CHAPTER 6

Evaluation of the Present USE

6 Evaluation of the Present USE

6.1 Water Supply

6.1.1 National Aspects and Institutional System

The management indices of INAA indicate progressive development that is expected to continue in the near future.

INAA satisfies this aim and has decentralized through regional and municipal branches.

This strategy will be improved with the proposed decentralization of functions between INAA and ENACAL (Dec. Nº 27-95 and 31-95). INAA would entrust its operational, commercial and economic functions to ENACAL, maintaining its regulatory and monitoring functions. ENACAL would be an enterprise able to relegate some of its responsibilities with local branches and share its activities with private enterprises.

Decree Nº 32-95 provides economic self-sufficiency to ENACAL and completes the new strategy, that is still waiting for approval by the National Assembly.

A public education program should be considered for now and in the future to save water, and protect natural resources.

6.1.2 Leon

a. Technical System

i. Water Supply Sources

The present maximum capacity of the pumps of the wells in Leon is 43,372 m^3/day (502 liters/sec), and the total urban population is 124,117 as of 1995.

Assuming the following, the daily water supply capacity per capita for the present total urban population was estimated at 147.4 liters/person/day:

Supply population	:	124,117 persons
Efficiency	:	58 %
Non-household usage	:	10 %
Yearly fluctuation coefficient	:	1.25

$$(((43,372 \times 1,000 / 124,117) \times 0.58)/1.1)/1.25 = 147.4 \quad \text{(l/person/day)}$$

Although this figure (147.4 liters/person/day) suggests that the existing wells have a capacity almost equivalent to the 1995 average daily water consumption (144.9 liters/person/day), there is a need to develop new potable water sources (i.e., wells) in view of the future population growth in the urban area.

ii. Water Quality

There are no specific problems in any of the wells in operation except for the one in the San Felipe well field (I, II, and III). The nitrate concentrations observed causes some concern, although they are still below the permissible level.

iii. Water Transmission

As described in INAA's Pre-feasibility Study, the water from "Los Tanques" and "Pila de Agua" wells is pumped into their respective reservoirs while water from other wells is pumped directly to the distribution mains.

Making connections directly into the mains, fundamentally, is not allowed, in order to maintain two fundamental hydraulic conditions: i.e., optimum head in the transmission main and regulation of hourly pressure fluctuations in the net due to consumption.

Regarding the former, if the head along the transmission main is reduced because of illegal connections, it is necessary to operate the well pump at a level higher than the design level to compensate for the losses. A pump operating outside its optimum range has a reduced life expectancy due to increased fatigue.

Once regulation of hourly variations due to consumption is achieved, the flow into the reservoirs could become more constant and hourly variations in the output of well pumping is reduced.

In conclusion, a conceptual change in the transmission system should be implemented. That is, pumping should be done directly into reservoirs from the wells, and from the reservoirs into the distribution mains.

iv. Storage

According to technical procedures practiced by INAA, the reservoir tanks are generally designed to have a storage capacity equal to 25% of the average daily supply plus a provision for shortages and fire extinguishing (72 m^3).

The daily average consumption is approximately 27,300 m^3/day, under the following assumptions.

Supply population	:	124,117	(urban total)
Consumption	:	160[1]	(l/person/day)
Non-household usage	:	10	(%)
Yearly fluctuation coefficient	:	1.25	

Including unaccounted for water (42%), the average daily supply is approximately 47,000m^3.

Considering 25% of this value plus 72 m^3 for emergencies, approximately 11,800m^3 of storage is needed.

Given that the current storage volume is 9,000 m^3, it is concluded that this volume is below what is necessary.

Finally, it is recommended that future reservoirs be strategically located, with the objective of receiving well water (which is currently directly pumped to the distribution mains), and subsequently to act as centers of water distribution.

[1] This is refereed to the figure proposed for a city of more than 50,000 population by the INAA's Pre-feasibility Study financed by IDB (Interamerican Development Bank).

v. **Mains Supply**

Generally, the pressures in the mains are acceptable, with the exception of the highest points of the "low area net" and "high area net". This is due to the low elevations of the storage tanks and because the pressures at some locations are below the required minimum head of 15 m.

INAA at this moment is executing various pipe replacement works. Replacing existing pipes with larger diameter pipe to increase pressures in problematic sections.

At present, significant pressure variations exist in the mains due to the direct pumping from the well pumps into the distribution mains.

In conclusion, only a few points in the urban area do not have adequate service. Comprehensive planning should be carried out including the requirements of the existing and future storage systems so that the distribution system becomes more efficient.

6.1.3 Chinandega

a. **Technical System**

An evaluation of the present urban sanitation environment of Chinandega was executed based on the INAA Pre-feasibility Report, and the results clearly illustrate the actual conditions of the water supply and sewer systems of the city.

The evaluation helped the study team discern the development activities of INAA which is very important in order to fully comprehend the recommendations in the Pre-feasibility Report.

The INAA study only covered two conditions:

1. Studies on water supply systems only included the relationship between the wells, reservoirs and the distribution network. Further studies on well pumping facilities suitable for the existing system should be conducted to be able to assess the necessity of the system.

2. Studies on the sewerage system was limited to cities with a combined sewer system. The use of alternative technologies were not fully considered due to resource restrictions. Cheaper technologies that would improve hygienic conditions but to a lesser degree should be introduced in the fringe areas of the city.

i. **Water Supply Sources**

The present maximum capacity of the well pumps in Chinandega is 33,782.4 m^3/day (391 liters/sec.), and the total urban population in 1995 is 84,281.

Supply population	:	84,281	(persons)
Efficiency	:	72	(%)
Non-household usage	:	10	(%)
Yearly fluctuation coefficient	:	1.25	

(((33,762/ 84,281) X 0.72)/1.1)/1.25 =210 (l/person/day)

With the above assumptions, daily water supply capacity per capita for the present total urban population is calculated at 210 liters/person/day, which exceeds the guideline (160 liters/person/day) for a city with a population of over 50,000 proposed in INAA's Pre-feasibility Study.

ii. Water Quality

Nitrate concentrations are high in general, although they are still below the INAA's permissible level.

This could be attributed to infiltration of agricultural chemicals from the surface. Therefore, in view of high permeability in the area, it is anticipated that nitrate concentration in the well water might exceed the permissible level in the near future.

iii. Water Transmission

As described in INAA's Pre-feasibility Study, currently, water from "La Mora", "La Pila and "El Jirón" wells is pumped into their respective reservoirs, whereas water from other wells is fed directly to the distribution mains.

Making connections directly into the mains, fundamentally is not allowed, in order to maintain two fundamental hydraulic conditions: i.e., optimum head in the transmission main and regulation of hourly pressure fluctuations in the net due to consumption.

Regarding the former, if the head along the transmission main is reduced because of illegal connections, it is necessary to operate the well pump at a level higher than the design level to compensate for the losses. A pump operating outside its optimum range has a reduced life expectancy due to increased fatigue.

Once regulation of hourly variations due to consumption is achieved, the flow into the reservoirs could become more constant and hourly variations in the output of well pumping is reduced.

In conclusion, a conceptual change in the transmission system should be implemented. That is, pumping should be done directly into reservoirs from the wells, and from the reservoirs into the distribution mains.

iv. Storage

According to the technical procedures practiced by INAA, the reservoir tanks are generally designed to have a storage capacity equal to 25% of the average daily supply plus a provision for shortages and fire extinguishing (72 m^3).

The daily average consumption is approximately 18,500 m^3/day, under the following assumptions.

Supply population	:	84,281	(urban total)
Consumption	:	160[2]	(l/person/day)
Non-household usage	:	10	(%)
Yearly fluctuation coefficient	:	1.25	

Including unaccounted for water (28%), average daily supply is approximately 25,700m^3.

[2] This is referred to the figure proposed for a city of more than 50,000 population by the INAA's Pre-feasibility Study.

Considering 25% of this value plus 72 m^3 for emergencies, approximately 6,500m^3 of storage is needed.

Given that the current storage volume is 9,000 m^3, it is concluded that, at this moment, this volume is above what is necessary.

Finally, it is recommended that future reservoirs be strategically located, to receive well water (which is currently directly pumped to the distribution mains today), and subsequently to act as centers of the water distribution to the mains.

v. **Mains Supply**

Generally the pressures in the distribution mains are acceptable, with the exception of the high areas. This is due to the low elevations of the reservoirs and because the pressures in some areas are below the required minimum head of 15 m.

INAA at this moment is executing various pipe replacement works. Replacing existing pipes with larger diameter pipes to increase pressures in problematic sections.

At present, significant pressure variations exist in the mains, due to the direct pumping from the well pumps into the distribution mains.

In conclusion, only few points in the urban area do not have an adequate service. Comprehensive planning should be carried out including the requirements of the existing and future storage systems so that the distribution system becomes more efficient.

6.1.4 Granada

a. **Technical System**

i. **Water Supply Sources**

The present maximum capacity of the pumps in the wells in Granada is 25,263 m^3/day (292.4 liters/sec.). However, the nitrate concentration in the water of the "Quinta Ena IV" well exceeds the permissible level: water supply from this well should be terminated in the near future. Therefore, the present maximum capacity above, excludes that of "Quinta Ena IV" (3,750 m^3/day).

Daily water supply capacity per capita for present total urban population was calculated at 119.9 liter/person/day with the following assumptions.

Supply population	:	71,783	(persons)
Efficiency	:	57	(%)
Non-household usage	:	10	(%)
Yearly fluctuation coefficient	:	1.25	

(((25,263/ 71,783) X 0.57)/1.1)/1.25 = 145.9(l/person/day)

The calculated value is considerably lower than the guideline (160 liters/person/day) for a city of over 50,000 people proposed in INAA's Pre-feasibility Study and falls short of the present supply level (151 liters/person/day). Therefore it is necessary to develop new water supply sources for Granada City.

ii. Water Quality

All the well water, other than that of Quinta Ena IV, complies with the requirements. Priority should be given to constant monitoring for Quinta Ena IV for the time being. If nitrate concentrations are observed to increase, the well should be abandoned.

iii. Water Transmission

As described in INAA's Pre-Feasibility Study, currently water is pumped from the wells to both the reservoirs and the distribution network. There is no independent line between the wells and the reservoir; lines branch off directing water to the distribution net.

The present arrangement transgresses two fundamental hydraulic conditions: constant flow from the well and regulation of hourly pressure fluctuations in the net due to consumption.

Regarding the former, if the head along the transmission main is reduced because of illegal connections, it is necessary to operate the well pump at a level higher than the design level to compensate for the losses. A pump operating outside its optimum range has a reduced life expectancy due to increased fatigue.

Once regulation of hourly variations due to consumption is achieved, the flow into the reservoirs could become more constant and hourly variations in the output of well pumping is reduced.

In conclusion, a conceptual change in the transmission system should be implemented. That is, pumping should be done directly into reservoirs from the wells, and from the reservoirs into the distribution mains.

iv. Storage

According to technical procedures practiced by INAA, the reservoir tanks are generally designed to have a storage capacity equal to 25% of the average daily supply plus a provision for shortages and fire extinguishing (72 m^3).

The daily average consumption is approximately 15,800 m^3/day, under the following assumptions.

Supply population	:	71,783	(urban total)
Consumption	:	160[3]	(liter/person/day)
Non-household usage	:	10	(%)
Yearly fluctuation coefficient	:	1.25	

Including unaccounted for water (43%), average daily supply is approximately 27,700m^3.

Considering 25% of this value plus 72 m^3 for emergencies, approximately 7,000 m^3 of storage is needed.

Given that the current storage volume is 8,300 m^3, it is concluded that, at this moment, this volume is above what is necessary.

[3] This is referred to the figure proposed for a city of more than 50,000 population by INAA's Pre-feasibility Study.

v. Mains Supply

In general, the pressures in the mains are acceptable, with the exception of the southwest and northwest zones. This occurs where the topography is high and sometimes the pressures are below the required minimum head of 15 m. However, INAA is promoting the replacement of some pipes to eliminate the problem.

The barrios El Capullo and Reparto San Juan are about 7.0 m higher than the ground level of existing reservoirs, therefore water is pumped a few hours per day from tank No. 3 to each of the barrios.

In conclusion, as for distribution mains for the city, only barrio El Capullo and Reparto San Juan do not have adequate services. For that reason, a study to propose solutions to the problems in this area is needed.

Attention should be drawn, in this regard, to the possibility of limiting urban expansion in elevated areas.

6.2 Stormwater Control

6.2.1 National Aspects and Institutional System

Both INAA and the municipalities lack institutional and financial requirements for maintaining stormwater drains and the sewer system. At the same time they are faced with tremendous sanitary problems - as mentioned in Chapter 5 (Present USE).

The insufficiency of the sewage system is the major reason for these problems. The lack of environmental concern on the part of the public results in the illegal discharge of wastewater into stormwater systems and streams.

A brief analysis of the economic data presented in Chapter 5 (Present USE) indicates that the increase in the sewage system in the three cities is highly conceivable.

- The revenue from the sewage charges is much higher than expenditure.
- The proportions of revenue from sewage services to the water supply varies from 8.9% in Granada to 17.6% in Leon .
- The average tariff for the sewage system was 33% of that of potable water.
- There is a potential for increase in the sewage coverage with corresponding increase of income.

In spite of the municipal ability to manage stormwater drains, it needs to be in harmony with INAA's functions, in order to:

- Preserve the technical parameters to collect and treat sewage without rainwater into the collectors;
- Preserve the natural and artificial drainage systems without polluting them with wastewater.

Sewage and drainage systems must be separated. The municipality should have the power to penalize both INAA and the citizens for wastewater discharge into any drainage system - open or closed drains. At present, this action should be supported by MINSA/SILAIS.

The municipality should be in charge of the maintenance of the micro-drainage system, involving the SW sector (MS Department). Also the Street Maintenance sector should be responsible for conduit and canal maintenance.

Macro-drainage system (rivers, channels) maintenance should be assisted by the Construction and Transportation Ministry (MCT). The drainage system must be included in the cadastre system (SISCAT).

6.2.2 Leon

a. Technical System

a.1 General Conditions

The probable rainfall intensity (66.1mm/hr: 1/5year) for Leon is considerably high, although its average annual precipitation (1,220mm/year) is not so high compared with Tokyo (50mm/hr : 1/5 year, around 1,400mm/year). The climate in Leon is divided into the rainy season and the dry season.

It is very important to designate an authority to be responsible for stormwater drainage planning and management in order to minimize the effects of heavy rainfall, e.g., flooding.

a.2 Inundation Damage

Inundation has considerably affected the daily lives of people in the study area in Leon, according to the Public Opinion Survey (POS). The Inundation Damage Survey (IDS) further confirmed how destructive it is in view of the damage inflicted on houses and the prevalence of infectious diseases.

The results of the POS and the IDS confirmed the importance of preventing inundation in the study area. However, because the study had to cover a wide area in a short period of time, sampling was limited and the number of questions were reduced to a minimum. As a result, the survey was not able to determine the specific causes of inundation.

Therefore, stormwater control should also be included not only in the Master Plan, but also in the Conceptual Master Plans like other USE components (water supply, wastewater and solid waste management).

6.2.3 Chinandega

a. Technical System

a.1 General Conditions

Of the three cities, Chinandega has the highest rainfall intensity at 79.2mm/hr, 1/5year (annual recurrence interval (ARI). The average annual precipitation is also considerably high at 1,920mm/year. Rain falling in the rainy season accounts for the total annual precipitation in Chinandega.

a.2 Inundation Damage

Inundation has significantly affected the daily lives of the people in the study area in Chinandega according to the Public Opinion Survey (POS). The Inundation Damage Survey (IDS) further confirmed how destructive it is in view of the damage inflicted on houses and the prevalence of infectious diseases.

The results of the POS and IDS confirmed the importance of preventing inundation in the study area. However, because the study had to cover a wide area in a short period of time, sampling was limited and the number of questions were reduced to a minimum. As a result, the survey was not able to determine the specific causes of inundation.

The survey also observed serious damage to the road in Somotillo, located on the northern part of the city, caused by rapid flow of a nearby stream. This rapid stream flow also affected the living conditions of people residing along the road and the stream.

Therefore, stormwater control should also be included not only in the Master Plan, but also in the Conceptual Master Plans like other USE components (water supply, wastewater and solid waste management).

6.2.4 Granada

a. Technical System

a.1 General Conditions

Of the three cites, Granada has the lowest rainfall intensity at 66.7mm/hr, 1/5 years (ARI). However, the average annual precipitation is second to Chinandega at 1,517mm/year. Rain falling in the rainy season accounts for the total annual precipitation in Granada.

a.2 Inundation Damage

The city of Granada was reported to only have three (3) inundation prone areas. Inundation has significantly affected the daily lives of the people in the study area in Granada, according to the Public Opinion Survey (POS). The Inundation Damage Survey (IDS) further confirmed how destructive it is in view of the damage inflicted on houses and the prevalence of infectious diseases.

The results of the POS and IDS confirmed the importance of having to prevent inundation in the study area. However, because the study had to cover a wide area in a short period of time, sampling was limited and the number of questions were reduced to a minimum. As a result, the survey was not able to determine the specific causes of inundation.

Therefore, stormwater control should also be included not only in the Master Plan, but also in the conceptual Master Plans like other USE components (water supply, wastewater and solid waste management).

6.3 Domestic Wastewater Management

6.3.1 National Aspects and Institutional System

INAA prepared Pre-feasibility Study Reports on each of the three cities in this study that is currently implemented.

Studies on Domestic Wastewater Management (DWWM) are usually patterned after international parameters for the analysis of sewer systems. Although these parameters are proven to be technologically accurate, they are not applicable to the situation concerned due to limited resources. The system idealized by these parameters cannot be attained under inappropriate conditions.

The Pre-feasibility Study Reports of INAA on the three cities only covered sewage treatment based on the international parameters. The reports hardly covered the importance of having to integrate an on-site system into the sewage treatment system. The present situation in Nicaragua suggests that the Pre-feasibility Report of INAA should also propose the integration of an on-site system into the sewage system.

In the three cities, sewage is transported and treated in stabilization lagoons.

Presented overleaf is a brief analysis of the types of on-site treatment that may be implemented in the study area.

Evaluation of the institutional system with regard to DWWM is included section 6.2.1.

The municipality should encourage INAA to extend the sewage system, in a combined plan for urban drainage.

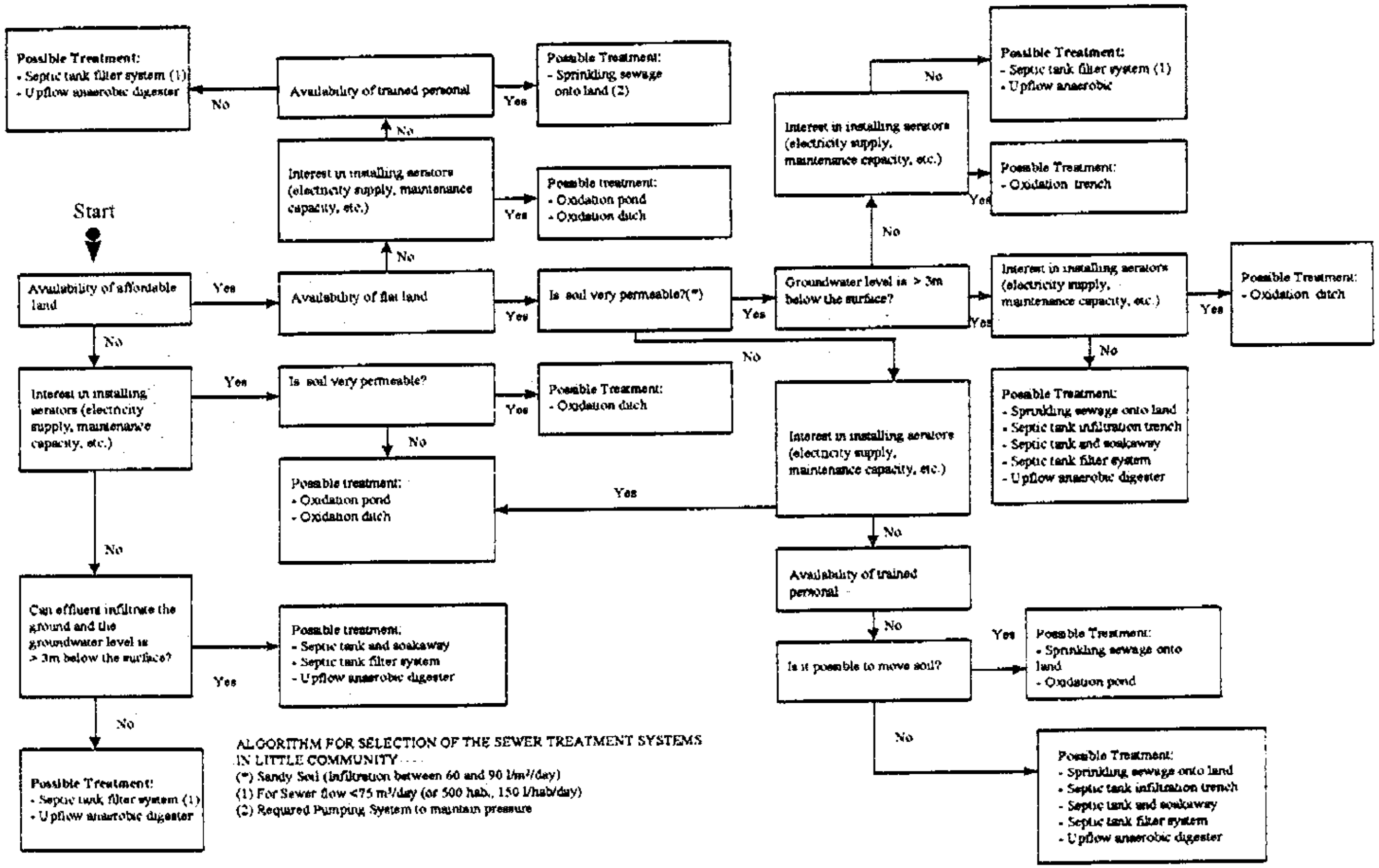

Figure 6-1: Algorithm for Selection of the Sewer Treatment Systems in Little Community

Table 6-1: Comparison of Sewer Treatment Options Suited to Small Drainage Basins

Characteristics	Septic tank + Soakaway	Septic tank +Infiltration trench	Septic tank + Filter system	Anaerobic + Facultative Lagoon (Australian System)	Facultative Lagoon (unicellular)	French drain installation	Upflow Anaerobic Digester,	Aerated lagoon + Decanter lagoon	oxidation ditch
Area required for the system	small	large	small	large	large	very large	very small	small	small
Residents' share of the cost (*)	medium	large	medium	small	small	small	small	medium	large
Cost of operation and maintenance	small	small	small	very small	very small	small	small	medium	large
Reliability	medium	medium	large	very large	very large	very large	large	large	large
Manual labor for operation	necessary	very necessary	very necessary	necessary	necessary	necessary (**)	necessary	necessary	necessary
Energy for operation	not required	not required	not required	not required	not required	not required (**)	not required	required	required
Sludge to be disposed	yes	yes	yes	no	no	no	yes	no	yes
Potential reutilization of by-product	none	none	yes (biogas)	yes (use of effluents for irrigation)	yes (use of effluents for irrigation)	yes (nutrients)	yes (biogas)	no	no
Removal of organic material	minimum	minimum	minimum	maximum	maximum	maximum	large	very large	very large
Removal of nutrients	none	none	none	some	some	total nutrients	none	no remove	can remove some
Pathogenic levels in the effluent: viruses bacteria protozoa helminths	(***)	(***)	huge amount huge amount small amount(?) small amount(?)	small amount small amount none none	small amount small amount none none	(***)	huge amount huge amount small amount(?) small amount(?)	huge amount huge amount small amount small amount	large amount large amount small amount small amount
Observation: (*) Not included in the cost of land (**) except for sprinkling (***)insignificant effluent	until 75m3 sewer/day	until $75m^3$ sewer/day	until $75m^3$ sewer/day						

Source: CETESB-Brazil

6.3.2 Leon

a. Technical System

i. Sewage Collection Systems

Discharging domestic sewage directly into gutters and open stormwater drains of streets is common practice in places without sewer systems.

The northwest area of Leon lacks a sewer system; an examination of this situation should be made independent of the current system. Integration with the present system is advisable to treat future flows.

An interconnection between other sectors of the city to the current system is feasible, given that this system drains by gravity directly toward the lagoons through the principal collectors.

The calculations presented in INAA's Pre-feasibility Study verifies that the hydraulic capacity of the present sewer mains, especially in the south of the city, has not been surpassed by the current wastewater volume generated. There is an exception in the rainy periods: the sewer system is overloaded due to a high number of illegal stormwater connections. This present situation furthermore inhibits the biological degradation processes in the treatment plants.

Special efforts should be made regarding stormwater intrusion into the sewer mains. All the main pipes will have to be examined to identify major points of stormwater intrusion for effective remedy.

ii. Sewage Treatment

The water/BOD balance (April/96) was estimated by the Team based on the available data. The results indicate that:

- Approximately 1,500 m^3/day of wastewater of unknown origin enters the sewer system, given the assumption that 100% of potable water consumed reaches the lagoon.
- Where BOD generation is assumed as 52g/person/day (the design load for the Chinandega lagoon: INAA's Pre-feasibility Study), BOD concentration in wastewater of unknown origin is supposedly about 280 mg/l. On the other hand, if the total BOD load flowing into the lagoon is divided by the population covered by the sewers, the BOD generation becomes 58 g/person/day.

Wastewater, other than DWW, intrusion is small compared with the other 2 cities.

It can be deduced that the lagoons have other inputs in addition to DWW (e.g., stormwater or industrial wastewater).

Studies on rehabilitation of stabilization lagoons in León undertook flow measurements and found that there was an immediate increase in flow following rain, revealing the contribution of rain into the sewer system.

The flow into the lagoon "Subtiava" is 143.6 liters/s which is almost double the maximum flow which enables BOD levels to be reduced to acceptable levels.

iii. On-site Systems

Based on the results of relevant studies, the installation of traditional sewer systems is unnecessary in areas with a population density of less than 50 persons/ha. There is, therefore, a need to look into alternative systems, e.g., on-site system.

In the city of León, varying sewerage treatment systems were adopted. In "Reparto William Fonseca" the use of septic tanks connected to filter drains was introduced, while the residents of "Reparto Adiac" discharge their waste into trenches that were connected to street drains.

These on-site-systems are economically feasible and should be introduced in areas with low population density and without any sanitary infrastructure.

As stated previously, the sewage collection services currently cover 61.4% of the population, which is equivalent to an average flow of 205.03 l/sec. Of the remaining population not covered by the services, 15.4% use septic tanks or cesspools -- 51.4 l/s of the discharge permeate the soil -- 23.2% use either dry or wet latrines which has an economic life of three to five years -- new latrines are built in areas adjacent to the old. The flow from the latrines is estimated at 77.5 l/s.

In zones without sewer systems, gray water is usually discharged into gutters and stormwater drains in the streets.

6.3.3 Chinandega

a. Technical System

i. Sewage Collection Systems

The present sewer coverage is low in view of the existing population density.

Discharging domestic wastewater directly into gutters and stormwater drains along the streets is common practice in places without sewer systems.

The north and east sectors lack a sewer system; an examination of this situation should be made independent of the current system. Integration with the present system is advisable to treat future flows.

An interconnection between other sectors of the city to the current system is feasible, given that this system drains by gravity directly toward the lagoons through the principal collectors.

It was also found that in the rainy season, the sewer capacity is insufficient because of the high number of illegal stormwater connections, either from houses or from street drainage, into the sewer system. This furthermore inhibits the biological degradation processes of the treatment plants.

ii. Sewage Treatment

The water/BOD balance (May/96) was estimated by the Team based on the available data. The results indicate that:

- Approximately 1,200 m^3/day of wastewater of unknown origin enters the sewer system given the assumption that 100% of potable water consumed reaches the lagoon.
- Where BOD generation is assumed as 52 g/person/day (design load for the Chinandega lagoon: INAA's Pre-feasibility Study), BOD concentration in wastewater of unknown origin is supposedly 1,058 mg/l.

If it is assumed that this wastewater of unknown origin is from some DWW connections not identified by INAA, the additional population discharging into the sewer is estimated at 24,423 persons:

- 1,270 kg/day ÷ 52 g/person/day = 24,423 persons

  i.e., this total population is estimated based on the total BOD load in the wastewater of unknown origin (1,270 kg/day) and the BOD generation per person (52 g/person/day: INAA's Pre-feasibility Study).

Accordingly, the total population with sewer connections in the urban area is about 61,400 persons, about 25% of the water supply service population, and their wastewater generation rate is 107 liter/person/day.

- 6,600 m^3/day ÷ 61,400 persons = 107 liter/person/day

However, in view of the present state of the sewerage system, it is difficult to assume a sewer coverage of 70% in Chinandega's urban area. On the other hand, in the calculation of BOD balance, BOD concentration in wastewater of unknown origin is estimated to be much higher than what is normally expected for DWW.

Therefore, if laboratory analysis of BOD is reliable, the source of wastewater of unknown origin might not be DWW but industrial wastewater.

It can be deduced that the lagoon have other inputs in addition to DWW (e.g., rainwater or industrial wastewater).

Studies on rehabilitation of stabilization lagoons in León undertook flow measurements and it was found that there was an immediate increase in flow following rain, revealing the contribution of rain to the sewer system.

The current flow into "Lagoon I" is 34.63 liters/s, which is 30% above the maximum flow which enables BOD levels to be reduced to acceptable levels.

On the other hand, the current flow into "Lagoon II" is 6.27 liters/s and is below the maximum design flow. Hence BOD can be reduced to acceptable levels.

iii. On-site System

The on-site-system previously pointed out would be economically feasible in areas with low population density.

As stated previously, the sewage collection services currently cover 39.5% of the population, which is equivalent to an average flow of 108.1 l/sec. Of the remaining population not covered by the services, 2.1% use septic tanks or cesspools -- about 5.7 l/s permeate the soil -- 34.3% use either dry or wet latrines which have an economic life of three to five years -- new latrines are built in areas adjacent to the old. The flow from the latrines is estimated at 93.9 l/s.

In areas without sewer systems (10.6%), gray water is usually discharged into gutters and stormwater drains in the streets.

6.3.4 Granada

a. Technical System

i. Sewage Collection Systems

The total length of the existing sewer system is 27,874 m, of an estimated total length of 131,000 m (streets). This represents 21.3% of the total streets.

The northwest sector, as well as other parts of the city, lacks a sewer system.

The calculations presented in the INAA's Pre-feasibility Study, verifies that the principal collector has sufficient hydraulic capacity to conduct additional wastewater from, as yet unconnected, higher areas.

The wastewater from Reparto Villa Sandino flows toward the pumping station through the main sewer. Subsequently, pumped wastewater should be routed to the treatment site through a line 300 mm in diameter. Illegal stormwater connections into sewerage need to be examined further.

ii. Sewage Treatment

The water/BOD balance was estimated by the Team based on the available data. The results imply:

- Approximately 1,400 m^3/day of wastewater of unknown origin intrudes into the sewer system, given the assumption that 100% of potable water consumed reaches the lagoon.
- Where BOD generation per person is assumed as 52g/person/day (same as the design load for the Chinandega lagoon: INAA's Pre-feasibility Study), BOD concentration in wastewater of unknown origin is about 590 mg/liter.

If wastewater of unknown origin is from DWW connections not identified by INAA: the additional population discharging into the sewer is 15,763 persons.

- 820 kg/day ÷ 52 g/person/day = 15,763 persons

  i.e., this total population is estimated based on the total BOD load in wastewater of unknown origin (820 kg/day) and the BOD generation per person (52 g/person/day: INAA's Pre-feasibility Study).

Accordingly, the total population with sewer connections in the urban area is about 29,000 persons, about 46% of the water supply service population, and their wastewater generation rate is 117 liters/person/day.

- 3,400 m^3/day ÷ 29,000 persons = 117 liters/person/day

However, in view of the present state of the sewerage system, it is difficult to assume a sewer coverage of 46% in Granada urban area. On the other hand, in the calculation of

BOD balance, the BOD concentration in wastewater of unknown origin is estimated to be much higher than what is normally expected for DWW.

Therefore, if the results of the laboratory BOD analysis are reliable, the source of wastewater of unknown origin might not be DWW but industrial wastewater.

Given that the retention time is so long, a BOD reduction of 90% could be expected. Therefore, it can be deduced that the lagoons are receiving from other sources in addition to DWW.

The lagoons have a treatment capacity of 10,000 m^3/day in view of organic load reduction, while the sewer coverage is about 18% of the population and the flow into the lagoons is around 3,400 m^3/day. Therefore, this might imply that the lagoons have the treatment capacity to serve a population three times the present (54% of the current urban population). However, the actual efficiency of the lagoons, e.g., BOD and COD removal rates, is small.

This maybe attributed to one or more of the following :

- Unstable retention time of the lagoon due to stormwater intrusion as pointed out by INAA's Pre-feasibility Study.
- Intrusion of such substances that impede degradation of organic matter.
- Errors in laboratory analysis.

Meanwhile, DWW in general has a COD/BOD of approximately 2. Wastewater flowing into the Leon and Chinandega lagoons has a COD/BOD of approximately 1.8 and is, therefore, assumed to be mainly domestic wastewater. However, wastewater flow into Granada lagoon shows a COD/BOD of approximately 1.1.

Given that the laboratory analyses of wastewater in the 3 cities were carried out based on general laboratory standards and level of integrity, DWW in the Granada sewer system is assumed to contain a significant amount of wastewater containing biodegradable and chemically oxidizable substances.

In practice, wastewater with these characteristics could possibly be identified as industrial wastewater. Industries generating wastewater with a COD/BOD of approximately 1.0 are : those who use raw materials that are easily biodegraded (e.g., sugar), namely, confectionery, beverage and brewery industries.

iii. On-site System

In some areas, mainly in the suburbs, the introduction of an on-site system is very important. The on-site system to be considered for these areas are small in scale, and hence economically feasible.

The sewage collection services currently cover 21.2% of the estimated number of households in the area, based on the INEC 1995 National Population Estimate, the 1995 "Granada Socio-environmental Survey" by CIRA/UNAN, and the INAA 1994 report on "Drinking Water Systems for the Operation and Maintenance Division".

Information gained from the report on the "Environmental Action Plan (June 1996)" of Granada was also used in the study. The report reveals that 70% of the polled population use latrines, 10.4% septic tanks, while 4.9% do not have any of these systems.

6.4 Industrial Waste Management

6.4.1 National Aspects and Institutional System

a. Industrial Wastewater

The Sanitary Code is primarily used to enforce sanitary and environmental control, but Law Nº 217-96 and Decree Nº 33-95 supplies all fundamentals to support industrial wastewater and solid waste management. However, being new legal acts, they need detailed regulation and technical instructions to become useful.

Skilled personnel to manage the control of IWW is needed more than regulations. Decree Nº 33-95 recognizes this aspect when enforcing a "gradual decontamination plan" in two stages.

At present, the municipalities have the Sanitary Code as a legal instrument to prevent environmental contamination by IWW with the help of MINSA/SILAIS for applying stiff penalties on defrauders.

b. Industrial Solid Waste

All direct responsibility on ISW was transferred to MINSA and MARENA under the Sanitary Code, Law Nº 217-96 and Decree Nº 33-95.

Municipalities may assist MINSA and MARENA but do not have the power to enforce strong administrative sanctions.

The municipalities must establish their own SWM systems with rules, penalties and clear information for generators. They must operate a system for domestic and non-hazardous waste, set restrictions for hazardous waste management within the city, and may offer special services for industries - making money and solving problems.

Municipalities must efficiently use the authority transferred by the Law of Municipalities (Art.7/10/11/12), and use AMUNIC (Asociación de Municipios de Nicaragua) as a representative in the CNA - National Environmental Agency to compensate for Law No. 217-96. They should take advantage of the Prosecutor's Office for the Environment and Natural Resources Defense (Law No. 217-96, Art.9 and 10) to improve their Environmental Sector and train its officials to use all legal authorities transferred to the municipality.

6.4.2 Leon

a. Technical System

a.1 Wastewater

An estimated 92,000 tons/year of wastewater is generated in Leon. Out of this, tanneries generate 54,000 tons/year. Wastewater from tanneries contain high concentrations of organic contaminants and chemicals such as chromium, sodium hydroxide. Moreover, all industrial wastewater is disposed of into rivers or sewers without treatment.

Therefore industrial wastewater is one of the major water pollution sources of public water bodies (e.g., rivers).

a.2 Solid Waste

Industrial code No. CIIU3116 (processing of dry seeds) is the largest solid waste generation source in Leon; solid waste from these industries are mainly non-hazardous organic materials. High potential hazardous waste generation industries e.g., CIIU3231 (leather tanning and finishing), 3512 (pesticide), and 3522 (pharmaceutical products) are also located in Leon. However, solid waste generated from these industries is not much.

The amount of SW treated is only 1% of the total amount: solid waste is mainly disposed of at the municipal landfill site without any filling plan.

The present disposal method is considered as poor landfill management: at least separate filling of ISW and MSW is necessary.

6.4.3 Chinandega

a. Technical System

a.1 Wastewater

An estimated 5,500 tons/year of wastewater is generated in Chinandega, almost all of which is generated by seafood industries and vegetable oil industries. Wastewater from these industries contains organic material (non-hazardous). There are also industries (CIIU3522) that are generators of potentially hazardous waste in Chinandega, however, the amount generated is low (37.9 tons/year).

All industrial wastewater is disposed of into the environment (e.g., rivers, evaporates into the air) without treatment.

Therefore, industrial wastewater is one of the major water pollution sources of public water bodies (e.g., rivers).

a.2 Solid Waste

Industrial Code No. CIIU3116 (processing of dry seeds) is the largest solid waste generator in Chinandega; solid waste from these industries is mainly non-hazardous organic materials. High potential hazardous waste generating industries which include 3512 (pesticides) are also located in Chinandega. However, solid waste generation is not high.

The amount of SW treated is 28% of the total generation amount: solid waste is mainly disposed of at the municipal landfill site without following any filling plan.

The present disposal method is considered as poor landfill management: at least separate filling of ISW and MSW is necessary.

6.4.4 Granada

a. Technical System

a.1 Wastewater

An estimated 1,045,000 tons/year of wastewater is generated in Granada. Out of this total, industries under code No. CIIU3523 (soaps, detergents, shampoos) generate 919,800 tons/year. Wastewater from CIIU3523 has a high pH value and contains fat, oil and sodium hydroxide etc. Also there are tanneries. Moreover, all industrial wastewater is disposed of into the environment (e.g., rivers) without treatment. Therefore industrial wastewater is a major water pollution source of public water bodies (e.g., rivers, Lake Nicaragua).

a.2 Solid Waste

Only thirty-two percent (32) of the total solid waste generation amount is treated; most of the amount is disposed of into the municipal landfill site without following any filling plan.

The present disposal method is considered as poor landfill management, at least separate filling of ISW and MSW is necessary.

6.5 Municipal SWM

6.5.1 National Aspects and Institutional System

a. Technical System

There are no technical guidelines that cover the whole country. Also the current waste collection and disposal system is dependent on: municipalities for things such as finance and personnel, volume and composition of waste, and weather and other factors. Therefore, a guideline for the waste collection and disposal system should be established based on careful consideration of these factors. As for locations of waste management facilities, a regulation that controls the location should be established immediately to avoid secondary contamination. Especially, as the problems of the landfills in the three cities were confirmed, (e.g., contamination of surrounding areas) strict controls on the location of landfills are one of the important matters to be solved.

b. Institutional System

Law Nº 217-96 classifies the municipal responsibility on non-hazardous SW only, while MARENA and MINSA supervise hazardous waste, which is the responsibility of the generators (not yet completely defined).

The responsibility of municipalities on MSWM is expressed in Law Nº 40-88 and the Municipal Tributary Plan prestates a specific tax that should recover at least 50% of the services costs.

Although the taxes are generally lower, most the beneficiaries do not pay them because they are either unemployed or are on low income, or because the services are not satisfactory.

Furthermore, the collection method is expensive, unproductive, and biased.

Also, the classification of customers in order to set the taxes, relies too heavily on the the collector or inspector's discretion. Hopefully, the new cadastre will improve this condition.

The improvement of the services is also hindered by the lack of social interaction among communities. The tax system should be redesigned, considering income levels, services offered and their running costs.

6.5.2 Leon

a. Technical System

With the exclusion of the landfill site and regardless of its limited equipment, the MSWM in Leon City is carried out appropriately.

The collection of waste is carried out well despite the lack of equipment, as can be seen from the collection service coverage rate of 88.7%. The collection service has to be strengthened, however, in view of the frequently observed illegal dumping of waste (6.5 tons/day) in the city: a considerable number of people (58%) who answered in the Public Opinion Survey said that solid waste problems significantly affect their daily life, hence they lack respect for the waste collection service.

The present landfill condition is bad. The landfill site deteriorates the value of the hill as a tourist spot as the area is only used as an open dump site. It is feared that waste causes secondary contamination of the arable land down the hill. Furthermore, the waste dumped in this site can be seen everywhere in the city, lowering the dignity of the citizens.

Consequently, the first priority problem to be solved is the landfill. The development of an appropriate new landfill has to be done immediately.

6.5.3 Chinandega

a. Technical System

With the exclusion of the landfill site and regardless of its limited equipment, the MSWM in Chinandega City is carried out appropriately.

The collection of waste is carried out well despite the lack of the equipment, as can be seen from the collection service coverage rate of 78.4%. The collection service has to be strengthened, however, in view of the frequently observed illegal dumping of waste (9.2 tons/day) in the city: some people (28%) who answered in the Public Opinion Survey said that solid waste problems significantly affects their daily life and are dissatisfied with the service.

The present landfill site condition is bad. The landfill is located on the left bank of the Acome River. It does not function as a landfill site, but as an open dump site. It is obvious that the scattering of waste causes secondary contamination of the Acome River and its tributaries.

Consequently, the first priority problem to be solved is the landfill. The development an appropriate new landfill has to be done immediately.

6.5.4 Granada

a. Technical System

With the exclusion of the landfill site and regardless of its limited equipment, the MSWM in Granada City is carried out appropriately.

The collection of waste is carried out well despite the lack of the equipment, as can be seen from the collection service coverage rate of 82.2%. The collection service has to be strengthened, however, in view of the frequently observed illegal dumping of waste (6.7 tons/day) in the city: a considerable number of people (43%) who answered in the Public Opinion Survey said that solid waste problems significantly affects their daily life, hence, they lack respect for the waste collection service.

The workshop for the maintenance of the waste disposal equipment is in a bad state. There is little equipment and spare parts. The building is inadequate as a workshop, because it was originally built to be a market. Therefore, it is desirable to construct a new workshop or improve the existing one to make it more suitable as a maintenance shop.

The present landfill condition is the most serious problem. It is located next to the southernmost crater, which is one of three craters located north of the landfill. As stipulated in Chapter 4 of this report, leachate from the landfill may have been contaminating groundwater resources which is Granada's tap water source.

Consequently, the first priority problem to be solved is the landfill. The development of an appropriate new landfill has to be done immediately.

6.6 Medical SWM

6.6.1 National Aspects and Institutional System

a. Technical System

a.1. Formulation of "Medical Waste Management Plan" or establishment of a "Code of Practice"

There is neither a national or municipality planning guideline for planning medical waste management. There is also no "Code of Practice" for infectious/hazardous medical waste management. Therefore, infectious/hazardous medical wastes are collected by the municipal collection system without segregation. Although there is no report published giving evidence of contamination or infection from wastes, it is believed there are potential cases.

a.2. Cancellation of incinerator installation project in the whole country

EC had an incinerator installation project in principal cities in the whole of Nicaragua in 1994. This also included other Central American countries. However, it was canceled because of unfavorable results in the financial negotiations. Therefore, the central government has no plan regarding medical SWM to this date.

a.3. Education and Training

Education and training of medical workers is carried out either "only at the beginning of employment, as initiation training" or "never"

a.4. Hypodermic Needles Incineration Project in Chinandega

The municipality collects hypodermic needles, which are considered as one of the most infectious medical wastes, from two major medical institutions and incinerates them every two weeks in an open air pit in the corner of the municipal disposal site. This project has been promoted under the cooperation of a JICA volunteer program and the municipality. The future plan involves other infectious wastes, and institutions such as clinics, laboratories, pharmacies.

a.5. A Hospital construction project in Granada under a Japanese Government Grant Aid Scheme by JICA

JICA has started to construct a hospital in Granada. The details of the institution will be clarified in the next field survey.

a.6. Evaluation of National Medical SWM

The national level of medical SWM is evaluated as "poor", due to the absence of plans or "Code of Practice" for handling medical wastes. Medical SWM is left to the discretion of the medical institutions.

b. Institutional System

There are no specific regulations on hazardous or non-hazardous waste management. MINSA and MARENA are responsible for establishing these regulations.

However, the municipality should also establish rules because it is in charge of the collection/disposal services, and should charge the customers for these services.

Some technical procedures should be designed and gradually implemented, such as segregation and internal management (before collection), as well as landfilling, and further thermal treatment.

6.6.2 Leon

The present medical SWM in Leon is evaluated as "poor" because of incomplete segregation, mixed collection, irregular collection, insufficient training of medical workers, etc.

6.6.3 Chinandega

The technical system of the medical SWM system in Chinandega is evaluated as "fair". Although the conditions are similar to the other two cities, the municipality has started a project to incinerate hypodermic needles from 2 medical institutions in a pit at a corner of the municipal landfill site, with the cooperation of a JICA volunteer.

The project involves a future plan to accommodate other types of wastes for incineration and increase the number of service medical institutions.

6.6.4 Granada

The technical system of the medical SWM system in Granada is evaluated as "poor", and there are no improvement plans to date. The medical SWM system of the hospital being constructed under the Japanese Grant Aid Program will have an impact on the present medical SWM system of other medical institutions.

CHAPTER 7

Selection of a First Priority City

7 Selection of a First Priority City

7.1 Criteria for Selection of a First Priority City

7.1.1 Requirements for a First Priority City

The purposes of selecting a first priority city are:

- to concentrate the limited resources and time of the Study into one city (of the three geographically separate cities) in order to formulate both an M/P and F/S. This is in order to achieve an effective outcome, and at the same time support the Japanese government's grant aid policy, which promotes self-sufficiency of recipient countries.
- To formulate conceptual M/Ps for the other 2 cities to a certain level to encourage self-sufficiency so that the M/P and F/S can be formulated and introduced by the cities.

In other words, even if the formulation of an M/P and execution of an F/S are limited to the first priority city, the Study should contribute to the improvement of the USE in the three cities; an essential objective of the Study.

In view of the purposes mentioned above, **the first priority city (FPC) should be a city that absolutely needs the formulation of (among the 3 cities) an M/P for USE improvement by the Study.** In other words, the two other cities should have the capability and/or support available to formulate M/Ps by themselves based on the conceptual M/Ps to be prepared by the Team.

Formulating the M/P for the FPC would result in reaping potential **benefits** that are realized only when related projects are implemented. In this context, therefore, and in view of aiming to achieve effective results, the FPC should be a city that would gain the highest predicted benefits in the following areas:

1. **Economic benefits:** e.g., prevention of future cost generated to counteract urban pollution, and/or indirect benefits (i.e., benefits of sectors other than USE).
2. **Social benefits:** contribution toward social equality and justice e.g., updating the social welfare system to protect vulnerable people (e.g., absolute poor, women), improved public health benefits, etc.

Although the formulation of an M/P would result in potential benefits, it would only be achieved if the M/P is actually implemented step by step in each project. Therefore, the FPC should at least be able to maintain a certain level of **capability** in implementing the projects.

7.1.2 Evaluation Items

Based on the above-mentioned requirements for the FPC, 4 principal evaluation items, that the selection is based on, are summarized below.

1. Necessity for formulating an M/P.

2. Economic benefits expected.
3. Social welfare contribution.
4. Capability to implement associated projects.

The 4 "principal evaluation items" are classified by "key evaluation components", that are described in the "detailed evaluation elements". The structure of evaluation is summarized in the table below.

Table 7-1: Structure of Evaluation for the Selection of a First Priority City

Principal Evaluation Items	Key Evaluation Components	Detailed Evaluation Elements
Necessity for formulating an M/P	1. Urgent needs in improvement of USE (seriousness of current outstanding problems)	1. Contamination of drinking water and surface/ground water, inundation, public nuisance (offensive odor, etc.), adverse impacts on fishery/agriculture, landscape, tourism, fauna/flora, needs expressed by citizens.
	2. Absence of plans	2.1 City development M/P 2.2 Water supply sector 2.3 Sewage sector (sewerage and other DWW, industrial wastewater, stormwater management) 2.4 SWM sector (municipal, industrial and medical SWM)
	3. Problems caused by the absence of the plans	3.1 Problems due to the absence of industrial wastewater management plan 3.2 Problems due to the absence of stormwater management plan 3.3 Problems due to the absence of SWM plans
	4. Planning deficiency	4.1 Lack of resource for municipal planning (manpower and budget of planning department) 4.2 External assistance in planning (foreign and institutional assistance)
Economic Benefits expected	1. Economic benefits expected on USE sectors 2. Economic benefits expected on other than USE sectors	1.1 Prevention of future costs for counteracting urban pollution (contamination of drinking water and surface/ground water, inundation, public nuisance) 2.1 Preventing destruction of resources (fishery/agriculture, landscape, tourism, fauna/flora)
Social Welfare Contribution	1. Social equity	1.1 Coverage rate of water supply, sewerage, toilets, refuse collection and stormwater drainage 1.2 Foreign aid and subsidy from central government per capita 1.3 USE expenditures for each sector per capita 1.4 Benefits for vulnerable people (GDP, unemployed rate, etc.)
	2. Health indicators	2.1 Neonatal and maternal mortality rate 2.2 Morbidity/mortality rate of major epidemics 2.3 Poor health caused by inadequate USE facilities
Capability to Implement Associated Projects	1. Financial capability of the executing body and citizens	1.1 Financial capability of the executing body (budgets, etc.) 1.2 Financial capability of citizens (tax payment, willingness to pay according to the POS)
	2. Administrative capability for implementation	2.1 Administrative capability of the municipality 2.2 Administrative capability for receiving foreign/domestic assistance

7.1.3 Weighted Evaluation

a. Principal Evaluation Items

The evaluation of each detailed element was based on a given weighting system. The points for each detailed evaluation element were decided depending upon availability of data for evaluation. At the meeting held during the P/R (1), the Team proposed the weighting system below, which was approved by the Nicaraguan side, for the 4 principal evaluation items.

Necessity for formulating an M/P:	50
Economic benefits expected:	20
Social welfare contribution:	20
Capability to implement associated projects:	10
Total:	**100**

The reasons for selecting the weighting system are described below.

1. **Necessity for formulating an M/P** is an essential and primary requirement for the first priority city (FPC). In other words, the FPC was selected by evaluating its needs for an M/P, instead of evaluating the M/P.

2. At the selection stage it was not known whether which sectors and/or projects would be derived from the M/P, therefore, the estimation of **economic benefits expected** and **social welfare contribution** from projects were conditional and subject to many assumptions. Therefore, it was unreasonable to place a large emphasis on conditional benefits expected.

3. The Team placed the same weight on both "economic benefits expected" and "social welfare contribution".

4. The Team judged that the "**capability to implement associated projects**" should receive a smaller weight than "economic benefits expected" or "social welfare contribution". The reason being that the evaluation item (capability to implement associated projects) is contradictory to the 1st evaluation item (necessity for formulating an M/P). In other words, cities that have the **capability to implement associated projects** should be able to formulate M/Ps by themselves based on the conceptual M/Ps prepared by the Team.

b. Point Allocation for the Detailed Evaluation Elements

Points given were either 0, 1, or 2, in accordance with the criteria set up for each "detailed evaluation element".

7.2 Selection of a First Priority City

7.2.1 Evaluation Principles

Where various authorities are interrelated and involved with USE improvement plans, one evaluation method would be to assess the M/P as a composite of all their views. However, the aim of the M/P is to improve USE in the selected city, even though the M/P is related to several sectors that other authorities are in charge of. Therefore, this evaluation examines the comparative situation of the 3 cities.

Meanwhile, the data and information on which this evaluation is based were obtained by the Team during the First Work in Nicaragua (i.e., data and information presented in Progress Report (I) and related comments by the counterpart).

Furthermore, the evaluation items were not intended to cover all aspects of the situation in the 3 cities, but was limited so far as to what is related to USE in the 3 cities.

7.2.2 Outcome of the Evaluation

The outcome of the evaluation was analyzed in the following 3 cases, where each case assumed different weighting.

Case-1	Point weighting was as stated in Progress Report (I): necessity for formulating an M/P (50 points), economic benefits expected (20 points), social welfare contribution (20 points), and capability to implement associated projects (10 points).
Case-2	The four principal evaluation items received equal weighting i.e.: necessity for formulating an M/P (25 points), economic benefits expected (25 points), social welfare contribution (25 points), and capability to implement associated projects (25 points).
Case-3	Without weighting principal evaluation items, all "detailed evaluation elements" received the same weighting.

a. Case-1

The results of the Case-1 analysis are shown in Table 7-2 and Figure 7-1. As shown in the table, Granada is ranked top with 71.9 points, followed by Chinandega with 60.9 points, and Leon with 56.3 points.

b. Case-2

The results of the Case-2 analysis are shown in Table 7-3 and Figure 7-2. As shown in the table, Granada is ranked top with 65.7 points, followed by Leon with 59.0 points, and Chinandega with 55.3 points.

c. Case-3

As shown in Table 7-4, even when the weighting of the 4 principal evaluation items is eliminated and detailed evaluation items receive the same weighting, the results are: Granada 82 points, Chinandega 71 points, and Leon 64 points.

With the above evaluation analyses results, the Team proposed that Granada should be selected as the first priority city of the Study.

Table 7-2: Outcome of Evaluation (Case - 1)

Detailed Evaluation Elements	Results of Evaluation		
	Leon	Chinandega	Granada
a. Necessity for formulating an M/P			
1. Urgent Needs in Improvement of USE			
1.1 Contamination of drinking water	1	1	2
1.2 Contamination of surface water	2	2	2
1.3 Contamination of ground water	2	2	2
1.4 Inundation	1	2	1
1.5 Public nuisance (offensive odor, etc.)	2	2	2
1.6 Adverse impacts on fishery and agriculture	1	1	1
1.7 Aesthetic degradation	2	2	2
1.8 Adverse impacts on tourism	1	1	1
1.9 Adverse impacts on fauna/flora	0	0	2
1.10 Needs expressed by citizens	1	1	1
2. Absence of Plans			
2.1 City development M/P	0	2	2
2.2 Water supply system plan	0	0	0
2.3 Sewerage system improvement plan	0	0	0
2.4 Industrial wastewater management plan	1	2	2
2.5 Stormwater management plan	2	2	2
2.6 Municipal SWM plan	1	1	0
2.7 Industrial SWM plan	2	2	2
2.8 Medical SWM plan	2	1	2
3. Problems caused by Absence of Plans			
3.1 Due to absence of industrial wastewater management plan	1	2	2
3.2 Due to absence of stormwater management plan	1	2	1
3.3 Due to absence of municipal SWM plan	2	2	2
3.4 Due to absence of industrial SWM plan	2	2	2
3.5 Due to absence of medical SWM plan	2	1	2
4. Planning Deficiency			
4.1 Planning capability of the municipality (1)	1	0	2
4.2 Planning capability of the municipality (2)	0	2	1
4.3 External assistance in planning (1)	1	1	2
4.4 External assistance in planning (2)	0	1	2
sub-total	31	37	42
50 weighted points	28.7	34.3	38.9
b. Economic Benefits Expected			
1. Economic Benefits Expected in USE Sectors			
1.1 Prevention of drinking water contamination (municipal level)	1	1	2
1.2 Prevention of drinking water contamination (regional level)	0	0	2
1.3 Prevention of surface water contamination	1	1	2
1.4 Prevention of ground water contamination	2	2	2
1.5 Prevention of inundation	1	2	1
1.6 Prevention of public nuisance	2	2	2
2. Economic Benefits Expected in Sectors other than USE			
2.1 Prevention of adverse impacts on fishery and agriculture	2	2	2
2.2 Prevention of aesthetic degradation	2	2	2
2.3 Prevention of adverse impacts on tourism	1	0	2
2.4 Prevention of adverse impacts on fauna/flora	0	0	2
sub-total	12	12	19

Detailed Evaluation Elements	Results of Evaluation		
	Leon	Chinandega	Granada
20 weighted points	12	12	19
c. Social Welfare Contribution			
1.Contribution to Social Equity			
1.1 Coverage rate of the water supply system	0	2	1
1.2 Coverage rate of the sewer system	0	1	2
1.3 Toilet per capita	0	1	2
1.4 Coverage rate of refuse collection service	0	2	1
1.5 Coverage rate of stormwater drainage	1	2	0
1.6 Amount of foreign aid per capita	0	2	1
1.7 Amount of subsidy from central government per capita	1	0	2
1.8 Expenditure for water supply system improvement (per capita)	1	2	0
1.9 Expenditure for sewerage system improvement per capita	0	1	2
1.10 Expenditure for SWM per capita	1	2	0
1.11 GRDP	2	0	1
1.12 Unemployment rate	2	0	1
2. Contribution to the Improvement of Public Health			
2.1 Maternal death rate	1	0	2
2.2 Neonatal death rate	2	0	1
2.3 Morbidity rate by major epidemic diseases	2	1	0
2.4 Mortality rate by major epidemic diseases	0	2	1
2.5 Poor health caused by inadequate USE facilities	0	0	0
sub-total	13	18	17
20 weighted points	7.6	10.6	10
d. Capability to Implement Associated Projects			
1. Financial Capability of the Executing Body and Citizens			
1.1 Financial capability of the municipality	2	0	1
1.2 Financial capability of citizens (1)	0	1	2
1.3 Financial capability of citizens (2)	2	1	1
2. Administrative Implementation Capability			
2.1 Administrative capability of municipal staff	2	1	0
2.2 Groundwork to receive foreign/domestic assistance	2	1	0
sub-total	8	4	4
10 weighted points	8	4	4
Grand Total	64	71	82
50,20,20,10 weighted point	56.3	60.9	71.9

Principal Evaluation Items	Leon	Chinandega	Granada
a. Necessity for Formulating an M/P	28.7	34.3	38.9
b. Economic Benefits Expected	12	12	19
c. Social Welfare Contribution	7.6	10.6	10
d. Capability to Implement Associated Projects	8	4	4
Total	56.3	60.9	71.9

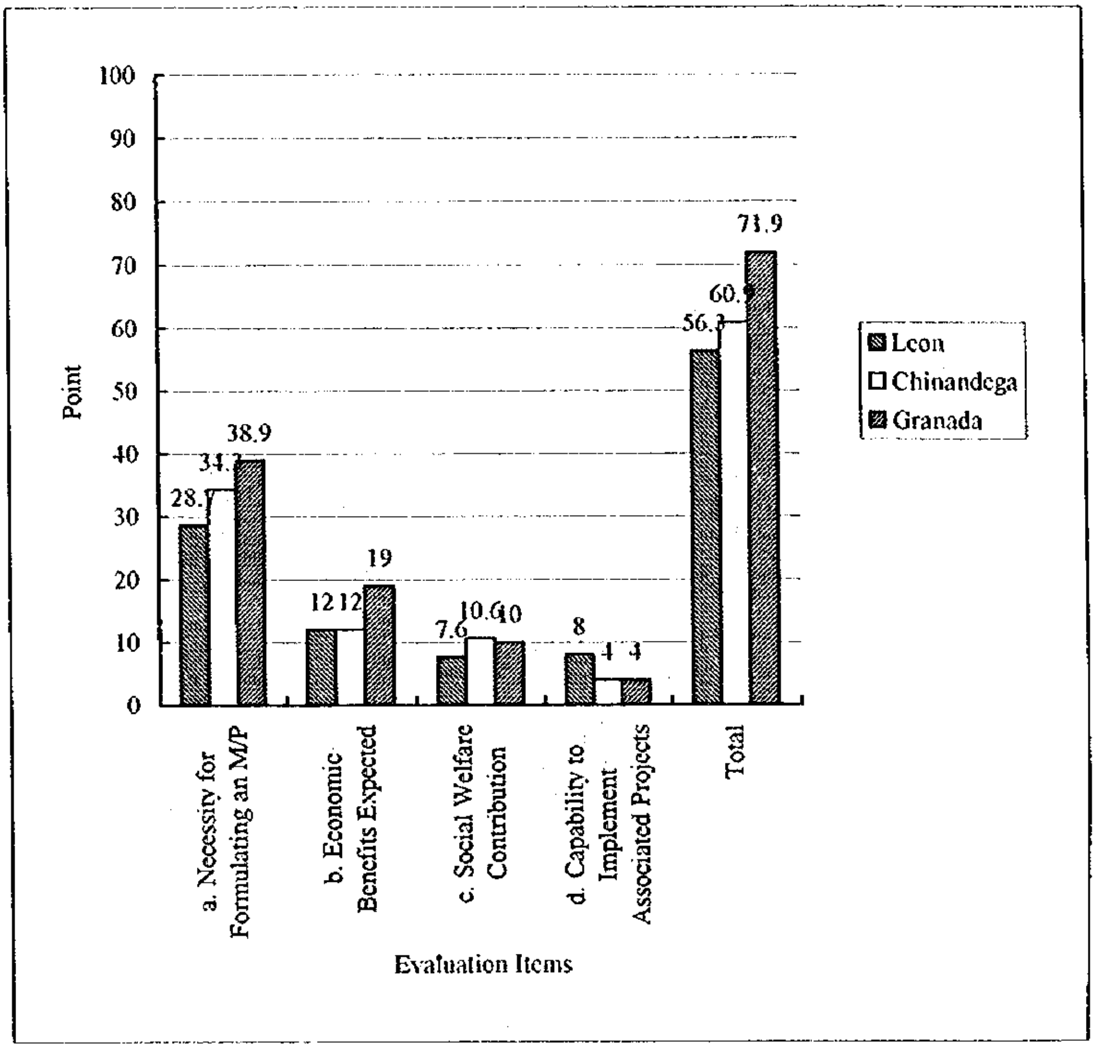

Figure 7-1: Outcome of Evaluation (Case - 1)

Table 7-3: Outcome of Evaluation (Case - 2)

Detailed Evaluation Elements	Results of Evaluation		
	Leon	Chinandega	Granada
a. Necessity for Formulating an M/P			
1. Urgent Needs in Improvement of USE			
1.1 Contamination of drinking water	1	1	2
1.2 Contamination of surface water	2	2	2
1.3 Contamination of ground water	2	2	2
1.4 Inundation	1	2	1
1.5 Public nuisance (offensive odor, etc.)	2	2	2
1.6 Adverse impacts on fishery and agriculture	1	1	1
1.7 Aesthetic degradation	2	2	2
1.8 Adverse impacts on tourism	1	1	1
1.9 Adverse impacts on fauna/flora	0	0	2
1.10 Needs expressed by citizens	1	1	1
2. Absence of Plans			
2.1 City development M/P	0	2	2
2.2 Water supply system plan	0	0	0
2.3 Sewerage system improvement plan	0	0	0
2.4 Industrial wastewater management plan	1	2	2
2.5 Stormwater management plan	2	2	2
2.6 Municipal SWM plan	1	1	0
2.7 Industrial SWM plan	2	2	2
2.8 Medical SWM plan	2	1	2
3. Problems caused by Absence of Plans			
3.1 Due to absence of industrial wastewater management plan	1	2	2
3.2 Due to absence of stormwater management plan	1	2	1
3.3 Due to absence of municipal SWM plan	2	2	2
3.4 Due to absence of industrial SWM plan	2	2	2
3.5 Due to absence of medical SWM plan	2	1	2
4. Planning Deficiency			
4.1 Planning capability of the municipality (1)	1	0	2
4.2 Planning capability of the municipality (2)	0	2	1
4.3 External assistance in planning (1)	1	1	2
4.4 External assistance in planning (2)	0	1	2
sub-total	31	37	42
25 weighted points	14.4	17.1	19.4
b. Economic Benefits Expected			
1. Economic Benefits Expected in USE Sectors			
1.1 Prevention of drinking water contamination (municipal level)	1	1	2
1.2 Prevention of drinking water contamination (regional level)	0	0	2
1.3 Prevention of surface water contamination	1	1	2
1.4 Prevention of ground water contamination	2	2	2
1.5 Prevention of inundation	1	2	1
1.6 Prevention of public nuisance	2	2	2
2. Economic Benefits Expected in Sectors other than USE			
2.1 Prevention of adverse impacts on fishery and agriculture	2	2	2
2.2 Prevention of aesthetic degradation	2	2	2
2.3 Prevention of adverse impacts on tourism	1	0	2
2.4 Prevention of adverse impacts on fauna/flora	0	0	2
sub-total	12	12	19

Detailed Evaluation Elements	Results of Evaluation		
	Leon	Chinandega	Granada
25 weighted points	15	15	23.8
c. Social Welfare Contribution			
1. Contribution to Social Equity			
1.1 Coverage rate of the water supply system	0	2	1
1.2 Coverage rate of the sewer system	0	1	2
1.3 Toilets per capita	0	1	2
1.4 Coverage rate of refuse collection service	0	2	1
1.5 Coverage rate of stormwater drainage	1	2	0
1.6 Amount of foreign aid per capita	0	2	1
1.7 Amount of subsidy from central government per capita	1	0	2
1.8 Expenditure for water supply system improvement (per capita)	1	2	0
1.9 Expenditure for sewerage system improvement per capita	0	1	2
1.10 Expenditure for SWM per capita	1	2	0
1.11 GRDP	2	0	1
1.12 Unemployment rate	2	0	1
2. Contribution to the Improvement of Public Health			
2.1 Maternal death rate	1	0	2
2.2 Neonatal death rate	2	0	1
2.3 Morbidity rate by major epidemic diseases	2	1	0
2.4 Mortality rate by major epidemic diseases	0	2	1
2.5 Poor health caused by inadequate USE facilities	0	0	0
sub-total	13	18	17
25 weighted points	9.6	13.2	12.5
d. Capability to Implement Associated Projects			
1. Financial Capability of the Executing Body and Citizens			
1.1 Financial capability of the municipality	2	0	1
1.2 Financial capability of citizens (1)	0	1	2
1.3 Financial capability of citizens (2)	2	1	1
2. Administrative Implementation Capability			
2.1 Administrative capability of municipal staff	2	1	0
2.2 Groundwork to receive foreign/domestic assistance	2	1	0
sub-total	8	4	4
25 weighted points	20	10	10
Grand Total	64	71	82
25 weighted points	59	55.3	65.7

Principal Evaluation Items	Leon	Chinandega	Granada
a. Necessity for Formulating an M/P	14.4	17.1	19.4
b. Economic Benefits Expected	15	15	23.8
c. Social Welfare Contribution	9.6	13.2	12.5
d. Capability to Implement Associated Projects	20	10	10
Total	59	55.3	65.7

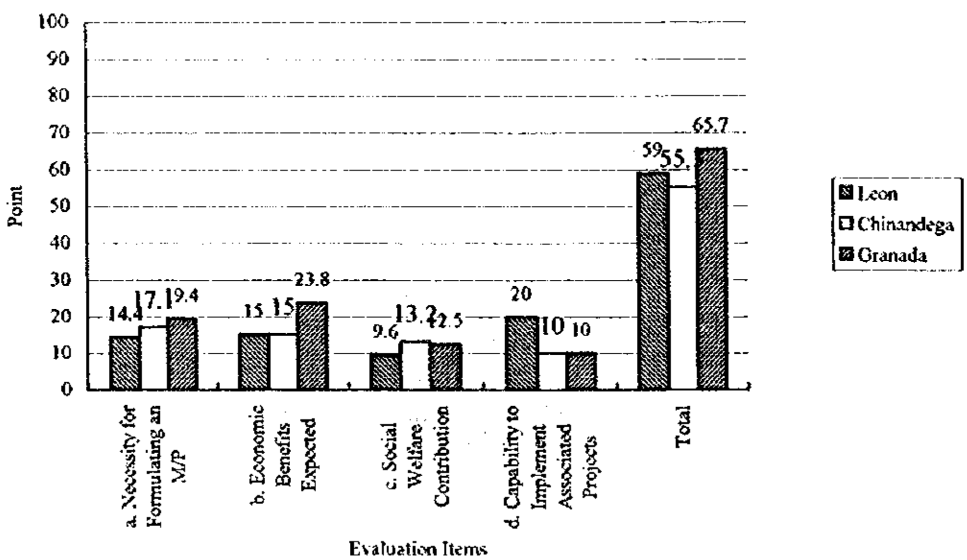

Figure 7-2: Outcome of Evaluation (Case - 2)

Table 7-4: Outcome of Evaluation (Case - 3)

Detailed Evaluation Elements	Results of Evaluation		
	Leon	Chinandega	Granada
a. Necessity for Formulating an M/P			
1. Urgent Needs in Improvement of USE			
1.1 Contamination of drinking water	1	1	2
1.2 Contamination of surface water	2	2	2
1.3 Contamination of ground water	2	2	2
1.4 Inundation	1	2	1
1.5 Public nuisance (offensive odor, etc.)	2	2	2
1.6 Adverse impacts on fishery and agriculture	1	1	1
1.7 Aesthetic degradation	2	2	2
1.8 Adverse impacts on tourism	1	1	1
1.9 Adverse impacts on fauna/flora	0	0	2
1.10 Needs expressed by citizens	1	1	1
2. Absence of Plans			
2.1 City development M/P	0	2	2
2.2 Water supply system plan	0	0	0
2.3 Sewerage system improvement plan	0	0	0
2.4 Industrial wastewater management plan	1	2	2
2.5 Stormwater management plan	2	2	2
2.6 Municipal SWM plan	1	1	0
2.7 Industrial SWM plan	2	2	2
2.8 Medical SWM plan	2	1	2
3. Problems caused by Absence of Plans			
3.1 Due to absence of industrial wastewater management plan	1	2	2
3.2 Due to absence of stormwater management plan	1	2	1
3.3 Due to absence of municipal SWM plan	2	2	2
3.4 Due to absence of industrial SWM plan	2	2	2
3.5 Due to absence of medical SWM plan	2	1	2
4. Planning Deficiency			
4.1 Planning capability of the municipality (1)	1	0	2
4.2 Planning capability of the municipality (2)	0	2	1
4.3 External assistance in planning (1)	1	1	2
4.4 External assistance in planning (2)	0	1	2
sub-total	31	37	42
b. Economic Benefits Expected			
1. Economic Benefits Expected in USE Sectors			
1.1 Prevention of drinking water contamination (municipal level)	1	1	2
1.2 Prevention of drinking water contamination (regional level)	0	0	2
1.3 Prevention of surface water contamination	1	1	2
1.4 Prevention of ground water contamination	2	2	2
1.5 Prevention of inundation	1	2	1
1.6 Prevention of public nuisance	2	2	2
2. Economic Benefits Expected in Sectors other than USE			
2.1 Prevention of adverse impacts on fishery and agriculture	2	2	2
2.2 Prevention of aesthetic degradation	2	2	2
2.3 Prevention of adverse impacts on tourism	1	0	2
2.4 Prevention of adverse impacts on fauna/flora	0	0	2
sub-total	12	12	19

Detailed Evaluation Elements	Results of Evaluation		
	Leon	Chinandega	Granada
c. Social Welfare Contribution			
1. Contribution to Social Equity			
1.1 Coverage rate of the water supply system	0	2	1
1.2 Coverage rate of the sewer system	0	1	2
1.3 Toilet per capita	0	1	2
1.4 Coverage rate of refuse collection service	0	2	1
1.5 Coverage rate of stormwater drainage	1	2	0
1.6 Amount of foreign aid per capita	0	2	1
1.7 Amount of subsidy from central government per capita	1	0	2
1.8 Expenditure for water supply system improvement (per capita)	1	2	0
1.9 Expenditure for sewerage system improvement per capita	0	1	2
1.10 Expenditure for SWM per capita	1	2	0
1.11 GRDP	2	0	1
1.12 Unemployment rate	2	0	1
2. Contribution to the Improvement of Public Health			
2.1 Maternal death rate	1	0	2
2.2 Neonatal death rate	2	0	1
2.3 Morbidity rate by major epidemic diseases	2	1	0
2.4 Mortality rate by major epidemic diseases	0	2	1
2.5 Poor health caused by inadequate USE facilities	0	0	0
sub-total	13	18	17
d. Capability to Implement Associated Projects			
1. Financial Capability of the Executing Body and Citizens			
1.1 Financial capability of municipality	2	0	1
1.2 Financial capability of citizens (1)	0	1	2
1.3 Financial capability of citizens (2)	2	1	1
2. Administrative Implementation Capability			
2.1 Administrative capability of municipal staff	2	1	0
2.2 Groundwork to receive foreign/domestic assistance	2	1	0
sub-total	8	4	4
Grand Total	64	71	82

Principal Evaluation Items	Leon	Chinandega	Granada
a. Necessity for Formulating an M/P	31	37	42
b. Economic Benefits Expected	12	12	19
c. Social Welfare Contribution	13	18	17
d. Capability to Implement Associated Projects	8	4	4
Total	64	71	82

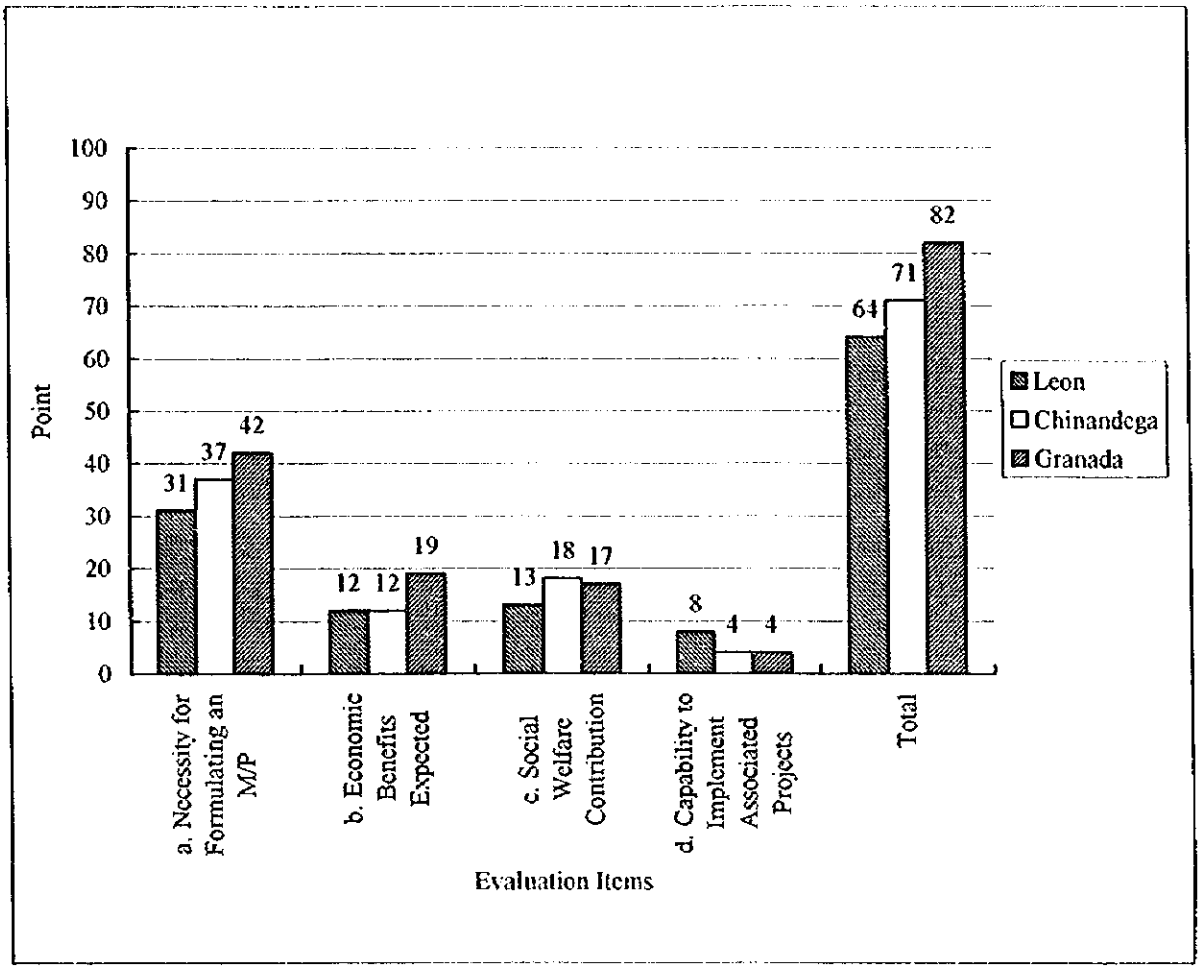

Figure 7-3: Outcome of Evaluation (Case - 3)

7.2.3 Requirements for the Selected First Priority City

Aiming to select a city which absolutely needs the formulation of a USE M/P, the Team proposed Granada to be the FPC. Granada being the FPC means that the city, in comparison to other 2 cities, requires the most support from the Team in formulating plans, improving administration and consolidating implementation capabilities.

CHAPTER 8

Outline of the Works for the M/P and the Conceptual M/Ps

8 Outline of the Works for the M/P and the Conceptual M/Ps

The USE M/P for FPC and the Conceptual M/P for the other 2 cities were formulated within a 5 month period from January to May of 1997. Because USE covers various fields, e.g., water supply, wastewater, SWM, the formulation of the plans required smoothly conducted investigations. Accordingly, along with the differences in the M/P and Conceptual M/P, the following planning frameworks were defined for the Study Team and the Nicaraguan side to mutually agree on the details of the works involved.

- frameworks necessary for respective M/P and conceptual M/Ps; and.
- the differences in works for a M/P and conceptual M/Ps formulation.

8.1 Target Year and Population

a. Target Year

In accordance with the S/W, the target years are set up as follows:

Master Plan: Year 2010
Feasibility Study: Year 2005

b. Population

The population forecasts available are: those adopted in INAA's plans[1] for the 3 cities, and the population forecast for Leon in the "Structural Master Plan" for the city. The difference in forecast population between those two plans for Leon is quite small. Therefore, the Team employed INAA's population forecast as the Study's population forecast as outlined in the table below.

Table 8-1: Future Population Forecast

	Population			
Year	1995	2000	2005	2010
Leon	123,865	183,519	213,156	245,421
Chinandega	97,387	115,393	133,753	153,444
Granada	71,783	105,341	125,597	148,374

8.2 Economic Conditions

Economic growth rate in Nicaragua is assumed as follows.

The World Bank forecasts the average around growth rate (between year 1996 to 2005) for Latin American and Caribbean countries to be 3.8%. On the other hand, the

[1] Estudio de Priorización de Inversiones en el Sector de Agua Potable y Alcantarillado Sanitario, Estudio de Prefactibilidad, INAA, Marzo 1996

Nicaraguan government raises the targets for economic development in the "Plan Nacional de Desarrollo Sostenible 1996 -2000" as follows:

- Year 1996 - 1997: 4.5% real growth rate, and
- Year 1998 - 2000: 6 to 7% real growth rate.

The central bank of Nicaragua estimated in June 1996 that real economic growth rate for the year 1996 will be 5%. Because actual values usually exceed the estimate, the Study forecasts the annual economic growth rate as follows:

- **Year 1996 - 1997**: **5%**, referring to the central bank forecast;
- **Year 1998 - 2000**: **6%**, referring to the lower target of the government plan;
- **Year 2001 - 2005**: **5%**, assuming that the growth rate will fall close to 3.8%/year, which is the average growth rate in Latin American countries;
- **Year 2006 - 2010**: **3.8%**, adopting the average growth rate of Latin American countries.

8.3 Water Supply Management

Although certain problems in the water supply management of the 3 cities prevail, most of those problems could be solved, if projects are implemented along with the plans of INAA. Therefore, the planning framework of the Study for "water supply management", was basically in accordance with INAA's plans.

8.4 Domestic Wastewater Management (DWWM)

The M/P for the First Priority City and the Conceptual M/P for the other two cities was be formulated in Phase II, based on the results of the investigations in Phase I.

The works for the formulation of M/P and the Conceptual M/P for DWWM are outlined in the table below.

Table 8-2: Outline of the Works for the M/P and the Conceptual M/P for DWWM

<table>
<tr><th rowspan="2">Stage</th><th colspan="2">Outline of the Works</th></tr>
<tr><th>M/P</th><th>Conceptual M/P</th></tr>
<tr><td rowspan="6">2nd Work in Nicaragua

P/R(2)</td><td colspan="2">I. Setting up the Planning Framework</td></tr>
<tr><td>II. Investigation for Site Selection</td><td>———</td></tr>
<tr><td colspan="2">III. Methods and Target Establishment for Improving Domestic Wastewater Treatment/Disposal
1.defining areas to be covered by sewer by 2010
2.defining areas to be covered by sewer after 2010
3.defining areas that non-sewer systems to be introduced.
4.clarifying measures for improving DWWM in each area, then classifying the areas according to their urgency of improvement</td></tr>
<tr><td colspan="2">IV. Examination of Technical System
1.DWW treatment/disposal
2.sewer system (off-site treatment/disposal)
3.non-sewer system (on-site treatment/disposal)
4.sludge collection and treatment/disposal</td></tr>
<tr><td colspan="2">V. Examination of Step-wise Improvement in DWWM</td></tr>
<tr><td>VI. Examination of Localization of Major Facilities
VII. Selection of an Optimum Technical System
VIII. Examination of Principles for Operation and Maintenance
IX. Examination of an Optimum Institutional System
X. Formulation of Implementation Plans
XI. Examination of Pilot Project(s)</td><td>———</td></tr>
<tr><td>2nd Work in Japan

IT/R(2)</td><td>XII. Preliminary Design of Facilities
XIII. Cost Estimation for M/P
XIV. Examination of Financial Plan
XV. Evaluation of M/P</td><td>———</td></tr>
<tr><td colspan="3">↓</td></tr>
<tr><td>Phase III</td><td>Feasibility Study</td><td>———</td></tr>
</table>

8.5 Industrial Wastewater Management (IWWM)

Nicaragua does not have an institutional framework for the comprehensive management of industrial wastewater. Government authorities are not fully aware of the conditions that currently affect industrial waste generation and disposal. To identify and grasp these conditions, the Team conducted questionnaire surveys in factories.

The generation of industrial wastes, including industrial wastewater, is largely influenced by the industrial structure, economic trends and market demands. To forecast future industrial waste generation, a set of comprehensive data was gathered to estimate future economic trends. And the extrapolation necessary to estimate future generation required a significant amount of time because of the complex nature of the work.

The treatment and disposal of industrial waste (including industrial wastewater) are the responsibilities of the waste generator (i.e., factories). Wastes should be treated and disposal of appropriately in accordance with relevant legislation. Due to time constraints the study did not forecast future ISW, although it recommends several industrial waste management measures to be implemented by both government authorities and the generators.

8.6 Stormwater Management

The inundation prone areas surveyed are basically classified as shown below.

Table 8-3: 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 downstream of larger catchment areas	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 countermeasures against each type of inundation are shown below.

[Classification: 1.1]

An integrated river system management plan (including a reforestation plan, a drainage basin improvement plan, etc.) would be an ideal countermeasure for the areas classified herewith. However, it would be physically impossible to carry out such a countermeasure in this Study, as it requires considerable time and resources to acquire the voluminous basic data (e.g., rainfall, river regime, land use) for it.

[Classification: 1.2 and 2.2]

A stormwater drainage plan mainly consisting of a drainage basin plan (to determine the design rainfall, and the scale of drainage channels) would be ideal for areas classified under 1.2 and 2.2, and this work will be simpler than that of the integrated river system management plan. However, it would be impossible to conduct this countermeasure in this Study, because it requires certain basic data (e.g., detailed topographical maps) and a substantial amount of time. Currently the cities have no detailed topographic maps.

[Classification: 2.1]

Administrative measures such as prohibiting construction of houses in flood plains (i.e., riverside lands) or demanding people to leave from riverside lands, would be applicable for areas classified herewith.

With inundation damage as one of the major USE problems, in view of the limitation described above, the Team conducted the following works as a part of the Study for the 3 cities:

1. Identification of inundation prone areas, inundation damage and inundation causes.
2. Proposed countermeasures to mitigate inundation damage.
3. Indication of "planning processes" to improve stormwater management.

Besides the above items, the improvement of areas 1.2 (small drainage basin) and 2.2 (others) was carried out through the conduct of a pilot project in the FPC. The works involved \topographic survey, the results of which were used to produce the local drainage map, and consequently a drainage improvement plan for the pilot area.

8.7 Municipal Solid Waste Management

The M/P for the First Priority City and the Conceptual M/P for the other two cities were formulated in Phase II, based on the results of the investigations in Phase I and the WACS conducted in Phase II.

The works for the formulation of the M/P and the Conceptual M/P on Municipal SWM are outlined in the table below.

Table 8-4: Outline of the Works for the M/P and the Conceptual M/P on Municipal SWM

Stage	Outline of the Works	
	M/P	Conceptual M/P
2nd Work in Nicaragua	I. Setting up the Planning Framework	
	II. Investigation for Site Selection	————
	III. Examination of Institution System 1.Measures to strengthen organization and legislation 2.Measures to strengthen financial capability 3.Measures to strengthen public health education and community participation 4.Measures for waste generation minimization	
	IV. Examination of Technical System 1.Street sweeping 2.Discharge and storage 3.Collection and transportation 4.Intermediate treatment 5.Final disposal	
	V. Examination of Step-wise Improvement of Municipal SWM	
P/R(2)	VI. Examination of Localization of Major Facilities VII. Selection of an Optimum Technical System VIII. Examination of Principles for Operation and Maintenance IX. Examination of an Optimum Institutional System X. Formulation of Implementation Plans XI. Examination of Pilot Project(s)	————
2nd Work in Japan IT/R(2)	XII. Preliminary Design of Facilities XIII. Cost Estimation for M/P XIV. Examination of Financial Plan XV. Evaluation of M/P	————
	↓	
Phase III	Feasibility Study	————

8.8 Industrial Solid Waste Management (ISWM)

Based on the same reasons expressed in Section 8.5, ISWM generation in target years was not forecast, but the study recommended several measures on how to appropriately control ISW generation.

8.9 Medical Solid Waste Management

Questionnaire surveys for medical SWM, including medical wastewater management, were carried out in the 2nd Work in Nicaragua, to generally identify and understand the generation of medical SW (especially infectious waste).

Based on such survey results, medical SW generation in target years was estimated and the optimum technical and institutional systems for medical SWM were determined to enable the Nicaraguan side to: appropriately control, collect, treat and dispose medical waste.

CHAPTER 9

USE M/P for Granada

9 USE M/P for Granada

9.1 Planning Frameworks for a USE M/P

9.1.1 Goals, Targets and Strategies

a. Goals

The principal goal of the Master Plan for Granada is to improve the Urban Sanitation Environment (USE) of Granada City, by the target year 2010, where the population and major economic activities of Region IV are centered.

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

- **promote the citizens' well-being.**
- **support sustainable development of the city.**
- **contribute to regional economic growth.**

The goals 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., groundwater resources, Lake Nicaragua's water quality and ecology, etc.).
4. Encourage the public to be more environmentally aware.
5. Increase the provision of USE services (i.e., water supply, sewer system, SW collection, etc.) at affordable and appropriate levels.
6. Establishment of self-sustainable management systems for USE services.
7. Establishment of a "beneficiary-pays-principle" (BPP) under which recipients pay for the USE services.
8. Development and promotion of community participation in USE systems.
9. Adoption of satisfactory measures for the protection of environmental and public health in the operation and maintenance of USE facilities.
10. Prevention of pollution caused by industrial wastewater and solid waste.

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

12. Establishment of a coordination system for the city and national institutions concerning USE management.

b. Targets

In accordance with the S/W of the Study, the target years are set up as follows:

Master Plan: Year 2010

Feasibility Study: Year 2005

In order to achieve the principal goals, the target figures for the 3 major sectors that constitute USE were set as indicated in the table below.

Table 9-1: Target Figures for the Technical System in Granada

	Present (1995/96)	F/S (2005)	M/P (2010)
Water Supply Coverage	89.7 %	85 %	85 %
Domestic Wastewater System			
Off-site sewer system	21.9 %	38 %	55 %
On-site system	1.6 %	10 %	17 %
Soak pit system	37.5 %	24 %	13 %
Latrine only system	28.1 %	22 %	15 %
No system	10.9 %	6 %	0 %
Municipal SWM			
Coverage rate (waste amount)	82.0 %	90 %	100 %
Coverage rate (population)	63.0 %	89 %	100 %

Note: The INAA established a target water supply coverage rate of 85% of the whole urban population. The target figure is set up in accordance with the INAA's target. Consequently, the coverage rates for 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 attain the goals and targets should, in practice, be introduced step by step toward the target year 2010. Therefore, it is recommended to divide the period up to the target year into 3 phases.

Table 9-2: Strategies for the Realization of the USE Master Plan

Classification Phase	Technical Aspects	Institutional Aspects
Phase 1 **(1998 - 2000) Preparation for Priority Projects Implementation**	**Water Supply System** • The water supply system should be consolidated to maintain a 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 area with sewers, connection to sewer should be promoted and system improvement necessary for maintaining the present sewer coverage (21.9%) should be provided. • As for the non-sewer area, in order to prepare for "model communities integrated USE improvement" projects (PECM), public education programs should be encouraged to raise citizens' awareness of the environment. **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 through PECM. **Municipal SWM** • 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. 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	**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, which they should easily understand appropriate sanitary practices and civil procedures. • Urban development plan of the city (at least including the land use regulations) should be prepared. 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 coordinate to establish a steering committee for "Special Program for Model Community Integrated USE Improvement Project" (PECM) 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 coordinate to establish a steering committee for PECM 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 collection of municipal taxes and charges for the services.

	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.	**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 38%. • 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 10%. **Stormwater Management** • Drainage should be improved in accordance with Flood Damage Area Improvement Plan. • Integrated Arroyo Management Plan (comprising: land use regulation; catchment conservation with reforestation; and drainage channel improvement) should be formulated. • Rain drainage in UFA should be further improved through PECM.	**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 put in practice to guide and to restrict the land use, in order to maintain a preferable urban environment (e.g., protect potable water sources in southern part 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. **Stormwater Management** • Respective institutional system (e.g. funds, design guidelines) for macro- and micro-drainage should be established.

	Municipal SWM • Facilities and vehicles acquired in Phase-I 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.	• 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 55% of the population. • As for no sewer area, the on-site system should be consolidated to maintain target coverage of 17% of the population. • As for area served with "model communities integrated USE improvement" projects, self-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	**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 treatment projects, from water and wastewater charges collected. **Stormwater Management** • PECM steering committee should raise funds for constructing rain drainage

	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).	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.

9.1.2 Forecast on Future Demands for USE Services

The table below summarizes the forecast on future demands for respective USE sectors, as key indicators.

Table 9-3: Forecast on Future Demands for USE Services

Item	Present	(2000)	F/S (2005)	M/P (2010)
1. Area and Population	(year 1995)			
Area				
Total (km^2)	531	531	531	531
Projected Service Area (km^2)	14.3	14.3	14.3	14.3
Population				
Total	96,996	126,307	147,830	171,618
Projected Service Population	71,783	97,078	114,760	135,106
2. Water Supply System	(year 1995)			
Water supply coverage area	8.4 km^2	8.4 km^2	9.3 km^2	9.3 km^2
Supplied population	64,411	82,516	97,546	114,255
Coverage (of population)	89.7 %	85 %	85 %	85 %
Water production (m^3/year)	6,107,590	9,742,945	10,631,355	10,847,800
Water production rate (l/p/day)	259.8	324	299	260
Efficiency	57%	60 %	65%	75%
Water consumption (m^3/y)	3,454,251	5,845,840	6,910,545	8,135,850
Water consumption rate (l/p/day)	146.3	195 (160*)	195 (160*)	195 (160*)

Item	Present	(2000)	F/S (2005)	M/P (2010)
3. Domestic Wastewater System	(year 1995)			
3.1. Areas with sewers				
Service area	2.0 km²	2.0 km²	3.7 km²	5.6 km²
Service population	15,706	21,260	44,125	74,266
Coverage (population)	21.9 %	21.9 %	38.5 %	55%
Treated amount (m^3/day)	2,592	3,402	7,060	11,883
3.2 Areas without sewers				
On-site system	1,122 persons	1,553 persons	11,555 persons	23,110 persons
	1.6%	1.6%	10.1 %	17.1%
Soak pit system (sumidero)	26,917 persons, 37.5%	36,356 persons 37.5 %	27,817 persons, 24.2 %	16,879 persons 12.5 %
Latrine system	20,188 persons, 28.1%	27,298 persons 28.1 %	24,991 persons, 21.8 %	20,851 persons, 15.4%
No system	7,850persons,	10,611 persons	6,272persons,	0 person
	10.9 %	10.9 %	5.5 %	0 %
4. Municipal SWM	(year 1996)			
Population in the study area	76,250	97,078	114,760	135,106
Waste generation amount (ton/day)	57.1	76.6	97.5	123.4
Waste discharge amount (ton/day)	43.2	59.5	78.2	102.0
Waste collection amount (ton/day)	35.4	48.8	70.4	102.0
Final disposal amount (ton/day)	36.9	50.2	72.7	104.5
Coverage (% of waste amount)	82.0	82	90	100
Coverage (% of population)	63.0	63	89	100
Service population	48,037	61,159	101,843	135,106
Non service population	28,213	35,919	12,917	0
Length of road swept (km)	35	35	40	47
5. Medical SWM	(year 1996)			
Medical waste generation	99 g/day	127 kg/day	149 kg/day	176 kg/day
Non-hazardous waste generation	49 kg/day	63 kg/day	74 kg/day	87 kg/day
Infectious waste generation	48 kg/day	62 kg/day	73 kg/day	86 kg/day
Other hazardous waste generation	2 kg/day	2 kg/day	2 kg/day	3 kg/day

Note: * These figures exclude commercial and industrial water use.

9.1.3 Other Planning Considerations

a. Economic and Financial Conditions

Key economic and financial indicators employed in the M/P's economic and financial evaluations were calculated based on the following conditions. Table 9-4 shows the summary of the calculations.

- **Gross regional domestic product (GRDP) in 1995**: The Nicaraguan authorities were not able to provide the GRDP of Granada Department. Therefore, the regional product ratio (Granada Department total product/total national product) for each industrial category is assumed equal to the *regional income ratio* (Granada Department total income/total national income). For the calculation of the *regional income ratio* of each industrial category, the national and regional INSSBI data (number of people covered by the social security system and their average income) were used. The contribution of the industrial sector to the GDP was multiplied by the *regional income ratio* to compute the GRDP. The growth rate of GRDP in Granada Department is assumed to be equal to the GDP growth rate.

- **Municipal budget**: Municipal budget is assumed to increase in proportion to the GRDP growth.
- **Household income**: Total household income in Granada in 1995 was assumed based on the data provided by the Ministry of Labor. It is estimated that the growth rate of total household income is in proportion to the product of the "GRDP growth rate" and "increase in average number of persons per household". It is estimated that the average number of persons per household in Granada will grow slightly from 5.674 persons/household in 1995 to 5.81 persons/household in 2000, in accordance with the existing INAA plan.
- **Budget of INAA Region IV**: It is estimated that the ratio of "INAA Region IV budget" to "INAA national budget" will remain the same as in 1995.

Table 9-4: Economic and Financial Indicators in the M/P

	Unit	1995	2000	2005	2010
GRDP	C$ million	258.2	340.5	434.5	523.6
Number of households	Numbers	12,651	16,709	19,752	23,254
Average income per household	C$/year	15,300	15,278*1	16,494	16,883
Budget of INAA Region IV	C$1,000	9,026	10,883	12,375	14,184
Budget of Granada Municipality	C$1,000	13,616	17,957	22,918	27,617

Note: *1 Since growth rate (between 1995 and 2000) in number of households is slightly larger than the growth rate of GRDP, average income per household slightly declines from 1995 to 2000.

b. Conditions for Cost Estimation

b.1 Commodity Prices and Foreign Exchange Rate

Commodity prices as of September 1997 and foreign exchange rates as of beginning of September 1997 (US$ 9.6 = C$9.11 = Japanese Yen 120.0) were used for cost estimation.

b.2 Personnel Cost

Personnel costs in the INAA F/S were adopted for the water supply M/P and DWWM M/P personnel cost estimation. For the municipal SWM M/P, the personnel cost was calculated based on the present salary (i.e. Granada's SWM section staff) plus 18% social security charge.

9.2 Outline of Water Supply M/P

The present water supply coverage rate in Granada is about 90%, more than the INAA target coverage (85%) for 2005 and 2010. This rate presently covers almost all of the urban population in Granada. Even with the predicted increase in population, the proper maintenance of the present water supply system and its expansion could help to attain the future water supply target. Basically, the M/P is in accordance with the plan of the INAA. The table below summarizes the water supply M/P outline.

Table 9-5: Outline of Water Supply M/P for Granada

Item	1995	2000	2005	2010
FORECAST ON KEY INDICATORS				
Projected service area	14.3 km^2	14.3 km^2	14.3 km^2	14.3 km^2
Projected service population	71,783	97,078	114,760	135,106
Water supply coverage area	8.4 km^2	8.4 km^2	9.3 km^2	9.3 km^2
Supplied population	64,411	82,516	97,546	114,255
Coverage rate (population)	89.7 %	85%	85 %	85 %
Number of connections	11,352	14,202	18,199	21,425
Water production amount	6,107,590 m^3/y	9,742,945m^3/y	10,631,355 m^3/y	10,847,800 m^3/y
Water production rate	259.8 l/p/d	324l/p/d	299 l/p/d	260 l/p/day
Efficiency rate	57 %	60 %	65 %	75 %
Water consumption amount	3,454,251 m^3/y	5,845,840 m^3/y	6,910,545 m^3/y	8,135,850 m^3/y
- Domestic use	85.7 %	82 %	82 %	82 %
- Commercial use	3.6 %	13.6 %	13.6 %	13.6 %
- Industrial use	1.2 %	1.7 %	1.7 %	1.7 %
- Others	9.6 %	2.7 %	2.7 %	2.7 %
Water consumption rate (l/p/d)	147	194 (160*)	194 (160*)	194 (160*)
PARTICULARS OF THE PLAN				
1. Water source				
Type of water source	Groundwater	Groundwater	Groundwater	Groundwater
Number of wells	6	8	6	6
Data on wells				
- Total pump capacity	292.4 liters/sec	292.4 liters/sec	525 liters/sec	525 liters/sec
- Total production amount	6,107,590 m^3/y	9,742,945m^3/y	10,631,355 m^3/y	10,847,800 m^3/y
2. Disinfection				
System	Line injection	Line injection	Line injection	Line injection
Method	Chlorination	Chlorination	Chlorination	Chlorination
3. Water transmission and distribution facilities				
Method	Mainly direct connection	Mainly direct connection	Mainly direct connection	Mainly direct connection
Distribution reservoir				
Number of reservoirs	4	4	5	5
Total volume of reservoir	8,356 m^3	8,356 m^3	16,660 m^3	16,660 m^3
Total length of network	98 km	98 km	118 km	122 km
4. Operation and maintenance of facilities				
Responsible authority	INAA Region IV Granada branch office	INAA Region IV Granada branch office	INAA Region IV Granada branch office	INAA Region IV Granada branch office
Type of operation	Direct	Direct	Direct	Direct
Number of personnel	48 (incl. sewers)			
5. Finances				
INAA annual budget (C$1,000/year, incl. sewage)	302,605	364,859	414,897	475,532
Regional bureau budget (C$1,000/year, incl. sewage)	9,026	10,883	12,375	14,184

Item	1995	2000	2005	2010
Water charges				100 % of real operation cost
- For household	C$2.05/ m³	C$2.05/ m³	C$2.37/ m³	C$2.37/ m³
- Others	C$4.98/ m³	C$4.98/ m³	C$5.76/ m³	C$5.76/ m³
Collection method	Direct collection	Direct collection	Direct collection	Direct collection
Collection rate	98 %	98 %	98 %	98 %
Revenue from water charges	C$ 8,952,000	C$ 11,752,000	C$16,548,000	C$ 20,531,000

Note: * The figures exclude commercial and industrial water use.

9.3 Outline of Domestic Wastewater Management M/P

The Study's DWWM M/P was planned for:

- projected sewer areas in 2010 (INAA projection)
- areas without sewers in 2010

Areas without sewers refer to:

- areas where water supply is provided (about 30% of the urban population).
- areas where water supply is not provided (about 15% of the urban population).

The table below summarizes the outline of the DWWM M/P.

Table 9-6: Outline of the Domestic Wastewater System M/P for Granada

	1995	2000	2005	2010
FORECAST ON KEY INDICATORS				
Projected service area	14.3 km²	14.3 km²	14.3 km²	14.3 km²
Projected service population/ Coverage rate	71,783/ 100%	97,078/100%	114,760/100%	135,106/100%
Sewer system (off-site)	15,706/ 21.9%	21,260/ 21.9%	44,125/38.5%	74,266/55 %
On-site system	1,122/1.6%	1,553/1.6%	11,555/10.1%	23,110/17.1 %
Soak pit system (sumidero)	26,917/ 37.5%	36,356/ 37.5%	27,817/24.2%	16,879/12.5%
Latrine system	20,188/28.1%	27,298/28.1%	24,991/21.8%	20,851/15 %
No-system	7,850/10.9%	10,611/10.9%	6,272/5.5 %	0/ 0%
PARTICULARS OF THE MASTER PLAN				
1. Areas with sewers				
Service area	2.0km²	2.0km²	3.7km²	5.6km²
Service population	15,706	21,260	44,125	74,266
Number of connections	2,768	3,659	7,595	12,782
Coverage rate	21.9 %	21.9 %	38.5 %	55.0 %
Number of pump stations	1	1	1	3
Sewage production per capita	165.0 l/p/d	160 l/p/d	160 l/p/d	160 l/p/d
1.1 Sewage treatment plant				
Number of plants	1	1	1	1
Name of plant	Tepetate	Tepetate	Tepetate	Tepetate
Treatment method	Facultative lagoon	Facultative lagoon	Aerated lagoon	Aerated lagoon
Intake amount (mean annual value)	2,592 m³/day	3,402m³/day	7,060 m³/day	11,883 m³/day

	1995	2000	2005	2010
Intake water quality	BOD: 440 mg/l COD: 500 mg/l SS: 260 mg/l	BOD: 340 mg/l COD: 600 mg/l SS: 570 mg/l	BOD: 340 mg/l COD: 600 mg/l SS: 570 mg/l	BOD: 340 mg/l COD: 600 mg/l SS: 570 mg/l
Treated water quality	BOD: 280 mg/l COD: 300 mg/l SS: 240 mg/l	BOD: 90 mg/l COD: 180 mg/l SS: 80 mg/l	BOD: 90 mg/l COD: 180 mg/l SS: 80 mg/l	BOD: 90 mg/l COD: 180 mg/l SS: 80 mg/l
Discharge point	Infiltration	Infiltration	Infiltration	Infiltration
1.2 Operation and maintenance				
Responsible authority	INAA Region IV Granada branch office	INAA Region IV Granada branch office	INAA Region IV Granada branch office	INAA Region IV Granada branch office
Number of personnel	48 (incl. water supply)			
1.3 Finances				
INAA annual budget (C$1,000/year, incl. water)	302,605	364,859	414,897	475,532
Regional bureau budget (C$1,000/year, incl. water)	9,026	10,883	12,375	14,184
Sewage charge				
- For households	C$16.7 /month/household	C$16.7 /month/household	C$16.7 /month/household	C$16.7 /month/household
- Others	30% of total charge	30% of total charge	30% of total charge	30% of total charge
Collection rate	98 %	98 %	98 %	98 %
Charge collection method	Direct collection	Direct collection	Direct collection	Direct collection
Revenue from sewage charges (C$1,000)	799	1,069	2,558	4,500
2. Areas without sewers				
On-site system				
Service population	1,122	1,553	10,737	23,110
Coverage rate	1.6 %	1.6 %	9.4 %	17.1 %
Soak pit system (sumidero)				
Service population	26,917	36,356	28,635	16,879
Coverage rate	37.5	37.5	25.0	12.5
Latrine system				
Service population	20,188	27,298	24,991	20,851
Coverage rate	28.1	28.1	21.8	15
No system				
Service population	7,850	10,611	6,272	0
Coverage rate	10.9	10.9	5.5	0
Facilities of On-site system	Septic tank	Septic tank and collective system	Septic tank and collective system	Septic tank and collective system
Responsible authority	INAA, MINSA, Municipality	INAA, MINSA, Municipality	INAA, MINSA, Municipality	INAA, MINSA, Municipality
Legislation	None	To be established	To be established	To be established