is not carried out, the Secretariat of Health will be informed so as to demand the compliance with the related norms.

2.2.6.2 Organization Concerned

a. Secretariat of Urban Development and Environment (SEDUMA)

SEDUMA's vision is to achieve a harmonic and balanced development with due respect to ecology, arrangement of human settlements and consolidation of urban and traffic infrastructure, promoting betterment of life quality of all the dwellers in Quintana Roo.

The Secretariat's mission is the harmonic and balanced development of the state through an organic structure that fosters a planned and focused development of the human settlements; the regulation of urban development and housing; the sustainable management and utilization of the natural resources and preservation of the environment; regulation of transportation and communications of local competence and the execution of public works; so as to provide the

state's population with a sustainable and integral development under the pillars of legality, honesty, efficiency and efficacy for the sake of Quintana Roo people.

b. Committee of Potable Water and Sewerage (CAPA)

In its article 18th, the Law on Potable Water and Sewerage creates the Committee of Potable Water and Sewerage (CAPA) as a decentralized public entity of a mixed (state and municipal) nature, which will be in charge of the public services of water and sewerage at a whole state level.

Its mission is to plan, construct, reinstate, expand, operate, conserve and upgrade potable and desalted water systems, sewerage, treatment and reuse of waste waters, pursuant to the terms of the respective state and federal laws.

2.2.7 Priority Ranking of Infrastructure Investment

a. Othon P Blanco

Public investment during 2001 in Othón P. Blanco amounted to 351.1 Million Pesos, the top places being 91.3 Million Pesos in Urban/Social Development, and 68.5 Million Pesos in Education. A more detailed investment by sector is shown below.

Table 2-24: Public Investment in Othón P. Blanco in 2001

Public Investment	Q.Roo (Million Pesos)	Othón P. Blanco (Million Pesos)
Total	885.08	351.07
Education	299.05	68.45
Urban/Social Development	218.31	91.34
Communication & Transport	69.50	59.01
Administration & Finance	60.32	39.18
Agriculture & Forestry	57.50	12.00
Drinking Water	46.05	35.03
Social Welfare	27.68	9.91
Electricity	23.47	13.79
Ecology	18.33	3.88
Security	17.02	4.77
Sport	16.68	1.14
Culture	10.56	7.16
Tourism	9.57	1.01
Health	4.09	0.08
Housing	3.95	2.34
Trade & Supply	2.74	1.95
Fishing	0.27	0.03

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

The above table shows that public investment in specific sectors in Othón P. Blanco Municipality during 2001 amounted to 35.0 Million Pesos in the Drinking Water, 3.9 Million Pesos in Ecology, and 1.0 Million Pesos in Tourism.

b. Felipe C Puerto

Public investment during 2001 in Felipe Carrillo Puerto Municipality amounted to 73.2 Million Pesos, the top places being 22.2 Million Pesos in Education, and 21.0 Million Pesos in Agriculture & Forestry. A more detailed comparison of investments by sector in Quintana Roo State and Felipe Carrillo Puerto Municipality is shown below.

Table 2-25: Public Investment in F. Carrillo Puerto in 2001

Public Investment	Q.Roo (Million Pesos)	F. Carrillo Puerto (Million Pesos)
Total	885.08	73.19
Education	299.05	22.21
Urban/Social Development	218.31	9.17
Communication & Transport	69.50	1.18
Administration & Finance	60.32	4.06
Agriculture & Forestry	57.50	21.03
Drinking Water	46.05	0.75
Social Welfare	27.68	7.42
Electricity	23.47	1.11
Ecology	18.33	0.70
Security	17.02	2.47
Sport	16.68	1.62
Culture	10.56	0.00
Tourism	9.57	0.10
Health	4.09	0.00
Housing	3.95	0.82
Trade & Supply	2.74	0.55
Fishing	0.27	0.00

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

The above table shows that public investment in Felipe Carrillo Puerto Municipality during 2001 in specific sectors amounted to 0.75 Million Pesos in the Drinking Water, 0.7 Million Pesos in Ecology, and 0.1 Million Pesos in Tourism.

c. Solidaridad

Public investment during 2001 in Solidaridad amounted to 81.6 Million Pesos, the top places being 37.5 Million Pesos in Education, and 25.9 Million Pesos in Urban/Social Development. A more detailed investment by sector is shown below.

Table 2-26: Public Investment in Solidaridad in 2001

Public Investment	Q.Roo (Million Pesos)	Solidaridad (Million Pesos)
Total	885.08	81.55
Education	299.05	37.54
Urban/Social Development	218.31	25.86
Communication & Transport	69.50	2.43
Administration & Finance	60.32	0.92
Agriculture & Forestry	57.50	1.00
Drinking Water	46.05	4.36
Social Welfare	27.68	2.08
Electricity	23.47	3.33
Ecology	18.33	0.72
Security	17.02	0.00
Sport	16.68	3.29
Culture	10.56	0.00
Tourism	9.57	0.00
Health	4.09	0.02
Housing	3.95	0.00
Trade & Supply	2.74	0.00
Fishing	0.27	0.00

Source: Anuario Estadístico 2002, Quintana Roo, INEGI

The above table shows that public investment in specific sectors in Solidaridad Municipality during 2001 amounted to 4.4 Million Pesos in the Drinking Water, and 0.7 Million Pesos in Ecology.

Chapter 3

Field Investigations

3 Field Investigations

3.1 Wastewater Treatment Capacity Survey

3.1.1 Objectives and Methodology

The survey encompasses the following objectives: to assess the treatment capacity of a plant and to examine the countermeasures for solving the problems existing in a sewage treatment plant.

In general, the causes of declining efficiency in the treatment of wastewater using activated sludge can be divided in two large groups: the first one, where problems arise in the aeration tank; and the second one, where problems arise in the sedimentation of the activated sludge, causing the outflow of mixed activated sludge and effluents.

In order to assess the capacity of treatment and to examine the countermeasures appropriate for the problem, the following analyses were conducted:

- Water quality analysis,
- Sludge analysis to grasp the situation of activated sludge in the process of sewage treatment and
- Flow analysis (measurement of flow volume) to examine variation in wastewater inflow amount and its retention time in the wastewater treatment process.

The analyses were carried out in Playa del Carmen's sewage treatment plant. Sampling point and analysis types are shown below.

Table 3-1: Sampling Point and Number of Samples

Places of Sampling	Number of Samples		Flow Volume Measurement
	Water Quality Analysis	Sludge Analysis	
Grit Chamber	1	-	-
Aeration Tank intake (After sieve)	1 (inflow water)	-	24 hours (intake sewer and return sludge)
Aeration Tank	1 (taken from the outlet of the aeration tank)	2 (taken from the inlet and return sludge)	-
Final Sedimentation Tank	1 (treated water)	1 (Sludge blanket area)	24 hours
Water from Sludge Thickening	1	-	-
Sludge Storage Tank	-	1	-
Sub Total	5 samples	4 samples	3 places
Number of Sampling/ Measurement Times	3 times		
Total	15 samples	12 samples	9 places

Table 3-2: Analysis Items

Water Quality Analysis	Sludge Analysis	Flow Volume Measurement
BOD, COD, T-N(total nitrogen), NH ₃ -N(ammoniac nitrogen), NO ₂ /NO ₃ -N(nitrite/nitrate nitrogen), Cl ⁻ (Chlorine ion concentration), SS, water temperature, pH	MLSS, MLVSS, SV (measured only for the samples from the aeration tank; settled sludge volume after 1, 5, 10, 20, 30, 40, 50, 60, 120, and 180 minutes settling)	Manual measuring: water level and flow velocity Automatic measuring: reading current meter displayed number

3.1.2 Findings

a. Flow Pattern and Required Regulation Amount

The figure below shows flow pattern in the treatment plant that is estimated by the inflow survey for 3 days and operating records of the plant. Coefficient of variation (ratio between hourly inflow and average inflow for 24 hours) reaches a peak during 6:00 and 9:00 in the morning.

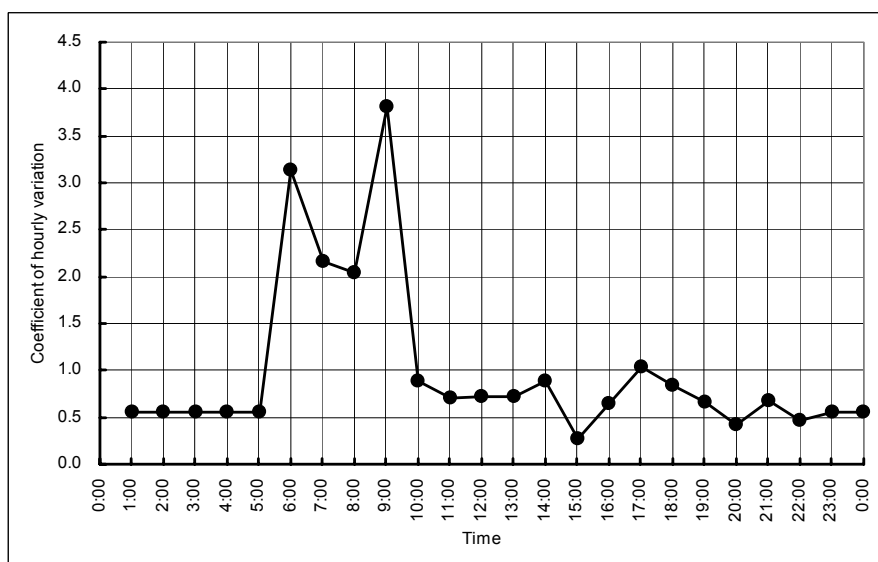


Figure 3-1: Flow Pattern of Playa del Carmen Sewerage Treatment Plant

During the survey, average inflow for 24 hours was 39.3 liter/sec and the peak inflow was recorded at 9:00 a.m. as 150 liter/sec. The peak inflow was 3.3 times the rated average treatment capacity of the plant, 45 liter/sec, and 2.2 times the maximum treatment capacity, 68 liter/sec.

Required regulation amounts were calculated in case of the rated average treatment capacity, 45 liter/sec, and the maximum treatment capacity, 68 liter/sec. 1,157 m³ in case of the average treatment capacity and 826.6 m³ in case of the maximum treatment capacity, and detention times are to be 7.2 hours and 5.1 hours respectively, as shown in the tables below.

Table 3-3: Required Regulation Amount

Treatment capacity		Required regulation tank	
		volume (m ³)	Detention time for average flow amount(hour)
Average	45 liter/sec	1,157.8	7.2
Maximum	68 liter/sec	826.6	5.1

b. Treated Water Quality

The table below compares the results of water quality analysis and designed water quality. As the table shows, the plant worked well. No problem was found in the aspect of treated water quality.

Table 3-4: Comparison of Treated Water Quality (measured and designed)

Item	Treated water (actual)	Designed(target)
Water temp (°C)	29.9	-
pH	6.4	5 to 10
BOD (mg/liter)	21.0	30
COD (mg/liter)	39.3	-
SS (mg/liter)	21.0	40
VSS (mg/liter)	12.7	-
T-N (mg/liter)	11.9	15
T-KN (mg/liter)	7.4	-
NH ₄ -N (mg/liter)	4.1	-
NO ₂ -N (mg/liter)	4.4	-
NO ₃ -N (mg/liter)	0.138	-
Cl ⁻ (mg/liter)	326.9	-
DO (mg/liter)	1.0	-

c. Treatment Capacity and Issues

As mentioned above, no problem was found in the aspect of treated water quality. However, the average inflow at the survey was 39.5 liter/sec that was below the design values (45 liter/sec of the average treatment capacity; 68 liter/sec of the maximum treatment capacity).

c.1 Conclusions

What treatment status would be in case that inflow reaches the design values was examined. Based on the examination, it can be said that:

- The maximum treatment capacity of the plant when considering removal of nitrogen as well as BOD is to be 45 liter/sec.
- It is possible to treat wastewater of 68 liter/sec, if removal of nitrogen is not considered.

Consequently, a regulation tank is necessary for removing nitrogen as well as BOD. Recommended capacity of the tank is 1,158 m³ and over.

3.2 Social and Public Opinion Survey

3.2.1 Objectives and Methodology

The survey aims to grasp information regarding public living conditions and awareness on environmental sanitation. It has also an objective to obtain qualitative information on community organizations and their capabilities.

For this study, in each of the three municipalities was selected one community from an urban area and one from a local area, i.e. 6 communities in total were selected. Next, 20 households were selected as samples in each community. Consequently, 120 households were selected for the questionnaire survey.

Meanwhile, a group of each community was selected and interviewed. 6 groups were surveyed in total.

3.2.2 Findings

It should be first mentioned that numbers of samples in urban areas are the same as one in rural areas, however, urban population is much bigger than rural on the whole study area. Public services such as water supply, sewerage and solid waste collection are focused on the urban area. Therefore, it can be said that the results reflect situation in rural areas than in urban areas. Furthermore, number of sample was only 120. This samples size is too small to explain the situation over the study area. However, the results give hints to grasp the present situation of environmental sanitation in the study area.

a. Households

- Large portion of the samples drinks bottled water as they feel that tap water is unsafe. Meanwhile, hygiene habits are well taught at school. Almost all samples wash their hands after defecating. However, a considerable percentage suffers from parasites and/or diarrhoea.
- Large portion is unsatisfied with water supply service as it is frequently suspended and low pressure. However, about half portion accepts the fee as reasonable. It may suggest that the residents would be more willing to pay for the service, if such technical problems were improved.
- According to investigation so far, the present SWM costs are assumed between 200 and 400 pesos/ton. This means that a family having about 5 members should pay about 30 to 60 pesos per months for the service, if the service is self-sufficient. Meanwhile, a large portion showed their willingness to pay between 10 and 20 pesos. This suggests

difficulty to make the service self-sufficient or to apply a new technology requiring more costs.

- A large portion has septic tanks or cesspools and they are like to be satisfied with the system. This may imply difficulty to expand sewer system.

b. Groups

- Interviewed people said that they have been living in the locality where they were asked in the survey for 20 years on average. They consider that the organization in which they are enlisted is incorporated to all society strata.
- 80% consider drinking water supplied by CAPA is Unsafe or It needs to be boiled, 80% drinking water supply service rendered by CAPA is considered Sometimes satisfactory or Unsatisfactory, because Service is frequently suspended and Water with odor and color; 45% People also think that drinking water service fee is High or very High and 45% Acceptable
- 100% consider that a sewage system is necessary in the city mainly to Protect the environment, Preserve beaches, rivers, lagoons, coral reefs, etc., to promote tourism and create jobs and Protect family's health.
- 100% said that they don't have a sewage system and it is worsening subsurface water contamination. 85% They said that their organization would be able to persuade community inhabitants to accept connecting their houses to sewage system and pay for such service
- Solid waste collection service frequency is 85% Every day, Twice or Three a week, in Chunhuas towns said there are not this service; Satisfaction with Municipal solid waste collection service 55% said Very satisfactory or Satisfactory and 45% sometimes satisfactory or unsatisfactory, reasons Collection frequency and Collectors make unpleasant noise
- People mentioned that their organization would be able to collaborate in persuading the community to accept paying for such service.
- 85% People asked in the survey said that their organization would be able to collaborate in encouraging the community to participate in activities towards protecting the environment, 70% they mentioned that their organization would be interested in protecting the environment to Preserve natural resources for the future generations and Live in a clean environment.

- 88% People consider that the community could get benefits from protecting the environment, mainly: Health, Quality of life and Better economy.
- 86% People think that encouraging community inhabitants to participate in activities towards protecting the environment can be achieved if authorities intensify environment curricula on the schools and authorities and community prepare a plan.
- 90%% are proud of their localities but said that it is necessary to work on solid waste management, take care of beaches and avoid damaging coral reefs.
- 80% People suggested some ways to participate in city beautification. Such suggestions are: No littering, Recycle, To plant trees and Don't waste drinking water.
- 42% People considered that the following important topics should be included in environment protection curricula on schools: Cenotes, rivers lakes and lagoons contamination and Solid waste collection

Chapter 4

*Present Situation of
the Environmental Sanitation*

4 Present Situation of the Environmental Sanitation

4.1 Wastewater Management

4.1.1 Overview of Wastewater Management

4.1.1.1 Present Situation

a. Othon P Blanco

Only Chetumal is covered by sewer system in urban areas of Othón P. Blanco. Rural areas are hardly covered by the system, although Mahahual is exceptionally provided with the system along with adjoining large scale tourism development. Sewer service coverage in Chetumal was 40% in 2000 based on sewage treatment capacity. However, there are still many houses that do not have connection with sewer pipe. Actual sewer service coverage would be much lower than 40 %.

b. Felipe C Puerto

Sewer system is hardly working in Felipe C. Puerto. Only 140 houses developed by the private sector in an urban area are covered by the system.

c. Solidaridad

Playa del Carmen which is the capital city of Solidaridad is only covered by a sewer system in the municipality. No sewer system is found in rural area.

Table 4-1 describes outline of the sewer system and Table 4-1 shows service coverage of the sewer system in the Study Area.

Table 4-1: Outline of Sewer System

Item	State of Quintana Roo	Othon P. Blanco	Felipe C Puerto	Solidaridad
1. Basic item				
Area of administrative boundary (km ²)	50,843	18,760	13,806	4,419
Population of administrative boundary	1,233,490	240,971	65,861	111,533
Service projected area (km ²)	76.02	6.35	0.02	13.24
Water production amount (1,000 m ³ /year)	112,737.78	27,659.70	6,223.25	12,406.35
Effective (billing) water supply amount (1,000 m ³ /year)	45,700.42	7,200.32	1,405.47	3,946.38
Water supply population	1,171,816	234,000	57,220	105,600
Unit water production amount (l/day/person)	263.58	323.8	297.97	321.88
Effective Unit water supply amount (l/day/person)	106.84	84.3	66.39	102.39
Sewage generation rate for planning (l/person/day)	75% of water supply amount*			
Unit sewage pollution load (g/person/day) BOD	54	54	54	54
SS	52	52	52	52
2. Service projected and present served population for wastewater management				
Sewer system(off-site) Plan	372,994	38,851	567	37,091
Actual	370,955	37,044	567	6,655
On-site system Plan	-	589 (year2002)	0	1,767 (year2002)
Actual	-	0	0	0
Latrine system Plan	0	0	0	0
Actual	Not available	Not available	Not available	not available
No-system Plan	-	167,338	56,653	5,006
Actual	800,861	169,045	56,653	35,442
3. Off site sewer system				
Responsible authority	C.A.P.A.			
Construction	C.A.P.A.			
O & M	ORG. OPER.			
Service area (km ²)	62.38	5.81	0.02	8.23
Service population	370,955	37,044	567	6,655
Number of connections	90,698	8,799	114	1,770
Service coverage rate (population)	30.07	39.23	2.88	25.59
Length of pipe line	1,088,376	444,528	6,804	79,860
Number of pump station	-	12	0	3
STP intake amount (lps)	1,251.83	20.48	1.34	64.21
Sewage production per capita	291.6	47.8	204.2	2,024,927
Sewage treatment plant (STP)				
Number of STP	16	1	1	3
Treatment method	Activated sludge			
Treatment Capacity	1,432	137	5	65
Annual average intake amount				
Intake waste quality (Jan. to June/2003) BOD	-	139	100.8	322.89
COD	-	393	249.99	507.27
SS	-	265	68.33	455
Treated water quality (Jan. to June/2003) BOD		1.90	2.15	11.18
COD		39.90	12.64	55.19
SS		2.00	6.00	19

Source : CAPA July 2003, * Manual de Agua Potable, Alcantrillado y Saneamiento Ver 2.0, 2001, CNA

Table 4-2: Service Coverage of Sewer System in 2000

Municipality	City	Population	Service coverage		
			Water supply	Sewer line	Sewage treatment capacity
OTHON P. BLANCO	CHETUMAL	118,553	96%	50%	40%
	BACALAR	9,047	88%	0%	0%
	CALDERITAS	4,617	92%	0%	0%
	INGENIO ALVARO OBREGON	3,331	97%	0%	0%
	NICOLAS BRAVO	3,524	92%	0%	0%
	ALVARO OBREGON	3,019	91%	0%	0%
	SERGIO BUTRON CASAS	2,712	98%	0%	0%
	Total	144,803	95%	41%	33%
FELIPE CARRILLO PUERTO	FELIPE CARRILLO PUERTO	17,690	86%	0%	0%
	CHUNHUHUB	4,338	86%	38%	0%
	TIHOSUCO	4,188	93%	0%	0%
	Total	26,216	87%	6%	0%
SOLIDARIDAD	PLAYA DEL CARMEN	39,005	50%	30%	15%(21.9%*)
	TULUM	7,975	79%	0%	0%
	Total	46,980	55%	25%	13%
State total		720,567	95%	57%	73%

Source: CAPA Plan Estratégico APAS 2001-2025, * EVALUACIÓN SOCIOECONÓMICA PROYECTO DE REHABILITACIÓN DE LA PLANTA DE TRATAMIENTO DE AGU RESIDUALES DE PLAYA DEL CARMEN, SOLIDARIDAD, QUINTANA ROO, MAYO DE 2002/ CNA

d. Plan

CAPA prepared a strategic plan¹ of wastewater management for the whole Quintana Roo State in 2001, from which Table 4-3 and Table 4-4 show implementation and investment plans in the three municipalities.

Table 4-3: Phased Implementation Plan in Urban Area of Othón P. Blanco

Item	2001 to 2005	2006 to 2010	2011 to 2025	Total
1. Othon P Blanco				
Water supply amount (litter/sec)	221	208	618	1,047
Sewer system (ha)	1,103	579	1,736	3,418
Sewage treatment amount (litter/sec)	519	128	384	1,031
Acc. sewage treatment amount (litter/sec)	519	647	1,031	-
2. Felipe C Puerto				
Water supply amount (litter/sec)	15	10	21	46
Sewer system (ha)	109	39	86	234
Sewage treatment amount (litter/sec)	114	8	17	139
Acc. sewage treatment amount (litter/sec)	114	122	139	-
3. Felipe C Puerto				
Water supply amount (litter/sec)	707	501	1,445	2,653
Sewer system (ha)	1,240	837	2,396	4,473
Sewage treatment amount (litter/sec)	543	339	911	1,793
Acc. sewage treatment amount (litter/sec)	543	882	1,793	-

Source: CAPA Plan Estratégico APAS 2001-2025,

Table 4-4: Investment Plan for Othón P. Blanco Urban Area (Million pesos)

Item	2001 to 2005	2006 to 2010	2011 to 2025	Total
1. Othon P Blanco				
Water supply	122.4	87.5	261.6	471.5
Sewer line	468.0	93.0	278.0	839.0
Sewage treatment	82.0	26.0	77.0	185.0
Land acquisition	11.0	10.0	31.0	52.0
Total	683.4	216.5	647.6	1,547.5
2. Felipe C Puerto				
Water supply	42.2	5.2	11.1	58.5
Sewer line	85.0	6.0	14.0	105.0
Sewage treatment	16.0	2.0	3.0	21.0
Land acquisition	1.0	0.0	1.0	2.0
Total	144.2	13.2	29.1	186.5
3. Solidaridad				
Water supply	280.5	180.0	516.5	977.0
Sewer line	191.0	134.0	383.0	708.0
Sewage treatment	119.0	68.0	182.0	369.0
Land acquisition	35.0	25.0	72.0	132.0
Total	625.5	407.0	1,153.5	2,186.0

Source: CAPA Plan Estratégico APAS 2001-2025,

¹ PLAN ESTRATÉGICO DE LOS SERVICIOS AGUA POTABLE, ALCANTRILLADO Y SANEAMIENTO 2001-2035, CAPA

4.1.1.2 Off-site System

a. Othon P Blanco

The system targets 38,851 residents. However, estimated number of residents covered with the system is only about 6,400. This gives 16.5% of actual service coverage, and the coverage is judged as quite low. A major reason why the coverage is quite low is that many houses are unwilling to connect to the sewer system due to widespread use of septic tanks and financial burden for the connection (2,000 to 5,000 pesos/house). Outflow from the septic tanks percolates into underground, then, causes underground water contamination.

The sewage treatment plant in Chetumal, which was constructed in 1998, has a capacity of 137 liter/sec (11,873m³/day) at present, although it will have a total capacity of 360 liter/sec (31,104 m³/day) in the future. However, actual inflow rate is 20.48 liter/sec (1,769m³/day) due to low connection rate to sewer pipe. It is drastically lower than the planned inflow rate. Table 4-5 shows outline of the sewage treatment plant in Chetumal.

Table 4-5: Outline of Chetumal Sewage Treatment Plant

Item	Parameter
Treatment capacity	137 liter/sec (11,837 m ³ /day)
Actual treatment amount	20.48 liter/sec (1,770m ³ /day)
Intake water quality	BOD: 139mg/liter, COD: 393mg/liter, SS:265 mg/liter
Treated water quality	BOD: 1.9mg/liter, COD: 40mg/liter, SS: 2 mg/liter
Treatment method	Activated sludge method

Source: CAPA

Two injection wells were constructed for discharging treated water to underground at 100m depth. The injection was operated for one year between 1998 and 1999. However, the injection was judged impossible because of difficulty of maintaining injection pressure, etc. Then, the treated water is discharged to an adjoining lagoon.

b. Felipe C Puerto

The off-site sewer system has hardly been developed in Felipe C. Puerto, except the 140 houses. A sewage treatment plant for the 140 houses treats 1.34 liter/sec (116 m³/day) of wastewater. As for on-site system, septic tank dominates.

Table 4-6 shows outline of the sewage treatment plant for the 140 houses.

Table 4-6: Outline of Felipe Carrillo Puerto Sewage Treatment Plant

Item	Parameter
Actual treatment amount	1.34liter/sec (116 m ³ /day)
Intake water quality	BOD:101mg/litter, COD:250mg/litter, SS:68 mg/litter
Treated water quality	BOD:2.2mg/litter, COD: 13mg/litter, SS: 6 mg/litter
Treatment method	Activated sludge method

source: CAPA

c. Solidaridad

The sewer system covers areas where 62% of residents live such as Playacar and Calica in Playa del Carmen. In the covered areas, both combined and separate sewer systems are found.

The sewage treatment plant of CAPA has expanded to a capacity of 66 liter/sec at present and the operation has been improved. In addition, CAPA has a plan to construct a new treatment plant having capacity of 400 liter/sec in order to cope with rapid increase of the wastewater amount.

4.1.1.3 On-site System

Principal type of on-site system is septic tank. Even in areas where the sewage system is provided, many residents still use the septic tank.

At present, CAPA is constructing a collective on-site system at 4 communities having less than 2,500 residents in the state. Three of them are located in the Study Area. Table 4-7 shows outline of the collective on-site system. The system applies an-aerobic digestion + filtration treatment method.

Table 4-7: Outline of Collective On-site System

Municipality	Location	Projected population	Treatment capacity	Treated water quality
LAZARO CARDENAS	Holbox	1,633 (year 2022)	1.88 liter/sec (162.4m3/day)	BOD:30 (mg/litter) SS: 30 (mg/litter)
SOLIDARIDAD	Puerto Aventuras	1,048 (year 2022)	1.20 liter/sec (103.7 m3/day)	BOD:30 (mg/litter) SS: 30 (mg/litter)
	Akumal	2,078 (year 2022)	2.39 liter/sec (206.5 m3/day)	BOD:30 (mg/litter) SS: 30 (mg/litter)
OTHON P. BLANCO	Subteniente López	2,320 (year 2022)	2.66 liter/sec (229.8 m3/day)	BOD:30 (mg/litter) SS: 30 (mg/litter)

Source : CAPA/CONSORICO DE INGENIERIA MEXICANA, S.A. DE C.V.

4.1.1.4 Sewage-discharge Sources and BOD Generation Amount

a. Sewage-discharge Sources

Table 4-8 shows wastewater discharge amount with respect to each source in Quintana Roo State in 2001. Discharge amount from Service such as hotels is distinguishing due to the active tourism. It occupies more than 70% of the whole discharge amount. Meanwhile, discharge amount from industry such as manufacturing, mining, etc. is very small. It makes up only 1.48%.

Table 4-8: Wastewater Discharge Amount to Federal Control Water Body in 2001

Source	Wastewater Discharge amount (m ³ /year)	Ratio
Domestic	378,100	0.44%
Industry	1,271,600	1.48%
Service	62,439,000	72.83%
Urban public	21,536,100	25.12%
Others	106,000	0.12%
Total	85,730,800	100.00%

Source : ANUARIO ESTADÍSTICO Quintana Roo edición 2002/INEGI

b. BOD Generation Amount

The Study Team estimated BOD generation amount in the Study Area as shown in the table below based on information available and supposing that BOD pollutant load unit is 54 g/person/day².

Table 4-9: Estimated BOD Generation Amount

	Population		BOD generation amount (ton/year)		
	Settlement	Tourist(Person/year)	Settlement	Tourist	Total
Cozumel	62,078	455,621	1,223.565	24.604	1,248.169
Felipe C Puerto	61,703		1,216.158		1,216.158
Isla Mujeres	14,911	141,785	293.896	7.656	301.552
Othón P Blanco	230,718	205,216	4,547.448	11.082	4,558.530
Benito Juárez	438,872	2,987,841	8,650.163	161.343	8,811.506
José María Morelos	31,668		624.176		624.176
Lázaro Cárdenas	20,891		411.758		411.758
Solidaridad	86,863	1,504,052	1,712.078	81.219	1,793.297
Quintana Roo state	947,704	5,294,515	18,679.242	285.904	18,965.146

4.1.2 Financial System

a. Othon P Blanco

CAPA provides water supply and sewer services in Othon P. Blanco Municipality through the Chetumal system for water supply and sewer services in the city of Chetumal, and the rural water supply system. The numbers of water supply connections in 2001 were 34,395 in the Chetumal system and 12,874 for the rural water supply system, for a total of 47,269 connections or 54% of the State total. Service coverage was estimated at 95% water supply and 25% sewer service by the Chetumal system, and 88% water supply and 0% sewer service by the rural water supply system.

Households comprised the overwhelming majority of customers with almost 45,000 connections or 95%, followed by 3% of commercial firms, 1.6% of General Services, 0.06%

of industrial firms, and 0.08% of hotels. CAPA water rates are set by customer category, being composed of a base monthly rate depending on volume (cubic meter per month), and an excess consumption rate that is priced as Pesos per cubic meter consumed. The excess consumption rate increases with consumption, as it corresponds to a progressive rate.

The water rates being applied by CAPA in June 2003 are shown in the following table.

Table 4-10: CAPA Water Rates in June 2003

DOMESTIC WATER RATE			
Consumption Range (m3/month)		Base Rate	Excess Consumption
Lower Bound	Upper Bound	(Pesos/month)	(Pesos/m3)
0	10	35.40	0.00
11	20	38.93	3.54
21	40	88.62	5.27
41	60	193.61	10.56
61	999,999	400.90	26.42
COMMERCIAL WATER RATE			
Consumption Range (m3/month)		Base Rate	Excess Consumption
Lower Bound	Upper Bound	(Pesos/month)	(Pesos/m3)
0	10	36.03	0.00
11	20	59.52	10.80
21	50	159.44	15.49
51	100	632.11	19.58
101	200	1,595.04	28.40
201	999,999	4,430.95	44.44
INDUSTRIAL WATER RATE			
Consumption Range (m3/month)		Base Rate	Excess Consumption
Lower Bound	Upper Bound	(Pesos/month)	(Pesos/m3)
0	10	21.62	0.00
11	50	59.75	5.30
51	100	271.47	10.93
101	200	992.91	17.68
201	500	2,761.24	23.09
501	1,000	9,669.72	53.15
1,001	999,999	35,695.55	55.86
HOTEL WATER RATE			
Consumption Range (m3/month)		Base Rate	Excess Consumption
Lower Bound	Upper Bound	(Pesos/month)	(Pesos/m3)
0	100	93.59	9.32
101	750	999.10	10.72
751	1,500	7,959.57	16.11
1,501	5,000	24,236.22	21.73
5,001	20,000	100,319.58	26.69
20,001	999,999	500,576.88	29.44
WATER RATE FOR GENERAL SERVICES TO THE COMMUNITY			
Consumption Range (m3/month)		Base Rate	Excess Consumption
Lower Bound	Upper Bound	(Pesos/month)	(Pesos/m3)
0	20	75.65	0.00

21	50	79.17	4.04
51	100	201.74	4.43
101	150	419.56	4.72
151	250	661.20	5.14
251	350	1,174.51	5.54
351	500	2,428.66	5.95
501	750	2,631.01	6.43
751	1,000	4,250.97	6.97
1,001	1,500	5,998.57	7.53
1,501	999,999	9,771.07	7.98

Note: Indexed to the State minimum salary and updated every time the minimum salary changes

Note: Indexed to the National Consumer Price Index (NCPI) and updated every time the NCPI changes

Source: CAPA

CAPA has the authority to set the water rates as its own decision. Waste water charges are added as 20% over the water consumption. In the case of Othon P. Blanco Municipality, income from water supply between 2000 and 2002 accounted for 80% or more of total income, while income from waste water service comprised only around 3%.

The balance of income and expenditures was negative in Othon P. Blanco water supply systems between the years 2000 and 2002. Actual income covered 41% of budgeted expenses in the year 2000, 32% in 2001, and 46.5% in 2002.

b. Felipe C Puerto

CAPA provides water supply service in Felipe Carrillo Puerto Municipality, where the number of water supply connections in 2001 was 10,852 or 12.4% of the State total. Households comprised the overwhelming majority of customers with 10,309 connections or 95.0%, followed by 2.66 % of commercial firms, 2.29% of General Services, 0.02% of industrial firms, and 0.04% of hotels. Service coverage was estimated at 87% water supply and 1% sewer service.

In Felipe Carrillo Puerto Municipality, income from water supply between 2000 and 2002 accounted for 85% or more of total income, while income from waste water service was zero.

The balance of income and expenditures was negative in Felipe Carrillo Puerto Municipality between the years 2000 and 2002. Actual income covered 22.6% of budgeted expenses in the year 2000, 18.9% in 2001 and 26.7% in 2002.

c. Solidaridad

CAPA provides water supply and sewer services in Solidaridad Municipality, where the number of water supply connections in 2001 was 6,491 or 7.4% of the State total. Households comprised the majority of customers with 4,864 connections or 75%, followed by 21 % of

commercial firms, 2% of General Services, 2% of hotels and 0.1 % of industrial firms. Service coverage was estimated at 43% water supply and 15% sewer service.

In Solidaridad Municipality, income from water supply between 2000 and 2002 accounted for 60% or more of total income, while income from waste water service comprised 2-4% of total income.

The balance of income and expenditures was positive in CAPA Solidaridad Municipality between the years 2000 and 2002. Actual income covered 140% of budgeted expenses in the year 2000, 182% in 2001 and 111% in 2002.

4.1.3 Environmental Education

a. Othon P Blanco

The Secretariat of Urban Development and Environment (SEDUMA) through the Office of Environmental Contamination Prevention and Control carried out a program of environmental education with the objective of strengthening awareness in students, the respect and protection of the environment and conservation of the biodiversity. This program has the goal of sensitizing students of primary schools, regarding the conservation of the living environment. The activities were carried out mostly in primary schools located at the riverside of Rio Hondo with the purpose of participating actively inside an institutional promotion work group for the environmental culture. In the activities audio-visual was projected with regard to harmful effects generated by the solid waste. Regarding the wastewater management issues are shown in a very general way the types of pollutants in the aquatic ecosystems. For the period 2003-2004 the Office intends to continue the activities of environmental education in the northern areas (along the highway towards Felipe Carrillo Puerto and on the Costa Maya).

b. Felipe C Puerto

The State Commission for Potable Water and Sewerage (CAPA) implemented a program "Friendly School - Green House" with the objective to improve and raise the life quality of families in needs through simple and appropriate technologies to the region, through school lectures and chats, chats with parents, lecture on sanitation and reforestation, maintenance of physical and sanitary conditions of water supply and control of the quality of water, among others. Also CAPA through the "Clean Water" Program, carries out within the communities visited (Señor, Canzepchen, Kampocolche Nuevo, Chanchen Comandante, Tixcal Guardia), actions focused on control of water quality to reduce the risks of transmission of gastrointestinal diseases.

With the purpose of reinforcing the institutional initiative in the implementation process of the work program, CAPA was supported by the National Water Commission (CNA), the Mobile Net Promoters of Family Development of the State and by leaders of the community. The lectures to the community were focused on the promotion of the importance, care and use of water as issues related to the health.

c. Solidaridad

CAPA also implemented the program "Friendly School - Green House" in Solidaridad. Also CAPA carries out the "Clean Water Program" in the communities (Hondzonot, Yaxche, Chanchen Palmar, San Silverio, Yalchen, all located at western sector of the municipality).

With the purpose of reinforcing the institutional initiative in the implementation process of the work program, CAPA was supported by the National Water Commission (CNA), the Promoters of Mobile Net for Family Development of the State and by leaders of the community. The lectures to the community were focused on the promotion of water importance, care and use as issues related to the health.

4.2 Solid Waste Management

4.2.1 Overview of the Solid Waste Management

a. Othon P Blanco

Currently the Direction Office of Municipal Public Services directly runs the collection, haulage, final disposal and sweeping operations, with service to the city of Chetumal and the locations of Subteniente López, Xul-Ha, Huay-Pix, Raudales, Laguna Guerrero and Luis Echeverría; in other locations such as Bacalar, Nicolás Bravo, Calderitas, Javier Rojo Gómez, Alvaro Obregón, etc., the service is provided independently from the Direction Office by the city halls or districts and with their own funds by providing vehicles and payment to the staff employed for the service. In the remaining locations no service is being rendered and generators deal with their own wastes by burning the same. Within the municipality there is a single private service that serves the location of Mahahual, which includes the collection, haulage, cleaning of beaches, sweeping and final disposal, due to the tourism activity developing within the area.

The Direction Office of Municipal Public has a Department of Urban Image within its flowchart, which is in charge of operating the collection, haulage, sweeping and final disposal services of municipal solid wastes. The service is aimed mainly at the city of Chetumal, an only once a week are wastes collected at the locations of Subteniente López, Xul-Ha, Huay-Pix, Raudales, Laguna Guerrero and Luis Echeverría.

The wastes collected correspond to household, commercial, pruning and junk waste. The discharge system within the city varies, with predominance of supermarket plastic and small plastic containers for household wastes; in the case of businesses, the same are generally stored in bulk and in drums in front of the commercial stalls.

The collection service is provided seven days of the week with three shifts: morning, afternoon and night shift. The collection frequency will vary depending on the sector, with a daily frequency for downtown area and three times a week for the rest of the city. The collection method is door-to-door.

The service is designed to serve the entire city with a total of 31 collection routes, employing 17 vehicles with diverse capacity and type; additionally, it has an additional 10 vehicles to carry out special operations and the collection in other locations. It is important to mention that most of the vehicles are in poor conditions, some of them with longevity of up to 15 years.

A control of the trips and the tonnage collected and introduced to the final disposal site is carried out, which is determined as per the nominal capacity of the vehicle. Throughout 2002, according to this log a total of 71,540 tons of household wastes, 18,250 tons of commercial wastes, 19,710 tons of prunings and garden waste and 449 tons of junk were collected.

On an annual basis, the Direction Office carries out two operations with the purpose of picking up junk and bulky waste to prevent the proliferation of mosquitoes and other sanitary vectors.

The total of workers regarded in the collection service adds up to 150 people; most of them work seven days a week, thus, several extra time is paid if it is considered that the working week is of five days.

Regardless of the fact that the collection service is contemplating the frequencies and established routes, there are sectors in the city that are not clean, mainly due to the fact that the collection schedules are not attended as a consequence of the poor mechanical status of the vehicles and because the users do not take out their wastes when the collection truck passes by.

The sweeping service is provided only in the city of Chetumal, with a coverage ratio of 50% of the city; it is mechanical and covers the main avenues, the Bahia boulevard and some secondary streets. Manual sweeping is carried out from Monday to Sunday in a single shift from 04:00 through 11:00. As of this year, two mechanical brand new sweepers have been incorporated into the service, which service Boulevard and main avenues between 04:00 and 14:00.

Sweeping wastes are carried to gathering points, where they are later collected by vehicles devoted exclusively to such activity and disposed of in the municipal dumpsite.

The total of workers regarded in the service totals de 75 people, who generate several extra time as the collection workers, as they work seven days a week.

All the wastes collected are disposed of in a dumping site located in Calderitas, approximately 15 Km. of the city. During its first stage, this disposal site performed as a sanitary landfill; however, due to budget issues and a poor operation it became an open dumping site that currently poses serious environmental risks, such as the proliferation of sanitary vectors because the wastes are not covered and not arranged in concentrated areas, presence and infiltration of leachate and fires.

The dumpsite has an area of 15 hectares and above 85% of the same has been utilized and, according to estimates by the Direction Office of Municipal Public Services, its useful life would not surpass two years.

There is a staff at the dumping site that records all the vehicles coming in, regardless where they come from; there is also a D-9 bulldozer and a D-6 bulldozer. However, only the D-6 is in operative conditions and spreads and compacts the wastes. The inappropriate mechanical conditions of the same do not allow their continued operation, and thus the construction of waste cells cannot be maintained. The staff assigned for the dumpsite includes two arrangers, two people in charge of registering and controlling the entrance of vehicles and three guards.

Due to the environmental and sanitary problem posed by the dumpsite, the Secretaryship of Urban Development and Environment (SEDUMA) has planned the construction of a sanitary landfill next to the current dumpsite, which currently under review of the Environmental Impact Manifest.

The Direction Office of Municipal Public Services has no control over the costs of the service, and all of the input, pieces of equipment, personnel, and so on, are provided by the Municipal Clerkship Office. The latter situation has an impact on development of the service, since the resources available are unknown and a programmed maintenance of the vehicles is impossible. Also, their renewal is not contemplated, which in turn affects the coverage and quality of the same and higher costs of the service.

With respect to charges for the service, only the commercial sector pays at the Municipality's Treasury when they have to renew the stall's business permit.

b. Felipe C Puerto

The municipality of Felipe Carrillo Puerto sets up and conducts its municipal solid waste management services through the Direction Office of Municipal Public Services, who renders the collection, haulage, final disposal and sweeping activities directly and exclusively to the municipality's capital town of Felipe Carrillo Puerto; the other towns are not rendered with the service.

The service is conducted exclusively at the municipality's capital city; other towns such service is not provided and wastes are disposed of by burning them at the points of generation. In several of these towns the accumulation of wastes, such as plastic bottles, is perceivable; the accumulation of wastes on the roads and unoccupied lots is also important.

The service provided by the Direction Office is ineptive and thus reflects serious deficiencies, as a consequence of the lack of resources and service planning. Funds come

mainly off the municipality's pockets, and the service is not charged to any of the users whatsoever.

The collected wastes include household, commercial, institutional and medical residues. The management of medical wastes is worth mentioning, as the service collects all the wastes generated at health institutions, including pathogenic organic wastes, which are latter disposed of at the town's dumping site, posing a serious risk to health.

The service is rendered at a total of 11 neighborhoods that add up to 50% of town inhabitants, and therefore a 23% coverage of the entire population.

The collection frequency is on a daily basis for downtown and medical wastes and three times a week for the rest of the city. Several of the neighborhoods covered have some their streets unattended, because of their faulty status.

Collection is carried out in two shifts; 6:00 through 13:00 and 14:00 through 18:00, Monday to; Saturdays and Sundays have only one shift from 06:00 to 11:00. The service is provided with two, 11 m³ dump trucks plus a 4 m³ high platform pickup; each of them with a crew formed by the driver and three collection workers. Given the number and capacity of the trucks, not the entirety of the wastes are collected at the serviced zone, and so wastes remain on the streets and are scattered by dogs; thus spoiling the city image. Sometimes wastes are disposed of at illegal dumping sites illegally by the generators.

In general terms, the morning shift trucks travel twice to the dumping site, and only two of them do so in the afternoon shift. The bad status of the trucks, along with the lack of resources, cause them to be non-operational for a long time, meanwhile the service is not rendered or downtown areas are attended only.

Most of the times the wastes are stored in bags or drums provided installed by the municipality at concurred places such as town squares, market places or tourism spots. The Users do not always hand over their wastes when the collection truck passes, and they remain on the streets. The collection method is door-to-door; however, at those sectors where trucks are unable to enter, wastes are carried to gathering points where no structure exists to contain them.

Three times a year an operation is conducted to clean up and collect the wastes at the locations of Señor, Laguna Kana, Tihosuco, Polyuc, Chumhub and Tepic; the wastes collected are mainly of bulky and junk type.

The wastes generated at markets are collected by a truck owned by the merchants, who pay for that system.

Two private entities provide the household collection service; they serve several residencies who cash out between \$5 and \$10 pesos every time wastes are collected. This service is not programmed however and it responds only to the needs of its users.

According to estimates by the Direction Office, roughly 1,000 ton/month are collected; this figure has been determined in function of the truck's capacity and the number of trips; however, a great uncertainty remains over the values, as no control exists to establish whether the trucks are fully loaded or not when they get to the dumping site, the type of wastes are not classified and since they are no compaction trucks, big differences in weight prevail due to the density of the wastes.

The annual cost of the collection and haulage service adds up to \$1,200,000 Pesos, including the operation of the vehicles and labor.

The sweeping service is carried out exclusively at downtown areas and on the main access roads, of a manual nature and executed by fifteen people.

Sweeping is conducted only in one shift from 06:00 to 13:00, Monday through Friday, and 6.5 Km of avenues per day are serviced and around 3 tons per day are collected.

Wastes from the sweeping activity are gathered in a cart that is picked up by the collection truck; when the truck is the carts are carried to the city hall to unload the wastes in the following collection shift.

All the wastes collected are transported to an open dumping site, located 6 Km away from the city at one side of the federal highway that joins the town with Cancun.

At this site, wastes are disposed of with no control whatsoever, and the wastes are scattered all over the place; no accumulation of liquid percolation is perceived, which probably seeped and evaporated. There is an important amount of birds, mosquitoes and flies.

No staff exists at the dumping site; therefore no control exists over residues coming in; no infrastructure exists either and the site is open for any type of waste to be discharged.

This dumping site has undergone through several fires that affect the highway, since the smoke hinders the drivers' visibility, with fatal accidents that have taken place. Most of these fires are provoked in order to minimize the volume of the wastes and thus generate additional space to unload additional wastes.

The only work carried out by the Direction Office at the dumping site is the arrangement of the wastes, an activity executed every six months and that responds to the need of incrementing the available disposal space.

Currently the Direction Office of Municipal Public Services is planning to move the dumping site to a location owned by it, located in Km 137+000 of the federal highway between Carrillo Puerto-Valladolid, which will allow the reduction of costs, as the current land is a rental.

The new piece of land is located 10 Km away from the city, with a greater area than the current dumpsite and has a tree-buffering zone that lowers the visual impact of the activity.

c. Solidaridad

The municipality of Solidaridad, whose capital city is Playa del Carmen, records the greatest population growth rate in the country as a consequence of the strong development of tourism it is undergoing; thus, the above situation directly impacts on the generation of household wastes, especially Playa del Carmen, Tulum and the rest of the tourism locations at the Mayan Riviera.

Currently the collection, haulage and final disposal service is carried out by a private company (Servicios Ambientales Urbanos S.A. de C.V.), who began operations in June 2002, servicing the city of Playa del Carmen. As of January 2003, the locations of Chemuyil, Puerto Aventuras, Akumal and Tulum are incorporated into the service, where the locations of Coba, Manuel Antonio Hay, Francisco Uh May and Macario Gómez are provided with the special service (rendered once a week). The collected wastes are unloaded at a final disposal site located around 13 Km. away from Playa del Carmen.

The service contract between the City Hall and the company "Servicios Ambientales Urbanos S.A. de C.V." will be in force until April 2004 and includes the collection, haulage, final disposal, sweeping and cleaning services. The dumping site calculates a total of 3,000 tons/month with a cost of \$ 1,472,900 pesos plus Value-Added Tax; however, currently the service picks up and unloads around 4,000 tons/month.

The collection service is provided Monday through Friday, spanning morning and night shifts and with diverse collection frequencies, depending on the sector, ranging from once a week to a daily basis. The main collection method is door-to-door, and in some instances gathering points exist.

In general terms, the locations served seem quite neat, both in front of the houses and on streets and roads and public spots; however, some unoccupied land lots adjacent to the houses are perceived, with some concentrations of aged wastes.

The sweeping service is provided in the night and exclusively at the urban zone of Playa del Carmen, with the help of a mechanical sweeper that keeps the avenues and streets clean. On

the other hand, in Playa del Carmen's downtown, 30 stainless steel containers have been installed with three compartments to separate the wastes.

In hotels and tourism centers, the management of the wastes is conducted by the Direction Office of Municipal Services through the franchised company and it serves around 50% of the area; the rest of the works is handled by the generators of wastes, who hire small private companies.

In remote locations no collection or haulage service of the wastes is offered; therefore, the community has to burn down the wastes at their premises' backyards. These locations have a population below 500 people.

The total of persons being served sums roughly 113,156 out of 133,634 people; i.e., the service coverage hovers around 85%.

Three open air dumpsites exist within the area being serviced by the Direction Office of Municipal Services: the first one is located 8 Km. away from Tulum, on one side of the Tulum-Coba federal highway; the second one is located in Akumal; and the third one is 13 Km. north of Playa del Carmen. Out of these three dumping sites, only the place located in Playa del Carmen is running and is in charge of the franchised company, which not only conducts the final disposal of the wastes collected but is also running a cleaning program of the site. Prior to the beginning of the program, this dumpsite posed serious environmental risks; the lack of covering material was ripe for the proliferation of flies, mosquitoes, rodents and birds and allowed the burning of the wastes by the scavengers, in order to facilitate the extraction of recoverable material. The constant combustion of wastes generated lots of smoke that reached the highway and even the city of Playa del Carmen, if the winding conditions were appropriate. Currently, the dumpsite is running in a controlled manner, arranging and compacting the wastes, with daily coverage, a single shift and installing a gas venting system.

The total of wastes disposed of between June of 2002 and May 2003 totals 77,708 tons, out of which 70% accounts for the wastes collected by the franchised company and 30% for the residues collected by particulars.

The other dumpsites do not have a sanitation program. In the case of the Tulum dumping site, it is used in emergency situations and no closing system exists to prevent the unloading of the wastes. The Akumal dumpsite is fenced to prevent the access; however, around its perimeter and in front of the highway there is an important accumulation of wastes, mainly bulk waste. In both dumpsites wastes are scattered throughout the land; deep waste deposits are not perceived or concentrations of seepage, which leads to think that such liquid has percolated.

No surveys or monitoring that demonstrate the contamination of the aquifer by percolated liquids exist to date; nevertheless, in July of this year an environmental and urban geo-reference will take off that will include variables, water status in water bodies. In relation with biogas, no background exists that leads to conclude about its existence; however, since part of the wastes have been burned and combustion continues for long periods in spite of the humidity of the wastes, it is believed that biogas is behind such circumstance.

In order to strengthen the solid waste management service, the Direction Office of Municipal Public Services and the Direction Office of the Environment, in coordination with other entities such as NGOs and the private sector, are developing the Integral Municipal Solid Waste Management Program, which includes a general diagnosis on the status of the same and pilot projects such as the waste classification, minimization and recycling. On the other hand, the 2002 – 2005 Municipal Development Plan sets out the promotion of the recycling culture and segregation of wastes as the action items within the municipal residues.

At a state level, the Secretaryship of Urban Development and Environment has fostered the construction of a sanitary landfill for Tulum, whose Environmental Impact Manifest is under review.

4.2.2 Present Waste Stream

Figure 4-1, Figure 4-2 and Figure 4-3 show waste streams in 2003 that are obtained based on the information above.

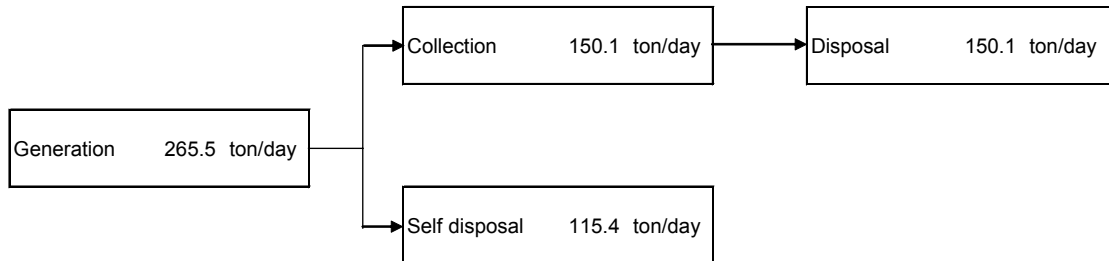


Figure 4-1: Present Waste Stream (Othon P Blanco)

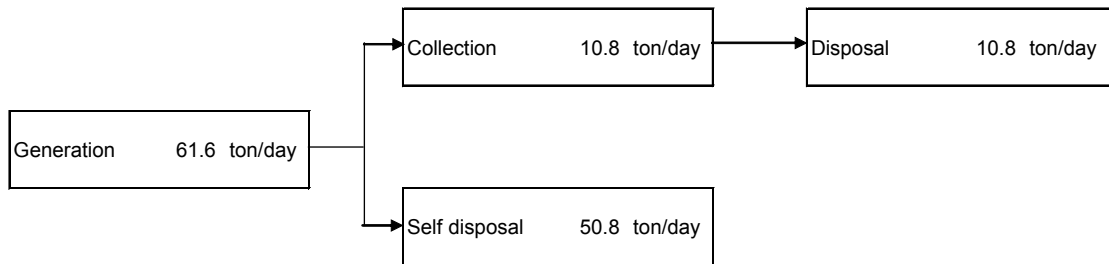


Figure 4-2: Present Waste Stream (Felipe Carrillo Puerto)

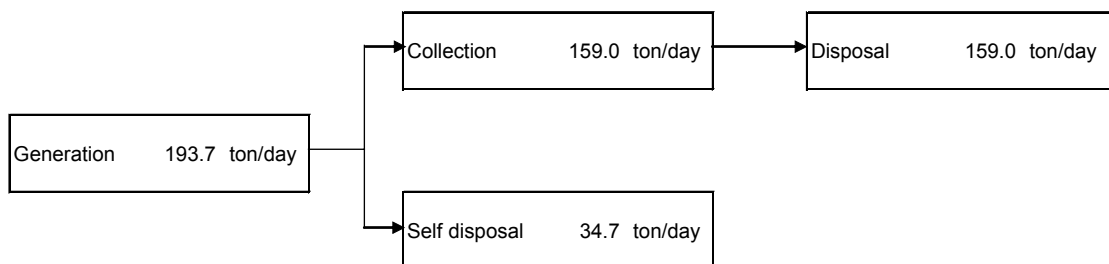


Figure 4-3: Present Waste Stream (Solidaridad)

4.2.3 Review of State Plans

a. Othon P Blanco

The state of Quintana Roo, aware of the inappropriate operating conditions of the final disposal sites and the risks for the environment and the tourism activity, has drafted a plan along with the Secretaryship of Urban Development and Environment (SEDUMA) to construct sanitary landfills in the short term that will replace the principal open dumpsites.

The sanitary landfill project will have an area of 15 ha. and will be designed for a useful life of 12 years, to be built in three stages and with a volume capacity of 1,203,304 m³, including coverage. The site is next to the existing dumping site.

The solution planned by the Seduma to get rid of the current dumpsite in Calderitas has a highly beneficial impact for the community and the environment; however, there is an important risk throughout the process that the sanitary landfill project has not been linked with the cleaning and closure of the current dumping site. Linking both projects will improve the sanitary and environmental conditions of the place, minimizing the contamination risks posed today by the dumpsite. On the contrary, if the current conditions prevail, it is possible that given the closeness between the same the project work goes out of control in the short term because no physical barriers exist to stop the current sanitary and environmental conditions from damaging the planned site; for instance, the presence of vectors and infiltration of leachate. Additionally, modification of the existing operational practices at the dumpsite is necessary, a thing that seems hard if no prior preparation exists.

To ensure the execution of cleaning and closure projects by programming both works in tandem, so when the operation of the sanitary landfill begins the dumpsite will have notoriously improved its operations, thus allowing a smooth transition between both projects.

b. Felipe C Puerto

SEDUMA has elaborated an Executive Project for a Sanitary Landfill and the Environmental Impact Manifest for a sanitary landfill that replaces the current dumpsite of the city of Felipe Carrillo Puerto.

The selected site to develop the project has a surface of 12.7 hectares and it is found in a land lot known as Rancho Raymundo, in Km 10.5 of the federal highway No. 184 between 184 Felipe Carrillo Puerto – Chunhuas, on its Southside. The project's life is estimated in 10 years and will allow the disposal of 200,000 tons approximately.

The projected sanitary landfill, although it represents a solution for the management of solid wastes for the city of Felipe Carrillo Puerto, in reality it does not fit for budgetary purposes of

the municipality or to the amount of wastes generated. Some of the works are over-dimensioned, as well as the operational activities.

A sanitary landfill project for this city will only be feasible as long as there is availability of resources and, given the municipality does not charge for the service, for now it seems impossible to raise the budget allocated to the management of solid wastes. This criterion should be borne in mind, not only for final disposal but for the entire planning of the service.

Right now, it is important that a strong link between the City Hall and the SEDUMA be established, so that they can face the solid waste management issue in tandem, not only in regards to final disposal, but to the services as a whole. Therefore, they will make a planning of the same with short-term and long term goals, thus avoiding the collapse of the system.

c. Solidaridad

SEDUMA has planned the conduction of surveys and executive projects of a sanitary landfill in the municipalities of the state of Quintana Roo, including Tulum.

The site chosen to develop the project has an area of around 13 ha. and is located approximately 10.5 Km northwest of Tulum, 400 m on the right side of the federal highway between Tulum and Coba, between the coordinates 20°16' northern latitude and 87° 30' western longitude. The selected land is approximately 1.3 Km north of the existing dumping site.

The project is designed to receive 270,886 tons of wastes and the useful life is expected at 10 years.

The sanitary landfill project outlined for the location of Tulum represents a great progress towards the management of household solid wastes; however, costs will jump considerably, which poses an important risk to the continuity of the works.

For the particular case of the municipality of Solidaridad, the waste collection and haulage service involves all the locations at the Mayan Riviera, the city of Playa del Carmen and other neighboring locations. This structure will allow the provision of the service at a lower cost and with the best utilization of the equipment. The same criterion should be regarded as for the final disposal, to consider a single sanitary landfill that serves all of the locations.

The above would not represent further issues or costs in the collection and haulage services, as wastes today are disposed of in the dumpsite of Playa del Carmen, regardless of the distance. If a sanitary landfill is intended between Playa del Carmen and Tulum, its execution is feasible and such would allow the economies of scale, thus shrinking the investment and operational costs.

On the other hand, within the strategy to improve the final disposal of the wastes, no project is being devised to recover and close the Tulum and Akumal dumpsites; and so unsanitary places would exist within the zone that pose an important environmental risk and that would carry diseases with an important impact on the tourism activity. Therefore, it is necessary that the closure of such dumpsites is planned along with new projects, ensuring that wastes are confined and the place monitored to spot any pollution issue right away and enforce the required corrective measures. The aforementioned is not difficult to achieve, especially when the recovery program of Playa del Carmen dumpsite has kicked off.

4.2.4 Financial System

a. Othon P Blanco

Solid waste service fees are charged only to commercial firms, but the awareness of these firms to comply with payments appears to be low. License to operate commercial firms needs to be renewed during the first months of every year, the firms being required to be up-to-date on payment of taxes and fees, and this requirement appears to be the major reason for commercial firms to pay the solid waste service fee during the first three months of the year.

In the case of Othon P. Blanco Municipality, income from solid waste service fees covers only a minimum part of the cost of providing the service. In 2001, income from solid waste service amounted to 1.37 Million Pesos (95% Chetumal and 5% Bacalar), while the cost of the service was estimated at 16.91 Million Pesos. This means that the income from solid waste service fee covered only 8% of the service cost. As the municipal budget in 2001 was 202 Million Pesos, expenditures on solid waste disposal required around 8% of the municipal budget.

Solid waste generation in Othon P. Blanco Municipality is reported as 170 ton per day, or 62,000 ton per year. At a total service cost of 16.91 Million Pesos in 2001, the cost per ton could be estimated to be around 270 Pesos, or about USD27, which may be more appropriate to be interpreted as the cost of solid waste collection service. CEPIS (Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente) indicated the acceptable range of solid waste collection cost per ton to be USD25-40 in 2001.

b. Felipe C Puerto

In the case of Felipe Carrillo Puerto Municipality, solid waste service is at present provided free of charge. However, recognition is growing that some service fee needs to be charged as fixed monthly tariff for households and for commercial firms.

In 2002, the cost of solid waste service was estimated at 1.16 Million Pesos. As the municipal expenditures in 2000 amounted to 86.6 Million Pesos in 2002, expenditures on solid waste disposal accounted for 1.3% of municipal expenditures in Felipe Carrillo Puerto.

The solid waste collection cost would be around 265 Pesos per ton, or USD26 per ton. CEPIS (Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente) indicated the acceptable range of solid waste collection cost per ton to be USD25-40 in 2001.

c. Solidaridad

Between January and May 2003, expenditures by Solidaridad Municipality on solid waste service amounted to 7.51 Million Pesos, while income from the service amounted to 3.83 Million Pesos, a deficit of 3.68 Million Pesos in 5 months.

The solid waste concession service in Solidaridad Municipality is estimated to dispose 4,000 ton a month at a cost of 1.47 Million Pesos plus 10% tax. This is equivalent to around 405 Pesos per ton, or about USD40 per ton. CEPIS indicated the acceptable range of solid waste collection cost per ton to be USD25-40, and USD4-10 per ton of disposal cost in 2001.

4.2.5 Environmental Education

a. Othon P Blanco

The Secretariat of Urban Development and Environment (SEDUMA) through the Office of Environmental Contamination Prevention and Control carried out a program of environmental education with the objective of strengthening awareness in students, the respect and protection of the environment and conservation of the biodiversity. This program has the goal of sensitizing students of primary schools, regarding the conservation of the living environment. The activities were carried out mostly in primary schools located at the riverside of Rio Hondo with the purpose of participating actively inside an institutional promotion work group for the environmental culture. In the activities were projected audio visual regarding the harmful effects generated by the solid waste and the different types of pollutants in the aquatic, air and terrestrial ecosystems, and showing of didactic material regarding the importance reef system roles in the marine life, etc. For the period 2003-2004 the Office intends to continue the activities of environmental education in the northern areas (along the highway towards Felipe Carrillo Puerto and on the Costa Maya).

The Municipality of Othon P. Blanco through its Urban Development and Ecology Office, is carrying out environmental education programs for kindergarten and primary schools, through a series of characters called "Reciclosa", "Tlacuachino" and "Manatín", each one of them presents a specific function regarding environmental management.

The first character represented by a bear forms "the club of Reciclosa and their friends" and it is a project focused on environmental nature activities for kindergarten children and primary schools, specifically focused on use an management of organic and inorganic wastes, and reforestation with the participation of "Reciclosa" as the main actor during the project. The project objective is to implement a program of "formal" type Education and Environmental Communication with issues and activities related to the appropriate domestic waste management, as well as to induce for reforestation and care of plants in its own school, through the central character of "Reciclosa" as motivational outstanding for kinder and primary schoolchildren.

An ONG "Friends of the Manatee" (a civil association) submitted a proposal to the Secretariat of Education and Culture on the importance of "Area Subject for the Sanctuary Ecological Conservation of the Manatee" to implement a support program in formal education for care and improvement of the environment. This program is focused on basic and middle level grades, and through of didactic activities and spreading of the information it is possible to transmit the knowledge, values and the respect to the ecological issues and how to manage the ecosystems that conforms the sanctuary of manatee, as well as learning of rational and sustainable use of natural resources of the living environment.

b. Felipe C Puerto

Environmental protection activities were carried out in the municipality of Felipe Carrillo Puerto through an Environmental Education Program to promote the Biodiversity and Management of the Sian Ka'an Biosphere Reserve by an NGO in coordination with the Ministry of Education and Culture among schoolchildren. This program consisted of guided visits to observe the flora and fauna of the region. The Municipality of Felipe Carrillo Puerto, in coordination with SEMARNAT, also distributed trees for planting to primary and secondary schools with the objective of protecting the environment. However, regarding solid waste management there are no environmental education programs with the exception of cleansing programs implemented by the municipality itself.

c. Solidaridad

The City Council of the Municipality of Solidaridad through the Environmental Office carries out a series of environmental education activities, training and events as follows.

c.1 Radio and television broadcastings

Radio broadcastings with information messages of environmental nature in different topics were carried out.

c.2 Recycling program

On November of 2002, the Environmental Office of the Municipality of Solidaridad began an installation program of containers including didactic material for storing and recycling of solid waste in the schools of the municipality.

c.3 Cleaning of beaches

On October 5 of 2002, the Environmental Office in coordination with the Tourism Office of the Municipality of Solidaridad carried out a cleaning of beaches in commemoration of world day celebration of "The International Cleaning of Beaches" with the participation of high school students in beaches of the city of Playa del Carmen.

c.4 Professional training

Development of courses for professional training:

- Ecological architecture
- Environmental Impact Assessment
- Tourism, sustainability and environment
- Basic and modern techniques for wastewater treatment.

c.5 International event "Riviera Maya Eco'03"

On June of 2003 an event was carried out with magisterial conferences, expositions, round table, environmental education workshop (recycling of paper), among other, for the environmental protection of Solidaridad.

c.6 Other Activities of Environmental Education in Solidaridad

Several non government organizations (NGO) and eco-tourist parks develop activities of environmental education: among these stand out Clean Planet, MOCE YAXCUXTAL A.C. and the Ecological Center of Akumal; Gea Urbilla in Tulum (in representation of Pronatura); Xel Ha Park and Xcaret Park.

c.7 State Plan of Environmental Education

SERMANAT through the Training Center for Sustainable Development (CECADESU) is promoting in each federative entity a State Plan for Environmental Education. In Quintana Roo this initiative is summed up by the University of the Caribbean in cooperation with the University of Quintana Roo. They are defined planning workshops with the educators of North and South sectors and the edition of respective results.

4.3 Groundwater Management

4.3.1 Extraction and Injection Wells

4.3.1.1 Extraction

a. Othon P Blanco

According to CNA, number of the registered wells is 1,014, which is largest in the three municipalities. Extraction wells for agricultural purpose make up 65% (658 wells) of the total number. The wells for public water supply are ranked to the second, which makes up 14.5% (147 wells). The public wells are for urban and rural water supply by CAPA.

b. Felipe C Puerto

Number of registered production wells in Felipe C. Puerto is 449 according to CNA. Of the 449 wells, agricultural wells make up 75% (336 wells) and public wells 16.5% (74 wells). Number of wells for service sector is only four (4) wells.

c. Solidaridad

Number of registered production well is 222. The production wells for service sector make up 58% (129) of the total number. On the other hand, public and agricultural wells are less than other two municipalities due to smaller municipality area and population in Solidaridad. Number of well is 29 for public and 35 for agriculture, respectively.

4.3.1.2 Injection well

a. Othon P Blanco

There are registered 91 injection wells in Othon P. Blanco, of which 82 wells are for service sector. CAPA has two injection wells in its sewage treatment plant, which were constructed 4 years ago, however, they are not being operated because of high artesian pressure of the wells. The depth and screen position is unknown.

b. Felipe C Puerto

An injection well is being operated by CAPA. In addition, according to CNA, twenty (20) injection wells are registered. Most of them are utilized for livestock waste water injection.

A waste water treatment is being operated for FRANCISCO VILLAGE, which is located between the street 57 and 59 of the town. This village has 114 houses. The plant was designed to treat 5 LPS of waste water, which only covers 2.0% of Felipe C. Puerto. The treated water is injected into the CAPA injection well.

c. Solidaridad

CAPA Playa Del Carmen has two injection wells in its sewage disposal plant. Depth of the injection well is 120 m. Casing diameter is 12 inches, however, the screen position is unknown. Injection rate is 45 LPS. This amount is a total of treated wastewater in the plant.



Figure 4-4: Injection Well in the Treatment Plant of CAPA in Playa Del Carmen

In addition to this injection well, Playa Del Carmen has another sewage disposal plant in *PLAYADEL* resort golf course. This plant has a capacity of 80 LPS. An injection well of 65 m depth is installed, however, it is operated mainly in rainy season. In most of the seasons, treated water is discharged to lagoon or irrigated for golf course.

Meanwhile, according to CNA, number of injection wells registered in Solidaridad runs up 184 wells. This figure is a largest among three (3) municipalities in the study area. Particularly, injection wells for service sector make up 92% (169 wells) of the total. These injection wells are densely located in the coastal town areas of Solidaridad.

4.3.2 Present Status of Monitoring

a. Othon P Blanco

There are no CNA monitoring wells in the municipality of Othon P. Blanco. However, CAPA regularly conducts monitoring of water quality. Parameters monitored are, CaCO_3 , chloride, alkalinity, acid degree, pH, colour, electric conductivity, temperature, turbidity and TDS. According to the data of May 13th, 2003, electric conductivity of the production wells ranges from 835 to 1,724 (micro S/cm) and chloride contents of 70 to 100 mg/litter at a temperature of 27° C. Coliform is also checked at a regular interval.

In addition to monitoring of the groundwater, the navy carried out monitoring of surface water in Chetumal Bay and Lake Bacalar Area in 2002. The results say that relation between NH_4 and PO_4 in the freshwater is remote, meanwhile, they may have a relation in the coastal water. This might imply that pollutants including NH_4 and PO_4 at a constant rate such as domestic wastewater flow in Chetumal Bay.

b. Felipe C Puerto

CNA has not yet constructed monitoring wells in this area. CAPA is conducting water analysis of the production wells at six (6) months interval.

c. Solidaridad

There are thirty (30) monitoring wells installed recently by CNA. Therefore, water levels and quality could be monitored not only in the town of Playa Del Carmen, but also other towns in the coastal area of Solidaridad.

Chapter 5

*Assessment of the Present
Situations and Confirmation
of Key Problems*

5 Assessment of the Present Situations and Confirmation of Key Problems

Assessment of the present situations and key problems describing what the present situations should be in the future are presented in this section.

5.1 Wastewater Management

The table below presents assessment and key problems in the field of wastewater management.

Table 5-1: Assessment and Key Problems in Wastewater Management

No.	Assessment	Key Problems
10	State level	
101	<ul style="list-style-type: none"> Various observations on coastal water body and freshwater body in and around the study area have been carried out by various institutions. The navy conducts periodical and fixed point observation targeting those water bodies. CAPA carries out periodical observations on wells such as hardness of water for water supply source management. CNA studies groundwater in Riviera Maya where tourist industry has been developed rapidly and many injection wells of wastewater exist. 	A system to integrate data and activities carried out by various institutions should be established.
102	<ul style="list-style-type: none"> CNA has an intention to create a new regulation or modify existing regulation on wastewater management in order to make them suit to specific geological condition, limestone terrain, of Yucatan Peninsula. Hotels are large water consumers and wastewater dischargers. Wastewater treatment facilities in hotels are not necessarily sufficient. 	It should be considered necessity of specific regulation on wastewater management with purpose to protect groundwater.
103	<ul style="list-style-type: none"> It has been established as CAPA's policy to be a leading organization in the water supply and wastewater sector based on the quality of its service and the implementation of the best technical, commercial, and administrative processes. It is also intended to attain operational, economic, and financial self-sufficiency with the purpose to contribute to the development of the State. The document called "Manual de Organización y Procedimientos" was elaborated by a consultant firm contracted by CAPA. If they are implemented and applied, it could result in an improvement of efficiency in general. CAPA has numerous data and this makes possible to implement evaluation indicator system. For this purpose, the consultantship proposed a General Evaluation System which includes infrastructure and coverage indicators, income and operative and commercial efficiencies. 	CAPA is like to be on the right track. It is recommendable to implement what they have planned.
11	Othon P Blanco	
111	<ul style="list-style-type: none"> BOD generation and discharge to the environment in Othon P Blanco are highest in three municipalities. Only Chetumal has a population that makes up about 60% of total population of the municipality. CAPA has constructed about 8,800 connection pits that connect house drainage to sewer. However, it is estimated that houses actually have connection would be about 1,500. 	Connection of house drainage to sewer pipe should be urgently promoted in Chetumal

No.	Assessment	Key Problems
112	<ul style="list-style-type: none"> Although there exists no operating sewerage system in the rural area at present, CAPA has begun to introduce a system. However, it is concerned that the same problem about connection to house drainage as in Chetumal would appear. A countermeasure to solve this problem is expected. Design parameters of the system are based on literatures, not based on actual operation. Therefore, it is necessary to obtain the parameters through actual operation and to establish an operation manner. The sewage system mentioned above targets communities that have certain population density. Alternatives for smaller communities should be considered. 	Appropriate technology for rural and semi-urban areas should be established to reduce pollution road from the areas
113	<ul style="list-style-type: none"> The water supply and sewer services in Othon P. Blanco Municipality have resulted in financial deficits during the past three years. Low rate of micro-metering restricts the potential application of the progressive water rates. Resources are scarce by definition. Being realistic, it will likely be more and more difficult to depend on the higher levels of government to finance all necessary services. To persuade service users to pay their share of service costs, it would be easier when service users are relatively satisfied with the service. Fortunately, the CAPA head office has plans to complete installation of water meters (micro-metering) within the next two years. 	Financial status of water supply and sewer service in Othon P Blanco conducted by CAPA should be improved. This could be achieved through improvement of water supply service; application of existing water rates through micro-metering, reduction in unaccounted for water, and improvement in water quality. These efforts should be monitored through selected performance indicators.
114	<ul style="list-style-type: none"> In the Municipality of Othon P Blanco, environment education is given separately by a number of agencies such as SEDUMA, CAPA, the Municipality of Othon P. Blanco and NGOs. There are few programs directed specifically at wastewater management with the objective of preserving the environment. Society as a whole can barely grasp the magnitude of environmental sanitation problems; as a result, limited participation from the population in wastewater management and modest public awareness on environmental issues has been observed. 	Various organizations, SEMARNAT, SEDUMA, CAPA, the Municipality, NGO, etc., join efforts and work together as a team to disseminate knowledge through concrete practices with the participation of the community starting with schoolchildren and communities in general.
12	Felipe C Puerto	
121	<ul style="list-style-type: none"> An off-site system works in an area of Felipe C Puerto City, which targets only 567 residents. This leads to 3% of sewerage service coverage for the city's population and 1% for the total municipal population. A sewage treatment plant in Felipe C Puerto City has a capacity of 5 litter/sec (432m3/day). However, actual inflow is 1.34 litter/sec (116 m3/day) or 27% of the rated capacity. 	Wastewater in the city of FCP should be collected up to the rated capacity of the existing treatment plant and the sewerage system should be expanded.
122	<ul style="list-style-type: none"> There exists no operating sewerage system in the rural area at present. As the population of communities having between 100 and 2,500 residents makes up more than 50% of the total population in the municipality, a certain adequate measures should be taken to meet the situation. 	Appropriate technology for rural and semi-urban areas should be established to reduce pollution road from the areas.
123	<p>The water supply service in Felipe Carrillo Puerto Municipality has not paid for itself during the past three years.</p> <ul style="list-style-type: none"> Low rate of micro-metering restricts the potential application of the progressive water rates. Resources are scarce by definition. Being realistic, it will likely be more and more difficult to depend on the higher levels of government to finance all necessary services. To persuade service users to pay their share of service costs, it would be easier when service users are relatively satisfied with the service. Fortunately, the CAPA head office has plans to complete installation of water meters (micro-metering) within the next two 	Financial status of water supply and sewer service conducted by CAPA should be improved. This could be achieved through improvement of water supply service; application of existing water rates through micro-metering, reduction in unaccounted for water, and improvement in water quality. These efforts should be monitored through selected performance indicators.

No.	Assessment	Key Problems
	years.	
124	<ul style="list-style-type: none"> Latrine programs have been carried out in the past in some communities. However, due to adaptation problems and the inadequate management and maintenance of the latrines, outdoor defecation is still practiced. Infection and contamination due to outdoor defecation and inappropriately located latrines, as well as animals in the urban areas are the main causes of gastrointestinal diseases. 	Appropriate use of latrines in rural area should be disseminated.
13	Solidaridad	
131	<ul style="list-style-type: none"> Only Playa del Carmen has a population that makes up about 68% of total population of the municipality. In Playa del Carmen actual inflow almost reaches to the rated capacity of the plant and expansion and/or construction of sewage treatment plant is urgent. In order to cope with this situation, CAPA has a plan to construct a plant having a capacity of 360 liter/sec (31,110 m³/day). 	A new treatment plant should be constructed and operated to cope with increasing demand.
132	<ul style="list-style-type: none"> There exists no operating sewerage system in rural area at present. However, CAPA begins to introduce the sewerage system in the rural area and gets to work on a small scale collective sewage treatment facility and a sewer system at Puerto Aventuras and Akumal in Riviera Maya. Design parameters of the system are based on literatures, not based on actual operation. Therefore, it is necessary to obtain the parameters through actual operation and to establish an operation manner. The sewage system mentioned above targets communities that have certain population density. Alternatives for smaller communities should be considered. 	Appropriate technology for rural and semi-urban areas should be established to reduce pollution road from the areas.
133	<ul style="list-style-type: none"> The water supply and sewer service in Solidaridad Municipality showed positive financial results during the past three years. The financial sufficiency of water supply and sewer services in Solidaridad Municipality may be attributable a relatively high micro-metering rate of 56%, as well as to the 132 hotels identified in the area. Financial self-sufficiency should not lead to complacency, as the situation can change quickly. The present favourable situation is the time to establish the mechanism to monitor and improve the service on permanent basis. Solidaridad Municipality will further benefit from the CAPA head office plans to complete installation of water meters (micro-metering) within the next 2 years. 	The good finance status should be sustained with improvement of the application of existing water rates, expansion of micro-metering, careful watch on unaccounted for water, and constant improvement of water quality. These efforts should be monitored through selected performance indicators.

5.2 Solid Waste Management

The table below presents assessment and key problems in the field of solid waste management.

Table 5-2: Assessment and Key Problems in Solid Waste Management

No.	Assessment	Key Problems
20	State Level	
201	<ul style="list-style-type: none"> New and various requirements in SWM arise along with economic development such as collection service for growing population, sanitary landfilling and recycling, however the municipalities are not so capable as to meet with the requirement. There is a framework where the state government through SEDUMA supports the municipalities, although it cannot be said that it functions well. The new requirements need large finance. The municipalities can only access the financial resources through the state government. 	The framework where the state government and the municipalities collaborate on SWM should be encouraged in order to cope with the new requirements.
202	<ul style="list-style-type: none"> The municipalities have problems in final disposal. SEDUMA carries out projects for constructing new sanitary landfills in Chetumal, Felipe C Puerto and Tulum to cope with this situation. The project in Chetumal would be preferable for the municipality. However, it may be difficult to realize other projects. Felipe C Puerto has pointed out high operation costs of the landfill, for which the municipality could not afford. Important aquifer may exist around the project site in Tulum. Any project does not consider improvement of current operation manner, closure and remediation of existing and abandoned dumping sites. Those are important issues to realize sanitary landfilling in the study area, as it is very difficult to jump up from the bottom to the top at once technically and financially. 	<p>Final disposal in the municipalities should be improved. Projects conducted by SEDUMA, which is for new landfills construction in Chetumal, Felipe C Puerto and Tulum, shall proceed. However, those may need to take into consideration respective conditions of municipalities, especially Felipe C Puerto and Solidaridad.</p> <p>Current disposal operation manner should be improved. Closure and remediation of existing and abandoned dumping sites should be planned and implemented.</p>
21	Othon P Blanco	
211	<ul style="list-style-type: none"> The waste collection works is well carried out, however, there are some threats to discontinue the good situation such as; unbalanced collection route design gives over workloads on collection vehicles and does not allow them to receive appropriate maintenance, and a long duration to obtain spare parts stays the collection vehicles away from works and it loses money. Final disposal amount in the site of Calderitas recorded by the municipality, about 9,000 tons of waste per month (300 ton/day), is far beyond the estimated disposal waste amount, 120 ton/day. To know correct disposal amount is fundamental not only for planning operation schedule but also for controlling operation costs. Waste amount should be recorded correctly. Income from solid waste service in Othon P Blanco Municipality covered only 8% of service costs in 2002. Even if the solid waste service continues within the municipal system, justification to secure or increase its budget can be more convincing if specific cost figures are used. Then, a careful record-keeping of all service activities becomes essential to translate them into cost figures. The records will permit preparation of performance indicators of diverse nature, operational-commercial-financial, which can be constantly monitored as a way to improve efficiency and effectiveness of the solid waste service. The expected end result will be improved finances of solid waste management service. 	Management capability of the municipality should be strengthened by a careful record-keeping and introduction of indicators in order to provide stable, effective and efficient SWM services.
222	<ul style="list-style-type: none"> The disposal site in Calderitas presents serious sanitary and environmental risks; proliferation of insects and animals, fire, leachate, etc. 	The existing disposal site in Calderitas should be improved.

No.	Assessment	Key Problems
223	<ul style="list-style-type: none"> There exist open dumpsites around small towns such as Bacalar. Although degree of adverse sanitary and environmental impacts is not yet significant compared with of the dumpsite in Calderitas, it may become considerable along with development in the future. 	A sound solid waste management including an appropriate final disposal system should be established in small towns.
224	<ul style="list-style-type: none"> The municipality shows their interest in composting. Recycling including composting is one of good manners to encourage resource conservation. However, those should be implemented based on financial feasibility to sustain their operation. 	Introduction of composting should be considered chiefly from a viewpoint of financial feasibility.
225	<ul style="list-style-type: none"> In addition to the existing problems in solid waste management, new problems would arise in Costa Maya in the near future where a large tourism development is expected. 	A solid waste management system in COSTA MAYA should be established with participation of the tourism sector in order to cope with demands derived from its development.
226	<ul style="list-style-type: none"> In the Municipality of Othon P Blanco, environment education is given separately by a number of agencies such as SEDUMA, CAPA, the Municipality of Othon P Blanco and NGOs. However, there are few programs directed specifically at solid waste management. Society as a whole can barely grasp the magnitude of environmental sanitation problems. Modest public awareness on environmental issues has been observed. 	The organizations (SEMARNAT, SEDUMA, CAPA, the Municipality, NGOs, etc.) join efforts and work together as a team to disseminate knowledge through concrete practices with the participation of the community starting with schoolchildren and communities in general.
22	Felipe C Puerto	
221	<ul style="list-style-type: none"> Waste collection service is only provided to the city of Felipe C Puerto. 50% of the residents of the city is covered with the service. This is quite low service coverage for a city. The low service coverage reflects what clandestine waste dumping can be found at many places in the city. Poor status of collection vehicles makes it difficult to provide proper waste collection service. 	The collection service coverage in the city of Chetumal should be improved.
222	<ul style="list-style-type: none"> Municipal records say that about 30 ton of waste is collected and disposed every day. However, estimated collection and disposal waste amount is around 10 ton/day. This misunderstanding may lead improper preparation of plan and operation. Correct waste amount should be recorded. The issue is the financial deficit of solid waste management service. Felipe Carrillo Puerto Municipality is provided free of charge. No solid waste service charges have been established up to the present. Even if the solid waste service continues within the municipal system, justification to secure or increase its budget can be more convincing if cost figures are used. Then, a careful record-keeping of all service activities becomes essential to translate them into cost figures. The records will permit preparation of performance indicators of diverse nature, operational-commercial-financial, which can be constantly monitored as a way to improve efficiency and effectiveness of the solid waste service. The expected end result will be improved finances of solid waste management service. 	Management capability of the municipality should be strengthened by a careful record-keeping and introduction of indicators in order to provide stable, effective and efficient SWM services.
223	<ul style="list-style-type: none"> The current disposal site is an open dumping site without control. It causes several problems such as fire, odor, proliferation of insects and animals, air pollution, groundwater contamination, etc. 	The current dumping site should be improved immediately with taking into consideration lack of capability of the municipality.
224	<ul style="list-style-type: none"> Hospital waste is collected separately from ordinal waste collection service. However, it is disposed of with the ordinal waste. In order to minimize expansion of diseases, the hospital waste should be carefully and separately disposed of. 	Hospital waste should be carefully and separately disposed of.
225	<ul style="list-style-type: none"> There are few environmental education activities on solid waste management developed in Felipe Carrillo Puerto. In many 	Public awareness on environmental issues should be encouraged.

No.	Assessment	Key Problems
	<p>areas in the periphery of the city of Felipe Carrillo Puerto, materials such as plastic bags and plastic bottles are seen scattered in the streets and open areas. Modest public awareness on environmental issues would be one of causes of the situation.</p>	
23	Solidaridad	
231	<ul style="list-style-type: none"> • There are two abandoned dumping sites in the municipality, which have awful sanitary and environment conditions. 	<p>The two abandoned dumping sites should be closed properly and immediately.</p>
232	<ul style="list-style-type: none"> • In the municipality, several recycling activities have been carried out. This should be appreciated. However, some of them reportedly failed due to lack of finance. 	<p>Financial feasibility should be taken into account for sustaining recycling activities.</p>
233	<ul style="list-style-type: none"> • New solid waste service charges were established in January 2003, which appear to be comprehensive enough to cover the different types of service users, but maybe there have been unforeseen administrative obstacles in the application of these user charges during the initial stage. Perhaps service users are not familiar with these user charges, despite being published in an Official Gazette, and are therefore reluctant to pay. 	<p>Income should be improved by facilitating the application of service charges established in January 2003.</p>
234	<ul style="list-style-type: none"> • Municipality of Solidaridad has carried out a series of activities including environmental education, training and events related to solid waste management with the participation of schools and a private company. Most of the activities were developed in Playa del Carmen and in the coastal areas of Riviera Maya where no big solid waste problems are observed. However, in some towns scattered waste is observed mainly in open lands. This situation indicates that in spite of the effort deployed by the municipality, community participation is still required. 	<p>Community participation in SWM should be encouraged in small towns.</p>

5.3 Groundwater Management

The table below presents assessment and key problems in the field of groundwater management.

Table 5-3: Assessment and Key Problems in Groundwater Management

No.	Assessment	Key Problems
301	<ul style="list-style-type: none"> Well inventory of the Study Area is kept in the computer of CNA. However, the design of the registered well and geologic log at the construction time is not submitted and stored in the inventory. These data are important as a basis for construction of groundwater management tools, such as hydro-geological map, cross section and computer groundwater model. Particularly important are those of the injection wells. 	Well design and geologic log data at construction time should be kept and maintained.
302	<ul style="list-style-type: none"> Although the inventory has the concession water amount of the well, actual amount of extraction and injection is not recorded. At least once a year, the users should report their actual amount as well as its water quality. 	Actual extracted and injected water amount should be recorded.
303	<ul style="list-style-type: none"> CNA should have a regular inspection on actual water amount of extraction and injection and their water quality in the selected wells at least once a year. Groundwater monitoring wells have been constructed recently in the area of Cancun-Tulum. Water levels and water quality is regularly checked manually at a 6 months interval. It is not necessary to install automatic water level and quality recorders for all the wells at present, however, several selected wells should be monitored automatically. 	Inspection and monitoring system on water quality of wells should be established.
304	<ul style="list-style-type: none"> Many injection wells have already been operated in the Study Area. However, injection standard has not been established. 	A standard on injection well should be established and enforced.