CHAPTER 3 PRESENT AND FUTURE WATER DEMAND PROJECTION

3.1 Domestic and Industrial Water

3.1.1 Present Situation

(1) Service Area

The service area to be covered by the Study for domestic and industrial water supply is shown in Figure 3.1.1, including:

- Cañete River Basin itself (34 districts).
- Axis Chilca-Cañete (6 districts).
- Lima South Cone (10 districts out of 12)
- Pampas Concón-Topará (2 districts)

Within the Cañete River Basin and Axis Chilca-Cañete there are 9 water supply systems which are administrated and operated by EMAPAC S.A. (Cañete Municipal Enterprise of Water Supply and Sewerage). These are Imperial, San Vicente, Mala, San Luis, Quilmana, Cerro Azul, San Antonio, Santa Cruz de Flores and Lunahuaná. In the Lima City South Cone all water supply systems are administrated and operated by SEDAPAL except Punta Hermosa, Punta Negra, San Bartolo and Santa María which are administrated by the district municipalities. Remaining water supply system in the service area are administrated either by the district municipalities or by the communities.

(2) Summary of Main Indexes of the Water Supply Systems in the Service Area

After a field survey carried out in the service area as well as after reviewing SEDAPAL M/P (Master Plan of Drinking Water and Sewerage Systems in Lima and Callao, 1998) and EMAPAC M/P, main results are summarized below:

1) Water supply systems administrated and operated by EMAPAC S.A.

- Surface water source : 25% (numbers of surface water intake)
- Groundwater source : 75% (numbers of groundwater intake)
- Surface water production (*) : 168,347 m^3/month (25%)
- Groundwater production (*) : 493,125 m^3/month (75%)
- Average unaccounted water (*) : 47% (Total water supply system losses)
- Average service continuity (*) : 19 hours/day
- Average service coverage (*) : 65% (% of population with drinking water service)

(*) These numbers are supported in Tables 3.1.6 and 3.1.7 referred to the present situation of the Water Supply System Administrated by EMAPAC S.A.

- Average unit water sales price (*): US$ 0.14/m^3
- Population with drinking water service as of 1998 (*) : 72,594
- Deficit of water as of 1998 (*) : 400,329 m^3/month

2) Metropolitan Lima water supply system administrated and operated by SEDAPAL.

- Groundwater production (**) : 18,973,440 m^3/month (7.32 m^3/s)/(32%)
- Surface water production (**) : 40,746,240 m^3/month (15.72 m^3/s)/(68%)
- Average unaccounted water (**) : 35%
- Average service continuity (**) : 16.5 hours/day
- Average service coverage (**) : 82.7%
- Average unit water sales price (**) : US$ 0.42/m^3
- Population with drinking water service as of 1998(**) : 5,894,126 (82.7%)
- Deficit of drinking water as of 1998 (**) : 23,976,000 m^3/month (9.25 m^3/s)
- Total population as of 1998 (**) : 7,130,008
- Population without drinking water service as of 1998 (**) : 1,235,882 (17.3%)

(3) Domestic and Industrial Water Use

At present share of the domestic and industrial water consumption by user is reported as follows:

Present Domestic and Industrial Water Consumption

Water Use	SEDAPAL %	EMAPAC S.A. %
Social	0.5	---------
Domestic	91.1	74.3
Commercial	6.8	25.2
Industrial	1.0	0.5
State (Government)	0.6	-------
Total	100.00	100.00

(4) Present Water Consumption

Present annual water consumption (1998) in Metropolitan Lima-Callao City is 1,018.3 MCM. Since there is no aggregate record of the present water consumption in the study Area, its present annual water demand is estimated based

(**) Taken from "Master Plan of Drinking Water and Sewerage Systems of Lima and Callao" SEDAPAL, 1998 (SEDAPAL M/P)

on population. It is estimated to be 125.93 MCM (average 3.9 m^3/s) as summarized below (refer to breakdown in Tables 3.1.3, 3.1.4 and 3.1.5). Lima South Cone is a part of Metropolitan Lima-Callao City as well as of a part of the study area.

Present Water Demand (1998)

Lima-Callao City and Study Area	Population in Year 1998	Water Production Required year 1998 (MCM)[1]	Water Production Required (m^3/s)[1]	Water Production Required in year 1998 (MCM)		
				Domestic	Industrial	Tourism
Lima Callao City	7,130,008(*)	1,018.30/ 1,053.001	32.29/33.39			
Study Area						
Lima South Cone	1,023,520	113.25/ 119.42	3.59(**)/3.79	120.70(** *)/ 120.86	4.97/ 10.98	0.26
Axis Chilca-Cañete	45,628	3.11	0.10			
Cañete River Basin	141,062	9.37	0.30			
Concón-Topará	4,224	0.20	0.006			

3.1.2 Water Demand Projection

Water demand consists of those for domestic, industrial and tourism uses. Future water demand is projected by the following procedure.

(1) Domestic Use:

Domestic water use was projected by projecting future population by each district in the service area, and unit water demand (per person water consumption).

(2) Industrial Use:

Industrial water use was projected in case of Lima South Cone for two cases, a) to be the same as projected by SEDAPAL M/P, which is ranging from 3.7% (1998) to 1.8% (2030) of the total water consumption and b) as 10% of the domestic water consumption for the area where population is equal or larger than 10,000 as an alternative estimate.

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[1] In fractions numerator indicates figures given by SEDAPAL M/P and denominator indicates figures estimated by JICA Study Team.

(*) Taken from SEDAPAL M/P.

(**) Ten (10) districts out of twelve (12) have been considered in accordance with Alternative 1 and 1a of SEDAPAL M/P.

(***) Total amount of water production for the Service Area which includes Lima South Cone, Axis Chilca-Cañete, Cañete River Basin and Concón-Topará.

(3) Tourism Use:

Tourism water use is projected by estimating future domiciliary connection in resort areas in the service area and unit consumption of water per connection.

Projection of future population until the year 2030 is shown in Table 3.1.1 and projected water demand in Tables 3.1.2, 3.1.3, 3.1.4 and 3.1.5. Projection of total population of Metropolitan Lima was taken from SEDAPAL M/P, which was elaborated in accordance with INEI (National Institute of Statistics) guideline and following annual growth rates: 1998-2000 (2.62%), 2000-2005 (1.87%), 2005-2010 (1.65%), 2010-2015 (1.40%) and 2015-2030 (1.36%).

Results of water demand projection are summarized in the table below.

Water Demand Projection (2030)

Lima-Callao City and Sevice Area	Population in Year 2030	Water Production Required year 2030 (MCM)	Water Production Required (m^3/s)	Water Production Required in year 2030 (MCM)		
				Domestic	Industrial	Tourism
Lima-Callao City	11,751,197(*)	1,282.88/ 1,330.001	40.68/42.17			
Study Area						
Lima South Cone	2,207,308	199.94/ 205.6	6.34(**)/6.52	239.34(***)/230.69	7.32/ 21.67	2.67
Axis Chilca-Cañete	117,688	15.17	0.48			
Cañete River Basin	252,962	29.59	0.94			
Concón-Topará	34,748	4.63	0.15			

The results of the above projection show close figures between those of the SEDAPAL M/P and JICA Study Team. The figures adopted for year 2030 water demand are 1,282.9 MCM for Metropolitan Lima-Callao and 249.33 MCM for the Service Area.

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[1] In fractions numerator indicates figures given by SEDAPAL M/P and denominator indicates figures estimated by JICA Study Team.

(*) Taken from SEDAPAL M/P.

(**) Ten (10) districts out of twelve (12) have been considered in accordance with Alternative 1 and 1a of SEDAPAL SEDALAP M/P. For the purpose of water balance analysis 5.00 m^3/s out of 6.34 m^3/s was taken because 1.34 m^3/s will be supplied by other source to Lima South Cone instead of the Cañete River.

(***) Total amount of water production for the Service Area which includes Lima South Cone, Axis Chilca-Cañete, Cañete River Basin and Concón-Topará.

3.1.3 SEDAPAL M/P

(1) Summary of the M/P

SEDAPAL M/P (Master Plan of Drinking Water and Sewerage System in Lima and Callao, 1989) study was carried out between June 1997 and December 1998 for the following purposes:

- To ensure continuity (24 hours) and a better quality of the drinking water service.
- To ensure an adequate sewerage system in order to avoid diseases and to reduce the environment pollution.
- To propose an institutional and operative improvement program (MIO) in order to improve all services to a middle term.
- To select expansion priority projects from technical, environmental, economic and financial view points and to choose that one with the minimum cost.
- To establish an investment program.
- To establish a feasible water tariff.

As of the year 1998 deficit of drinking water in Metropolitan Lima amounted to 23,976,000 m^3/month (9.25 m^3/s) and average unaccounted water at 35%. Only 18% of household have water consumption metering system and pipes leakage accounted for 9% of total loss.

Groundwater overdraft has taken place to supplement the current deficit of potable water in Metropolitan Lima, resulting in the fact that polluted sea water has penetrated into inland, and thus Lima aquifer has become contaminated, and presence of sulfate and nitrate have been reported. There is evidence of overpumping too, and consequently water table has been lowered drastically. Currently SEDAPAL administrates and operates 442 wells of which 371 are operating. The total discharge as of 1998 was 7.32 m^3/s. Due to such background the maximum groundwater withdrawal is recommended: i.e., 5.0 m^3/s as the maximum annual average, 5.93 m^3/s as the maximum discharge during low water season (May to November) and 3.70 m^3/s during high water season (December to April).

With the implementation of the MIO program total loss is expected to be reduced from 35% to 25% that is considered as the maximum economically feasible figure attained in the Latin American countries.

The population of Metropolitan Lima up to the year 2030 has been assessed to be 11,751,000 and the coverage by drinking water will be 98%. The active water demand in the year 2030 will be 31 m^3/s and necessity of water production will be 40.68 m^3/s, as shown in Tables 3.1.8 and 3.1.9 respectively.

Active water demand in Table 3.1.8 is elaborated based on the detailed field survey, and an assumption that all customers would have a water meter device in the period between 2002 and 2030. Unit water demand per district for the period 1998-2030

was calculated and in average it ranges from 297 ℓ per day (1998) and 228 ℓ per day. This unit water demand was divided into domestic and non-domestic use (industrial, commercial, state and gardening). Non-domestic demand accounts for 22% in 1998 and 20% in 2030, out of which industrial is 3.7% in 1998 and 1.8% in 2030.

Necessity of water production estimated in Table 3.1.9 was gauged by adopting the figures in Table 3.1.8, in consideration of potable water service coverage and efficiency ratio (1-unaccounted water).

(2) Implementation of Potable Water Projects

Following the programs in the M/P, projects in nine (9) categories are currently under implementation including:

- Development of surface source and groundwater source.
- Raw water conveyance.
- Water treatment plants.
- Conveyance of drinking water which includes main and secondary distribution network pipe.
- Storage of drinking water.
- Pumping station of drinking water.
- Drinking water distribution including domiciliary pipe connection.
- MIO Program.
- Tariff.

All above projects were under an integrated evaluation in the M/P, and Alternative 2 was selected which proposes implementation of new water sources including Mantaro-Carispaccha water transfer, Chillón River development, Huascacocha reservoir & water transfer and Lurín groundwater exploitation.

The master plan has been planned to cover the period 1998-2030 and it is to be revised and updated every 5 years.

3.2 Agricultural Water

3.2.1 General

It should be noted first of all that large scale development of irrigated agriculture is not expected in the upper basin higher than Nuevo Imperial because the land development has already been maximized wherever topography permits. Rather, population in this area has been decreasing, and a part of the terraces developed in high and very steep lands have been abandoned. The fact indicates that the Study on water demand can be made without considering further water use for agriculture in the area. Therefore, the Study was carried out for the areas located downstream the Nuevo Imperial intake.

The existing condition of the Cañete River basin is complicated in view of topography and climate. Especially, altitude ranges from seashore (0 m msl) to origin of the River (more or less 5,000 m msl). The basin is divided into three zones, i.e. upper, middle and lower basins for the Study on river discharge and rainfall. The distribution chart of yearly rainfall indicates that there are considerable rainfall in the high mountain ranges and little in the coastal areas. Temperature also depends on the altitude. Likewise, any other climatic conditions differ from place to place. It should be noted that dense cloud (mist) prevails in the coastal area during the months of May to September.

Most of the existing agricultural lands and virgin lands which are proposed for agricultural development with water are situated in the lower basin of the river, of which climatic conditions seem to be represented by the records at the Cañete meteorological station. In this regard, the climatic information at this station is used for the period of 30 years from 1969 to 1998 for the Study on agriculture.

3.2.2 Present Condition of Agriculture and Irrigation

(1) Present Condition of Agriculture

The present agricultural land in the Study area is located in and around the San Vicente de Cañete within the range of about 15 km from the coast extending towards northeast and about 18 km from northwest to southeast, mostly on the right bank of the Cañete River.

The local Government offices concerned have conducted inventory surveys six times since 1970 for the areas being irrigated. The result is shown in the table below. It is understood from the table that the total net area of the agricultural land ranged between 22,193 ha and 23,614 ha.

Name of Agencies in Charge	Year Conducted	Cultivated Area (ha)
Oficina Nacional de Evaluacion de Recursos Naturales – ONERN	1970	23,200.00
Administracion Tecnica de Agua del Rio Cañete – ATAC	1970	23,415.66
Padron de Usuario del Distrito de Riego Cañete – PUDRC	1972	22,193.31
Direccion Generai de Aguas – DGA	1993	22,583.05
Junta de Uruarios, Cañete – JUC	1990	22,214.51
Proyecto Especial Sur Medio – INADE	1990	23,614.26

INADE summarized the land use in the Valle de Cañete. It indicates that out of the total land area of 28,983 ha, agricultural lands can be extended to 24,052 ha or

83.0%, which consist of 43.3% of extensive cultivation of cotton, 16.3% of maize and potato, 3.0% of horticulture, 8.6% of orchard of apple, grape, citrus, etc. and 11.8% of fodder. Remaining lands with an area of 4,931 ha or 17.0% consist of urban areas and/or public and private properties, and unsuitable areas for agriculture due to ill soil and salinity.

(2) Present Condition of Irrigation

In order to grasp the water demand in the existing condition (See Figure 3.2.1), estimate of consumptive use was based on the potential evapotranspiration was worked out by the methods of Hargreaves, Radiation and Blanney-Criddle (Source: Hidrologia Valle del Cañete, INADE, June 1990). However, according to the guideline prepared by FAO (1977), it is suggested that modified Penman method be used since it offers the best results with the minimum error of plus or minus 10% in summer, and up to 20% under low evaporative conditions, whereas the Radiation method, in extreme conditions, involves a possible error up to 20% in summer, and the Blaney-Criddle method should only be applied for a period of one month or longer; in humid, windy, mid-latitude winter conditions. Table 3.2.1 compares the potential evapotranspiration calculated by the three methods of Hargreaves, Radiation and Blanney-Criddle with the modified Penman method (calculated by the JICA Study team). It is understood that the potential evapotranspiration calculated by the modified Penman method gives the lowest values. It is important to note that dense cloud (mist) prevails during the months from May to September in this area, and hence sunshine hour is eventually short. Since the Blanny-Criddle method neglects effect of sunshine hour in its formula, it should not be used in such area in predicting evapotrnspiration as presented in the said study report. In this regard, the modified Penman method was used for the Study on the water demands for agriculture hereinafter.

A higher level of dependable rainfall (say 9 out of 10 years) needs to be selected during the periods that crops are germinating or are most sensitive to water stress, and yields are severely affected. Only a portion of heavy and intensive rains can enter and be stored in the root zone and the effectiveness is consequently low. It is recommended that the daily rainfall less than 5 mm/day is to be regarded as non-effective (FAO Irrigation and Drainage Paper No. 25, Effective Rainfall, 1975).

Probability analysis of daily rainfall is conducted by Gumbel method using the records at Cañete Meteorological Station covering a period of 30 years from the years 1969 to 1998. It is understood from the analysis that the dependability of once in two years is 4 mm/day and that of 9 out of 10 years is only 0.9 mm/day, which is far below the recommended magnitude of 5 mm/day. Moreover, rainfalls which were more than 5 mm/day occurred only eight times in the last 30 years. Considering these situations, it is not practical to anticipate effective rainfall of

dependable 9 out of 10 years. Therefore, in estimating water demand for agriculture, rainfalls are regarded as non-effective.

PRONADRET and PE-SUR MEDIO jointly conducted measurement of irrigation canal discharge for the major six (6) canals located downstream the Aforos Socsi Station namely, Canals Nuevo Imperial, Viejo Imperial, Palo Herbay, Ramadilla, Meria Angola and San Miguel from August 1990 to July 1991 in order to estimate the conveyance efficiency of respective irrigation canals. The results are shown in the following table:

Irrigation Canal	Conveyance Efficiency (%)
Canal Nuevo Imperial	81
Canal Viejo Imperial	70
Canal Palo Herbay	78
Canal Remadilla	85
Canal Meria Angola	75
Canal San Miguel	79

It is seen from the above that the conveyance efficiency ranges between 70% and 85% (average: 75%).

(3) Estimate of Present Water Demand

Estimate of the present water demand is based on the potential evapotranspiration (ETo) worked out by the modified Penman method, of which calculation result is shown in Table 3.2.1. The effect of the crop characteristics on crop water requirement is given by the crop co-efficient (kc) which represents the relationship between potential (ETo) and crop evapotranspiration (ETcrop) or ETcrop = kc･ETo. On the assumption of 45% overall irrigation efficiency (conveyance efficiency 75%, application efficiency 60%) and the applied cropping pattern shown in Figure 3.2.1, the total water demand for agriculture for an area of 24,052 is estimated as shown in Table 3.2.2. It is understood from the table that the annual demand is 378.82 MCM, while the peak demand is 59.86 MCM, which occur in February.

3.2.3 Evaluation of Present Irrigation Water Use and Problems

There are several problems in the presently irrigated land, the Valle de Cañete, which can be solved by improving and rehabilitating the present conditions in order to economize on the use of water and to raise the agricultural productivity of the land.

(1) Seasonal Inconsistency of river Discharge and Water Demand

One of the important problems is the seasonal lack of water for irrigation due to the irregularity of the river flow. The water balance study conducted for the Valle de Cañete indicates that at present there is an annual deficit of about 46 MCM, which

are equivalent to 12% of the annual demands (Source: Evaluacion de Racional de los Recursos Naturales del Rio Cañete prepared by ONERN in 1970).

(2) Deterioration of the Water Intake and Conveyance Facilities

A significant loss of water is observed in the deteriorated intake structures and canals, and temporary structures constructed with gravel and wood, though a part of them has been already improved using concrete.

(3) Improper Water Management

It does not seem that water management is always conducted properly. Many of the gates on the intake structures are deteriorated, and measuring devices have not been fully installed. (Installation of measuring flumes and gages have commenced from this year as will be discussed in Section 7.3.) Diversion of water in the canals seem to depend on intuition of the local people so far. Since there is no regulating pond (reservoir and/or farm pond), it is hardly possible to manage irrigation water properly. The fact implies that there is a significant loss of water at night.

(4) Low Irrigation Efficiency

Furrow irrigation is practiced in the area. Its irrigation efficiency is eventually low. In undulating and sloping lands, because of mal-improvement of lands, its efficiency is worse. Water saving irrigation, such as sprinkler and drip methods, etc. is not practiced.

(5) Inundated and Saline Areas

It is important to note that the consecutive loss of land is progressing due to inundation and/or salinization, which have been caused by over irrigation and lack of drainage. The studies made by CENDRET and ONERN indicate that approximately 3,140 ha or 13% of the total cultivated area of the Valle de Cañete are under this situation.

3.2.4 Review of Agriculture and Irrigation Development Plans

(1) Valle de Cañete

Although the total area to be irrigated in future is limited to 24,052 ha due to the topographic and soil conditions, it is possible to increase irrigation efficiency by improving conveyance facilities, furnishing regulating ponds and applying water saving irrigation methods. According to the study made by INADE, irrigation efficiency could be raised as high as 55%. However, it does not seem to be practical to raise it more than 50% (conveyance efficiency 78% and application efficiency 65%) as indicated by the guideline of FAO (1977), even after the

improvement and rehabilitation of the present conditions, as far as the existing canals remain unlined and furrow irrigation is practiced.

(2) Pampas de Concón-Topará y Chincha Alta

Pampas de Concón-Topará is located at left bank of the Cañete River. It extends about 14 km from the coast towards northeast, and 18 km from northwest to southeast with an area of about 27,000 ha. The land is not used at present due to devastated dune. It is proposed to be developed as an irrigated agricultural land by constructing a barrage on the Rio Cañete near Lunahuana, which is located at about 28 km from the estuary, and a main canal from the barrage with a length of 25 km.

The proposed land use (cropping pattern) consists of extensive cultivation of cotton, potato, maize, horticulture (vegetables and flowers), orchard of citrus and mango, and perennial crops (alfalfa, etc.). Nevertheless, recent experience on new irrigation projects shows a trend high yield export oriented cropping patterns. This could be the case of Concón-Topará y Chincha Altas, even though this analysis is beyond the scope of this Study.

For the newly proposed agricultural land, the irrigation efficiency was estimated to be as high as 67% by applying water saving irrigation methods and water conveyance facilities (Source: Hidrologia Valle del Cañete, INADE, June 1990). However, according to the guideline of FAO, the conveyance efficiency will be, in normal case, 85% for the concrete canals in such a large area and application efficiency, 75% for the sprinkler and drip irrigation methods. As a result, overall irrigation efficiency will be 60%.

(3) Pampas Altas de Imperial

This project consists of the incorporation of the Pampas Altas de Imperial and the Pampas de Quilmana (840 ha), Bandurria (1,040 ha), Conta (400 ha) and Chivato (195 ha). The total area for development is estimated at 2,475 ha, of which 1,110 ha are proposed for agricultural development, whilst 1,365 ha for forest exploitation. Considering that the conveyance facilities are proposed to be lined with concrete, irrigation efficiency is estimated at 52% (conveyance efficiency 80% and application efficiency 65%).

(4) Potential Agricultural Land Located at the Coastal Area

The area located between the proposed water transmission line and the coast is generally hilly. There exist three non-perennial small rivers in the area, i.e., the Rio Omas, the Rio Mala and the Quebrada Chilca from the east. The estuaries of these rivers are flat, and soils are suitable for agriculture. In this regard, it is possible to develop these lands for agriculture using the water of the planned water conveyance system to Lima (mountain route). In order to minimize the water

demand, it is suggested that the conveyance facilities be either concrete flume or pipeline, and water saving irrigation such as sprinkler and/or drip methods be practiced.

Net irrigable area located along the Rio Omas is estimated at 2,720 ha. Irrigation water for the area will be obtained from the conveyance system at the station 76+850. Annual water demand is 35.40 MCM on the condition stated above, and peak water demand, 4.74 MCM which occur in February. Thus, the peak discharge of 1.96 m^3/sec is to be released from the conveyance system.

The land suitable for the development of irrigated agriculture extends both banks of the Rio Mala with a net area of 1,960 ha. Water is to be issued for the proposed land from the conveyance system at the station 112+640. Water demand throughout a year is estimated at 25.51 MCM, whereas that of the peak month of February, 3.42 MCM, which is equivalent to 1.41 m^3/sec.

Likewise, a land potential for agricultural development with an area of approximately 2,270 ha exists along the Quebrada Chilca. Water for the area is to be obtained from the same conveyance system at the station 132+650. Annual water demand is estimated at 29.54 MCM, and peak water demand, at 3.9 MCM also in February. Thus the peak discharge to be released will be 1.64 m^3/sec.

3.2.5 Water Demand for Agriculture

The discussions made above for water demands for the respective on-going and grew project areas are summarized as follows (see Tables 4.3.8 (1) to (3)):

(1) Independent Projects

Projects	Net Area	Peak Demand		Annual Demand
	(ha)	(MCM)	(m^3/s)	(MCM)
Valle de Cañete (complete 2004)	24,052	53.89	22.28	340.20
Concón-Topará y Chincha Alta	27,000	47.06	19.45	351.41
Sub-total	51,052	100.95	41.73	691.61

(2) Projects on the Water Conveyance System

Projects	Net Area	Peak Demand		Annual Demand
	(ha)	(MCM)	(m^3/s)	(MCM)
Pampas Altas de Imperial	2,475	4.06	1.68	30.17
Rio Omas	2,720	4.74	1.96	35.40
Rio Mala	1,960	3.42	1.41	25.51
Quebrada Chilca	2,270	3.96	1.64	29.54
Sub-total	9,425	16.18	6.69	120.62

(3) Total Water Demand

60,477	117.13	48.42	812.23
	(in February)		

3.3 Hydroelectric Power

3.3.1 Nationwide Power System

(1) Institutional Framework

Electrical sector in Peru is ruled by the law of Electrical Concessions enacted 19th November, 1992. Its regulation was approved 25th February of the following year.

Enactment of this Law decided the role of the State in this sector turning from operator into investor, being in charge of legislation, concession, regulation and supervision activities.

Within legislative framework, it mainly considered the following:

- Transformation of electrical sector structure by separating the electricity generating, transmission and distribution processes, limiting their duties and economical relationships among companies and of these companies with users by means of a tariff system that has as main objective to promote efficient management in operation and costs in this sector.
- Promotion of private investment stating basic conditions to guarantee investor's activities and to allow that any of sector activities may be carried out by individuals or legal entities, national or international, in accordance with stated Concession and Authorization System.
- Conditions under which electricity service is rendered, quality of service received by final users depend not only on commercial operation but also on investments that will be made so as to improve supply system and facilities in general.

Organizations in charge of regulation of electric sector are:

- Commission for Energy Tariff (CTE) in charge of tariff regulation
- Economical System Operation Committee (COES) which organizes selling of energy in the system
- General Directorate of Electricity (DGE) of Ministry of Energy and Mining (MEM) in charge of normative matters and Referential Plan of Electricity.
- Controller Organism of Investment on Energy (OSINERG) in charge of supervising activities of sector.
- National Institute of Defense of Competence and Protection of Copyright (INDECOPI) in charge of look after free competition and consumer protection.

(2) Interconnected Systems

Peruvian electrical system is composed of the following systems:

- two electrical interconnected systems,
- electrical isolated systems,
- self-producers which are mainly large mining and industrial companies.

Installed capacity of Middle North and South Interconnected Systems (SICN and SISUR) makes up more than 80% of the installed capacity all around the country.

Middle North Interconnected System (SICN) covers the coast strip from Marcona to Tumbes in the north and central area of the country from Ayacucho in the south to Aucayacu in the north.

South Interconnected System (SISUR) is composed of interconnections of South-east systems (Cuzco, Puno and Apurimac) and Southeast (Arequipa, Moquegua and Tacna) since beginning of 1997.

These two systems, as shown in Figure 3.3.1, will be interconnected with Mantaro-Socabaya Transmission Line in the year 2000, setting up the National Interconnected System (SIN).

Installed and effective capacity in SICN and SISUR Interconnected Systems are shown in Tables 3.3.1 and 3.3.2.

1) Hydropower generation

Hydropower generation capacity in the SICN corresponds to 16 hydropower stations with a total installed power of 2,045 MW and an effective power of 1,771 MW. Companies with the most effective power in hydroelectric power generation are Electroperú with 780 MW, Edegel with 520 MW, Egenor with 225 MW and Electroandes with 165 MW.

In the SISUR, there are 9 hydroelectric power stations with total installed power of 314 MW, however effective power is only 200 MW due to a condition that Macchu Picchu Hydropower Station (110 MW) is at present out of service because of a disaster occurred in February, 1998. Egasa company is the one which has more numbers of stations (6 in total), among which the most important one is Charcani V Hydropower Station with an effective power of 135 MW.

2) Thermal generation

Installed power of thermal station in the SICN sums up 1,346 MW and total effective power 1,254 MW. The most important stations are thermal stations in Ventanilla in charge of Etevensa with 493 MW of effective power, Santa Rosa Thermal Station of Edegel with 260 MW, stations of Egenor company that sum up a total of 172MW, Aguaytia Thermal Station with

natural gas of 155 MW and Malacas Thermal Station with natural gas of 111 MW, as well.

In the SISUR total installed capacity is 398 MW with effective power 341 MW. The most important station is that of CT Ilo in charge of Enersur with 261 MW installed power and 212 MW effective power.

3) Transmission network

According to Electrical Concession law, electric power transmission systems are classified in two types of networks: main and secondary one.

- Main System: which permits generators to commercialize the power and energy at any bar of such system, is made up circuits that do not permit to identify flux in two ways and their tension levels are at the order of high to very high tension.
- Secondary System: which permits generators to be connected to Main System to commercialize power and energy or to permit supply to specific charges.

In the SICN, total length of transmission lines of the main system is 982 km and that of the secondary system is 5,184 km. In the SISUR, total length of transmission lines of the main system is 392 km and secondary system is 1,919 km.

4) Current supply and demand balance

The total effective capacity and the demand in 1998 are compared in Table 3.3.3. It is observed that the effective power capacity has reserves of 43% and 32% in SICN and SISUR, respectively. As for energy balance, reserves are estimated at 38% and 28% in SICN and SISUR, adopting an average plant factor of 0.7.

(3) Referential Plan of Power Development

1) Demand forecast as of year 2030

Three levels of demand forecast, low, medium and high forecasts, are usually prepared, taking into account of how the Gross National Product and population will grow in the future.

A medium forecast as of the year 2030 for the National Interconnected System (SIN) is 9,700 MW. Referential Electricity Plan made in 1998 by the Ministry of Energy and Mining (MEM) has given a forecast for the period between 2000 and 2010. Assuming an annual increase of energy demand at 4% and a load factor at 0.79, forecast is extended to the year 2030, as shown on Figure 3.3.2.

2) Expansion plan of power generation up to year 2010

Plan up to 2003

Expansion plan of power generation for the period of 2000 – 2003 which is on the basis of Facilities Plan published in the "Procedimiento y Cálculo de la Tarifa en Barra" by the Commission of Energy Tariff in May, 1999 is shown in Table 3.3.4. According to the Electricity Concession Law, the MEM is in charge of the elaboration of Referential Plan of Electricity which includes this expansion plan of power generation for 4 years so as that Tariff Commission can estimate the tariff. Additional capacity of 1,039 MW is assumed by the year 2003.

Plan up to 2010

According to the Referential Electricity Plan, the expansion of power generation depends on Project of Transportation of Natural Gas from Camisea to Lima. Therefore, in order to meet the increase of demand for the period 2003-2010, the following is proposed:

- transformation of the thermal station of Santa Rosa into a natural gas station,
- transformation of thermal station of Ventanilla into a combined system station, obtaining an additional capacity of 250 MW, and
- four turbo gas generator sets of 150 MW each.

In addition to this, transformation of the Aguaytia and Malacas Station into combined cycle system is also proposed in this Referential Plan in order to obtain additional capacities of 85 MW and 43 MW, respectively with the natural gas existing in the vicinity of those stations.

In general, the proposed generation plans for the period of 2003 – 2010 are currently in study stage, of which technical characteristics will depend largely on the on-going bidding of Camisea Project.

As for the nationwide hydroelectric power generation alternatives, temporary concessions were given in June, 1998 for development of 25 hydroelectric power objects under Electricity Concession Law. Any concession, temporary or definitive, has been suspended since September 1998.

3.3.2 Power System in Study Area

(1) Current Power Supply

Present situation of power supply in the study area is illustrated in Figure 3.3.3, as briefed below.

Area of Luz del Sur S.A.

Lima districts, Pucusana, Santa María, San Bartolo, Punta Negra, Punta Hermoza and Lurin and a part of Cañete districts (Chilca, Santa Cruz de Florez, San Antonio, Mala, Calango and Asia) area supplied by the distribution company Luz del Sur with 3 sub-stations (Lurín, San Bartolo and Bujama) and by means of a 60-kV transmission line coming from San Juan Sub-station, a part of Center-North Interconnected System. Total installed capacity is 37 MW.

Area of EDECAÑETE

Districts of Cañete central area (Zúñiga, Pacarán, Lunahuaná, San Vicente de Cañete Imperial, Nuevo Imperial, San Luis, Quilmana and Cerro Azul) are supplied by the distribution company EDECAÑETE with the San Vicente Sub-station which is fed by a line of 60kv that comes from the Independencia Sub-Station, part of the Center-North Interconnected System, located in Ica department south of Cañete. The installed capacity is of 17 MW.

Area of small electric existing systems

Catahuasi district is supplied by a 60-kW hydropower mini-station.

Hongos, Cacra, Huangascar, Viñas, Madean districts are supplied by a 125 kW hydropower mini-station.

Huancaya, Vitis, Tomás, Alis, Miraflores, Carania and Laraos are supply by a small electric system from the Chumpe substation of Electroandes electric system, a part of the Center-North Interconnected System. The installed capacity of Chumpe substation is 0.4 MW.

Coayllo, Tupe, Lincha, Chocos, Azangaro, Colonia, Ayauca, Putinza y Tanta do not have electricity.

Present situation of power capacity and demand is shown in Table 3.3.5, which shows surplus in the Luz del Sur and Edecañete area, while deficit in the Small Electric Systems is due that 9 districts do not have any electricity service.

(2) Present and Projected Demand up to 2030

The demand forecast of power and energy projected for the year of 2030 is shown in Table 3.3.5.

In estimating demand in the areas of Luz del Sur and Edecañete, annual growing rate of energy demand is assumed at 3%, and the present load factor provided by electricity companies are adopted to calculate power.

In estimating demand in the area of the Small Electric Systems, information from previous studies which include demand projections up to the year 2015 was referred to and the projection for the year 2030 was made by adopting the same values of the growing rate and load factor of such studies.

(3) Expansion Plan of Power System

The MEM foresees 4 small electric systems as follows:

- System “Lunahuana”. - which consists of the extension of the existing primary line from Zúñiga to Catahuasi and Tupe.
- System “Hongos” Stage II. - which consists of the extension of Villafranca Hydropower Station up to 250 kW and extension of the small existing system up to Chocos, Azangaro and Lincha. Also it proposes to interconnect this system with the small Lunahuana system at place close to San Juanito.
- System “Yauyos”. - capacity of Chumpe sub-station will be increased up to 1.6 MW and small existing system will be extended up to Huantan, Yauyos, Colonia, Ayauca, Putinza and Tanta districts.
- System “Asia-Coayllo”. – the existing primary line will be extended from Asia up to Coayllo, comprising Omas and Tauripampa districts which are out of the Study area.

With the above expansion plan of electrification, MEM intends to integrate all district capitals and most of the towns in the Study area into the SIN in the year 2000.

3.4 Aggregate Basin Water Demand Tward 2030

The present annual water demand inside the Cañete river basin is 388.119 MCM (average 12.3 m^3/s). It is mostly used by the existing irrigation in Valle de Cañete (97.6%). Potential water demand consisting of that in the Cañete river basin and that expected outside the basin is projected up to the year 2030 as set out below. Instream water use for hydropower generation is not included.

The aggregate annual water demand in 2030 is projected to be increased to 1,106.71 MCM (average 35.1 m^3/s) if water transfer to outside the basin is accepted by the residence.

Share of D/I water supply (249.33 MCM), irrigation (721.78 MCM) and river maintenance flow (135.6 MCM) is 22.5%, 65.2% and 12.3% respectively. There is no requirement of river maintenance flow at present. Introduction of river maintenance flow of 1 m^3/s ~ 4.3 m^3/s is proposed by the study (refer to Section 4.3).

Sector	Annual Water Demand (MCM) Present 1998/1999	Present 2020	Present 2030
D/I Water Supply Total	125.93 (24.9%)	188.85 (18.1%)	249.33 (22.5%)
• Lima South Cone(L)	113.25	158.94	199.93
• Axis Chilca-Cañete	(3.11)	8.48	15.18
• Cañete River Basin(CB)	9.37	18.68	29.59
• Concón-Topará	(0.20)	2.76	4.63
Irrigation Total	378.82 (75.1%)	721.78 (69.0%)	721.78 (65.2%)
• Valle de Cañete (CV24,052 ha)	378.82	340.20	340.20
• Concón-Topará y Chincha Alta (CTP 27,000 ha)	-	351.41 (2012)	351.41
• Pampas Altas de Imperial (CLC 2,475 ha)	-	30.17	30.17
River Maintenance Flow, Q_{99} (4.3 m^3/s)	no requirement	135.60 (12.9%)	135.60 (12.3%)
Total	504.75 (100%)	1,046.23 (100%)	1,106.71 (100%)

Table 3.1.1 Projection of the Total Population by District

Zone	Year	1998	1999	2000	2005	2010	2015	2020	2025	2030
	District	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Cañete River Basin	1. San Lorenzo de Quinti (1)	52	51	49	41	34	28	24	20	16
	2. Tanta (2)	537	540	546	568	591	615	640	666	692
	3. Huancaya	462	455	448	413	382	353	326	301	278
	4. Tomas	946	943	941	929	917	905	894	882	871
	5. Vitis	313	309	306	288	271	255	240	225	212
	6. Miraflores	441	437	433	413	394	376	359	343	327
	12. Carania	268	263	259	238	219	202	186	171	157
	13. Alis	3,664	3,744	3,826	4,264	4,753	5,298	5,905	6,581	7,335
	14. Laraos	1,179	1,173	1,166	1,135	1,104	1,074	1,045	1,017	990
	19. Tauripampa (3)	661	657	655	641	627	613	599	585	572
	20. Ayauca	1,123	1,119	1,115	1,094	1,073	1,053	1,033	1,013	994
	21. Yauyos	2,001	2,000	1,999	1,995	1,991	1,987	1,983	1,979	1,976
	22. Colonia	1,510	1,498	1,486	1,428	1,373	1,320	1,268	1,219	1,172
	23. Putinza	454	454	453	450	448	445	442	439	437
	24. Huantán	918	913	907	878	851	824	798	773	749
	25. Catahuasi	1,393	1,429	1,465	1,663	1,886	2,140	2,428	2,755	3,126
	26. Tupe	563	544	526	443	374	315	266	224	189
	27. Cacra	892	881	871	819	770	724	681	640	602
	28. Hongos	465	462	460	447	435	423	412	400	389
	29. Lincha	462	453	445	404	368	334	304	277	252
	30. Viñac	1,675	1,668	1,662	1,631	1,600	1,570	1,540	1,511	1,483
	31. Chocos	738	728	718	669	624	581	542	505	471
	32. Huangáscar	735	718	702	624	556	494	440	392	349
	33. Madean	845	837	829	790	754	719	685	653	623
	34. Azángaro	671	665	659	629	601	574	548	523	499
	35. Zuñiga	1,284	1,285	1,286	1,292	1,298	1,304	1,310	1,316	1,322
	36. Pacaran	1,679	1,708	1,739	1,890	2,045	2,203	2,361	2,518	2,673
	37. Lunahuaná (4)	4,518	4,605	4,694	5,135	5,587	6,047	6,508	6,969	7,421
	38. S Vicente de cañete (5)	31,632	32,366	33,117	37,131	41,617	46,629	52,225	58,473	65,445
	39. Nuevo Imperial	14,415	14,634	14,856	16,019	17,274	18,626	20,085	21,657	23,353
	40. Imperial	34,541	35,252	35,977	39,834	44,106	48,834	54,070	59,868	66,287
	41. San Luis	11,288	11,488	11,692	12,765	13,937	15,217	16,614	18,139	19,804
	42. Quilmana	12,955	13,310	13,674	15,649	17,910	20,497	23,458	26,847	30,726
	43. Cerro Azul	5,781	5,901	6,024	6,677	7,401	8,203	9,093	10,079	11,172
	Sub total River Basin	**141,062**	**143,492**	**145,982**	**159,290**	**174,169**	**190,782**	**209,312**	**229,963**	**252,962**
Chilca Cañete Axis	44. Asia	3,890	3,967	4,046	4,462	4,922	5,428	5,987	6,604	7,284
	45. Coayllo (6)	323	322	320	312	304	296	288	280	272
	46. Mala	22,012	22,659	23,325	26,963	31,167	36,028	41,646	48,141	55,648
	48. Sta Cruz de Flores (7)	2,073	2,087	2,102	2,178	2,256	2,337	2,421	2,507	2,596
	49. San Antonio	3,055	3,096	3,137	3,350	3,577	3,820	4,079	4,356	4,652
	50. Chilca (8)	14,275	14,822	15,390	18,567	22,393	26,998	32,541	39,211	47,236
	Sub total Axis	**45,628**	**46,953**	**48,319**	**55,831**	**64,619**	**74,907**	**86,962**	**101,099**	**117,688**
Corridor Lurin Cañete Lima South Cone	51. Pucusana	4,510	4,781	5,068	6,623	8,453	10,789	13,770	17,574	21,900
	52. Sta Maria del Mar	224	237	251	369	568	835	1,314	2,069	3,040
	53. San Bartolo	3,693	3,988	4,307	6,041	8,472	11,883	16,667	22,835	30,558
	54. Punta Negra	3,143	3,331	3,531	4,615	6,032	7,884	10,062	13,026	16,625
	55. Punta Hermosa	4,263	4,519	4,790	6,410	8,579	11,480	14,652	18,700	22,751
	56. Lurín	42,714	45,704	48,904	68,590	91,789	122,834	156,771	190,736	232,059
	57. Pachacamac	25,807	27,614	29,547	41,441	55,457	74,214	94,718	115,239	140,206
	58. Villa M. Del Triunfo	304,305	316,477	329,136	363,393	401,215	442,974	489,079	539,983	596,185
	59. Villa el Salvador	303,574	315,717	328,346	362,520	400,251	441,910	487,904	538,686	594,753
	60. S. J. Miraflores	331,287	341,226	351,463	388,043	428,431	461,542	497,212	522,574	549,231
	Sub total South Cone	**1,023,520**	**1,063,594**	**1,105,343**	**1,248,045**	**1,409,247**	**1,586,345**	**1,782,149**	**1,981,422**	**2,207,308**
Pampas Concón Topará	San V. De Cañete*	3,753	3,828	3,904	4,310	11,256	16,140	19,676	23,580	26,962
	Grocio Prado	471	480	490	541	2,850	4,434	5,540	6,760	7,786
	Sub total Concon-Topara	**4,224**	**4,308**	**4,394**	**4,851**	**14,106**	**20,574**	**25,216**	**30,340**	**34,748**
Total Population		**1,214,434**	**1,258,346**	**1,304,038**	**1,468,018**	**1,662,141**	**1,872,609**	**2,103,640**	**2,342,824**	**2,612,706**

Table 3.1.2 DOMESTIC USE UNIT WATER DEMAND FOR SERVICE AREA OTHER THAN LIMA SOUTH CONE

POPULATION GROUP		Unit Water Demand (ℓ/p/d)								
		1998	1999	2000	2005	2010	2015	2020	2025	2030
I.	Up to 2,000	60	61	62	67	72	77	82	87	92
II.	2,001 to 5,000	100	101	102	107	112	117	122	127	132
III.	5,001 to 10,000	130	131	132	137	142	147	152	157	162
IV.	10,001 to 20,000	160	161	162	167	172	177	182	187	192
V.	20,001 to 50,000	180	182	184	194	204	214	224	234	244
VI.	50,001 and more	210	212	214	224	234	244	254	264	274

As for population group I,II,III and IV it has been considered 1 ℓ/p/d as annual unit water demand increment
As for population group V and VI it has been considered 2 ℓ/p/d as annual unit water demand increment
Year 1998 has been considered as the basic year for unit water demand

Table 3.1.3 Projection of Water Production in Thousand of Cubic Meter and Million of Cubic Meter *

Year	Drinking Water Production in Thousand of Cubic Meter per Month													TOTAL
	TYPE \ MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AGU	SEP	OCT	NOV	DEC	(MMC)
1998	Domestic	10,508	10,922	11,074	10,611	10,056	9,755	9,437	9,699	9,553	9,239	9,773	10,075	**120.70**
	Industrial	425	439	446	432	415	407	397	407	400	386	404	411	**4.97**
	Tourism	26	51	51	20	15	13	13	13	13	13	13	15	**0.26**
	Total	**10,959**	**11,412**	**11,571**	**11,063**	**10,486**	**10,175**	**9,846**	**10,119**	**9,966**	**9,638**	**10,190**	**10,502**	**125.93**
1999	Domestic	10,114	10,513	10,655	10,206	9,669	9,373	9,066	9,316	9,179	8,884	9,399	9,697	**116.07**
	Industrial	353	364	369	358	344	338	330	338	333	322	336	341	**4.13**
	Tourism	36	71	71	29	21	18	18	18	18	18	18	21	**0.36**
	Total	**10,503**	**10,948**	**11,096**	**10,593**	**10,035**	**9,729**	**9,414**	**9,672**	**9,530**	**9,224**	**9,753**	**10,059**	**120.56**
2000	Domestic	9,694	10,076	10,209	9,775	9,257	8,966	8,671	8,907	8,780	8,505	8,999	9,292	**111.13**
	Industrial	290	299	303	294	284	279	273	279	275	267	277	282	**3.40**
	Tourism	55	111	111	44	33	28	28	28	28	28	28	33	**0.55**
	Total	**10,040**	**10,486**	**10,623**	**10,114**	**9,574**	**9,273**	**8,972**	**9,214**	**9,083**	**8,799**	**9,304**	**9,607**	**115.09**
2005	Domestic	10,691	11,112	11,261	10,785	10,215	9,899	9,574	9,836	9,693	9,385	9,930	10,249	**122.63**
	Industrial	326	336	340	331	319	314	307	314	309	300	312	316	**3.82**
	Tourism	60	121	121	48	36	30	30	30	30	30	30	36	**0.60**
	Total	**11,077**	**11,569**	**11,722**	**11,164**	**10,570**	**10,243**	**9,911**	**10,180**	**10,033**	**9,715**	**10,272**	**10,601**	**127.06**
2010	Domestic	11,725	12,188	12,346	11,821	11,193	10,839	10,482	10,766	10,614	10,283	10,882	11,239	**134.38**
	Industrial	366	377	382	371	358	353	345	353	348	337	350	356	**4.30**
	Tourism	85	170	170	68	51	42	42	42	42	42	42	51	**0.85**
	Total	**12,176**	**12,734**	**12,898**	**12,260**	**11,602**	**11,234**	**10,869**	**11,162**	**11,004**	**10,663**	**11,275**	**11,645**	**139.52**
2015	Domestic	13,734	14,277	14,454	13,830	13,086	12,655	12,235	12,560	12,392	12,022	12,726	13,162	**157.13**
	Industrial	350	358	362	354	343	339	333	339	335	327	337	341	**4.12**
	Tourism	126	251	251	101	75	63	63	63	63	63	63	75	**1.26**
	Total	**14,209**	**14,887**	**15,067**	**14,284**	**13,504**	**13,057**	**12,631**	**12,962**	**12,790**	**12,412**	**13,126**	**13,579**	**162.51**
2020	Domestic	15,957	16,590	16,783	16,047	15,172	14,651	14,160	14,528	14,346	13,938	14,759	15,289	**182.22**
	Industrial	423	433	437	428	416	411	404	411	407	398	409	414	**4.99**
	Tourism	164	328	328	131	98	82	82	82	82	82	82	98	**1.64**
	Total	**16,545**	**17,351**	**17,548**	**16,606**	**15,687**	**15,145**	**14,646**	**15,021**	**14,835**	**14,418**	**15,250**	**15,801**	**188.85**
2025	Domestic	18,343	19,072	19,276	18,415	17,394	16,766	16,197	16,605	16,416	15,978	16,927	17,569	**208.96**
	Industrial	518	528	534	523	510	504	497	504	499	489	502	507	**6.12**
	Tourism	210	421	421	168	126	105	105	105	105	105	105	126	**2.10**
	Total	**19,071**	**20,021**	**20,231**	**19,106**	**18,030**	**17,375**	**16,799**	**17,215**	**17,020**	**16,572**	**17,534**	**18,203**	**217.18**
2030	Domestic	21,054	21,894	22,111	21,107	19,918	19,168	18,510	18,964	18,766	18,296	19,390	20,161	**239.34**
	Industrial	619	631	637	625	610	604	595	604	598	587	601	607	**7.32**
	Tourism	267	535	535	214	160	134	134	134	134	134	134	160	**2.67**
	Total	**21,941**	**23,060**	**23,282**	**21,945**	**20,689**	**19,905**	**19,239**	**19,702**	**19,498**	**19,017**	**20,125**	**20,929**	**249.33**

* Drinking Water service coverage it was set for Lima Districts ranging from 85% (1998) to 98% (2030) and Districts in Cañete River Basir Chilca-Cañete Axis and Concón-Topará ranging from 65% (1998) to 95% (2030)

Table 3.1.4 Projection of Water Production by District in Thousand of Cubic Meter

Drinking Water Production per Year in (1000 m^3/year)

Zone		Year / District	1998	1999	2000	2005	2010	2015	2020	2025	2030
Cañete River Basin		1. San Lorenzo de Quinti (1)	3.0	3.0	3.0	2.5	2.2	2.2	2.3	2.3	2.3
		2. Tanta (2)	16.0	16.4	16.7	16.4	16.8	19.8	23.2	28.5	32.7
		3. Huancaya	14.0	14.0	14.0	12.3	11.3	12.0	12.5	13.0	13.5
		4. Tomas	27.0	27.4	27.7	25.9	26.7	29.9	33.3	36.8	40.4
		5. Vitis	10.0	10.1	10.1	9.0	8.4	9.0	9.6	10.2	10.7
		6. Miraflores	13.4	13.5	13.6	12.3	11.7	12.7	13.7	14.6	15.6
		12. Carania	7.2	7.2	7.2	6.3	5.8	6.0	6.3	6.5	6.7
		13. Alis	164.1	169.6	175.1	183.1	203.4	315.1	388.9	476.3	581.4
		14. Laraos	31.7	32.0	32.4	29.9	29.0	32.2	35.5	38.8	42.1
		19. Tauripampa (3)	17.7	17.9	18.2	16.9	16.5	18.4	20.3	22.3	24.3
		20. Ayauca	30.2	30.6	30.9	28.8	28.2	31.6	35.0	38.6	42.3
		21. Yauyos	53.7	54.6	55.5	52.6	52.3	59.6	67.3	75.4	84.0
		22. Colonia	40.6	40.9	41.2	37.6	36.1	39.6	43.0	46.5	49.8
		23. Putinza	12.2	12.4	12.6	11.9	11.8	13.3	15.0	16.7	18.6
		24. Huantán	24.7	24.9	25.2	23.1	22.4	24.7	27.1	29.5	31.9
		25. Catahuasi	37.4	39.0	40.7	43.8	49.6	95.7	121.1	152.2	190.0
		26. Tupe	15.1	14.9	14.6	11.7	9.8	9.4	9.0	8.5	8.0
		27. Cacra	24.0	24.1	24.2	21.6	20.2	21.7	23.1	24.4	25.6
		28. Hongos	12.5	12.6	12.8	11.8	11.4	12.7	14.0	15.3	16.6
		29. Lincha	12.4	12.4	12.3	10.7	9.7	10.0	10.3	10.5	10.7
		30. Viñac	45.0	45.6	46.1	42.9	42.0	47.1	52.2	57.6	63.1
		31. Chocos	19.8	19.9	19.9	17.6	16.4	17.4	18.4	19.2	20.0
		32. Huangáscar	19.7	19.6	19.5	16.4	14.6	14.8	14.9	14.9	14.8
		33. Madean	22.7	22.9	23.0	20.8	19.8	21.5	23.2	24.9	26.5
		34. Azángaro	18.0	18.2	18.3	16.6	15.8	17.2	18.6	19.9	21.2
		35. Zuñiga	34.5	35.1	35.7	34.0	34.1	39.1	44.4	50.2	56.2
		36. Pacaran	45.1	46.6	48.3	49.8	53.7	66.0	80.1	96.0	113.7
		37. Lunahuaná (4)	181.4	191.3	204.6	208.9	265.0	327.1	395.1	472.4	555.6
		38. S Vicente de cañete (5)	2,681.7	2,804.1	2,959.8	3,085.1	3,422.0	4,341.9	5,426.4	7,477.9	9,209.6
		39. Nuevo Imperial	1,034.0	1,063.4	1,093.1	1,095.1	1,127.8	1,360.8	1,623.7	2,398.0	2,863.6
		40. Imperial	2,967.9	3,067.4	3,169.6	3,243.1	3,531.7	4,399.7	6,164.2	7,536.4	9,164.8
		41. San Luis	646.1	672.9	711.2	910.9	975.2	1,165.7	1,410.9	1,697.7	2,030.1
		42. Quilmana	753.9	780.5	808.0	842.7	928.3	1,391.1	1,749.9	2,418.9	3,000.2
		43. Cerro Azul	333.1	349.5	371.1	382.0	426.6	536.9	745.9	913.4	1,200.0
		Sub total River Basin	**9,370.0**	**9,714.2**	**10,116.1**	**10,534.0**	**11,456.4**	**14,521.9**	**18,678.5**	**24,264.2**	**29,586.7**
Corridor Lurin Cañete	Axis Chilca Cañete	44. Asia	150.5	160.4	172.0	180.0	199.9	255.1	315.9	389.2	550.1
		45. Coayllo (6)	8.7	8.8	8.9	8.2	8.0	8.9	9.8	10.7	11.6
		46. Mala	1,643.1	1,727.0	1,833.9	2,213.5	2,547.9	3,353.3	4,343.5	5,591.1	7,941.7
		48. Sta Cruz de Flores (7)	55.7	57.0	58.3	57.4	59.3	70.1	82.1	131.2	149.8
		49. San Antonio	128.4	134.4	143.7	141.0	149.7	181.0	213.6	252.1	295.5
		50. Chilca (8)	1,127.7	1,192.1	1,273.0	1,397.9	1,916.7	2,613.2	3,511.5	4,688.5	6,226.4
		Sub total Axis	**3,114.1**	**3,279.6**	**3,489.8**	**3,997.8**	**4,881.5**	**6,481.6**	**8,476.4**	**11,062.8**	**15,175.0**
	Lima South Cone (*)	51. Pucusana	630.7	630.7	630.7	630.7	946.1	1,261.4	1,576.8	1,892.2	2,522.9
		52. Sta Maria del Mar	31.5	31.5	31.5	31.5	94.6	94.6	315.4	315.4	315.4
		53. San Bartolo	630.7	630.7	630.7	1,261.4	1,576.8	2,207.5	2,838.2	3,784.3	5,045.8
		54. Punta Negra	630.7	630.7	630.7	630.7	946.1	946.1	1,261.4	1,576.8	1,576.8
		55. Punta Hermosa	946.1	946.1	946.1	1,261.4	1,576.8	2,207.5	2,522.9	3,153.6	3,784.3
		56. Lurín	5,045.8	5,045.8	5,045.8	6,937.9	8,830.1	11,668.3	15,137.3	18,606.2	22,390.6
		57. Pachacamac	2,522.9	2,675.2	2,838.2	3,784.3	4,730.4	6,307.2	7,884.0	9,776.2	11,668.3
		58. Villa M. Del Triunfo	33,428.2	31,573.1	29,643.8	31,851.4	33,743.5	37,527.8	41,942.9	46,357.9	51,403.7
		59. Villa el Salvador	30,274.6	28,728.7	27,121.0	29,643.8	31,536.0	35,635.7	40,366.1	45,096.5	50,773.0
		60. S. J. Miraflores	39,104.6	36,463.7	33,743.5	36,266.4	38,158.6	41,627.5	45,096.5	47,619.4	50,457.6
		Sub total South Cone	**113,245.8**	**107,356.3**	**101,262.1**	**112,299.7**	**122,138.9**	**139,483.7**	**158,941.4**	**178,178.4**	**199,938.2**
Pampas Concón-Topará			197.1	206.0	219.9	225.2	1,046.1	2,021.0	2,757.0	3,671.7	4,631.7
Sub total Pampas Concón-Topará			**197.1**	**206.0**	**219.9**	**225.2**	**1,046.1**	**2,021.0**	**2,757.0**	**3,671.7**	**4,631.7**
TOTAL (MMC)			**125.93**	**120.56**	**115.09**	**127.06**	**139.52**	**162.51**	**188.85**	**217.18**	**249.33**

(*) Information taken from " Master Plan of Drinking Water and Sewerage Sistems of Lima and Callao", SEDAPAL, 1998

Table 3.1.5 Projection of Water Production by District in m^3/s

Drinking Water Production in (m^3/s)

Zone		Year / District	1998	1999	2000	2005	2010	2015	2020	2025	2030
Cañete River Basin		1. San Lorenzo de Quinti (1)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		2. Tanta (2)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0007	0.0009	0.0010
		3. Huancaya	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
		4. Tomas	0.0009	0.0009	0.0009	0.0008	0.0008	0.0009	0.0011	0.0012	0.0013
		5. Vitis	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
		6. Miraflores	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005
		12. Carania	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
		13. Alis	0.0052	0.0054	0.0056	0.0058	0.0064	0.0100	0.0123	0.0151	0.0184
		14. Laraos	0.0010	0.0010	0.0010	0.0009	0.0009	0.0010	0.0011	0.0012	0.0013
		19. Tauripampa (3)	0.0006	0.0006	0.0006	0.0005	0.0005	0.0006	0.0006	0.0007	0.0008
		20. Ayauca	0.0010	0.0010	0.0010	0.0009	0.0009	0.0010	0.0011	0.0012	0.0013
		21. Yauyos	0.0017	0.0017	0.0018	0.0017	0.0017	0.0019	0.0021	0.0024	0.0027
		22. Colonia	0.0013	0.0013	0.0013	0.0012	0.0011	0.0013	0.0014	0.0015	0.0016
		23. Putinza	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0006
		24. Huantán	0.0008	0.0008	0.0008	0.0007	0.0007	0.0008	0.0009	0.0009	0.0010
		25. Catahuasi	0.0012	0.0012	0.0013	0.0014	0.0016	0.0030	0.0038	0.0048	0.0060
		26. Tupe	0.0005	0.0005	0.0005	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
		27. Cacra	0.0008	0.0008	0.0008	0.0007	0.0006	0.0007	0.0007	0.0008	0.0008
		28. Hongos	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005
		29. Lincha	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
		30. Viñac	0.0014	0.0014	0.0015	0.0014	0.0013	0.0015	0.0017	0.0018	0.0020
		31. Chocos	0.0006	0.0006	0.0006	0.0006	0.0005	0.0006	0.0006	0.0006	0.0006
		32. Huangáscar	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
		33. Madean	0.0007	0.0007	0.0007	0.0007	0.0006	0.0007	0.0007	0.0008	0.0008
		34. Azángaro	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005	0.0006	0.0006	0.0007
		35. Zuñiga	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012	0.0014	0.0016	0.0018
		36. Pacaran	0.0014	0.0015	0.0015	0.0016	0.0017	0.0021	0.0025	0.0030	0.0036
		37. Lunahuaná (4)	0.0058	0.0061	0.0065	0.0066	0.0084	0.0104	0.0125	0.0150	0.0176
		38. S Vicente de cañete (5)	0.0850	0.0889	0.0939	0.0978	0.1085	0.1377	0.1721	0.2371	0.2920
		39. Nuevo Imperial	0.0328	0.0337	0.0347	0.0347	0.0358	0.0431	0.0515	0.0760	0.0908
		40. Imperial	0.0941	0.0973	0.1005	0.1028	0.1120	0.1395	0.1955	0.2390	0.2906
		41. San Luis	0.0205	0.0213	0.0226	0.0289	0.0309	0.0370	0.0447	0.0538	0.0644
		42. Quilmana	0.0239	0.0247	0.0256	0.0267	0.0294	0.0441	0.0555	0.0767	0.0951
		43. Cerro Azul	0.0106	0.0111	0.0118	0.0121	0.0135	0.0170	0.0237	0.0290	0.0381
		Sub total River Basin	**0.2971**	**0.3080**	**0.3208**	**0.3340**	**0.3633**	**0.4605**	**0.5923**	**0.7694**	**0.9382**
Corridor Lurin Cañete	Axis Chilca Cañete	44. Asia	0.0048	0.0051	0.0055	0.0057	0.0063	0.0081	0.0100	0.0123	0.0174
		45. Coayllo (6)	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004
		46. Mala	0.0521	0.0548	0.0582	0.0702	0.0808	0.1063	0.1377	0.1773	0.2518
		48. Sta Cruz de Flores (7)	0.0018	0.0018	0.0019	0.0018	0.0019	0.0022	0.0026	0.0042	0.0048
		49. San Antonio	0.0041	0.0043	0.0046	0.0045	0.0047	0.0057	0.0068	0.0080	0.0094
		50. Chilca (8)	0.0358	0.0378	0.0404	0.0443	0.0608	0.0829	0.1114	0.1487	0.1974
		Sub total Axis	**0.0987**	**0.1040**	**0.1107**	**0.1268**	**0.1548**	**0.2055**	**0.2688**	**0.3508**	**0.4812**
	Lima South Cone	51. Pucusana	0.0200	0.0200	0.0200	0.0200	0.0300	0.0400	0.0500	0.0600	0.0800
		52. Sta Maria del Mar	0.0010	0.0010	0.0010	0.0010	0.0030	0.0030	0.0100	0.0100	0.0100
		53. San Bartolo	0.0200	0.0200	0.0200	0.0400	0.0500	0.0700	0.0900	0.1200	0.1600
		54. Punta Negra	0.0200	0.0200	0.0200	0.0200	0.0300	0.0300	0.0400	0.0500	0.0500
		55. Punta Hermosa	0.0300	0.0300	0.0300	0.0400	0.0500	0.0700	0.0800	0.1000	0.1200
		56. Lurín	0.1600	0.1600	0.1600	0.2200	0.2800	0.3700	0.4800	0.5900	0.7100
		57. Pachacamac	0.0800	0.0848	0.0900	0.1200	0.1500	0.2000	0.2500	0.3100	0.3700
		58. Villa M. Del Triunfo	1.0600	1.0012	0.9400	1.0100	1.0700	1.1900	1.3300	1.4700	1.6300
		59. Villa el Salvador	0.9600	0.9110	0.8600	0.9400	1.0000	1.1300	1.2800	1.4300	1.6100
		60. S. J. Miraflores	1.2400	1.1563	1.0700	1.1500	1.2100	1.3200	1.4300	1.5100	1.6000
		Sub total South Cone	**3.5910**	**3.4042**	**3.2110**	**3.5610**	**3.8730**	**4.4230**	**5.0400**	**5.6500**	**6.3400**
Pampas Concón-Topará			0.0062	0.0065	0.0070	0.0071	0.0332	0.0641	0.0874	0.1164	0.1469
Sub total Pampas Concón-Topará			**0.0062**	**0.0065**	**0.0070**	**0.0071**	**0.0332**	**0.0641**	**0.0874**	**0.1164**	**0.1469**
TOTAL			**3.9931**	**3.8228**	**3.6494**	**4.0289**	**4.4242**	**5.1531**	**5.9885**	**6.8866**	**7.9063**

Tabla 3.1.6 Present Situation of the Water Supply Systems Administrated and Operated by EMAPAC S.A.

District	Present Water Production (m^3/month)			Water Sales (m^3/mes)		Losses m^3 / month	Losses (%)	Continuity (hours per day	Coverage (%)	Cost		
	Groundwater	Surface water	Total							Tipo	S/.$/m^3$	$ / m^3
Imperial	43,760	168,347	212,107	Domestic:	71,282	119,861	57	24	74	Domestic:	0.46	0.14
				Comercial:	20,964					Comercial:	0.68	0.21
				Industrial:	0					Industrial:	0.00	0.00
				Total:	92,246					Weighted:	0.51	0.15
San Vicente	189,878	0	189,878	Domestic:	66,059	90,273	48	20	63	Domestic:	0.53	0.16
				Comercial:	32,217					Comercial:	0.78	0.24
				Industrial:	1,329					Industrial:	1.54	0.47
				Total:	99,605					Weighted:	0.62	0.19
Mala	71,542	0	71,542	Estimated (*)		2,766	4	17	63	Average :	0.46	0.14
				Total:	68,775							
San Luis (**)	49,605	0	49,605	Domestic:	13,445	34,195	69	24	45	Domestic:	0.42	0.13
				Comercial:	1,965					Comercial:	0.67	0.20
				Industrial:	0					Industrial:	0.00	0.00
				Total:	15,410					Weighted:	0.46	0.14
Quilmana	47,706	0	47,706	Domestic:	21,989	19,411	41	18	56	Domestic:	0.28	0.09
				Comercial:	6,306					Comercial:	0.35	0.11
				Industrial:	0					Industrial:	0.00	0.00
				Total:	28,295					Weighted:	0.30	0.09
Cerro Azul (**)	33,070	0	33,070	Domestic:	16,050	13,985	42	24	89	Domestic:	0.37	0.11
				Comercial:	3,035					Comercial:	0.75	0.23
				Industrial:	0					Industrial:	0.00	0.00
				Total:	19,085					Weighted:	0.43	0.13
San Antonio	25,384	0	25,384	Domestic:	10,465	10,640	42	9	90	Domestic:	0.46	0.14
				Comercial:	4,279					Comercial:	1.02	0.31
				Industrial:	0					Industrial:	0.00	0.00
				Total:	14,744					Weighted:	0.62	0.19
Santa Cruz de Flores	11,744	0	11,744	Domestic:	5,500	5,252	45	8	94	Domestic:	0.41	0.13
				Comercial:	992					Comercial:	0.59	0.18
				Industrial:	0					Industrial:	0.00	0.00
				Total:	6,492					Weighted:	0.44	0.13
Lunahuana	20,437	0	20,437	Domestic:	4,649	14,506	71	24	32	Domestic:	0.30	0.09
				Comercial:	1,282					Comercial:	0.59	0.18
				Industrial:	0					Industrial:	0.00	0.00
				Total:	5,931					Weighted:	0.37	0.11
Total	**493,125**	**168,347**	**661,472**	**350,583**		**310,889**	**47**	**Average : 19**	**65**	**Average :**	**0.47**	**0.14**

Exchange rate: 1$=3.30 Nuevos Soles

(*) Estimated based on the monthly water sales divided by average tariff

(**) Out of the total water production for both systems it was taken 60% for San Luis and 40% for Cerro Azul

Table 3.1.7 Present Deficit of Water for EMAPAC Water Supply System

System	Urban Population 1998 (1)	Rural Population 1998 (1)	Urban Population With Water Service (1)	Rural Population With Water Service (1)	Present Water Production (2)	Population Without Water Service	Per Person Net Consumption (3) (l/p/d)	Eficiency Ratio (%)	Per Person Gross Consumption (l/p/d)	Deficit (4) (m^3/mes)
Imperial	33,634	3,363	21,553	2,156	212,107	13,288	175	43	406	161,909
San Vicente	27,300	2,731	18,613	1,862	189,878	9,556	175	52	336	96,277
Mala	17,553	1,755	10,915	1,091	71,542	7,302	152	96	158	34,662
San Luis	9,331	932	3,403	340	49,605	6,520	125	31	402	78,648
Quilmana	6,784	679	4,049	405	47,706	3,009	125	59	211	19,067
Cerro Azul	3,902	390	3,253	325	33,070	714	97	58	168	3,595
San Antonio	2,421	242	2,143	214	25,384	306	97	58	168	1,540
S. Cruz de Flores	1,530	153	1,262	126	11,744	295	61	55	111	981
Lunahuana	1,330	132	804	80	20,437	578	61	29	210	3,650
Total	**103,785**	**10,377**	**65,995**	**6,599**	**661,473**	**41,568**	**155**	**48**	**321**	**400,329**

(1) Numbers reported by EMAPAC Master Plan

(2) Numbers reported by EMAPAC Master Plan adjusted by JICA Study Team

(3) Proposed by JICA Study Team

(4) Population without service multiplied by person gross consumption

Table 3.1.8 Active Projection of Water Demand For Metropolitan Lima Per District And Per Service Center Period 1998-2030 (*)

(m^3/s)

DISTRICT	YEAR							
	1998	2000	2005	2010	2015	2020	2025	2030
CARABAYLLO	0.36	0.30	0.38	0.40	0.52	0.57	0.60	0.65
COMAS	1.42	1.10	1.13	1.20	1.26	1.33	1.30	1.42
INDEPENDENCIA	0.56	0.40	0.42	0.40	0.43	0.44	0.40	0.45
LOS OLIVOS	0.95	0.70	0.86	0.90	1.00	1.03	1.00	1.10
PUENTE PIEDRA	0.33	0.30	0.41	0.50	0.70	0.89	1.20	1.64
RIMAC	0.62	0.40	0.46	0.40	0.47	0.48	0.40	0.49
SAN MARTIN DE PORRAS	1.45	1.10	1.14	1.20	1.30	1.37	1.40	1.52
C. S. COMAS	**5.68**	**4.50**	**4.80**	**5.20**	**5.67**	**6.09**	**6.60**	**7.27**
BELLAVISTA	0.33	0.20	0.25	0.20	0.25	0.26	0.20	0.26
CALLAO	1.35	1.00	1.08	1.10	1.21	1.27	1.30	1.41
C. DE LA LEGUA	0.14	0.10	0.10	0.10	0.11	0.12	0.10	0.13
LA PERLA	0.25	0.10	0.18	0.10	0.18	0.18	0.10	0.19
LA PUNTA	0.03	0.00	0.03	0.00	0.03	0.03	0.00	0.03
VENTANILLA	0.33	0.20	0.34	0.40	0.47	0.56	0.60	0.78
C. S. CALLAO	**2.42**	**1.90**	**1.98**	**2.10**	**2.26**	**2.43**	**2.60**	**2.81**
BREÑA	0.39	0.30	0.29	0.20	0.30	0.30	0.30	0.31
JESUS MARIA	0.37	0.20	0.30	0.30	0.31	0.32	0.30	0.34
LA VICTORIA	1.02	0.70	0.75	0.70	0.78	0.79	0.80	0.82
LIMA CERCADO	1.69	1.30	1.28	1.30	1.33	1.36	1.30	1.41
MAGDALENA	0.25	0.20	0.21	0.20	0.22	0.23	0.20	0.23
PUEBLO LIBRE	0.34	0.20	0.27	0.20	0.29	0.29	0.30	0.30
SAN MIGUEL	0.54	0.40	0.44	0.40	0.47	0.48	0.40	0.49
C. S. BREÑA	**4.59**	**3.50**	**3.53**	**3.60**	**3.69**	**3.77**	**3.80**	**3.91**
ATE VITARTE	1.03	0.90	1.04	1.20	1.33	1.41	1.40	1.50
CHACLACAYO	0.12	0.10	0.11	0.10	0.12	0.12	0.10	0.13
CIENEGUILLA	0.04	0.00	0.05	0.00	0.08	0.10	0.10	0.14
EL AGUSTINO	0.45	0.30	0.37	0.30	0.40	0.42	0.40	0.44
LA MOLINA	0.53	0.40	0.60	0.70	0.84	0.94	1.00	1.07
LURIGANCHO	0.32	0.20	0.32	0.30	0.38	0.41	0.40	0.46
SAN LUIS	0.24	0.10	0.18	0.10	0.18	0.18	0.10	0.19
SANTA ANITA	0.41	0.30	0.39	0.40	0.49	0.54	0.50	0.62
C. S. ATE VITARTE	**3.13**	**2.70**	**3.06**	**3.40**	**3.83**	**4.13**	**4.30**	**4.55**
S. J. LURIGANCHO	1.89	1.60	1.68	1.80	1.93	2.05	2.10	2.30
C. S. S.J. LURIGANCHO	**1.89**	**1.60**	**1.68**	**1.80**	**1.93**	**2.05**	**2.10**	**2.30**
BARRANCO	0.17	0.10	0.14	0.10	0.15	0.15	0.10	0.16
CHORRILLOS	0.72	0.50	0.60	0.60	0.64	0.67	0.60	0.70
LINCE	0.37	0.20	0.26	0.20	0.28	0.29	0.20	0.30
MIRAFLORES	0.49	0.40	0.47	0.40	0.50	0.52	0.50	0.55
SAN BORJA	0.51	0.50	0.53	0.50	0.58	0.60	0.60	0.62
SAN ISIDRO	0.38	0.30	0.37	0.30	0.40	0.41	0.40	0.44
STGO. SURCO	0.96	1.00	1.17	1.20	1.41	1.54	1.60	1.82
SURQUILLO	0.33	0.30	0.31	0.30	0.32	0.33	0.30	0.34
C. S. SURQUILLO	**3.92**	**3.60**	**3.85**	**4.00**	**4.29**	**4.51**	**4.70**	**4.92**
LURIN	0.12	0.10	0.16	0.20	0.29	0.37	0.40	0.54
PACHACAMAC	0.06	0.00	0.09	0.10	0.15	0.19	0.20	0.28
PUCUSANA	0.02	0.00	0.02	0.00	0.03	0.04	0.00	0.06
S. J. MIRAFLORES	0.95	0.80	0.84	0.90	1.01	1.09	1.10	1.22
VILLA MARIA	0.82	0.70	0.74	0.80	0.91	1.01	1.10	1.25
V. SALVADOR	0.74	0.60	0.69	0.70	0.87	0.98	1.10	1.23
C. S. V. EL SALVADOR	**2.71**	**2.30**	**2.54**	**2.80**	**3.26**	**3.68**	**4.10**	**4.59**
SAN BARTOLO	0.02	0.01	0.03	0.04	0.05	0.07	0.09	0.12
PUNTA HERMOSA	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.09
PUNTA NEGRA	0.02	0.01	0.01	0.02	0.02	0.03	0.04	0.04
SANTA MARIA	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
ANCON	0.05	0.05	0.07	0.11	0.15	0.19	0.24	0.30
SANTA ROSA	0.05	0.04	0.05	0.05	0.07	0.08	0.08	0.10
NO ADM. FOR SEDAPAL	**0.15**	**0.10**	**0.20**	**0.20**	**0.34**	**0.43**	**0.50**	**0.66**
METROPOLITAN LIMA	**24.50**	**20.50**	**21.63**	**23.40**	**25.28**	**27.09**	**29.00**	**31.01**

Note : Does not include own source however it includes Parks and Gardens irrigation

(*) This table was taken from SEDAPAL Master Plan, 1998

Table 3.1.9 Active Projection Of The Water Production Necessity For Metropolitan Lima Lima Per District and Per Service Center
Period 1998-2030 (*)
(m^3/s)

DISTRICT	YEAR							
	1998	2000	2005	2010	2015	2020	2025	2030
CARABAYLLO	0.47	0.43	0.52	0.60	0.68	0.75	0.80	0.86
COMAS	1.86	1.51	1.55	1.56	1.65	1.74	1.80	1.86
INDEPENDENCIA	0.72	0.58	0.57	0.55	0.56	0.57	0.58	0.59
LOS OLIVOS	1.25	1.05	1.17	1.23	1.30	1.35	1.39	1.44
PUENTE PIEDRA	0.43	0.42	0.57	0.71	0.91	1.16	1.61	2.15
RIMAC	0.81	0.64	0.62	0.60	0.61	0.62	0.63	0.64
SAN MARTIN DE PORRAS	1.91	1.52	1.56	1.60	1.69	1.80	1.90	2.00
C. S. COMAS	**7.45**	**6.16**	**6.57**	**6.85**	**7.41**	**7.99**	**8.71**	**9.54**
BELLAVISTA	0.44	0.34	0.34	0.33	0.33	0.34	0.34	0.35
CALLAO	1.77	1.45	1.49	1.49	1.58	1.67	1.76	1.85
C. DE LA LEGUA	0.18	0.14	0.14	0.14	0.15	0.16	0.17	0.17
LA PERLA	0.32	0.25	0.25	0.24	0.24	0.24	0.24	0.25
LA PUNTA	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
VENTANILLA	0.43	0.40	0.46	0.52	0.62	0.73	0.87	1.02
C. S. CALLAO	**3.17**	**2.62**	**2.71**	**2.76**	**2.96**	**3.18**	**3.42**	**3.69**
BREÑA	0.53	0.41	0.40	0.38	0.39	0.40	0.41	0.41
JESUS MARIA	0.50	0.40	0.41	0.40	0.41	0.43	0.44	0.45
LA VICTORIA	1.37	1.05	1.04	1.00	1.02	1.04	1.06	1.08
LIMA CERCADO	2.30	1.80	1.77	1.72	1.75	1.79	1.82	1.86
MAGDALENA	0.34	0.28	0.28	0.28	0.29	0.30	0.30	0.31
PUEBLO LIBRE	0.45	0.37	0.37	0.36	0.37	0.38	0.39	0.39
SAN MIGUEL	0.72	0.60	0.61	0.59	0.61	0.63	0.64	0.64
C. S. BREÑA	**6.19**	**4.91**	**4.88**	**4.74**	**4.85**	**4.96**	**5.05**	**5.14**
ATE VITARTE	1.36	1.21	1.42	1.56	1.74	1.85	1.92	1.97
CHACLACAYO	0.15	0.13	0.15	0.15	0.15	0.16	0.16	0.17
CIENEGUILLA	0.06	0.05	0.07	0.08	0.11	0.13	0.16	0.18
EL AGUSTINO	0.58	0.50	0.51	0.50	0.53	0.55	0.56	0.58
LA MOLINA	0.70	0.65	0.82	0.95	1.10	1.23	1.31	1.40
LURIGANCHO	0.42	0.40	0.44	0.46	0.50	0.54	0.57	0.61
SAN LUIS	0.32	0.25	0.24	0.23	0.24	0.24	0.25	0.25
SANTA ANITA	0.54	0.48	0.54	0.58	0.64	0.71	0.77	0.81
C. S. ATE VITARTE	**4.11**	**3.67**	**4.19**	**4.52**	**5.00**	**5.41**	**5.71**	**5.96**
S. J. LURIGANCHO	2.46	2.14	2.30	2.37	2.52	2.69	2.85	3.02
C. S. S.J. LURIGANCHO	**2.46**	**2.14**	**2.30**	**2.37**	**2.52**	**2.69**	**2.85**	**3.02**
BARRANCO	0.23	0.19	0.19	0.19	0.19	0.20	0.20	0.21
CHORRILLOS	0.93	0.80	0.81	0.81	0.84	0.88	0.90	0.91
LINCE	0.51	0.36	0.36	0.36	0.37	0.38	0.39	0.39
MIRAFLORES	0.67	0.64	0.65	0.64	0.66	0.69	0.71	0.73
SAN BORJA	0.67	0.67	0.73	0.72	0.76	0.79	0.81	0.82
SAN ISIDRO	0.52	0.50	0.52	0.51	0.53	0.55	0.56	0.58
STGO. SURCO	1.25	1.38	1.60	1.67	1.84	2.02	2.22	2.38
SURQUILLO	0.44	0.43	0.43	0.42	0.42	0.43	0.44	0.45
C. S. SURQUILLO	**5.21**	**4.97**	**5.29**	**5.31**	**5.61**	**5.93**	**6.22**	**6.46**
LURIN	0.16	0.16	0.22	0.28	0.37	0.48	0.59	0.71
PACHACAMAC	0.08	0.09	0.12	0.15	0.20	0.25	0.31	0.37
PUCUSANA	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.08
S. J. MIRAFLORES	1.24	1.07	1.15	1.21	1.32	1.43	1.51	1.60
VILLA MARIA	1.06	0.94	1.01	1.07	1.19	1.33	1.47	1.63
V. SALVADOR	0.96	0.86	0.94	1.00	1.13	1.28	1.43	1.61
C. S. VILLA EL SALVADOR	**3.51**	**3.14**	**3.46**	**3.75**	**4.26**	**4.82**	**5.38**	**6.01**
SAN BARTOLO	0.02	0.02	0.04	0.05	0.07	0.09	0.12	0.16
PUNTA HERMOSA	0.03	0.03	0.04	0.05	0.07	0.08	0.10	0.12
PUNTA NEGRA	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05
SANTA MARIA	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
ANCON	0.06	0.07	0.10	0.14	0.19	0.25	0.32	0.40
SANTA ROSA	0.06	0.06	0.07	0.07	0.09	0.10	0.11	0.13
NO ADM. FOR SEDAPAL	**0.19**	**0.20**	**0.27**	**0.34**	**0.45**	**0.57**	**0.71**	**0.87**
METROPOLITAN LIMA	**32.29**	**27.80**	**29.67**	**30.64**	**33.05**	**35.54**	**38.05**	**40.68**

Note: Includes Water Demand of Clients with own source as well as unaccounted Water

(*) This table was taken from SEDAPAL Master Plan, 1998

Table 3.2.1 COMPARISON OF ET_0 ESTIMATED BY THE DIFFERENT METHODS

Station: Cañete - Latitude 13°07' S
Longitude 76°12' W

Month	Hargreaves		Radiation		Blanny - Criddle		Modified Penman	
	ET_0 (mm/month)	ET_0 (mm/day)	ET_0 (mm/month)	ET_0 (mm/day)	ET_0 (mm/month)	ET_0 (mm/day)	ET_0 (mm/month)	ET_0 (mm/day)
Jan.	151.25	4.88	151.94	4.90	169.01	5.45	128.03	4.13
Feb.	136.65	4.88	139.63	5.00	152.65	5.45	121.80	4.35
Mar.	138.03	4.45	142.47	4.60	163.79	5.28	118.42	3.82
Apr.	108.33	3.61	128.38	4.28	147.96	4.93	105.00	3.50
May	80.17	2.59	92.84	3.00	139.24	4.49	78.74	2.54
Jun.	70.93	2.36	53.40	1.78	125.10	4.17	60.30	2.01
Jul.	65.89	2.13	49.48	1.60	126.33	4.08	55.80	1.80
Aug.	75.15	2.42	52.71	1.70	128.73	4.15	59.21	1.91
Sept.	86.06	2.87	65.45	2.18	129.65	4.32	69.90	2.33
Oct.	109.87	3.54	91.27	2.94	143.07	4.62	88.66	2.86
Nov.	124.96	4.17	110.12	3.67	148.39	4.95	105.00	3.50
Dec.	142.90	4.61	136.02	4.39	163.20	5.26	121.52	3.92
Total / Average	1,290.19	3.54	1,213.71	3.34	1,737.12	4.76	1,112.38	3.06

Note: In estimating consumptive water requirements, it is recommended to use modified Penman method as calculated by the JICA Study Team.

ET_0 : Potential Evapotranspiration

Table : 3.2.2 IRRIGATION WATER DEMAND AT THE EXISTING CONDITION IN THE VALLE DE CAÑETE (24,052 HA)

(Unit : MCM)

Crops (ha)	Area (ha)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Cotton	10,726	31.03	32.68	28.39	16.50					6.24	10.73	20.02	28.79	174.38
Starchy maize	1,373	3.96	4.15	2.86							0.92	1.66	3.06	16.61
Potato	2,745				2.34	2.67	3.84	3.46	3.35	0.56				16.22
Yellow maize for feed	1,965	5.56									1.34	3.32	5.35	15.57
Starchy maize	1,965		2.14	2.65	3.45	3.36	2.77	2.47	2.29	0.94				20.07
Yellow maize for feed	1,965	2.34	4.84	5.25	3.86			0.82	2.02	3.21	1.84			24.18
Cotton in the submerged	1,811	5.24	5.52	4.56	2.79					1.05	1.81	3.38	3.78	28.13
Horticulture	868	0.94	2.01	2.21	1.42	0.56	0.93	1.04	0.77	0.54	1.32	2.03	1.59	15.36
Citrus	819	1.46	1.55	1.35	1.34	0.94	0.77	0.74	0.78	0.89	1.09	1.34	1.39	13.64
Orchard (apple, grape, etc.)	1,710	2.83	2.97	2.61	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	2.68	27.01
Pasture (alfalfa, etc.)	667	1.56	1.65	1.45	1.33	0.93	0.76	0.68	0.72	0.88	1.08	1.33	1.48	13.85
Starchy maize	776	2.20	2.35	1.61	0.66	0.76	0.96	0.98	0.95	0.16	0.52	0.92	1.73	13.80
Total	27,390	57.12	59.86	52.94	35.68	11.21	12.02	12.18	12.87	16.46	22.64	35.99	49.85	378.82

Note : Irrigation efficiency is estimated at 45%.

Interconnected Systems

Table 3.3.1
Central North Interconnected System (SICN)
1998

Company	Central	Type	Installed Power (MW)	Effective Power (MW)
ELECTROPERU S.A.	C.H. MANTARO	HIDROPOWER	798.0	580.0
	C.H. RESTITUCION	HIDROPOWER	210.4	200.0
	Sub - Total	*HIDROPOWER*	*1008.4*	**780.0**
	TOTAL ELECTROPERU		**1008.4**	**780.0**
EDEGEL S.A.	C.H. HUINCO	HIDROPOWER	258.4	240.0
	C.H. MATUCANA	HIDROPOWER	120.0	120.0
	C.H. CALLAHUANCA	HIDROPOWER	71.0	71.0
	C.H. MOYOPAMPA	HIDROPOWER	63.0	60.0
	C.H. HUAMPANI	HIDROPOWER	31.4	29.0
	Sub - Total	*HIDROPOWER*	*543.8*	*520.0*
	CT SANTA ROSA	THERMAL	289.7	**259.8**
	Sub - Total	*THERMAL*	*289.7*	*259.8*
	TOTAL EDEGEL		**833.5**	**779.8**
CAHUA S.A.	C.H. CAHUA	HIDROPOWER	41.5	41.5
	C.H. PARIAC	HIDROPOWER	5.2	5.2
	Sub - Total	*HIDROPOWER*	*46.7*	**46.7**
	TOTAL CAHUA		**46.7**	**46.7**
ETEVENSA - EEPSA	TG VENTANILLA	THERMAL	519.2	493.2
	TG MALACAS	THERMAL	116.0	111.0
	Sub - Total	*THERMAL*	*635.2*	*604.2*
	TOTAL ETEVENSA		**635.2**	**604.2**
EGENOR S.A.	C.H. CAÑON DEL PATO	HIDROPOWER	153.9	150.0
	C.H. CARHUAQUERO	HIDROPOWER	75.1	75.0
	Sub - Total	*HIDROPOWER*	*229.0*	*225.0*
	TG CHIMBOTE	THERMAL	63.4	58.7
	TG PIURA	THERMAL	24.3	20.4
	TG TRUJILLO	THERMAL	22.8	19.9
	GD PIURA	THERMAL	26.3	22.3
	GD CHICLAYO NORTE	THERMAL	7.5	6.0
	GD CHICLAYO OESTE	THERMAL	21.0	18.0
	GD PAITA	THERMAL	8.3	7.9
	GD SULLANA	THERMAL	8.0	7.6
	TV TRUPAL	THERMAL	12.0	11.0
	Sub - Total	*THERMAL*	*193.6*	*171.8*
	TOTAL EGENOR		**422.6**	**396.8**
SHOUGESA	TV SAN NICOLAS	THERMAL	62.5	54.7
	Sub - Total	*THERMAL*	*62.5*	*54.7*
	TOTAL SHOUGESA		**62.5**	**54.7**
CNP ENERGIA S.A.	GD PACASMAYO	THERMAL	10.1	8.8
	Sub - Total	*THERMAL*	*10.1*	*8.8*
	C.H. GALLITO CIEGO	HIDROPOWER	34.0	34.0
	Sub - Total	*HIDROPOWER*	*34.0*	*34.0*
	TOTAL CNP ENERGIA		**44.1**	**42.8**
ELECTROANDES S.A.	C.H. YAUPI	HIDROPOWER	108.0	100.0
	C.H. OROYA	HIDROPOWER	9.0	9.0
	C.H. PACHACAMAC	HIDROPOWER	12.0	12.0
	C.H. MALPASO	HIDROPOWER	54.4	44.0
	Sub - Total	*HIDROPOWER*	*183.4*	*165.0*
	TOTAL ELECTROANDES		**183.4**	**165.0**
MAPLE GAS	CT AGUAYTIA	THERMAL	155.0	155.0
	Sub -Total	*THERMAL*	*155.0*	*155.0*
	TOTAL MAPLE GAS		*155.0*	*155.0*
TOTAL HIDROPOWER STATION			**2045.3**	**1770.7**
TOTAL THERMAL STATION			**1346.1**	**1254.3**
TOTAL CENTER - NORTH INTERCONNECTED SYSTEM			**3391.4**	**3025.0**

Table 3.3.2
South Interconnected System (SISUR)
1998

Company	Central	Type	Installed Power (MW)	Effective Power (MW)
EGASA	CC.HH. CHARCANI (I,II,III,IV,VI)	HIDROPOWER	32.02	29.70
	CHARCANI V	HIDROPOWER	136.80	135.00
	Sub - Total	*HIDROPOWER*	*168.82*	*164.70*
	CT CHILINA	THERMAL	52.40	52.40
	CT MOLLENDO	THERMAL	32.09	31.70
	Sub - Total	*THERMAL*	*84.49*	*84.10*
	TOTAL EGASA		**253.31**	**248.80**
EGESUR	CC.HH. ARICOTA I Y II	HIDROPOWER	35.7	34.90
	Sub - Total	*HIDROPOWER*	*35.70*	*34.90*
	CT CALANA	THERMAL	19.20	19.20
	CT PARA	THERMAL	2.50	2.50
	Sub - Total	*THERMAL*	*21.70*	*21.70*
	TOTAL EGESUR		**57.40**	**56.60**
ENERSUR	CT ILO (VAPOR)	THERMAL	176.00	132.00
	CT ILO (CATKATO)	THERMAL	3.30	3.30
	CT ILO (TGAS)	THERMAL	81.69	77.00
	Sub - Total	*THERMAL*	*260.99*	*212.30*
	TOTAL ENERSUR		**260.99**	**212.30**
EGEMSA	C.H. MACHUPICCHU	HIDROPOWER	109.90	(1)
	Sub - Total	*HIDROPOWER*	*109.90*	(1)
	CT DOLORESPATA	THERMAL	15.62	12.20
	CT BELLAVISTA	THERMAL	7.83	5.90
	CT TAPARACHI	THERMAL	7.80	5.10
	Sub - Total	*THERMAL*	*31.25*	*23.20*
	TOTAL EGEMSA		**141.15**	**23.20**
TOTAL HIDROPOWER STATIONS			**314.42**	**199.60**
TOTAL THERMAL STATIONS			**398.43**	**341.30**
TOTAL SOUTH INTERCONNECTED SYSTEM			**712.85**	**540.90**

(1) Out of service, at present

Table 3.3.3
Effective Power Capacity and Demand
1998

System	Effective Power (MW)	Demand (1) Power (MW)	Demand (1) Energy (GWH)
SICN	3025	2121	13410
SISUR	541	410	2598

(1) Source: "Procedimiento y Cálculo de la Tarífa en Barra." Commission of EnergyTariff, May 1999

Table 3.3.4
Expansion Generation Program
1999 - 2003

Company	Project	Type	Installed Power (MW)	Operation Starting
EGENOR	CARHUAQUERO EXTENSION	HIDROPOWER	12.0	1999
EGENOR	CAÑON DEL PATO EXTENSION	HIDROPOWER	90.0	1999
EGASA	CT MOLLENDO EXTENSION	TURBO - GAS THERMAL POWER	74.0	1999
EGESUR	C.T. CALANA EXTENSION	DIESEL SET THERMAL POWER	6.4	1999
ELECTROPERU	INCLUDING CC.TT. TUMBES	THERMAL	27.8	1999
EDEGEL	YANANGO	HIDROPOWER	40.5	2000
EGESG	SAN GABAN II	HIDROPOWER	125.0	2000
ENERSUR	TV N° 1 de C.T. ILO II	COAL THERMAL POWER	125.0	2000
TRANSMANTARO	SICN -SIS MANTARO - SOCABAYA INTERCONNECTED LINE			2000
EDEGEL	CHIMAY	HIDROPOWER	142.0	2001
EGEMSA	REENTRY OF C.H. MACCHUPICHU (PELTON)	HIDROPOWER	75.0	2001
ENERSUR	TV N° 2 de C.T. ILO II	COAL THERMAL POWER	125.0	2001
EGEMSA	REENTRY OF C.H. MACCHUPICHU (FRANCIS)	HIDROPOWER	66.0	2002
EGECEN	YUNCAN	HIDROPOWER	130.0	2002
		TOTAL	**1038.7**	

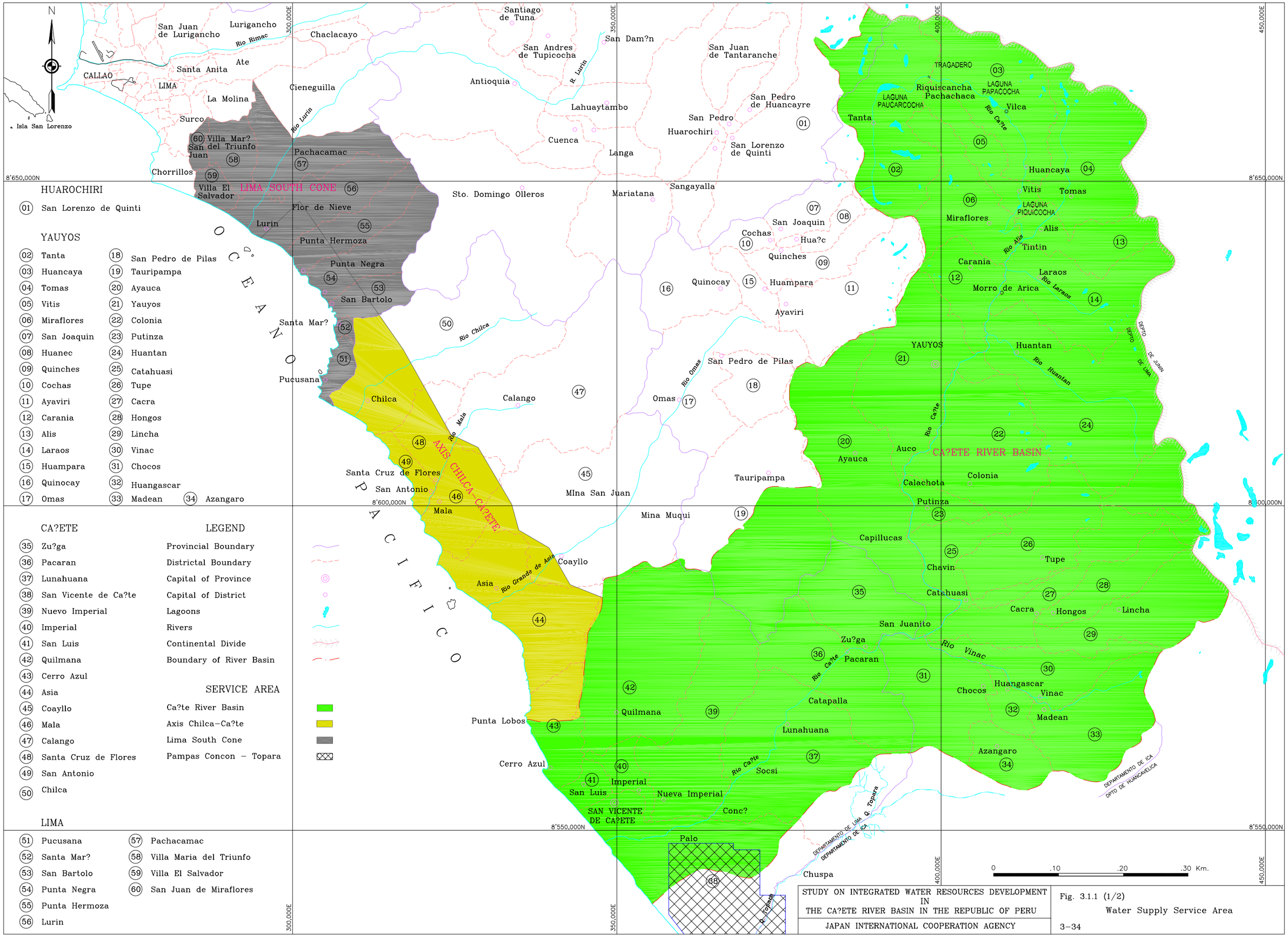
SOURCE: "Procedimiento y Cálculo de la Tarífa en Barra."
Commission of Energy Tariff, May 1999

Table 3.3.5

Electrical Capacity and Demand in Study Area

Electric Sistem	Installed Capacity (MW)	Present Demand		Future demand 2030	
		Power (MW)	Annual Energy (GW H)	Power (MW)	Annual Energy (GW H)
Luz del Sur	37.00	17.60	113.80	44.11	284.51
EDECAÑETE	14.00	9.38	52.20	26.74	150.00
Small Electrical Systems	0.66	0.94	2.51	3.73	10.71
Total	**51.66**	**27.92**	**168.51**	**74.58**	**445.22**

Source : Table made based on information from Luz del Sur, EDECAÑETE and Ministry of Energy and Mining.



HUAROCHIRI

(01) San Lorenzo de Quinti

YAUYOS

(02) Tanta
(03) Huancaya
(04) Tomas
(05) Vitis
(06) Miraflores
(07) San Joaquin
(08) Huanec
(09) Quinches
(10) Cochas
(11) Ayaviri
(12) Carania
(13) Alis
(14) Laraos
(15) Huampara
(16) Quinocay
(17) Omas
(18) San Pedro de Pilas
(19) Tauripampa
(20) Ayauca
(21) Yauyos
(22) Colonia
(23) Putinza
(24) Huantan
(25) Catahuasi
(26) Tupe
(27) Cacra
(28) Hongos
(29) Lincha
(30) Vinac
(31) Chocos
(32) Huangascar
(33) Madean
(34) Azangaro

CA?ETE

(35) Zu?ga
(36) Pacaran
(37) Lunahuana
(38) San Vicente de Ca?te
(39) Nuevo Imperial
(40) Imperial
(41) San Luis
(42) Quilmana
(43) Cerro Azul
(44) Asia
(45) Coayllo
(46) Mala
(47) Calango
(48) Santa Cruz de Flores
(49) San Antonio
(50) Chilca

LIMA

(51) Pucusana
(52) Santa Mar?
(53) San Bartolo
(54) Punta Negra
(55) Punta Hermoza
(56) Lurin
(57) Pachacamac
(58) Villa Maria del Triunfo
(59) Villa El Salvador
(60) San Juan de Miraflores

LEGEND

Provincial Boundary
Districtal Boundary
Capital of Province
Capital of District
Lagoons
Rivers
Continental Divide
Boundary of River Basin

SERVICE AREA

Ca?te River Basin
Axis Chilca-Ca?te
Lima South Cone
Pampas Concon - Topara

STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT IN THE CA?ETE RIVER BASIN IN THE REPUBLIC OF PERU	Fig. 3.1.1 (1/2) Water Supply Service Area
JAPAN INTERNATIONAL COOPERATION AGENCY	3-34

YAUYOS

(17) Omas
(18) San Pedro de Pilas
(19) Tauripampa
(20) Ayauca
(21) Yauyos
(22) Colonia
(23) Putinza
(24) Huantan
(25) Catahuasi
(26) Tupe
(27) Cacra
(28) Hongos
(29) Lincha
(30) Vinac
(31) Chocos
(32) Huangascar
(33) Madean
(34) Azangaro

CA?ETE

(35) Zu?ga
(36) Pacaran
(37) Lunahuana
(38) San Vicente de Ca?te
(39) Nuevo Imperial
(40) Imperial
(41) San Luis
(42) Quilmana
(43) Cerro Azul
(44) Asia
(45) Coayllo
(46) Mala
(47) Calango
(48) Santa Cruz de Flores
(49) San Antonio
(50) Chilca

LIMA

(51) Pucusana

CHINCHA

(68) Grocio Prado
(69) Pueblo Nuevo
(70) Chav?
(71) San Pedro de Huarcapana
(72) San Juan de Yanac
(73) Chincha Alta
(74) Tambo de Mora
(75) Sunampe
(76) Alto Laran
(77) Chincha Baja
(78) El carmen

LEGEND

Provincial Boundary
Districtal Boundary
Capital of Province
Capital of District
Lagoons
Rivers
Continental Divide
Boundary of River Basin

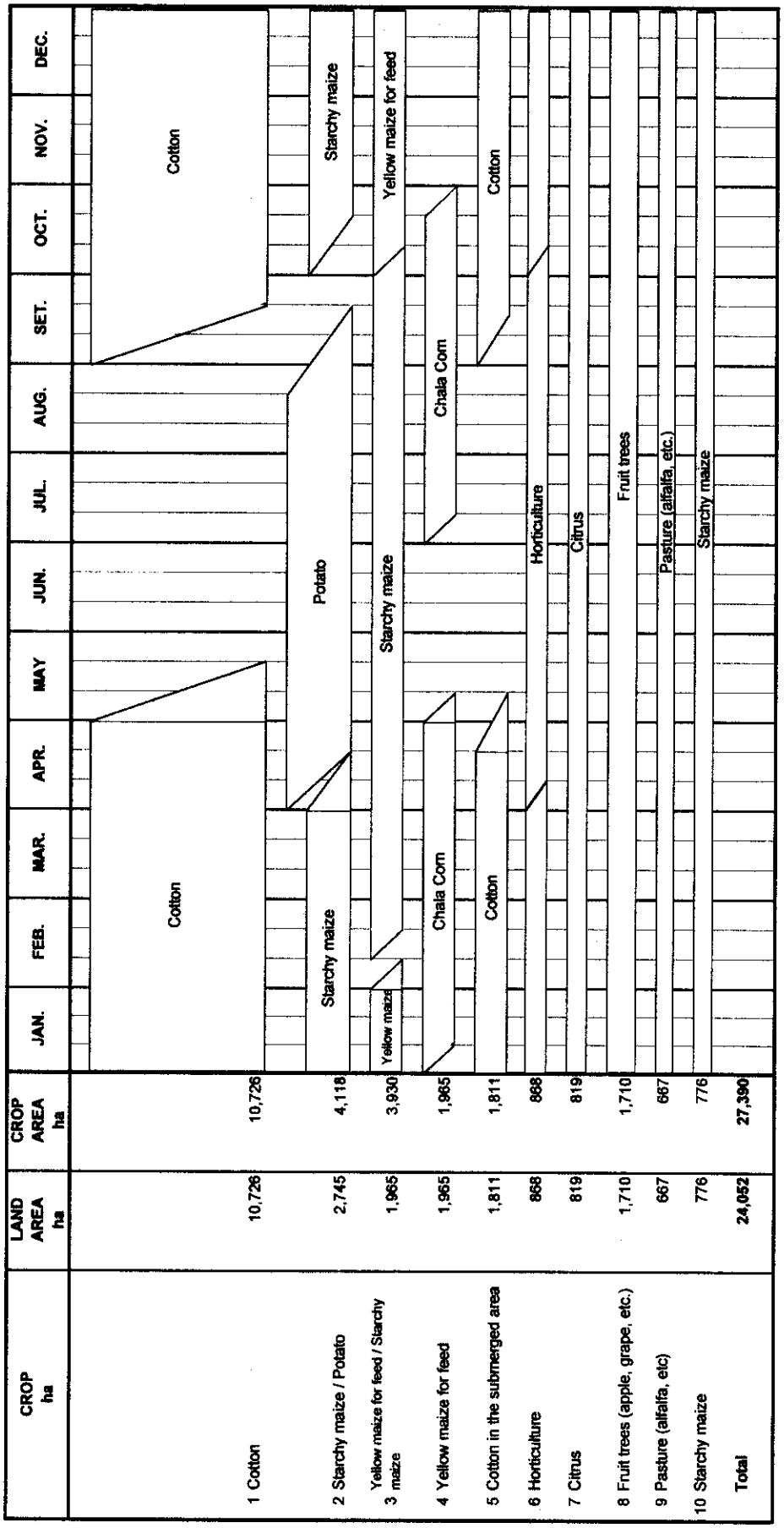
SERVICE AREA

Ca?te River Basin
Axis Chilca-Ca?te
Lima South Cone
Pampas Concon - Topara

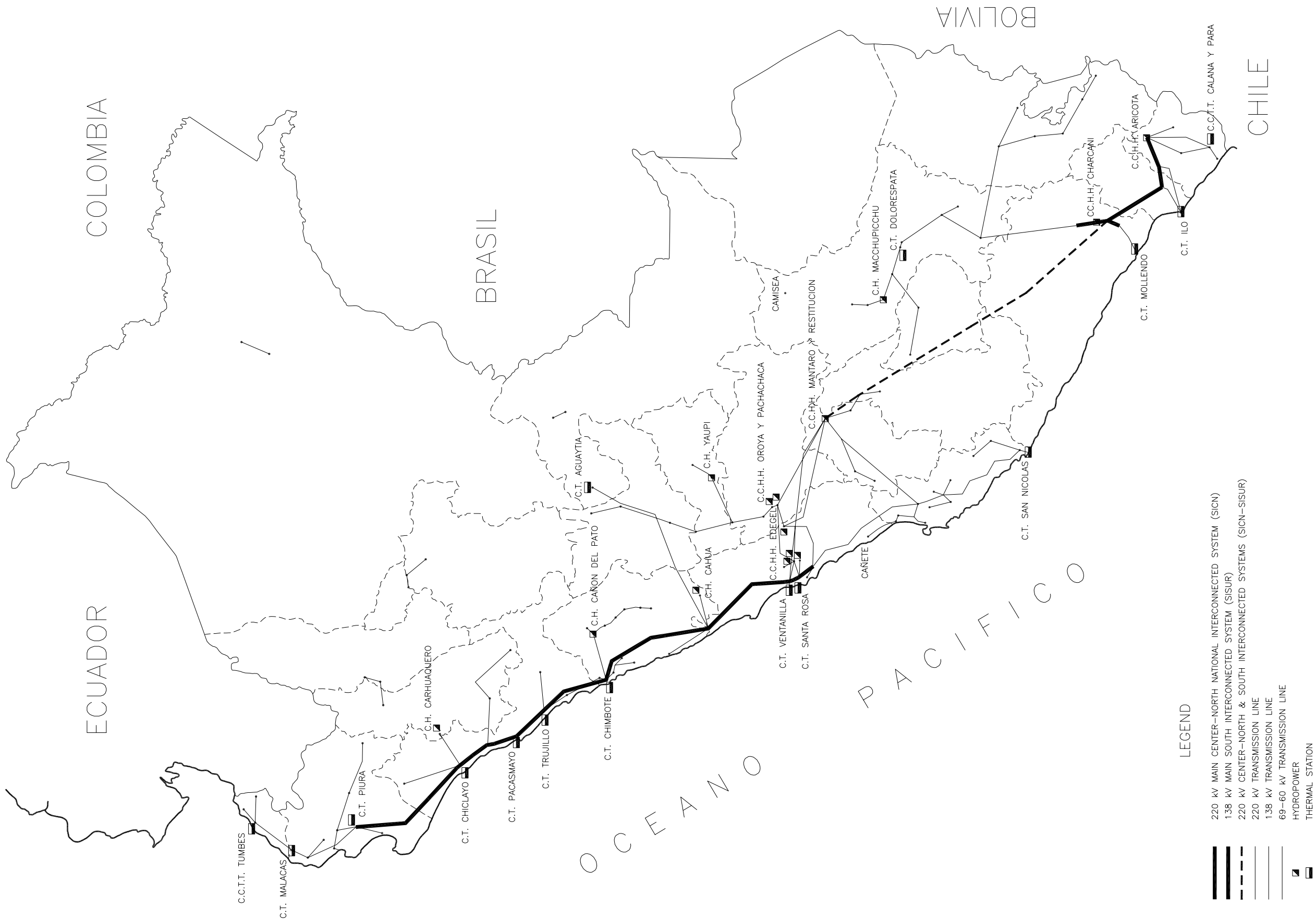
Pucusana
Chilca
Calango
Omas
Rio Omas
Rio Mala
Rio Huantan
Rio Ca?te
AXIS CHILCA-CA?ETE
CA?ETE RIVER BASIN
Auco
Ayauca
Tauripampa
Calachota
Colonia
Santa Cruz de Flores
San Antonio
Mala
MIna San Juan
Mina Muqui
Putinza
DEPTO DE JUNIN
DEPTO DE LIMA
Capillucas
Chavin
Tupe
Catahuasi
Cacra
Hongos
Lincha
San Juanito
Zu?ga
Rio Vinac
Pacaran
Huangascar
Chocos
Vinac
Catapalla
Quilmana
Madean
Punta Lobos
Lunahuana
Azangaro
Cerro Azul
Socsi
Imperial
San Luis
Nueva Imperial
SAN VICENTE DE CA?ETE
Conc?
Palo
Q. Topara
Chavin
San Pedro de Huacarpana
DEPARTAMENTO DE LIMA
DEPARTAMENTO DE ICA
Chuspa
San Juan de Yanac
Chincha Alta
Pueblo Nuevo
DEPARTAMENTO DE ICA
DPTO DE HUANCAVELICA
San Pedro
Rio San Juan
Tambo de Mora
Sunampe
Alto Laran
Rio Chico
Chincha Baja
El Carmen
OCEANO PACIFICO
N
8'600,000N
8'550,000N
8'500,000N
300,000E
350,000E
400,000E
450,000E
0 .10 .20 .30 Km.

STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT
THE CA?ETE RIVER BASIN IN THE REPUBLIC OF PERU
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.1.1 (2/2)
Water Supply Service Area



STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT IN THE CANETE RIVER BASIN IN THE REPUBLIC OF PERU JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure 3.2.1** **Existing Cropping Pattern in the Valle de Cañete (24,052 ha)**



STUDY ON INTEGRATED WATER RESOURCES DEVELOPMENT IN THE CAÑETE RIVER BASIN IN THE REPUBLIC OF PERU	Figure 3.3.1 National Interconnected System in Perú - 1,999
JAPAN INTERNATIONAL COOPERATION AGENCY	