

THE GOVERNMENT OF
THE REPUBLIC OF TRINIDAD AND TOBAGO

THE STUDY ON THE IMPROVEMENT
OF
WATER SUPPLY SUPERVISORY SYSTEM
IN
TRINIDAD AND TOBAGO

FINAL REPORT

SUPPORTING REPORT

SEPTEMBER 1961

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A: SOCIO-ECONOMY

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A: SOCIO-ECONOMY

1. Introduction

Objective of the socio-economic study is to provide fundamental data necessary for formulating the improvement plan of water supply supervisory system. The study is composed of two principal matters; one is to grasp historical trend and present situation of the national socio-economy, and the other one is to arrange and review the existing regional and city development plans such as "National Physical Development Plan" and "Port of Spain Land Use Plan". These results are summarized in Sections 2 and 3, respectively.

2. National Socio-Economic Situation

2.1 Location and Administrative Division

The Republic of Trinidad and Tobago consists of two major islands; Trinidad and Tobago. The Trinidad Island is situated between 10° and 11° North Latitude and between 61° and 62° West Longitude, and it faces the Caribbean Sea on north, the Atlantic Ocean on east, the Columbus Channel on south and the Gulf of Paria on west. The Island is 105 km long and 77 km broad with an area of 4,769 sq. km, and is mostly flat with the highest peak of 940 m in the northern part.

The Tobago Island is situated about $11^{\circ} 15'$ North Latitude and $60^{\circ} 40'$ West Longitude; the northeast of the Trinidad Island from which it is separated by the channel of about 31 km wide. It is about 51 km long and 18 km broad with an area of 297 sq.km. The topography is broken by a central chain of peaks with the highest of 549 m.

Administratively, the country is divided into nine counties including Tobago, and each county has several wards which are regarded as the smallest local administrative units, and number of the wards amounts to 36 in the country as a whole (see Fig. 1.1).

Besides these counties, there exist two cities and some boroughs as the administrative units. Port of Spain which is situated in St. George County forms a centre of administration and economic activity in the country as the capital city. San Fernando which lies Victoria County is a central city of regional administration and economic activity in the southern area of Trinidad.

Arima and Point Fortin which are the representative boroughs in the country are situated in St. George county and St. Patrick county respectively, and form the centre of economic activity in respective regions.

Apart from the afore-mentioned administrative divisions, WASA establishes a water supply system which is divided into 34 areas in Trinidad and Tobago. Details of the water supply system are discussed in 4 "EXISTING WATER SUPPLY SUPERVISORY SYSTEM" of Part I of the Main Report.

2.2 Population

Population censuses of Trinidad and Tobago have been conducted eight times since 1901. The censuses indicate that population of Trinidad and Tobago increased from 827,957 in 1960 to 1,055,763 in 1980 via 931,071 in 1970. The intercensal growth rate was 1.18 % and 1.26 % for the periods 1960-1970 and 1970-1980, respectively (See Table 1.1). Such a comparatively low growth was due mainly to out-migrants to Canada and America.

Lower growth than that of the country as a whole was appeared for both cities of Port of Spain and San Fernando. During the foregoing both intercensal periods, the annual growth rate was -3.97 % and -1.16 % for Port of Spain, and -0.77 % and -0.99 % for San Fernando, respectively. Such a minus growth in the city areas was due to out-migrants not only to foreign countries but also to peripheral counties. The censuses show that population decreased from 93,954 in 1960 to 55,800 in 1980 for Port of Spain and from 39,830 in 1960 to 33,395 in 1980 for San Fernando.

Among counties, population in both counties of St. George and Caroni showed the annual growth rate of nearly 2 % owing to in-migrants from the city areas in addition to in-migrants from the less developed rural regions; Nariva, Mayaro, St. Patrick and Tobago. During the period 1970-1980, one of the main features of population distribution in the country appears to be the concentration of population in the western counties of Trinidad, as shown in Table 1.1.

Population density in the country as a whole showed 206 persons/sq.km in 1980 on the increase by 24 persons/sq.km compared with the density in 1970. While the city areas were decreasing the population density due to the minus growth in population as mentioned above; the density decreased from 6,543 persons/sq.km in 1970 to 5,825 persons/sq.km in 1980 for Port of Spain, and from 5,691 persons/sq.km in 1970 to 5,154 persons/sq.km in 1980 for San Fernando. Judging from situation of the existing land use in both cities and growth in Gross Domestic Product in recent years, the population densities of both cities will be a little growth for the time being. In contrast with both cities, Arima Borough showed considerable increase in the density, i.e. 1,996 persons per sq.km in 1980 which correspond to twice as many as that in 1970, and it is expected that the population density of Arima will continue the further increase owing to in-migrants from Port of Spain and peripheral counties.

Less developed counties in the eastern regions of Trinidad; St. David, St. Andrew, Nariva and Mayaro, have very low population density, i.e. below 60 persons/sq.km in 1980, under the influence of out-migrants which are caused by lack of employment opportunities.

Population projections of the Central Statistical Office show that population in the country will amount to 1,280 thousand in 1990 and 1,520 thousand in 2000 at a growth rate of about 1.7 % per annum since 1980, and population in the capital region consisting of Port of Spain, Arima Borough and the part of St. George will account for 43 % of the total population in the country, i.e. approximately 550 thousand in 1990 and 650 thousand in 2000. Details of the population projections are discussed in 2.1 "POPULATION AND WATER DEMAND" of Part II of the Main Report.

2.3 Labour Force and Employment

According to estimates of the Central Statistical Office, Labour force of Trinidad and Tobago amounted to 483.5 thousand persons in 1988 on the increase by 51 thousand persons against those in 1983. This figure in 1988 corresponds to 59 % of population of 15 years and over of age. But the population employed actually was 376.8 thousand persons (77.9 % of the labour force) in 1988, that is, unemployment rate in 1988 was 22.1 %. As indicated in Table 1.2, the unemployment was increasing year by year, and a creation of employment opportunity is becoming one of the important policy of the Government.

Table 1.3 shows a distribution of the labour force by industrial origin for three years, 1986 to 1988. As seen in this table, the labour force share of petroleum sector in the whole industry would be low comparatively, or less than 5 %, even if the sector had the dominant share in the GDP. In fact, the share of petroleum sector in the labour force was only under 5 % during the period 1986-1988 as seen in the fore-mentioned table.

Among other sectors, construction and distribution sectors showed the highest share on labour force, for example, 16.3 % and 15.7 % respectively in 1988. However in the same year, the unemployed in the construction sector amounted to 52 % which suggested an economic depression of this country. Considering a fact that petroleum and related industries are declining, the surplus labour force produced from the petroleum sector is expected to be absorbed into other industrial sectors such as agriculture (including sugar industry) and other manufacturing industries which accounted for the share of about 20 % of the total labour force.

2.4 Gross Domestic Product

Gross Domestic Product (GDP) of the Republic of Trinidad and Tobago amounted to nearly T\$ 20,000 million at current prices in 1982 growing rapidly since 1970, but due to the world recession which was represented by depression of petroleum market it came to T\$ 16,000 million in 1988 going down gradually after that time (see Table 1.4).

The GDP of Trinidad and Tobago has been mostly dominated by the petroleum industry, hence the aggravation of petroleum industry had serious influence on the national economy. The real growth rates of the GDP for whole industry and petroleum sector for the period 1985-1988 are given in percentage as follows:

	1985-1986	1986-1987	1987-1988
Whole	-3.3	-7.4	-3.8
Petroleum	-4.0	-8.2	-6.2

As shown in Table 1.5, the real growth rates of almost all the industrial sectors, except agricultural sector, also showed minus in recent years, and only the agricultural sector continued economic growth at an average rate of 4.7 % per annum.

Despite the share of petroleum sector in the GDP fell to 20 % (T\$ 3,200

million) in 1988 from 43 % (T\$ 6,400 million) in 1980, the petroleum industry still is the dominant sector in the GDP (see Table 1.6), i.e. it make a significant contribution to the economic development of T&T and to the maintenance of good living condition for people.

In proportion to decline in the GDP, the Gross National Product (GNP) and the Per Capita GNP also showed a drop, for example, the per capita GNP reduced to T\$ 12,300 in 1988 from approximately T\$ 20,000 at the beginning of 1980's. The GNP and the Per Capita GNP since 1985 are as follows:

	1985	1986	1987	1988
GNP at factor cost (million T\$)	17,458	16,331	15,533	15,286
Per Capita GNP (T\$)	15,486	13,618	12,762	12,374

2.5 External Trade

External trade of Trinidad and Tobago achieved exports of T\$ 9,796 million and imports of T\$ 7,654 million in 1980, the highest trade amount in the past, being supported with a great demand for petroleum in the world. After 1980, the trade amount showed a reduction gradually due to a decline of the world economic activity, and as a result exports and imports recorded the lowest in 1986 and in 1985 respectively, or T\$ 4,978 million and T\$ 3,731 million. However, the exports trends somewhat upward in recent years (see Table 1.7).

Trade balance of Trinidad and Tobago has maintained surplus every year except both years of 1982 and 1983 since 1978. In 1988 the surplus amounted to T\$ 1,128 million, or exports of T\$ 5,411 million and imports of T\$ 4,283 million.

Petroleum, of course, made the greatest contribution to such a favorable trade balance, though the share of petroleum in exports was trending downward, for example, 72 % in 1986 and 61 % in 1988.

In recent years, exports of the industrial commodities such as methanol, iron, steel, urea and ammonia were increasing, that is, the total share of these commodities in exports increased from 20 % in 1986 to 25 % in 1988. While the total share of sugar, cocoa beans and coffee beans did not exceed 2 % of the whole exports every year during the period 1986-1988 (see Table 1.8). Significant destinations for the export were the USA, EEC and Caribbean countries and exports to the USA accounted for more than 50 % of the total exports for each year.

On the other hand, import goods of Trinidad and Tobago are distributed into every commodity from foods to heavy machine. Share of each commodity therefore is a little. Vegetables had the highest share in imports, or about 14 % on average during three years from 1986 to 1988. With respect to imports the USA also continued, during the said three years, to be major source, accounting for about 40 % of the total exports.

2.6 Balance of International Payments

Despite the external trade balance was surplus as mentioned above, current account in the balance of international payments showed deficit for the period 1984-1988 due to imbalance of service and transfer accounts which resulted from increase in travels and remittances to foreign countries (see Table 1.9).

Although a part of such deficit of current account was compensated by capital account, the balance of international payments showed deficit every year during the above period, for example, the deficit in 1988 amounted to T\$ 266 million. As a result, the foreign currency reserves of Trinidad and Tobago came to minus T\$ 24 million in 1988 reducing at a rate of about T\$ 600 million per annum during the said period.

2.7 Budget of Central Government

Revenue of the Central Government indicated T\$ 4,775 million in 1988 on the decrease by about 32 % against T\$ 7,067 million in 1982, the highest annual revenue in the past, and expenditure also declined from the highest annual expenditure of T\$ 9,414 million in 1982 to T\$ 5,977 million in 1988. During the above period, the expenditure exceeded the revenue every year, or the deficit showed between T\$ 900 million and T\$ 2,400 million per annum, and such a deficit was compensated by external and internal loans mainly (see Table 1.10).

Current revenue which accounted for the majority of the total revenue consisted of the tax revenue of 80 % and the non-tax revenue of 20 % approximately, for example, in 1988 these were T\$ 3,972 million and T\$ 782 million respectively which corresponded to 67 % of each revenue in 1982.

The tax revenue is broadly divided into five categories; (1) taxes on incomes and profits, (2) taxes on property, (3) taxes on goods and services, (4) taxes on international trade, and (5) other taxes. Percentage of these categories in the tax revenue showed 67.2 %, 0.8 %, 21.8 %, 9.6 % and 0.6 % in 1988 against 83.9 %, 0.3 %, 6.0 %, 9.2 % and 0.6 % in 1982, respectively. As seen in the above figures, share of (1) taxes on incomes and profits, which held the highest position in the tax revenue, fell from the share of 83.9 % in 1982 to that of 67.2 % in 1988, and to the contrary, share of (3) taxes on the goods and services, which rank second in the tax revenue, rose to 21.8 % in 1988 against 6.0 % in 1982. The tax revenues of (1) and (3) in 1988 were T\$ 2,669 million and T\$ 866 million corresponding to approximately 1/2 and 2.5 times of the 1982 revenue, respectively (see Table 1.11).

The non-tax revenue is mainly composed of seven categories; (i) interest income, (ii) royalties, (iii) profits from public enterprises, (iv) administrative fees and charges, (v) non-industrial sales, (vi) post office and (vii) others. Among them, the total revenue of (i), (ii) and (iii), in 1982 and 1988, accounted for about 90 % and 80 % of the whole non-tax revenue respectively, and the 1988 revenue was T\$ 620 million on the decrease by 41 % against T\$ 1,060 million in 1982.

As seen in Table 1.11, almost all of the revenue factors, except goods and services factors, were reducing gradually respective revenues since 1982, and it is expected from historic trend that the reduced revenue will continue for the time being, provided that there is no considerable change in the external

and internal economic situations in near future.

Only the taxes on goods and services have a possibility of increase in revenue by the Governmental policy. In fact, the tax revenue of these factors in 1988 came to 2.5 times of that in 1982, and it is further said that the Government expects the increased revenue by a rise in tax rate of these factors. The rise of this tax rate would have an effect of the saving of consumers' goods as well as increase in the Government revenue, but on the other hand it would be to bring the worse living condition for people, especially for low-income earners.

Decrease in such a revenue compelled a decline of the government expenditure, and a distribution between current and capital expenditures in the total expenditure changed considerably from 64 % and 36 % in 1982 to 81 % and 19 % in 1988. Of the current expenditure, share of expenditure on wages and salaries accounted for 50 % in 1982 and 48 % in 1988, however the amount declined from T\$ 3,100 million in 1982 to T\$ 2,330 million in 1988.

The decreased expenditure of the Government influenced particularly on expenditures to development programme and funds for the long-term projects, for example, the total of these expenditures and funds fell to T\$ 1,232 million in 1988, corresponding to about one-third of that (T\$ 3,415 million) in 1982, as shown in Table 1.12.

2.8 Prices and Wage

In recent years, retail prices of Trinidad and Tobago rose at the rather high rate, compared with those of ordinary other countries, namely, at an average annual rate of 10.7 % for all items and 14.0 % for foods item during the period 1982-1988.

On the other hand, producers' prices showed a stable rise comparatively at an average annual rate of 5.2 % for the period from 1983 to 1988 (see Table 1.13).

Against a high rise in retail prices, wage rates showed a lower growth. According to statistics, during the period 1982-1984 although an average minimum wage rate of workers showed the growth rate higher than 10 % per annum, reducing gradually the rate after that time, the growth has continued a stagnant condition since 1986 as shown in Table 1.13.

It is expected that an unfavorable situation of the high rise in retail prices and the low growth in workers' wages will continue for the time being, judging from recent trend of the national economic development, and as a result the economic living condition for people may be worse than the present. An urgent measure for the economic development is required to break such an unfavorable situation.

3. Regional and City Development Plans

3.1 Existing Land Use and Regional Economic Feature

The Republic of Trinidad and Tobago has an area of 512,843 ha, of which almost 35 % is cultivated, nearly 8 % is developed or under mining operation, and remaining 57 % is still undeveloped area such as forest and swamp. The undeveloped areas are widespread but concentrated more in the Northern, Central and Southern Ranges and within the Eastern counties, St. Patrick, Victoria and Tobago (Fig. 1.2).

According to the "National Physical Development Plan", the country can be grouped into the following five areas in order to establish a framework of the regional economic development: (1) North Western Trinidad, (2) Pt. Lisas - San Fernando - Pt. Fortin Axis Area, (3) Central and East Trinidad, (4) Southern Rural Periphery and (5) Tobago. Economic features of the five regions grouped are outlined below:

(1) North Western Trinidad

North Western Trinidad area includes the Port-of-Spain, Arima urban complex and its periphery, the Northern Valleys, the North West Peninsula, and Western Caroni. This area is essentially characterized by intensive development as the urban areas in terms of settlement and socio-economic activities.

(2) Pt. Lisas - San Fernando - Pt. Fortin Axis Area

This area is the intensively developed section as a oil belt, and further includes the centre of Couva, San Fernando. Penal, Siparia, Fyzabad, Pt. Fortin and La Brea characterized by intensive agriculture. Industry consists mainly of oil and sugar refineries and petrochemical industries.

(3) Central and East Trinidad

This area is composed of three counties of Nariva, St. Andrew and St. David, and South Eastern Caroni Basin. These counties are typified by low developed areas and depend on extensive agriculture, forests and recreation resources.

(4) Southern Rural Periphery

This area has an oil belt which the development is extensive in contrast with the San Fernando - Pt. Fortin Axis developed intensively. Typical industries are extensive agriculture, forests and fisheries.

(5) Tobago

Tobago is an island with low development densities which are characterized by extensive agriculture and forests, and recreation and tourism resources. This island has peculiar problems associated with its physical isolation.

In consideration of existing land use and regional economic feature within the country, the Government formulated the regional and city development plans including the industrial development plan as described in succeeding paragraphs.

3.2 Regional Population Distribution

As described in Paragraph 2.2, the censuses indicated that population of Trinidad and Tobago amounted to approximately 1,056 thousand in 1980 at an average annual growth rate of 1.26 % during the period 1970-1980, against the 931 thousand population in 1970. and at the same time it revealed that there was uneven distribution of population among regions due to concentration of population to the western counties with a lot of job opportunity.

According to population projection of the Central Statistical Office, it shows that population of T&T will increase from 1,058,300 in 1980 to 1,543,700 in 2000, of which the urban population will be over 70 %. Based on such a population projection and the regional economic features of five groups stated in Paragraph 3.1, the Government has projected a preferable regional distribution of population dividing into ten regions: (i) Capital Region, (ii) North Coast Region, (iii) San Raphael Region, (iv) North-East Region, (v) Caroni Region, (vi) San Fernando Region, (vii) Rural Victoria Region, (viii) South-West Region, (ix) South-East Region, and (x) Tobago (See Table 1.14 and Fig.1.3). Main features of this population distribution are as follows:

- Population of the Capital Region will increase from 441 thousand in 1980 to 642 thousand in 2000, maintaining the share of about 42 % in the total population, that is, the growth rate will indicate 1.89 % per annum which is close to that of the national population.

- The North Coast Region will decrease the population at an annual rate of minus 1.67 % so that the 2000 population will come to approximately 1,500.

- The San Raphael will increase the population from 4,300 in 1980 to 6,200 in 2000.

- The North-East Region is earmarked for greater population growth than historical trends by 1980 due to development of the San Grande growth centre. The 2000 population is estimated at approximately 78,700 at an average annual growth rate of 2.55 % for the period 1980-2000.

- The Caroni Region is expected to experience the rapid population growth mainly due to the presence of the Couva-Pt.Lisas growth centre. The population will increase from 142,200 in 1980 to 222,300 in the year 2000 at an annual growth rate of 2.26 % during this period.

- The San Fernando Region is designated to maintain its share in the national population on account of the proximity to Pt. Lisas and Pt. Fortin. The population will amount to about 190,000 in the year 2000 on increase by 54,000 against 136,000 in 1980.

- The Rural Victoria Region will continue lower population growth than that of the national population due to emigration to the western urban and other areas. The 2000 population is estimated to be approximately 117,300 on the increase by 30,000 against the 1980 population.

- The South-West Region will maintain its share of the national population stemming the emigration trend to other areas by accelerating development of the Pt. Fortin growth centre. The population will amount to about 176,000 in 2000 with an annual growth rate of 1.75 % for the period from 1980 to 2000.

- The South-East Region will experience a rapid growth because of the Pt. Galeota potentials and the development of a growth centre on the south-east coast. The population is estimated to be 52,500 in 2000 at an annual growth rate of 2.17 % during the period 1980-2000.

- Tobago will maintain its share of the national population, stemming a net migration loss due to the development of many recreation centres. The population will increase from 40,700 in 1980 to 57,100 in 2000.

Detail breakdown of population projection related to the water supply system is shown in Table II-2.1 "Population Projection by Water Area" in Part II of the Main Report.

3.3 Urban Settlements

In order to accelerate the effective development of all regions, in the "National Physical Development Plan" the Government proposed two settlement strategies: one is to establish a new settlement system and the other is to put some growth centres.

(I) The Proposed Settlement System

A new settlement system is proposed to achieve the development plan improving the existing settlement structure. It categorizes all urban units in the country according to their proposed functions in the national hierarchy and their proposed growth. The proposed structures of urban centres are as illustrated in Fig. 1.5, and the hierarchy is classified into four levels as follows:

(1) National urban centre: the Port-of-Spain.

(2) Regional urban centres: San Fernando and Scarborough. But the Port-of-Spain will have also function of regional centre.

(3) Sub-regional centres: San Juan, Tunapuna, Arima, Sangre Grande, Couva-Point Lisas, Chaguanas, Princes Town, Rio Claro, Point Fortin, Siparia, Mayaro/Galeota and Roxborough.

(4) District centres: urban and incipient urban areas such as Diego Martin, Carenage, Curepe, St. Augustine, Arouca, Penal, Moruga, Toco, Cunupia, Valencia and St. Mary's.

(1) National Urban Centre

The Port-of-Spain will maintain the functions as the national capital and main metropolitan area at least by 2000, but its growth will be curbed so that its relative dominance to the remaining urban centres in the country is reduced. On the other hand, the Capital Region which includes the Port-of-Spain will experience the significant increase in population from 441,200 in 1980 to approximately 642,200 in 2000. Accordingly, it is essential to improve infrastructure and service functions to ease the congestion and to ameliorate the growing pressure.

(2) Regional Urban Centres

Both regional urban centres, San Fernando and Scarborough, will be important as places of employment and service facilities not only for the local municipality but also for wide regions in the South Trinidad and in Tobago, respectively. These towns therefore will have to be upgraded so that they possess a comprehensive supply of high level services and a wide range of job opportunities. Decentralization of some administrative functions of the central government will be a first step of making the regional centres.

San Fernando will act as the focus of communications for three regions; San Fernando, South West and Rural Victoria. The total population of three regions is projected to increase from 347,700 in 1980 to 483,200 in 2000. Such a great increase of population suggests a demand far beyond the existing capabilities of San Fernando, that public facilities will have to be upgraded and newly supplied. San Fernando and its periphery have the sufficient developable land to satisfy the requirements for growth of this regional centre to the year 2000 and beyond.

Scarborough must play an important role as the regional capital and major urban centre of Tobago, the sister island of Trinidad. Therefore for the local self-determination, and high level services and creation of varied job opportunities for the inhabitants of Tobago, Scarborough will be equipped with facilities commensurate with its role as the regional capital. By the year 2000, population will increase from 9,000 in 1980 to 15,000 for Scarborough, and from 40,700 to 57,100 for Tobago. The public facilities of Scarborough will be also required their quantity as well as quality.

(3) Sub-Regional Centres

The fore-mentioned twelve sub-regional centres will be important as places of employment as well as for service facilities, and they will serve not only the local community but also their hinterlands which include smaller towns and villages.

For these sub-regional centres, the dispersal of central government administrative units should benefit considerably. Towns such as San Grande, Tunapuna, Rio Claro, Siparia, Couva and Princes Town, already have some of the decentralized central government offices with low level functions. The "National Physical Development Plan" has proposed that all sub-regional centres should provide a civic core area where the governmental facilities are centrally located. It is expected that private enterprises will be located in this civic core area following the government. Accordingly, establishment of the civic core area will be to encourage the development of the sub-regional centres.

According to the projection of the Central Statistical Office, population of each sub-regional centre in the year 2000 will be as follows:

San Juan	105,000	Princes Town	35,000
Tunapuna	50,000	Rio Claro	13,000
Arima	80,000	Pt. Fortin	35,000
San Grande	38,000	Siparia	15,000
Couva-Pt. Lisas	75,000	Mayaro/Galeota	15,000
Chaguanas	60,000		

Sizes of these population suggest that a much greater variety of job opportunities and public services will be required in these centres, and a massive demand will be made for developable lands for the residential purposes.

(4) District Centres

At the lower level in the hierarchy like district centres, there is a wide range of different types of community, though their basic function is to service inhabitants in districts concerned. General functions of the centres could be classified into both urban and rural districts.

The majority of urban district centres are situated close to more developed superior urban centres and are part of their immediate labour markets (See Fig. 1.5). These centres are Carenage, Diego Martin, St. Joseph, Curepe-St. Augustine, Arouca-D'Abadie within the highly urbanized Capital Region, and La Romain, Gasparillo, Marabella, and St. Margaret's-Claxton Bay in the San Fernando urban sub-region (See Figs. 1.4 and 1.5).

Rural district centres are situated in more sparsely populated areas where job opportunities are closely related to primary activities in agriculture and mining. Some of them, however, such as La Brea, Penal, St. Mary's-Freeport, Cunupia, Valencia, etc., are expected to be more urbanized because they are located within potential growth areas.

Other rural district centres, such as Moruga, Cedros, Erin, Carapichaima, Waterloo, Tabaquite, Flanagin Town and Toco in Trinidad, and Plymouth and Speyside in Tobago, are expected to remain as the rural areas in character. The government policy for these centres is to upgrade further the existing public services and utilities to improve the quality of life in rural areas.

(II) The Growth Centres

The growth centre strategy was emerged out of the framework of the national settlement strategy outlined above as the primary mechanisms for achieving a variety of national objectives. According to the "National Physical Development Plan", objectives of the growth centre strategy are:

- to redress the social and economic imbalances which exist between the developed urban and undeveloped rural areas, and
- to effect savings and efficiency in investment on infrastructural works by concentrating the growth at a few selected points.

The growth centre strategy is therefore aimed at redistributing that are

ripe for decentralization from the capital, and to generate a new economic activity from the development potential identified at a limited number of potentially viable settlements.

To achieve the afore-mentioned strategy, four growth centres, such as Couva-Pt.Lisas Complex, Pt.Fortin, Sangre Grande and Mayaro/Galeota, were selected out of the sub-regional centres, in consideration of distribution in the country, development potential, possession of a suitable infrastructure, environmental conservation, etc. Besides these centres, the South-West Tobago was selected as a development area under the different condition.

Couva-Pt.Lisas Growth Centre

The Couva-Pt.Lisas Complex area, compared with other regions outside of the core area around the Port-of-Spain, possesses many advantages for development in view of economic and physical conditions. Using these advantages, the Government has in fact already made considerable investment in infrastructure and industrial development of Couva-Pt.Lisas Complex. The existing major facilities equipped are as follows:

- an industrial estate with 800 hectares of land for capital industries based mainly on oil and natural gas,
- a cross country gas line from Point Galeota to Point Lisas,
- an electric power plant with capacity of 634 megawatts,
- harbour with docking facilities and 3 km long approach channel dredged to 12.8 metres,
- large-scale industries such as fertilizers, iron and steel, aluminum smelter, petro-chemicals, cement and liquefied natural gas plant,
- development of land for urban uses including housing, commercial and public facilities.

At the present time, the development of this area is in progress under a long term plan covering the period 1987-2007, in accordance with the growth centre strategy. According to the "Couva-Point Lisas Structure Plan Proposals" (1987), Couva-Pt.Lisas is expected to increase its population from 22,339 in 1980 to more than 75,000 by the end of the plan period. According as such the population increased, approximately 11,000 additional dwelling units, except some 1,000 units which were constructed during the 1980-1985, would be required to accommodate the population of Couva-Pt.Lisas.

Labour force also will increase from 8,000 persons in 1985 to 29,000 persons in 2007, and the Structure Plan expects that new jobs to be created for 21,000 persons increased will be provided by the expansion of firms/industries already located in this area and the creation of new economic activity in the Couva-Pt.Lisas Growth Centre.

To cope with such a vast industrial development and the increased population, the Structure Plan proposes that a greater investment should be made for infrastructure and public facilities. These cost is estimated at approximately T\$ 9,000 million in total during the period 1987-2007. Details

are given in the "Couva-Pt.Lisas Structure Plan Proposals"(1987).

Point Fortin Growth Centre

Point Fortin forms part of the oil mining and refining areas in the South West Region. Since 1960's the Region however has been in relative decline due mainly to the depletion of oil reserves and the high cost of exploration. In addition, agriculture which has been a mainstay of the regional economy, is very difficult in the present state to generate the employment and incomes necessary. Nevertheless, the Pt. Fortin area possesses several potentials for development which explain the selection as a growth centre, as shown below:

- There exists the oil refinery of the Trinidad and Tobago Oil Company which has made plans for expansion and modernization, and this oil industry could be the basis for attracting industries related into the area.
- This area has vacant parcels which may be utilized for industrial activity and urban development.
- Pt.Fortin and La Brea have the available coastal lands for port development.
- The South West Region possesses a tradition of oil industrial skills which can be channeled into new industrial activities.
- Pt. Fortin has an urban settlement which can upgrade as a growth centre.

Pt. Fortin which possesses such a high development potential, will increase its population from 16,710 in 1980 to approximately 35,000 in the year 2000, and the "National Physical Development Plan" proposes that the development of Pt. Fortin as a growth centre should be made not only for industry and urban settlement but also for infrastructure such as road transportation and communications in and around the area.

Sangre Grande Growth Centre

Sangre Grande is expected to experience a steady and consistent population growth by the year 2000 on the basis of the expansion of the economic base and improvement in the urban settlement. At the present time Sangre Grande has the following several factors which can be exploited to enhance its role as a growth centre:

- A favorable geographical location in relation to the Capital Region,
- Major transportation lines in the North-East Region and to the South-East Region,
- Function as the major administrative, commercial and residential centre in the North-East Region, and
- Its hinterland which is rich in agricultural and forestry potentials.

Sangre Grande already is beginning the growth as a new centre, for example, private land-owners and developers have converted several hundred

acres of undeveloped or formerly agricultural land to residential uses, and many new commercial enterprises have been established in response to increasing demands in the area. The Government has several significant projects in the planning stage or in implementation as follows:

- North-Oropouche water and drainage scheme which can have a great impact in boosting the nation's potable water supply and in bringing the fertile lands in the flood-plain into commercial production,
- Balandra Resort Development project in which over 202 hectares are being developed for recreational uses including resort housing, a golf course and ancillary entertainment facilities, and
- Establishment of manufacturing enterprises of furniture, glass, ceramics, concrete blocks, handicraft and food processing which are based on local materials and skills.

Based on the afore-mentioned development, Sangre Grande growth centre and its surrounding area are expected to increase their population from 43,600 in 1980 to approximately 73,000 in 2000, and the said "National Physical Development Plan" proposes the improvement of infrastructure, housing and public service facilities commensurate with the growth in these areas.

Mayaro-Galeota Growth Centre

Mayaro-Galeota area is the most distant growth centre from the Capital Region in Trinidad. The major reasons which this area was selected as a growth centre are as follows:

- Location close to the offshore sources of oil and gas. At present, most of the oil and gas come ashore at Pt. Galeota and are thus available as the basic feedstock for petro-based industries. There is also considerable potential for service sectors related to the oil industry;
- A coastal location where the modest port facilities may be developed;
- Proximity to the undeveloped Nariva Swamp which can potentially make available 3,600 ha for intensive farming and 3,000 ha for livestock rearing. The development of this swamp and the cultivation of other lands with good agricultural potential can form the basis of a sizable food-processing and other agro-based industries; and
- Existence of potentials in forestry, fishing and recreation.

Although the Mayaro-Galeota zone has favorable condition for development mentioned above, inhabitants in this zone have not received so much social, economic and cultural benefits because of the location of relative isolation in terms of time and distance from the national urban centre. The development of a major urban centre in the South-East Region would be essential in achieving a more balanced urban settlement pattern in the country.

Many significant projects have been already implemented in the Mayaro-Galeota area due to impetus from the oil industry. Among them, the greater project is land development undertakings in close proximity to Mayaro and

along the Mayaro-Guayaguayare Road by private individuals involving resort, residential and commercial activities.

For realizing the Mayaro-Galeota growth plan, it will be required to create job opportunity by private enterprises in addition to the upgrading of public facilities by the Government. The plan is envisaged to realize virtually a new town with a population of about 15,000 by the year 2000.

South-West Tobago (A Special Zone)

According to the "National Physical Development Plan", although the growth centres have not been earmarked for Tobago, South-West Tobago is designated as a development area in consideration of regional circumstances of Tobago. This area is recognized as a growth zone for the following main reasons:

- A favorable location in close proximity to Scarborough, the regional capital and astride the main communication line between the airport and the regional capital, and
- Proximity to the tourist resorts such as Pigeon Point, Buccoo and Store Bay.

At the Canaan-Bon Accord area which is a centre in South-West Tobago, the Plan envisages the development of small commercial and industrial activities and some tertiary activities oriented to tourism industry. In this case, improvement in the physical environment particularly in terms of water supply and sewerage is required to serve inhabitants and tourists. The area is expected to have a population between 5,000 and 10,000 by the year 2000.

3.4 Development Plans of Industries

Development plans together with historic production trend are described in terms of several industrial sectors which are expected to make an important contribution to the economic development of Trinidad and Tobago by increasing exports or by saving imports. These sectors are agriculture including forestry and fishery in the primary sector, petroleum, quarrying and manufacturing industries in the secondary sector, and tourism in the tertiary sector.

(I) Agricultural Sector

Table 1.14 shows the principal agricultural products of Trinidad and Tobago, of which Sugar, cocoa and coffee are the important export goods. Sugar indicated a production of 130.2 thousand tonnes in 1988 at an annual growth rate of about 10 % during the period 1983-1988. In the same year, productions of cocoa and coffee beans were 1,712 tonnes and 582 tonnes respectively decreasing those production year by year during the said period. Particularly coffee beans was a considerable reduced production, i.e. an annual minus growth rate of 17.4 %. Whereas the total share of these three goods in exports was only about 2 % in recent years as shown in Table 1.8.

On the other hand, food has indicated a rather high amount in the external trade of T&T especially in imports, for example, in 1988 the imports and exports of food were T\$ 720.2 million (share in exports: 17 %) and T\$ 241.7 million (share in exports: 5 %) respectively. However the trade balance of food was a deficit, and in fact such a deficit has been showing every year as follows:

Year	Food Imports (T\$ Million)	Food Exports (T\$ Million)	Food Exports as % of Food Imports
1970	103.4	79.0	76.4
:	:	:	:
1980	707.8	172.0	24.3
1981	834.7	159.7	19.1
1982	904.7	125.5	13.9
1983	923.8	107.6	11.6
1984	894.1	100.7	11.3
1985	764.1	88.4	11.6
1986	786.7	160.6	20.4
1987	833.4	190.4	22.8
1988	720.2	241.7	33.6

The food trade imbalance was spreading since 1970 and came to its peak in 1984 as shown in the above table, however after that year the imbalance is indicating the reduced trend due to increase in the domestic food production.

Trinidad and Tobago essentially is a traditional agricultural country, that is, the agriculture was the mainstay of national economy at the former times. Nevertheless, the agricultural sector has kept falling its share in the GDP since oil boom in the 1960's. In order to recover the agricultural production which has been declining, the Government has conducted a variety of measures throughout several National Development Plans since 1969. The goal oriented for the agricultural sector in the Plans are as follows:

- Import substitution in food production,
- Self-sufficiency in certain food products,
- Rehabilitation of export crops,
- Diversification within the agricultural sector,
- Improving the efficiency of agricultural production, and

- Facilitating the expansion of the agricultural sector.

Particularly in the National Physical Development Plan, the major objectives for the agricultural sector are:

- minimizing the nation's dependence on external resources for its primary needs by achieving maximum productivity and self-sufficiency in the sector,
- generation of employment by creating new jobs in the sector,
- development of a rational land use pattern by making best use of the nation's agricultural resources,
- reduction of geographic imbalance in welfare by development of the sector,
- sustained growth by linkages with other sectors, and
- contribution to the net foreign exchange earnings and savings which result from export of the agricultural products and the increased-production of commodities imported.

To achieve these objectives, various development programmes were formulated in terms of land use, land reformation, rural development, etc. This is summarized as follows:

- Zoning lands for different categories of agriculture and forestry usages. Fig. 1.6 indicates a land use in 2000 proposed in the "National Physical Development Plan";
- Acquisition of the abandoned agricultural estates and other suitable lands for agriculture which are not being used at present. The acquired lands are reallocated only to the bona fide farmers, subject to the certain stipulations as to production, etc.;
- Creation of agricultural lands by draining swamp and lagoon areas, Nariva Swamp, Oropouche Lagoon, etc.;
- Preservation and conservation of existing agricultural productive land (See Fig. 1.6); and
- Comprehensive development of rural areas: North East Trinidad, East Caroni, East Nariva, Rural Victoria, Rural St. Patrick and North East Tobago (Fig. 1.7). This rural development strategy consists essentially of programmes involving:
 - measures to increase real incomes,
 - improvement and/or installation of physical and social infrastructures,
 - measures to increase the levels of employment and the ability of rural areas to generate productive job opportunities internally, and

- development of mutually interdependent linkages with the urban and national economies.

In regard to the forestry, the Government emphasizes in the "National Physical Development Plan" that the majority of forest lands in the mountainous areas should be maintained and conserved in just the state it is (Fig. 1.6), and that a new reafforestation scheme must be undertaken in suitable areas.

On the other hand, to promote the development of fishery sector the Government designates the following nine places as the fishing centres of inshore fisheries activity: Port-of-Spain, San Fernando, Cedros, Erin, Mayaro, Toco, Las Cuevas, Scarborough and Charlotteville (Fig. 1.5), and it is expected to have a great economic impact on rural areas in and around respective centres by rationalizing them and by upgrading their social and economic infrastructures.

(II) Industrial Sector

Of industrial products, the crude oil sector which has made greatest contribution to the GDP of T&T showed the production of 8,778 thousand cu.m. in 1988 reducing at an annual rate of 2.9 % on average since 1984. Whereas the refinery output amounted to the production of 4,950 thousand cu.m. in 1988 increasing at an average annual rate of 4.1 % against 4,200 thousand cu.m. in 1984 (See Table 1.15).

Among other industrial products than petroleum, fertilizer, methanol and steel (including direct reduced iron, billets and wire rods) were increasing remarkably their productions at the average annual rates of approximately 10 %, 20 % and 18 % respectively during the period 1984-1988, and as a result amounted to the production of 2,200 thousand tonnes, 400 thousand tonnes and 1,160 thousand tonnes in 1988.

Besides the afore-mentioned products, assembly products such as motor vehicles and television sets, except radio, were reducing their productions considerably during the said period, while the productions of edible oil and its related products were increasing greatly. Statistics indicates that in general the production was reducing on expensive articles due to a decline of the purchasing power of people and increasing on daily commodities owing to improvement of the living condition of people.

As illustrated in Fig. 1.3, oil fields of T&T are mainly distributed in the South West, the South East and the Rural Victoria Regions, and petroleum ports are placed in four points; Pointe-a-Pierre, Point Fortin, La Brea and Point Galeota. Economic activities in these ports have greatly contributed to the development of communities around the ports.

The mining products such as sand, gravel and limestone has tended to be concentrated in the North Range and the Central Range foothills. Sand and gravel deposits extend from Wallerfield in the west to Matura in the east. These deposits are extensively worked for the production of road and concrete aggregates, and plastering sand. Limestone deposits are mainly found in the Central Range foothills and in the Northern Range. Reefal limestone found in the Central Range is a basic raw material in domestic cement production, and limestone deposits in the Northern Range constitute one of the main sources of roadstone and road aggregate. This concentration of quarrying activities in

the north and northern Trinidad has served to impose serious constraints on land use in these and surrounding areas.

In Tobago, the mineral deposits consist of aggregate from river boulders and quarry sites in volcanic areas. Currently boulders from the Goldsboro River are crushed and serve as aggregate for a variety of uses. State owned land at the Green Hill Quarry contains resources estimated at approximately 40,000 cubic metres.

Manufacturing industries are concentrated within both areas; one is the Capital Region particularly in the Diego Martin to Arima strip, and other one is the Couva-Point Lisas area which currently possesses a variety of large-scale industries as a growth centre as described in Para. 3.3 (II). Such a concentration in the Capital Region is due to the existence of a variety of significant facilities and also the desire of most investors to have easy access to the major commercial port of the country.

The selection of manufacturing industrial sites is one of the significant industrial strategies for the future development of themselves and also for the development of areas located. For example, agro-based industries could have a real potential by locating in rural areas, and also most of the spin-off industries from the energy-based industries could make effective activities in the production by locating in these areas. It is expected that those developments would aid in the transformation and diversification of the economy and reduce the country's dependence on petroleum.

(III) Tourism Sector

As indicated in Table 1.16, number of annual visitors from overseas to Trinidad and Tobago was nearly 200,000 with a little fluctuation over the period 1983-1988. Among them, hotel visitors, including business visitors which stayed at hotels, were an annual average of 77,000 corresponding to 38 % of the total visitors. However the estimated expenditure of tourists increased from T\$ 208.7 million in 1983 to T\$ 353.1 million in 1988, despite the hotel occupancy rates decreased from 60.7 % in 1983 to 42.5 % in 1988. On the other hand, a contribution of the hotel and guest house industries to the GDP was T\$ 102.1 million in 1988, at a share less than 1 % of the GDP every year as indicated in Tables 1.3 and 1.4.

Table 1.17 indicates a distribution of visitors by country of origin. The Commonwealth Caribbean which had occupied the first position as supplier of visitors by 1986, but after that year the position has been replaced by the United States. During the period 1983-1988, more than 60 % of the total visitors was travelers from the United States and The Commonwealth Caribbean. Canada and Britain followed the above both countries as suppliers of the visitors.

Although the estimated contribution of tourism sector to the GDP has shown a rate less than 1 % in recent years, it appears that Trinidad and Tobago possesses the basic resources and attractions necessary to sustain a tourism industry. The Government, therefore, has intended to pursue the exploitation of these potentials with the utmost vigour, as one element of strategies to strengthen the national economy.

To realize this intention of the Government, the development strategy and policy have been provided throughout three planning documents; National

Physical Development Plan (1984), Macro Planning Framework 1989-1995 (1988) and Tourism Policy (1988). These plans, which have the same content basically, are summarized below:

At present the tourism sector is only partially developed. In Trinidad the available tourist accommodation is heavily concentrated in the Port-of-Spain and its environs, and in Tobago nearly 90 % of hotels and guest houses are located along beach fronts of the western tip of the island. The installed accommodation base is presently about 2,100 rooms in hotels distributed at the ratio of 3:2 between Trinidad and Tobago. Employment in the tourism sector is estimated at nearly 5,000 persons or roughly 1.5 % of the total employment.

Piarco International Airport serves eleven international airlines together with about 1.5 million passengers per annum. The national airline operates a domestic shuttle service between Piarco in Trinidad and Crown Point in Tobago for approximately 0.5 million passengers yearly.

Development and promotion of the tourism industry in Trinidad and Tobago place emphasis on the country's cultural heritage, natural resources and history. The following priority locations have been identified for resort and hotel developments in Trinidad and Tobago:

- Tobago,
- The North Coast of Trinidad: between Maracas and Blanchisseuse,
- The North-East Coast from Toco to Balandra,
- Chaguaramas,
- Piarco, and
- Port-of-Spain.

In order to provide the basic preconditions for development of the tourism industry, the Government is committed to the following programme of supporting the investment in infrastructural improvements:

- The establishment of a deep-water harbour facility at Scarborough with adequate provision for the berthing of international cruise ships,
- Expansion of the runway and ancillary facilities at Crown Point to permit the international air carriers to fly visitors directly to Tobago,
- Improvements to the airport facilities at Piarco to accommodate the anticipated increase in visitor arrivals and to avoid the negative image generated by passenger and baggage processing.
- Effective improvements in the electricity and water supply in Tobago to facilitate the expansion in the tourism plant on the island.

In addition to these improvements of infrastructure, the Government expects an appropriate investment by both local and foreign capitals to promote the expansion of marketing and service facilities for tourists. Details of the development plan are discussed in the foregoing three documents, and it is expected to gain the main three goals; improvement in the quality of life, generation of employment and reduction of geographic

inequity.

4. Conclusion

The Government has formulated magnificent development plan in both social and economic aspects throughout the National Physical Development Plan and other some sectorial plans. In the present study, the review for the national development plans has been made in terms of some sectors: urban settlement and industries such as agriculture (including forestry and fishery), petroleum, manufacture and quarry in the secondary sector, and tourism in the tertiary sector, which would be regarded as the most significant sectors for encouraging the regional development and equity.

The realization of these sectorial development programmes would require the vast investment of the Government and private enterprises. The Government budget, however, is not sufficient for these development due to the decrease in the revenue (Para.2.7), and also most of private enterprises have not enough investment fund under the influence of the domestic economic recession in recent years as is obvious from the decline of GDP (Para.2.4).

At present it will be among the most significant efforts to produce a favorable trade balance by increasing the production of external commodities, and at the same time it seems to be essential to stimulate the development of domestic economy by the investment of foreign capitals which include loans and grants. Thus, a favorable condition created for the national economy will make a substantial contribution for realization of the development plans of all sectors mentioned above. However to the contrary, if there is no steady base of the national economy, it will be difficult to expect a satisfactory realization of these plans.

Table 1.1 POPULATION CENSUSES

Administrative Division	Area (ha)	Population			Average Annual Growth Rate (%)		Population Density (per sq. km)		
		1960	1970	1980	1960-1970	1970-1980	1960	1970	1980
Trinidad & Tobago	512,843	827,957	931,071	1,055,763	1.18	1.26	161	182	206
Cities & Towns	2,814	144,766	111,195	113,307	-2.60	0.19	5,144	3,951	4,027
Port of Spain	958	93,954	62,680	55,800	-3.97	-1.16	9,807	6,543	5,825
San Fernando	648	39,830	36,879	33,395	-0.77	-0.99	6,147	5,691	5,154
Arima	1,208	10,982	11,636	24,112	0.58	7.56	909	963	1,996
Counties	510,029	683,191	819,876	942,456	1.84	1.40	134	161	185
St. George*	90,755	256,478	312,085	370,572	1.98	1.73	283	344	408
Caroni	55,423	90,513	115,254	140,385	2.45	1.99	163	208	253
Nariva/Mayaro	91,168	23,306	28,350	30,883	1.98	0.86	26	31	34
St. Andrews/St. David	93,681	38,622	45,080	50,171	1.56	1.08	41	48	54
Victoria	81,348	132,721	163,164	187,009	2.09	1.37	163	201	230
St. Patrick**	67,548	108,218	117,189	123,912	0.80	0.56	160	173	183
Tobago	30,106	33,333	38,754	39,524	1.52	0.20	111	129	131

Sources: Population Censuses 1960, 1970 and 1980, Central Statistical Office.
Draft Medium Term Macro Planning Framework 1989 - 1995, National Planning Commission.

Note : * Excludes Port of Spain and Arima Borough.
** Includes Pt. Fortine Borough.

Table 1.2 LABOUR FORCE AND EMPLOYMENT ESTIMATES

ITEM	Unit: Thousand Persons					
	1983	1984	1985	1986	1987	1988
Non-Institutional pop. of 15 yrs & over	748.2	759.7	770.9	795.3	807.4	819.2
Labour Force	442.5	470.9	463.2	471.0	473.0	483.5
Persons Employed	393.4	410.6	392.5	393.0	370.7	376.8
Persons Unemployed	49.1	60.0	70.7	78.0	102.3	106.8
Participation Rate (%)	59.1	62.0	60.1	59.2	58.6	59.0
Unemployment Rate (%)	11.1	12.7	15.3	16.6	21.6	22.1

Source: Review of the Economy 1988, Central Statistical Office.

Table 1.3 DISTRIBUTION OF LABOUR FORCE BY INDUSTRIAL ORIGIN

Industrial Origin	1986		1987		1988	
	Persons ('000)	Rate (%)	Persons ('000)	Rate (%)	Persons ('000)	Rate (%)
Total	471.0	100.0	473.0	100.0	483.5	100.0
Petroleum	22.2	4.7	22.0	4.7	21.9	4.5
Agriculture	38.3	8.1	38.0	8.0	39.7	8.2
Sugar	13.0	2.8	12.4	2.6	18.5	3.8
Food, Beverage & Tobacco	10.9	2.3	13.2	2.8	14.9	3.1
Textiles, Garments & Footwear	4.0	0.9	3.3	0.7	3.9	0.8
Printing, Publishing, etc.	3.5	0.7	4.5	1.0	4.6	1.0
Paper	5.3	1.1	5.9	1.2	5.3	1.1
Chemical & Non-metallic Minerals	4.8	1.0	3.8	0.8	6.0	1.2
Assembly Type & Related Industries	11.5	2.5	9.1	1.9	8.8	1.8
Miscellaneous Manufacturing	1.7	0.4	2.1	0.4	2.7	0.6
Electricity, Gas & Water	8.7	1.8	10.1	2.1	10.5	2.2
Construction	83.3	17.7	86.7	18.3	78.7	16.3
Distribution & Restaurants	74.6	15.8	70.3	14.9	75.9	15.7
Hotel & Guest House	2.2	0.5	1.8	0.4	2.8	0.6
Transport, Storage & Communication	29.8	6.3	33.1	7.0	33.2	6.9
Finance, Insurance, Real Estate & Business Services	29.3	6.2	29.6	6.3	29.3	6.1
Central & Local Government	46.2	9.8	46.0	9.7	43.6	9.0
Education & Cultural Services	24.4	5.2	23.0	4.9	25.8	5.3
Personal Services	49.9	10.6	56.6	12.0	56.2	11.6
Not Stated	7.4	1.6	1.2	0.3	1.2	0.2

Source: Review of the Economy 1988, Central Statistical Office.

Table 1.4 GROSS DOMESTIC PRODUCT OF TRINIDAD AND TOBAGO AT MARKET PRICES (CURRENT PRICES), 1978 - 1988

Unit: T\$ Million

Industrial Origin	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Gross Domestic Product	8,643.3	11,136.7	15,031.1	16,432.8	19,128.4	18,719.4	18,828.6	18,076.8	17,242.4	16,571.5	15,973.2
Petroleum	2,977.1	4,261.1	6,412.5	5,993.5	5,103.5	4,541.3	5,065.9	4,814.6	3,808.7	3,794.2	3,227.7
Agriculture	406.0	462.1	452.6	423.0	453.3	384.2	349.4	590.7	662.2	719.9	743.6
Manufacture	613.9	720.2	793.4	845.9	1,006.4	1,363.9	1,418.6	1,324.4	1,541.4	1,519.8	1,583.3
Electricity & Water	49.8	51.4	25.7	31.1	(3.9)	(5.3)	176.9	181.2	198.4	236.4	234.2
Construction & Quarrying	1,100.9	1,333.5	1,723.5	2,450.9	3,030.5	2,734.0	2,402.4	2,004.2	1,836.4	1,738.6	1,867.5
Distribution & Restaurants	1,074.2	1,143.8	1,544.2	1,950.7	2,291.4	2,287.0	2,025.6	1,897.0	1,833.0	1,593.3	1,546.8
Hotels & Guest Houses	38.2	47.9	57.4	67.9	74.6	78.3	70.4	63.3	63.2	83.6	102.1
Transport, Storage & Communication	767.8	976.7	1,469.7	1,548.2	2,036.4	1,882.2	1,752.0	1,712.3	1,741.6	1,633.9	1,589.0
Finance, Insurance, Real Estate, etc.	774.3	1,075.7	1,433.9	1,840.8	2,166.5	2,295.5	2,179.0	2,130.5	2,027.6	1,896.4	1,861.1
Government	763.4	1,064.4	1,173.5	1,475.2	2,868.2	2,617.3	2,775.7	2,741.4	2,809.6	2,652.6	2,441.4
Education & Cultural Community Services	252.3	288.7	380.3	383.1	812.6	808.8	856.4	853.3	884.4	680.2	743.7
Personal Services	200.4	288.0	322.5	401.7	456.7	476.6	533.9	549.0	558.5	639.9	636.3
Correction for Imputed Service Charge	-375.0	-576.8	-758.1	-1,079.2	-1,167.8	-746.6	-777.5	-785.1	-722.5	-617.3	(603.5)

Sources: Review of the Economy 1988, Central Statistical Office.

Draft Medium Term Macro Planning Framework 1989 - 1995, National Planning Commission.

Table 1.5 GROWTH RATES OF GROSS DOMESTIC PRODUCT AT MARKET PRICES

Unit: Percent

Industrial Origin	at Current Prices				at 1985 Constant Prices			
	1984 - 1985	1985 - 1986	1986 - 1987	1987 - 1988	1984 - 1985	1985 - 1986	1986 - 1987	1987 - 1988
Gross Domestic Product	-4.3	-6.3	-6.8	-3.6	-4.4	-3.3	-7.4	-3.8
Petroleum	-5.0	-21.6	-4.2	-12.0	7.4	-4.0	-8.2	-6.2
Agriculture	73.9	6.3	5.1	9.4	6.0	3.0	5.0	4.7
Manufacture	-9.3	12.8	3.4	4.2	-17.1	8.3	-6.9	1.5
Electricity & Water	2.9	29.3	-17.0	0.9	0.9	9.1	5.5	-0.9
Construction & Quarrying	-16.2	-15.6	-19.9	7.4	-20.5	-14.2	-8.8	4.9
Distribution & Restaurants	-12.0	-9.0	-8.0	-2.9	-12.4	-9.9	-22.6	-9.5
Hotels & Guest Houses	-10.1	-0.3	15.5	22.1	-13.5	-3.3	-1.0	1.8
Transport, Storage & Communication	2.0	1.4	-2.9	-2.8	4.1	0.1	-2.7	-2.8
Finance, Insurance, Real Estate, etc.	2.2	-4.8	-6.5	-1.9	-9.2	-11.7	-15.3	-8.2
Government	1.3	2.6	-17.0	-8.0	-1.2	2.5	-5.6	-7.9
Education & Cultural Community Services	0.2	3.5	-11.8	9.3	3.1	0.2	-1.5	1.2
Personal Services	2.8	1.7	14.6	-0.6	-5.5	-0.8	5.3	-4.3
Correction for Imputed Service Charge	-1.0	8.0	14.6	-2.2	6.2	14.6	23.2	-8.6

Source: Review of the Economy 1988, Central Statistical Office.

Table 1.6 SECTORAL CONTRIBUTIONS OF GROSS DOMESTIC PRODUCT AT MARKET PRICES (CURRENT PRICES)

Unit: Percent

Industrial Origin	1984	1985	1986	1987	1988
Petroleum	26.4	26.8	21.8	22.1	20.2
Agriculture	3.5	4.6	5.9	6.2	4.7
Manufacture	7.2	6.7	8.2	8.6	9.3
Electricity & Water	2.2	2.5	2.5	2.5	1.5
Construction & Quarrying	12.7	11.1	10.7	10.7	11.7
Distribution & Restaurants	6.9	5.9	6.2	6.2	9.7
Hotels & Guest Houses	0.4	0.3	0.4	0.5	0.6
Transport, Storage & Communication	11.2	11.5	12.1	11.7	9.9
Finance, Insurance, Real Estate, etc.	11.5	11.8	11.9	11.7	11.7
Government	14.7	15.2	16.5	16.4	15.3
Education & Cultural Community Services	4.5	4.7	5.2	4.2	4.7
Personal Services	2.7	2.9	3.2	3.8	4.0
Correction for Imputed Service Charge	-4.1	-4.4	-4.2	-3.8	-3.8

Source: Review of the Economy 1988, Central Statistical Office.

Table 1.7 EXPORTS, IMPORTS AND TRADE BALANCE
Unit: T\$ million

Year	Exports		Total	Imports	Trade Balance
	Domestic Products	Foreign Products			
1978	4,809.0	87.9	4,896.9	4,745.0	151.9
1979	6,178.0	78.4	6,256.4	5,060.2	1,196.2
1980	9,733.2	63.1	9,796.3	7,653.9	2,142.4
1981	8,720.3	302.5	9,022.8	7,455.1	1,567.7
1982	7,185.8	210.0	7,395.8	8,869.8	-1,474.0
1983	5,430.5	193.2	5,623.7	6,179.3	-555.6
1984	5,042.3	163.2	5,205.5	4,597.7	607.8
1985	5,065.9	169.8	5,235.7	3,731.4	1,504.3
1986	4,879.2	99.0	4,978.2	4,932.4	45.8
1987	5,177.9	76.8	5,254.7	4,380.6	874.1
1988	5,345.8	65.7	5,411.5	4,283.0	1,128.5

Source: Overseas Trade 1988, Part B, Central Statistical Office.

Table 1.8 PERCENTAGE OF PRINCIPAL COMMODITIES
IN DOMESTIC EXPORTS
Unit: Percent

Commodities	1986	1987	1988
Crude petroleum	40.7	36.1	30.2
Petroleum products	31.2	35.8	30.8
Natural asphalt	0.4	0.4	0.4
Non-alcoholic beverages	0.2	0.4	0.6
Sugar	1.7	1.5	1.7
Cocoa beans	0.2	0.2	0.2
Coffee beans	0.2	0.1	-
Methanol	2.3	2.8	4.3
Iron and steel bars, rods	4.9	5.0	5.4
Urea	3.5	2.9	5.0
Ammonia	9.2	7.8	10.8
Gas	0.3	0.2	0.2
Rum	0.5	0.3	0.3
Bitters	0.1	0.1	0.1
Clothing	0.1	0.2	0.2
Soaps	0.2	0.3	0.4
Others	4.3	5.9	9.4

Source: Overseas Trade 1988, Part B, Central Statistical Office.

Table 1.9 BALANCE OF INTERNATIONAL PAYMENTS

Unit: T\$ million

Items	1984	1985	1986	1987	1988
Current Account	-1,337	-263	-2,275	-890	-576
Merchandise	462	1,430	-387	801	1,078
Services	-1,528	-1,542	-1,751	-1,559	-1,514
Transfers	-270	-151	-137	-132	-140
Capital Account	-61	327	-68	104	419
Public Sector	79	479	311	16	339
Private Sector	-140	-152	-243	88	80
Errors & Omissions	-351	-326	-180	-130	-109
Overall Deficit	-1,749	-262	-2,387	-916	-266
Valuation Change	-399	983	-	-	-45
Change in Reserves (increase (-)/decrease(+))	2,148	-721	2,387	916	311
Reserves at the Year End	2,850	3,580	1,185	267	-24

Source: Annual Economic Survey 1988, Central Bank of Trinidad and Tobago.

Table 1.10 FISCAL OPERATIONS OF THE CENTRAL GOVERNMENT

Unit: T\$ million

I t e m s	1982	1983	1984	1985	1986	1987	1988
Total Revenue and Grants	7,066.9	6,552.0	6,612.8	6,664.8	5,455.8	5,300.0	4,775.5
Current Revenue	7,066.7	6,551.2	6,609.1	6,492.2	5,455.6	5,299.3	4,754.4
Tax Revenue	5,897.4	5,469.4	5,661.5	5,407.7	4,209.8	4,234.0	3,972.2
Non-Tax Revenue	1,169.3	1,081.8	947.6	1,084.5	1,245.8	1,065.3	782.2
Capital Receipt	0.2	0.8	3.7	171.8	0.2	0.7	21.1
Grants	0	0	0	0.8	0	0	0
Total Expenditure	9,413.6	8,768.0	8,268.5	7,582.2	6,468.1	6,312.0	5,977.3
Current Expenditure	6,038.2	6,237.6	6,273.0	6,037.7	5,590.5	5,066.4	4,816.3
Capital Expenditure & Net-Lending	3,375.4	2,530.4	1,995.5	1,544.5	877.6	1,245.6	1,161.0
Overall Balance	-2,346.7	-2,216.0	-1,655.7	-917.4	-1,012.3	-1,012.0	-1,201.8
Financing Requirements	2,346.7	2,216.0	1,655.7	917.4	1,012.3	1,012.0	1,201.8
External	265.2	228.1	457.5	325.7	-261.6	-17.8	-171.9
Internal	2,081.5	1,987.9	1,198.2	591.7	1,273.9	1,029.8	1,373.7

Source: Review of the Economy 1988, Central Statistical Office.

Table 1.11 BREAKDOWN OF CURRENT REVENUE OF THE CENTRAL GOVERNMENT

Unit: T\$ million

Items	1982	1983	1984	1985	1986	1987	1988
Total Current Revenue	7,066.7	6,551.2	6,609.1	6,492.2	5,455.6	5,299.3	4,754.4
Tax Revenue	5,897.4	5,469.4	5,661.5	5,407.7	4,209.8	4,234.0	3,972.2
Taxes on Incomes & Profits	4,947.4	4,358.3	4,506.5	4,055.5	2,997.9	3,068.7	2,669.1
Taxes on Property	17.8	14.5	14.9	24.9	28.7	25.7	32.3
Taxes on Goods & Services	352	488.3	616.5	646.4	649.5	712.1	866.2
Taxes on International Trade	541.7	564	481.2	629.4	500	398.4	379.6
Others	38.5	44.3	42.4	51.5	33.7	29.1	25
Non-Tax Revenue	1,169.3	1,081.8	947.6	1,084.5	1,245.8	1,065.3	782.2
Interest Income	271.9	141.3	102.3	130.2	86.0	148.2	87.1
Royalties	536.7	445.5	444.2	451.6	381.4	382.5	310.9
Profits from Enterprises	251.5	391.2	298.7	331.9	466.8	303.4	222.4
Administrative Fees & Charges	20.2	29.4	29.7	36.8	37.0	33.7	51.8
Non-Industrial Sales	7.7	10.4	10.0	10.2	11.6	9.5	9.9
Post Office	13.2	13.6	12.2	17.3	16.2	21.9	22.7
Others	68.1	50.4	50.5	106.5	246.8	166.1	77.4

Source: Review of the Economy 1988, Central Statistical Office.

Table 1.12 BREAKDOWN OF THE CENTRAL GOVERNMENT EXPENDITURE

Unit : T\$ million

Items	1982	1983	1984	1985	1986	1987	1988
Total Expenditure	9,413.6	8,768.0	8,268.5	7,582.2	6,468.1	6,312.0	5,977.3
Current Expenditure	6,038.2	6,237.6	6,273.0	6,037.7	5,590.5	5,066.0	4,816.3
Wages and Salaries	3,098.7	2,660.6	2,760.9	2,710.0	2,740.7	2,451.3	2,329.7
Goods and Services	370.1	370.6	448.8	349.8	360.3	430.5	421.9
Interest Payments	160.7	197.1	265.4	277.9	441.8	464.6	522.0
Subsidies and Transfers	2,408.7	3,009.3	2,797.9	2,700.0	2,047.7	1,720.0	1,542.7
Capital Expenditure	3,375.4	2,530.4	1,995.5	1,544.5	877.6	1,245.6	1,161.0
Acquisition of Foreign Fixed Assets	10.8	4.3	0.0	1.3	0.9	1.0	1.0
Development Programme	190.4	213.5	120.3	151.5	251.9	1,319.4	1,231.7
Funds for Long-Term Projects	3,225.0	2,324.2	1,882.7	1,493.6	726.4	0.0	0.0
Net-Lending	-50.8	-11.6	-7.5	-101.9	-101.6	-74.8	-71.7

Source: Review of the Economy 1988, Central Statistical Office.

Table 1.13 PERCENTAGE OF ANNUAL INCREASE/DECREASE OF RETAIL AND PRODUCERS' PRICES, AND MINIMUM WAGES, 1982 - 1988

Unit: Percent

Items	1982 - 1983	1983 - 1984	1984 - 1985	1985 - 1986	1986 - 1987	1987 - 1988
Retail Prices						
All Items	16.7	13.3	7.7	7.7	10.8	7.8
Foods	23.3	10.0	8.1	10.6	19.4	12.8
Producers' Prices	12.5	5.2	4.6	6.2	4.3	5.9
Minimum Wage Rates	18.6	10.4	5.4	3.7	2.0	0.4

Sources: Economic Indicators Oct. - Dec. 1987, Central Statistical Office.
 Quarterly Economic Report Apr. - Jun. 1989, Central Statistical Office.
 Trinidad and Tobago Gazette No. 283, Nov. 15th, 1989.

Table 1.14 PRINCIPAL AGRICULTURAL PRODUCTION

Products	Unit	1983	1984	1985	1986	1987	1988	Annual Growth Rate (%) 1983-1988
Suger	1,000 tonnes	77.4	960.0	114.3	119.3	118.5	130.2	10.40
Cocoa beans	1,000 kg	1,733.0	1,560.0	1,307.0	1,426.0	1,501.0	1,712.0	-0.24
Coffee beans	1,000 kg	1,389.0	852.0	2,141.0	1,334.0	1,842.0	582.0	-17.40
Citrus	1,000 kg	-	3,264.0	6,079.0	4,322.0	2,869.0	4,754.0	9.40
Tobacco	1,000 kg	41.2	61.4	43.5	70.7	68.8	-	12.08
Broilers	1,000 birds	18,724.0	17,420.0	17,581.0	14,870.0	15,799.0	13,795.0	-6.11
Table eggs	1,000 doz	3,142.0	2,292.0	2,958.0	3,077.0	3,018.0	3,198.0	0.35
Meet	1,000 kg	4,982.0	4,987.0	4,651.0	4,185.0	4,770.0	-	-1.09
Milk	1,000 litres	9,017.0	10,065.0	10,557.0	11,325.0	9,892.0	9,700.0	1.46

Sources: Quarterly Agricultural Report, Oct. - Dec. 1987, Central Statistical Office.
 Annual Economic Survey, 1988, Central Bank of Trinidad and Tobago.

Table 1.16 TOTAL ARRIVALS BY CATEGORY OF VISITOR, HOTEL OCCUPANCY RATES AND ESTIMATED EXPENDITURE OF TOURISTS

Categories	1983	1984	1985	1986	1987	1988
Number of Visitors	188,540	191,470	187,090	191,260	210,716	186,271
of which						
Hotels	20,240	18,260	18,100	19,800	23,115	26,770
Private Homes	111,190	109,440	109,370	107,960	112,683	111,104
Business	52,330	58,570	56,360	60,010	59,883	42,210
Others	4,780	5,200	3,260	3,490	6,035	6,187
Hotel Occ. Rates (%)	60.7	49.7	51.6	46.8	44.0	42.5
Est. Exp. of Tourists *1	208.7	236.5	238.0	299.7	337.2	353.1

Source: Review of the Economy 1988 & 1989, Central Statistical Office

Note: *1: Million of T\$

Table 1.15 PRINCIPAL INDUSTRIAL PRODUCTION

Commodities	Unit	1984	1985	1986	1987	1988	Annual Growth
							Rate (%) 1984-1988
Crude Oil	1,000 m3	9,480.0	10,221.0	9,802.0	8,964.0	8,778.0	-2.92
Refinery Output	1,000 m3	4,201.0	4,209.0	4,788.0	4,995.0	4,948.0	4.09
Asphalt	1,000 tonnes	31.1	21.3	24.1	21.0	20.2	-10.79
Natural Gas	1,000 m3	7,229.0	7,550.0	7,585.0	7,672.0	7,438.0	0.71
Fertilizer	1,000 tonnes	1,458.0	1,661.0	1,884.0	1,837.0	2,206.0	10.35
Methanol	1,000 tonnes	181.0	358.0	324.0	424.0	396.0	19.57
Steel	1,000 tonnes						
(i) Direct Reduced Iron		239.0	243.0	337.0	441.0	548.0	20.75
(ii) Billets		199.0	167.0	327.0	376.0	361.0	14.89
(iii) Wire Rods		135.0	103.0	217.0	276.0	251.0	15.50
Cement	1,000 tonnes	405.0	329.0	338.0	326.0	360.0	-2.94
Assembly Products	Units						
(i) Refrigerators		21,803.0	9,654.0	14,354.0	15,116.0	13,894.0	-11.26
(ii) Motor Vehicles		22,753.0	15,098.0	11,287.0	5,171.0	4,320.0	-41.54
(iii) Gas Cookers		20,320.0	19,303.0	20,242.0	18,085.0	11,420.0	-14.41
(iv) Radios		2,194.0	3,840.0	8,118.0	9,581.0	11,462.0	41.33
(v) Television sets		19,150.0	21,473.0	15,390.0	10,383.0	6,332.0	-27.67
Alcoholic Beverages							
(i) Spirits	1,000 proof Gals.	2,868.0	2,420.0	2,307.0	3,629.0	3,208.0	2.80
(ii) Beer	1,000 litres	28,816.0	22,339.0	27,140.0	32,958.0	33,040.0	3.42
(iii) Stout	1,000 litres	4,951.0	4,016.0	3,115.0	4,310.0	4,384.0	-3.04
(iv) Molta	1,000 litres	2,890.0	2,378.0	2,635.0	3,227.0	3,254.0	2.97
Edible Oil and Related Products							
(i) Edible Oil	1,000 litres	6,233.0	5,925.0	12,064.0	10,047.0	8,289.0	7.13
(ii) Margarine	1,000 kgs	2,392.0	4,983.0	5,198.0	5,493.0	5,763.0	21.98
(iii) Lard Substitute	1,000 kgs	1,645.0	2,034.0	2,240.0	2,380.0	2,583.0	11.28
(iv) Soap	1,000 kgs	1,695.0	2,897.0	2,903.0	2,574.0	3,627.0	19.02

Source: Annual Economic Survey, 1988, Central Bank of Trinidad and Tobago.

Table 1.17 DISTRIBUTION OF VISITORS BY COUNTRY OF ORIGIN

Countries	Unit: Percent					
	1983	1984	1985	1986	1987	1988
United States	28.1	27.7	29.3	29.8	33.2	33.4
Canada	12.2	12.4	12.5	10.9	12.2	12.4
Britain	8.6	8.5	8.5	8.3	9.0	8.8
Commonwealth Caribbean	38.0	40.0	39.2	39.6	30.4	28.9
Rest of the World	13.1	11.4	10.2	11.4	15.2	15.5

Source: Review of the Economy 1988 & 1989, Central Statistical Office

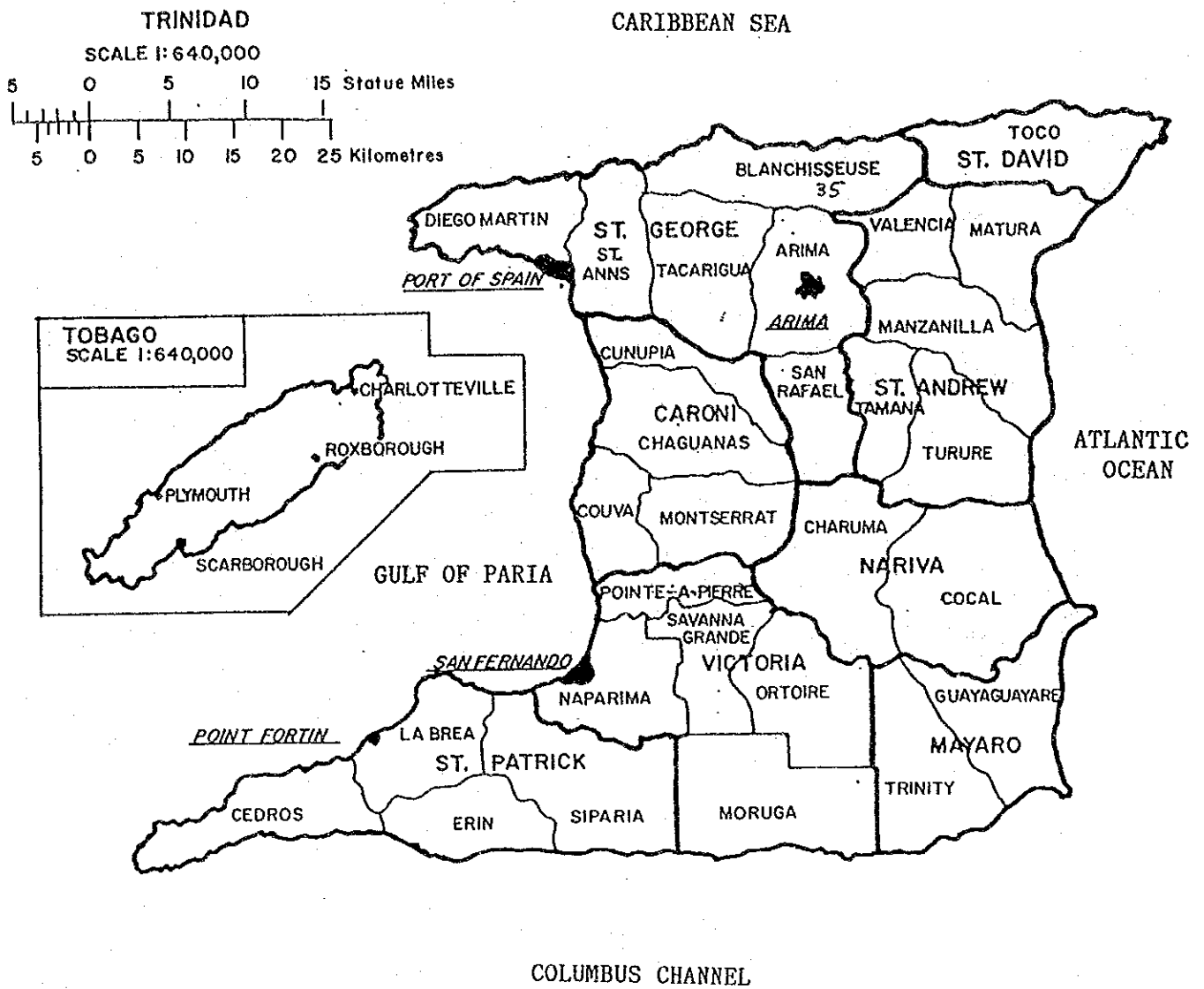


Fig. 1.1 Administrative Areas 1980

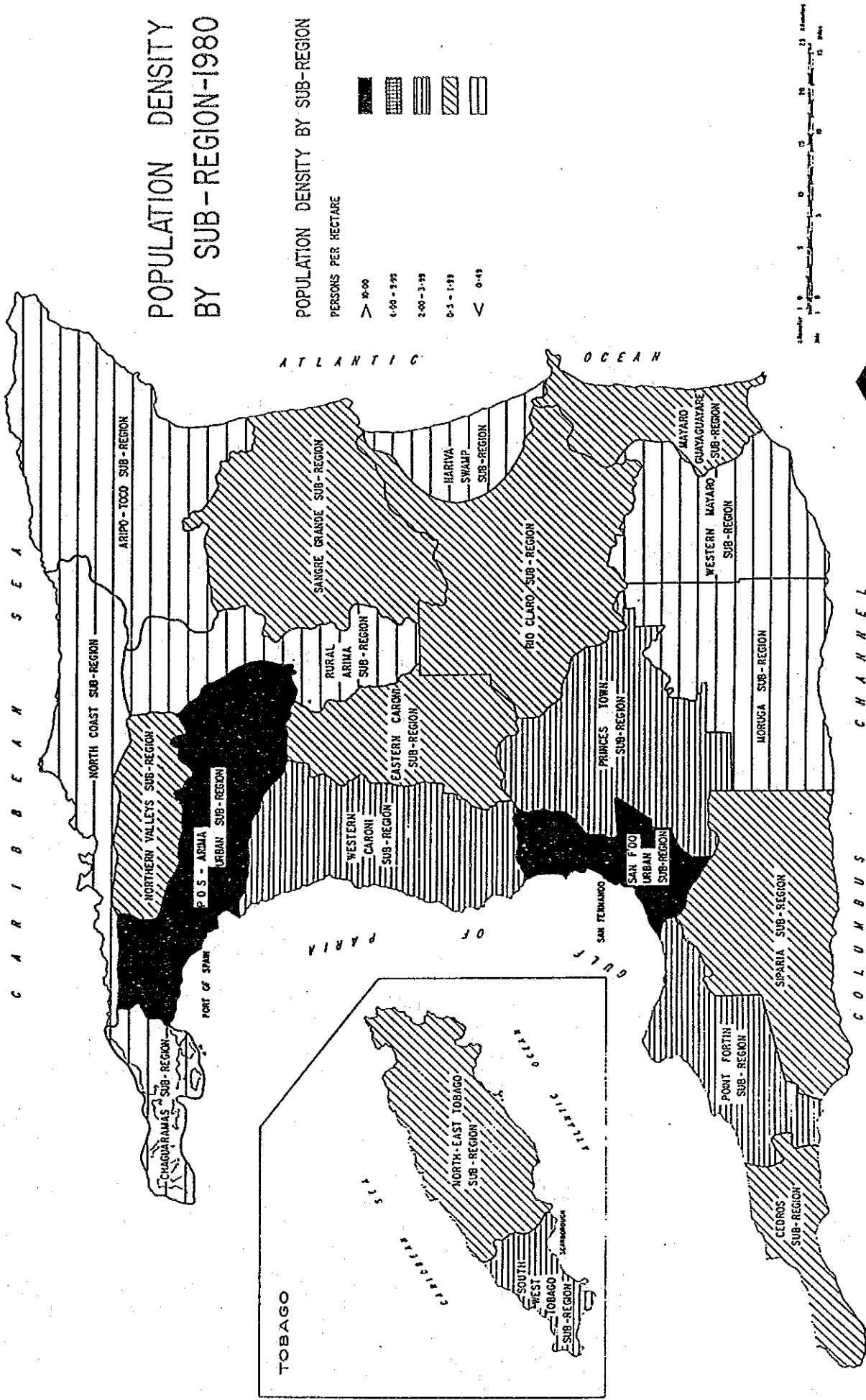


Fig. 1.4 Population Density by Sub-region 1980
(National Physical Development Plan, Trinidad and Tobago)

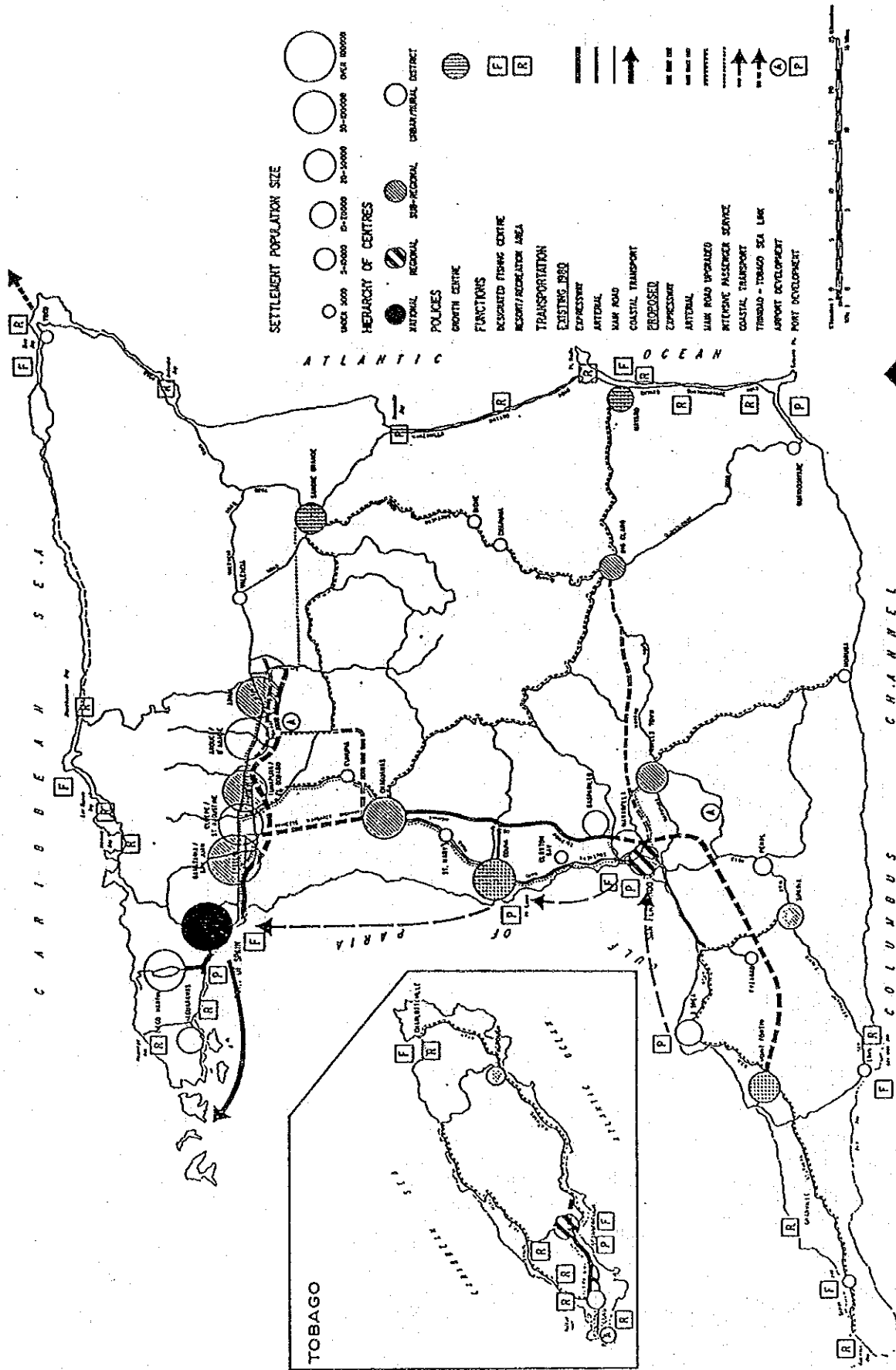


Fig. 1.5 Proposals: Settlements and Population - Year 2000
(National Physical Development Plan, Trinidad and Tobago)

PROPOSALS: LAND USE - YEAR 2000.

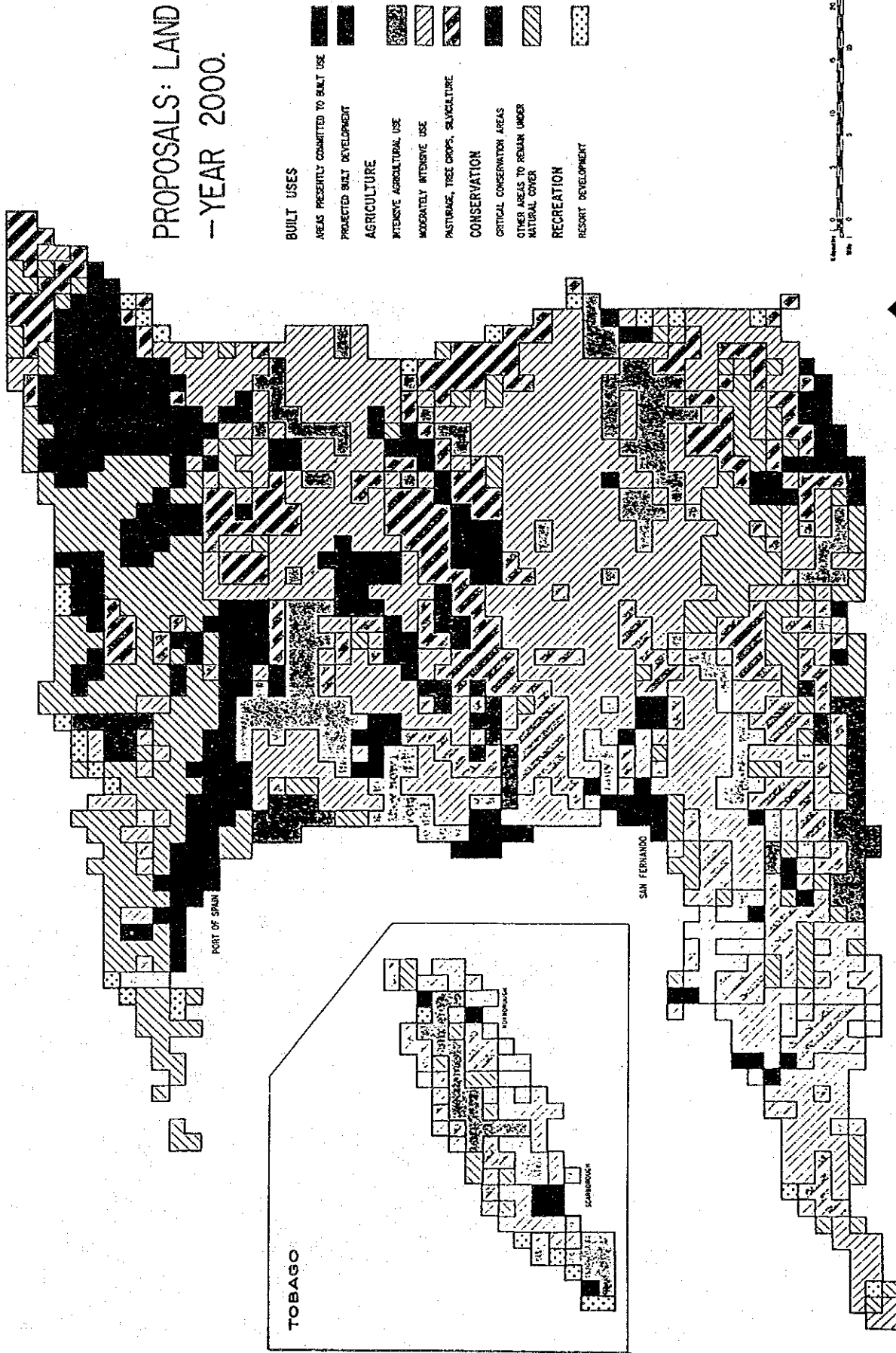


Fig. 1.6 Proposals: Land Use - Year 2000
(National Physical Development Plan, Trinidad and Tobago)

KEY PROPOSALS - YEAR 2000

SETTLEMENT AND POPULATION

- SETTLEMENT POPULATION SIZE
- UNDER 5000
- 5-10000
- 10-20000
- 20-50000
- 50-100000
- OVER 100000
- GROWTH CENTRE

AGRICULTURE

- INTENSIVE AND MODERATELY INTENSIVE AGRICULTURE
- OTHER AGRICULTURE
- AREA ENHANCED FOR RURAL DEVELOPMENT PROGRAMMES
- DESIGNATED FISHING CENTRE

ENVIRONMENT

- CONSERVATION AREA
- RESORT DEVELOPMENT
- NATIONAL PARK

TRANSPORTATION

- EXISTING 1980
- EXPRESSWAY
- ARTERIAL
- MAJOR ROAD
- COASTAL TRANSPORT
- PROPOSED
- EXPRESSWAY
- ARTERIAL
- MAIN ROAD UPGRADED
- INTENSIVE PASSENGER SERVICE
- COASTAL TRANSPORT
- TRINIDAD-TOBAGO SEA LINK
- AIRPORT DEVELOPMENT
- PORT DEVELOPMENT

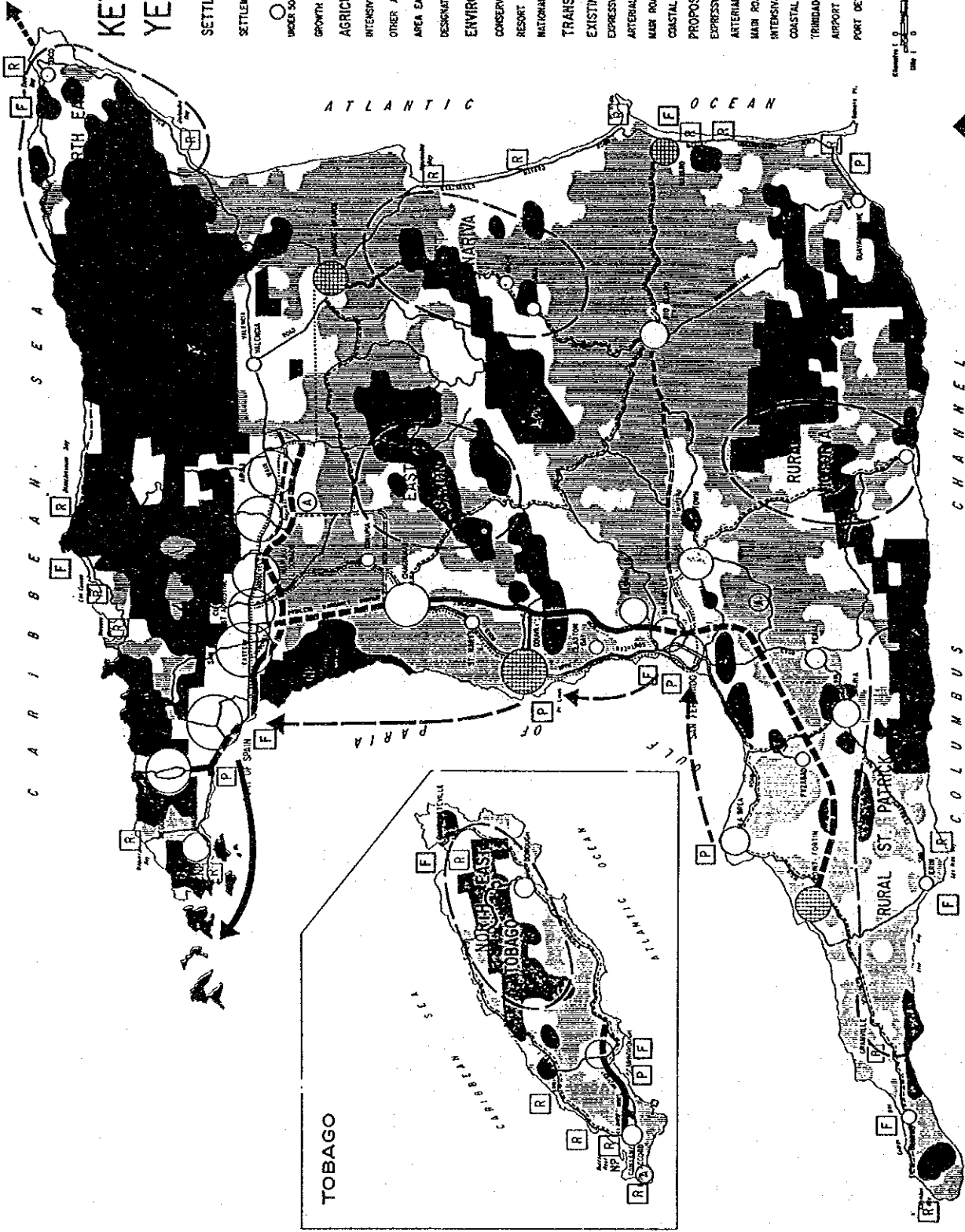


Fig. 1.7 Key Proposals - Year 2000
(National Physical Development Plan, Trinidad and Tobago)

B: WATER SOURCE

C O N T E N T S

1. General.....	B- 1
2. Climate.....	B- 2
3. Hollis Impounding Reservoir.....	B- 8
4. North Oropouche River.....	B-14
5. Arena Impounding Reservoir and Caroni River.....	B-17
6. Navet Impounding Reservoir.....	B-19
7. Hillsborough Impounding Reservoir.....	B-21
8. Other River Intake Sources.....	B-27
9. Groundwater Sources.....	B-39
10. Estimated Dependable Yields.....	B-49
11. Water Quality.....	B-51

1. General

This Appendix aims to evaluate the production capabilities of the existing major water sources.

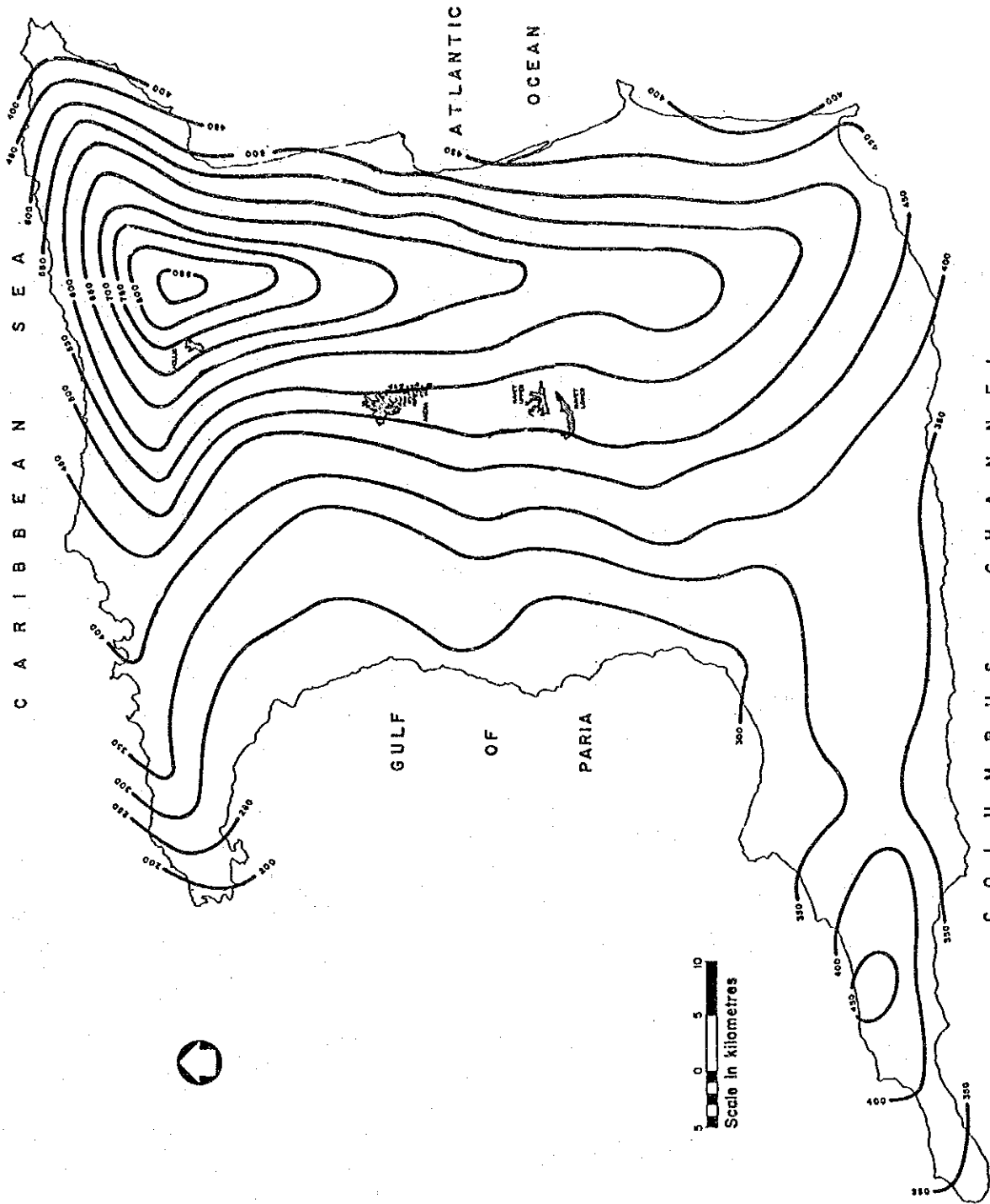
The latest report prepared by Lourdes Marte Brathwaite, titled "The Water System Balance in Trinidad 1985", investigated supply capability of each source, and listed production capacity of each source in conjunction with Operation and Maintenance Department of WASA. The figures in the report were referred here as listed productions to compare with the past production records.

Production records since 1976 were obtained from Technical Record Section. However, the records from most of groundwater sources have been estimated due to no flow meters. Estimates were usually made from pump operation periods.

Evaluation of production capabilities was made first by collecting the past production records and comparing them to the listed production. Secondly seasonal variation of the production was investigated.

2. Climate

Climate in Trinidad and Tobago is divided into two seasons, a dry season with almost no rainfall and a rainy season with abundant rainfall. The dry season usually starts from January and ends during May, and the rainy season lasts from June to December. Rainfall usually rises to a maximum within July or August. 70-year isohyethal maps prepared in annual basis and seasonal bases by WRA are reproduced on Figs. 2.1 to 2.6.



C O L U M B U S C H A N N E L

Fig. 2.1 Isohyetal Map of 75 Year Mean Dry Season Rainfall (mm), Trinidad
Record Period 1911 - 1985, Prepared by WRA

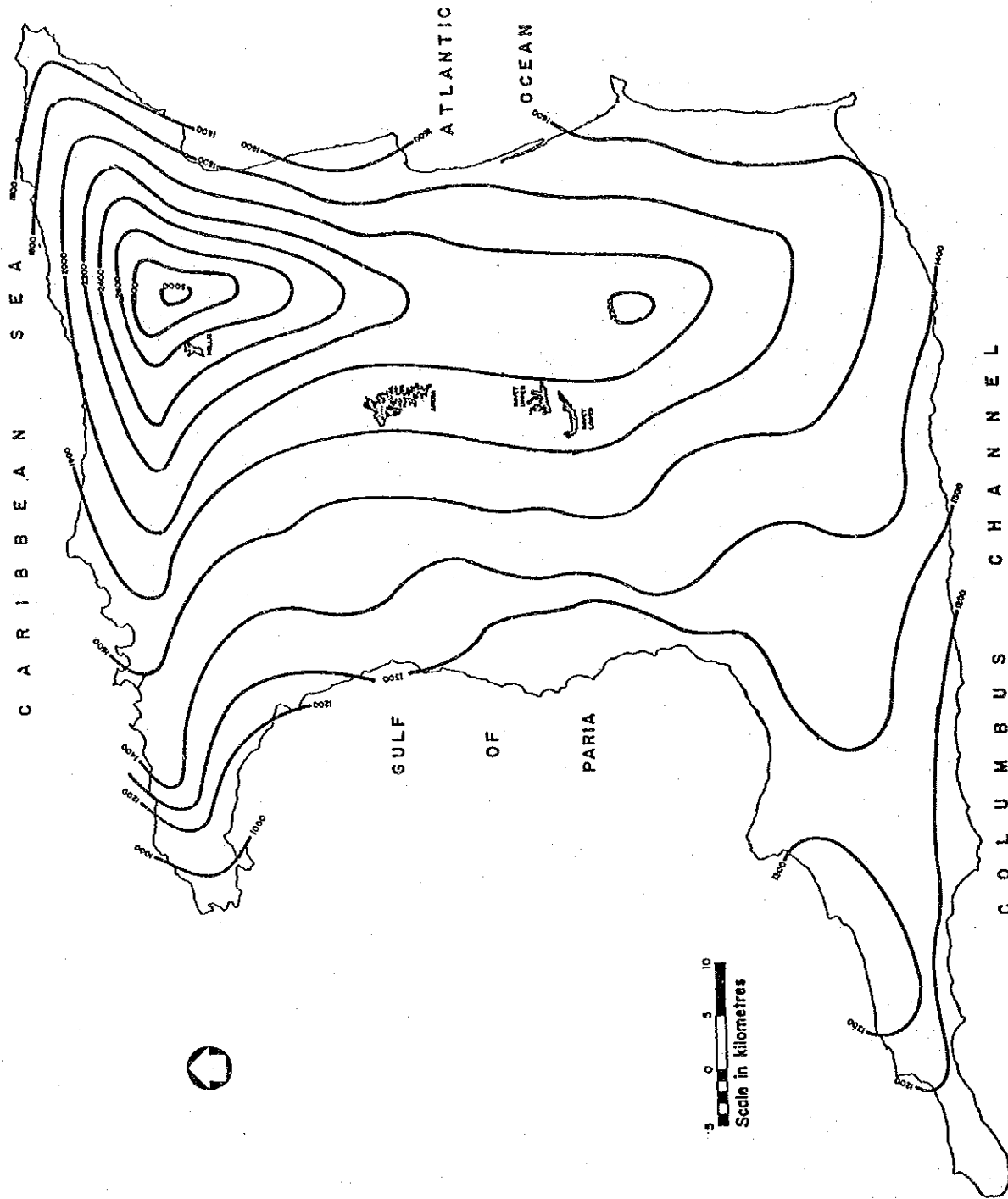
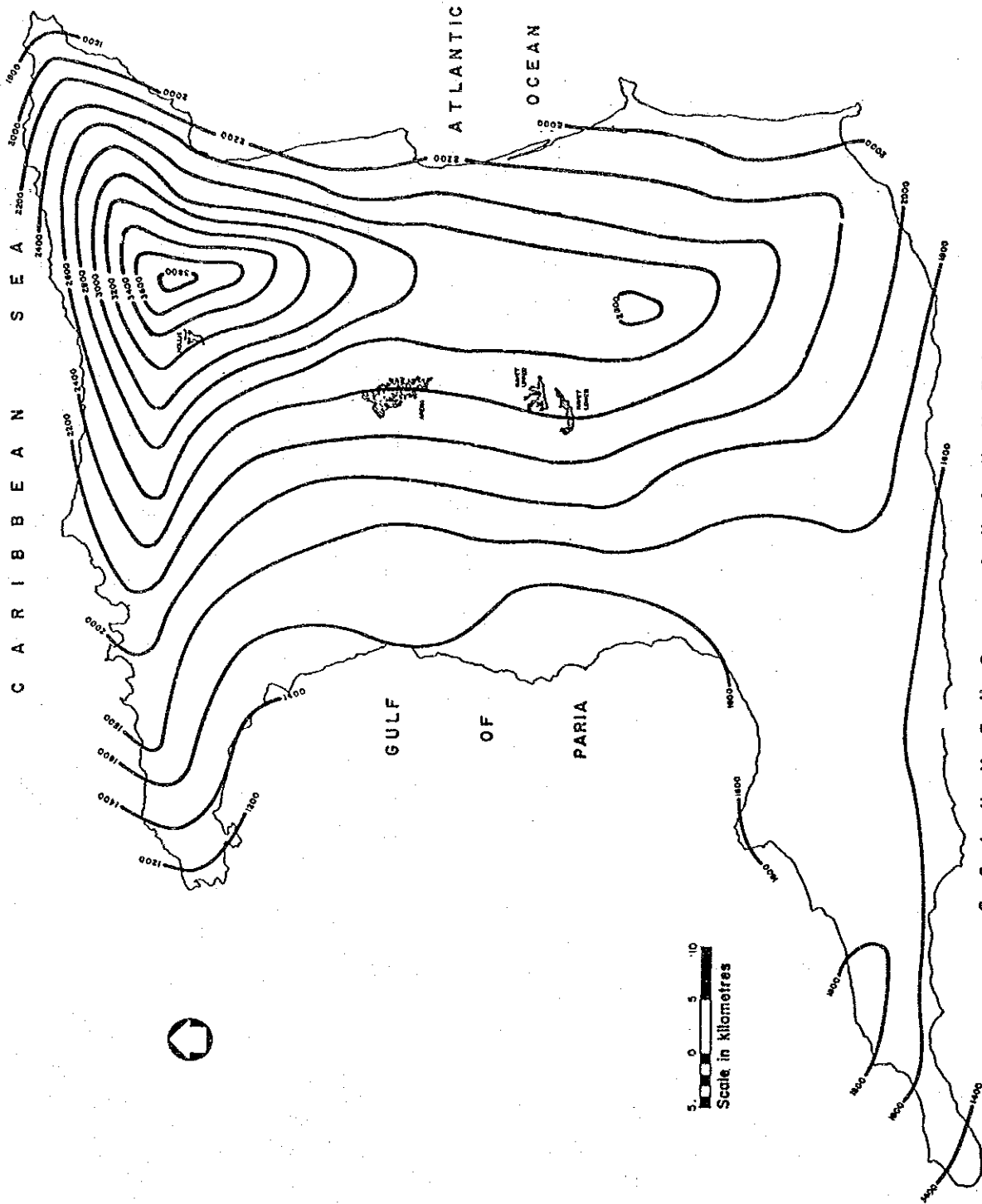


Fig. 2.2 Isohyetal Map of 75 Year Mean Rainy Season Rainfall (mm), Trinidad
 Record Period 1911 - 1985, Prepared by WRA



C O L U M B U S C H A N N E L

Fig. 2.3 Isohyetal Map of 75 Year Mean Annual Rainfall (mm), Trinidad
Record Period 1911 - 1985, Prepared by WRA

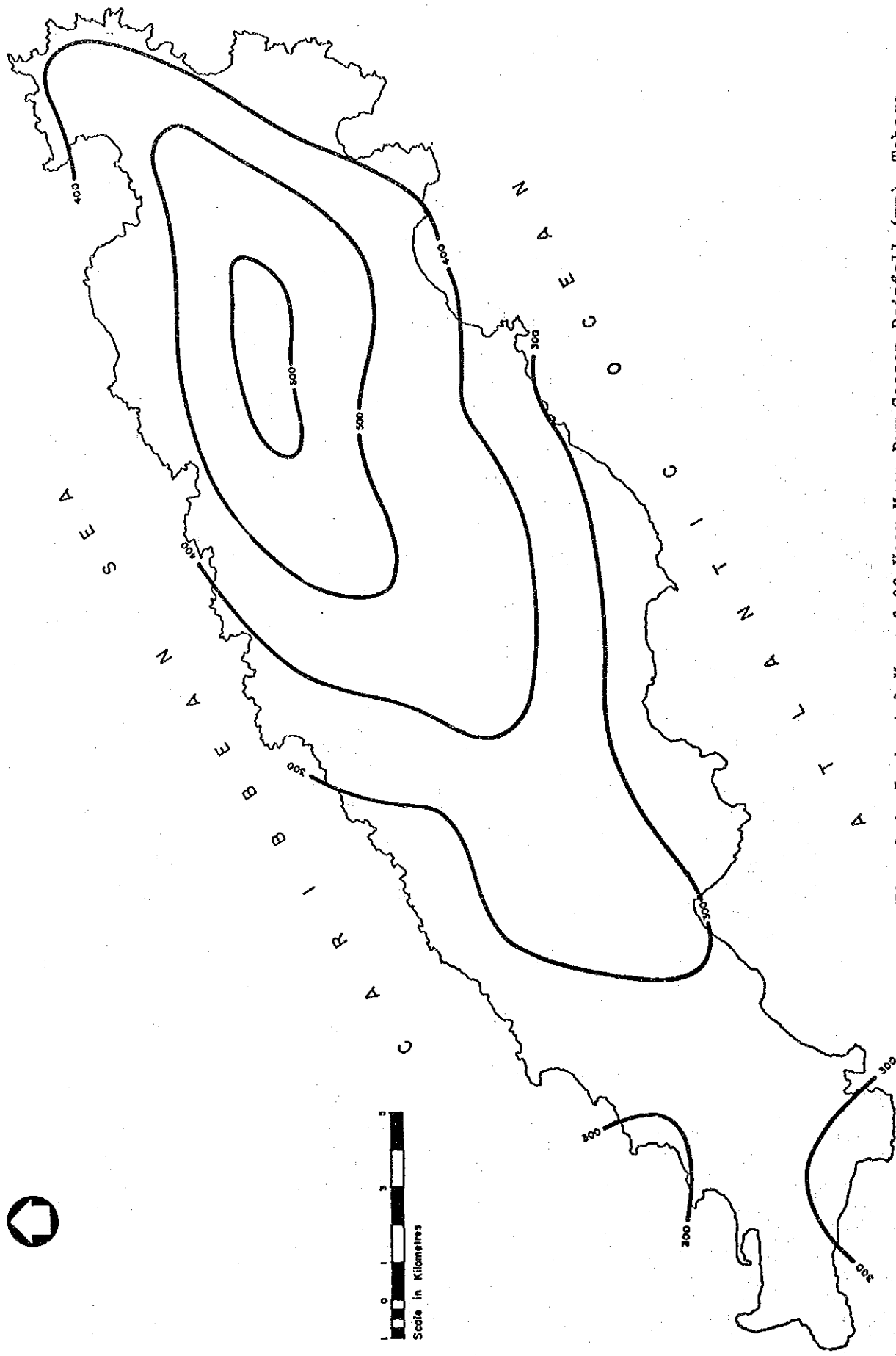


Fig. 2.4 Isohyetal Map of 30 Year Mean Dry Season Rainfall (mm), Tobago Record Period 1956 - 1985, Prepared by WRA

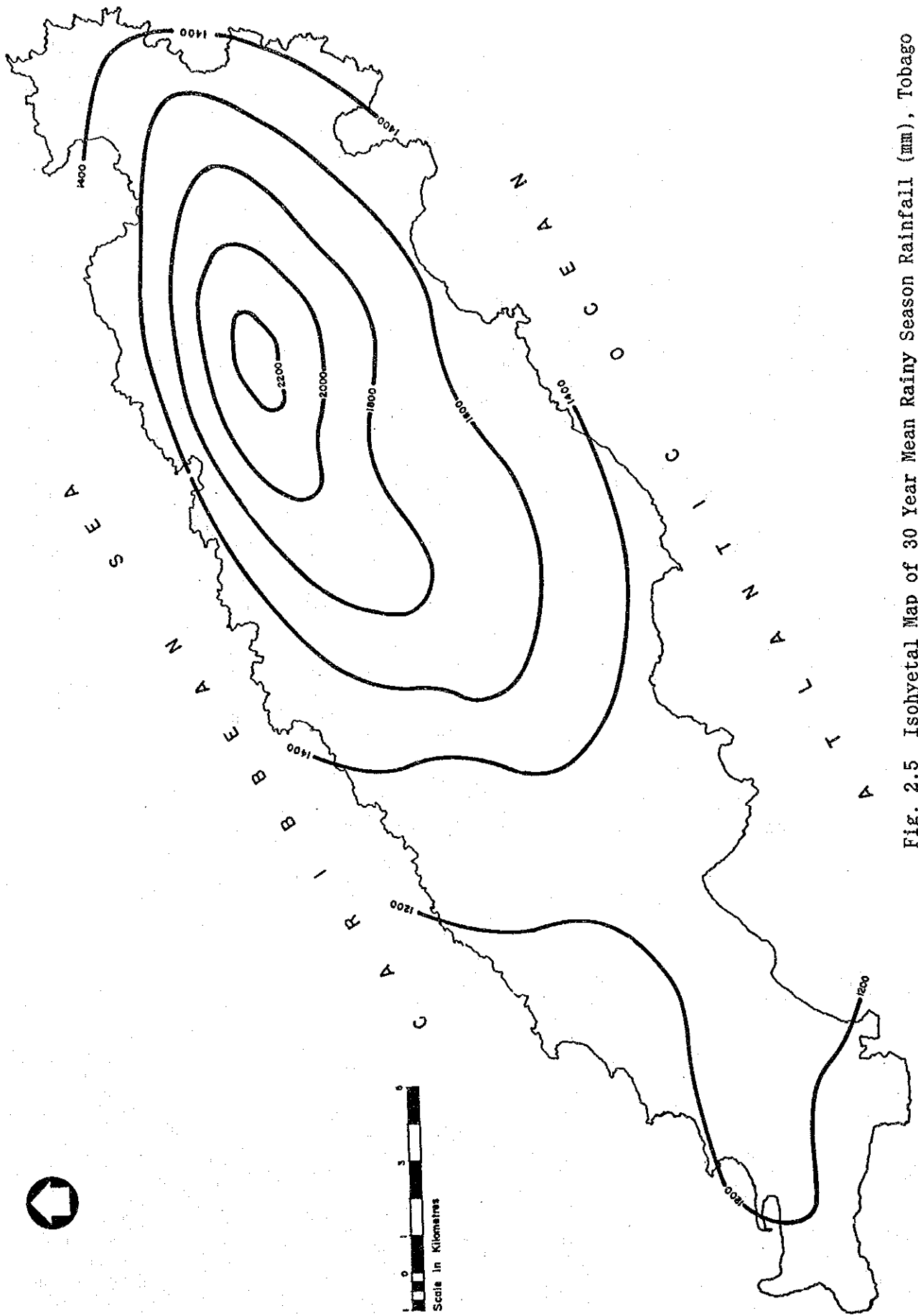


Fig. 2.5 Isohyetal Map of 30 Year Mean Rainy Season Rainfall (mm), Tobago Record Period 1956 - 1985, Prepared by WRA

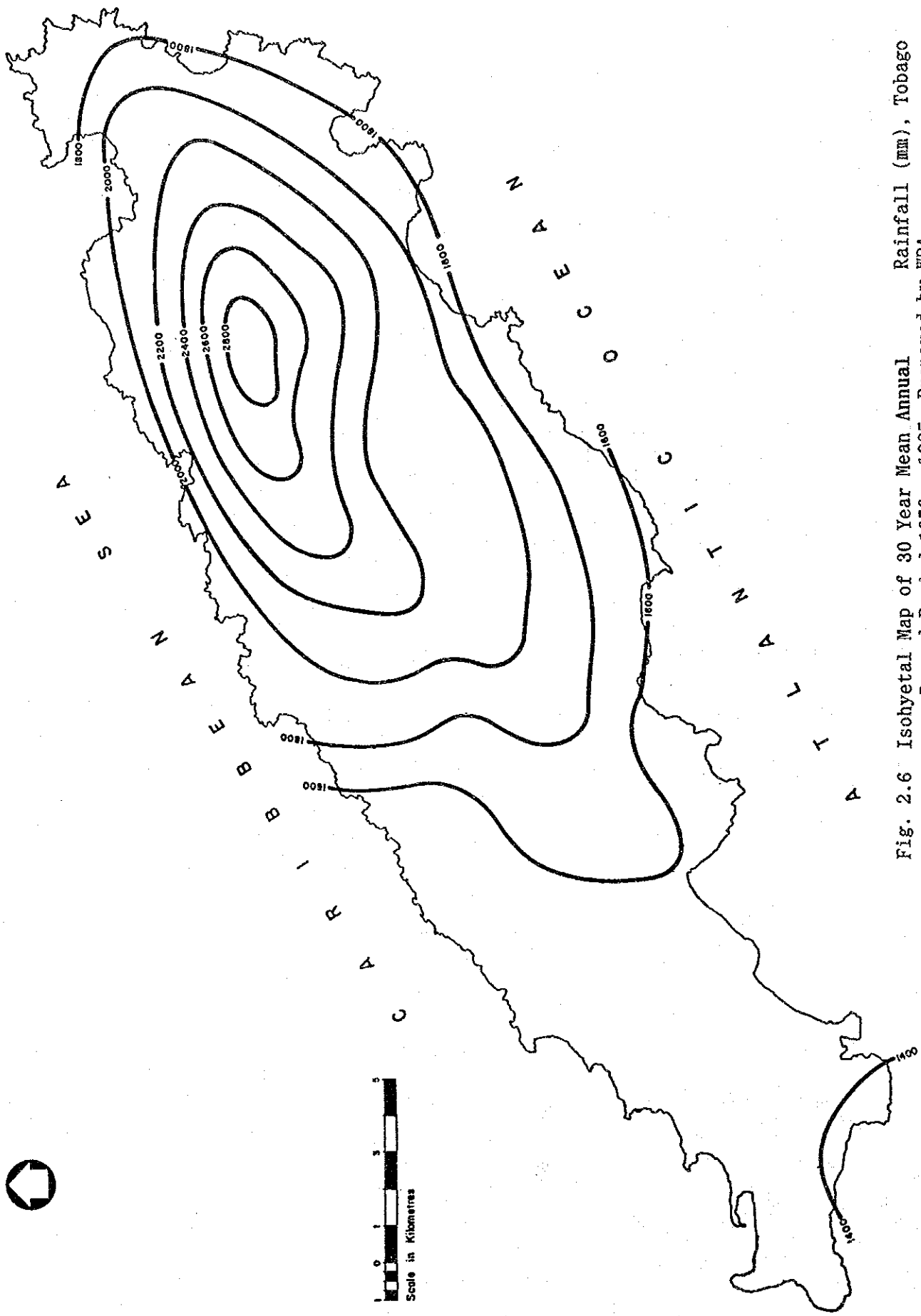


Fig. 2.6 Isohyetal Map of 30 Year Mean Annual Rainfall (mm), Tobago
 Record Period 1956 - 1985, Prepared by WRA

3. Hollis Impounding Reservoir

Hollis Reservoir is located in the north west of Trinidad where the annual rainfall is the largest in the country and has the following features:

Catchment Area	17.1 km ²
Available storage	4,700,000 m ³
Surface Area when full	66 hectares
Depth when full	18.3 m

Hollis Impounding Reservoir was completed in 1936 and provided a source of supply of 29,545 m³/d. Its production was then increased to 31,820 m³/d. Table 3.1 tabulates production records from 1976 to 1989. The production tends to decrease from March to July. Drawdown levels of the reservoir usually fall to a minimum in July, while the precipitation in the catchment area during June or July is a annual maximum in most cases. The abstraction from the reservoir was usually determined by the engineers experience, observing the reservoir levels and the rainfall condition.

Table 3.2 tabulates the actual available storage and actual monthly outflow from 1976 to 1989 together with the estimated available storage simulated under the condition that 35,009 m³/d (10 % of the production 31,820 m³/d added as the loss in Waterworks) is extracted from the reservoir throughout the periods. Although runoff records in the catchment area are not available, runoff was estimated from the past abstraction records from the reservoir and the actual water level fluctuation of the reservoir. Then, the estimated reservoir drawdown was calculated provided that the difference of evaporation loss derived from the different surface areas between actual and simulated abstractions is neglected. It is implied from the results of the simulation that the listed production, 35,009 m³/d could be constantly extracted from the reservoir through the period from 1976 to 1989.

Table 3.1 Production Record Hollis Waterworks (in monthly average production m3/d)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC AVERAGE
1976	33,755	32,618	32,336	31,895	31,173	33,391	34,277	33,023	34,159	33,459	34,914	34,455
1977	34,195	33,232	32,455	31,000	28,318	24,332	25,982	31,218	31,777	33,800	34,541	34,545
1978	26,559	26,495	29,868	29,000	25,173	25,745	26,955	31,164	30,259	30,259	31,809	32,359
1979	32,582	32,164	32,727	32,909	30,659	30,714	30,686	30,714	30,714	30,714	31,741	30,714
1980	30,027	30,027	29,909	30,886	30,323	30,323	30,027	30,032	39,623	33,418	29,114	31,068
1981	29,773	25,968	29,773	29,545	29,405	29,750	29,473	29,773	31,818	32,273	30,791	31,818
1982	31,780	32,731	31,822	31,822	31,822	31,822	31,822	31,822	31,822	31,822	31,822	31,822
1983	31,822	31,822	30,795	31,822	31,822	31,822	31,822	31,822	31,822	31,675	31,822	31,675
1984	31,675	31,822	31,694	30,000	31,641	31,822	31,822	31,821	33,618	32,511	32,503	31,827
1985	30,967	34,137	31,822	28,156	25,000	22,730	22,730	22,730	33,246	31,135	32,833	33,883
1986	31,822	31,822	28,741	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	26,449
1987	25,000	22,730	22,730	22,730	22,730	22,730	22,730	22,730	24,187	22,730	22,726	22,726
1988	22,730	32,000	20,836	21,127	19,896	22,730	20,973	21,444	22,304	29,389	38,840	36,396
1989	29,079	23,184	20,940	23,250	28,452	32,883	23,826	23,826	19,204	9,874		23,452
AVE. 76-89	30,126	30,054	29,032	28,507	27,958	28,271	27,720	28,366	29,968	29,147	31,423	31,343
AVE./LIST.	95	94	91	90	88	89	87	89	94	92	99	98%

Listed Production : 31.826 m3/d

Table 3.2 Reservoir Drawdown Estimation Hollis Reservoir 1976 - 1989 (1)

YEAR	MONTH	ACTUAL STORAGE 1ST DAY OF MONTH (X 1,000 m ³)	DAILY ACTUAL PRODUCTION (m ³ /d)	MONTHLY ACTUAL PRODUCTION (m ³ /MONTH)	MONTHLY ACTUAL DRAFT RATE (m ³ /MONTH)	ESTIMATED STORAGE WHEN DRAFT RATE IS 35,009 m ³ /d (X 1,000 m ³)
76	JAN	4,709	33,755	1,046,390	1,098,709	4,709
1976	FEB	4,538	32,618	913,308	958,974	4,499
1976	MAR	4,418	32,336	1,002,426	1,052,548	4,449
1976	APR	4,090	31,895	956,863	1,004,706	4,007
1976	MAY	3,742	31,173	966,354	1,014,671	3,680
1976	JUN	3,209	33,391	1,001,726	1,051,813	3,090
1976	JUL	3,962	34,277	1,062,594	1,115,724	3,946
1976	AUG	4,622	33,023	1,023,704	1,074,889	4,599
1976	SEP	4,597	34,159	1,024,772	1,076,010	4,536
1976	OCT	4,554	33,459	1,037,231	1,089,092	4,563
1976	NOV	4,452	34,914	1,047,408	1,099,778	4,404
1976	DEC	4,606	34,455	1,068,090	1,121,494	4,638
77	JAN	4,530	34,195	1,060,058	1,113,061	4,513
1977	FEB	3,994	33,232	930,490	977,014	3,969
1977	MAR	3,310	32,455	1,006,090	1,056,394	3,360
1977	APR	2,539	31,000	929,999	976,499	2,460
1977	MAY	1,893	28,318	877,863	921,756	1,804
1977	JUN	1,168	24,332	729,954	766,452	960
1977	JUL	1,451	25,932	803,886	844,080	1,155
1977	AUG	1,381	31,218	967,763	1,016,151	1,099
1977	SEP	2,162	31,777	953,317	1,000,983	2,045
1977	OCT	2,513	33,800	1,047,799	1,100,189	2,448
1977	NOV	3,368	34,541	1,036,226	1,088,038	3,330
1977	DEC	3,727	34,545	1,070,908	1,124,453	3,748
78	JAN	3,456	26,559	823,331	864,498	3,441
1978	FEB	2,992	26,495	741,872	778,966	2,730
1978	MAR	2,507	29,868	925,913	972,208	2,348
1978	APR	1,926	29,000	869,999	913,499	1,766
1978	MAY	1,326	25,173	780,354	819,371	1,174
1978	JUN	965	25,745	772,363	810,981	660
1978	JUL	1,683	26,955	835,590	877,370	1,431
1978	AUG	3,590	31,164	966,072	1,014,375	3,341
1978	SEP	3,742	30,259	907,772	953,160	3,623
1978	OCT	4,657	30,259	938,031	984,932	4,545
1978	NOV	4,606	31,809	954,272	1,001,985	4,458
1978	DEC	4,562	32,359	1,003,131	1,053,287	4,498
79	JAN	4,469	32,582	1,010,035	1,060,537	4,387
1979	FEB	3,828	32,164	900,581	945,610	3,752
1979	MAR	3,069	32,727	1,014,544	1,065,272	3,085
1979	APR	2,501	32,909	987,272	1,038,635	2,430
1979	MAY	1,797	30,659	950,431	997,952	1,766
1979	JUN	989	30,714	921,408	967,479	854
1979	JUL	1,044	30,686	951,276	998,840	946
1979	AUG	4,034	30,714	952,122	999,728	3,900
1979	SEP	4,657	30,714	921,408	967,479	4,524
1979	OCT	4,589	30,714	952,122	999,728	4,491
1979	NOV	4,571	31,741	952,226	999,838	4,437
1979	DEC	4,674	30,714	952,122	999,728	4,607

Table 3.2 Reservoir Drawdown Estimation Hollis Reservoir 1976 - 1989 (2)

YEAR	MONTH	ACTUAL STORAGE 1ST DAY OF MONTH (X 1,000 m3)	DAILY ACTUAL PRODUCTION (m3/d)	MONTHLY ACTUAL PRODUCTION (m3/MONTH)	MONTHLY ACTUAL DRAFT RATE (m3/MONTH)	ESTIMATED STORAGE WHEN DRAFT RATE IS 35,009 m3/d (X 1,000 m3)
80	JAN	4,692	30,027	930,845	977,387	4,559
1980	FEB	4,519	30,027	840,763	882,801	4,365
1980	MAR	4,286	29,909	927,181	973,540	4,237
1980	APR	3,727	30,836	925,090	971,344	3,569
1980	MAY	3,044	30,323	940,004	987,004	2,949
1980	JUN	3,027	30,323	909,681	955,165	2,882
1980	JUL	4,653	30,027	930,845	977,387	4,543
1980	AUG	4,684	30,032	930,985	977,535	4,530
1980	SEP	4,610	39,623	1,188,681	1,248,115	4,455
1980	OCT	4,368	33,418	1,035,963	1,087,761	4,546
1980	NOV	4,709	29,114	873,408	917,079	4,709
1980	DEC	4,626	31,068	963,113	1,011,268	4,478
81	JAN	4,632	29,773	922,954	969,101	4,510
1981	FEB	4,154	25,968	727,108	763,464	3,992
1981	MAR	3,605	29,773	922,954	969,101	3,429
1981	APR	2,811	29,545	886,363	930,681	2,648
1981	MAY	3,977	29,405	911,540	957,117	3,842
1981	JUN	4,622	29,750	892,499	937,124	4,448
1981	JUL	4,641	29,473	913,654	959,336	4,513
1981	AUG	4,626	29,773	922,954	969,101	4,455
1981	SEP	4,645	31,818	954,545	1,002,272	4,482
1981	OCT	4,622	32,273	1,000,454	1,050,476	4,558
1981	NOV	4,550	30,791	923,726	969,913	4,465
1981	DEC	4,688	31,818	986,363	1,035,681	4,593
82	JAN	4,657	31,780	985,180	1,034,439	4,558
1982	FEB	4,538	32,731	916,468	962,291	4,438
1982	MAR	4,645	31,822	986,482	1,035,806	4,679
1982	APR	4,139	31,822	954,660	1,002,393	4,040
1982	MAY	3,401	31,822	986,482	1,035,806	3,337
1982	JUN	2,696	31,822	954,660	1,002,393	2,597
1982	JUL	4,077	31,822	986,482	1,035,806	4,013
1982	AUG	4,382	31,822	986,482	1,035,806	4,283
1982	SEP	4,524	31,822	954,660	1,002,393	4,425
1982	OCT	4,641	31,822	986,482	1,035,806	4,577
1982	NOV	4,674	31,822	954,660	1,002,393	4,575
1982	DEC	4,645	31,822	986,482	1,035,806	4,581
83	JAN	4,657	31,822	986,482	1,035,806	4,558
1983	FEB	4,487	31,822	891,016	935,567	4,388
1983	MAR	3,859	30,795	954,645	1,002,377	3,866
1983	APR	2,907	31,822	954,660	1,002,393	2,777
1983	MAY	2,001	31,822	986,482	1,035,806	1,937
1983	JUN	2,627	31,822	954,660	1,002,393	2,529
1983	JUL	4,697	31,822	986,482	1,035,806	4,633
1983	AUG	4,665	31,822	986,482	1,035,806	4,567
1983	SEP	4,653	31,822	954,660	1,002,393	4,554
1983	OCT	4,661	31,675	981,925	1,031,021	4,598
1983	NOV	4,641	31,822	954,660	1,002,393	4,537
1983	DEC	4,487	31,675	981,925	1,031,021	4,423

Table 3.2 Reservoir Drawdown Estimation Hollis Reservoir 1976 - 1989 (3)

YEAR	MONTH	ACTUAL STORAGE 1ST DAY OF MONTH (X 1,000 m ³)	DAILY ACTUAL PRODUCTION (m ³ /d)	MONTHLY ACTUAL PRODUCTION (m ³ /MONTH)	MONTHLY ACTUAL DRAFT RATE (m ³ /MONTH)	ESTIMATED STORAGE WHEN DRAFT RATE IS 35,009 m ³ /d (X 1,000 m ³)
84	JAN	4,546	31,675	981,925	1,031,021	4,443
1984	FEB	4,567	31,822	891,016	935,567	4,463
1984	MAR	4,237	31,694	982,514	1,031,640	4,243
1984	APR	3,390	30,000	900,000	945,000	3,288
1984	MAY	2,560	31,641	980,871	1,029,915	2,440
1984	JUN	1,943	31,822	954,660	1,002,393	1,838
1984	JUL	1,543	31,822	986,482	1,035,806	1,479
1984	AUG	2,804	31,821	986,451	1,035,774	2,706
1984	SEP	4,028	33,618	1,008,540	1,058,967	3,930
1984	OCT	4,219	32,511	1,007,841	1,058,233	4,211
1984	NOV	4,709	32,503	975,090	1,023,845	4,632
1984	DEC	4,709	30,996	960,876	1,008,920	4,666
85	JAN	4,601	30,967	959,977	1,007,976	4,477
1985	FEB	3,950	34,137	955,836	1,003,628	3,825
1985	MAR	3,341	31,822	986,482	1,035,806	3,420
1985	APR	2,413	28,156	844,680	886,914	2,315
1985	MAY	1,506	25,000	775,000	813,750	1,329
1985	JUN	904	22,730	681,900	715,995	594
1985	JUL	751	22,730	704,630	739,862	405
1985	AUG	2,410	22,730	704,630	739,862	2,030
1985	SEP	2,999	33,246	997,380	1,047,249	2,618
1985	OCT	3,946	31,135	965,185	1,013,444	3,927
1985	NOV	4,709	32,883	986,490	1,035,815	4,589
1985	DEC	4,657	33,883	1,050,373	1,102,892	4,626
86	JAN	4,406	31,822	986,482	1,035,806	4,371
1986	FEB	4,098	31,822	891,016	935,567	3,999
1986	MAR	3,368	28,741	890,971	935,520	3,374
1986	APR	2,747	25,000	750,000	787,500	2,553
1986	MAY	1,860	25,000	775,000	813,750	1,585
1986	JUN	1,397	25,000	750,000	787,500	1,087
1986	JUL	2,248	25,000	775,000	813,750	1,973
1986	AUG	2,393	25,000	775,000	813,750	2,083
1986	SEP	3,324	25,000	750,000	787,500	3,014
1986	OCT	4,302	25,000	775,000	813,750	4,027
1986	NOV	4,657	25,000	750,000	787,500	4,347
1986	DEC	4,632	25,000	775,000	813,750	4,357
87	JAN	4,483	25,000	775,000	813,750	4,173
1987	FEB	3,770	22,730	636,440	668,262	3,460
1987	MAR	3,090	22,730	704,630	739,862	2,815
1987	APR	2,290	22,730	681,900	715,995	1,909
1987	MAY	1,482	22,730	704,630	739,862	1,137
1987	JUN	807	22,730	681,900	715,995	426
1987	JUL	878	22,730	704,630	739,862	533
1987	AUG	1,447	22,730	704,630	739,862	1,066
1987	SEP	1,860	24,187	725,610	761,891	1,480
1987	OCT	2,140	22,730	704,630	739,862	1,840
1987	NOV	2,612	22,726	681,780	715,869	2,231
1987	DEC	3,452	22,726	704,506	739,731	3,107

Table 3.2 Reservoir Drawdown Estimation Hollis Reservoir 1976 - 1989 (4)

YEAR	MONTH	ACTUAL STORAGE 1ST DAY OF MONTH (X 1,000 m3)	DAILY ACTUAL PRODUCTION (m3/d)	MONTHLY ACTUAL PRODUCTION (m3/MONTH)	MONTHLY ACTUAL DRAFT RATE (m3/MONTH)	ESTIMATED STORAGE WHEN DRAFT RATE IS 35,009 m3/d (X 1,000 m3)
88	JAN	3,766	22,730	704,630	739,862	3,385
1988	FEB	3,202	32,000	896,000	940,800	2,821
1988	MAR	2,592	20,836	645,916	678,212	2,604
1988	APR	1,902	21,127	633,810	665,501	1,463
1988	MAY	1,310	19,896	616,776	647,615	915
1988	JUN	818	22,730	681,900	715,995	350
1988	JUL	1,142	20,973	650,163	682,671	797
1988	AUG	990	21,444	664,764	698,002	555
1988	SEP	2,340	22,304	669,120	702,576	1,920
1988	OCT	3,153	29,389	911,059	956,612	2,794
1988	NOV	4,626	38,840	1,165,200	1,223,460	4,452
1988	DEC	4,692	36,396	1,128,276	1,184,690	4,709
89	JAN	4,678	29,079	901,449	946,521	4,709
1989	FEB	4,241	23,184	649,152	681,610	4,057
1989	MAR	3,724	20,940	649,140	681,597	3,462
1989	APR	3,059	23,250	697,500	732,375	2,622
1989	MAY	2,340	28,452	882,012	926,113	2,011
1989	JUN	1,599	32,883	986,490	1,035,815	1,396
1989	JUL	1,030	23,826	738,606	775,536	999
1989	AUG	1,090	23,826	738,606	775,536	743
1989	SEP	678	19,204	576,120	604,926	332
1989	OCT	668	9,874	306,094	321,399	213

4. North Oropouche River

North Oropouche Waterworks came on stream in December 1979, which extracts river flow directly with no impoundment. Table 4.1 shows monthly average production from the time of the inception, December 1981 to October 1989. North Oropouche's production capacity is listed 90,920 m³/d. However, this figure has not been achieved in monthly average basis ever since the operation started. It is reasonably assumed that the plant is presently required to be operated at its maximum level to meet the increasing demands. However, the production reported remains lower than the listed production.

The reason for this difference was explained due to the deficient capacity of intake pumps and insufficient river flow at the intake during the dry season.

Table 4.2 shows the estimated discharge at the North Oropouche intake. It is an unfortunate fact that North Oropouche River discharge has not been measured at the intake. However, the flow has been measured downstream from the intake which is after the confluence of La Seiva River, Turure River and Quare River. The discharge at the intake was estimated from the rainfall in the catchment area above the intake and the actual discharge records at the downstream. Rainfall data were obtained from Hollis reservoir catchment west of the Oropouche because locations of rain gauges are limited.

The estimated discharges in the rainy seasons are judged to provide sufficient amount of raw water to obtain 90,920 m³/d of production. However, those in the dry seasons are lower than the level to produce 90,920 m³/d. In conclusion, the North Oropouche River discharge is sufficient during the rainy seasons while in the dry seasons the flow limits the production.

Table 4.1 NORTH OROPOUCHE WATERWORKS PRODUCTION RECORD PRODUCTION CAPACITY 90,920 m³/d
 NORTH OROPOUCHE WATERWORKS CAME ON STREAM IN DEC. 1979.

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE THR. YEAR
1979													5,336
1980	22,316	18,580	30,147	35,833	43,409	61,403	74,893	68,448	82,596	73,424	65,030	76,238	54,360
1981	84,782	90,282	85,337	64,444	67,561	48,745	59,821	29,074	30,497	32,451	33,788	36,524	55,271
1982	27,569	13,150	21,699	25,628	19,710	19,398	18,533	19,895	20,660	25,771	29,941	49,941	24,325
1983	49,941	45,067	41,976	38,168	35,514	36,969	37,950	34,370	36,890	37,151	45,696	47,800	40,624
1984	50,354	49,540	49,903	48,000	17,245	44,444	40,179	41,580	45,205	47,405	29,078	28,140	40,923
1985	52,314	70,848	61,952	50,871	50,635	57,916	61,815	60,823	57,913	57,378	62,225	62,387	58,923
1986	65,494	72,947	62,730	72,687	67,577	69,923	74,788	65,672	60,270	64,391	67,128	66,514	67,510
1987	70,032	67,881	62,124	54,494	46,864	53,947	46,051	49,580	51,664	47,522	47,330	49,188	53,890
1988	48,559	49,101	45,697	48,672	46,725	46,206	46,559	45,025	47,231	45,070	57,926	43,967	47,562
1989	46,060	50,416	51,554	59,438	57,508	59,385	58,743	59,036	72,341	58,862			47,779
AVERAGE	51,737	52,781	51,312	49,823	45,275	49,834	51,933	47,350	50,527	48,943	48,682	46,603	
MAXIMUM	84,782	90,282	85,337	72,687	67,577	69,923	74,893	68,448	82,596	73,424	67,128	76,238	
MINIMUM	22,316	13,150	21,699	25,628	17,245	19,398	18,533	19,895	20,660	25,771	29,078	29,078	5,336
AVE./LIST.	57	58	56	55	50	55	57	52	56	54	54	54	51%

Listed Production : 90,920 m³/d

Average in Rainy Season : 49,125 m³/d
 Average Lowest Two Months Production in Dry Season : 44,825 m³/d

Table 4.2 ESTIMATED NORTH OROPOUCHE RIVER DISCHARGE AT INTAKE (in m³/d)

YEAR	CATCHMENT AREA		53 km ²											
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	DECEMBER	
RUNOFF COEFFICIENT	0.69	0.48	0.63	0.63	0.27	0.24	0.30	0.34	0.40	0.45	0.66	0.65	0.65	
1980	200,758	121,850	186,518	102,055	164,032	189,222	190,335	175,406	127,979	355,397	631,422	220,799		
1981	149,519	95,080	32,009	582,366	227,113	175,114	137,443	190,023	275,343	213,844	356,581	391,430		
1982	239,111	230,085	103,688	183,191	82,075	198,161	145,520	174,077	216,828	215,863	382,644	434,307		
1983	236,115	38,540	37,207	146,157	244,348	240,808	188,251	168,318	242,137	193,247	301,791	240,342		
1984	346,981	115,850	64,018	31,663	77,737	96,173	289,737	234,760	187,571	438,390	641,491	292,552		
1985	79,704	123,235	44,047	60,781	45,258	99,942	282,572	166,104	266,189	535,922	275,729	491,767		
1986	155,512	44,309	181,659	30,815	84,772	152,067	103,961	204,049	161,903	363,676	350,558	210,007		
1987	30,863	21,924	9,575	14,418	44,555	124,281	192,029	164,627	150,954	193,045	288,760	170,923		
1988	109,967	86,541	27,905	52,300	55,694	127,404	126,630	236,975	169,621	343,685	570,708	282,926		
1989	83,599	114,004	111,348	51,346	38,458	56,325	120,637	99,515	111,465	117,321				

- Runoff coefficients were calculated from the river discharge data (1984 - 1986) from Caura, Guanapo, Matelot and Matura rivers.

- Rainfall data at Hollis were used for this calculation.

5. Arena Reservoir and Caroni River

Arena Impounding Reservoir was constructed to provide storage for raw water to supplement the natural flow in the Caroni River during the dry season. Major facilities constructed for this purpose are Arena Dam, Tumpuna Weir and Pump Station. Runoff collected from the catchment area behind Tumpuna Weir is transferred into the reservoir through the Pump Station. This pumping operation is mainly made in the rainy season. The general feature of Caroni system is shown below.

Catchment Area

1) behind Arena dam	20 km ²
2) behind Tumpuna Weir	85 km ²
3) Caroni River at the Intake (incl. 1), 2)	386 km ²

Arena Impounding Reservoir

Available storage	43,187,000 m ³
Surface Area when full	647 hectares
Depth (average)	6.7 m

Ratio of released reservoir water vs. river discharge at intake (from the 1988's operation record)

JAN.	9 %	MAY	87 %
FEB.	40 %	JUN.	65 %
MAR.	67 %	JUL.	67 %
APR.	75 %	AUG. - DEC.	0 %

Caroni system was brought into service in 1981 and provides the nation's largest supply, 272,760 m³/d. The past production record of Caroni Treatment Plant is shown in Table 5.1. From this record, it is implied that Arena Reservoir and Caroni River could provide constant supply which is almost equivalent to the listed production, 272,760 m³/d through a year.

Table 5.1 CARONI TREATMENT PLANT PRODUCTION RECORD (in monthly average production m3/d)

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
1981				32,574	79,873	105,227	102,986	102,409	118,777	140,423	146,714	140,718	80,808
1982	196,278	204,058	216,226	191,032	177,117	203,395	199,006	206,956	195,925	198,600	187,814	208,577	198,749
1983	220,967	223,314	201,145	214,714	196,999	200,906	208,901	214,476	233,276	220,299	230,653	218,644	215,358
1984	218,676	222,711	231,049	226,487	242,430	244,836	243,651	246,465	241,276	229,855	241,891	226,610	234,661
1985	214,542	212,173	220,615	237,275	236,613	239,611	207,699	230,540	242,530	245,424	250,469	246,806	232,025
1986	259,025	264,000	250,584	250,584	260,066	252,557	250,689	237,387	234,516	248,954	236,920	233,131	248,201
1987	244,756	247,716	260,590	259,486	258,382	261,302	260,211	262,060	266,553	270,274	261,054	260,639	259,424
1988	266,499	250,000	275,444	268,740	264,681	256,100	248,347	257,496	266,252	254,640	262,953	246,219	259,781
1989	264,673	258,381	260,160	259,682	257,290	273,092	274,329	264,283	274,352	252,255			264,850
AVE. 87-8	258,643	252,032	265,398	265,969	260,118	263,498	260,962	261,280	269,052	259,056	262,004	253,459	258,064

AVE./LIST 95 92 97 98 95 97 96 99 95 96 95 96 93 %
 Listed Production : 272,760 m3/d

CARONI TREATMENT PLANT CAME ON STREAM IN APRIL 1981.

6. Navet Reservoir

Navet system is composed of a major reservoir referred to as High Dam Reservoir which has 18,600,000 m³ storage capacity, Low Dam Reservoir with 4,090,000 m³ storage capacity, and Pumped Storage Lift Station. High Dam was completed in 1962, providing a source of supply of 55,000 m³/d and Low Dam in 1976, increasing production capacity to 77,280 m³/d. Low Dam is situated about 3 km downstream of the High Dam. Collected runoff by the Low Dam is transferred to the High Dam Reservoir by pumping at Pumped Storage Lift Station. This transfer process is mostly operated in the rainy season.

The general features of the Navet reservoirs are shown below.

	Low Dam	High Dam
Catchment Area	28.5 km ²	18.6 km ²
Available storage	4,090,000 m ³	18,600,000 m ³
Surface Area when full	184 hectares	266 hectares
Depth when full	3.7 m	20.4 m

Production record of Navet Waterworks from the year of 1976 is tabulated in Table 6.1. The record show constant outputs from the Waterworks through a year, which are over 95 % of the listed production on average.

Table 6.1 NAVET WATERWORKS PRODUCTION RECORD (in monthly average production m3/d)

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
1976 *	51,359	51,359	51,359	51,359	51,359	59,085	59,085	68,175	68,175	68,175	68,175	68,175	59,653
1977 *	72,829	68,957	67,770	60,071	70,129	62,139	63,535	76,220	67,502	68,002	73,765	75,692	68,884
1978 *	69,179	54,995	53,899	50,904	48,632	49,995	44,314	49,795	60,067	58,126	60,026	79,660	56,633
1979	76,647	79,510	74,820	73,038	70,670	69,034	74,533	66,398	65,803	69,770	68,534	71,616	71,698
1980	72,993	74,370	76,806	71,120	76,183	77,210	73,838	73,479	77,670	73,134	73,315	76,611	74,727
1981	75,661	76,833	76,606	77,701	76,756	73,015	73,147	73,352	70,384	75,715	76,165	73,584	74,910
1982	72,418	76,738	76,204	75,862	77,561	73,896	76,094	68,234	74,190	71,151	67,371	75,039	73,730
1983	72,028	73,639	65,941	74,993	72,574	71,178	73,705	70,849	74,511	72,333	73,864	69,298	72,076
1984	75,495	72,555	75,769	74,743	74,175	74,192	68,506	72,077	75,808	76,052	76,832	73,219	74,077
1985	74,870	77,370	77,629	76,775	77,188	73,644	72,394	77,175	76,813	75,810	74,586	73,627	75,657
1986	74,937	76,775	77,001	74,575	78,676	78,199	77,391	77,865	76,174	74,371	77,451	77,922	76,779
1987	78,110	76,158	73,538	75,397	77,255	76,613	74,631	73,560	76,122	76,429	74,003	73,928	75,479
1988	75,527	80,810	73,737	69,235	66,540	64,365	66,093	64,666	74,595	73,140	78,984	77,513	72,100
1989	78,467	78,537	73,649	78,002	75,972	74,293	74,986	76,876	73,043	56,540			74,037
AVE. 79-89	75,196	76,663	74,700	74,676	74,868	73,240	73,211	72,230	74,101	72,222	74,062	74,236	
AVE./LIST.	97	99	97	97	97	95	95	93	96	93	96	96	96 %
Listed Production :	77,280 m3/d												

* : Estimated

7. Hillsborough Reservoir

Hillsborough Reservoir was commissioned to provide the supply in 1952 and has the following feature.

Catchment Area	17.1 km ²
Available storage	4,700,000 m ³
Surface Area when full	66 hectares
Depth when full	18.3 m

Production records from 1976 are shown in Table 7.1. The average productions are much lower than the listed production, 8,582 m³/d. In order to investigate whether the reservoir could sustain the constant output of 8,582 m³/d the reservoir drawdown was estimated for the constant abstraction 9,011 m³/d (10 % added to the listed production, 8,582 m³/d) from 1976 to 1988. Although runoff records in the catchment area are not available, runoff into the reservoir was estimated from the past abstraction records from the reservoir and the actual water level fluctuation of the reservoir.

Table 7.2 shows the result of the simulation under the condition that the differences of the evaporation loss and leakage from the reservoir between the actual storage and estimated storage which are derived from the difference of the storages can be neglected for the simulation. It is implied from the result that the reservoir can sustain an average daily output of 8,582 m³/d.

Table 7.1 HILLSBOROUGH WATERWORKS PRODUCTION RECORDS (in monthly average production m³/d)

	JANUARY	FEBRUARY	MARCH	APRIL	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	AVERAGE
1976	5,254	6,781	6,799	6,953	7,349	6,986	7,017	7,149	7,413	7,477	8,067	6,994
1977	7,495	7,013	6,481	6,608	6,108	5,840	5,381	5,709	7,022	6,917	6,877	6,504
1978	6,008	4,986	5,831	5,290	4,681	5,309	6,613	7,604	5,781	5,449	6,268	5,707
1979	6,599	7,545	6,618	6,990	5,936	5,827	5,736	5,659	5,454	6,004	4,772	6,077
1980	5,881	6,299	6,595	6,618	6,818	6,908	6,840	6,163	6,058	6,181	5,963	6,392
1981	6,831	6,977	6,772	6,640	6,563	6,967	6,336	5,886	6,036	6,077	5,999	6,448
1982	6,103	6,044	5,694	6,037	6,305	5,694	5,694	5,682	5,694	5,833	5,806	5,854
1983	5,806	5,806	5,694	7,036	6,364	6,364	6,364	6,364	6,364	4,942	4,783	6,059
1984	4,751	4,399	4,633	4,242	5,301	5,149	4,640	5,285	5,228	6,407	6,495	5,117
1985	5,853	6,229	5,306	5,342	5,352	5,724	5,760	5,804	5,951	5,855	5,805	5,800
1986	5,558	5,917	5,917	5,682	6,203	6,635	6,435	5,678	5,533	5,602	5,656	5,862
1987	5,642	5,300	4,812	4,643	4,285	5,208	6,550	5,998	7,847	8,148	7,664	5,881
1988	6,569	6,648	6,788	6,994	6,353	6,867	7,119	7,457	7,805	8,238	7,880	7,111
1989	7,633	6,373	6,960	7,293	7,396	7,210	5,845	6,866	7,428			7,070
AVE. '76-'89	6,142	6,165	6,064	6,173	6,072	6,192	6,166	6,236	6,401	6,387	6,310	
AVE./LIST.	72	72	71	72	71	72	72	73	75	74	74	74 %

Listed Production : 8,582 m³/d

Table 7.2 Reservoir Drawdown Estimation Hillsborough Reservoir 1976 - 1989 (1)

YEAR	MONTH	WATER LEVEL (FEET)	ACTUAL STORAGE 1st DAY OF MONTH (x 1,000 m3)	DAILY ACTUAL PRODUCTION (m3/DAY)	MONTHLY ACTUAL PRODUCTION (m3/MONTH)	MONTHLY ACTUAL DRAFT RATE (m3/MONTH)	ESTIMATED STORAGE WHEN DART RATE IS 9,011 m3/DAY (x 1,000 m3)
76	JAN	870.0	1,032	5,254	162,875	171,018	1,032
1976	FEB	869.6	1,007	6,781	189,872	199,366	923
1976	MAR	869.4	994	6,799	210,779	221,318	954
1976	APR	867.9	904	6,963	208,888	219,333	936
1976	MAY	865.8	787	6,672	206,834	217,176	853
1976	JUN	862.8	637	7,349	220,478	231,502	725
1976	JUL	866.2	809	6,986	216,556	227,383	598
1976	AUG	868.3	928	7,017	217,542	228,419	757
1976	SEP	870.0	1,032	7,149	214,479	225,202	877
1976	OCT	870.0	1,032	7,413	229,800	241,290	987
1976	NOV	869.3	988	7,477	224,296	235,511	994
1976	DEC	869.2	982	8,067	250,089	262,593	953
77	JAN	869.8	1,019	7,495	232,336	243,953	965
1977	FEB	867.9	904	7,013	196,362	206,180	984
1977	MAR	865.8	787	6,481	200,916	210,962	858
1977	APR	862.9	642	6,608	198,253	208,166	719
1977	MAY	860.2	522	6,595	204,439	214,661	579
1977	JUN	856.1	368	6,108	183,254	192,417	457
1977	JUL	855.2	338	5,840	181,050	190,103	290
1977	AUG	852.6	261	5,381	166,820	175,161	249
1977	SEP	856.7	388	5,709	171,256	179,818	157
1977	OCT	857.8	428	7,022	217,683	228,567	298
1977	NOV	865.0	745	6,917	207,525	217,901	377
1977	DEC	867.9	904	6,877	213,174	223,833	693
78	JAN	867.2	864	6,008	186,263	195,576	849
1978	FEB	867.7	893	4,986	139,604	146,584	781
1978	MAR	865.8	787	5,831	180,768	189,807	787
1978	APR	863.1	651	5,290	158,711	166,647	698
1978	MAY	859.3	485	4,659	144,417	151,638	547
1978	JUN	858.3	447	4,681	140,441	147,463	358
1978	JUL	857.6	421	5,309	164,565	172,794	324
1978	AUG	868.8	958	6,613	205,002	215,252	314
1978	SEP	869.6	1,007	7,604	228,114	239,519	894
1978	OCT	868.9	964	5,781	179,218	188,179	976
1978	NOV	870.0	1,032	5,449	163,484	171,658	873
1978	DEC	870.0	1,032	6,268	194,294	204,009	933
79	JAN	869.1	976	6,599	204,580	214,809	956
1979	FEB	867.1	859	7,545	211,252	221,814	911
1979	MAR	864.3	710	6,618	205,143	215,400	828
1979	APR	861.9	595	6,990	209,706	220,192	646
1979	MAY	860.0	514	5,790	179,500	188,475	545
1979	JUN	856.4	378	5,936	178,073	186,977	423
1979	JUL	859.0	473	5,827	180,627	189,659	295
1979	AUG	869.9	1,026	5,736	177,809	186,700	384
1979	SEP	869.9	1,026	5,659	169,756	178,244	933
1979	OCT	870.0	1,032	5,454	169,074	177,528	933
1979	NOV	870.0	1,032	6,004	180,118	189,124	930
1979	DEC	870.0	1,032	4,772	147,940	155,337	951

Table 7.2 Reservoir Drawdown Estimation Hillsborough Reservoir 1976 - 1989 (2)

YEAR	MONTH	WATER LEVEL (FEET)	ACTUAL STORAGE 1st DAY OF MONTH (x 1,000 m3)	DAILY ACTUAL PRODUCTION (m3/DAY)	MONTHLY ACTUAL PRODUCTION (m3/MONTH)	MONTHLY ACTUAL DRAFT RATE (m3/MONTH)	ESTIMATED STORAGE WHEN DART RATE IS 9,011 m3/DAY (x 1,000 m3)
80	JAN	870.0	1,032	5,881	182,318	191,434	908
1980	FEB	870.0	1,032	6,299	176,382	185,201	944
1980	MAR	869.5	1,001	6,595	204,439	214,661	965
1980	APR	868.2	922	6,618	198,526	208,452	936
1980	MAY	865.8	787	6,381	197,817	207,707	860
1980	JUN	866.3	814	6,818	204,525	214,751	716
1980	JUL	869.3	988	6,908	214,160	224,868	759
1980	AUG	870.0	1,032	6,840	212,047	222,649	934
1980	SEP	869.9	1,026	6,163	184,891	194,135	975
1980	OCT	870.0	1,032	6,058	187,813	197,204	949
1980	NOV	870.0	1,032	6,181	185,436	194,708	950
1980	DEC	870.0	1,032	5,963	184,854	194,097	956
81	JAN	870.0	1,032	6,831	211,765	222,353	947
1981	FEB	869.0	970	6,977	195,344	205,111	975
1981	MAR	867.6	887	6,772	209,934	220,430	923
1981	APR	865.1	750	6,640	199,207	209,168	828
1981	MAY	867.4	876	6,295	195,140	204,897	689
1981	JUN	869.3	988	6,563	196,889	206,734	801
1981	JUL	869.4	994	6,967	215,992	226,792	925
1981	AUG	869.9	1,026	6,336	196,408	206,228	942
1981	SEP	870.0	1,032	5,886	176,573	185,402	952
1981	OCT	870.0	1,032	6,036	187,109	196,464	947
1981	NOV	869.9	1,026	6,077	182,300	191,415	949
1981	DEC	870.0	1,032	5,999	185,981	195,280	947
82	JAN	870.0	1,032	6,103	189,193	198,653	948
1982	FEB	869.6	1,007	6,044	169,232	177,694	951
1982	MAR	869.0	970	5,694	176,514	185,340	932
1982	APR	867.5	881	6,037	181,110	190,166	876
1982	MAY	865.1	750	5,806	179,986	188,985	801
1982	JUN	862.8	637	6,305	189,150	198,608	660
1982	JUL	866.5	825	5,694	176,514	185,340	565
1982	AUG	867.9	904	5,694	176,514	185,340	731
1982	SEP	869.8	1,019	5,682	170,460	178,983	810
1982	OCT	870.0	1,032	5,694	176,514	185,340	928
1982	NOV	870.0	1,032	5,683	170,490	179,015	938
1982	DEC	870.0	1,032	5,806	179,986	188,985	941
83	JAN	870.0	1,032	5,806	179,986	188,985	941
1983	FEB	870.0	1,032	5,806	162,568	170,696	941
1983	MAR	869.1	976	5,694	176,514	185,340	950
1983	APR	867.2	864	7,086	212,580	223,209	882
1983	MAY	865.4	766	6,768	209,808	220,298	817
1983	JUN	866.2	809	6,364	190,920	200,466	707
1983	JUL	870.0	1,032	6,364	197,284	207,148	739
1983	AUG	870.0	1,032	6,364	197,284	207,148	960
1983	SEP	870.0	1,032	6,364	190,920	200,466	960
1983	OCT	870.0	1,032	6,364	197,284	207,148	962
1983	NOV	870.0	1,032	4,942	148,260	155,673	960
1983	DEC	870.0	1,032	4,783	148,273	155,687	917

Table 7.2 Reservoir Drawdown Estimation Hillsborough Reservoir 1976 - 1989 (3)

YEAR	MONTH	WATER LEVEL (FEET)	ACTUAL STORAGE	DAILY ACTUAL PRODUCTION	MONTHLY ACTUAL PRODUCTION	MONTHLY ACTUAL DRAFT RATE	ESTIMATED STORAGE WHEN DART RATE IS 9,011 m ³ /DAY
			1st DAY OF MONTH (x 1,000 m ³)	(m ³ /DAY)	(m ³ /MONTH)	(m ³ /MONTH)	(x 1,000 m ³)
84	JAN	870.0	1,032	4,751	147,281	154,645	908
1984	FEB	870.0	1,032	4,399	123,172	129,331	907
1984	MAR	869.4	994	4,633	143,623	150,804	909
1984	APR	867.9	904	4,242	127,260	133,623	866
1984	MAY	865.9	793	4,869	150,939	158,486	768
1984	JUN	865.0	745	5,301	159,030	166,982	672
1984	JUL	862.1	605	5,149	159,619	167,600	642
1984	AUG	863.0	646	4,640	143,840	151,032	493
1984	SEP	865.4	766	5,285	158,550	166,478	518
1984	OCT	864.4	715	5,228	162,068	170,171	662
1984	NOV	870.0	1,032	6,407	192,210	201,821	605
1984	DEC	870.0	1,032	6,495	201,345	211,412	963
85	JAN	870.0	1,032	5,853	181,443	190,515	964
1985	FEB	870.0	1,032	6,229	174,412	183,133	943
1985	MAR	869.5	1,001	5,306	164,486	172,710	963
1985	APR	867.3	870	5,342	160,260	168,273	894
1985	MAY	866.6	831	6,584	204,104	214,309	768
1985	JUN	862.5	623	5,352	160,560	168,588	766
1985	JUL	861.2	564	5,724	177,444	186,316	521
1985	AUG	868.7	952	5,760	178,560	187,488	471
1985	SEP	870.0	1,032	5,804	174,120	182,826	860
1985	OCT	870.0	1,032	5,951	184,481	193,705	944
1985	NOV	870.0	1,032	5,885	176,550	185,378	946
1985	DEC	870.0	1,032	5,805	179,955	188,953	947
86	JAN	870.0	1,032	5,558	172,298	180,913	941
1986	FEB	869.6	1,007	5,917	165,676	173,960	933
1986	MAR	868.0	910	5,917	183,427	192,598	928
1986	APR	866.0	798	5,682	170,460	178,983	824
1986	MAY	863.5	670	5,529	171,399	179,969	707
1986	JUN	859.4	489	6,203	186,090	195,395	571
1986	JUL	862.0	600	6,635	205,685	215,969	414
1986	AUG	859.0	473	6,435	199,485	209,459	537
1986	SEP	859.9	510	5,678	170,340	178,857	404
1986	OCT	866.8	842	5,533	171,523	180,099	418
1986	NOV	870.0	1,032	5,602	168,060	176,463	743
1986	DEC	870.0	1,032	5,656	175,336	184,103	938
87	JAN	869.8	1,019	5,642	174,902	183,647	937
1987	FEB	867.4	876	5,300	148,400	155,820	924
1987	MAR	865.0	745	4,812	149,172	156,631	779
1987	APR	861.9	595	313	9,382	9,851	623
1987	MAY	858.4	450	4,474	138,694	145,629	335
1987	JUN	854.4	313	4,285	128,550	134,978	317
1987	JUL	857.9	432	5,208	161,448	169,520	178
1987	AUG	862.2	609	6,550	203,050	213,203	322
1987	SEP	861.8	591	5,998	179,940	188,937	543
1987	OCT	870.0	1,032	7,847	243,257	255,420	510
1987	NOV	869.0	970	8,148	244,440	256,662	1,008
1987	DEC	870.0	1,032	7,664	237,584	249,463	956

Table 7.2 Reservoir Drawdown Estimation Hillsborough Reservoir 1976 - 1989 (4)

YEAR	MONTH	WATER LEVEL (FEET)	ACTUAL STORAGE 1st DAY OF MONTH (x 1,000 m3)	DAILY ACTUAL PRODUCTION (m3/DAY)	MONTHLY ACTUAL PRODUCTION (m3/MONTH)	MONTHLY ACTUAL DRAFT RATE (m3/MONTH)	ESTIMATED STORAGE WHEN DART RATE IS 9,011 m3/DAY (x 1,000 m3)
88	JAN	869.6	1,007	6,569	203,639	213,821	1,002
1988	FEB	868.5	940	6,648	186,144	195,451	941
1988	MAR	866.8	842	6,788	210,428	220,949	883
1988	APR	863.6	675	6,994	209,820	220,311	783
1988	MAY	859.5	493	6,589	204,259	214,472	625
1988	JUN	854.0	301	6,353	190,590	200,120	428
1988	JUL	855.7	355	6,867	212,877	223,521	231
1988	AUG	854.2	307	7,119	220,689	231,723	299
1988	SEP	865.4	766	7,457	223,710	234,896	260
1988	OCT	870.0	1,032	7,805	241,955	254,053	731
1988	NOV	870.0	1,032	8,258	247,740	260,127	1,007
1988	DEC	870.0	1,032	7,880	244,280	256,494	1,022
89	JAN	870.0	1,032	7,633	236,623	248,454	1,009
1989	FEB	869.6	1,007	6,373	178,444	187,366	1,001
1989	MAR	868.9	964	6,960	215,760	226,548	942
1989	APR	868.0	910	7,293	218,790	229,730	911
1989	MAY	865.8	787	7,692	238,452	250,375	870
1989	JUN	861.7	587	7,396	221,880	232,974	758
1989	JUL	857.9	432	7,210	223,510	234,686	549
1989	AUG	856.6	385	5,845	181,195	190,255	387
1989	SEP	855.2	338	6,866	205,980	216,279	296
1989	OCT	861.5	578	7,428	230,268	241,781	284