L.2 USE Conceptual Master Plan for Leon

L.2.1 Planning Frameworks for and ISE M/P

L.2.1.1 Goals, Targets and Strategy

a. Goals

The principal goal of the Conceptual Master Plan for Leon is to improve the Urban Sanitation Environment (USE) of the Leon City till the target year 2010 where people and major economic activities of the Region II are centered.

Through the improvement of USE in Leon City, **the Plan aims to:**

- **promote the Citizens' Well-being;**
- **support Sustainable Development of the City; and**
- **contribute to the Growth of the Regional Economies.**

The goals in practice of the Master Plan are as follows:

1. Improvement of public health in the city,
2. Reduction of health hazards in and around the city;
3. Protection of natural resources and environment (e.g., underground water resources and ecology);
4. Encouragement of citizens' environmental consciousness;
5. Increased provision of USE services (i.e., water supply, sewer, SW collection, etc.) in affordable and appropriate levels;
6. Establishment of self-sustainable management systems on USE services;
7. Establishment of a Beneficiary-Pay-Principles (BPP) under which services recipients pay for the USE services;
8. Development and promotion of community participation in USE systems;
9. Employment of satisfactory measures for protection of environment/human health in the operation and maintenance of USE facilities;
10. Prevention of pollution by industrial wastewater and solid waste;

11. Establishment of appropriate legislation, regulations and guidelines on USE through modifications and revisions of the existing ones; and

12. Establishment of a coordination mechanism for the city with national institutions for USE management.

b. Targets

Target years are set up as follows:

Master Plan: Year 2010

Feasibility Study: Year 2005

In order to achieve the principal goals, target figures in 3 major sectors comprising USE are set up as indicated in the Table below.

Table L-99: Target Figures of Technical System in Leon

	Present(1995/96)	F/S(2005)	M/P(2010)
Water Supply Coverage	92.2 %	*85 %	*85 %
Domestic Wastewater Treatment			
Sewer coverage	55.3 %	60 %	65 %
On-site system coverage	2.1 %	7 %	12 %
Latrine only system	35.2 %	29 %	23 %
No system rate	7.4 %	4 %	0 %
Waste Collection Coverage			
Collection rate of all waste	86.7 %	95 %	100 %
Collection rate of household waste	80.0 %	94 %	100 %

Note: The INAA established a target water supply coverage rate of urban population as 85% for the country. The above-mentioned target figure is set up in accordance with the INAA's target. Consequently, the coverage rates of the year 2005 and 2010 is lower than 89.7%, the rate of 1995/1996. However, the supplied population in 2005 will be about 1.6 times more than that in 1995/1996 and that in 2010 will be about 1.8 times.

c. Strategies

Strategic actions to reach the goals and targets should, in practice, be deployed in a stepwise manner toward the target year 2010. Therefore, it is recommended herewith to divide the period to the target year 2010 into 3 phases.

Table L-100: Strategies for the Realization of USE Master Plan

Classification Phase	Technical Aspects	Institutional Aspects
Phase 1 **(1998 - 2000) Preparation for Priority Projects Implementation**	**Common Aspects** • An USE M/P should be urgently formulated and F/S on priority projects should be conducted along with the M/P. **Water Supply System** • The water supply system should be consolidated to maintain target coverage of 85% for the increasing population. **Domestic Wastewater System** • In order to execute the priority projects (F/S projects), the required funds shall be secured and the detailed design of the projects shall be conducted. • As for sewer area, connection to sewer should be promoted and system improvement necessary for maintaining the present sewer coverage (55.3%) should be provided. • As for the non-sewer area, F/S for introducing on-site DWW treatment system should be carried out, referring PECM (Special Program for Model Community Integrated USE Improvemenet Project) in Granada. In order to prepare for such projects, public education program should be deployed to encourage citizens' environmental consciousness. **Stormwater Management** • Technical guidelines necessary for storm water management should be prepared. • Basic investigation (e.g., topographic survey) for inundation prone area should be conducted for planning the improvement and recruiting necessary funds. • Rain drainage in urban fringe areas (UFA) should be improved, referring PECM in Granada. **Municipal SWM** • A site for a future municipal SW final disposal site should be selected from some candidate sites. Its preliminary design and the environmental impact assessment (EIA) should be carried out. • In order to execute the priority projects (F/S projects), the required funds shall be secured	**Common Aspects** • Regulations of wastewater discharge into sewer/public water body should be legally and practically enforced. • The municipality should provide norms and guidelines regarding USE to the citizens, from which citizens should easily understand appropriate sanitary practices and civil procedures. • Appropriate land use management should be further promoted along with the present urban development plan. Meanwhile, a cadastre of real property and public services should be established. **Domestic Wastewater System** • Guidelines for appropriate on-site DWWM should be elaborated. • INAA, MINSA and the municipality should, referring PECM in Granada, coordinate to establish a steering committee for PECM in Leon necessary for introducing on-site DWW treatment system and to seek foreign and domestic grants for such projects. **Stormwater Management** • Authoritative competency for storm water management (planning, maintenance and repair) should be reviewed respectively for macro- and micro- drainage. • INAA, MINSA and the municipality should, referring PECM in Granada, coordinate to establish a steering committee for PECM in Leon necessary for improving rain drainage in UFA and to seek foreign and domestic grants for such projects. **Municipal SWM** • Regulations on urban cleansing should be established to clarify municipality's powers (including placing penalties) and duties as well as citizen's rights and duties. • The municipality should improve

	and the detailed design of the projects shall be conducted. Then, construction of the facilities and procurement of vehicles and equipment shall be done. • Technically satisfactory level of sanitary landfill operation should be maintained in the present landfill until its closure, in order to reduce the pollution impacts to the environment. Meanwhile, illegal dumping should be reduced through improved collection services. **Industrial Waste Management** • Based on the "polluter pays principle", industries should be instructed to implement appropriate on-site management of their solid/liquid wastes and residual water. **Medical Waste Management** • Appropriate on-site management (e.g., separation of hazardous/infectious medical waste from other waste) in institutions should be promoted.	collection of municipal taxes and charges for the services. **Industrial Waste Management** • Waste classification suited for Nicaraguan authorities' present IWM should be established. Management of hazardous waste should be prioritized. • Inventory of factories and their waste generation should be made for identifying ISW and IWW. • With regard to ISWM and IWWM, authorities should be empowered to conduct administrative measures such as monitoring, supervision and guidance. **Medical Waste Management** • Classification of medical waste should be established. Code of practice for respective medical waste categories should be formulated.
Phase 2 **(2001 - 2005) Priority Projects Implementation**	**Water Supply System** • The water supply system should be consolidated to maintain target coverage of 85% for the increasing population. **Domestic Wastewater System** • Facilities and equipment provided in Phase-1 should be operated and maintained appropriately. • In order to prepare for M/P projects, designs and funds recruitment for the projects should be prepared. Then, facilities construction should be implemented. • Sewer provision should be improved to attain the target coverage of 60%. • In the non-sewer area citizens' participation in the "model communities integrated USE improvement" projects should be substantiated in order to sustain the projects in affordable and appropriate levels. Meanwhile coverage rate of on-site system should be raised to 7%. **Stormwater Management** • Drainage should be improved in accordance with Flood Damage Area Improvement Plan. • Integrated Arroyo Management Plan (comprising: land use regulation; catchment	**Common Aspects** • The norms and guidelines regarding USE provided by the municipality should be demonstrated through public education programs in order for the citizens to practice appropriate sanitation measures and civil procedures. • The urban development plan should be further utilized to guide and to restrict the land use, in order to maintain a preferable urban environment (e.g., protect potable water sources of the city, regulate industrial activities and NIMBY facilities in designated areas). • The cadastre of real property and public services, perhaps applying crossed subsidies; should be utilized for establishing the management system on USE services and also promoting a Beneficiary-Pay Principles for the services. **Domestic Wastewater System** • PECM steering committee should further seek foreign and domestic grants for constructing on-site DWW treatment projects.

	conservation with reforestation; and drainage channel improvement) should be formulated. • Rain drainage in UFA should be further improved through PECM. **Municipal SWM** • Facilities and vehicles acquired in Phase-1 should be appropriately operated and maintained. • Technically satisfactory level of sanitary landfill operation should be maintained in the new landfill. Meanwhile, illegal dumping should be further reduced through improved collection services. **Industrial Waste Management** • On-site ISWM and IWWM should be further strengthened. • Treatment/disposal by private sectors, mainly for hazardous waste, should be implemented. **Medical Waste Management** • Appropriate on-site management (e.g., separation of hazardous/infectious medical waste from other waste) in institutions should be obligated. • Treatment/disposal of hazardous/infectious medical waste should be implemented by private sectors.	**Stormwater Management** • Respective institutional system (e.g. funds, design guidelines) for macro- and micro-drainage should be established. • PECM steering committee should further seek foreign and domestic grants for constructing rain drainage facilities. **Municipal SWM** • Authorities should encourage recycling activities by waste generators and private recyclers. However, the administrative support should be such a manner with least financial burden on authorities. **Industrial Waste Management** • Legislative framework to obligate appropriate IWM (e.g., manifest system) should be established. • With regard to ISWM and IWWM, authorities should practice administrative measures (e.g., monitoring, supervision and guidance) and apply penalties (if necessary) against illegal measures by industries. • Formulation of commercial mechanism for appropriate treatment/disposal should be promoted. **Medical Waste Management** • Code of Practice on medical waste management should be enforced.
Phase 3 **(2006 - 2010)** **M/P Projects Implementation**	**Water Supply System** • The water supply system should be consolidated to maintain target coverage of 85% for the increasing population. **Domestic Wastewater System** • The M/P projects should be reexamined and implemented, with reference to the outcome of the priority projects (F/S projects). • As for sewer area, the off-site system should be consolidated to maintain target coverage of 65% of the population. • As for no sewer area, the on-site system should be consolidated to maintain target coverage of 12% of the population. • As for area served with "model communities integrated USE improvement" projects, self-	**Common Aspects** • Public education programs related with the norms and guidelines regarding USE provided by the municipality should be deployed widely. • The urban development plan should be put in practice to restrict the land use, in order to maintain a preferable urban environment. Meanwhile the plan should serve for planning USE services corresponding to the urban expansion and the population increase therein. **Water Supply System** **Domestic Wastewater System** • PECM steering committee should raise funds for constructing on-site DWW

	help of communities should be employed in operation and maintenance of the facilities. **Stormwater Management** • Reforestation, drainage improvement works, etc. should be implemented in accordance with Integrated Arroyo Management Plan. • Rain drainage facilities in UFA should be further constructed through PECM. **Municipal SWM** • The M/P projects should be reexamined and implemented, with reference to the outcome of the priority projects (F/S projects). • Satisfactory municipal SWM both technically and environmentally should be continued. In maintaining 100% waste collection rate, illegal dumping should be eradicated. **Industrial Waste Management** • Industries should take initiatives for introducing "waste minimization and cleaner production" technologies for their production. **Medical Waste Management** • Appropriate collection, treatment and disposal should be practiced for all medical waste (including hazardous and infectious ones).	treatment projects, from water and wastewater charges collected. **Stormwater Management** • PECM steering committee should raise funds for constructing rain drainage facilities, from automobile taxes etc. **Municipal SWM** • Introduction of separate collection system should be examined in order to promote waste minimization and resource recovery from waste. **Industrial Waste Management** • Authorities should promote introduction of "cleaner production" mainly for factories that generate hazardous waste. **Medical Waste Management** • Appropriate control, treatment and disposal of medical waste should be enforced in line with the Code of Practice for Medical Waste Management.

d. Strategic Management

d.1 General Directions in the Management

d.1.1 The Municipality as the Citizens Main Support

The municipality should manage and coordinate all the services and public needs for the USE in the municipal territory. In order to reach this goal, the municipality should be able to:

- Provide norms and directives to the population with respect to the location, sanitary structures and civil procedures to live and work under satisfactory environmental and sanitary conditions;
- Provide services of their own competence, and coordinate and promote other institutions' services for the citizens.

The main rational measures by the municipality should be:

- An urban development plan or, at least, zoning and regulations for urban land use;
- A regulation for construction/extension/rehabilitation of residential and non-residential buildings and/or other installations;
- A cadastre for real property and public services to be offered for the citizens;

- Regulations for the municipality responsible services such as waste collection and disposal, public areas cleaning and micro-drainage.

d.1.2 Legal Improvement

The Constitution of the Republic establishes the principle of Municipal Autonomy, which is explicit in the Law of Municipalities No. 40-88, article 2, 6, 7, 9 and 10 (which refers sanitary and environmental issues). This municipal competence is also declared in the Environmental Law No. 217-96, article 16 and 129.

Municipal Ordinance (MO) are the documents dictated by the Municipal Council after accepting the Mayor's request (Law No. 40-88, article 28 and 34), which will empower the municipal government to administrative measures and necessary sanctions for the municipal government in order to execute municipality's functions and demand citizens burden sharing.

d.1.3 Organizational Improvement

The Annex N presents organizational structures and respective functions recommended to the municipality, which are compatible with the needs to develop a Master Plan. It recommends a transition from the actual organization to the proposed one, to be assisted by an expert in organization, improvement methodologies and human resource training.

d.1.4 Municipal Personnel Training

The training should be done stepwise in order to obtain results (i.e., operational instruction; training; and professional formation) immediately. Furthermore such training should be selective in accordance with the necessity of reaching the targets.

It is recommended that it should be programmed and evaluated by an expert, with a priority on training of:

- Department chiefs;
- all the personnel of the sections very linked to what proposed in the M/P (e.g., assistance to the cadastre on real property);
- chiefs of the sections and sectors in "Waste Collection and Public Cleaning" and "Vehicles and Equipment";
- chiefs of "Administration" and "Finances" sections; and
- chiefs of "Fee Collection" and "Audit" sectors.

It is very important that the directors and chiefs be selected according to their formation and personal aptitudes which should make a perfect match to their attributions in their operational branches and divisions.

d.1.5 Coordination with the National Entities that Provides Public Services in the Municipal Territory

The municipality should coordinate and offer to the citizen **instructions** (concerning services of municipal competence and other entities' competence), in the pursue to make the instructions simple and to have a quick access to services. In such a way the citizens will have the opportunity to obtain the required information in just one place.

The **instructions** should be simple, specific and prompt documents (i.e., which should be an easy-to-understand translation of the regulations, technical and administrative

norms). It should be presented in words, drawings and other basic forms that makes them easier to understand for the common citizens. They do not require legislative approval to be emitted, but they should be prepared by the entity that offers such services.

The municipality should try to coordinate with the national entities in order to develop intersectorial projects, in such a manner the municipality could always remain expected to request better services by the institutions. Along with MINSA, the municipality should intensify its pro-active mobilization of the communities involved in the sanitation projects. In agreement with MCT, the municipality should begin joint works to clean and protect the dry ditches and streams (arroyos). The municipality at the same time should prevent the illegal disposal of solid waste in such places. On the other hand, INAA and MINSA should control the liquid waste disposal. The municipality should correspond to MARENA to classify the urban ditches and to define responsibilities for their maintenance and protection. Meanwhile, MARENA should supply the instructions regarding industrial waste and "infectious" medical waste to the municipality (and also to those interested in).

The Municipal Council and INIFOM should unite together in order to support the municipality's plans firmly and to request cooperation from national entities. Assistance by INIFOM is considered as a fundamental requirement for the success of the Master Plan, specially in view of institutional improvement and municipal personnel training.

d.1.6 New Services by INAA

With regard to on-site sewage treatment/disposal systems, INAA (through an agreement with the municipality) should extend its services, including the construction and operation/maintenance of the on-site collective systems, as well as the removal of sludge from individual/collective septic tanks.

d.2 Management on Constructions and Urban Development

d.2.1 Residential Constructions

The municipality should establish the Permission System which comprises: permission for construction; and permission for the use of constructed residences (which should include the real property cadastre, so that it proceeds to receive all the public services available in the micro-region, and the services should be paid for).

Issues of the construction permits will indicate the services demand in the future (in the medium term). Meanwhile issues of permits for use of constructed residences will indicate the immediate demand of the services and the potential incomes corresponding to that.

The municipality should supply, to those interested to construct, the Instructions and orientations, in order for that the constructions fulfill the sanitary requirements and others requirements without bearing needless costs. Meanwhile the municipality should maintain the design submitted in files. Once the construction works are concluded, the municipality should inspect whether it is constructed as proposed in the design, and then the use permission is granted. This should be informed immediately to the other public services suppliers. The immediate transmission of such information should be through the data processing network among the municipality and the services suppliers in order for that those service suppliers should also fulfill their duties and rights.

The permission process should be simple and at a low cost in order to make it feasible. Some models of low-cost housing should be designed, pre-approved and permitted by the municipality. Furthermore such low-cost housing should be offered by the municipality to low income citizens, however, the inspection and register in cadastre should not be exempted once the work has finished.

Similar procedures should also be applied to: renovations of existing residence for other use purposes; and reforms with extension of constructed one.

The municipality, by the Municipal Ordinance, should also establish the obligation of connection to the sewer (of off-site or on-site system) from all residential buildings where such sewer exists in the adjacent street or neighboring property.

d.2.2 Non-Residential Constructions

For buildings of non-residential use, the pre-approved designs and permits (as mentioned above) should not be applicable. The construction permission for non-residential building should establish the obligation to observe the Decree 33-95, in order to permit to connect them to the existing sewer system.

d.3 Management of Wastewater in Non-Sewer Areas

The municipality should establish, by Municipal Ordinance, the obligatory nature of citizens to make an appropriate disposal of their wastewater. For such purpose, viable alternatives and a reasonable assistance will be offered, before applying sanctions as they are established in the Ordinance.

In the micro-regions where sewer system would not be feasible, on-site treatment (preferably a collective system) should be adopted. However for the time being, it should be tolerated with the more primitive solutions of current practices, but with an appropriate sanitary control.

The municipality should coordinate a Special Program for Model Community Integrated USE Improvement Project (PECM) to be developed by INAA and MINSA, with initial funds from a Rotating Fund which will be maintained and will support the continuity of PECM through the payments of the services for the system construction, connection to the houses, operation and maintenance of the system. These payments will be facilitated and could be reduced through the beneficiary citizens' burden sharing by participation, which should be stimulated by a community mobilization.

The municipality should also establish the obligatory nature and tolerance for those who operate commercial and industrial establishments. To the existing industrial establishments, it will be demanded to certify that they have complied with the ordinance of article 72 of the Decree 33-95 and the Gradual Decontamination Plan accepted by MARENA or INAA.

d.4 Urban Cleaning Management

The municipality, by Municipal Ordinance, should regulate whatever regarding the Urban Cleaning (e.g., the waste collection as an result of the citizen behavior, provision of norms for the cleaning services, etc.). One clear issue is that the feasible level of the cleaning service is defined by the citizens' behavior and the financial capacity of the society to sustain it. The cleaning is shared by the municipality and the citizen, but the

latter should support the cleaning service and should operate one part in order to reduce the costs incurred therein.

Meanwhile, the municipality should establish a tariff plan (that should be socially viable) so that everybody pays for the service a compatible amount of money according to their income. It is recommended that the total amount collected should not be less than 50% of the costs; as it is established in the Municipal Tax Plan (Decree No. 455-89, article 40). It is desired that the percentage be gradually increased up to 100% according to the stepwise improvement in providing *regular and frequent* services.

The urban cleaning services should be previously planned in a "permanent" nature or in the long term, or they should be programmed for the short term. On such basis, the services should be controlled and then their results and costs be evaluated.

The "privatization" of the services, in other words, the contract or cession to a third party, will not be prudent whenever the municipality does not have structure nor capable personnel to make or hire the planning of services. Only when the municipality has such structure and capable personnel, parameters for control are established and the control of results and costs are effectively executed.

L.2.1.2 Forecast of Future USE Services Demand

a. Projected Service Area

During the discussion of the Inception Report (IC/R), the Nicaraguan side requested to expand the boundary of the Study Area (1995). The Team agrees to expand the present Study Area up to the urban limits by the target year 2010, provided that the counterpart supplies the team with relevant information, e.g., boundaries, population estimates, for the projection of the outcome of the USE improvement plan in 2010.

Based on the above discussion, the counterpart from the Municipal Government of Leon (MGL) presented a Structural Master Plan and maps showing the boundary of the urban area of Leon in 1995 and the coverage of the urban expansion program for 2010.

The urban area in 1995 measured 19.09 km^2, as stated in the Structural Master Plan provided by the municipality of Leon. Using the digital planimeter and based on the final map the coverage of the urban expansion program for 2010 was calculated at 43.00 km^2 by the Team.

For 2000 and 2005, no data was provided. Therefore, the projected areas were estimated by the Team by interpolation. As a result, the projected service areas for the selected years are as follows:

Year	Projected Service Area (km^2)
1995	19.09
2000	27.00
2005	35.00
2010	43.00

Accordingly, the main objective of this section is to provide fundamental data for future USE service demands to forecast urban growth, water supply, domestic wastewater, municipal and medical solid wastes within the projected service area.

b. Population Forecast

As described in the Interim Report (1), one of the three alternatives to estimate future population is to be used to forecast the USE service demands and the formulation of conceptual M/P for Leon. The study shall use the 1995 population census data of INEC, the latest INAA population projection, and shall consider the future expansion of the urbanized areas in Leon.

Accordingly, the population of the service area for 2010, the target year for the conceptual M/P, is estimated at approximately 245 thousand. The average annual population growth rate in the projected service area for the period 1995-2010 is estimated at about 3.0%.

The following table shows the population forecast by selected years (1995, 2000, 2005 and 2010).

Table L-101: Population Forecast

Year	1995	2000	2005	2010
Urban (Service Area)	123,865	183,519	213,156	245,421
Rural	37,665	40,776	43,928	47,090
City Total	161,530	224,295	257,084	292,511
Service Area (km^2)	19.09	27.00	35.00	43.00

Source: 1995 statistical census data of INEC
2000, 2005 and 2010, projected urban population provided by INAA
2000, 2005 and 2010, projected rural population estimated by Team

c. Water Supply

Future water supply demand for the Study is forecast in compliance with the INAA's Pre-feasibility study[7] and based on the following conditions. The results are shown in Table L-102 and Figure L-36.

- Water supply coverage in years2000, 2005 and 2010 is 85% of total population in the urban areas both years;
- Water consumption ratio is 160 l/person/day;
- Water supply ratio for areas without water supply system is 30 l/person/day; and
- Commercial, institutional, and industrial water use are 8%, 8% and 2% of the water consumption of served population, respectively.

[7] Estudio de Priorizacion de Inversiones en el Sector de Agua Potable y Alcantaillado Sanitario Marzo 1996, INAA, ITS, Lotti, Lamsa

Table L-102: Forecast of Future Water Supply Demand

		1995	2000	2005	2010
Urban Population		123,865	183,519	213,156	245,421
Service Coverage (%)		92.2	85	85	85
Served Population		114,199	155,991	181,183	208,784
No Served Population		9,666	27,528	31,973	36,637
Daily Consumption (m^3/day)	Served Population	-	24,959	28,989	33,406
	No Served population	-	826	959	1,099
	Commercial	-	1,997	2,319	2,672
	Institutional	-	1,997	2,319	2,672
	Industries	-	499	580	669
	Partial Demand	16,946	30,278	35,166	40,518

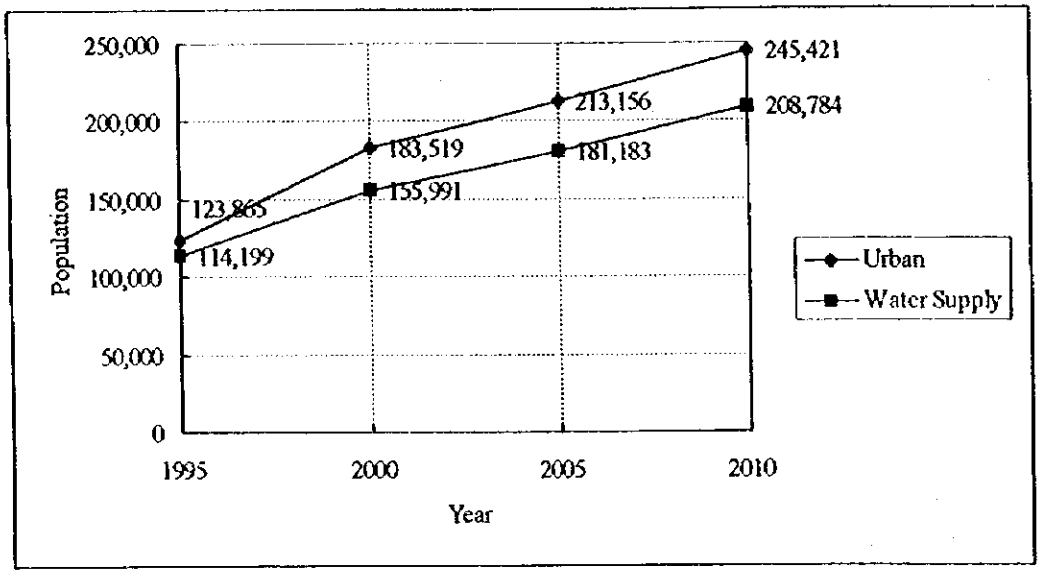


Figure L-36: Forecast of Future Water Supply Population

d. Domestic Wastewater

d.1 Definition of DWWM System

Domestic wastewater mainly comprises from night soil and DWW generated from households. Systems for DWWM in Leon comprise:

- system of joint treatment/disposal for night soil and DWW e.g., sewer system and septic tank;
- system of night soil only disposal through infiltration e.g., latrine; and
- no system.

Table L-103 shows prevalence of the respective systems in the city.

Table L-103: Present Domestic Wastewater Treatment / Disposal System

Unit : population

	Sewer System	Septic Tank	Latrine and/or Soak System	No System
Night Soil + Sullage	68,510(55.3%)	2,601(2.1%)	-	9,166 (7.4%)
Night Soil	-		43,588 (35.2%)	-

In view of the present system, definitions of respective DWWM systems listed below are clarified as follows:

Sewer System:

nightsoil and DWW generated through citizens' household activities are collected in a large scale through sewers and treated at off-site (i.e., sewage treatment plant).

On-site System:

nightsoil and DWW generated through citizens' household activities are collected in a small scale (only one to a couple of decade households) through channels (open or closed) and treated locally in the vicinity of generation sources (e.g., septic tank, community collective system, etc.).

Soak System:

Nightsoil and DWW (or only nightsoil) generated through citizens' household activities are individually disposed in a wet system through infiltration locally in the vicinity of generation sources.

Latrine System:

only nightsoil generated through citizens' household activities are individually disposed in a dry system through infiltration locally in the vicinity of generation sources.

No System:

There is no system to treat nor dispose nightsoil/DWW generated through citizens' household activities.

d.2 Forecast of Future DWWM Service Demand

As indicated in Table L-103, present sewer coverage in Leon ranges about 55% of the urban population, and septic tank (i.e., on-site system) coverage is minimal. Latrine, which avoids treatment and directly disposes the nightsoil for infiltration and therefore being potentially an underground water contamination source, covers about 35% of the total urban population today. In recent years, many of newly constructed soak pit receives only nightsoil in a wet system in order to prolong its service life, and therefore DWW are discharged to roadside and/or rivers without any treatment. Consequently it accelerates deterioration of USE in the city.

In view of the present situation of USE, followings are raised as target figures:

- coverage of nightsoil disposal systems in water supply areas and no water supply areas in the target year 2010; and

- DWW treatment systems (sewer and/or on-site systems) coverage is 90% in water supply population in the target year 2010.

Future USE service demand is estimated for the years 2005 and 2010 based on the following conditions, which is shown in Table L-104 and Figure L-37.

- Water supply coverage is 85% (i.e., 208,784 persons) of total urban population in the year 2010; and
- Sewer coverage is 65% of the total urban population in the year 2010.

The population covered by the on-site domestic wastewater treatment system from 1995 to 2000 are the residents from the high income bracket who install septic tanks at their own expenses. Supposing that, as a result of the increase in off-site sewerage system, these domestic wastewater treated in the septic tank is discharged into off-site sewerage system, the service population of the on-site treatment system (i.e., septic tank only) will be zero in 2005.

Table L-104: Forecast of Future DWWM Service Demand

		1995	2000	2005	2010
Urban Population		123,865	183,519	213,519	245,421
Water Served Population		114,199	155,991	177,259	208,784
Sewer System Area					
Served Area (km^2)		9.45			
Served Population		68,510	101,486	128,320	159,658
Service Coverage (%)		55.3	55.3	60.2	65
Treatment Amount (daily average, m^3/day)		15,516	16,136	20,540	25,321
Non Sewer System Area					
On-site System (Night Soil + Sullage Treatment)	Population	2,601	3,854	14,920	29,450
	Service Coverage (%)	2.1	2.1	7.0	12.0
Latrine System (Night Soil Disposal System)	Population	43,588	64,599	62,029	56,447
	Service Coverage (%)	35.2	35.2	29.1	23.0
No System	Population	9,166	13,580	7,887	0
	Service Coverage (%)	7.4	7.4	4.0	0

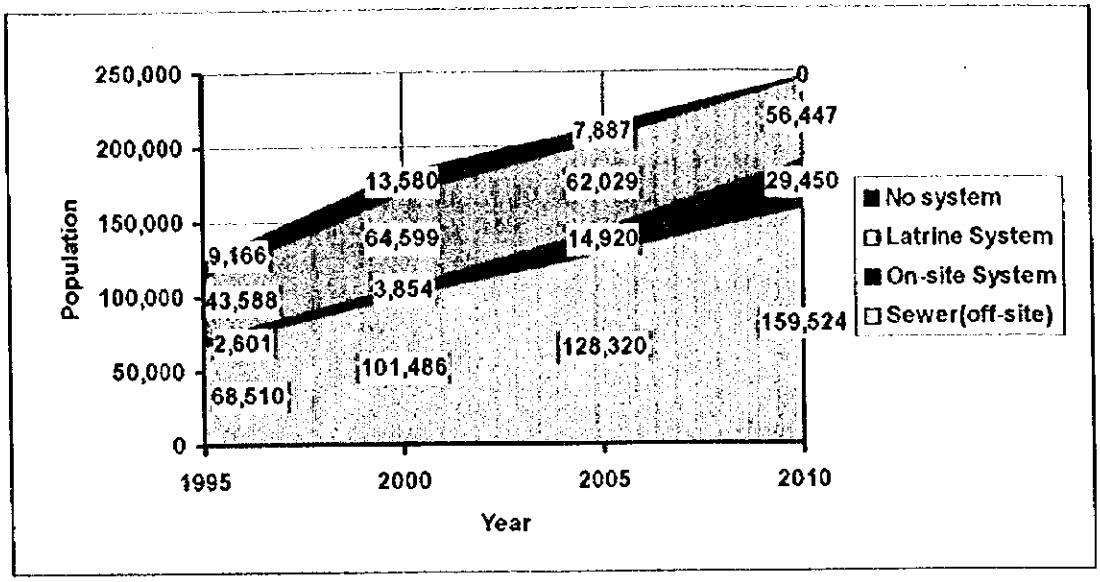


Figure L-37: Forecast of Future DWWM Service Demand

e. Municipal Solid Waste

The future demand on Municipal Solid Waste Management is almost determined by the future population. The demand on collecting and disposing waste will rapidly increase with the steep increase of population in urbanized cities in developing countries. This can be applied to Leon city.

The items concerning to the future demand on the MSWM in Leon are shown in the following table.

Table L-105: Future Demand on MSW in Leon

	1996	2000	2005	2010
Population in the study area	133,997	183,519	213,156	245,421
Waste generation amount (ton/day)	102.1	147.5	186.1	229.5
Waste discharge amount (ton/day)	67.9	101.1	132.1	168.7
Waste collection amount (ton/day)	58.9	87.7	125.5	168.7
Final disposal amount (ton/day)	60.0	88.3	128.4	171.8
Coverage rate (to waste amount) (%)	86.7	87	95	100
Coverage rate (to population) (%)	80.0	80	94	100
Served population	107,918	146,816	200,436	245,421
Non served population	26,799	36,703	12,720	0
Length of sweeping served road (km)	55	55	104	104

f. Medical Solid Waste

f.1 Medical Solid Waste

The estimation of the future medical solid waste generation in Leon is summarized in Table L-106, which is obtained through extrapolation of the Team's survey as summarized in Table L-106 and Table L-107.

Table L-106: Future Medical Solid Waste Generation Amount in the Medical Institutions (Whole institutions) in Leon

Item		1996	2000	2005	2010
Basic data	Population in the Study Area	135,796	183,519	213,165	245,421
	growth rate of inpatients beds	1.000	1.351	1.570	1.807
	number of beds for inpatients risk *2	523 149.3	707	821	945
Risky Waste*1 (kg/day)	risk*2	149.3	201.7	234.4	269.8
	hazardous*3	4.8	6.5	7.5	8.7
	special*4	1.6	2.2	2.4	2.8
	subtotal	155.7	210.4	244.3	281.3
Common Waste*5		139.1	187.9	218.4	251.4
Grand Total		294.8	398.3	462.7	532.7

Note : *1 Study team's prepared category
*2 Waste with infection (sharps, blood, blood sustained and etc.), infected waste from laboratories, waste from infectious disease patients and wastewater etc.
*3 Chemical waste (medicines, drugs, etc.), radioactive waste etc.
*4 Ash from incinerator, sludge etc.
*5 Office waste, kitchen waste, packing waste, bulky waste, garden waste, domestic wastewater and etc.

f.2 Medical Wastewater in the whole Institutions in Chinandega

The estimation of the future medical wastewater generation amount is summarized in Table L-107, which is obtained through extrapolation of the Team's survey as summarized in Table L-138 and Table L-140.

Table L-107: Future Medical Wastewater Generation Amount in the Medical Institutions (Whole institutions) in Leon

Category	Item	1996	2000	2005	2010
Population	Population in the Study Area	135,796	183,519	213,165	245,421
	Population Growth Rate	1.000	1.351	1.570	1.807
Water (ton/day)	Water Consumption	223.0	301.3	349.3	403.0
	Wastewater Generation	178.4	241.0	279.4	322.4

L.2.1.3 Economic and Financial Conditions in the Region

a. Economic and Financial Conditions in the Region

- The Gross Regional Domestic Product (GRDP) of Leon in 1995 was calculated based on the data of INSSBI on the number of people insured (adjusted by regional ratio of participation) and the average salary by industry and region. After 2001, it is assumed to grow in proportion to the national Gross Domestic Product (GDP).

- The municipal budget of Granada is assumed to increase in proportion to the GRDP growth.
- The family income in 1995 is calculated based on the data of the Ministry of Labor (MITRAB) on the number of employees by income. After 2010, this is estimated to increase in proportion to per capita GRDP multiplied by average family size, which is assumed to slightly increase from 5.654 in 1995 to 5.65 after 2000.
- In proportion to the overall budget of the INAA financial plan, the budget of INAA Region II(Leon) is assumed to remain as it was in 1995.

The major economic and financial indicators are summarized in the following table.

Table L-108: Major Economic and Financial Indicators

		1995	2000	2005	2010
GRDP	million C$	700.7	924.1	1,179.4	1,421.2
No. of Households		21,907	32,481	37,727	43,437
Family income	C$/year	15,708	13,972*	15,353	16,068
INAA Region II	1000C$	17,926	21,614	24,578	28,170
Municipal Budget	1000C$	32,213	42,482	54,219	65,335

Note *: Because the increase in the number of households from 1995 to 2000 is estimated to be slightly higher than the growth in GRDP, the family income in 2000 is forecast to slightly decrease.

L.2.2 Water Supply Management

L.2.2.1 Future Water Use

Daily average water supply (excluding UFW) in Leon is estimated: about 35,200m^3/day in year 2005; and about 40,500m^3/day in year 2010.

On the other hand, INAA has a plan to improve the efficiency rate from the present 58% to 75% both in years 2005 and 2010. However, a reasonable figure for the year 2005 is estimated in 65%.

In order to reach this 75% value by the year 2010, it is necessary to have in mind that a step by step solution should be implemented. Taking that into account, the 60%(year 2000) and 65% (year 2005) value is an intermediate value between the actual value of UFW and the one expected by the year 2010.

This process implies that INAA should have an adequate control, administration, and planning of the system; and should also have systematic investment in micro-measuring.

Referring to these figures, particulars of future water use are calculated based on the INAA's planning figures (e.g., coefficient of daily peak, coefficient of hourly peak, etc.) as shown in Table L-109.

Table L-109: Future Water Use

		1995	2000	2005	2010	Remarks
a.	Daily consumption demand (m^3/day)	16,946	30,278	35,166	40,518	
b.	Efficiency rate (%)	58	60	65	75	INAA' s Pre F/S
c.	Daily average flow (m^3/day)	29,217	50,463	54,749	54,024	a./b.
d.	Coefficient of daily peak	NA	1.5	1.5	1.5	INAA' s Pre F/S
e.	Daily peak consumption flow (m^3/day)	NA	45,417	52,749	60,777	a. x d.
f.	Daily peak flow (m^3/day)	NA	65,602	71,685	74,283	e.+(c.-a.)
g.	Coefficient of hourly peak	NA	2.5	2.5	2.5	INAA' s Pre F/S
h.	Hourly peak consumption flow (l/sec)	NA	876	1,018	1,172	a. x g.
i.	Hourly peak flow (l/sec)	NA	1,110	1,237	1,328	h.+(c.-a.)

Note : NA : not available

L.2.2.2 Selection of an Optimum Technical System

a. Water Resources

8 wells serving for present water supply in Leon have, in total, maximum pumping capacity of 502 l/sec (43,373m^3/day). Meanwhile, present average pumping amount ranges 319.5 litter/sec (27,605m^3/day), which corresponds about 64% of the pumping capacity and satisfies present daily average consumption of 29,203 m^3/day.

Potable water supply sources could be classified into: underground water (deep water, shallow water); surface water; riverbed water; etc. in general. Present potable water source in Leon comes exclusively from deep wells. Since the underground water is comparatively in good quality and it only requires chlorination for potable use, which is much more economical than what requires conventional water purification facilities. Furthermore, in view of the topography and geology there, it is highly possible that available underground water near the city is abundant.

Meanwhile, INAA's pre-F/S plans that water supply sources in Leon in year 2010 should only be deep wells. In view of economical advantages, and topographic and geological conditions therein, it should be judged that the plan with deep wells are optimum and recommendable. Therefore the Study, in formulating the M/P, follows the INAA's plan of water sources relying on the underground water.

It is planned in the INAA's pre-F/S that 7 numbers of new deep well (pumping capacity: 75 litter/sec/well) should be installed by the year 2005 to satisfy the demand in the year 2010 as shown in Table L-110 . The Study follows this concept in formulating the M/P.

Table L-110: Existing and Future Wells Capacity and Installation Plan

Unit : litter/sec.

Year	1995	2000	2005	2010
San Felipe I	73	73	73	73
San Felipe II	56	56	abandon	-
San Felipe III	70	70	70	70
Ermita	41	41	reserve	abandon
San Carlos	64	64	64	64
Las Pilas	84	84	84	84
Las Tanques	32	32	32	32
Ruben dario	82	82	82	82
Future 1	-	75.0	75.0	75.0
Future 2	-	75.0	75.0	75.0
Future 3	-	75.0	75.0	75.0
Future 4	-	75.0	75.0	75.0
Future 5	-	75.0	75.0	75.0
Future 6	-	-	75.0	75.0
Future 7	-	-	75.0	75.0
Total	502	877	930	930
Daily average flow	338	584	626.2	625.3
Daily average flow/Total	67.4 %	66.6	67.3 %	67.2 %
Daily peak flow	-	759.3	829.7	859.8
Daily peak flow/Total	-	86.6	89.2 %	92.4 %

Source : INAA's pre-F/S

b. Water Purification System

Present potable water source is all from deep wells. Since the underground water is comparatively of good quality and it only requires chlorination for potable use. Since future water sources will rely on underground water, water purification systems (other than chlorination) is not required.

c. Transmission and Distribution System

Present transmission system employs direct transmission from the wells to the distribution net. In certain area, storage tanks are connected on a distribution net. Although this type of transmission and distribution system has problems of unstable and/or insufficient pressure and water supply quantity in some areas in the distribution net, it has an advantage in expanding distribution net with lesser costs. It is observed that INAA will continue to abide by this prevalent system of transmission and distribution. Namely, INAA's pre-F/S adopts this transmission and distribution system in the future water supply plan for Leon.

To make a project with totally independent conduction from the wells to the distribution reservoirs, conveniently located, it would make that the current conductor and main distributor pipelines would be transformed into the reservoirs' supply pipeline. These pipelines would have dimensions corresponding to the maximum daily consumption because the maximum hourly consumption will be absorbed by the reservoirs. Given that the coefficient of maximum hourly flow is $k2 = 1.67$, it will increment proportionally the efficiency of pipelines which with the same diameter will be able to cover a lager number of persons who will be served by the reservoirs.

It is also clear that given the current situation, the conductor and main distributor pipelines are functioning as distributors which conduct flows corresponding to the daily maximum consumption ($k1=1.5$) and hourly maximum consumption ($k2=1.67$). This results in smaller pressures found in the farthest sectors of the network and the farthest highest points of the network which in some cases are found, in fact, at a very large distance from the source.

With an independent reservoir conduction and distribution, the piezometric heads which will be established in the influence area will provide adequate permanent pressures in all the area. Certainly, chronic cases of water shortage that were dealt through special maneuvers and stepwise scheduling supply will be corrected.

It is evident, once the reservoirs have been installed, the distribution loops which nowadays are supplied directly by conductors and main distributor pipelines (that result in high pressures) will be supplied directly by the reservoirs. This is an efficient measure to control losses due to exaggerated pressures.

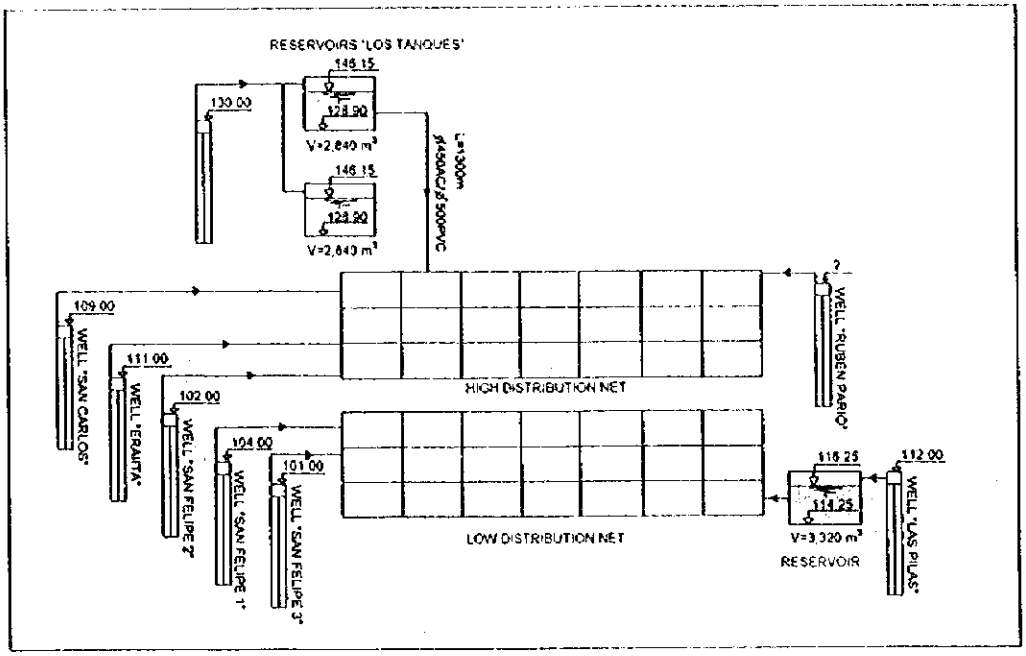
It should be observed that direct distribution from the wells to the network is not capable to provide large enough flows to cover cumulatively K1 and K2 coefficients. Furthermore, it can be observed that wells projected in the future (Table L-110) are not enough to supply totally the network; it is necessary a complement from the reservoirs.

However, in view of the advantages in utilizing existing transmission and distribution systems and reminding the primary target of the water supply coverage increase, the Study, in conformity with INAA's plan, will adopt this system in its formulating M/P. Nevertheless, it is advisable to concentrate efforts on the study of direct transmission system from the wells to the reservoirs, and from these reservoirs to the network system.

Table L-111 and Figure L-38 shows INAA's future improvement plan on transmission and distribution system.

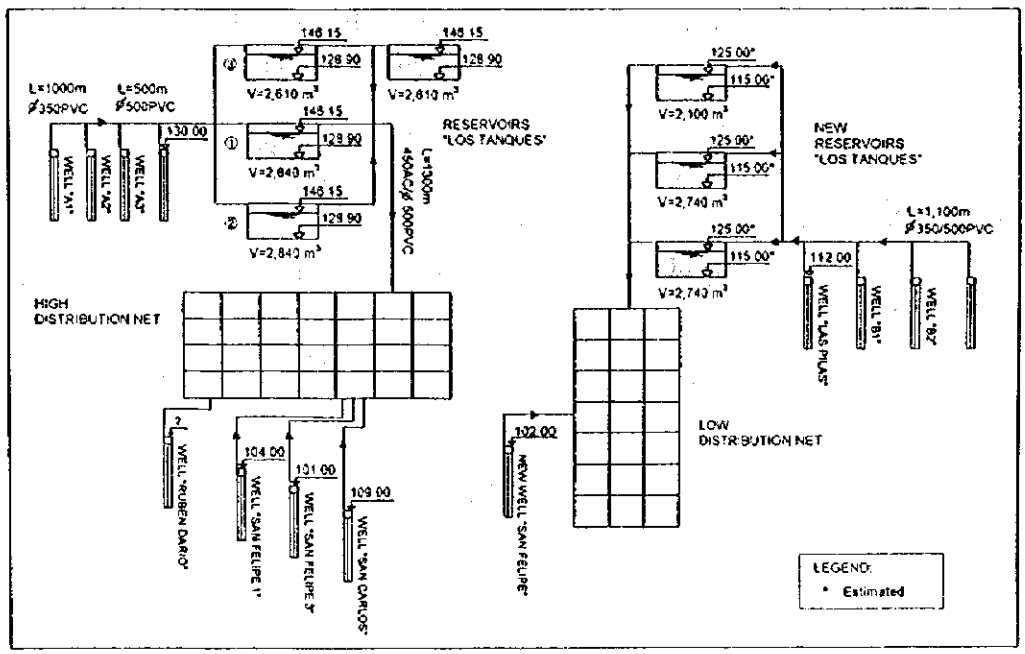
Table L-111: Construction Plan of Transmission and Distribution System

		2005	2010
Transmission Line	length (km)	1.75	1.0
	Diameter (mm)	350 to 500, and 700	350
Distribution Net	length (km)	28.62	10.87
	Diameter (mm)	100 to 350	100 to 350
Small diameter connection		for 47,000 new consumer	for 47,000 new consumer



LEON
Present Water Supply and Transmission System

Present System



LEON
Future Water Supply (2010) and Transmission System

Future System in 2010

Figure L-38: Present and Future Transmission System

d. Storage System

Current storage capacity of the water supply system in Leon is 9,000 m^3. INAA's pre-F/S plans to install storage tanks:

- to satisfy the storage demands of the year 2010, by the year 2005; and
- to satisfy the storage demands of the year 2020, by the year 2010.

The outline of the storage system plan is shown in the Table L-112 .

Table L-112: Construction Plan of Storage System by INAA's Pre F/S

		1995	2000	2005	2010	2020
Daily average flow (m^3/day)		29,730	50,463	54,749	54,024	76,056
Daily peak flow (m^3/day)		-	65,602	71,685	74,283	104,579
Detention time (hr)	For average flow	7.3	6.8	6.0	8.2	7.8
	For peak flow	-	5.2	4.6	6.0	5.7
Construction plan		-	5,350	2,740	4,710	6,200
Total volume (m^3)		9,000	14,350	13,770*	18,480	24,680

Note *: abandon tank 3,320 m^3.

Storage capacity is determined, in general, as the quantity of 6 hours to 12 hours of daily peak supply plus the quantity for emergency use (in case of fire). Whereas, INAA determines the minimum storage capacity be 6 hours of daily average supply plus 72m^3 as the emergency provision. Table L-112 shows that the INAA's pre-F/S recommends a more than sufficient storage capacity.

Therefore, the Study's M/P follow the INAA's plan of storage system.

L.2.2.3 Institutional Requirements

If the National Assembly ratifies Decree No. 27-95, 31-95, and 32-95,INAA will have to share its responsibilities with ENACAL and several changes will be needed. Even INAA maintains all its present attributions, institutional changes might not be required, because INAA is well structured in what it is concerned with water supply to the municipality. In addition, the industrial characteristic of this type of service recommends that it should be operated at a larger extension than the municipality segments because of economic reasons.

Where there exists water supply network, following should be specific and different from the household, commercial, or industrial uses:

- the costs;
- administrative procedures to contract; and
- the technical requirements to be connected to INAA's network.

Meanwhile, the municipality, representing the citizens and protecting their interests, should maintain close ties with INAA, such as to make sure that the water supply service

expansion plans (which is already examined with a feasibility study) be fulfilled as scheduled.

Now and in future, a public education program regarding water management (e.g., to save water, to protect the sources, etc.) should be considered by all related institutions and be substantiated.

L.2.3 DWW Management

Unit cost per person for a DWW treatment project decreases in proportion to the population served by a project increase. This is so called scale merit of project (scale of economy).

In general, sewage treatment projects (i.e., off-site system) are planned and implemented based on this theory. On the other hand in the practical side, since substantially longer time is needed to be spent in the improvement of the sewer systems, effect of investment hardly appears in case where the sanitation improvement is challenged only with sewer improvement.

Outline of M/P on DWWM is listed in the table below.

Table L-113: Outline of Master plan on DWWM

Item	Present (1995)	(2000)	(2005)	M/P (2010)
FORECAST ON KEY INDICATORS				
Service projected area	19.1 km^2	27.0 km^2	35.0 km^2	43.0 km^2
Service projected population	123,865	183,519	213,156	245,421
Sewer system area	55.3 %	55.3 %	60 %	65 %
No-sewer area	44.7 %	44.7 %	40 %	35 %
On-site system	2.1 %	2.1 %	7 %	12 %
Soak and/or Latrine system	35.2 %	35.2 %	29 %	23 %
No system	7.4 %	7.4 %	4 %	0 %

Sewer (i.e., off-site treatment) coverage rate in Leon is presently about 55 % of the urban population, where INAA's plan has the target of covering 65% of total urban population in the year 2010.

Therefore the Study's M/P on DWWM herewith will deploy planning respectively for:

- sewer projected areas in 2010 (as INAA projected); and
- no-sewer areas in 2010.

Furthermore, "no-sewer areas" in 2010 will comprise:

- the areas where the water supply is provided (about 20% of the urban population); and
- the areas where the water supply is not provided (about 15% of the urban population).

In this context, the M/P deploys planning for:

- the management of nightsoil and DWW for "with water without sewer" areas; and
- the management of nightsoil for "without water" areas.

In practice, since it is estimated that DWWM in "sewer area" will be achieved through the INAA's sewer development plan, the M/P will basically follow the INAA's plan for the "sewer area", and it will be reviewed if necessary. On the other hand, the M/P will independently deploy planning for the DWWM in "no-sewer" areas.

L.2.3.1 Definition of Area by Method of Treatment/Disposal

a. Definition of Area

The service projected area is defined as the estimated urban area in the year 2010, which comprises: the water supply areas; and the no water supply areas. Furthermore, the water supply areas should consist of 2 areas: the areas where off-site treatment/disposal system (i.e., sewer) is rationally suited; and the area where on-site treatment/disposal system is rationally suited.

In practice, off-site system areas in year 2010 will comprise:

- present sewer coverage areas; and
- the areas where the future sewer extensions planned by INAA will be provided by the year 2010.

On the other hand, on-site system areas in the 2010 will comprise:

- the areas where the future sewer system by INAA will not be provided by the year 2010;
- the areas where the future sewer system by INAA will not be provided even after the year 2010; and
- the areas where the future sewer system by INAA by 2010 is planned but its provision will not be easily extended due to topographical constraints, etc.

Meanwhile, the area subject to nightsoil only treatment/disposal system (i.e., latrine system) are the area which are within the service projected areas but where the water is not supplied in 2010.

b. Sewer Service Area by and after 2010

b.1 Sewer Service Area by 2010

According to INAA's pre-F/S, areas subject to "sewer provision by 2010" lie on "urban area in 2010" only. The Study estimates that the areas where sewer provision will be achieved by INAA with relative ease by the year 2010 are subject to off-site system (sewer). Meanwhile the Study plans "on-site system" for the areas where sewer provision will not be easily achieved, as a tentative measure till the sewer provision. When sewer is provided in such areas, on-site system being abandoned, connection to sewer should be realized.

b.2 Sewer Service Area after 2010

The M/P has its target year 2010 and the urban area after 2010 are not defined at this moment. Areas subject to "sewer provision after 2010" lie on "urban area in 2010" and "urban area extension after 2010".

The Study plans on-site system for the areas subject to "sewer provision after 2010" and on "urban area in 2010". The M/P recommends that the on-site system in those areas be abandoned when sewer system are provided there sometime after 2010, and off-site system(sewer) should be utilized. The M/P does not deal with the areas of "urban area extension after 2010".

c. Non-sewer System Area

c.1 Water Supply Area

Considerable amount of domestic wastewater might be generated in such areas due to water supply provision. Therefore, an on-site system to treat and dispose both nightsoil and DWW will be proposed.

c.2 Non Water Supply Area

Amount of domestic wastewater generated might be substantially small in such areas due to no water supply. Therefore, an on-site system to treat and dispose only nightsoil will be proposed.

d. Step-wise Improvement Plan

Actual practices for improving USE with regard to domestic wastewater comprise:

- DWWM by sewer system;
- DWWM by on-site system; and
- Nightsoil management by latrine system in no-water supply areas.

The stepwise improvement plan should promote the USE improvement by combination of the above practices (i.e., an appropriate practice be applied based on respective situation) and in consideration of step by step development in time frame.

In practice, M/P on DWWM by sewer system basically follows the INAA's plan. As for the situation in the areas other than covered by INAA sewer, the more populated area might have more suffered with USE deterioration.

Followings are proposed in view of the situations in non-sewer areas:

- Improvement through on-site system should be carried out "area-wise" in the order of from a area with higher population density to a area with lower density; and
- As population density in no water supply areas are very low, ranking indicator for such areas might not be clearly defined. However, judging from that the areas adjacent to on-site system areas might become more populated in future (than other no water area), "area-wise" improvement with latrine system will be started from the area adjacent to on-site system areas.

L.2.3.2 Future DWW Amount and Quality

a. Sewer System

a.1 Forecast of Future Sewage Amount

INAA estimates the sewer served population in 2010 as 159,658. However, sewer served population in intermediate years are not estimated by INAA. Therefore, Study estimates its increase from the present served population to estimated served population in 2010 be lineal, sewage treatment amount in future based on the estimate are listed in Table L-24.

Table L-114: Forecast of Future Sewage Amount

Year	Urban Population	Sewer Served Population	Sewage Amount (daily average flow, m^3/day)
1995	123,865	68,510	15,516
2000	183,519	101,486	16,136
2005	213,156	128,320	20,540
2010	245,421	159,658	25,321

a.2 Forecast of Future Sewage Quality

a.2.1 Pollution Loading Ratio (PLR)

Sewage quality and quantity are characterized with "pollution loading ratio (PLR)" and "sewage discharge ratio".

WPLS in the Phase I of the Study resulted pollution loading of : BOD 58.7g/person/day; COD 107.8g/person/day; and SS 50.2g/person/day. WPLS resulted average "water consumption ratio" being 227litter/person/day. INAA sets up "sewage discharge ratio" to be 80% of the "water consumption ratio". It derives 182litter/person/day for "sewage discharge ratio".

Table L-115 shows: the sewage quality calculated based on the above data; and INAA's measurement on sewage quality entering the treatment plant.

Table L-115: Comparison of Sewage Quality

		BOD	COD	SS
By Results of WPLS	PLR (g/person./day)	58.7	107.8	50.2
	Concentration (mg/l)	323	592	276
INAA measured (mg/l)		300 to 340	500 to 600	238 to 340

Table L-116 shows PLR calculated from the INAA measurement on sewage quality, sewage treated amount in 1995 (15,516 m^3/day) and the sewer served population (68,510 persons). It also shows some examples of PLR on BOD and SS in other countries as references.

Table L-116: Comparison of Water Pollution Loading Ratio

		BOD	COD	SS
Based on INAA's Data	Concentration (mg/l)	300 to 340	500 to 600	238 to 340
	PLR (g/person/day)	67.9 to 77.9	113.2 to 135.0	53.9 to 72.0
Examples in other Countries	Kampala, Uganda	63	-	-
	San Paulo, Brazil	44	-	-
	India	35	-	-
	USA	76 to 100	-	46 to 91
	Japan	64 to 84	-	13 to 56
	WHO (recommendation)	45	-	-

In comparison of the BOD data, the PLR of BOD in Leon based on INAA measurement (67.9 to 77.9 g/person/day) is extremely high. This could be attributable to the measurement frequency. In other words, the error might be attributable to the calculation that analysis results once in a few months are applied as the annual representing figure on BOD. Therefore, the M/P sets up the PLR design indicators as shown in the table below based on the WPLS results. It is estimated that the PLR design indicators set up remain constant to the future in the same value.

Table L-117: Pollution Loading Ratio for M/P

	BOD	COD	SS
Results of WPLS (g/person/day)	58.7	107.8	50.2
PLR Design Indicators (g/person/day)	59	108	50

Meanwhile, INAA designates the design indicator on "sewage discharge ratio" as 160litter/person/day. In this connection, the M/P also employs this value. Sewage quality (i.e., concentration) calculated from this value (sewage discharge ratio) and the PLR design indicators set up as shown in Table L-27 and their round figures as the "sewage quality design indicators" are listed in Table L-118.

Table L-118: Future Sewage Quality

	BOD	COD	SS
PLR Design Indicators (g/person/day)	59	108	50
Concentration (mg/l)	369	675	313
Sewage Quality Design Indicators (mg/l)	370	680	320

b. On-site System

Since sewage quality to be dealt with on-site system is deemed same as what dealt with in the sewer system, the same design indicators (on "sewage discharge ratio", "pollution loading ratio" and "sewage quality") for sewer system are employed as those for on-site system. The table below shows forecast of on-site system treatment amount.

Table L-119: Forecast of On-site System Treatment Amount

Year	Urban Population	On-site System Population	On-site System Treatment Amount (daily average flow, m^3/day)
1995	123,865	2,601	416
2000	183,519	3,854	617
2005	213,156	14,920	2,387
2010	245,421	29,450	4,712

L.2.3.3 Selection of an Optimum Technical System

In this section, technical systems of DWWM is examined to select an optimum technical system which will be proposed in the Master Plan.

a. Criteria for Selection

Taking the current situation and background of DWWM in Leon City into account, the policies for the selection of a technical system are as follows:

1) Systems and technologies to be adopted should be as simple as possible so that operation and maintenance would be easy and inexpensive;

2) The foreign currency requirements for the purchase, operation and maintenance of systems should be minimized. The use of locally available materials and services should be maximized;

3) The use of labor intensive rather than capital intensive techniques should be used where technically feasible and economically viable;

4) Technical system proposals have to be consistent with the institutional requirements should be maxim to ensure their efficiency.

b. Examination of an Optimum Technical System

b.1 Sewer (Off-site) System

b.1.1 Collection System

Collection systems for domestic wastewater comprise: the system to collect only sewage ("separate sewer system (SSS)"); and the system to collect both domestic wastewater and pluvial water ("combined sewer system (CSS)").

SSS has the merit to employ smaller dimensions in sewers (than that for CSS), but has the demerit of requiring another sewer system for draining stormwater. Therefore, total cost of installing SSS will be higher than the cost of installing CSS. However, since stormwater intrusion in the case of SSS even when raining is much smaller (than the case of CSS) and therefore sewage flow is constant, SSS is preferable in view of sewage treatment.

CSS collects domestic wastewater and stormwater together when raining, therefore a large peak is created in the flow entering the sewage treatment plant. Treatment capacity of sewage treatment plant is in general designed for sewage flow at no raining conditions. Therefore, peak flows of stormwater and sewage water mixture over the

design flow are directly discharged to public watercourses without treatment. It contributes to the pollution on public watercourses.

The present domestic waste water collection system in Leon employs SSS which is preferable for preventing the public watercourses contamination, and at the same time the INAA's plan on future sewer expansion in Leon proposes SSS. Therefore the M/P abides by SSS for domestic waste water collection system in Leon.

b.1.2 Treatment System

Treatment systems for domestic waste water comprise: the system to treat the waste water employing acceleration of microbiology functions (activated sludge style system); and the system to treat the waste water employing algae and microbiology functions (facultative lagoon style treatment).

The activated sludge style treatment has the merit of capacity to treat a large quantity of the domestic waste water to a significantly improved quality requiring a small land area for the facility. On the other hand, costs of its construction, operation and maintenance are extremely large compared with the facultative lagoon style treatment.

The facultative lagoon style treatment has the merit of much smaller costs in its facility construction, operation and maintenance compared with the activated sludge style, although it requires larger land use for lagoons. Consequently it has a much more applicability for the developing countries.

The present domestic waste water treatment system in Leon is facultative lagoon style and INAA's plan on future sewage treatment in Leon proposes aerated lagoon treatment through aerators installation in the present facultative lagoon. Therefore, in view of efficient and effective utilization of existing systems and plans, the M/P abides by the INAA's plan on future treatment system.

b.2 Non-sewer (On-site) System

Domestic waste water mainly consists of nightsoil and DWW. Treatment of domestic waste water is categorized mainly into three: nightsoil exclusive treatment; DWW exclusive treatment; and nightsoil/DWW composite treatment. Table L-30 summarizes on-site systems and the components of respective on-site system.

The on-site systems comprise: "individual on-site system" and "collective on-site system". The individual on-site system has a treatment at the generation points (i.e., in a premises) and the collective on-site system has its collective treatment/disposal system outside of the plural generation points (i.e., in a separate location).

The conceptual M/P examines the intrinsic situation of the areas subject to on-site system and proposes appropriate system(s) for the situation.

Table L-120: On-site System Components

Type of wastewater	Name of System	Toilet System	Collection System	Typical Treatment and/or Disposal	
				Method	Mechanism
Night soil	On-site Disposal System	- Latrine - VIP latrine - Pour-flush toilet	Non	Soak pit	Soak to ground
	On-site Storage with Off-site Treatment System	- Vault toilet	- Special cart - Special Vehicle	Throw into sewer system	Combine sewerage treatment
				Digestion and gas recovery with tricking filter	An-aerobic decomposition and aerobic decomposition
				Digestion and gas recovery with activated sludge method	Aerobic decomposition and aerobic decomposition
	On-site Treatment System	- Pour flush toilet - Cistern-flush toilet	Non	Septic tank	An-aerobic decomposition
				Simple jokaso	An-aerobic and/or aerobic decomposition
Night soil + Sullage	On-site Disposal System	- Cistern-flush toilet - Pour-flush toilet	Non	Soak pit	Soak to ground
	On-site Treatment System	- Pour flush toilet - Cistern-flush toilet	Non	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition
	On-site Collective System	- Pour flush toilet - Cistern-flush toilet	Pipe line	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition
Sullage	On-site Disposal System	-	Non	Soak pit	Soak to ground
	On-site Treatment System	-	Non	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition
	On-site Collective System	-	Pipe line	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition

b.2.1 Nightsoil Treatment and Disposal System

Nightsoil treatment/disposal systems , being closely related to "toilet systems", comprise the following three types.

Type-1 On-site Disposal System

Latrine (pit latrine), VIP(ventilated improved pit) latrine, Pour-flush toilet with pit are categorized into this type (i.e., Type-1: On-site Disposal System). Main advantageous features of this type are:

- the construction is easy;
- it has an effect on some diseases prevention (since the system prevents breeding of flies and mosquitoes); and
- the operation and maintenance costs are cheap.

On the other hand, the system has a disadvantage that it might probably contaminate the underground water if the groundwater table is comparatively high or the ground is relatively permeable, since nightsoil is infiltrated to the ground without disinfection.

Type-2 On-site Storage with Off-site Treatment System

Vault toilet, which was widely employed in the developing stages in Japan, is categorized into this type. (i.e., Type-2: On-site Storage with Off-site Treatment). It prevents the risks of underground water contamination, which is a disadvantage of Type-1. However, it additionally requires measures of transport/treatment/disposal of the stored nightsoil and comparatively higher cost of facility construction, operation and maintenance will accrue.

Type-3 On-site Treatment System

Pour-flush toilet with septic tank or simple jokaso, Cistern-flush toilet with septic tank or simple jokaso are categorized into this type (i.e., Type-3: On-site Treatment System). Since this type is equipped with treatment function, it prevents risks of groundwater contamination and nuisance of periodical transport of stored nightsoil. On the other hand, costs of facility construction, maintenance and operation is the most expensive among the three types.

"Septic tank" system facilitates anaerobic digestion of nightsoil and DWW retained in a single or plural pits. It substantially achieves separation of solid contents, reduction of E.coli. However, the septic tank system lacks efficiency in removal of organic polluting substances.

"Jokaso" is the system that "septic tank" is followed by a secondary treatment (e.g., "trickling filter", "anaerobic filter" and "activated sludge system"). Hence, it removes organic polluting substances more than the septic tank only system. However, its total cost is considerably high and a comparatively high technology is required in its operation and maintenance activities.

b.2.2 Combined with Nightsoil and Sullage Treatment and Disposal System

Treatment/disposal systems for nightsoil and DWW composite, being closely related to "toilet systems", comprise the following three types.

Type-1 On-site Disposal System

"Pour-flush toilet with soak pit", "Cistern-flush toilet with soak pit" are categorized into this type (i.e., Type-1: On-site Disposal System). Main advantageous features of this type are:

- the construction is relatively easy;
- it has an effect on some diseases prevention (since the system prevents breeding of flies and mosquitoes); and
- the operation and maintenance costs are cheap.

On the other hand, the system has a disadvantage that it might probably contaminate the underground water if the groundwater table is comparatively high or the ground is relatively permeable, since nightsoil and DWW are infiltrated to the ground without disinfection.

Type-2 On-site Treatment System

"Pour-flush toilet with septic tank or combined jokaso" and "Cistern-flush toilet with septic tank or combined jokaso" are categorized into this type (i.e., Type-2: On-site Treatment System). This type is to treat both nightsoil and DWW together in-situ, it prevents risks of groundwater contamination and nuisance of periodical transport of stored nightsoil. On the other hand, the facility construction, maintenance and operation requires considerably high costs. The system of "cistern-flush toilet with **combined** jokaso" is still widely used in Japan today where sewer system is not provided.

However, the initial construction cost for "cistern-flush toilet with **combined** jokaso" is considerably high, as well as that for "cistern-flush toilet with **simple** jokaso". Comparatively high technology is further required in its operation and maintenance activities.

Type-3 On-site Collective System

This type employs the same concepts with Type-2 in its treatment and disposal. Whereas the Type-2 is applied for individual households, the Type-3 is applied for plural households. The Type-3 could have a scale-merit compared to the Type-2. The collective system solution (e.g., cistern-flush toilet with **combined** jokaso **for plural households)** is still widely used in Japan today where sewer system is not provided.

b.2.3 Sullage Treatment and Disposal System

Sullage (only) treatment/disposal systems also employ mostly the same technologies or practices as those for the treatment/disposal systems for nightsoil and DWW composite. The systems comprise the following three types. In case that existing systems of nightsoil treatment/disposal are working satisfactorily, the improvement of USE with "DWW treatment/disposal system" becomes effective.

Type 1 On-site Disposal System

The Type-1 basically takes measures of infiltrating DWW to the ground. Main advantageous features of this type are:

- it has an effect on some diseases prevention (since the system prevents breeding of flies and mosquitoes); and
- the operation and maintenance costs are cheap.

On the other hand, the system has a disadvantage that it might probably contaminate the underground water if the groundwater table is comparatively high or the ground is relatively permeable. However, groundwater contamination only by DWW infiltration might be less significant than nightsoil infiltration.

Type 2 On-site Treatment System

Main features of the Type-2 (DWW only on-site treatment) are mostly same as those of the Type-2 for "nightsoil/DWW composite". This system treats the domestic wastewater where it was generated. It prevents risks of groundwater contamination. On the other hand, the facility construction, maintenance and operation requires considerably high costs. Comparatively high technology is further required in its operation and maintenance activities.

Type 3 On-site Collective System

Type-3 also employs the same concepts of Type-2 in its treatment and disposal. Where the Type-2 is applied for individual households, the Type-3 is applied for plural households. The Type-3 could have a scale-merit compared to the Type-2.

b.2.4 Selection of an Optimum Technical System

In view of the on-site system components described above, Table L-121 shows comparison of applicable technical systems to the M/P.

Team evaluates applicability of respective technical system for the M/P reminding the following 3 items:

- facility construction cost should be relatively low;
- operation and maintenance cost should be ranked in medium or low; and
- soil/groundwater contamination by the system should be none or very less.

Consequently, the systems listed below are concluded to be more applicable.

- "Pour-flush toilet with septic tank" of nightsoil exclusive treatment;
- "Pour-flush toilet with septic tank" of nightsoil/DWW composite treatment; and
- on-site system and on-site collective system of DWW exclusive treatment.

Meanwhile, the on-site collective system could have an advantage of scale merit compared to individual systems. Therefore, the Study recommends to optimize the application of the on-site collective system in Leon's USE improvement.

Table L-121: Comparison of Applicable Technical System

Type of wastewater	Name of System	Toilet and Disposal and/or Treatment System	Construction Cost	Operation Cost	Ease of Construction	Water Requirement	Possibility of Soil Contamination	Applicable for the project
Night soil	On-site Disposal System	Latrine with soak pit	Low	Very low	Very easy	Non	Yes	No
		VIP latrine with soak pit	Low	Very low	Easy	Non	Yes	No
		Pour-flush toilet with soak pit	Medium	Very low	Requires builder	Water near toilet	Yes	No
	On-site Storage with Off-site Treatment System	Vault toilet	Medium	High	Requires builder	Non	Non	No
	On-site Treatment System	Pour flush toilet with septic tank	Medium	Medium	Requires builder	Water near toilet	Non	Yes
		Cistern-flush toilet with septic tank	High	Medium	Requires builder	Water pipe to house	Non	No
Night soil + Sullage	On-site Disposal System	Pour-flush toilet with soak pit	Medium	Low	Requires builder	Water near toilet	Yes	No
		Cistern-flush toilet with soak pit	High	Low	Requires builder	Water pipe to house	Yes	No
	On-site Treatment System	Pour-flush toilet with septic tank	Medium	Medium	Requires builder	Water near toilet	Non	Yes
		Cistern-flush toilet with septic tank	High	Medium	Requires builder	Water pipe to house	Non	No
	On-site Collective System	Pour-flush toilet with septic tank	Medium	Medium	Requires builder	Water near toilet	Non	Yes
		Cistern-flush toilet with septic tank	High	Medium	Requires builder	Water pipe to house	Non	No
Sullage	On-site Disposal System	Soak pit	Low	Very low	Very easy	Non	Yes	No
	On-site Treatment System	Septic tank	Medium	Medium	Requires builder	-	Non	Yes
	On-site Collective System	Septic tank	Medium	Medium	Requires builder	-	Non	Yes

b.3 Sludge Management

Treatment/disposal of sludge generated from sewage treatment varies depending upon the types of sewage sources and its treatment methods.

INAA has the plan of sewage treatment in Leon that the existing "lagoon style" treatment be continuously employed and the lagoons will be in future modified to "aerated lagoons" (i.e., aerators will be installed in the lagoon when in future it becomes necessary.). In general, sludge generated from "lagoon style" treatment is very small in quantity and therefore an independent management of on-site generated sludge can generally be neglected in planning.

Sludge generated from on-site treatment facilities is estimated to be about 0.35m^3/person/year. Table L-32 shows forecast of sludge generation amount from the on-site systems proposed in the Study for the years 2005 and 2010. The forecast of sludge generation from on-site facilities in 2010 be about 10,308 m^3/year. Assuming that this amount is extracted from facilities in 240 working days, daily sludge generation in 2010 is estimated to be about 43m^3/day.

On the other hand, the lagoon sewage treated amount (or influent volume) in 2010 is estimated to be about 25,300m^3/day. If it is assumed that sludge generated from on-site facilities are discharged into the lagoons, it accounts for about 0.2% of the influent volume. Therefore, it could be considered that INAA's off-site system (i.e., the lagoon) has the capability to manage sludge generated from the on-site systems proposed in the Study. The M/P in this regard proposes sludge generated from on-site systems be disposed into the lagoon of off-site system.

Table L-122: Forecast of Sludge Generation Amount from On-site System

	2005	2010
Served Population	14,920	29,450
Sludge Generation Amount (m^3/year)	5,222	10,308

L.2.3.4 Institutional Requirements

a. Connection to the Sewer

Where there exists sewer network, following should be specific and different from the household, commercial, or industrial uses:

- the costs;
- administrative procedures to contract; and
- the technical requirements to be connected to INAA's network.

A Municipal Ordinance should enforce and orient the citizens, using the permits system in order to connect to the sewer network, during their houses are constructed, if it passes by in front of their houses.

INAA jointly with the municipality and MINSA should prepare a program to connect existing houses to the sewer at feasible costs for the householder.

b. Wastewater Management in Non-sewer Area

b.1 Roles of INAA

Where there does not exist a sewage collector in the street, the citizen must provide an adequate treatment and disposal facility for his/her wastewater. Therefore, this facility should be built/installed according to INAA's technical instructions and INAA might recommend individual or collective systems for it, depending on which system is suited for respective situations. Municipal Ordinance might enforce the appropriate recommendation.

INAA should build and/or operate collective facilities. In any case, INAA should operate sludge collection service for the local treatment (both individual septic or soak systems and collective systems), and should provide inspection/maintenance services for the on-site facilities. The municipality and MINSA should plan and cooperate with INAA to get the most feasible local solutions for domestic wastewater originated in very poor communities where the sanitary and social conditions are determinants.

INAA should provide the citizens, through the municipality, of the requirements referred in the Annex N.

b.2 DWWCTS

The municipality should establish, by Municipal Ordinance, the obligatory nature of citizens to make an appropriate disposal of their wastewater. For such purpose, viable alternatives and a reasonable assistance will be offered, before applying sanctions as they are established in the Ordinance.

In the micro-regions where sewer system would not be feasible, on-site treatment (preferably a collective system) should be adopted. However for the time being, it should be tolerated with the more primitive solutions of current practices, but with an appropriate sanitary control.

The municipality should coordinate a Special Program for Collective Treatment/Disposal of Domestic Wastewater (DWWCTS) to be developed together with INAA and MINSA, with initial granted for the investments since the beneficiaries agree to pay for the operation and maintenance of the correspondent facility. The investments and service payments could be reduced through the beneficiary citizens' burden sharing by participation, which should be stimulated by a community mobilization.

c. Institutions other than INAA

c.1 Municipality

The municipality should improve its organizational structure and personnel in order to:

- Provide norms and directives to the population with respect to the location, sanitary structures and civil procedures to live and work under satisfactory environmental and sanitary conditions;
- Provide services of their own competence, and coordinate and promote services of other entities;

- Emit and implement the Municipal Ordinance proposed in the Annex N, referring to the domestic wastewater management;
- Coordinate with MARENA and MCT, having INIFOM and MINSA as supporting institutions, in order to divide the competence on micro and macro drainage, as it is proposed in the Annex N. This is because the drainage system is closely related to damages done by wastewater which are not conducted by a pipe.

c.2 MINSA

MINSA should increase its capacity to mobilize communities and develop programs of sanitary education, observing not only to DWWCTS, but also to objectives and actions with intersectorial integration proposed (see tables in the Annex N).

L.2.4 Industrial Wastewater Management

L.2.4.1 Major Findings of the Industrial Waste Survey

In spite of that 88% of industrial wastewater in 3 cities contain "hazardous substances" to certain extent, most industrial wastewater (99%) are discharged into sewer/watercourses or soaked into underground without treatment. Contribution of industrial wastewater generation by Leon, Chinandega, and Granada count for 10%, 1%, and 89% respectively.

Industrial wastewater generation amount in Leon is estimated 98,634 m^3/year. (see Table L-123)

Table L-123: Waste Generation Amount in Leon(1996)

Wastewater (ton/year)	Solid Waste (ton/year)	Total (ton/year)
91,197	7,437	98,634

Wastewater generation amount in Leon is estimated 91,000m^3/year. Among other, industrial wastewater from CIIU3231 industries (leather tanning) ranges about 54,000 m^3/year in Leon, which contains high concentration of organic compounds and hazardous compounds such as chromium. Therefore the pollution impacts to the environment would be thought serious. Immediate countermeasures for this industrial pollution should be raised in Leon.

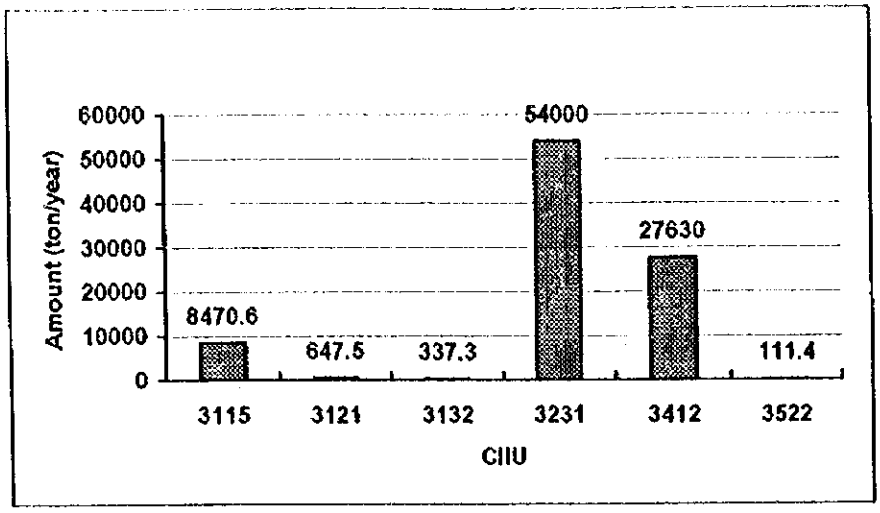


Figure L-39: Wastewater Generation Amount

Since the legislation is newly established, detailed regulations and technical instructions to complement it are not prepared at present. Therefore, current industrial wastewater are mostly discharged without treatment to the environment. Consequently it becomes one of major sources that deteriorate the USE.

L.2.4.2 General Recommendations for the Improvement of the Industrial Wastewater management

a. Technical System

Since the industrial wastewater are generated and discharged as a result of industrial production activities, cost of its safe treatment/disposal should be born by the industries, based on the "polluter pays principle (PPP)".

On the other hand from technological management viewpoint, following will be listed as the key solutions for the problems:

- Reduction of wastewater generation amount and reduction of its generated pollution load by means of production processes (including raw/auxiliary materials) conversions;
- Wastewater treatment by industries themselves in their premises ; and
- Industrial wastewater treatment/disposal by third party (i.e., market mechanism of industrial wastewater treatment/disposal).

In this context, authorities' administrative measures and empowerment in conducting industrial wastewater management are awaited. Since actual application and enforcement of Decree 33-95 will be a key for this management, an integrated mechanism to bind both industries and authorities in facilitating the appropriate industrial wastewater management should be sought and established.

b. Institutional System

MARENA is the competent authority for the management of industrial solid waste (ISW) and industrial wastewater (IWW) by the Law No. 217-96 and Decree 33-95. MARENA should establish the regulations related to ISW and IWW, as well as

restrictions for its disposal and the operational limits of the municipality. It should also expedite to facilitate technical information to the IW generators, professionals, university students, and those interested in about IW and the IW management services that can be provided for industries in Nicaragua. On the other hand, MARENA should be in charge of supporting industries in finding accessible finances that industries could execute their projects of IW treatment/disposal and/or "cleaner production".

The municipality, on the other hand, should not collect nor accept ISW in the municipal landfill, until the waste are certified as **"non-hazardous"**. and such certification should be provided by MARENA. MARENA should originate the instructions with which the municipality could guide industries located in the city area. Meanwhile, the competence to inspect and penalize the IW management belongs to MARENA and MINSA. INAA is also competent whenever they receive wastewater. The Municipality can establish legal and technical norms restricted to the municipality which can not be more tolerant than the national norms (see Annex N).

The Annex N shows "Instructions and/or Regulations (as well as Tables with Strategies and Intersectorial Integration)" which is recommended for MARENA, and complementarily for MCT, MINSA and the Municipality.

b.1 Polluter Pays Principle (PPP) and Authorities' Management

The IW are qualitative and quantitative dependent of the type of industry, industrial process, of the raw materials, source of energy, and the management of the generator establishments, especially the training and discipline of the personnel, also the equipment maintenance and the working environment.

The IW is strictly industries' responsibility. Since the costs of IW management are included in the products price, the company that generates non-hazardous IW and/or less IW, they could achieve lower production cost. In addition, the "environmentally friendly products" are commonly an important marketing element with respect to customers consciousness.

It is an premise universally accepted premise: **"The generator is responsible for the waste generated by him or her"**, i.e., he or she is responsible for the management of the waste and its effects on the environment and public health, with all the costs to be born therewith. These costs constitute an incentive to minimize waste, in other words, it encourages a "clean production" which is the objective of a competitive and environmentally-conscious industries.

In general, the largest part of ISW results from the industrial effluents, therefore, the management on ISW and IWW should consider all the IW in total.

The consulting and operational services related to IWM constitute an attractive economic activity, once the market has reached certain level. In this context, the public authorities could create the situation that makes such economic activity (ISWM by private sectors) viable, which solves the problems involved with industrial contamination and pollution when the regulations for the IW management is established and its requirements are enforced obviously in a stepwise manner in a feasible time frame. The municipal/national government should not invest more than necessary for the studies, cadastres, regulation, technical information, inspection, monitoring and sanction to the transgressor when it is related to IW.

L.2.5 Storm Water Management

The tendency of damage in the inundation prone areas in each city was recognized by the questionnaire survey conducted in the first work in Nicaragua. The result indicated that the damage was a serious problem for the three cities.

It was inferred from the result of the questionnaire survey and the field reconnaissance that inundation causes would be classified into two major types and in detail for minor types as shown in the following table.

Table L-124: Inundation Prone Area Classification

Principal Classification	Detailed Classification	Features
1. Areas with drainage channels (mainly located in the urban area)	1.1 These areas are located at downstream of larger catchment area	1.1 Large amount of water flows into these areas from the hinterland catchment area. These areas usually experience considerable flood damage.
	1.2 These areas are located in a smaller drainage basin, which mostly overlaps with the study area.	1.2 Inundation occurs because the drainage channels in these areas are small or clogged with waste. The damage is comparatively small.
2. Areas without drainage channels (mainly located in the urban fringe)	2.1 Flood plain (i.e., inside river banks)	2.1 Flooding occurs when the water level of the river or stream rises due to heavy rain.
	2.2 others	2.2 These areas are located in lowlying areas and lack of road and roadside drains intensifies the damage.

The result on inundation damage survey is limited only on the basis of interview and field reconnaissance, because there are no base data such as detailed topographical maps, river regime. And to obtain these data in this study is physically impossible as it requires considerable time and resources.

L.2.5.1 Identification of Inundation causation

The following table shows inundation causation in each areas and Figure L-40 shows the inundation prone areas in Leon City.

Table L-125: Inundation Causation

No.	Name of Area	Classification	Damage	Causation
1	San Jerónimo	2.2	Inundation of houses, occurrence of epidemic	This area inclines towards the west. Although, there is a non-paved watercourse along the east side of the area, there are no stormwater drains in the area, and the roads are not paved. Almost all the houses' floors are at the same level as the roads. Inundation heavily happens at the west part of the area.
2	Venceremos, Augusto Cesar Sandino, Linda Vista	2.2	ditto	The area inclines towards the northwest steeply. Therefore, inundation heavily happens in the northwestern part of the area next to the agricultural land. This area has no drains and no paved roads. The houses are easily affected by inundation, because the houses' floors are at the same level as the roads.
3	Araceli Pérez	2.2	ditto	The area is located in a low land. The area has no drains and no paved roads.
4	Puente el By-pass Anexo 23 de Julio	1.2	ditto	The area is located along the river, 'Chiquito', so that, stormwater gathers towards there. However, the roads are paved and the level of houses are higher than the roads.
5	Puente Avenida II de Julio la Granja	1.2	ditto	The stormwater coming from the east is blocked by the ex-railroad bank to go the drain which is at the opposite side of the bank. The area has no paved road.
6	La Cuchilla	2.2	ditto	Although this area is high income area, there are no drains. However, the roads are paved.
7	Reparto San Carlos	2.2	ditto	The area steeply inclines towards the river ' Pochote'. Therefore, the most nearby houses to the river is heavily damaged.
8	San Luis	2.2	ditto	The houses are located at the steep slope along 'Pochote'. The area has no paved roads.
9	Rastro Municipal	2.2	ditto	This area extends at a low land along the river 'Chiquito', a low income area. The area has no drains and no paved roads. Stormwater comes from the upper area.
10	Mercedes Varela	2.2	ditto	This area is located in an agricultural land. There are only a few houses.
11	Héroes y Mártires de Zaragoza	2.2	ditto	This area extends at a steep slope along 'Pochote', a low income area. It has no paved roads. Stormwater comes form the upper area.
12	18 de Agosto	2.1	ditto	This is located at the riverbed of 'Chiquito'. Rainwater comes from the next area.
13	Walter Ferreti	2.2	ditto	The area is low land where a sewage treatment plant is located. Since the plant was built, inundation happens. The area has no paved roads.
14	Rosendo Daniel Pacheco	2.2	ditto	The area extends at a steep slope, a low income area. It has no paved roads. The end of the slope is heavily damaged.
15	Santa Lucia	2.2	ditto	The area extends at a steep slope along 'Pochote'. It has no drain and no paved road. The end of the slope is heavily damaged.

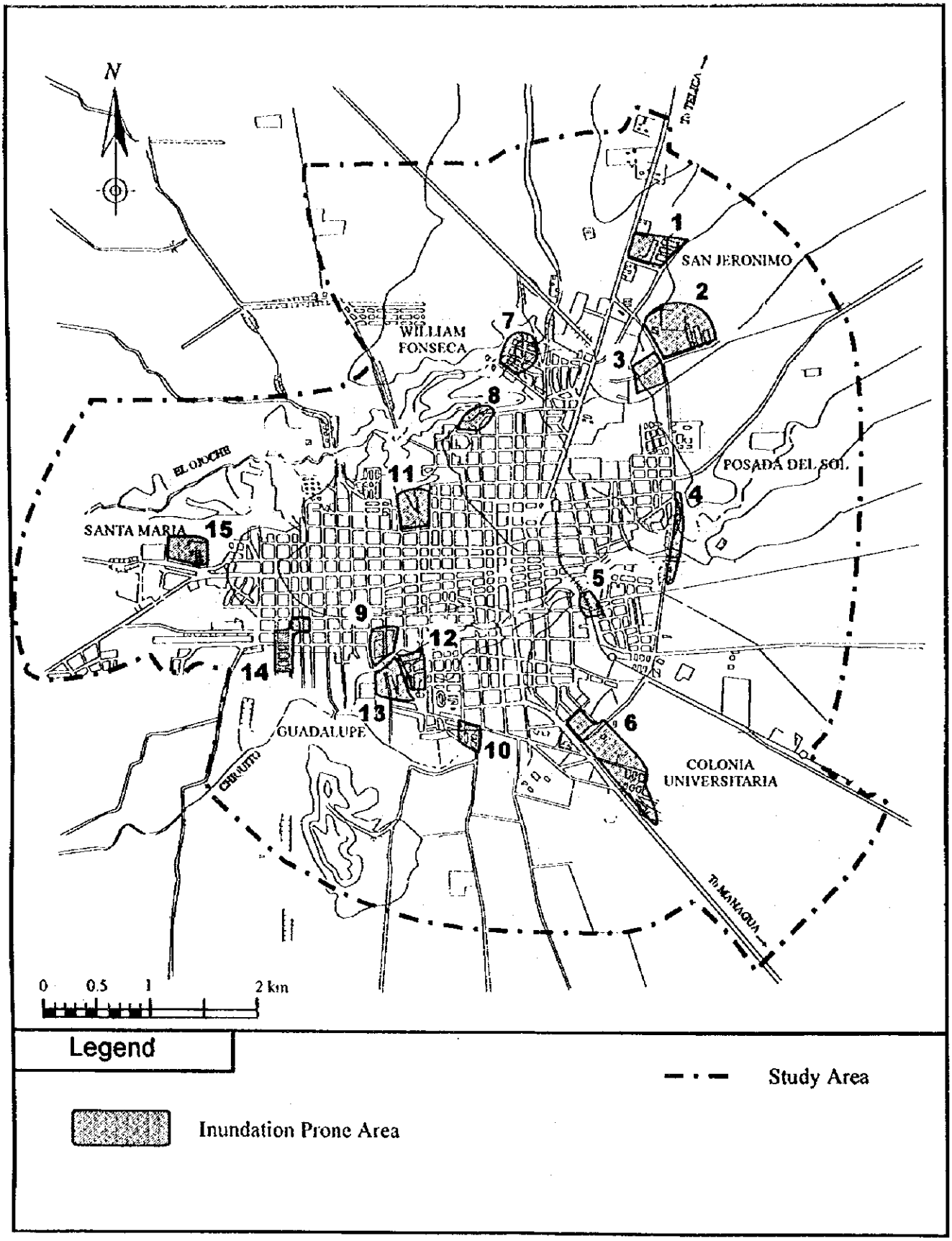


Figure L-40: Inundation Prone Area in Leon

L.2.5.2 Recommendations to Mitigate the Damage

a. Recommendation for Short Term Improvement

The following table shows countermeasures for each inundation prone area to be improved in a short term. The priority order was proposed by the municipality.

Table L-126: Recommendation for Short Term Improvement

No.	Name of Area	Priority	Recommendation
1	San Jerónimo	1	to improve the roads in the area. (pavement ,or at least to make the level of the roads lower than one of the houses.) to construct a watercourse along the east side of the road bound for Chinandega.
2	Venceremos, Augusto Cesar Sandino, Linda Vista	1	to improve the roads in the area. to construct rainwater drains in the area.
3	Araceli Pérez	2	to improve the roads in the area. to construct rainwater drains in the area. to construct a watercourse along the northeastern side of the area to block the water.
4	Puente el By-pass Anexo 23 de Julio	3	no need to improve the area immediately.
5	Puente Avenida II de Julio la Granja	3	to construct a watercourse along the east side of the bank and connect it with the watercourse of the west side.
6	La Cuchilla	3	to construct drains in the area.
7	Reparto San Carlos	2	to improve the roads in the area. to construct a watercourse to block the rain water form the upper area.
8	San Luis	3	to construct a watercourse to block the rain water form the upper area.
9	Rastro Municipal	3	to improve the roads in the area. to construct a watercourse to block the rain water form the upper area.
10	Mercedes Varela	3	no need to improve the area immediately.
11	Héroes y Mártires de Zaragoza	3	to improve the roads in the area. to construct a watercourse to block the rain water form the upper area.
12	18 de Agosto	3	to construct a watercourse to block the rain water form the upper area. However, the movement of the houses is the fundamental countermeasure.
13	Walter Ferreti	3	to construct a watercourse along the sewage plant. to improve the road in the area.
14	Rosendo Daniel Pacheco	2	to improve the roads in the area. to construct drains in the area.
15	Santa Lucia	2	to improve the roads in the area. to construct drains in the area.

The inundation areas in Leon are where are located in the periphery of the city and along the rivers. These areas are geographically adverse ones, so that they are easily damaged by inundation. To make matters worse, the form of houses themselves causes damage, i.e., the level of the houses are almost the same as the roads. Almost all the areas are low income areas.

Therefore, it is regarded that only improving roads, to make the level of roads lower than the houses, is highly effective in these areas. Actually, the municipalities did it in some areas. Furthermore, the measures prohibiting the new settlement to the areas should be taken to avoid the expansion of inundation damage. Especially, the settlement in riverbeds must be strictly prohibited.

However, in order to make these improving actions more effectively, first of all the following steps should be taken:

- to work out guidelines to control water storm,

  Guidelines should include following items:

  - responsibility sphere of each organization (See Section L.2.5.4 Institutional Requirement),
  - a technical guideline (ex. Capacity of the river should be calculated on the basis of once 10 year probable rainfall.),
  - and adjustment of laws and regulation regarding storm water management.

- to conduct basic investigation on the inundation prone areas according to the guideline (conduct topographical survey, design rivers and watercourses, etc.),
- to raise necessary funds for making the plan and executing it.

b. Recommendation for Middle and Long Term Improvement

A flood defense plan is needed for middle and long term improvement. A planning process of the plan is shown in the following section L.2.5.3. In this section, items which should be taken into account when a flood defense plan is made are described.

1) The study area in Leon inclines towards the southwest basically. Therefore, it is important to plan watercourses which avoid the rainwater coming from the northeast to go through the inside of the city.
2) It should be taken into account when the drain distribution plan is made to prevent the lower areas from the water flow from the upper areas directly.
3) It is clear that the land use in the upriver area would much affect the features of water flow of the rivers 'Chiquito' and 'Pochote'. Accordingly, the land use should be taken into consideration in view of middle and long term improvement.

L.2.5.3 Planning Process for the Improvement

Figure L-41 shows a general flow of planning process of a flood defense plan.

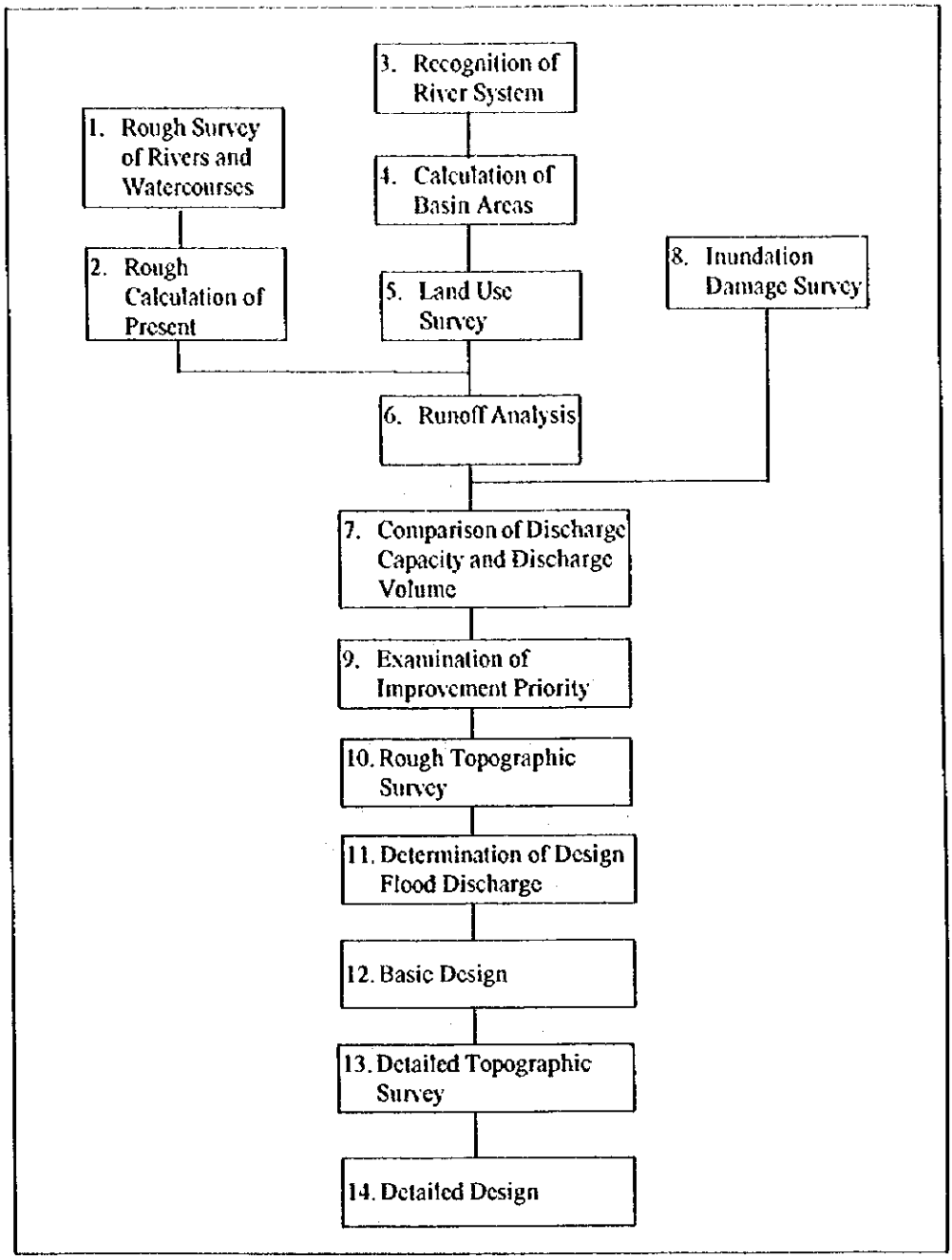


Figure L-41: Flow of Planning Process of Flood Defense Plan

1. Rough Survey of Rivers and Watercourses

To survey about three cross sections (a upstream point, a middle point, a downstream point) of rivers and watercourses.

2. Rough Calculation of Present Discharge Capacity

On the basis of the above survey result, present discharge capacity of rivers and watercourses are calculated by Manning's formula.

Manning's formula

$$V=1/n \times R^{2/3} \times I^{1/2}$$

V: flow velocity (m/s)
n: roughness coefficient
R: hydraulic radius (m)
I: gradient

$Q=A \times V$

Q: discharge capacity (m^3/s)
A: sectional area (m^2)

3. Recognition of River System

To recognize a relation ship of rivers (main rivers, tributaries).

4. Calculation of Basin Areas

According to the river system, to calculate the drainage areas which are divided by each tributary.

5. Land Use Survey

This survey is conducted in order to determine runoff coefficient, and the result of the survey is useful upon planning a river alignment.

6. Runoff Analysis

Although there are some runoff analysis methods, the rational formula method is recommendable for the rivers in the study area. Because the drainage areas of the rivers in the study area are comparatively small. In general, it can be said that the rational formula method is appropriate for a less than $200km^2$ drainage area and shorter than 2 hours time of concentration.

$Q=1/3.6 \times f \times r \times A$

Q: design flood discharge (m3/sec)
f: runoff coefficient
r: average rainfall intensity (mm/hr) with in the time of flood concentration
A: drainage area (km^2)

7. Comparison of Discharge Capacity and Discharge Volume

To recognize parts of rivers which are needed to be improved by comparing the result of 2 and 7.

8. Inundation Damage Survey

To investigate actual inundation damages which have occurred, in order to mainly give priority order of improvement.

9. Examination of Improvement Priority

Upon considering the above items synthetically, priority order of improvement is examined.

10. Rough Topographic Survey]

According to the priority order, to conduct a rough topographic survey on a river for a basic design. The survey may consist of horizontal plan and vertical alignment.

11. Determination of Design Flood Discharge

To decide a design flood discharge of a river.

12. Basic Design

On the basis of the design flood discharge decided in 11, a basic design is made, which consists of horizontal, vertical and cross section plan, and rough design of structures.

13. Detailed Topographic Survey

To conduct a detailed topographic survey in order to conduct a detailed design.

14. Detailed Design

The detailed design is made for construction, which consists of horizontal, vertical and cross section design, and other necessary designs for construction.

L.2.5.4 Institutional Requirements

The pluvial drainage is the municipal competence. Meanwhile it is not well defined who would be the responsible for the maintenance and protection of: permanent rivers and seasonal or temporal rivers inside and outside of municipal extension. Law No. 217-96 establishes the competence of MARENA taking water as "a natural resource". Whereas, MINSA should control its quality. Other entities are involved in the use and protection of water (e.g., the Agriculture Ministry and the National Commission of Water Resources).

It is recommended to carry out an ample and detailed evaluation study on the basin and the ditches that cross the municipality, especially in the urban area. The study should be in such a way as to identify:

- simply what is an urban drainage way (i.e., municipal competence); and
- what exceeds the above aspect and could cause effects to: groundwater and surface water (natural resources), to the public health, to the safety of persons and physical assets (floods, erosions, etc.).

Based on this study, it is recommended to classify ditches and other drainage ways in two systems:

- **micro-drainage** (municipal responsibility); and
- **macro-drainage** (responsibility shared by the Municipality and the Central Government (MCT as operating agent)).

Because of its natural competence MARENA should lead this intersectorial study and should promote solution of:

- a local nature, through an agreement or treaty with the municipality; or
- a wider nature, by means of the Law.

The Annex N presents the recommendations on regulations and intersectorial actions in this regard.

L.2.6 Municipal Solid Waste Management

L.2.6.1 Future Waste Amount and Composition

a. Waste Amount

As explained in section L.1.6.2 Future Waste Amount and Composition in Granada, the Study Team uses the same forecast model, percentage of average GDP, factors in waste amount increase including methodology for the forecast-model to forecast future waste amount of Leon. The difference factor between both cities which the Study Team considering is the percentage of garden wastes (such as grass, wood) and cleaning waste (soils, etc.) in Leon which share about 47% of MSW. The Study Team concluded, therefore, the increase in waste generation per capita per year in the planning period in Leon is :

Leon = 1.4% (2.7 % x 0.53 = 1.431 say 1.4%)

a.1 Forecast on Waste Amount

Table L-127 shows a temporary forecast on waste generation ratio in Leon which estimated based on the generation ratio in 1996.

Table L-127: Forecast on Waste Generation Ratio for Leon

Unit : g/unit/day

Year	Leon			
	1996	2000	2005	2010
1. MSW				
1.1 Household	675	714	765	820
1.2 Restaurant	15,109	15,973	17,123	18,356
1.3 Other Shop	1,676	1,772	1,899	2,036
1.4 Institution	98	104	111	119
1.5 Market	2,827	2,989	3,204	3,434
1.6 Street Swept	36,677	36,677	36,677	36,677
2. Other Waste (ton/day)	2.5	2.6	2.8	3.0

In addition, a temporary forecast on the increase of the number of generation source in the Study Area is also estimated based on that in 1996 and tabulated in Table L-128.

Table L-128: Forecast on the Number of Generation Sources in Leon

Year	Leon			
	1996	2000	2005	2010
1. MSW				
1.1 Household Waste	133,997	183,519	213,156	245,421
1.2 Restaurant	77	105	122	141
1.3 Other Shop Waste	740	1,013	1,177	1,355
1.4 Institutional Waste	2,379	3,258	3,784	4,356
1.5 Market Waste	2,500	3,424	3,977	4,578
1.6 Street Sweeping (km)	55	55	117	135

The Study Team forecasts waste amount generation in Leon and tabulated in Table L-129.

Table L-129: Forecast on Waste Amount Generation in Leon

Unit : ton/day

Year	Leon			
	1996	2000	2005	2010
1. MSW				
1.1 Household Waste	90.4	130.0	162.5	201.1
1.2 Restaurant	1.2	1.7	2.1	2.6
1.3 Other Shop Waste	1.2	1.8	2.3	2.8
1.4 Institutional Waste	0.2	0.3	0.4	0.5
1.5 Market Waste	7.1	10.3	12.9	15.9
1.6 Street Sweeping	2.0	2.0	4.3	5.0
1.7 Bulky Waste*	0.0	1.4	2.1	2.8
Sub-total	102.1	147.5	186.6	230.7
2. Other Waste	2.5	2.7	2.9	3.1
Total	104.6	150.2	189.5	233.8

Note: * assumed 2% of the household waste.

b. Waste Composition

b.1 Forecast on Waste Composition

As same as forecast on future waste composition in Granada, the Study Team set the frame of the waste composition for Leon in 2010 as follows:

- The ratio of combustible contents and incombustible contents are rather stabilized.
- The ratio of kitchen waste at present will also stabilize at 28% in year 2010 while the ratio of paper and plastic will increase to 8% and 9% respectively in year 2010.
- On the other hand, the ratio of grass and wood and others (soil, etc.) will decrease gradually from 33% and 12% at the time being to 30% and 9% respectively in year 2010. Meanwhile, metal and glass ratios will increase from 1% to 4% and 3% respectively in year 2010.
- For textile, ceramic and stone, the percent of these contents are rather stabilized.

Table L-130 shows the forecast on waste composition of MSW in the Study Area.

Table L-130: Forecast on Composition of MSW in Leon

Unit : %

Composition	1996	2000	2005	2010
1. Combustible Contents	**80.65**	**80**	**80**	**80**
Kitchen Waste	27.98	28	28	28
Paper	5.80	6	7	8
Textile	2.15	2	2	2
Plastic	5.47	6	8	9
Grass and Wood	33.75	33	31	30
Leather and Rubber	5.50	5	4	3
2. Incombustible Contents	**19.35**	**20**	**20**	**20**
Metal	1.77	2	3	4
Glass	1.31	2	3	3
Ceramic and Stone	3.29	4	4	4
Others (soils, etc.)	12.98	12	10	9
Total	**100.00**	**100**	**100**	**100**

c. Waste Stream

The future waste stream is forecasted on the basis of the same conditions as one of Granada. The amount of each component in future waste stream as shown in Table L-131 and illustrated in Figure L-42 and Figure L-43.

Table L-131: Future Waste Stream of Leon in Year 2005 and 2010

Unit : ton/day

Items	1996	2000	2005	2010
Waste Generation	102.1	147.5	186.1	229.5
Recycling at Generation Source	16.3	23.5	29.7	36.6
Waste Discharge	67.9	101.1	132.1	168.7
Self-Disposal at Generation	17.9	22.9	24.3	24.2
Collection	58.9	87.7	125.5	168.7
Illegal Dumping	9.0	13.4	6.6	0.0
Recycling at Disposal Site	1.4	2.1	0.0	0.0
Other Wastes	2.5	2.7	2.9	3.1
Final Disposal	60.0	88.3	128.4	171.8

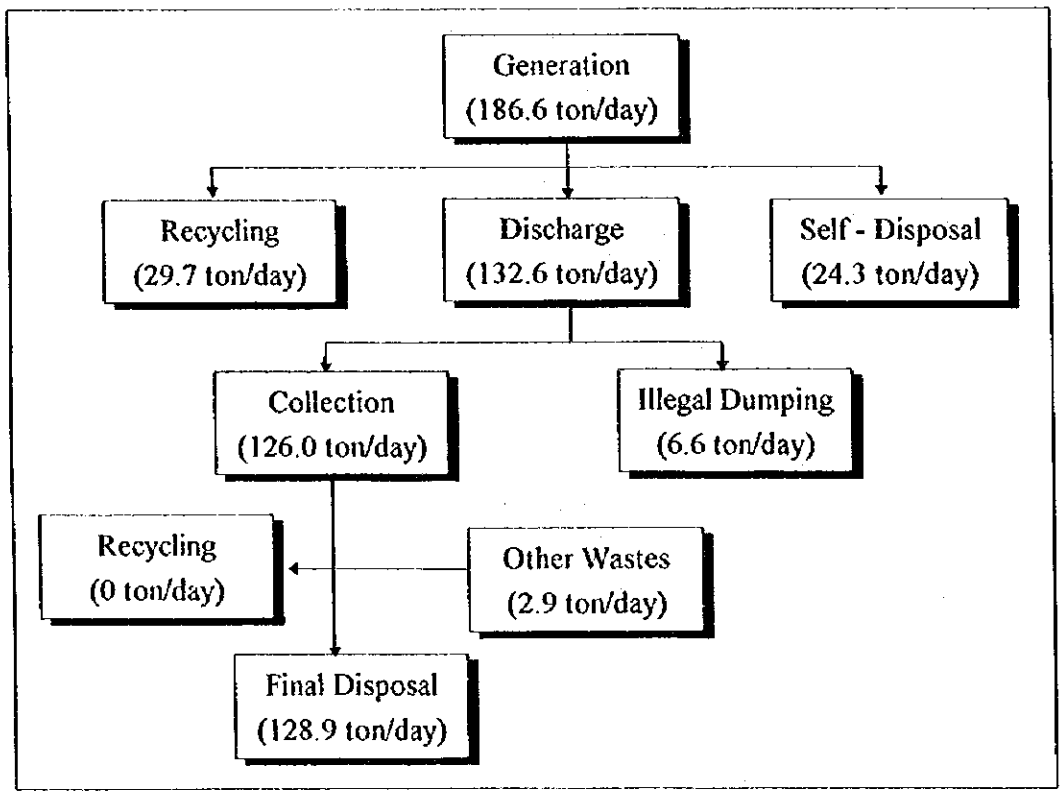


Figure L-42: Future Waste Stream of Leon in 2005

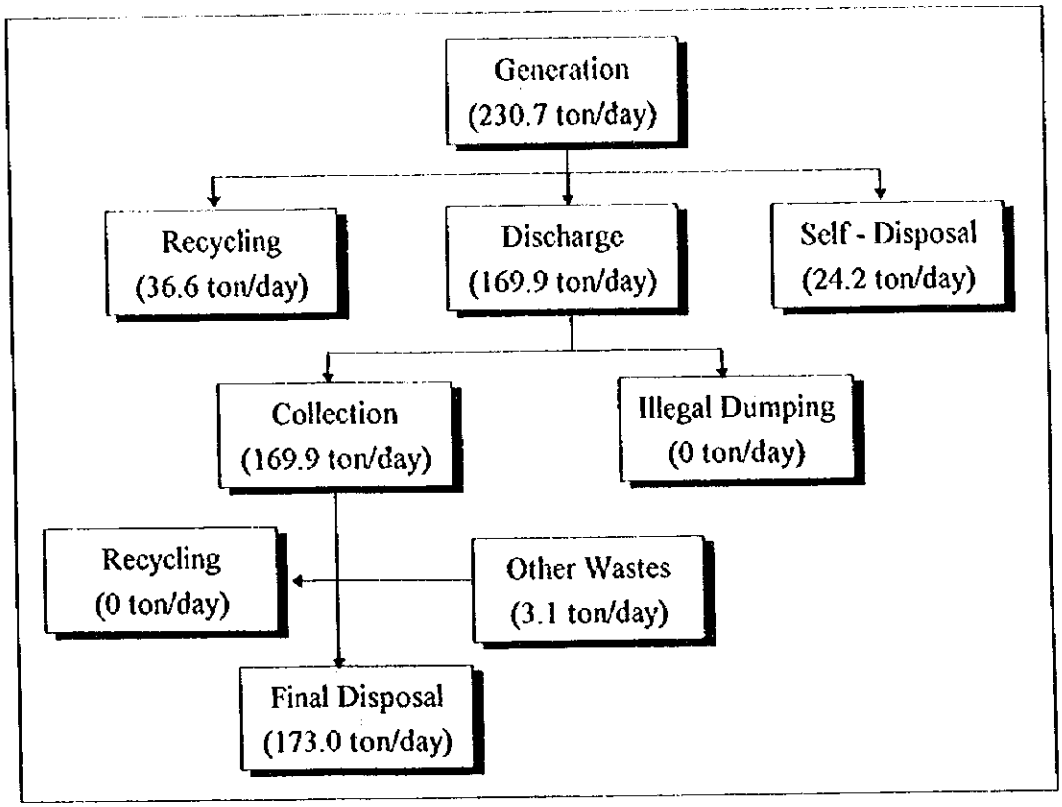


Figure L-43: Future Waste Stream of Leon in 2010

L.2.6.2 Selection of and Optimum Technical System

The procedures for examining SWM's technical systems for Leon are almost all the same as one for Granada. Therefore, only specific matters on Leon are discussed in this section.

L.2.6.2.1 Policy for Selection of an Optimum Technical System

a. Criteria for Selection

Taking the current situation and background of SWM in Leon City into account, the policies for the selection of a technical system are as follows:

1) Systems and technologies to be adopted should be as simple as possible so that operation and maintenance would be easy and inexpensive.

2) The foreign currency requirements for the purchase, operation and maintenance of systems should be minimized. The use of locally available materials and services should be maximized.

3) The use of labor intensive rather than capital intensive techniques should be used where technically feasible and economically viable.

4) Technical system proposals have to be consistent with the institutional requirements should be maxim to ensure their efficiency.

b. Selection Procedure of an Optimum Technical System

An SWM technical system consists of various technical subsystems such as discharge and storage system, collection and transportation system, street sweeping system, intermediate treatment system, final disposal system, etc. A number of alternatives can be formed from the combination of these various subsystems. Hence, selection of the optimum technical system will be carried out according to the following procedure:

1. Preconditions for selection of subsystems
2. Identification of potential subsystem technologies for Leon City
3. Screening potential subsystem technologies
4. Candidate technical systems

L.2.6.2.2 Preconditions for Selection of Subsystems

a. Location of Landfill and Workshop

The municipality has a plan to close the existing landfill and has two candidate sites for landfill in the southern part of the city which were shown to the study team.

The workshop for the waste collection vehicles is 'Plantel Municipal Service' which is located in the northern part of the city.

b. Road conditions

The road conditions of Leon are similar to ones of Granada, i.e., in the areas located in the periphery of the city and along rivers the road conditions are very bad.

3.6.2.3 Identification of Potential Subsystem for Leon

The screened potential subsystems for Leon are listed in the following table.

Table L-132: Potential Subsystems of SWM for Leon

Technical Systems	Technical Sub-systems	Sub-system Components
Discharge and Storage	• Source Separation	• Mixed discharge • Separate discharge
	• Type of Storage Equipment	• Nylon sacks • Plastic bags • Dustbins • On-site storage • Large containers
Primary Collection	• Type of Collection System	• Handcart • Animal cart
Secondary Collection and Transportation	• Collection Frequency • Collection Method	• Mixed collection • Separate collection
	• Type of Collection Service	• Curb collection • Door-to-door collection • Bell collection • Point collection • Public container collection
	• Collection Schedule	• Day collection • Night collection
	• Type of Collection Vehicle	• Compactor truck • Tractor and trailer • Tipper truck

Technical Systems	Technical Sub-systems	Sub-system Components
		• Skip truck
	• Transportation System • Transfer Station	• Motor vehicle
Street Sweeping	• Cleaning Method	• Manual street sweeping • Mechanical cleaning
Intermediate treatment	• Composting	• Centralized composting plant • On-site/community based composting
Recycling	• Government Related • Private Sector Centered	
Final Disposal	Method of Sanitary Landfill	
Maintenance of Vehicles and Equipment	• Preventive Service Workshop • Full Service Workshop	

L.2.6.2.3 Screening of Potential Subsystems

a. Discharge and Storage System

With the same reason as Granada, the recommendable receptacles are as follows:

- plastic bags and nylon sacks for household waste,
- plastic bags and dustbins for commercial waste,
- plastic bag, dustbins and containers for institutional waste,
- on-site storage and containers for market waste.

b. Primary Collection

Similarly to Granada, the usage of handcarts and animal drawn carts is considered inappropriate in a long term improvement. But in a short term, it should be taken into account.

c. Collection and Transportation

c.1 Collection Frequency

A twice or thrice a week collection is recommendable. A daily collection is inappropriate due to its high costs.

c.2 Mixed or Separation Collection

A mixed collection should be implemented because no intermediate treatment technologies are employed. However, the separation of recyclable and non-recyclable waste at generation sources are encouraged.

c.3 Collection System

A curb collection is recommendable for the central part of the city, and a point collection for the periphery area (bad road conditions' areas).

c.4 Collection Schedule

A daytime collection is recommendable for the most areas, and an early morning or a nighttime collection should be examined in the city center.

c.5 Collection Vehicle

Compactor trucks are recommendable for the city center, i.e., the well paved area, and tipper trucks for the periphery area. Leon already has compactor trucks, they are used to operate the trucks. For market waste, the introduction of container trucks or tipper trucks should be examined.

However, various kinds of trucks should not be introduced, because it cause high maintenance cost and difficult operation. The type of vehicle should be determined in view of a integrated system.

d. Street Sweeping

Manual sweeping is recommendable for street sweeping.

e. Intermediate Treatment

No intermediate treatment technology is recommended. However, On-site/community composting for private use may be a suitable mean of promoting self disposal.

f. Recycling

The following table shows the surveyed waste composition of Leon, the standard waste composition of industrialized countries and the United States. This comparison clearly shows that the present composition of recyclable waste in Leon is far less than that of industrialized countries: 21 % in Leon, 27-80 % in industrialized countries, and 67.5 % for the United States.

Table L-133: Comparison of Waste Composition

	Leon in 1996	Industrialized Countries	United States in 1990[b]
Kitchen	26.13 %	20-50 %	9.0 %
Paper	4.75 %	15-50 %	40.0 %
Textile	2.03 %	2-10 %	2.0 %
Plastic	5.32 %	2-10 %	7.0 %
Grass/Wood	35.26 %	-	20.5 %
Leather/Rubber	5.98 %	-	1.0 %
Metal	1.76 %	3-13 %	9.5 %
Glass	1.34 %	4-12 %	8.0 %
Ceramic/Stone	3.39 %	1-20 % (including others)	3.0 % (including others)
Others	14.04 %	-	-
Total	100.00 %	100.0 %	100.0 %

Note: Screened items are recyclable wastes.

As shown in the above table, there are little recyclable fraction in the waste generated in Leon. So that, to introduce a government related recycling system is unfeasible.

However, recycling should be encouraged in view of waste reduction and resource conservation.

g. Final Disposal

To mitigate having an adverse effect on environment, at least level 2 sanitary landfill should be introduced.

h. Maintenance of Vehicles and Equipment

To strengthen the ability of the workshop, 'Planet Municipal Service', more machinery especially for preventive work should be equipped.

And to reduce the operation costs of the work shop, it is better to be considered to allocate the work to the other work shop, 'Municipal Works'. Furthermore, the exchange of mechanical engineers or mechanics mutually will be contribute to promote skill.

L.2.6.2.4 Candidate Technical Systems

According to the procedure (1.Preconditions for selection of subsystems, 2.Identification of potential subsystem technologies, 3.Screening potential subsystem technologies) taken above, candidate technical systems are shown in the following table.

Table L-134: Candidate SWM's Technical Systems

System	Proposal
Discharge and Storage	Source separation: Separates recyclable and non recyclable wastes Type of storage: household waste Nylon sack, Plastic bag commercial waste Plastic bag, Dustbin institutional waste Plastic bag, Dustbin, Container market waste On-site storage, Container
Primary Collection	No primary collection
Collection and Transportation system	Collection frequency: More than twice a week Collection method: Mixed collection for non-recyclable wastes Type of collection: Curb collection, Point collection Collection time: Day collection for most areas, and night and early morning collection for the city center Type of collection vehicle: City center Compactor truck Other area Tipper truck Market Container truck, Tipper truck Transportation system: Direct transport by motor vehicle
Street sweeping	Manual sweeping method
Intermediate treatment	Only on-site/community based composting is encouraged.
Recycling	Recycling activities are encouraged through institutional and educational programs.
Final Disposal	Sanitary landfill Level 2 or more.
Maintenance of Vehicle and Equipment	for Preventive work mainly.

L.2.6.3 Institutional Requirements

Urban cleaning is essentially a municipal duty, given that it is the result of the citizens' livelihood and the Law No. 40-88 defines those services as municipal obligation. It lacks a **Regulation of Urban Cleaning**, which would establish the rights and duties of the citizen and the municipality regarding the urban cleaning, including the municipal competence to penalize transgressors. Today, MINSA has the prerogative (Decree No. 432-89) regarding sanitary aspects.

The Regulation is an executive document. Only when at the same time better municipal services are introduced and the community is motivated to comply with the burden, the use of the regulation becomes viable, and as a result, there will be an improvement in the environment and citizens will increase their trust for the municipality. At that moment, the citizens accept to pay for the services, and a tax plan to pay for the services could be introduced. Urban cleaning will not be derived from separated actions and investments, but from the integration of them. Therefore, in order to organize this integrity, trained persons and an adequate organization are needed. Meanwhile in order to introduce and develop the trained persons and adequate organization, a control system based on a prior planning is indispensable.

In short, the **institutional training** by the municipality will comprise at least:

- An Operational Plan with resources and costs dimensioned or estimated;
- An Urban Cleaning Regulation coherent with the Operational Plan;
- A Tax Plan coherent with the costs and economic capacity of the citizens. It should be considered that **everybody** should receive services and **pay** for the services according to the "viable quality" of the services and the economic capability of the citizens. The Tax Plan should consider averages for the social-economic segments;
- The organizational improvement and human resource training for the departments of Waste Collection, Public Cleaning, and Vehicles and Equipment will provide indispensable support to achieve the regularity of the services; and
- Community involvement should be implemented in proportion to the "improved and regular" services in order to attain the burden sharing by citizens. Meanwhile, the areas subject to the community participatory projects should be gradually expanded, but the contents of the participation should be full and complete in respective community.

Before it is decided whether to **"privatize"** those services partially or totally, it is considered that the waste collection services, street cleaning and landfill disposal should be being operated by the municipality until when the operation department and its staff are trained to be able to plan and control the operation results and costs.

Annex N presents recommendations on "Instructions and/or Regulations (as well as Tables with Strategies and Intersectorial Integration)".

The Main Report for F/S of Volume III includes (item 4.3.2) the proposed Regulation on SWM for Granada, that might be the same for the other municipalities.