RICE UNIVERSITY

THE DEVELOPMENT OF TRANSPORTATION IN BELIZE, CENTRAL AMERICA

by

Daniel H. Cooper

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MASTER OF SCIENCE

THESIS DIRECTOR'S SIGNATURE:

[Signature]

HOUSTON, TEXAS

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Abstract

The Development of Transportation in Belize, Central America

Daniel H. Cooper

The development of Belize with emphasis on the role of transportation is considered. The past and present situations are summarized, including a study of the various economic, social and cultural aspects. The historical growth of transportation is noted and related to the economic development of the country, and the present situation and immediate needs are analyzed. Finally, a plan for future development is presented. In this plan growth concepts are discussed and recommendations are made for efficient interaction between transportation and national development.

The historical development of Belize was built around the lumber industry and mercantile activities with Belize City evolving as the center of population, transportation and government. The decline in marketable timber and the absence of natural mineral resources has forced Belize to turn towards agricultural production as a source of export commodities as well as a means for reducing national dependence on imported food-stuffs. The most important potential agricultural areas are located inland and were, until recently, almost totally inaccessible.

The immediate transportation needs center around improved highway networks and port facilities, since air travel is developing in an adequate fashion and rail transport does not appear to be justified. There
is a clear need for an improved highway network that will allow convenient access to remote parts of the country and provide a means of marketing agricultural produce. In addition an improved highway system that is designed to connect to the existing Central American network would free Belize from its now isolated position.

The existing port facilities at Belize City and Commerce Bight are inadequate at present. The principle port at Belize City is required to handle all import and export items by means of lighters, since no deep water port facilities exist. The current governmental proposals for construction of new deep water port facilities at Belize City and Commerce Bight are discussed and possible alternatives examined.

Finally, considerations are made concerning the future development of transportation in Belize. Future needs are based on both the continued economic growth of the country and the need for a more complete regional transportation network. The identification of areas of unique economic potential and socio-economic regions is made, along with suggestions for establishing urban growth centers and their corresponding transportation links.
Dedicated to Charles Trost without whose help this thesis could not have been written, and to his wife Elizabeth for her continued encouragement.
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INTRODUCTION
Introduction

The relationship of transportation to the socio-economic growth of a country can be typified in many ways. The development of transportation routes within a country serves as a stimulus for increased land development, commodity production and community interaction; all of which are critical in any national development plan. The priority that should be given to transportation in any national development plan varies, but in almost all cases it will have a direct effect on national growth.

The country of Belize, formerly British Honduras, provides an excellent case study in how transportation plays an important role in national development. Located in tropical Central America and bordered by the Caribbean Sea, Belize was historically noted for being a regional center of trade and commerce. Because of strong ties to the sea and the dependence on marine transportation, Belize failed to expand internal transportation systems; and as a result, its economic development has been inhibited.

Only in the last 3 decades has Belize undertaken any major steps toward developing a plan for national growth and internal development. Belize has now reached a stage where a national development plan could be formulated and implemented with great efficiency. The lack of railroads and a deep water port, and the fact that the existing highway network is in need of major repairs and realignment has put Belize in the position
of needing to almost start anew with their transportation system. From this situation Belize can design and conveniently follow a national transportation plan that will most efficiently utilize current modes of transportation based on the latest theories of regional and national development.

This thesis describes the development of Belize with an emphasis on transportation. An attempt is made to describe every factor that might have significant bearing on development decisions and to discuss influences that these factors have on transportation. After studying the pertinent information regarding the country, a transportation plan is designed based on an analysis of this information in relation to future national growth policies.

The section of the thesis dealing with the description of Belize presents the geographic and economic situation in Belize. Included in this section are the physical characteristics of the country; the demographic and political composition; and a discussion of the country's economic base. Each of these factors play a definite part in establishing the needs and setting limitations on any proposed transportation program.

Included in the thesis is a section relating the historical development of Belize. This section offers insight as to why the country developed in such a limited fashion. The nature of the early economy, past public opinion and thwarted attempts at early development provide valuable information when trying to predict how new systems might be accepted. Although the attitudes towards internal development have improved considerably since the early 1900's, tradition still exists as one of the major opponents to beneficial change.
Analysis of current development programs gives an idea as to the country's present policy regarding transportation. Steps being taken by the government reflect attitudes toward future development and give an indication of what items are considered highest in priority. Historical accounts coupled with present attitudes give some idea as to how government and the population will react to future development. An understanding of traditional reaction to change will provide a definite edge in planning for the unexpected.

Domestic needs, physical limitations and national acceptance are all necessary conditions which must be met in order to be assured of producing a transportation plan that will suit the needs of Belize both as a developing and established nation.
DESCRIPTION of BELIZE
Geographic Location, Land Features and Geology

The country of Belize\textsuperscript{1} is situated within the Latin American community; being bordered on the north by Mexico and on the west and south by the Republic of Guatemala (see Figure 1). The Caribbean Sea forms the complete eastern boundary. The southern section of Belize is adjacent to the portion of the Caribbean Sea known as the Gulf of Honduras. The frontier borders of Belize are generally recognized as extending from the Gulf of Honduras westerly along the Sarstoon River to Gracias A Dios Falls. From this point the boundary extends northerly to Garbutt’s Falls on the Belize River near Benque Viejo and then due north to Blue Creek, a tributary of the Rio Hondo. Blue Creek and the Rio Hondo serve as the northern, Mexican, border. The present border definitions are currently being contested by the Republic of Guatemala with support of neighboring Latin American countries.

Belize is geographically located between longitude $87^\circ 45' \text{ west to } 89^\circ 10' \text{ west and latitude } 15^\circ 55' \text{ north to } 18^\circ 30' \text{ north. The mainland of Belize is approximately 174 miles north-south and 68 miles east-west. The mainland, along with the numerous cays, comprises a total land area of 8,866 square miles, making Belize the second smallest country on the American continent; the smallest being nearby El Salvador.}

The general topography of Belize ranges from steep mountains to low marshes. Forest of some variety covers almost 90\% of the country, but of

\textsuperscript{1} A detailed map of Belize is included in the back pocket
this it is estimated that only about 120 square miles contains marketable timber. Rivers that drain the country generally flow in an easterly or northeasterly direction with the exception of rivers draining the western side of the Maya Mountains. In this case the rivers flow to the west and then to the north before they eventually empty into the easterly flowing Belize River.

Belize can be subdivided into natural regions based on differences in topography, vegetation, geology and other land features. These natural regions are generally listed as:

1. Lowland Plains
2. Maya Mountains
3. Karst Landforms (between the mountains and the plains)
4. The Cays

Furley and Crosbie in their publication *Geography of Belize* (31)\(^2\) further divided the Lowland Plains into Northern Lowlands, Southern Lowlands and Coastal Plains; resulting in a total of six natural regions (see Figure 2).

Consisting of level plains and gently rolling hills, the Northern Lowlands region covers most of the northern portion of the country. In this region elevations seldom exceed 250 feet above sea level. This slight gradient is responsible for the deep, wide, slow moving rivers that cross the area. The more important rivers: Rio Hondo, New River and the Belize River, originally served as the major transportation and communication links. These rivers opened the interior to the early lumber companies;

\(^2\) The number in the parenthesis refers to sources listed in the List of References.
Figure 2
NATURAL REGIONS
and later, to Mexican immigrants who came to Belize primarily as farmers. Fertile, well drained land along with a mild climate and good river access helped the Northern Lowlands to become the most established and best settled of the regions.

Lying east of the Northern and Southern Lowlands and traversing the entire coastline, the Coastal Plains region forms a natural barrier of swamps and mangrove marshes. Although Belize City, the country's most important commercial and residential center, lies well within this region; the area for the most part is considered to be of little economic value and in many ways a handicap to the country's development. The fact that Belize City is situated only two to three feet above sea level has helped to delay the installation of a much needed sanitary sewer system to replace the existing open drainage canal method of waste disposal. Towns and villages lying in this region also face the threat of floods due to hurricanes, heavy rains or exceptionally high tides; and many of the residents are forced to rely on rainwater for their primary supply of fresh water.

The physical characteristics of the Coastal Plains have also prevented the construction of direct transportation routes between Belize City and the two district centers of Corozal and Stann Creek Town (recently renamed Dangriga). The cost involved in constructing adequate road beds through these areas has forced more out-of-the-way routes to be utilized.

Karst is the term most frequently used to describe the limestone hills that lie between the Lowland Plains and the mountains. This type of distinctive landform originated with a limestone formation that was gradually eroded by the action of water to produce an area of conically shaped hills and vertical cliffs. These hills are honeycombed with caves, eroded
depressions and sinkholes. Unusual characteristics possessed by this type of landscape include: either conically shaped hills or hills with steep cliffs; poorly drained hollows, often swampy, with dense vegetation; dry hollows with no available source of fresh water; eroded depressions or sinkholes sometimes containing water; numerous caves; and streams that vanish into hillsides or caverns.

The Limestone Hills region is located in the area from the Sibun River south to Mullins River or roughly within the triangle formed by the Western and Hummingbird Highways (refer to detailed map in back pocket). This landform can also be found near Punta Gorda, at the headwaters of the Temash River and south of the Yalbac Hills.

Because the terrain is rugged and provides little incentive for agriculture, this is one of the least developed areas in Belize. One possibility for development could rest in the numerous tourist attractions provided by the caves and unusual landforms; but unless these potentials are fully exploited, the area will probably remain terra incognita.

The Maya Mountains cover over one-fourth of the total land area of Belize and are located entirely in the southern half of the country. The actual mountainous portion of this region is a crescent shaped range stretching from the Bald Hills to the Cockscomb Hills and then south-westerly along the Main Divide to the Guatemala border. Within this crescent lies a granite basin, consisting mostly of a region called the Mountain Pine Ridge and the Vaca Plateau.

Although the mountains themselves are rugged and of little economic value, the interior basin and plateau have a potential for development.
Rapid storm water runoff in the Granite Basin has leached the soils and in steep areas such as the Bald Hills has even removed the available topsoil. The remaining highly acidic soil supports primarily "savannah type" grasses and pine trees. In the past the pine trees served as a source of resin for the turpentine industry in Belize, but now as more attention is being turned toward the production of softwood lumber, this area is expected to become a major supplier of timber. Large stands of hardwoods occur in areas of the Vaca Plateau and along the Chiquibul Branch of the Mopan River, but at present poor access to these regions has prevented large scale lumbering operations.

Because of fire hazards associated with the Mountain Pine Ridge vegetation, the Forestry Department of Belize has found it necessary to construct a series of roads throughout this area to serve as firebreaks. As a result, much of the interior is accessible by road, and possibly this accessibility will serve as an incentive for continued development.

The presence of the Maya Mountains has also been the major factor shaping the development of the Southern Lowlands. The natural barrier formed by the mountains has separated the southern region from the more populated North, isolating it from the major seaport and governmental headquarters. Until recently, the method of transportation between Punta Gorda and the rest of the coastline was by boat. Unpredictable rivers and coastal swamps delayed the construction of an all weather road, and even now the newly completed Southern Highway between Stann Creek and Punta Gorda is subject to "wash-outs" during periods of intense rainfall.

The Southern Lowlands region consists of gently rolling hills that become progressively steeper as they near the mountains. Most of the area
is covered by dense vegetation and has good agricultural potential. Inland swamps are prevalent over much of the region but need not be considered as a deterrent to development.

Although they comprise only a small portion of the total land area, the cays are one of the country's most valuable resources. Formed in conjunction with the coastal barrier reef (second only in size to the Great Barrier Reef of Australia) the cays dot the coastal waters for the entire length of the country.

Early development of the cays was centered around small fishing villages and coconut plantations. Although the export of seafood has remained an important industry among the villages, the coconut industry is slowly declining. This decline has been the result of the devastating effects of recent hurricanes on the coconut palms combined with the change in beach priority from coconut production to subdivided lots and developed tourism. White sands and swaying coconut palms along with the excellent diving and fishing are attracting an increasing number of tourists each year. Unfortunately, the majority of the cays are only mangrove swamps and would require extensive filling in order to be considered commercially desireable.

The barrier reef is not only important as a major tourist attraction, but it also serves as a damper for the incoming Caribbean waves. This damper is especially effective against the strong tidal surges resulting from hurricanes. As a result, the coastal waters between the reef and the mainland remain relatively calm.

Figure 3 illustrates the topographic features of the country lying along the cross sections of Figure 2.
Concerning the basic geology of Belize, the country can be divided into roughly three regions:

1. Areas formed over limestone
2. The Maya Mountains
3. Areas formed from alluvial deposits

Figure 4 and the geopogical map located in the back pocket show the geological composition of the country. Of these three regions only the Maya Mountains have been the subject of any extensive geological surveys.

The Maya Mountains consist of granite intrusions with some areas having overlays of shale and sandstone. Because of their intrusive origin and the nature of the source material, the Maya Mountains are the only area
Figure 4

GEOLOGY OF NORTHERN BELIZE

Source: Ower, 1926 (34)
in Belize where minerals of any economic value would occur. Surveys
dating back to the late 1800's have been made, but these showed only
minute traces of marketable minerals which did not warrant mining operations.

In 1970 the Institute of Geological Sciences of Britain investigated
the Maya Mountains, performing tests on the sediments of various streams
in search of traces of copper, lead, zinc, silver, beryllium, boron, tin,
niobium, arsenic and molybdenum. Their published report shows little
evidence of any minerals occurring in economically significant quantities,
and their recommendations discourage continued exploration except in the
Cabbage Haul Creek area south of Stann Creek.

Petroleum exploration in Belize over the past twenty years has up to
now been totally unproductive. Early drilling operations were centered in
the northern districts and offshore, but more recent attempts are being
made in the Toledo District in the south. The current drilling operations
have increased the optimism that oil will someday be discovered in Belize.

The Guatemalan earthquake of February, 1976, which measured 7.5 on
the Richter scale and caused over 20,000 fatalities will have a definite
effect on future engineering considerations in Belize. Fortunately, Belize
suffered no damage as a result of the earthquake, but the active fault that
the U. S. Geological Survey identified as the source of the earthquake
lies less than 130 miles from Belize City. Figure 5 outlines the plate
movement responsible for the earthquake and identifies the areas hardest
hit. The epicenter of the earthquake was calculated by the Survey as being
located approximately 12 miles west of Los Amates, just south of Lake
Izabal.
The Motagua fault (above), which separates the great North American and Caribbean tectonic plates of the earth’s crust, is identified as the main cause of the earthquake. Fault follows the Motagua River, (below) destroyed highway and railroad to the Atlantic. Striped area, below, indicates 90-100 per cent damage; checked area, 40-60 per cent damage.

Figure 5

Fault Responsible for the Guatemala Earthquake

Source: Zendequi (38) adapted from U. S. G. S.

The geological map in the back pocket shows the number of faults existing in southern Belize. Although none of these have shown signs of being dangerously active, the majority of them lie parallel to Guatemala’s Montagua...
Fault and within the range of the known plate movement. The position of Belize along this line of plate movement and the number of potentially active faults in the vicinity strongly suggests that there exists a possibility of a major earthquake occurring in the area.

Alluvial deposits such as those along the Belize coast represent one of the features of the earth's surface that react most violently to earthquake shock waves. Not only are these deposits susceptible to large displacements, but other phenomena such as soil liquefaction and tsunamic waves could also occur.

The possible effects of a major earthquake in or around Belize should be considered in all phases of transportation planning. In Belize the facility most likely to suffer the effects of an earthquake would be a port and its supporting structures. A port located in Belize City would be situated over alluvial deposits and, therefore, more prone to destruction due to ground movement and soil liquefaction. In the case of Guatemala the railway and road linking Guatemala City and the Atlantic ports lay along the fault line and as a result, suffered major damage. Measures should be taken to avoid similar situations in Belize.

Climate

While Belize is situated within the tropical zone, its climate is more often considered to be subtropical in nature. The country's proximity to the Caribbean Sea accounts for the mild breezes which help subdue the potentially high temperatures.
As characteristic with most tropical lands, the climate of Belize is generally warm throughout the year. The average yearly minimum and maximum temperatures at Belize International Airport range from a low of $64^\circ$ to a high of $91^\circ$, but extreme low and high temperatures have been recorded at $54^\circ$ and $96^\circ$ respectively. Because the cooling effect of the coastal sea breezes diminishes further inland, the temperature differential in these areas is more pronounced with temperatures exceeding $100^\circ$ recorded in the Cayo District.

Other conditions affecting the temperature in Belize include elevation and occasional cold fronts that come into the western Caribbean area between October and January. More noticeable temperature changes occur in the Maya Mountains and higher pine ridge areas where the effects of increased elevation produce cooler nights and more pleasant days. Cold fronts coming in from Mexico and the United States bring cooler temperatures and cloudless skies.

The highest humidity in Belize exists in the coastal regions. Here the relative humidity rarely drops below 65% and generally stays in the 80-90% range (see Table 1). However, the coastal breeze tends to reduce the discomfort associated with a high humidity, and the humidity is generally more noticeable in the inland areas where the breeze is less.

In Belize the seasons are determined by the amount of rainfall measured during a certain period, with an obvious wet and dry season existing. The dry season usually lasts from February to May but is often much shorter for the southern areas. During this period, river levels reach their lowest stage and much of the lowland that is generally under water becomes passable. Months that receive more than 4 inches of rainfall are considered to be
Table 1

Mean Monthly Relative Humidity (%)

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<th>F</th>
<th>M</th>
<th>A</th>
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Source: Furley and Crosbie (31)

in the wet season. This season brings a flooding of the low lying areas, a rise in river levels and an increase in the insect population. The wet season also replenishes the vat water supplies in areas where groundwater is not available and initiates the upcoming agricultural season.

Rainfall in Belize varies throughout the country as does the number of rainy days (see Figure 6 and Tables 2 and 3). The least rainfall occurs in the northern regions where there is little change in elevation; the average rainfall in Corozal being approximately 60 inches yearly. Farther south and along the eastern edge of the Maya Mountains the annual rainfall increases to an average of 140 inches in Punta Gorda and 188 inches in Machaca Camp just northwest of Punta Gorda.

The average rainfall also varies from year to year. For instance in Belize City, for the month of June (an important agricultural month) the 1966 rainfall was 20.45 inches, while it measured only 6 inches in 1967 and was nonexistent in 1975. This discrepancy often leads to serious crop
Table 2

Rainfall in 1970

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<td>0.00</td>
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<td>6.58</td>
<td>7.22</td>
<td>6.81</td>
<td>7.57</td>
<td>4.13</td>
<td>5.65</td>
<td>7.81</td>
<td>57.25</td>
<td>59.21</td>
<td>22</td>
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<tr>
<td>Augustine</td>
<td>5.20</td>
<td>2.56</td>
<td>0.44</td>
<td>0.22</td>
<td>2.78</td>
<td>3.37</td>
<td>8.17</td>
<td>7.61</td>
<td>8.71</td>
<td>9.01</td>
<td>10.47</td>
<td>5.49</td>
<td>63.93</td>
<td>61.2</td>
<td>22</td>
</tr>
<tr>
<td>Stann Creek</td>
<td>5.52</td>
<td>3.82</td>
<td>0.98</td>
<td>0.15</td>
<td>4.49</td>
<td>8.91</td>
<td>11.16</td>
<td>16.15</td>
<td>7.8</td>
<td>7.2</td>
<td>5.81</td>
<td>8.38</td>
<td>80.37</td>
<td>88.77</td>
<td>39</td>
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<tr>
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<td>10.32</td>
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<td>0.87</td>
<td>0.28</td>
<td>3.74</td>
<td>13.13</td>
<td>28.67</td>
<td>25.38</td>
<td>27.32</td>
<td>14.45</td>
<td>2.59</td>
<td>9.49</td>
<td>138.49</td>
<td>152.02</td>
<td>36</td>
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<tr>
<td>Machaca Camp</td>
<td>20.62</td>
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<td>15.44</td>
<td>0.12</td>
<td>4.75</td>
<td>13.71</td>
<td>28.59</td>
<td>31.07</td>
<td>29.00</td>
<td>14.50</td>
<td>3.95</td>
<td>7.80</td>
<td>187.92</td>
<td>132.59</td>
<td>14</td>
</tr>
</tbody>
</table>

Source: Furley and Crosbie (31)
CONTOURS REPRESENT ANNUAL RAINFALL IN INCHES

SCALE 1:1,600,000

Figure 6

ANNUAL RAINFALL
failures and there is never any guarantee that the following year will be any more productive.

The seasonal change is probably the most important factor involved in the development of Belize. The early logging industry depended on the dry season for locating and felling the mahogany and logwood trees and then on the wet season for floating these trees to the sea for loading onto ships.

As previously stated, the seasonal variation also plays an important role in agriculture. An extended dry season often results in poor crop yields. This decline not only reduces the amount of produce available for domestic consumption, but the principle export crops of sugar and citrus also suffer.

Most of the construction done in Belize is on a seasonal basis. Heavy rainfall generally brings to a temporary halt any bridge construction or road development occurring in low lying areas. The rapid rise in river
levels, on some rivers as much as 30 feet, is another reason why construction is delayed during the wet season. Along the Southern Highway many sections of the road are isolated from one another due to sudden rises in stream water levels well above those of the existing bridges. High water is also responsible for the destruction of many existing bridges and roadways.

Hurricanes pose an ever present threat during the months of June through November. Recent hurricanes have destroyed much of the Belize coast, and the destruction of Belize City in 1961 prompted the construction of the new capital at Belmopan. In association with the high winds of the hurricanes are tidal surges that cause heavy flooding to the low lying areas.

Flora and Fauna

Due to the varied climate, Belize enjoys a wide assortment of both plant and animal life. Mahogany logging has had little effect on the environmental balance; therefore, Belize now contains many species of animals, some of which are becoming rare in other countries. Animals such as the jaguar, mountain cow (tapir) and manatee; along with birds such as the jabiru stork can still be found in numbers uncommon in all but the most remote regions of other countries. Belize also contains a large number of game animals which include deer, squirrel and wild pigs. Game fowl are also plentiful in the swamps and lagoons, and tropical birds are common in the interior forests. Butterflies are prevalent, but insect pests such as botlass flies, mosquitoes and "wee-wee" ants also abound. The barrier reef and the coastal lagoons support many varieties of fish, and the fishing in
Belize is considered by many to be unequalled.

Aside from the fact that Belize lies in the tropical zone, the two most important factors determining the type of natural vegetation in an area are rainfall and soil. The effect of changes in rainfall and soil characteristics is evident on aerial photographs and on the natural vegetation map produced by A. S. C. Wright and company (37). This map produced in 1958 is the best available source of information regarding vegetation types for specific areas, and if it is compared with the soils map of the same series the relationship between soil and vegetation types becomes apparent. As previously stated, Belize is almost totally in forest. Broadleaf species predominate, but palms and pines are also abundant. The swamps contain vegetation indigenous to that environment, generally mangroves, but low bush also occurs.

Demography and Government

The population of Belize is a unique mixture of primarily African, English, Spanish and Native Indian nationalities. The majority of the population is Creole, a name given to descendants of the original African slaves brought to Belize to work in the timber industry. Other races include Carib, a mixture of African and Native Indian; Mexican; Anglo; Native Indian; along with traces of Chinese, Indian, German and assorted mixtures of the aforementioned.

Belize enjoys a racial harmony, but a slight segregation exists based on preferred living conditions and common interests. Creoles are commonly located in communities along major transportation routes in the Corozal,
Orange Walk and Belize Districts. Spanish descendents are mostly found in the Corozal and Orange Walk Districts where their ancestors settled after fleeing Mexico during the Caste Wars of the mid 1800's. There are also Spanish descendents along the Western border with Guatemala. Caribs inhabit the coastal area from Dangriga (Stann Creek Town) through Punta Gorda and the Native Indians prefer the remote areas of the Orange Walk and Toledo Districts. Mennonites, who migrated to Belize in the 1950's, settled in the areas around Spanish Lookout in the Cayo District and Blue Creek in the northern part of the Orange Walk District. Tables 4 and 5 list the current population by district and language spoken. Figure 7 illustrates the approximate population distribution.

The government of Belize is similar to those of the other former British colonies located in the Caribbean region with the exception that Belize has yet to receive full independence. Although the government of Belize determines all policy concerning internal affairs, the lack of a suitable national army has necessitated the presence of a British governor in Belize to assist in international affairs. The eventual goal of Belize is to become a totally independent nation.

Internal governing and diplomatic world affairs are carried out by the elected government of Belize. Governing districts (Figure 8) elect representative members to a national congress. The present two party system is similar to that in Britain with a party in power and an opposition party. The official leader of the country is the Premier who is also leader of the party in power. Ministers are selected by the Premier.

The Ministry dealing directly with transportation is the Ministry of Works. The Ministry is subdivided into the Roads, Bridges and Harbors
Divisions. Through field offices in the six districts, these divisions construct and maintain most of the transportation projects in the country.

Table 4
Population According to 1970 Census

<table>
<thead>
<tr>
<th>District and Subdivision</th>
<th>Both Sexes</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belize</td>
<td>49355</td>
<td>23938</td>
<td>25417</td>
</tr>
<tr>
<td>Belize City</td>
<td>39050</td>
<td>18457</td>
<td>20593</td>
</tr>
<tr>
<td>Belize Rural</td>
<td>10305</td>
<td>5481</td>
<td>4824</td>
</tr>
<tr>
<td>Corozal</td>
<td>15551</td>
<td>8150</td>
<td>7401</td>
</tr>
<tr>
<td>Corozal Town</td>
<td>4724</td>
<td>2343</td>
<td>2381</td>
</tr>
<tr>
<td>Corozal Rural</td>
<td>10827</td>
<td>5807</td>
<td>5020</td>
</tr>
<tr>
<td>Orange Walk</td>
<td>17041</td>
<td>8918</td>
<td>8123</td>
</tr>
<tr>
<td>Orange Walk Town</td>
<td>5698</td>
<td>2895</td>
<td>2803</td>
</tr>
<tr>
<td>Orange Walk Rural</td>
<td>11343</td>
<td>6023</td>
<td>5320</td>
</tr>
<tr>
<td>Stann Creek</td>
<td>13023</td>
<td>6364</td>
<td>6659</td>
</tr>
<tr>
<td>Stann Creek Town</td>
<td>6939</td>
<td>3208</td>
<td>3731</td>
</tr>
<tr>
<td>Stann Creek Rural</td>
<td>6084</td>
<td>3156</td>
<td>2928</td>
</tr>
<tr>
<td>Toledo</td>
<td>8989</td>
<td>4383</td>
<td>4606</td>
</tr>
<tr>
<td>Punta Gorda</td>
<td>2083</td>
<td>924</td>
<td>1159</td>
</tr>
<tr>
<td>Monkey River</td>
<td>279</td>
<td>143</td>
<td>136</td>
</tr>
<tr>
<td>Toledo Rural</td>
<td>6627</td>
<td>3316</td>
<td>3311</td>
</tr>
<tr>
<td>Cayo</td>
<td>15701</td>
<td>8088</td>
<td>7613</td>
</tr>
<tr>
<td>San Ignacio</td>
<td>4336</td>
<td>2099</td>
<td>2237</td>
</tr>
<tr>
<td>Benque Viejo</td>
<td>1921</td>
<td>970</td>
<td>951</td>
</tr>
<tr>
<td>Cayo Rural</td>
<td>9444</td>
<td>5019</td>
<td>4425</td>
</tr>
<tr>
<td>Belmopan</td>
<td>274</td>
<td>250</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>119934</td>
<td>60091</td>
<td>59843</td>
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</tbody>
</table>

Source: Government Census (7)
## Table 5

**Population - Language Spoken**  
**1970 Census**

<table>
<thead>
<tr>
<th>Districts and Sub-Divisions</th>
<th>Population</th>
<th>English</th>
<th>Spanish</th>
<th>Maya/Ketchi</th>
<th>Low German</th>
<th>Carib</th>
<th>Not Stated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belize City</td>
<td>39050</td>
<td>36157</td>
<td>2038</td>
<td>5</td>
<td>3</td>
<td>151</td>
<td>696</td>
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<tr>
<td>Belize Rural</td>
<td>10305</td>
<td>8886</td>
<td>1211</td>
<td>-</td>
<td>1</td>
<td>50</td>
<td>157</td>
</tr>
<tr>
<td>Total Belize District</td>
<td>49355</td>
<td>45043</td>
<td>3249</td>
<td>5</td>
<td>4</td>
<td>201</td>
<td>853</td>
</tr>
<tr>
<td>Corozal Town</td>
<td>4724</td>
<td>1805</td>
<td>2811</td>
<td>-</td>
<td>-</td>
<td>37</td>
<td>71</td>
</tr>
<tr>
<td>Corozal Rural</td>
<td>10827</td>
<td>1534</td>
<td>8528</td>
<td>592</td>
<td>-</td>
<td>108</td>
<td>65</td>
</tr>
<tr>
<td>Total Corozal District</td>
<td>15551</td>
<td>3339</td>
<td>11339</td>
<td>592</td>
<td>-</td>
<td>145</td>
<td>136</td>
</tr>
<tr>
<td>Orange Walk Town</td>
<td>5698</td>
<td>1736</td>
<td>3831</td>
<td>22</td>
<td>-</td>
<td>99</td>
<td>10</td>
</tr>
<tr>
<td>Orange Walk Rural</td>
<td>11343</td>
<td>720</td>
<td>6691</td>
<td>261</td>
<td>3412</td>
<td>24</td>
<td>235</td>
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<td>Total Orange Walk District</td>
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<td>2456</td>
<td>10522</td>
<td>283</td>
<td>3412</td>
<td>123</td>
<td>245</td>
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<td>Stann Creek Town</td>
<td>6939</td>
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<td>79</td>
<td>-</td>
<td>2</td>
<td>3582</td>
<td>125</td>
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<td>Stann Creek Rural</td>
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<td>482</td>
<td>126</td>
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<td>Total Stann Creek District</td>
<td>13023</td>
<td>7072</td>
<td>561</td>
<td>126</td>
<td>4</td>
<td>5000</td>
<td>260</td>
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<tr>
<td>Punta Gorda Town</td>
<td>2083</td>
<td>931</td>
<td>75</td>
<td>5</td>
<td>-</td>
<td>1051</td>
<td>21</td>
</tr>
<tr>
<td>Monkey River Town</td>
<td>279</td>
<td>265</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Toledo Rural</td>
<td>6627</td>
<td>1464</td>
<td>345</td>
<td>4237</td>
<td>-</td>
<td>321</td>
<td>260</td>
</tr>
<tr>
<td>Total Toledo District</td>
<td>8989</td>
<td>2660</td>
<td>420</td>
<td>4242</td>
<td>-</td>
<td>1383</td>
<td>284</td>
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<tr>
<td>San Ignacio</td>
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<td>2087</td>
<td>2221</td>
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<td>-</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>Benque Viejo</td>
<td>1921</td>
<td>62</td>
<td>1847</td>
<td>3</td>
<td>-</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Cayo Rural</td>
<td>9444</td>
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<td>3371</td>
<td>661</td>
<td>921</td>
<td>53</td>
<td>248</td>
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<tr>
<td>Total Cayo District</td>
<td>15701</td>
<td>6339</td>
<td>7439</td>
<td>669</td>
<td>921</td>
<td>62</td>
<td>271</td>
</tr>
</tbody>
</table>

Source: Government Census (7)
Figure 7

POPULATION DENSITY AND DISTRIBUTION

- REPRESENTS 1000 PEOPLE
- REPRESENTS 100 PEOPLE

This map is intended to show relative population density and distribution. It is not a census authority.

SCALE 1:1,600,000
Figure 8
GOVERNMENTAL DISTRICTS
Economic Situation

The economy of Belize, which at one time was based almost entirely on the export of forest products, is now in a transition. Although the emphasis has turned toward agriculture and the use of the vast amounts of undeveloped farmland, the government also realizes the potential of such industries as tourism, manufacturing and local crafts.

In 1963 the United Nations Technical Assistance Board recruited and financed an Economic Survey Mission to undertake a survey of the general economy of Belize and produce a broad outline to be used in devising a development plan for the period from 1964-70. As a result, the government produced a plan which contained an analysis of the current economic status and established the aims and policies of the government regarding future development.

The development realized by the country over the last ten years fell short of the anticipated goals of the 1964-70 plan. This is understandable, since it was during the 1960's that the economy made the drastic readjustment from forestry to agriculture. Now that the government has actually experienced an economy based on agriculture and witnessed many of the problems associated with the change, they are in the process of producing an updated, and less ambitious, development plan for the period after 1976.

One of the more serious problems confronted during the economic change has been the shortage of labor. Forestry required far less labor input than does the developing agricultural industry, and many of the large scale farms find themselves in need of imported field workers. Another problem has been the lack of skilled labor and qualified managers. The lack of
adequate transportation facilities is also a drawback. Not only is the internal highway system in serious need of repair and upgrading, but the country also lacks a deep water port, so necessary in building a profitable export trade.

The Gross Domestic Product estimated for 1971 shown in table 6 gives an idea of how the economy of Belize is divided. Although the G. D. P. is a good indication of how the production is separated among the different economic areas, the government office of economic development is quick to point out that factors such as employment levels, education and total per capita production are also necessary in establishing the total economic picture. The visible trade balance (Table 7) shows that Belize continues to operate in a deficit. In the past this has been made up by grants from the British Government, but in the future Belize hopes to use these grants for internal improvements and investments in order to produce a more stable economy.

Except for the vast amounts of undeveloped land and the ocean, Belize has no known natural resources. As a result, agricultural exports and tourism will almost surely emerge as the country's most profitable commodities. Tourism has been slow to develop in Belize, mainly because the country has never sought the tourist trade. Until the scheduling of airline flights into Belize in the 1950's the only access to the country was by cargo ship. Recently, a road has been built connecting Chetumal on the northern border with Belize to the rest of the Mexican highway system, and passenger ships visit Belize harbor on a regular basis.

Belize contains many natural features with outstanding tourist appeal (see Figure 9). Of these the archaeological sites and the ocean have the
Table 6

Gross Domestic Product at Factor Cost 1971 by Industrial Origin ($'000)

<table>
<thead>
<tr>
<th>Industry</th>
<th>$</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture (Inc. Forestry and Fisheries)*</td>
<td>18,377</td>
<td>20.9</td>
</tr>
<tr>
<td>Mining and Quarrying</td>
<td>174</td>
<td>0.3</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>9,986</td>
<td>11.3</td>
</tr>
<tr>
<td>Craft Industries</td>
<td>250</td>
<td>0.4</td>
</tr>
<tr>
<td>Electricity and Water</td>
<td>1,227</td>
<td>1.4</td>
</tr>
<tr>
<td>Building and Construction</td>
<td>6,140</td>
<td>6.9</td>
</tr>
<tr>
<td>Distribution</td>
<td>21,810</td>
<td>24.7</td>
</tr>
<tr>
<td>Transport, Storage and Communications</td>
<td>6,077</td>
<td>6.8</td>
</tr>
<tr>
<td>Finance, Insurance and Real Estate</td>
<td>6,195</td>
<td>7.0</td>
</tr>
<tr>
<td>Government</td>
<td>9,151</td>
<td>10.5</td>
</tr>
<tr>
<td>Private Non-Profit Making Bodies</td>
<td>2,599</td>
<td>2.9</td>
</tr>
<tr>
<td>Social and Personal Services</td>
<td>6,075</td>
<td>6.9</td>
</tr>
<tr>
<td>Total</td>
<td>88,061</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Excludes the Processing of Agricultural Produce

Source: Draft Development Plan 1974-76 (8)

best potential for immediate development. Development of the ocean related tourist activities has in the past been left to the individual property owners. Although the property owners have been allowed to develop according to their own discretion, the lack of large capital investments has restricted the type of improvements to modest endeavors. If, however, large
capital is put into improving the ocean related tourist trade, the government will probably regulate major construction in order to insure that nothing which might be eventually detrimental to the natural environment is attempted.

Table 7

Imports, Exports and Visible Trade Balance for 1960-1971 ($'000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Imports</th>
<th>Total Exports</th>
<th>Exports 1960-1969</th>
<th>Visible Trade Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Domestic Exports</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Re-Exports</td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>18,784</td>
<td>11,245</td>
<td>10,165</td>
<td>1,080</td>
</tr>
<tr>
<td>1968</td>
<td>43,982</td>
<td>25,004</td>
<td>19,815</td>
<td>5,189</td>
</tr>
<tr>
<td>1969</td>
<td>49,350</td>
<td>28,080</td>
<td>20,858</td>
<td>7,222</td>
</tr>
<tr>
<td>1970</td>
<td>55,611</td>
<td>31,335</td>
<td>23,239</td>
<td>8,096</td>
</tr>
<tr>
<td>1971</td>
<td>59,064</td>
<td>31,883</td>
<td>24,047</td>
<td>7,836</td>
</tr>
</tbody>
</table>

Source: Draft Development Plan 1974-76 (8)

The archaeological sites, on the other hand, are completely regulated by the government. Since the government archaeological staff is limited, the improvement of even the major ruin sites is seldom accomplished. Recent ruin discoveries have shown that Belize was once the location of Maya communities more advanced than originally expected. Fortunately, Belize is located in the path of tourists traveling between the Mexican ruins in the Yucatan and the Tikal ruins in the Peten District of Guatemala. Both Mexico and Guatemala have gone to great effort to reconstruct and develop
TOURIST ATTRACTIONS

Figure 9

SCALE 1:1,600,000

Maya Ruins in Mexico

Tikal Maya Ruin

Capital City

Local Crafts

Maya Ruin

Caves

Blue Hole

1000' Waterfall

Hunting

Beach Fishing

Tropical Rainforest

Maya Ruins

Beach Diving Fishing

Diving

Fishing

Blue Hole
these ruins for the tourist trade. Many of the overland tourists traveling between the Yucatan and Peten regions might be induced to spend more time in Belize investigating the local sites if Belize provided good access to the ruin sites and initiated a publicity program aimed at informing the tourist as to the extent that the Maya had developed in Belize.

Agriculture

In the 1960's agriculture emerged as the major supplier of export products. In 1960 agricultural exports represented 40% of the total exports, but continually increased so that by 1970 it accounted for 75% of the total. Mainly through the increase in sugar export, and somewhat through citrus exports, Belize has been able to develop an economy based on agriculture rather than forestry as had been the case since the origin of the colony.

Besides sugar and citrus, recent agricultural developments have aimed at increasing the output of fresh vegetables for local consumption, rice for local sale and export, local beef and dairy products, and bananas. Although during the late 1800's the banana industry represented the largest agricultural endeavor in Belize, disease and a decline in the market resulted in its disappearance.

Vegetables, cereal products, meat, and dairy products make up a large portion of the total imports (see Table A3-10). Belize has the capacity of producing the majority of these items for both internal consumption and export (production areas shown in Figure 10). Realizing this, the Government has spent much effort in creating a development plan which sets
Figure 10

ECONOMIC PRODUCE
forth progressive guidelines for increasing agricultural output.

Small farmers will probably produce food for the local market, while large scale farm operations will continue to supply the export demand. Because of the normally unstable world market, exporters of fresh vegetables have never been successful. Large operations in the Belize River Valley and near Big Creek (south of Stann Creek) have made attempts to export farm produce (this export is shown in Table A3-9), but the farms ran into financial difficulties after only a few years operation. The producers of cucumbers in the Belize River Valley constructed a port southwest of Belize City (located on Figure 35) in order to facilitate the shipment of their produce. The port also served as the facility for bulk fertilizer unloading and as the loading point for packaged meat, which was also being exported at the time. Since the cessation of the cucumber operation; however, the port has been idle and is now in need of dredging and minor repairs.

The Sugar Industry

The production of sugar in Belize is taking a commanding role in the country's economic development. In 1972 sugar and molasses accounted for approximately 88% of the total national export by weight. Quick to realize the economic importance of the sugar industry to national development, the government of Belize has taken major steps to aid in the future growth of the industry and to provide assistance in helping increase production yields.

Next to logging the production of sugar and sugar products is the
oldest industry in Belize. Introduced to northern Belize in 1848 by the
refugees of the Yucatan Indian Wars, the sugar industry was the first
attempt within the country to develop local agriculture to anything above
a subsistence level. The logging industry welcomed the Yucatan immigrants,
as their farm produce provided a needed alternative to the necessity of
imported food for the lumbermen. Agriculture in the northern districts
then gained a strong footing by producing both foodstuffs for the local
market supplied by the timber industry and sugar and rum for export.

The sugar market itself has suffered a series of highs and lows
throughout its history. British investments in the industry were first
made in the 1860's. It was during this period that the sugar estates were
formed and with them came the introduction of more efficient machinery to
process the sugar. In the 1870's and 1880's competition from the sugar
beet forced the industry into a decline. After reaching a peak export
production of 1,100 tons in 1882, the industry was reduced to supplying
only the local markets.

In the 1930's the industry was revived. The estates located in
Corozal once again started cane processing. The decline of the previous
years had proven disastrous to the estates; however, and they soon found
themselves incapable of meeting their production quotas. The primary
reason for this was the lack of local labor for the cane harvests. Since
the farmers of the region preferred milpa farming (the traditional method
of slash and burn farming) and land ownership to employment by the estates,
the inability of the estates to find enough labor to harvest their cane
became a serious problem.

Unaffected by the labor problems which plagued the estates, the small
farmers soon became the major producers of sugar cane. Generally farming only for subsistence or to supply a limited local market, the small farmers soon found that cane growing provided a cash crop to augment their income. As the large sugar estates continued to have cane production problems, the small farmer became the primary supply source. The sugar industry continued to grow steadily.

In 1951 Belize joined the Commonwealth Sugar Agreement, which guaranteed Belize sugar producers a portion of the British quota at favored prices. In 1953 the Libertad factory (located at Pembroke Hall, see Figure 11) was reequipped for greater production. During the early 1960's the government change in Cuba caused the United States to search for new sugar suppliers, and Belize then received a portion of the U. S. quota.

Production increased in the late 1960's when the existing processing facilities were bought out by a British firm. The new company, Belize Sugar Industries, then became responsible for meeting the quotas granted to Belize by Britain, Canada and the United States. The output of the Libertad factory was increased to 40,000 tons annually and a new factory capable of producing up to 100,000 tons annually was built at Tower Hill near Orange Walk Town (see Figure 11). Figure 12 shows how the production has increased over the last twenty years. Increased quotas along with the introduction of modern production techniques would almost insure that the sugar industry in Belize will continue to experience a steady growth.

Once sugar cane is cut it becomes stale very quickly, especially if the cane field has been recently burned. Traditionally, the sugar refineries and cane fields were located in close proximity in order to minimize the delivery time. Since both factories in Belize are capable of increasing
Figure 12
TOTAL SUGAR PRODUCTION 1955-75

Source: Agriculture Department and 1974 Deep Water Port Study Update
their production when necessary, it is doubtful that there will be plans for the construction of any new factories until far into the future. Instead, the cane fields will be forced to extend farther from the factory in order to find suitable farmland. The opening of new lands will require a feeder road system of high quality in order to provide efficient movement of cane. Realizing the importance of the growth of the sugar industry to the economic development of Belize, the government has begun an extensive program of feeder road construction throughout the production area.

The movement of the refined sugar and molasses to the location where the ships are eventually loaded involves barge transport and, depending on the production, intermediate storage in Belize City. Both refineries are situated on the New River and maintain complete barge loading and maintenance facilities. During the refining season, the barges loaded with the refined sugar or molasses are gathered at the mouth of the New River. When a sufficient number of barges are collected they are moved to the Belize Harbor where they are moored. They usually wait loaded until the ship arrives to receive the cargo. In periods of heavy production the sugar is often stored in the Belize City sugar warehouse (located on Figure 26) in order to free the barges for continued use. Figure 13 shows the existing sugar warehouse located in Belize City.

Although sugar production was also attempted in the Toledo District during the late 1800's, it never survived the decline suffered at the turn of the century. Because of the limited amount of suitable land and the difficulty of constructing feeder roads, there is little reason to assume that the southern district will become actively involved in sugar production.
New developments in the production of ethanol (alcohol) from plant carbohydrates could provide the basis for an alternative industry based on the processing of sugar cane. Sucrose, the sugar produced from cane, can easily be converted to alcohol by fermentation.

"Sugar cane is the most efficient natural quantum [energy from sunlight] converter we know today that both collects and stores the energy in a relatively useful form, with a conversion efficiency to sucrose of about 0.25%, which is very good for a field crop". (21)

If the cane is converted directly to alcohol; however, the yield is even higher.

"If the final product, however, is alcohol instead of sugar, and the cellulose is also used, the apparent yield will increase, with a solar energy efficiency conversion of over 1%". (21)

The alcohol produced from sugar cane is already becoming an important
source of fuel in Brazil, the leading sugar producer in the world. Originally produced only from the molasses, the Brazilian government is now providing an incentive for increased alcohol production as a primary product. Brazil not only uses the alcohol for industrial purposes, but it also serves as an excellent gasoline extender. The goal of Brazil is to raise the average alcohol content of gasoline to 10% by 1980.

The economics of alcohol production are gradually turning to carbohydrate fermentation as a source of supply.

"Because the price of ethylene made from petroleum was only about 6 cents/kg from 1950 to 1970, it did not pay to make alcohol from anything else. With the price of ethylene from petroleum today standing at approximately 28 cents/kg and projected to rise to 40 cents/kg in the near future, it again seems feasible to make ethylene from alcohol, at least in parts of the world where the raw materials are available in large quantities at a relatively low cost."(21)

The process of alcohol production from sugar cane is one that seems well suited to Belize. In the area around Punta Gorda where sugar cane is well suited, but not economically feasible for the construction of an entire sugar refinery, the cane could be used totally for alcohol production. This process requires only juice extraction and fermentation so the need for an expensive refining process is reduced.

**Citrus Production**

Situated primarily in the Stann Creek Valley (Figure 14), the citrus industry provides export products amounting to about 7% of the total exports by weight. Nearly all of the citrus that is grown is sold to the two foreign owned processing plants located near the village of Pomona in the Valley. Only about 2½% of all the fruit grown goes to the local market as
Figure 14
CITRUS and BANANA PRODUCING AREAS

Scale 0 1 2 3 4 5 Miles
fresh fruit, and about 1% is exported to Mexico. The remaining 96.5% is processed into frozen orange juice concentrate or canned juice and segments. Since its beginning in 1913, the citrus industry has progressed steadily. When the bananas were destroyed by disease and the cocoa trees by hurricane the farmers of the Valley turned almost completely to citrus production. Exact figures relating to the amount of citrus produced and the capacity of either of the two factories are difficult to obtain. Figure 15 shows how production has increased over the last 19 years, but statistics showing what per cent of the possible production that this represents are not available.

Of the estimated 9000 acres of citrus trees in Belize, 7000 are located in the Stann Creek Valley. The remaining acreage is scattered, some being around San Ignacio and other elsewhere in the Belize and Sibun River Valleys.

The poor quality of road that links the Stann Creek Valley with the Belize and Sibun River Valleys (the Hummingbird Highway) prevents large scale citrus production outside the Stann Creek Valley area. Although both the Belize and Sibun River Valleys are well suited to citrus production, the poor accessibility to the processing plants makes large scale groves in those areas impractical.

An alternative to transporting the fruit from the locations in the Belize or Sibun River Valleys would be the construction of a third processing plant, probably somewhere near Belmopan. Economics presently prevent this, however, since it would take approximately 5000 acres of citrus to justify the construction of a new plant. Another factor limiting the increase in
WEIGHT:
- GRAPEFRUIT: 80 LBS/BOX
- ORANGES: 90 LBS/BOX

SOURCE: BOWMAN

Figure 15

TOTAL CITRUS PRODUCTION 1956-74
citrus farming outside the Stann Creek Valley is the labor shortage. The cost for picking and transportation in the Stann Creek area is approximately $0.08 per box, but outside the Valley labor is presently not assured at any reasonable price.

The processed citrus and by-products are exported to Britain and Canada. Exportation of the products involves truck transfer to Commerce Bight pier where it is lightered to the waiting ships anchored a short distance offshore. Since most of the export is packaged, this lighterage process gives little problem other than the inconvenience of the intermediate transfer.

Other Important Agricultural Commodities

Other agricultural interests that show a potential for development in Belize include the production of bananas, mangoes, rice and processed beef. Except for beef processing, successful attempts are being made at increasing the yield in each of these areas. Although cattle production is also increasing, the lack of a proper abattior and packing plant has prevented the processing of beef for export.

The production of bananas takes place in the area south of Stann Creek around Cow Pen and Big Creek (see Figure 14). The 1964-70 Development Plan has listed these regions as potential banana producing areas:

<table>
<thead>
<tr>
<th>Region</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Stann Creek</td>
<td>5,000</td>
</tr>
<tr>
<td>Waha Leaf</td>
<td>2,000</td>
</tr>
<tr>
<td>Monkey River</td>
<td>35,000</td>
</tr>
<tr>
<td>Moho River</td>
<td>3,000</td>
</tr>
<tr>
<td>Temash</td>
<td>2,000</td>
</tr>
</tbody>
</table>
Transportation is presently one of the major reasons why banana production in Belize is not developing as fast as could be expected. Improper port facilities for shipping bananas has often resulted in the loss of fruit. On notice of the arrival of a banana ship the bananas must be cut, packaged and transported to the loading pier. In some instances the ship leaves before the loading is completed and the fruit is left.

The production of mangoes faces much the same problem with transportation. Besides transportation problems, the mangoes must go through quarantine and fumigation before they can be shipped to the U. S. as fresh fruit. Presently, the mangoes that are grown in the area south of Stann Creek are shipped to Mexico where they are treated and then reshipped to the U. S. The difficulties with fresh fruit shipments and the fact that mangoes grown to sell as fresh fruit are often lost when they ripen too soon will probably prompt the construction of a processing and canning plant in the southern region. If this becomes the case, transportation problems will no longer be as critical, since the processed mangoes can then be shipped in the same manner as processed citrus.

Rice production in the Belize River Valley at Big Falls has increased due to mechanized farming techniques. The majority of the rice produced previously came from the Toledo District, but the antiquated farming methods and lack of proper drying and storage facilities limited production in that area. The government has made attempts at trying to mechanize the farms in the South, and future plans include the construction of dryers and storage facilities for that region. In the event that the proposed deep water port is located in Belize City rice will probably serve as one of the major export items loaded through that port.
Processed meat, primarily beef, will probably be shipped through Belize City also. Once cattle production has reached a sufficient level to warrant mass processing for export, plans will be made for proper processing and shipping facilities to be constructed. The U. N. Economic Survey Mission suggested in the 1964-70 Development Plan that the production of beef for export will hold a major role in the future development of Belize.

Summary

The two major points brought forth in this section were the physical ruggedness of the country and the dependence of the national economy on agricultural production.

The physical characteristics of the country act as a natural deterrent to internal transportation with the coastal region offering the greatest problems. Poor soil characteristics and uncontrolled flooding increase the cost of road construction far beyond a feasible limit. Although the mountainous regions also hinder development, initial construction and maintenance costs are considerably less than those for the coastal region.

The lack of natural resources has forced Belize to turn to agriculture as the base for a national economy. Sugar and citrus are supplying most of the export commodities, but there is no indication that the export market should be limited to these items. The areas most favorable to agricultural purposes lie inland and many thousand acres of potential farmland remain completely inaccessible. In the interest of increased national production it is imperative that access to these lands be provided.
The HISTORICAL DEVELOPMENT of TRANSPORTATION in BELIZE
The Early Maya

When Columbus on his final voyage sailed into the Gulf of Honduras he was the first European to witness the high degree of development among the coastal inhabitants.

"Soon a great native trading dugout appeared carrying a large number of rowers and women and children passengers. An Indian of superior mien was in charge. The natives were dressed in excellently woven cotton, and the canoe carried well wrought articles which figured in the highly developed trade of the region..."(23)

The sophistication of the local population strengthened Columbus' hopes that he was finally nearing his primary goal. Although this was not the case, his voyage did provide a record showing to what degree the natives had advanced in trade and transport before the arrival of the first Europeans.

Actually, the natives that Columbus had met along the Bay coast were probably only the scattered remains of the once great Maya nation that had ruled the area from Honduras through the lower Mexico region centuries before. Over the span of years from about 1500 B. C. until the arrival of the first Spanish conquistadores in the early 1500's A. D. the Maya developed, flourished and declined. During this time; however, they managed to develop a system of hieroglyphic writing, a number system that included a zero, engineering skills and a trading relationship with the rest of the surrounding communities. They also discovered the process of dye extraction from the logwood tree; a discovery that would play an important role in the settlement of Belize centuries later.
Although little is known about early trade and transportation among the Maya, the fact that it did exist is generally accepted. Tools made from obsidian, common in the Guatemala highlands, have been found throughout the Belize lowlands as well as other parts of the Maya territory. Jade is another stone that is found in almost every area inhabited by the Maya yet its only source is isolated areas in Guatemala.

The movement of these items involved overland transport through rugged terrain and dense vegetation. This transport was carried out when possible by river travel; otherwise, runners were employed. The fact that the Maya never discovered the use of the wheel or utilized beasts of burden for transport purposes was a great drawback in the development of their overland transportation system. Eventhough these discoveries were never made, Maya engineers designed and constructed causeways and roads leading to major centers. The longest Maya road discovered lies between Coba and Yaxuna in the Yucatan. This 62 mile road was contructed through swamp and dense bush and at almost a constant level grade for the entire distance. Dobson states, "It is possible that the roads were first built as proces-sional ways, but Coba is the centre of a network of roads which must have been used for more normal purposes of trade". (28) Not only did trade exist between neighboring Maya communities, but also between the Maya and the Indians of North America. Runners from areas in what is now Northern Mexico and the Southwestern United States were employed to bring the prized feather of the Quetzal bird from Central America.

The decline of the Classic Period of the Maya, around 900 A. D., is noted by the migration of the Maya people from the Peten area in Guatemala to the Yucatan Peninsula. It is during the years that followed this
resettlement that coastal trading reached its height. Trading dugouts plied the coastal waters between the cities of the Northern Yucatan and the coastal villages of Honduras. There is little doubt that this new development in trade helped emphasize the strategic location of the area that is now Belize. The offshore barrier reef provided smooth coastal waters and safe anchorage for the large trading dugouts, and the coastal villages were in a position to trade such commodities as food and fresh water for a portion of the trade items carried by the travelers.

Early European Beginnings

When the Spanish first came to conquer the Yucatan in 1517 they found a disjointed Maya Empire that was segregated into factions and marked by tyranny. The Spanish made little attempt to completely subdue the Central American territory, since their main interests lay in the gold of Mexico and Peru. After their exploration revealed that this area contained no water passage between the Atlantic and Pacific Oceans it was left mostly to scattered colonial settlements.

The people who held a great interest in the Belize coast; however, were the English buccaneers and pirates. For them the protected and mostly uninhabited coast provided the ideal shelter from which they could venture out to raid the Spanish fleets carrying gold from Panama and Mexico to Cuba. The natural barrier reef gave them the protection that they needed from both foul weather and the revengeful Spanish.

The position of the English during the 16th and 17th centuries was based on their mobility and hit-and-run tactics. During the 1600's as
the Spanish gold shipments began to decline, the English turned to raiding the Spanish logwood settlements along the Yucatan coast. When the English buccaneers became aware of the value of logwood, which during this time was the base for all black, grey, purple and dark red dyes used in Europe, permanent English logwood settlements sprang up along the coast of the Bay of Honduras. Thus, the onetime pirates and buccaneers gradually became settlers and woodcutters.

The Spanish never recognized their new neighbors as rightful owners of the Belize coast, and as a result, there was constant rivalry between the two nationalities. This often led to the expulsion of the British settlers, but they inevitably returned and were eventually granted logging concessions between the Rio Hondo and the Sibun River.

By 1660 the small English settlement at the mouth of the Belize River was shaping into a town. The coastal stands of logwood trees were being exhausted so now the settlers were turning to the large stands of mahogany that grew along the river banks. Internal development of the colony during this period relied entirely on river transportation. Settlements grew up along the northern rivers where good access to the interior was available. The mahogany trees were cut during the dry season and then, when the wet season rains flooded the low areas, the trees were floated down the rivers to the sea where they were loaded onto ships for export.

Because the mahogany export proved to be so lucrative, little was done during this period to expand any large scale agricultural activities. Instead, the economy remained centered entirely around the export of timber; therefore, the only settlements in Belize were the town of Belize and small scattered logging camps located along the rivers.
The Rise and Decline of Belize As a Trading Center

After Central American independence from Spain in 1821, the role of Belize City in regional affairs was increased. This predominance hinged around the refusal of the British government to recognize the newly formed and unstable Central American governments. With no diplomatic relations between Britain and the governments of Central America, hence no commercial treaties, Belize City became the region's only reasonable wholesale outlet for the much needed European industrial products being shipped out of Britain.

1849 proved to be the beginning of the end; however, for the privileged trading position that Belize had enjoyed for the first half of the century. First, Britain opened diplomatic relations with Central America, thus giving British trading companies in those countries a firm position on which to establish direct trade agreements. Now British trade could by-pass the British port in Belize and enter directly through ports in Guatemala and Honduras.

The only event that could have been any more devastating for the already deteriorating trade in Belize had its foundations in the same year. The discovery of gold in the United States territory of California brought about an immediate demand for an Atlantic-Pacific connection. This connection was made in 1855 with the Panama Railway, and now a once impractical Pacific trade began to flourish.

These were hard times for the merchants of Belize. Since Belize itself could not consume any large amount of import items, most of the cargo ships from the United States and Europe sailed by the small British port in
favor of the Panama connection to the Pacific. Not only did the residents have to worry about their financial security, but the Indian revolt taking place in the Yucatan during this period posed an additional threat to their personal security. Thousands of refugees fled the Mexican Yucatan to the country south of the Rio Hondo where British authority had managed to maintain a more stable peace with the Indians. With them they brought the beginnings of a sugar industry so that by the latter part of the 1850's sugar and rum production had gained a footing in the Belize economy.

The 1859 Anglo-Guatemalan Treaty

In 1859 the governments of Britain and Guatemala finalized a boundary treaty for the territory to be called British Honduras. These boundary descriptions as stated in the opening section were regarded by the Guatemalan government to be a cession of land, since the British had no legal claim to any land below the Sibun River. However, the British had previously signed the Clayton-Bulwer Treaty with the United States, which in effect stated that no European nation could acquire additional land on the American continent, and any cession of land by Guatemala to Britain would be a violation of this treaty.

In order to get around this fine point of international law, Article 7 was written into the 1859 treaty. This article, which was later to serve as the cornerstone for Guatemala's claim to the entirety of Belize, states:

"With the object of practically carrying out the views set forth in the preamble of the convention for improving and perpetuating the friendly relations which at present so happily exist between the two high contracting parties, they mutually agree conjointly, to use their best efforts by taking adequate means for establishing the easiest communication (either
by means of a cart road, or employing the rivers, or both
united according to the opinion of the surveying engineers)
between the fittest place on the Atlantic coast near the
settlement of Belize and the capital of Guatemala; whereby
the commerce of England on the one hand, and the material
prosperity of the Republic on the other, cannot fail to be
sensibly increased, at the same time that the limits of the
two countries being now clearly defined, all further en¬
croachments by either party on the territory of the other
will be effectually checked and prevented for the future" . (33)

Guatemala has always contended that this article was added to the treaty
to compensate for the loss of territory, while Britain states that by its
own wording it was intended for the mutual benefit of both countries.

Whatever the original intent might have been, the representatives of
British Honduras failed to see what benefit they might gain from a trans¬
portation route connecting the Atlantic coast with the Guatemalan capital.
In fact, if the surveying engineers had chosen a route connecting one of
the Guatemalan ports to the capital as being the most practical, Belize
would have lost what little remaining trade they had left. As a result,
the route never materialized. Instead, the following years produced noth¬
ing more than a series of partial surveys, proposed compromises, diplomatic
delays and rebuttals.

The Last Half of the 19th Century

In the meantime the trade through Belize continued to diminish. This
seemed to be the continuing state of affairs until salvation appeared in
the form of the United States Civil War. The Southern States were placed
under a blockade by the Union forces that prevented both the South from
receiving the necessary munitions for waging war and England from receiving
the cotton that they needed to supply their growing textile industry.
The merchants of Belize were well trained in the area of illegal trade from having lived under tight Spanish controls for so many years, and with the imposition of the Union blockade they went into immediate action. Munitions left Belize Harbor on a regular basis destined for the Mexican port of Matamoros where they were then exchanged for Southern cotton. Once again the merchants of Belize provided the nucleus around which a profitable trade developed.

The federal government of the United States also realized the role Belize could play in supplying the Southern army and immediately sent a diplomatic agent to the colonial capital. Although the first agent was fully aware of the extent to which Belize was involved in the contraband trade; he lacked the diplomatic personality required to halt the action. He was soon replaced by a more "persuasive" agent who, through a series of well timed demands, was able to curtail the illegal trade.

Belize then returned to their former position; that of a small, out-of-the-way port for which no trading companies could really find a profitable use. Although they had gained the formal status of British colony in 1862, this did little to change their economic condition. Export trade was still centered around the mahogany industry with little being done to advance alternative forms of commercial production.

"By the end of 1865 the economic decline of British Honduras reached a crisis". The mahogany stands were being depleted and agriculture, except for a small amount of sugar production in the north, was for subsistence only. The only hope for a steady recovery in the economy was in immigration, primarily of refugees from the war torn Southern States. The colonial government realized the seriousness of the situation and set out
to attract immigrants. At this point; however, it seems that greed got the better of the local land owners. When the immigrants arrived they were heartily welcomed, but when they tried to buy land they found it all, including government owned land, priced at five dollars per acre. Considering that other developing countries of the region were offering free land to immigrants, the outcome for Belize was predictable—no immigrants, no new development. In fact the cheap land prices in neighboring countries even lured away some of the established residents of Belize. Eventually, the land prices were made more competitive and immigrants came to Belize, but for other reasons many of these soon drifted away.

The development of transportation in Belize during the last half of the 19th century centered around two aspects. One of these was the establishment of trade with the United States, and the other was the proposed construction of a railway connecting Belize with the rest of Central America. The construction of roads leading into the interior received little attention during this time.

The establishment of trade with the U. S. was a simple matter based on the rerouting of the government subsidized mail packet through New Orleans instead of Jamaica. This arrangement was tried just after the Civil War and proved to be both efficient and more economical. The establishment of a scheduled mail shipment between the U. S. and British Honduras was the basis for a gradually expanding trade between the two countries. This new increase in trade was short lived, however, since for political reasons the mail was rerouted back through Jamaica in 1872. This move produced a drastic cut back in the number of ships that visited Belize so that, "The six year period ending in 1872 thus appeared to some to end with a backward step in the field of transportation". (24)
The volume of trade handled by Belize merchants continued to decline through the 1870's, but trade with the U. S. gradually increased. It appears that the trade which continued to go through Belize during this period did so not of necessity, but because of shrewd business maneuvers practiced by the local merchants. With the return of sound governmental leadership to Belize in the late 1870's came the return of the mail route through New Orleans, the abolition of the excise tax on sugar and an increased interest by large fruit companies in the development of banana plantations in Belize. This increase in the production of bananas in Belize was a direct result of the reestablished mail route which assured a scheduled shipping line between Belize and New Orleans. Belize thus enjoyed another short lived prosperity that faded when the banana markets became glutted a few years later.

Belize remained in a general depression during the 1880's. The timber, banana and sugar markets were all suffering, and to make matters even worse the new government proved to be both incapable and irresponsible. The port of Belize had been reduced to a depot for goods in transit, and the merchants were fast realizing that internal improvements and development were becoming imperative if the economy was to revive.

One remedy for the decaying economy seemed to lie in the construction of a railroad linking Belize City to the interior of the country and to the already established Guatemalan railroad between Puerto Barrios and Guatemala City. This would not only open new lands for development, but it would also establish a new network of trade routes between Belize and the rest of the Central American countries. In 1884 Walter Regan, a promoter from the United States, made a railroad construction proposal to the Belize Government
that appeared to many to be the answer to most of their problems. Regan presented to the government a seven point proposal:

1. To construct a railroad starting from Yarborough bridge [southside of Belize City] taking a southwest direction to the Republic of Guatemala.

2. For which he asked for a grant of 12,800 acres of land per mile, along with sufficient crown land in or near the town of Belize for depots, sidings, etc.

3. The right to construct a lateral line from the main line (without more concessions) to the Hondo and Sarstoon Rivers.

4. That the title to the conceded lands be granted on the completion of each 10 miles of road.

5. That property of the railroad company be free from taxation for 35 years.

6. That if the construction of the road be not commenced within one year of the making of the concessions, these shall be forfeited.

7. That the work be completed within 4 years after the making of the concession under a penalty of $10,000 per annum for each and every year in excess of that period.

It appeared that Belize had a lot to gain and little to lose from such a proposal, especially since most of the land concessions were to come from government owned lands.

Political indecision and greed again emerged as a stumbling block in the development of Belize. In London the British government had neither the time nor the desire to involve themselves with the Belize railroad. In addition they seemed uncertain whether to approve any railroad scheme unless they were definitely sure that it satisfied the provision called for in the 1859 treaty with Guatemala. On the home front the proposal met opposition from another source.

"...Mr. Henry Fowler, the colonial secretary and interim administrator of the colony...personally blocked the Regan proposal when a preliminary survey convinced Regan that the
southwesterly route was more promising than the other a
Belize City-Peten route. Fowler held large tracts of land
around El Cayo [San Ignacio] the value of which would in-
crease several times over if the railroad passed near them".(24)

As a result, the proposal was never accepted, and again a much needed devel-
opment was thwarted.

Alternative proposals for a national railroad continued to appear
throughout the latter part of the 19th century, but solid backing for any
one proposal failed to materialize. In 1892 a light railway opened in the
Stann Creek Valley extending from the Commerce Bight Pier to Melinda and
later to Middlesex. Built by a private concern to facilitate in the banana
industry, the railroad gave immediate rise to increased development through-
out the valley. The effect that this short 16 mile segment of light rail-
way had on agricultural development might have been expected to inspire
additional railway construction, but nothing more than new proposals ever
resulted.

1900 to Present

"'Neither roads nor a road system exists. Land communications,
so far as it can be affected, has to depend today, as it had to,
doubtless, generations ago, on mahogany truck and wing paths,
on logwood 'picados' [machete clearances in the forest to bring
out logwood to roads by mule or donkey], and on the primitive
forest tracks that are utilized to connect such truck paths'".(1)

This description of Belize was printed in the official colonial report of
1891 and apparently accurately describes the condition of transportation
at the turn of the century.

The decline of the banana industry due to Panama disease in the first
decade of the century ended the short career of the banana plantations in
the Stann Creek Valley. In 1940 the railroad that had served the valley and Commerce Bight pier was removed and relocated in the northwestern mahogany forests between Hill Bank and Gallon Jug. The old right-of-way was then converted into a road linking Middlesex to Stann Creek Town.

The absence of any semblance of a road system during the early 1900's seriously disrupted any attempts at agricultural improvement. Poor transportation resulted in high prices for agricultural products by boosting production and marketing costs. In 1928 the Burdon Canal was opened connecting the Sibun River to Haulover Creek near Belize City. This was one of the first major steps in providing adequate transportation for agricultural purposes (other than the previously mentioned railroad in the Stann Creek Valley which was privately built) by giving the farmers in the Sibun River Valley safe and convenient access to the markets of Belize City.

The first serious attempt at improved transportation was initiated in the 1930's with the construction of highways connecting Belize City to Orange Walk, Corozal and Cayo. In 1954 the Stann Creek Valley road was extended to Roaring Creek where it joined with the Belize-Cayo highway. The most recent major road to be finished was the Stann Creek to Punta Gorda route which is still undergoing much needed improvements.

The ports and harbors situation has undergone little change since the beginning of Belize as a settlement. Belize City still remains the major port of entry and the disembarkation point for nearly all of the imported items. The mouth of Haulover Creek, which has always served as the port location, still acts as the receiving point for all imports (except petroleum products). Since water depth in the creek mouth is not sufficient for deep draft vessels, lighters must be employed to carry the goods from the
freighters moored in the harbor to the government wharf.

In 1922 the lighter wharf was completely rebuilt. A concrete sheet pile bulkhead was constructed and the area behind the wall completely filled. The wharf side channel was dredged to 8 to 9 feet and provided berthing for approximately 1600 feet. Although much of the channel has silted in, the bulkhead sheet piling remains in good condition.

In 1908 a 400 foot timber pier was built at Commerce Bight to serve the banana industry. The pierhead was replaced in 1917 by a concrete structure which remained in use until the timber approach trestle was destroyed by the 1942 hurricane. Because of the war and the dying banana trade, the pier was never rebuilt.

The fastest growing transportation development in Belize has been the air service. Major airlines visit Belize International Airport on a daily basis, providing Belize with immediate accessibility to the rest of the American continent. Light planes also serve an important role in local travel and communications. Airplane service is available to remote areas, some of which are still inaccessible by road.

The connection of Belize to the rest of Central America by road has been, until very recently, almost impossible. Although the Belize-Corozal road opened up the Mexican frontier and gave access to Chetumal, Chetumal has been traditionally an isolated community. The completion of the Yucatan road from Escarcega to Chetumal in the late 1960's connected Chetumal with the Mexican highway network and also provided an outlet for Belize. This development has made vehicular travel from the United States to Belize on paved roads possible.
The approach to Belize from Guatemala has undergone tremendous improvement, although its quality is not nearly as good as that of the Mexican route. Guatemala has, since 1960, had a road network in the Peten that connected with that of Belize. It was only recently; however, that Guatemala managed to connect the Peten road system to the rest of the national network. Before this connection an overland trip from Belize to Guatemala City involved a hazardous barge trip down the Sarstoon River which, although sometimes exciting, proved to be anything but convenient.

Summary

The historical development of transportation in Belize emphasizes four obvious "lacks" in transportation:

1. The lack of inland roads.
2. The lack of railroads.
3. The lack of international connections.
4. The lack of determination by the residents to push for internal transportation development.
The PRESENT STATUS of TRANSPORTATION in BELIZE
Regional Transportation

Regional transportation in the Central American area around Belize is concerned mostly with the highway network, as rail transport throughout the region is limited (see Figure 16). Figure 16 also shows the major highways that serve the Yucatan, Belize and Guatemala. Of these the poorest quality roads are in Belize and the Peten region of Guatemala.

The most serious drawback to the existing system lies in the inability of vehicles to move conveniently between the Yucatan and Guatemala City. In order to get from the Yucatan to Guatemala City either the traveler must tackle the rugged roads of Belize and the Peten, or they must go hundreds of miles out of the way in order to stay on paved roads.

Air transport is presently the primary means of regional transport. Regular flights between points in Honduras, Guatemala, El Salvador and Belize provide the most comfortable and convenient means of travel within the region. The alternative to air transport for mass transportation is the bus service. Although travel by this method is far less expensive, it is most often grueling at best.

Roads

At present the national road system includes a series of main roads, feeder roads, forest roads and bush trails. The main roads are those
Figure 16
REGIONAL TRANSPORTATION ROUTES

HIGHWAY
RAILROAD
connecting the major urban centers of the country. The Northern Highway connects Belize City, Orange Walk Town and Corozal Town and then extends to the Mexican border at Chetumal. The Western Highway runs from Belize City to Belmopan and then to San Ignacio and the Guatemalan frontier. From Belmopan the Hummingbird Highway extends to Stann Creek where it joins the Southern Highway connecting to Punta Gorda. Except for the Southern Highway all of the main roads are generally passable throughout the year; however, excessive flooding may render sections of the roads temporarily closed. The Southern Highway is more prone to washouts and flooding due to the heavy rainfall occurring in the area and the rapid runoff from the Maya Mountains.

Feeder roads are built primarily to give access to the scattered villages and to open for development previously inaccessible agricultural land. With the expanding sugar industry providing a new boost to the Belize economy more effort is being made to provide good all weather feeder roads to the potential sugar producing areas. Nearly all of the feeder roads are surfaced, usually with gravel or marl (a calcareous clay), and are maintained to a reasonable extent.

The bush trails are generally of poor quality and built, usually, as a means of removing felled timber from the interior forests. Often only usable during the dry season, these roads are seldom maintained and many revert to bush as the traffic is often insufficient to keep them free of growth. Forest roads are generally of better quality than the bush trails. These roads were built by the Forestry Department of Belize in areas where the danger of spreading forest fires existed. The area where these roads are most noticable is the Mountain Pine Ridge region west of the Maya Mountains.
Table 8 gives an idea as to the present quantity of roads in Belize.

<table>
<thead>
<tr>
<th>District</th>
<th>Hard Top</th>
<th>Improved</th>
<th>Unimproved</th>
<th>Total Milage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corozal</td>
<td>24</td>
<td>130</td>
<td>30</td>
<td>184</td>
</tr>
<tr>
<td>Orange Walk</td>
<td>18</td>
<td>127</td>
<td>19</td>
<td>164</td>
</tr>
<tr>
<td>Belize</td>
<td>78</td>
<td>64</td>
<td>75</td>
<td>217</td>
</tr>
<tr>
<td>Cayo</td>
<td>7</td>
<td>44</td>
<td>15</td>
<td>66</td>
</tr>
<tr>
<td>Stann Creek</td>
<td>39</td>
<td>144</td>
<td>33</td>
<td>186</td>
</tr>
<tr>
<td>Toledo</td>
<td>None</td>
<td>83</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>Belmopan</td>
<td>18</td>
<td>21</td>
<td>10</td>
<td>49</td>
</tr>
</tbody>
</table>

Source: Government of Belize (5)

"'The alignment of most of the roads are poor and sight distances on both horizontal and vertical curves are inadequate. The embankments are rather low and the formation widths are narrow in certain sections and excessive in some sections. Certain sections of roads in swampy areas are continually sinking and the surfaces are deteriorating too quickly with the result that the cost of maintaining these roads is rather high. The low bearing capacity of the soils available for the construction of road embankments in the coastal plains is mainly responsible for the poor performance of roads in the areas.... An example of a road having too many curves is the Northern Highway. It appears that this road was constructed along the old mule path and, as a result, this road has too many dangerous curves.... The quality of service is rather poor to provide satisfactory service to the people using the roads. The road pavements are not strong enough to sustain the ever increasing wheel loads on the roads with the result that the pavements fail at many places and the transportation costs increase on account of the heavy maintenance and replacement costs of vehicles, as these have to operate on rough roads". (18)
This comment on the condition of the roads in Belize was made by the U. N. Economic Survey Mission and does an adequate job of summing up the present situation. Although continuous improvements are being made to the existing road system, it seems to many that they are merely moving the holes to different locations. Actually, the need for road improvement far overshadows the means, and to simply bring the total highway system up to what might be considered "adequate" would require massive amounts of capital and labor.

Figures 17, 18, 19 and 20 are only representative of a small portion of the actual length of each of the major highways. For example the portion of the Western Highway between Belize City and Roaring Creek has recently been rebuilt and is at present the best section of road in Belize. On the other hand the portion of the same highway near Benque Viejo (Figure 18) is still surfaced only with gravel.

Ferry crossings on the major rivers are still widely used, especially along the Belize and New Rivers where river widths would make bridge construction costly and in some cases impractical. Figures 21 and 22 represent typical ferry crossings. Other ferry crossings occur along the Belize River and are located at Soccoths, Bermudian Landing and Burrel Boom.

A new concept in bridge construction in Belize is currently being tried at the New River ferry crossing at Orange Walk Town. There the existing ferry will be incorporated into a new bridge crossing. Because of the heavy sugar barge activity along the New River, the ferry must be capable of being swung clear of the main channel. If this prototype proves successful it is possible that variations of the same design can be applied to the other ferry crossings, thus eliminating the need for manned crossing facilities.
Figure 17

The Northern Highway Near Corozal Town

Figure 18

The Western Highway Near Benque Viejo
Figure 19

The Southern Highway at Waha Leaf Creek

Figure 20

The Hummingbird Highway Near the Sibun River
Figure 21
Ferry Across the Belize River at Baking Pot

Figure 22
Ferry Across the New River at Orange Walk
Future Road Developments

The stated objectives of the government policy for the continued improvements to the national road system are:

1. Open up new agricultural lands;

2. Improve the existing main road access between the principal areas, and links with the ports and with neighboring countries; and

3. Provide feeder links from productive areas and settlements with the main roads. (8)

To accomplish these objectives the government plans to widen and resurface the Western Highway, construct a gravel road between Roaring Creek and Orange Walk Town, strengthen and realign the Northern Highway, resurface the Hummingbird Highway and construct feeder roads in the more productive agricultural areas. Improvements to the Southern Highway will be limited to the construction of bridges necessary to ensure that the road remains passable throughout the year. In addition the government plans to construct bridges over the Belize River at Burrell Boom and Bermudian Landing and over the New River at Orange Walk Town.

The Belize government, in association with the British Ministry of Overseas Development, had road improvement studies made for section B of the Northern Highway as shown in Figure 23 and the section of the Western Highway from Belmopan to the Guatemalan border. Work has already begun on the Northern Highway, which includes the rerouting of a portion of the highway. The new route is shown in Figure 23.

The British government was responsible for the reconstruction of the Western Highway between Belize City and Belmopan. Although this section of road is presently the best in the country, its design quality is far from
SECTION B
NORTHERN HIGHWAY

Proposed Relocation of Northern Highway

Figure 23
what might be expected. The reduced quality of the road results mostly from the failure of the design engineers to allow for any cut areas in the cross section. Instead, the road was built only on the natural surface or filled areas. Borrow pits along the highway give evidence that great quantities of fill were required. The failure to cut small hills in order to fill adjacent valleys resulted in small hills scattered along the highway. These hills now pose definite problems in sight distance, and on a road that has no median stripe or caution signs a good sight distance is critical. In a country where two ton trucks and buses are the maximum loading criteria, pavement design is not as important as a design based on proper safety considerations.

Review of the Western Highway Road Survey

Appendix 5 is a reprint of the Western Highway Road Study (Reference 5). The study contains a survey of the existing road conditions, soil investigations, traffic studies, road design, cost estimates and an economic analysis. In general the study is thorough and seems to satisfy the criteria as set forth in Section 1.1 of the report.

The study concluded that the road should be redesigned or improved based on an average daily traffic count of over 250 vehicles per day and an increase in traffic after reconstruction of 33% of the then current traffic. Unlike the reconstruction of the Western Highway between Belize City and Belmopan, this study calls for the cutting of certain small hills for the purpose of increasing sight distances.

The nature of the soil along the Western Highway is that of a clayey
Table 3.2 in the report shows that the CBR (California Bearing Ratio) varies from 4 to 50%. Road design as proposed by the Study is based on a CBR of 10% which seems satisfactory.

Accurate traffic counts were obtained as called for in Section 1.1 of the report. These counts were analyzed and the results used as part of the design criteria. The results of the wheel load survey resulted in a determination of 52 standard axles per 100 commercial vehicles. In comparison the determination of standard axles on the Northern Highway resulted in 92 standard axles per 100 commercial vehicles. The average daily traffic count of 260 on the Western Highway was higher, however, than on the Northern Highway where the A. D. T. was only 192.

The Study assumed a design life of 10 years and, based on this assumption, suggested a pavement thickness of about 10 inches. The method of construction as suggested by the Study recommended that the improvements be made by the Public Works Department of Belize rather than an international contractor. This would result in a savings of over $4 million but at the same time require 4 years to complete instead of 2 as was suggested for the contractor.

The Study suggests that the traffic generated by the improvements to the road would amount to 33% of the current traffic. This figure was apparently derived from the assumption that travel costs would be reduced to 75% of the original costs after the road is improved. It seems that factors other than economy, such as convenience, could also influence the generated traffic and that the 33% estimate could prove to be low.

Since the Western district is undergoing rapid and, to a certain extent, unpredictable development, the traffic projections of the Study could undergo
unexpected change. It is the recommendation of this thesis, therefore, that consideration (including economic analysis) be given to accomplishing the improvements to the Western Highway by a planned stage construction method. This method would allow for a staged construction based on a longer time period. This time span would allow for additional time to study the trends of future development in the region and allow for more economical initial construction. If after the first few years the highway proved to be inadequate to serve the needs of the region, or for some other reason improperly designed, then the design could be altered as part of the planned stage construction.

Ports and Harbors

The principal ocean ports of Belize are at Belize City (Figures 24 and 26) and Commerce Bight (Figures 25 and 27). Only lighterage facilities are available at these locations to serve the loading and unloading of cargo. In addition to these ports private concerns have constructed wharfs and piers to aid in the export of bananas and other commodities. The pier at Riversdale (Figure 28) and the wharf at Big Creek are examples of these private endeavors. Punta Gorda, Stann Creek, Placencia, Corozal and San Pedro (on Ambergris Cay) all have small piers to handle local supply boats and fishing vessels.

The development of a deep water port was the subject of an intensive study sponsored by the Ministry of Overseas Development of the British government, resulting in a four volume final report (17). The report, released in July 1970, contained economic investigations for the related area,
BELIZE CITY PORT LOCATIONS

Figure 24
BELIZE CITY PORT LOCATIONS

COMMERCE BIGHT

Figure 25
COMMERCE BIGHT PIER
comparisons of possible locations, economic projections and alternative final designs.

The 1970 Deep Water Port Study proposed the new deep water pier be built in Belize City and that facilities be included on the pier head for sugar storage and transfer. Because these facilities require a substantial portion of the total funds necessary for the initial construction, and there were some suggested advantages of a Commerce Bight site over the Belize City location, the Caribbean Development Bank authorized an updating study to be made in 1974. This study was to exclude the sugar industry from
Figure 27

Commerce Bight Pier Viewed from End

Figure 28

Pier at Riversdale
the proposed facilities, thereby reducing the initial port costs. Although the Belize City recommendation remained essentially the same, the port design was redrawn to allow for a much simpler pier head arrangement and a reduction in supporting shoreside facilities.

Although the 1974 update supported the Belize City site as the location for the primary deep water port, a Commerce Bight location was thoroughly investigated. The positive features of a Commerce Bight location rest in the established export of citrus products from the existing Commerce Bight pier and in the future increased production of mangoes and bananas to the south. A more important consideration; however, is the fact that at this location the four fathom bathymetric contour occurs at approximately 1300 feet from the shore. Under these conditions an approach trestle 2400 feet long, as proposed in the 1970/74 study, would place a pier head in the 28 feet of water suggested for the deep water port. By eliminating the maintenance dredging that would be required at the Belize City site the long term cost of the pier would be drastically reduced. The following is a rough breakdown and comparison of costs involved in the Belize City and Commerce Bight deep water port alternatives.

Belize City Alternative:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Facilities and Construction</td>
<td>Bze$ 5,137,000</td>
</tr>
<tr>
<td>Cost of Initial Dredging</td>
<td>2,816,000</td>
</tr>
<tr>
<td>Total Cost</td>
<td>7,953,000</td>
</tr>
<tr>
<td>Annual Maintenance</td>
<td></td>
</tr>
<tr>
<td>Dredging</td>
<td>140,800</td>
</tr>
<tr>
<td>Port Maintenance</td>
<td>28,200</td>
</tr>
<tr>
<td>Total Annual Maintenance</td>
<td>169,000</td>
</tr>
</tbody>
</table>
Commerce Bight Alternative:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Facilities and Construction</td>
<td>Bze$ 5,854,000</td>
</tr>
<tr>
<td>Cost of Link Road (Commerce Bight to Belize City)</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Total Initial Cost</td>
<td>7,854,000</td>
</tr>
<tr>
<td>Annual Maintenance</td>
<td>39,400</td>
</tr>
</tbody>
</table>

Source: 1970/74 Deep Water Port Study (17)

The estimates for the Commerce Bight alternative include the cost of a highway connecting Commerce Bight to Belize City. The 1970/74 study suggested that this road would be necessary in order to link the port to Belize City; however, it failed to include any discussion on the economic impact of omitting such a road.

Figures 29 and 30 show the 1970/74 Deep Water Port Study proposals for the Belize City and Commerce Bight piers. The main port at Belize City would include berthing space, loading and unloading facilities, and warehouse and custom buildings. As stated before, the design omits facilities for sugar export. The Commerce Bight pier would be designed for small oceangoing vessels with no associated buildings or custom offices.

Unfortunately, Volume I of the original 1970 port study was not available to the author; and as this volume contained the original discussions for the port site choice, a fair review of the selection of the site for the new deep water port is not possible. It is not considered beyond the scope of this thesis; however, to parallel existing studies. Relying heavily on the collected data in the 1970/74 report, the situation will be subjected to reinvestigation. Hopefully, by presenting a second independent study, new considerations will be brought to light which can be incorporated
Figure 29
PROPOSED DEEP WATER PORT
BELIZE CITY
Figure 30

COMMERCE BIGHT
PROPOSED DEEP WATER JETTY BASED ON 1970 PORT STUDY
into future discussions. This thesis study will also result in recommendations that differ in some cases from the original port study recommendations, but each case will be supplemented by appropriate analysis and discussion.

In 1950 the Crown Agents commissioned an independent British consulting engineering firm to do a port development study (16) of much the same scope as the 1970/74 study but of far less complexity. This study is a source of much valuable information, especially since it gives accurate accounts of shipping and commerce in 1950.

If the port is constructed in Belize City, as proposed, the primary concern would be the siltation of the approach channel. Borings made in the harbor at different points near the location of the proposed port (Figure 31) show that the top layer of sediment is composed primarily of clay. Based on the normal settling velocities as given below:

<table>
<thead>
<tr>
<th>Settling Velocity (cm/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand (100 μ)</td>
</tr>
<tr>
<td>Silt (10 μ)</td>
</tr>
<tr>
<td>Clay (1μ)</td>
</tr>
</tbody>
</table>

Source: *Oceanography* (32)

and assuming that the source is nearby Haulover Creek, it can be seen that the current in the general area is slow enough to allow silt and clay to settle near the creek mouth.

Figure 32 is a drawing of the apparent erosion and accretion for Belize Harbor for the period from 1830 to 1958 as given in the 1970/74 study. The quantities shown were derived from overlaying a 1830 nautical chart over a 1958 chart. The result was taken as the difference between the two sets
of contours. Based on this estimate of accretion and erosion, it appears that most of the harbor has suffered accretion of 0-6 feet with some being as high as 6-12 feet. The areas of erosion are far enough from the proposed port area so as not to have any effect on the site study. The erosion occurring along the shore line can also be neglected at present.

The 1970/74 study sited the proposed port in a location where the approach channel would extend into an area of 0-6 feet of accretion. This location is also the closest point to the deep water contours. Based on Figure 32, this is probably the best possible site.
Figure 32
ACCRETION AND EROSION IN BÉLIZE HARBOR 1830-1958

Legend:
- Pink: 0-6 Feet of accretion
- Red: 6-12 Feet
- Blue: 0-6 Feet erosion
- Dark Blue: 6-12 Feet

Note: Quantities are apparent.
Source: 1970 Deep Water Port Study

BÉLIZE CITY
If the 1830 chart used to determine the original bathymetry is compared to the chart of 1896 almost the same results as in Figure 32 are obtained. It can be concluded from this comparison that either the harbor bed underwent a drastic change between 1830 and 1896 or that the 1830 chart was plotted incorrectly. Whichever the case, the change that occurred between 1896 and 1958 (Figure 33) is minimal as compared to the change supposedly occurring between 1830 and 1958. Not only the quantity, but also the arrangement is different. Figure 33 shows an area of erosion south of Belize City where Figure 32 had shown accretion of 6-12 feet.

Using Figure 33 as a guide, an estimate of the apparent sediment deposition over the last fifty years can be made. Figure 34 shows areas of apparent sediment deposition along with their probable sources. Considering the sedimentation information based on the 1896-1958 chart comparisons, the site for the proposed deep water port is no longer optimal. If the port were located at that site the approach channel would be situated in an area of apparent accretion; whereas, if the site were moved only a few hundred yards west the channel would extend through an area of apparent erosion.

The fact remains; however, that the 28 foot deep approach channel will act as a sediment trap no matter what the location. The sedimentation would be the result of both shore erosion and Haulover Creek deposits. To cite an example, the small cucumber loading port located just west of the proposed port site (see Figure 35) was plagued with siltation problems. Although there is no estuary located nearby (the Sibun River being farther south), the approach channel was constantly filling up with the material that eroded from the shore. Since the port has ceased operation, the channel has completely filled in to depths as shallow as two feet.
Figure 33

ACCRETION AND EROSION IN BELIZE HARBOR 1896 - 1958

Note: Quantities are apparent, being derived solely from comparison of 1896 and 1956 nautical charts.
Figure 3.4
SEEDMINT DEPOSITS IN BELIZE HARBOR
Based on apparent accretion and erosion in Belize Harbor.
Figure 35

BELIZE HARBOR

Soundings in fathoms
Source: U.S. Nautical Chart
One solution to the siltation problem could be in the construction of a north-south groin east of the proposed port area. This groin would not only act as a breakwater for the approach channel, but it would also retard the wave and current action that has proven to be so damaging to the western beach. Figure 36 shows what effects a groin might have on both the incoming waves and the longshore current.

The reaction of waves and currents to a groin, although theoretically possible to estimate, is most accurately predicted through scale model tests. Most agencies concerned with the design and construction of ports and harbors rely heavily on the outcome of model tests, and it is not obvious that Belize should be an exception.

An important consideration that must be taken into account when designing a port for Belize is the effects produced by hurricanes and earthquakes. Belize lies in a region subject to both phenomena, and each is capable of rendering a port and its facilities useless. The design of the port as presented in the 1970/74 Deep Water Port Study included allowances for hurricane forces, but it is not evident that earthquake effects were taken into consideration. The Guatemalan earthquake of 1976 proved that the area is susceptible to earthquakes of high magnitude.

The style of port design involving a pier leading into deep water, as was suggested for Belize, could be easily damaged in either a hurricane or earthquake. Since the berthing facilities are located at the end of the pier, any damage that would weaken the approach trestle could force the complete deep water facilities out of commission. Especially in an earthquake where ground movements of high order are encountered, a structure such as the approach trestle and pier head could suffer greatly. Damage of this
EFFECT OF GROIN ON WAVE AND CURRENT MOVEMENTS

Wave Diffraction Due to Groin

Current Alterations Due to Groin
nature would require a great deal of time to repair and could even result in new construction being required.

The best solution to the problem of hurricane and earthquake damage seems to be in locating the port facilities on the land and extending the approach channel to meet them. If a land based port is built in conjunction with the groin as previously mentioned a system might result in which the accretion-erosion effect of the groin would help prevent the turning basin and channel from silting.

As shown in Figure 29, the port calls for an approach trestle leading to a pier head. On the pier head are accommodations for deep water berthing and roll on/roll off service. The required depth of water for the deep water berth and turning basin is 28 feet while the RO/RO ships require 18 feet. Berthing space is limited, and the design does not seem to be readily adaptable to expansion.

In situations where the predominant wind is from the east it is usually considered to be poor design procedure to construct the berth on the east side of a north-south pier. Information obtained from local ship pilots in the 1950 port study tells of what happened to the concrete pier head at the Commerce Bight pier before it was destroyed.

"...nevertheless there are records that the concrete structure also suffered heavy damage on a number of occasions from the berthing of ships. This problem has been discussed at length with the two oldest surviving pilots in the colony, who explained that they did not care to bring a large vessel on to the western side of the ships' berth owing, no doubt, to lack of water for manoeuvring, and they stated that large ships were, therefore, always berthed on the outer, or eastern side of the pier. Since, on many occasions, strong winds would have been blowing from the east or from the south-east, it is evident that the operation of berthing a ship under these conditions alongside a pier aligned approximately north and south must have been most hazardous, and it is not surprising that the pier head was often damaged". (16)
The layout as shown in Figure 29 repeats the Commerce Bight mistake by placing the deep water berth on the east side of an approximately north-south pier head.

The approach trestle in the proposed port connects the pier head with the supporting facilities on shore. These facilities include warehouses, equipment storage areas and offices. The location of the port near Yarborough Lagoon provides limited area for expansion of the shore facilities except by use of extensive fill. Since the ESSO storage depot is located to the immediate west of the proposed site, all expansion would have to be aimed in the easterly direction, or into the lagoon.

Figure 37 shows an alternate port design based on the previously mentioned considerations. This alternate not only allows for increased berthing space, but also provides a turning basin better suited for the local wind conditions. Because the submerged pipeline extending from the ESSO storage depot along the eastern side of the proposed groin would be subject to burial by the anticipated accretion, it is suggested that the north-south berth be adapted to receive petroleum products. A pipeline from the port to the storage depot would be shorter than the submerged line and also easier to maintain. In addition the government could construct a bulk storage tank for bituminous material that could be unloaded through the same facility.

As it now appears that the deep water port will be located in Belize City, the consideration of such a facility at Commerce Bight is not nearly as likely. Instead, the development at Commerce Bight will probably center around providing adequate lighterage or deep water berthing for citrus product shipments. The 1970/74 port study suggested the construction of a deep water jetty (see Figure 30) at the site of the existing pier. It does
Figure 37

ALTERNATE PORT DESIGN -- BELIZE CITY
not seem feasible at this time to construct such an expensive facility to handle only an average of 10,000 tons annually (Table A3-14) of packaged citrus products. The pier does need to be upgraded; however, since the existing structure is deteriorating quite rapidly.

The proposal for Commerce Bight included in the 1950 port study called for the construction of a new lighter pier (see Figure 38). This design has the capability of being expanded into a deep water berthing facility, should the need arise, by extending the approach trestle to the required water depth. It was suggested in the 1950 port study that if the deep water pier was built, it should be located west of the existing pier in order to gain what shelter from the northeast winds as is afforded by the mainland. The 1950 report also suggested the construction of a breakwater around the lighter pier. This breakwater was to insure deep water around the lighter pier and to allow unhindered operation under all but the most severe weather conditions.

Recommendations for Sugar Exporting Facilities

The present decision of the government to exclude a sugar storage and loading facility from the new port should have little effect on the future of sugar and molasses export from Belize. Since the export of sugar and molasses is a specialized procedure that is presently being carried out by the Belize Sugar Industries, there seems to be no reason to anticipate future government involvement. When economics warrant the expansion or improvement of current procedures the sugar industry is probably best capable of devising and initiating the proper improvements within their own organization.
Figure 38

COMMERCe BIGHT
PROPOSED LIGHTER PIER BASED ON 1950 PORT STUDY
At such a time as Belize Sugar Industries feels that the expansion of transport facilities is necessary, decisions must be made involving the transport method to be employed and terminal location. The possible options could include building a mainland deep water wharf for direct loading onto ships, building a deep water wharf on an offshore cay or expanding the present system of using a sugar store along with ship loading from a barge.

The present method of barging sugar from the factory to the ship loading area probably will remain unchanged, since no competitive alternatives exist. With an increased sugar and molasses export, as projected by the 1970/74 port study (Table A3-4), the sugar industry will be forced to rely more on the intermediate storage of bulk sugar at a Belize City location. With the increase of small boat and barge traffic in Haulover Creek it seems highly likely that the sugar industry will soon find it advantageous to relocate their present storage shed to some more convenient location and at the same time update the loading and storage facilities.

Recommendations for future sugar transport follow from suggestions made in the 1950 port study concerning the group of cays around Robinson Point (see Figure 39). The 1950 report mentions,

"...the shore and water area in the vicinity of Robinson's Point. Here since 1926 has been a private shipyard with a slipway able to take vessels up to 125 feet in length and 200 tons deadweight. About a mile south of the slipway is a well protected inlet known as Papadopolo's where 35 to 40 feet of water is found..." (16)

Although the 1950 study discounts the possibility of this location serving as a site for the future deep water port, they do state,

"It is possible that if the sugar industry should eventually develop on a big enough scale to justify the cost of bulk handling facilities and of a special berth for sugar ships, then this development might possibly be sited at some deep water point away from the mainland". (16)
Figure 39
ROBINSON ISLAND

Soundings in fathoms
Source: U.S. Nautical Chart
Figure 39 shows the excellent protection that this site offers from the predominant winds and the depth of water occurring along the middle shore of Robinson Island. Establishment of the sugar export facility at this location would provide both convenient berthing of ships and operation unhindered by the unrelated port traffic.

**Air Transport**

Air transportation in Belize currently serves two functions. Jet traffic into the International Airport serves as the major means of transport for travelers to and from Belize, and the small commercial airlines operating from Municipal Airport in Belize City provide dependable access to towns within Belize. Air transport serves Belize adequately and has developed at a steady rate. Service provided by the major airlines of the Central American region helps curtail the isolationism Belize would otherwise be faced with. Internally, the small airlines are of similar necessity in preventing many remote areas from being isolated from the rest of the country.

Appendix A1-4 shows the frequency at which major airlines operate in Belize. Besides offering personal transportation the major airlines also serve as freight carriers. Air freight capability is a great asset, as it provides a quick means of import for vital items and an inexpensive means of shipment for small or perishable items such as local crafts and exotic plants.

Local airlines serve the towns of Corozal, Orange Walk, San Pedro, Belize City, Stann Creek and Punta Gorda with regularly scheduled flights.
Figure 40
AIRPORTS AND LANDING STRIPS

SCALE 1:1,600,000
These flights serve as both passenger and freight flights. Besides the regularly scheduled flights, charter flights can be arranged. Figure 40 locates the primary airports and landing strips within the country.

The quality of runways within the country is generally good. International Airport is well maintained and meets international standards for medium sized jet aircraft. Phased expansion of International Airport is in progress and will eventually result in new terminal buildings and a runway and apron designed to accommodate larger jet aircraft. Most of the local airstrips receive regular maintenance and are in fair to good condition.

Summary

The future of transportation in Belize depends almost entirely on the attitude and policies of the government. The current, most interesting transportation issue is the development of a deep water port. There is little doubt that Belize will get this facility in the future, but the immediate need is questionable. A rough guide for port development is to provide 6 berths per million tons of trade yearly, or 1 berth for every 150,000 tons. The projections for general cargo imports (Table A3-3) show that Belize will not meet this 150,000 ton criteria until 1985. The cost-benefit ratio for a deep water port, as calculated in the 1970/74 port study, also agreed with the 1985 date for the construction of a deep water port.

There exists an immediate need for improved lighterage facilities at both Belize City and Commerce Bight. The condition of the wharf in Belize City is adequate, but the congestion in the port area is continuing to reduce the efficiency of the lighterage operations. The small pier at Commerce
Bight is of extremely poor quality.

Internally, the outlook for transportation is improving. British assistance is providing plans for the upgrading of the Northern and Western Highways. Most of the new road construction is taking place in the northern districts where the increased demand for sugar has spurred the need for new and improved agricultural feeder roads.

There is little speculation that Belize will ever have need of a rail system. This could change; however, if Mexico ever connects its rail network with Chetumal. In this case Belize could tie into Chetumal and have the benefit of direct railway trade with the rest of America.

Air traffic in Belize is increasing at a respectable rate, and the international airport now provides all the services necessary for small jet connections. Since the airlines are foreign owned, the advancement of this facet of transportation will develop relatively independent of government or other transportation systems.
CONCEPTS
for FUTURE
DEVELOPMENT
and RELATED
TRANSPORTATION
REQUIREMENTS
Current Development Policy

The national development policy adopted by the Government is designed to reduce the current dependence on imported commodities and at the same time to increase the Gross Domestic Product, establish a more favorable balance of trade and promote an improved national identity and unity. This policy establishes guidelines for national development in the context of the nation in its entirety and can serve as a basis for comprehensive and conceptual analysis.

The lack of natural mineral and energy resources severely limits the potential for increased industrial development. As a result, the Government is emphasizing the development of agricultural and tourism potentials as the prime economic activities to generate employment, provide needed export commodities and increase self-sufficiency.

Following, is presented a concept of national development and a related transportation system based on these considerations.

Proposed Development Concepts

Analyses of land capability, resource inventories and comparisons of current production in relation to areas of latent potentials are necessary. This will, in turn, establish potential socio-economic regions within the country and the corresponding economic nodes, or growth centers,
associated with these regions. The existing urban centers will also be analyzed as to their current function and possible future role in national development.

Socio-economic regions in Belize are the result of demographic characteristics combined with variations in the economic productivity of individual areas. The development concept included in this thesis calls for the determination of these socio-economic regions. Each region is a combination of areas of unique economic capability and cultural relationships which satisfy the needs for potential social and economic independence. The socio-economic region will then serve as the basis for regional development in Belize.

Each socio-economic region will include an urban growth center. These centers should be located so as to best serve the entire region and should provide all of the necessary services for growth, including major medical services, complete shopping service facilities, professional and business functions, and social and cultural activities.

The geographical shape and dimensions of Belize suggests a linear approach to the organization of the socio-economic regions and their related urban growth centers. Arrangement of socio-economic regions and growth centers would be built around a centrally located North-South transportation corridor designed to serve as the backbone for a national transportation system.

An adequate and balanced transportation system should be designed so as to become a motivational force in assuring the optimal utilization of natural resources and appropriate population distribution and land use.
The anticipated increase in agricultural production throughout the country will require the convenient shipment of produce to markets or processing centers. In addition, efficient transportation will also aid in the ability of the people to move throughout the country. This ability will help relieve labor shortages and reduce the isolationism that now exists in many of the remote areas of the country.

Areas of Unique Economic Capability

An area of unique economic capability represents an area which will develop independently in accordance with the optimization of a composite of local resources and feasible production activities. Economic identity has already become evident in the North where sugar cane related products provide the principal economic base and in the Stann Creek Valley where citrus production and processing is the predominant economic activity. The determination of the areas is based not only on present land use, but also on the latent potential capabilities of the land. Soil types, climate, labor availability and access are all important factors to consider in determining how future economic development of an area might occur.

The primary source of information for potential land use in Belize is the series of land use maps prepared by A. S. C. Wright and company in 1958 (37). The series of maps includes present vegetation coverage, soil types, and potential land use (this map is reproduced in Appendix 6). This series of maps along with an understanding of local trends provides most of the base information necessary in establishing the approximate area boundaries. Other factors necessary in determining the economic development
to be expected in an area are accessibility and population density. These factors have been discussed in the previous sections.

Based on an analysis of these factors, the country can be divided into six areas of unique economic capability as shown in Figure 41. Each area is identified by a local urban center:

1. The Orange Walk Area. This area will develop as a result of the sugar industry, its urban center being Orange Walk Town. The boundaries of this area as shown in Figure 41 are based on current sugar refining capabilities and soil conditions. Although suitable soil conditions for sugar production extend farther south toward Hill Bank, unless economic changes justify a new refinery at another location, the limits of cane production will probably remain about the same as shown. The other local urban center located in the area, Corozal Town, will probably continue to serve only the immediate surrounding area; and as the importance of Orange Walk Town increases, Corozal Town will probably remain only a minor urban settlement.

2. The Belize City Area. Although Belize City is presently the major urban and commercial center of the country, the surrounding land is not readily suited to extensive agriculture. The production of rice in the Big Falls area of the Belize River, however, has proven profitable and could be expected to expand with time. Besides rice production, the only other agricultural activities will probably occur along the Sibun and Belize River Valleys and be limited to supplying the local market. The beef and dairy industries could also be supported here, but considering the greater potential of these industries in other areas, the effort will probably remain modest.
Figure 41
AREAS OF UNIQUE ECONOMIC CAPABILITY
Because of its seaside location and the proximity of the International Airport, Belize City will remain a transfer point for tourists who are going to other parts of the country. Tourist activities should be considered an important factor in the economic potential of the area.

3. **The Stann Creek Area.** Built mainly around the citrus industry, the economy in this area will probably remain almost totally tied to the processing of citrus and other fruits. Citrus growing is already extending to areas along the Sibun River and Roaring Creek, and with the eventual improvement of the Hummingbird Highway to allow for convenient transporting of produce, these areas along with the Caves Branch Valley and other areas around Belmopan will probably go into larger scale production. Besides citrus the production of bananas and mangoes south of Stann Creek is becoming a major economic activity.

4. **The Punta Gorda Area.** Originally the area around Punta Gorda was the principal rice production area of the country. The simple methods of small scale farming and the lack of efficient processing facilities have hampered increased production. Presently, the Government is making plans to provide the proper dryers for the locally grown rice. Besides rice the area also produces red kidney beans and corn, both important food products for the local market. The Punta Gorda area is also well suited for sugar cane production, but the absence of a local refinery has prevented this industry from gaining a footing in the regional economy. There is a possibility that, with the increased demand for sugar on the world market, the southern district might receive the financial backing necessary for sugar processing. Another alternative is the use of sugar cane in the production of alcohol.
This area also possesses the proper characteristics of soil and climate for intensive truck farming activities. Proper guidance and assistance should be provided to encourage the development of such activities which are greatly needed to supply the local market with fresh and processed vegetables; most of which are currently being imported. The production of fresh vegetables for a national market would necessitate a highway connection between Punta Gorda and the rest of the country far superior to that which exists now.

5. The San Ignacio Area. The San Ignacio area, including the area west of the Maya Mountains, is primarily in woodlands. Cultivated areas include the Belize River Valley, sections near Benque Viejo and along Barton Creek. The nationally sponsored Central Farm agricultural experimental station is located in this area just east of San Ignacio on the Western Highway and a successful Mennoite settlement has been founded near Spanish Lookout. These two attempts at large scale agriculture in the area have prompted additional farming and ranching ventures. The fact that nearly all of the land adjoining the Western Highway through this area has been cleared and is now in crops or pasture gives evidence that the area is well suited to agricultural production and will continue to develop.

6. The Hill Bank Area. Poor access has been the major reason that this area has not progressed beyond its present state. Located in the extreme northwest corner of the country and far from any of the major highways, this area has been considered primarily for its timber. The soils in this area are fertile and give rise to vegetation consisting of broad-leaf trees in the 70-100 foot height range. It is probable that this area, except for those portions adjacent to passable roads, will remain in forest
longer than any other because of the poor access and sparse population.

Figure 41 also shows areas of limited and no economic potential. Areas of limited economic potential; because of poor drainage, rugged terrain or unfertile soils; would be slow to develop regardless of improvements to local transportation. Areas of no economic potential include swamps, tidal plains or steep mountain slopes.

**Socio-Economic Regions**

Within Belize there exist regions of distinct social, cultural, geographic and economic characteristics. Socio-economic regions have evolved as the result of similarities in these characteristics, producing common affiliations and a singular identity evident throughout the region's sphere of influence.

When treated as the basis for a planning unit, the socio-economic region represents an economically independent community capable of serving the needs of the included population. Identification of the socio-economic region is based on criteria necessary for obtaining the intra-regional economic and social independence demanded. These criteria include:

1. That adequate and diverse agricultural potential exists within the region so as to eliminate the need for extra-regional sources of supply for basic food-stuffs;

2. That the size of the region be limited to an area capable of being served by a single, centrally located urban growth center accessible from any point within the region within a reasonable period of time;

3. That one or more large scale industrial or agricultural enterprises be associated with the region in order to provide a source of employment and general economic base;
4. That sufficient growth potential exist within the region to attract and support a total population adequate to warrant trade, service, social and cultural facilities;

5. That a program designed to provide these facilities be feasible and within the scope of the nation's capability to produce such facilities; and

6. That development of the region be in accordance with the traditional usages so as to represent customary affiliations and, therefore, to be accepted by the included population.

Based on these criteria, Belize can be divided into three distinct socio-economic regions; these regions constituting the northern, central and southern portions of the country. Except where obvious geographic constraints exist, the boundaries of these regions will tend to overlap so that no definite border exists between regions. This overlapping of regions creates fringe areas which assume a combination of the characteristics of the adjoining regions.

**Growth Centers**

Growth centers are urban areas strategically located and sufficiently developed so as to most conveniently provide a complete complement of professional, commercial and social services to the surrounding socio-economic region.

Present national growth is centered around Belize City, the single urban center now sufficiently large and diverse to satisfy the socio-economic needs of the country. The resulting transportation pattern is a network of fair to extremely poor roads radiating from Belize City to serve nearby communities. The present system effectively serves only the
area adjacent to Belize City and is inconvenient, inadequate and energy inefficient.

Belize City has in the course of history become the center of national, social and economic affairs. Locational factors relevant to its origin and growth have now changed or become ineffective in sustaining the City's existence. The location has, in fact, become detrimental to maintaining a quality environment and economic strength. The City must continue to be improved; however, its population should be reduced to a level compatible with the available supporting community services. This could be most effectively done by encouraging future growth away from Belize City.

The partial destruction of Belize City by hurricane "Hattie" in 1961 prompted the Government to consider moving the center of government from a coastal location. As a result, a new site for the national capital was chosen near Roaring Creek Village at the intersection of the Western and Hummingbird Highways. In 1970 Belmopan, the new capital, was ready for occupancy; and most of the government offices were moved from Belize City. Located in the foothills of the Maya Mountains approximately 50 miles from both Belize City and Stann Creek, near the geographic center of the country; Belmopan is comparatively free from the effects of hurricanes and flooding.

Industrial development areas were designated and adequate water and sewer facilities were provided in Belmopan to attract new industrial and commercial growth. At the same time emphasis was placed on discouraging continued growth in the Belize City area which is plagued by threats of hurricanes and flooding damage and where municipal services are inadequate and environmental quality restrictive.
In order to achieve the desired shift of economic importance from Belize City to Belmopan, the Government must include in their future development program provisions for social and cultural enhancement of the Belmopan area. The hypothesis being that if Belmopan can be made socially acceptable and easily adaptable to common lifestyles, then the employment potential of the area will provide the additional incentive needed to bring about the relocation of the Belize City labor force.

The northern socio-economic region will probably continue to be influenced by the Chetumal market. Although not within Belize, Chetumal should be considered a major factor in regional growth because of the large variety of trade items available and the potential buying power associated with the sugar cane industry.

A growth center located in the vicinity of Orange Walk Town is necessary to provide services to the northern socio-economic region. Although Orange Walk Town is now serving the immediate region, medical and other professional services are minimal and commercial retail facilities are inadequate to compete with those of Chetumal.

With future growth and diversification anticipated in the southern socio-economic region, a growth center located south of the Maya Mountains would be feasible and should be developed. Although the pattern of future growth in the southern region is not yet well defined; the Government can, by a positive program of development and assistance, assure the optimum utilization of natural resources and land use within the region.
Potentials for Tourist Development

Belize has two outstanding tourist potentials which can be easily and efficiently developed. These are the Caribbean Sea, along with the associated cays, and the numerous archaeological sites. The primary activity involving the sea is SCUBA diving. This is usually carried out by groups of divers who fly into Belize City and then proceed to the cays where they spend the remainder of their time in Belize. Transportation development will have little effect on this routine, since most of the movement is accomplished by air travel. Fishing and the tropical beaches also attract many tourists, but they usually depend on air transport, also. Few tourists attracted by the coastal appeal of Belize enter the country by automobile.

The archaeological sites in Belize must be treated differently, however. None of the numerous sites in Belize (see Figure 42) are directly accessible by air; therefore, roads offer the only approach. Of the many sites only Xunantunich near Benque Viejo and Altun Ha north of Belize City have been excavated and maintained for tourist exhibition. Although other sites have been excavated, the cost involved in keeping the areas clear has proven too expensive to warrant continued maintenance unless it was sure that the site would serve as a major tourist attraction.

Belize is fortunate in being located between the well maintained sites in the Yucatan and the popular Tikal ruins in the Peten area of Guatemala. Tourists visiting the ruins in the Yucatan could possibly be induced to travel through Belize to Tikal provided the condition of the highways was improved.
Figure 42
PROPOSED TOURIST ROUTE FOR ARCHAEOLOGICAL SITES

ARCHAEOLOGICAL SITES
1 SANTA RITA
2 SAN ESTEVEN
3 INDIAN CHURCH
4 ALTUN HA
5 SAN JOSE
6 BAKING POT
7 XUNANTUNICH
8 CAMP SIX
9 POMONA
10 MOUNTAIN COW
11 CARACOL
12 ACTUN BALAM
13 NEW DISCOVERY
14 LUBAATUN
15 PUSILHA
Port Location

The decision to build a major deep water port in Belize has a definite effect on future development. The question of which of the two proposed port sites, Belize City or Commerce Bight, would best serve the needs of the country has been seriously debated. In turn it has been seen that both sites offer unique advantages and serious drawbacks.

From an engineering and cost standpoint, as discussed in the "Ports and Harbors" section, the Commerce Bight location possesses more favorable qualities. From the cost estimates given in the 1970/74 Deep Water Port Study the initial costs for a port at either location appear similar. For the Belize City location initial dredging costs are over one-third of the total initial cost. In the case of a Commerce Bight location the construction of a coastal link road from Commerce Bight to Belize City represented approximately one-fourth of the total initial cost. While initial dredging at the Belize City site is a necessity, it appears that the need for a coastal link road may have been over stressed.

If, in fact, development is directed at deemphasizing Belize City as a growth center and encouraging economic growth at Belmopan, then a port located at Commerce Bight would help establish the changing trend. Instead of connecting Commerce Bight to Belize City through a new coastal link road that would serve limited purposes, the Western and Hummingbird Highways could be upgraded (which must eventually be the case, anyway) to carry the Commerce Bight-Belize City traffic. Belmopan would then become the focal point through which this process would take place.

Besides the cost of initial dredging associated with the Belize City
site, maintenance dredging also poses a problem. Estimated annual maintenance costs for the Belize City site are over 3% of the total initial cost while estimated annual maintenance costs for the Commerce Bight location are only about 0.5% of the initial cost. Another factor to be considered in the maintenance costs for the Belize City site is the amount of time the dredge will have to devote to deep water port maintenance; whereas, a port location at Commerce Bight would free the dredge for assignment elsewhere. As the present dredge units are now working a full schedule, the increased work load would force many needed dredging jobs to be postponed, unless new dredges were acquired at additional cost.

Economics also play an important role in port location. With the exclusion of sugar exporting facilities from the proposed port, citrus products constitute over 50% of the port related export trade. As these products are presently shipped from the Commerce Bight pier, a Belize City port site would not conveniently serve the export trade of the country.

The effect of a deep water port on current labor patterns will be significant regardless of the location. The present lightering method of loading and unloading ships requires a large number of employees over that which would be required at a deep water port handling the same volume of cargo. When the deep water berthing facility is in operation, the need for the lighters and many of the employees will be eliminated. Construction of the deep water port at Commerce Bight would tend to further increase the number of unemployed in Belize City, unless many of the former dock employees relocated to Stann Creek.

Possibly the most important, but not necessarily the most obvious, factor influencing the port location decision is the "port city" image
traditionally associated with Belize City. As could be seen throughout their history, the people of Belize are greatly influenced by tradition. The thought of Belize City no longer being the port city of Belize may be unacceptable to the general public no matter what economic factors or design criteria dictate. There exists the possibility that if Commerce Bight were chosen as the port site, the public would continue to use the lightering method of Belize City for reasons of continued employment, convenience or tradition.

The major constraint to industrial development in Belmopan is the lack of an adequate transportation linkage between Belmopan, other cities in the country and the site of the future deep water port. At present the port has been sited at Belize City; but whether the final location is Belize City or Commerce Bight, the effect of the port on the growth of Belmopan depends almost entirely on the ability to conveniently move goods between the coast and the inland site. In the event the port is finally constructed in or near Belize City steps should be taken to insure that new industrial growth does not remain tied to the port area.

Proposed Transportation System

National growth and development is directly related to the quality of transportation available. At present the transportation system of Belize is inadequate and ineffective in promoting development and optimum land utilization. A transportation system must be designed to serve two primary functions: The economic development of the country; and the social, cultural and governmental interaction of the population.
Economic considerations include improved accessibility to potentially productive areas, convenient transport of regional produce, convenient dispersal of concentrated labor forces and inexpensive distribution of domestic and import commodities. Agricultural development is based primarily on the accessibility of the land and the convenient transport of the produce to the related processing center or market. The ability of locally produced items to compete on both the national and world markets is in many ways dependent on the transportation related production costs.

Economic functions requiring large amounts of labor are common in Belize. Processing such crops as citrus and sugar cane demands seasonal labor often in excess of what is regionally available. In addition, continued industrial development in Belmopan will require imported labor from Belize City or San Ignacio. In either case the ability of the available labor force of the urban areas to conveniently move from residence to job site is a necessity.

The distribution of domestic and imported commodities throughout Belize is limited because of poor transportation connections between Belize City and the outlying communities. In remote areas of potential productivity new development is often discouraged when limited access delays or prevents the acquisition of needed supplies. Economic equality within the country can be achieved only when adequate transportation linkages are provided between commercial centers and isolated communities.

The strengthening of national unity relies heavily on cultural and social exchanges between socio-economic regions. Poor access to the remote areas of Belize has isolated many communities which otherwise offer positive contributions to national development. The effects of this isolation,
most of which could be eliminated with improved transportation, are im-
portant factors to be considered by the Government when ministering to the
needs of the country.

The proposed transportation system is designed to satisfy the eco-
nomic needs of the country and encourage growth and national unity. Con-
siderations are based on the interaction of highway, marine, air and rail
networks with each receiving individual attention. Each network is sub-
sequently analyzed as to current effectiveness, and recommendations are
made concerning necessary improvements.

The proposed transportation system is divided into two subsystems;
one satisfying regional requirements and the other satisfying national
requirements. The regional subsystem is necessary to obtain the suggested
independence associated with each socio-economic region and is designed
accordingly. The purpose of the national subsystem is to connect the
regional growth centers, thereby uniting the country. In addition, the
national subsystem will assist in the domestic or international marketing
of regionally produced commodities, provide access to potential tourist
sites and serve as an international transportation route for Central
America.

Development of Marine, Air and Rail Service

The marine aspect of the transportation system includes both inter-
national connections provided by visiting deep water cargo ships, and
regional connections between local coastal towns.
Since visiting deep water vessels are the basic carriers for nearly all of the imported items, government assistance has been primarily aimed at upgrading the deep water port facilities. Regional marine traffic, however, has received little noticeable governmental attention.

Even though the sugar industry uses barges exclusively in transporting raw sugar and molasses from the refinery to awaiting ships in Belize Harbor, there has been little attempt to provide adequate markers along the channel these barges use. Although lights have been placed at key positions, intermediate markers consist of small palm trees or stakes centered in the channel at sight distance intervals, making night travel difficult.

Since the entrance to Chetumal Harbor is along this same channel, traffic into Chetumal is likewise restricted. The construction of a new deep water port at either Belize City or Commerce Bight could also serve Chetumal provided a well maintained barge channel existed between the deep water port and Chetumal. Since the existing channel is of adequate depth, this maintenance need only include proper channel markers and target lights.

The transport of supplies between Belize City and Punta Gorda is best achieved by coastal supply boats. With the anticipated increase in agricultural production and development in the southern region, the Government should continue to encourage an active coastal barge and supply boat traffic.

Air service presently assumes an important role in the national and international transportation system. By offering both freight and
passenger services air transportation substitutes in many instances where highway transportation would normally be employed if such existed. Until the complete development of a highway network capable of providing convenient access to outlying communities, air transportation must continue to serve the country in this fashion.

At present Maya Airlines, operating from Belize City Municipal Airport, offers scheduled flights to Corozal, Orange Walk, San Pedro (Ambergris Cay), Stann Creek and Punta Gorda. Although expansion of these services does not appear necessary, improvement of the existing services is needed. The Belize City Municipal Airport offers limited facilities. In addition, the airstrip offers no cross wind capabilities and lies within the approach zone of Belize International Airport.

It is the recommendation of this thesis that consideration be given to the relocation of Maya Airlines from the Belize City Municipal Airport to Belize International Airport approximately 12 miles west of Belize City. By doing so, the scheduled local flights could operate from better facilities and be easily coordinated with the international flights. Not only would this arrangement offer safer flying conditions, but by operating from a single airport passengers transferring from international to local flights would be saved the nuisance involved in changing airports.

A closed network of railroads within Belize would, at present, be of little service. The construction of the deep water port may warrant a limited rail network to satisfy a demand for shipments between the port and Chetumal or the Peten region of Guatemala. The most promising outlook for railroad development, however, would follow as the result of a linkage of Chetumal to the rest of the Mexican railroad system. If this connection
existed, a Belize railroad network that tied into Chetumal would offer rail connections to all of North America.

Highway Development

Vast improvements to the existing highway network are necessary if Belize is to achieve economic strength and national unity. Current highway projects include plans for the rehabilitation of each of the major highways, with new construction being limited primarily to agricultural feeder roads located in the sugar producing areas. Creation of a comprehensive development and transportation plan, acceptable to the government, would insure that future highway expenditures satisfy long-term goals as well as immediate needs.

The development concepts proposed in this thesis suggest the need for both regional and national transportation subsystems. The regional transportation requirements center around a network of regional highways and feeder roads specifically designed to serve an individual socio-economic region. Depending on the transportation needs of the region, the highway network should radiate from the growth center, giving access to all areas of potential productivity. Incorporated into the radiating pattern would be agricultural feeder roads designed to provide convenient transport of produce from production site to processing centers or markets. In situations such as the northern region where the growth center is centrally located while the primary agricultural processing centers (the sugar refineries) are peripherally located, the radial network must be adapted so as to allow direct access to the processing facilities as well
as to the growth center.

The national highway network should connect the regional growth centers and primary activity centers. The socio-economic regions, lying in a linear arrangement, are best served by a North-South transportation corridor extending directly from the Mexican border at Chetumal south to Guatemala. This route would pass through each regional growth center and effectively tie the nation together. Although this corridor is primarily a highway route linking the northern, central and southern regions; it could also serve as the right-of-way for future transportation modes. It is recommended, therefore, that this central corridor be of sufficient width to accommodate a major highway and possible future expansion.

The recommended implementation of the North-South transportation corridor would require the construction of two new sections of highway and upgrading of existing highways to be incorporated. The new sections of highway should extend from Orange Walk to Belmopan along the most direct route and then from Belmopan to the southern regional growth center in the Toledo District. Existing highway incorporated into the corridor would include the Northern Highway from Orange Walk to the Mexican border and any roads lying within the corridor south of Belmopan. Design criteria for new construction and improvements should be based on an anticipated heavy truck traffic to insure adequate pavement strength, width and alignment.

A good quality highway extending from Orange Walk Town to Belmopan is of major importance. Figure 41 shows the suggested location of this highway running from Orange Walk Town through Hill Bank and ending in Belmopan. This highway would provide a direct link between the northern
socio-economic region, including Mexico, and central and southern Belize. Presently, all traffic going north from Belmopan is routed through Belize City and must travel the Northern Highway. The Northern Highway passes through an area of minimal economic potential (see Figure 41) and is of extremely poor quality. The construction of the suggested highway from Belmopan to Orange Walk would open the northwest portion of the country to new development and enhance the development potentials of Belmopan.

Construction aimed at making the Southern Highway a dependable all-weather road has been costly and ineffective. As a result, it is recommended that improvements to this highway be limited to providing the best available road at a restricted cost. Instead of serving as the single overland connection between the central and southern socio-economic regions, the Southern Highway should remain nothing more than a regional transportation route.

In order to tie the southern socio-economic region to the rest of the nation a new, more practical road must be constructed. The recommendation of this thesis is an extension of the Mountain Pine Ridge Road, running from the Western Highway along the western side of the Maya Mountains (see Figures 41 and 42), that would provide a continuous route between Belmopan and Punta Gorda. This suggested route would not only be shorter than the existing route, but it would also be built in terrain more suited to road construction and maintenance. Improvement of the road running along the west side of the Maya Mountains would also open the Vaca Plateau and the Chiquibul Branch Valley to new agricultural development. This highway should also continue into Guatemala near the southern border, giving Belize a better connection to Guatemala City. If the entrance into
Guatemala were made near the location shown in Figure 41 Belize might be spared the expense of constructing a bridge over the Sarstoon River.

The completion of this corridor would provide a direct route between the Mexican border and the southern border with Guatemala. This North-South route, passing through Belmopan and the northern and southern regional growth centers, would act as the backbone of the national transportation system, and change the emphasis of inter-regional travel from a system of indirect coastal highways to a direct internal route.

The transportation linkage between Belmopan and the new port must be of better than average quality to entice industry away from the hurricane prone but convenient port area locations. If the port location is chosen as Commerce Bight immediate major improvements to the Hummingbird Highway will be necessary. These improvements will not only serve the increased traffic from the port to Belmopan and Belize City, but they will also encourage expansion of citrus production into the Caves Branch and Sibun River Valleys. If the port remains in Belize City improvements to the Western Highway between Belize City and Belmopan will be necessary. Although this portion of the Western Highway has undergone recent reconstruction and realignment, additional strengthening would be necessary to withstand the increased truck traffic. It is recommended that the Hummingbird Highway be improved regardless of the eventual port location, with the ultimate goal of making both the Western and Hummingbird Highways modern, properly aligned and of sufficient strength and width to allow for unhampered truck transport.

Improvements to the Western Highway from Belmopan to the Guatemalan border are necessary for the increased agricultural development of the
area and to provide a link between the deep water port and the Peten area of Guatemala. As the Cayo District becomes more productive, especially in the processing of beef and dairy products, transportation connections between the West and the area of consumption and export will become more critical. The Peten region of Guatemala has always been in need of an outlet for locally produced commodities. With the construction of the proposed deep water port and improvement of the related highways, an increase in transshipments from Guatemala could be expected.

Improvements to the national highway network and the completion of a North-South highway extending from Mexico to the southern border would have a definite impact on tourist development. Figure 42 shows how many of the archaeological sites in Belize could be accessed from these roads. The North-South highway would also provide an important link in the Central American highway network by allowing convenient overland movement from the Mexican Yucatan to Guatemala City. Presently, the trip from the Yucatan to Guatemala City over paved highway requires a detour around Belize resulting in many hundreds of excess miles. The large number of archaeological sites in and surrounding Belize combined with a direct highway between the Yucatan and Guatemala City with a branch to the Peten could provide incentive for an increased tourist trade and pass through traffic.

The utilization of toll roads should not be excluded by the Government without a thorough investigation into their feasibility. Toll charges could help defray the cost of providing new, well constructed highways between major urban centers. The advantages afforded by these roads, such as decreased travel time, convenience, and increased vehicle life would
offer the highway user justification for the toll charge.

Summary

Development of Belize is aimed at increasing self-sufficiency and strengthening national unity. Presently, poor internal transportation is preventing the development of isolated, yet productive, regions of the country and hindering a close cultural inter-relationship among the population.

Belize can be divided into three socio-economic regions, based on economic capability, demographic characteristics and growth potential. These regions, constituting the northern, central and southern portions of the country, serve as the basis for regional development in Belize. Each region needs a centrally located growth center which provides the professional, commercial and social needs of the included population and helps promote regional independence.

The related transportation system is an interaction between highway, air, marine and rail networks, designed to serve both the economic development and the cultural, social and governmental needs of the population. Since air transportation is progressing at a steady rate and the need for rail transportation is not yet evident, transportation development in Belize is centered around the development of a deep water port to facilitate in the import-export trade, and a program of internal highway development designed to provide convenient movement of people and produce, to open heretofore isolated areas of the country, and to make Belize a link in the overall highway system of Central America.
The location of the proposed deep water port will have a significant effect on the location of highway development. Whether the final port location is Belize City or Commerce Bight, road improvement associated with the proposed port should provide a dependable and convenient link between the port location and the growth center of Belmopan.

Highway improvements are necessary, since the present system is of very poor quality. Many of the potentially productive areas of Belize are presently inaccessible by all-weather road. This inaccessibility has restricted development, especially for areas in the Northwest and South.

Transportation development should emphasize the need for construction of a major highway extending form the Mexican border directly to Belmopan and then, running west of the Maya Mountains, south to the Guatemalan border. This road would tie the country together and also provide the shortest, good quality overland connection between the Yucatan and Guatemala City.

The construction of this highway should have a direct effect on the number of tourists driving to Belize from the United States and Mexico. The relatively direct link provided between the Yucatan and the Peten District of Guatemala and the extension to Guatemala City should have a particularly significant effect on tourism associated with archaeological sites. A paved road connection between the Yucatan and Guatemala should also strengthen relations between the three neighboring countries.
APPENDIX I

Tables of Distances
Scheduled Air and Shipping Services
Table Al-1

Distances in Air Miles from Belize to Major Centers in the U. S., England, and the Surrounding Caribbean Area

<table>
<thead>
<tr>
<th>City</th>
<th>Air Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago, U. S. A</td>
<td>2700</td>
</tr>
<tr>
<td>Los Angeles, U. S. A.</td>
<td>4500</td>
</tr>
<tr>
<td>Miami, U. S. A.</td>
<td>780</td>
</tr>
<tr>
<td>New York, U. S. A.</td>
<td>1980</td>
</tr>
<tr>
<td>London, England</td>
<td>5600</td>
</tr>
<tr>
<td>Mexico City, Mexico</td>
<td>1140</td>
</tr>
<tr>
<td>Guatemala City, Guatemala</td>
<td>240</td>
</tr>
<tr>
<td>San Pedro Sula, Honduras</td>
<td>120</td>
</tr>
<tr>
<td>Tegucigalpa, Honduras</td>
<td>240</td>
</tr>
<tr>
<td>Managua, Nicaragua</td>
<td>420</td>
</tr>
<tr>
<td>San Salvador, El Salvador</td>
<td>300</td>
</tr>
<tr>
<td>San Jose, Costa Rica</td>
<td>600</td>
</tr>
<tr>
<td>Panama City, Panama</td>
<td>840</td>
</tr>
<tr>
<td>Kingston, Jamaica</td>
<td>780</td>
</tr>
<tr>
<td>San Juan, Puerto Rico</td>
<td>1860</td>
</tr>
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</table>

Source: Ministry of Trade and Finance (9)
### Table Al-2

**Road Distances from Belmopan to Major Centers in North and Central America**

<table>
<thead>
<tr>
<th>City</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guatemala City, Guatemala</td>
<td>500</td>
</tr>
<tr>
<td>Mexico City, Mexico</td>
<td>1300</td>
</tr>
<tr>
<td>San Salvador, El Salvador</td>
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<tr>
<td>Tegucigalpa, Honduras</td>
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<td>Managua, Nicaragua</td>
<td>1170</td>
</tr>
<tr>
<td>San Jose, Costa Rica</td>
<td>1450</td>
</tr>
<tr>
<td>Panama City, Panama</td>
<td>1950</td>
</tr>
<tr>
<td>Los Angeles, U. S. A.</td>
<td>3260</td>
</tr>
<tr>
<td>Chicago, U. S. A.</td>
<td>3250</td>
</tr>
<tr>
<td>New York, U. S. A.</td>
<td>3790</td>
</tr>
<tr>
<td>Toronto, Canada</td>
<td>4260</td>
</tr>
<tr>
<td>Merida, Mexico</td>
<td>420</td>
</tr>
</tbody>
</table>

### Table Al-3

**Road Distances from Belmopan and Belize City to Other Points Within Belize**

<table>
<thead>
<tr>
<th>From</th>
<th>Miles</th>
</tr>
</thead>
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<tr>
<td>Belmopan</td>
<td>Belize City</td>
</tr>
<tr>
<td>Belmopan</td>
<td>Guatemalan Border</td>
</tr>
<tr>
<td>Belmopan</td>
<td>Stann Creek</td>
</tr>
<tr>
<td>Belmopan</td>
<td>Corozal</td>
</tr>
<tr>
<td>Belmopan</td>
<td>Punta Gorda</td>
</tr>
<tr>
<td>Belize City</td>
<td>Corozal</td>
</tr>
<tr>
<td>Belize City</td>
<td>Orange Walk</td>
</tr>
<tr>
<td>Belize City</td>
<td>Guatemalan Border</td>
</tr>
<tr>
<td>Belize City</td>
<td>Stann Creek</td>
</tr>
<tr>
<td>Belize City</td>
<td>Punta Gorda</td>
</tr>
</tbody>
</table>

Source for Both Tables: Ministry of Trade and Industry (9)
Table A1-4

Scheduled Regular International Air Services to Belize International Airport

<table>
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<th>Airline</th>
<th>Route</th>
<th>Schedule</th>
<th>Services</th>
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<tr>
<td>TAN</td>
<td>Miami</td>
<td>Daily</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td></td>
<td>San Pedro Sula</td>
<td>Daily Except Sunday</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td></td>
<td>Tegucigalpa</td>
<td>Daily</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td>TACA</td>
<td>New Orleans</td>
<td>Daily Except Monday</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td></td>
<td>Guatemala City</td>
<td>Wednesday and Friday</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td></td>
<td>Miami</td>
<td>Daily</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td>SASHA</td>
<td>San Pedro Sula</td>
<td>Daily</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td></td>
<td>New Orleans</td>
<td>Daily</td>
<td>Passenger and Freight</td>
</tr>
<tr>
<td></td>
<td>Tegucigalpa</td>
<td>Daily</td>
<td>Passenger and Freight</td>
</tr>
</tbody>
</table>

Source: National Airlines
Table A1-5

Scheduled Shipping Lines Serving Belize City

<table>
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<th>Shipping Line</th>
<th>Route</th>
<th>Frequency</th>
<th>Service</th>
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<tr>
<td>United Brands Co.</td>
<td>New Orleans</td>
<td>Weekly</td>
<td>Cargo</td>
</tr>
<tr>
<td>United Brands Co.</td>
<td>New York</td>
<td>Fortnightly</td>
<td>Cargo and Passengers</td>
</tr>
<tr>
<td>Caribe Trading Co.</td>
<td>Miami</td>
<td>Monthly</td>
<td>Cargo</td>
</tr>
<tr>
<td>J. T. Harrison Ltd.</td>
<td>Liverpool</td>
<td>Fortnightly</td>
<td>Cargo and Passengers</td>
</tr>
<tr>
<td>J. T. Harrison Ltd.</td>
<td>South Hampton</td>
<td>Fortnightly</td>
<td>Cargo</td>
</tr>
<tr>
<td>R. B. Kirkconnell Bros.</td>
<td>Jamaica</td>
<td>Once Every 3 Weeks</td>
<td>Cargo</td>
</tr>
<tr>
<td>ESSO Tanker</td>
<td>Aruba, Jamaica</td>
<td>Once Every 2 Months</td>
<td>Petroleum Products</td>
</tr>
<tr>
<td>K-Line</td>
<td>Kobe, Japan</td>
<td>Monthly</td>
<td>Cargo</td>
</tr>
<tr>
<td>Canada, Jamaica Line</td>
<td>Canada</td>
<td>Monthly</td>
<td>Cargo</td>
</tr>
<tr>
<td>Foster Enterprise Co.</td>
<td>West Indies</td>
<td>Irregular</td>
<td>Cargo</td>
</tr>
<tr>
<td>Bucaneer Line</td>
<td>U. S. A.</td>
<td>Monthly</td>
<td>Cargo</td>
</tr>
<tr>
<td>Hawthorne Trader Co.</td>
<td>West Indies</td>
<td>Irregular</td>
<td>Cargo</td>
</tr>
<tr>
<td>Royal Netherlands S/S Co.</td>
<td>Amsterdam</td>
<td>Fortnightly</td>
<td>Cargo</td>
</tr>
<tr>
<td>Belize Express Line</td>
<td>Honduras, Guatemala</td>
<td>Irregular</td>
<td>Cargo</td>
</tr>
<tr>
<td>Belize Marine Ltd.</td>
<td>Amsterdam</td>
<td>Fortnightly</td>
<td>Cargo</td>
</tr>
<tr>
<td></td>
<td>Honduras</td>
<td>Weekly</td>
<td>Cargo and Passengers</td>
</tr>
</tbody>
</table>

Source: Ministry of Trade and Industry (9)
APPENDIX  2
Charts of Coastal Waters
CENTRAL AMERICA—EAST COAST

GULF OF HONDURAS AND APPROACHES

From a U.S. Navy survey in 1896
with additions from other sources to 1942

SOUNDINGS IN FATHOMS
HEIGHTS IN FEET

For Symbols and Abbreviations, see Chart No. 1

MERCATOR PROJECTION
SCALE 1:290,000 AT LAT. 16°30'

N.O. 28160

Published at Washington, D.C.,
by the U.S. NAVAL OCEANOGRAPHIC OFFICE
under the authority of the SECRETARY OF THE NAVY
CARIBBEAN SEA
CENTRAL AMERICA
BELIZE
APPROACHES TO BELIZE CITY

From British surveys between 1896 and 1922
Portions in hairline and soundings in slanting figures are from
a British survey of 1830

SOUNDINGS IN FATHOMS
reduced to approximately Mean Low Water Springs
HEIGHTS IN FEET ABOVE HIGH WATER OF SPRING TIDES

For Symbols and Abbreviations, see Chart No. 1
Names are not necessarily authoritative
MERCATOR PROJECTION
SCALE 1:125,000 AT LAT. 17°00’
APPENDIX 3

Import / Export Data
Table A3-1

Total Cargo Handled, All Ports, 1963/1972
('000 Long Tons)

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Bulk Petroleum</td>
<td>General Cargo</td>
</tr>
<tr>
<td>1963</td>
<td>19.4</td>
<td>56.4</td>
</tr>
<tr>
<td>1964</td>
<td>24.1</td>
<td>50.4</td>
</tr>
<tr>
<td>1965</td>
<td>27.1</td>
<td>47.6</td>
</tr>
<tr>
<td>1966</td>
<td>27.8</td>
<td>71.0</td>
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<tr>
<td>1967</td>
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<tr>
<td>1968</td>
<td>33.0</td>
<td>75.5</td>
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<tr>
<td>1969</td>
<td>42.4</td>
<td>73.1</td>
</tr>
<tr>
<td>1970</td>
<td>..</td>
<td>..</td>
</tr>
<tr>
<td>1971</td>
<td>38.4</td>
<td>75.2</td>
</tr>
<tr>
<td>1972*</td>
<td>..</td>
<td>..</td>
</tr>
</tbody>
</table>

*Provisional Figures Provided by Customs Dept.

Source: 1970/74 Deep Water Port Study (17)
Table A3-2

Traffic Through Belize City, 1962-1972
('000 Long Tons)

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<thead>
<tr>
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<th>Loaded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bulk</td>
<td>General</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Petroleum</td>
<td>Cargo</td>
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<td></td>
</tr>
<tr>
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<td>..</td>
<td>..</td>
</tr>
<tr>
<td>1964</td>
<td>22.2</td>
<td>..</td>
<td>..</td>
<td>..</td>
</tr>
<tr>
<td>1965</td>
<td>23.2</td>
<td>..</td>
<td>..</td>
<td>..</td>
</tr>
<tr>
<td>1966</td>
<td>24.9</td>
<td>69.5</td>
<td>94.4</td>
<td>51.3</td>
</tr>
<tr>
<td>1967</td>
<td>33.8</td>
<td>55.2</td>
<td>89.0</td>
<td>86.8</td>
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<tr>
<td>1968</td>
<td>29.6</td>
<td>70.1</td>
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<td>99.8</td>
</tr>
<tr>
<td>1969</td>
<td>40.2</td>
<td>69.5</td>
<td>109.7</td>
<td>84.1</td>
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<td>1970</td>
<td>..</td>
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<tr>
<td>1972*</td>
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<td>77.0</td>
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</table>

*Provisional Estimates Provided by Customs Dept.

Source: 1970/74 Deep Water Port Study (17)
Table A3-3

Forecast Future Traffic Through Belize City, 1975-1995
('000 Long Tons)

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</thead>
<tbody>
<tr>
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<td>Bulk Petroleum</td>
<td>General Cargo</td>
</tr>
<tr>
<td>1975</td>
<td>54.7</td>
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<td>1976</td>
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<td>91.9</td>
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<tr>
<td>1980</td>
<td>69.8</td>
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<tr>
<td>1985</td>
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<td>1990</td>
<td>137.3</td>
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<tr>
<td>1995</td>
<td>192.6</td>
<td>256.8</td>
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Source: 1970/74 Deep Water Port Study (17)
Table A3-4

Belize City: Exports by Main Item
('000 Long Tons)

<table>
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<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
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<td>57.7</td>
<td>57.3</td>
<td>67.7</td>
<td>66.5</td>
<td>71.5</td>
<td>78.0</td>
<td>80.0</td>
<td>90.0</td>
<td>100.0</td>
<td>110.0</td>
<td>120.0</td>
</tr>
<tr>
<td>Molasses</td>
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<td>24.1</td>
<td>26.4</td>
<td>21.8</td>
<td>24.0</td>
<td>25.0</td>
<td>26.0</td>
<td>27.0</td>
<td>30.0</td>
<td>33.0</td>
<td>37.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Timber</td>
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<td>6.3</td>
<td>3.9</td>
<td>3.3</td>
<td>3.3</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>4.0</td>
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<tr>
<td>Rice</td>
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<td>...</td>
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<td>50.0</td>
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<tr>
<td>Vegetables</td>
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<td>0.2</td>
<td>0.2</td>
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<td>Honey</td>
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<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
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<td>0.6</td>
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<tr>
<td>Meat R-O</td>
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<td>...</td>
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<td>...</td>
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<td>0.8</td>
<td>0.7</td>
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<td>0.9</td>
<td>1.0</td>
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<td>3.0</td>
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<td>1.4</td>
<td>1.5</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
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<tr>
<td>Total</td>
<td>83.3</td>
<td>93.8</td>
<td>93.7</td>
<td>95.3</td>
<td>98.2</td>
<td>108.7</td>
<td>122.3</td>
<td>128.3</td>
<td>153.5</td>
<td>193.1</td>
<td>239.2</td>
<td>264.8</td>
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<td>0.9</td>
<td>0.9</td>
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<td>1.0</td>
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<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>Total</td>
<td>84.1</td>
<td>94.7</td>
<td>94.6</td>
<td>96.3</td>
<td>99.2</td>
<td>109.7</td>
<td>123.3</td>
<td>129.3</td>
<td>154.5</td>
<td>194.1</td>
<td>231.2</td>
<td>265.8</td>
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Source: 1970/74 Deep Water Port Study (17)
Table A3-5

Production, Exports and Local Sales of Raw Sugar, 1960-1974
(Long Tons)

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>Exports</th>
<th>Local Sales</th>
</tr>
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<tbody>
<tr>
<td>1960</td>
<td>13,641</td>
<td>11,748</td>
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<tr>
<td>1961</td>
<td>27,608</td>
<td>25,053</td>
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<td>1962</td>
<td>25,817</td>
<td>24,250</td>
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<tr>
<td>1963</td>
<td>27,840</td>
<td>25,451</td>
<td>2,428</td>
</tr>
<tr>
<td>1964</td>
<td>33,591</td>
<td>30,447</td>
<td>2,726</td>
</tr>
<tr>
<td>1965</td>
<td>35,288</td>
<td>30,238</td>
<td>2,726</td>
</tr>
<tr>
<td>1966</td>
<td>43,454</td>
<td>43,120</td>
<td>2,603</td>
</tr>
<tr>
<td>1967</td>
<td>58,320</td>
<td>54,478</td>
<td>3,005</td>
</tr>
<tr>
<td>1968</td>
<td>63,588</td>
<td>60,946</td>
<td>2,666</td>
</tr>
<tr>
<td>1969</td>
<td>52,138</td>
<td>48,406</td>
<td>2,261</td>
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<tr>
<td>1970</td>
<td>66,793</td>
<td>57,666</td>
<td>2,538</td>
</tr>
<tr>
<td>1971</td>
<td>64,851</td>
<td>57,319</td>
<td>3,401</td>
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<tr>
<td>1972</td>
<td>69,967</td>
<td>67,258</td>
<td>3,500</td>
</tr>
<tr>
<td>1973*</td>
<td>68,000</td>
<td>66,500</td>
<td>3,900</td>
</tr>
<tr>
<td>1974*</td>
<td>76,500</td>
<td>..</td>
<td>4,000</td>
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*Estimated

Source: 1970/74 Deep Water Port Study (17)
Table A3-6

Production and Export of Molasses, 1964-1973
(Long Tons)

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>8,704</td>
<td>5,127</td>
</tr>
<tr>
<td>1965</td>
<td>11,871</td>
<td>7,420</td>
</tr>
<tr>
<td>1966</td>
<td>13,084</td>
<td>10,453</td>
</tr>
<tr>
<td>1967</td>
<td>21,054</td>
<td>18,444</td>
</tr>
<tr>
<td>1968</td>
<td>24,385</td>
<td>26,028</td>
</tr>
<tr>
<td>1969</td>
<td>18,686</td>
<td>17,409</td>
</tr>
<tr>
<td>1970</td>
<td>26,397</td>
<td>21,554</td>
</tr>
<tr>
<td>1971</td>
<td>22,960</td>
<td>26,420</td>
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<tr>
<td>1972</td>
<td>24,521</td>
<td>21,835</td>
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<tr>
<td>1973*</td>
<td>24,000</td>
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*Estimate

Source: 1970/74 Deep Water Port Study (17)
Table A3-7

Production and Exports of Timber, 1960-1972
(Production/Export '000 Long Tons)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mahogany</th>
<th>Cedar</th>
<th>Pine</th>
<th>Secondary Hardwoods</th>
<th>Total</th>
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<tbody>
<tr>
<td>1960</td>
<td>8.1/9.0</td>
<td>1.1/1.4</td>
<td>15.2/5.0</td>
<td>6.5/2.4</td>
<td>30.8/17.8</td>
</tr>
<tr>
<td>1961</td>
<td>10.3/7.7</td>
<td>2.0/0.6</td>
<td>9.3/4.5</td>
<td>4.7/2.6</td>
<td>26.3/15.4</td>
</tr>
<tr>
<td>1962</td>
<td>8.8/7.7</td>
<td>0.8/0.5</td>
<td>12.3/1.2</td>
<td>2.9/0.2</td>
<td>24.8/ 9.6</td>
</tr>
<tr>
<td>1963</td>
<td>9.2/8.9</td>
<td>0.8/1.1</td>
<td>14.0/2.4</td>
<td>2.4/0.3</td>
<td>26.4/12.6</td>
</tr>
<tr>
<td>1964</td>
<td>6.5/9.4</td>
<td>1.2/1.5</td>
<td>11.8/4.9</td>
<td>2.8/0.5</td>
<td>22.3/16.3</td>
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<tr>
<td>1965</td>
<td>8.4/6.4</td>
<td>1.2/1.2</td>
<td>22.7/2.5</td>
<td>9.2/0.3</td>
<td>41.4/ 8.3</td>
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<td>1967</td>
<td>5.5/3.6</td>
<td>1.3/0.9</td>
<td>6.3/0.3</td>
<td>1.9/0.2</td>
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</tr>
<tr>
<td>1968</td>
<td>6.4/3.1</td>
<td>0.6/1.2</td>
<td>4.5/0.1</td>
<td>3.7/0.6</td>
<td>15.2/ 4.9</td>
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<td>1970</td>
<td>3.9/3.9</td>
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<td>..</td>
<td>8.2/ ..</td>
<td>13.3/ ..</td>
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<tr>
<td>1971</td>
<td>3.9/2.8</td>
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<td>3.0/ ..</td>
<td>4.4/ ..</td>
<td>11.6/ ..</td>
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</table>

Source: 1970/74 Deep Water Port Study (17)
Table A3-8

Exports of Fish and Fish Products, 1960-1972
(Long Tons)

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<tr>
<th>Year</th>
<th>Tons</th>
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</thead>
<tbody>
<tr>
<td>1960</td>
<td>243</td>
</tr>
<tr>
<td>1961</td>
<td>232</td>
</tr>
<tr>
<td>1962</td>
<td>256</td>
</tr>
<tr>
<td>1963</td>
<td>330</td>
</tr>
<tr>
<td>1964</td>
<td>305</td>
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<td>1965</td>
<td>330</td>
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<td>1966</td>
<td>372</td>
</tr>
<tr>
<td>1967</td>
<td>607</td>
</tr>
<tr>
<td>1968</td>
<td>697</td>
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<td>1969</td>
<td>714</td>
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<td>1970</td>
<td>663</td>
</tr>
<tr>
<td>1971</td>
<td>772</td>
</tr>
<tr>
<td>1972*</td>
<td>800</td>
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</table>

*Estimate

Source: 1970/74 Deep Water Port Study (17)
<table>
<thead>
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<th>Year</th>
<th>Tons</th>
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<tr>
<td>1960-65</td>
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<tr>
<td>1966</td>
<td>460*</td>
</tr>
<tr>
<td>1967</td>
<td>2,540*</td>
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<td>1968</td>
<td>3,160*</td>
</tr>
<tr>
<td>1969</td>
<td>5,180</td>
</tr>
<tr>
<td>1970</td>
<td>3,960</td>
</tr>
<tr>
<td>1971</td>
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</tr>
<tr>
<td>1972</td>
<td>279</td>
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</table>

*Cucumbers Only

Source: 1970/74 Deep Water Port Study (17)
Table A3-10
Belize City: Imports by Main Item
('000 Long Tons)

<table>
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<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
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<td>15.2</td>
<td>10.7</td>
<td>11.4</td>
<td>14.3</td>
<td>15.7</td>
<td>17.3</td>
<td>19.0</td>
<td>20.8</td>
<td>39.0</td>
<td>55.0</td>
<td>77.0</td>
</tr>
<tr>
<td>Fertilizers and Bulk Chemicals</td>
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<td>5.0</td>
<td>4.5</td>
<td>4.7</td>
<td>5.0</td>
<td>5.5</td>
<td>6.0</td>
<td>6.5</td>
<td>10.0</td>
<td>16.0</td>
<td>25.0</td>
<td>40.0</td>
</tr>
<tr>
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<td>9.1</td>
<td>8.1</td>
<td></td>
<td></td>
<td></td>
<td>10.0</td>
<td>10.5</td>
<td>12.7</td>
<td>15.5</td>
<td>18.5</td>
<td>23.0</td>
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<tr>
<td>Potatoes</td>
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<td>0.7</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Fruit and Vegetables</td>
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<td>0.9</td>
<td>1.0</td>
<td></td>
<td></td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
<td>7.5</td>
<td>9.0</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>Animal Feed</td>
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<td>2.0</td>
<td>1.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>0.6</td>
<td>0.6</td>
<td>0.8</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
<td>1.0</td>
<td>1.1</td>
<td>1.3</td>
<td>1.6</td>
</tr>
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<td>Cereal Products</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td>0.6</td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Meat and Meat Preparation</td>
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<td>1.7</td>
<td></td>
<td></td>
<td>2.0</td>
<td>2.1</td>
<td>2.3</td>
<td>2.7</td>
<td>3.1</td>
<td>3.6</td>
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<td>4.7</td>
<td>4.5</td>
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<td>4.9</td>
<td>5.1</td>
<td>5.3</td>
<td>6.2</td>
<td>7.5</td>
<td>9.2</td>
<td>11.2</td>
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<td>2.4</td>
<td></td>
<td></td>
<td></td>
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<td>2.3</td>
<td>2.8</td>
<td>3.7</td>
<td>4.8</td>
<td>6.2</td>
</tr>
<tr>
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<td>2.8</td>
<td>2.7</td>
<td>3.0</td>
<td>3.2</td>
<td>3.4</td>
<td>3.6</td>
<td>3.9</td>
<td>5.1</td>
<td>7.5</td>
<td>10.3</td>
<td>14.7</td>
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<td>3.1</td>
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<td>4.9</td>
<td>7.0</td>
<td>9.5</td>
<td>13.0</td>
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<td>28.9</td>
<td></td>
<td></td>
<td></td>
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<td>30.6</td>
<td>33.0</td>
<td>38.0</td>
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<td>Total</td>
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<td></td>
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<td>53.3</td>
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<td>54.7</td>
<td>57.4</td>
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<td>97.9</td>
<td>137.3</td>
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<td></td>
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Source: 1970/74 Deep Water Port Study (17)
Table A3-11

Imports of Cement, 1960-1973
(Long Tons)

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<th>Imports</th>
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<tbody>
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<td>1961</td>
<td>3,787</td>
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<td>7,068</td>
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<td>1963</td>
<td>7,576</td>
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<td>1964</td>
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<td>1965</td>
<td>9,737</td>
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<td>1966</td>
<td>9,473</td>
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<td>1967</td>
<td>8,730</td>
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<td>1968</td>
<td>18,295</td>
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<tr>
<td>1969</td>
<td>13,932</td>
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<td>1970</td>
<td>15,180</td>
</tr>
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<td>1971</td>
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<tr>
<td>1972*</td>
<td>11,400</td>
</tr>
<tr>
<td>1973*</td>
<td>14,300</td>
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*Estimated

Source: 1970/74 Deep Water Port Study (17)
<table>
<thead>
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<th>Year</th>
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</tr>
</thead>
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</tr>
<tr>
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<td>457</td>
</tr>
<tr>
<td>1962</td>
<td>1.543</td>
</tr>
<tr>
<td>1963</td>
<td>3,004</td>
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<tr>
<td>1965</td>
<td>4,224</td>
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<tr>
<td>1966</td>
<td>3,052</td>
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<tr>
<td>1967</td>
<td>2,035</td>
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<tr>
<td>1968</td>
<td>4,608</td>
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<td>1969</td>
<td>6,226</td>
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<tr>
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<td>4,961</td>
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<td>1971</td>
<td>4,467</td>
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<td>1972*</td>
<td>4,700</td>
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<tr>
<td>1973*</td>
<td>5,000</td>
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*Estimate

Source: 1970/74 Deep Water Port Study (17)
Table A3-13
Traffic Through Commerce Bight
(‘000 Long Tons)

<table>
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<tr>
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<tbody>
<tr>
<td></td>
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<td>General</td>
<td>Total</td>
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<tr>
<td></td>
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<td>4.9</td>
<td>29.4</td>
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<td>1.7</td>
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<td>3.9</td>
<td>7.8</td>
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</tbody>
</table>

*Excluding March

Source: 1970/74 Deep Water Port Study (17)
Table A3-14

Exports of Citrus Products (Long Tons)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tonnes</th>
</tr>
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<tbody>
<tr>
<td>1960</td>
<td>8,895</td>
</tr>
<tr>
<td>1961</td>
<td>9,258</td>
</tr>
<tr>
<td>1962</td>
<td>4,479</td>
</tr>
<tr>
<td>1963</td>
<td>8,662</td>
</tr>
<tr>
<td>1964</td>
<td>9,507</td>
</tr>
<tr>
<td>1965</td>
<td>8,986</td>
</tr>
<tr>
<td>1966</td>
<td>11,520</td>
</tr>
<tr>
<td>1967</td>
<td>8,672</td>
</tr>
<tr>
<td>1968</td>
<td>10,600</td>
</tr>
<tr>
<td>1969</td>
<td>10,345</td>
</tr>
<tr>
<td>1970</td>
<td>9,177</td>
</tr>
<tr>
<td>1971</td>
<td>...</td>
</tr>
<tr>
<td>1972</td>
<td>7,800</td>
</tr>
</tbody>
</table>

Source: 1970/74 Deep Water Port Study (17)
APPENDIX 4

Wind and Wave Data for Belize Harbor
Notes:
1. Data taken from U.S. Department of Commerce - Environmental Science Services Administration statistics.
2. Observations recorded at Stanley Airport, Belize.

Legend:
- Thin line for % measurements
- % of calms
- Beaufort force
- Velocity
  - 1 - 2: < 1 knots
  - 3 - 4: 1 - 6 knots
  - 5 and over: 7 knots and over

Scale:

<table>
<thead>
<tr>
<th>Beaufort Force</th>
<th>Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>1 - 6</td>
</tr>
<tr>
<td>10 - 15</td>
<td>7 - 16</td>
</tr>
<tr>
<td>20 - 25</td>
<td>17 and over</td>
</tr>
</tbody>
</table>

British Honduras Deep Water Port Study
1970

Winds

Spring

Summer

Annual

Autumn

Winter
Notes
2. All wave heights shown are significant heights.

Legend
- % of cases
- %
- %
- %

Wave Height
- %
- %
- %
- %

Scale: 1 in = 20%

British Honduras Deep Water Port Study
1970

Locally-generated waves at Belize Harbour

Method of reading rose

Waves from the east - 1 ft for 20% of the time

Spring

Summer

Annual

All directions

Autumn

Winter
Observations recorded in Moresby Square 45, sub-square 50.
See Fig. No. 18 for key plan.

Method of reading wave rose

Waves from the east < 3 ft for 20% of the time
- = = = = = = = 0-1 ft = 16% = = =
- = = = = = = = 1-3 ft = 6% = =
- = = = = = = = > 3 ft = 4% = =

All directions

Annual

Legend:

Wave height
% of time
<3 ft
3-5 ft
5-8 ft
>8 ft

Scale: 1 cm to 20%
Swell at barrier reef

British Honduras
Deep Water Port Study
1970

Notes:
1. Data taken from U.S. Department of Commerce - Environmental Science Services statistics.
2. All wave heights shown are significant heights.

Legend:
- Wave height
  - 20% of cases
  - 1 ft - 6 ft
  - > 6 ft - 12 ft
  - > 12 ft

Scale 1 cm to 20%

Legend:
- Wave height
  - 20% of cases
  - 1 ft - 6 ft
  - > 6 ft - 12 ft
  - > 12 ft

Scale 1 cm to 20%

Observations recorded in Marden Square 45, sub-square 55.

All directions

Annual
Method of reading wave rose

Waves from the east 1-6 ft for 20% of the time

- = = 6-12 ft = 16% = =

- = = >12 ft = 6% = =

October

November

December
APPENDIX 5

Western Highway Road Study
ROAD STUDIES
NORTHERN AND WESTERN HIGHWAYS

FEASIBILITY STUDY

by

SIR WILLIAM HALCROW & PARTNERS

VOLUME 2C
WESTERN HIGHWAY

Belize Road Studies
August 1974
Volume 2C
Section C - Western Highway
Belmopan to Guatemalan Border

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<td>1.2 General Approach</td>
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<td>1.3 Conclusions</td>
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<td>4.3 Traffic Surveys</td>
<td>4/2</td>
</tr>
<tr>
<td>4.4 Analysis</td>
<td>4/2</td>
</tr>
</tbody>
</table>

August 1974

Sir William Halcrow & Partners,
Newcombe House,
45, Notting Hill Gate,
London W11 3JX
CHAPTER 1 – GENERAL

1.1 TERMS OF REFERENCE

The Terms of Reference which were given for Section C of the Western Highway are as follows:-

It is desired to undertake an outline engineering and economic study of the Western Highway from Belmopan to the Guatemalan border, in order to determine the type of road improvements likely to be justifiable and their most suitable phasing.

The consultants shall –

1. Analyse the present traffic flown on this road, according to origin/destination and type of traffic;

2. Examine the factors likely to lead to changes in the level and pattern of traffic, with and without major improvements in the road, and with special reference to the volume of traffic which might be expected to/from Guatemala;

3. Undertake such road inventory and surveys as are necessary to present an adequate picture of the physical condition of the existing road in order, in the light of expected traffic levels on various sections, to submit recommendations on:-

(1) The need for and comparative cost of improved standards of maintenance, minor repairs and improvements, or major reconstruction for each section of the road;

(2) The dates at which such improvements are likely to be economically justified.

1.2 GENERAL APPROACH

The existing road from Belmopan to the Guatemalan border is generally unsurfaced and runs across the terraces of the Belize River and through the foothills of the Mountain Pine Ridge. It passes through one of the best farming areas in Belize and serves the towns of San Ignacio and Benque Viejo.

The present traffic flows were analysed by dividing the road into four sections, conducting origin and destination surveys, registration number surveys and by using information provided by PWD censuses. The traffic was divided into four categories and differential growth rates applied to each category.

The traffic records of the border crossing between Belize and Guatemala were analysed and a visit was made to Guatemala to assess the volume of traffic which might be expected from that country. Other general factors were considered in arriving at the estimated growth rates.

Aerial photography of the whole length of the road was flown at a contact scale of 1 to 10,000 and major points were surveyed for mapping control. For the built-up areas and hilly sections of road minor control points were also surveyed by traversing and mapping was carried out by BKS Surveys Ltd, at a scale of 1 to 5,000 with a contour interval of 5 feet. For the purposes of this Report this mapping has been edited and reduced to a scale of 1 to 10,000 with a contour interval of 25 feet. As much information as possible to provide an adequate picture of the present situation along the road has been added to the Drawings (see Drawings Nos. C.1 to C.9 in the back of this Volume). As discussed in Chapter 4 of Volume 1 the road has been classified into Road Types and details are shown on the Drawings.

The proposals for improvement have been considered and evaluated in the economic analysis. The first involves major reconstruction of the road by an International Contractor over a construction period of 2 years, and the second is for a PWD series of improvements to a lesser design standard over a period of 4 years. The phasing and timing of these improvements have also been studied.

The Chapters which follow elaborate upon various aspects of the study, such as the condition of the existing road, soils and materials investigations, traffic studies, proposed road design, cost estimates and economic evaluations.

1.3 CONCLUSIONS

Our studies of the section of the Western Highway from Belmopan to the Guatemalan border lead us to conclude that:

Average daily traffic flows in 1974 on most of the road exceed 250 vehicles per day and the provision of a bitumen seal is considered justified.

In the year following reconstruction, generated traffic would amount to 33 per cent of the then current traffic.

The existing road has an unsatisfactory running surface and insufficient construction thickness over most of its length and its horizontal and vertical alignment are also unsatisfactory on some sections.

Good construction materials such as river gravels, marls and limestones are available near the line of the existing road.

The cost of reconstruction by an International Contractor would be BZE $7,377,000 at May 1974 prices. The Net Present Value of this Improvement is estimated to be BZE $3,971,000 and the Benefit/Cost ratio 1.85. (The discount rate employed is 8 per cent.).

The cost of PWD Improvements would be BZE $3,158,000 at May 1974 prices. The Net Present Value of this Improvement is estimated to be BZE $2,839,000 and the Benefit/Cost ratio 3.33. (The discount rate employed is 6 per cent.).
CHAPTER 2 - CONDITION OF EXISTING ROAD

2.1 GENERAL DESCRIPTION

The section of the Western Highway under consideration runs between Roaring Creek, near Belmopan, and the Guatemalan border some two miles west of Benque Viejo. About one and a half miles of the Hummingbird Highway linking the Western Highway at Roaring Creek to Belmopan is also considered. The Western Highway lies to the south of the Belize River between Belmopan and San Ignacio and to the north of the river between San Ignacio and the border. It crosses the Belize River via the single lane Hawkesworth suspension bridge which is sited in a picturesque setting between Santa Elena and San Ignacio (see Photograph Nos. 15 and 16 in Volume 1).

Two other single lane bridges are encountered on the route, one near Mile 57 and the other near Mile 64. Both are steel truss bridges. The approaches to the one near Mile 57 are on high narrow embankments on sharp horizontal curves which present a serious driving hazard.

The town of Benque Viejo has a rectangular grid road layout and the Western Highway enters the town at the north-east corner and leaves from the diametrically opposite south-west corner of the grid. The streets of the town are narrow and many of the houses are sited very close to the edges of the streets.

Between Belmopan and the Guatemalan border the Western Highway passes over two main land types. Thirteen miles of the route cross the flat terraces of the Belize River and nineteen miles are located through the northern foothills of the Mountain Pine Ridge.

At one time the length of the road between Roaring Creek and San Ignacio was surfaced but in 1967, at which time potholing and general disintegration became severe, long sections were scarified and have not since been resurfaced with the result that there is a severe dry season dust problem. Some sections of the road have a single lane width of surfacing, which is badly potholed, and along these lengths driving is often more comfortable on the unsurfaced half of the road. Through some of the towns and villages the sealing has been maintained in reasonable condition.

In accordance with the classification method detailed in Chapter 4 of Volume 1, the road has been divided into the Road Types as shown on the 1 to 10,000 series of Drawings in this Volume.

2.2 ROAD GEOMETRY

The horizontal and vertical alignment on the sections which pass over gently undulating river terraces is good. The pavement width varies between 24 feet and 33 feet. On the sections through hilly country, particularly Mile 54.8 to Mile 63.6 and from San Ignacio (Mile 72.5) to the Guatemalan border, the horizontal and vertical alignment of the existing road is very poor. Sight distances, especially on the crests of vertical curves, are dangerously substandard. The width of pavement varies from 19 feet to 42 feet.

2.3 RUNNING SURFACE

The running surface of the road varies from poor to very poor. The worst stretches are those through the hilly sections where water erosion has removed the fines from the surface and exposed the pitching of the underlying construction. On the flatter sections the running surface is potholed especially on the lengths which have a narrow width of surfacing.

During the dry season the road becomes dusty particularly on the flatter sections where there is a greater quantity of loose fines on the surface. After rain these sections are slippery and where there is inadequate super-elevation on bends driving conditions become very dangerous.

2.4 DRAINAGE AND DRAINAGE STRUCTURES

There are four major bridge crossings along the section of road under consideration. The Hawkesworth suspension bridge and the two steel truss bridges at Mile 57 and Mile 64 have been mentioned earlier in this Chapter. The fourth bridge (see Photograph No. 37), which is a reinforced concrete Spandrel arch bridge, is located near Roaring Creek at Mile 50.

Generally the drainage networks are well defined with a flow from south to north into the Belize River. Flooding occurs locally at Mile 58 and Mile 60 where runoff from the hills overtops the road.

The inventory of the existing bridges and culverts is given on the typed sheets which are interleaved with the 1 to 10,000 series of Drawings in this Volume.
CHAPTER 3 - SOILS AND MATERIALS INVESTIGATIONS

3.1 SOILS AND VEGETATION

The existing road passes through one of the main farming regions of Belize. From Mile 83 to Mile 72 much of the land is farmed, mainly under pasture, but citrus and coconut are also grown. There is little or no cultivation on the other sections.

The following descriptions of soils and vegetation are largely based on the work of the Land Use Survey Team.

From Belmopan to Mile 83 the soils are Caxa clay and a gravelly clay hill soil, derived from detrital limestone. They are slightly red but darkened by eolian dust and litter. The soils are deep and fertile and the natural vegetation is a deciduous seasonal forest.

From Mile 83 to San Ignacio the road passes through a region which is covered by a very fertile Caxuza river terrace soil, with pockets of Meltede silty clay, which is deep but slow draining. Both these soils are formed by deposition of river silt. The natural vegetation is a semi-evergreen seasonal forest.

From San Ignacio to Mile 77 the soil is Yaxa clay which is slow draining and moisture retentive. Usually there is no groundwater table and wetting does not, therefore, occur. The natural vegetation is a deciduous seasonal forest.

From Mile 77 to the Guatemalan border the road is on Caxa clay as from Mile 83 to San Ignacio. The natural vegetation is a semi-evergreen seasonal forest.

3.2 INVESTIGATION OF EXISTING ROAD AND PAVEMENT CONSTRUCTION

Trial holes were excavated in the existing pavement construction at 1 mile intervals to determine the type and thickness of materials and assess their suitability for retention as part of the pavement. The details of these trial holes are shown in Table 3.1. Generally the pavement was constructed with a single course of either marl and broken limestone or gravel. The thickness of construction ranged from 2 inches to 36 inches but was generally between 8 and 18 inches.

Undisturbed CBR samples were taken from the subgrade at Mile 54 (Hummingbird Highway), Mile 55 and Mile 64. Tests on these samples indicated an unsoaked subgrade CBR value of 8 to 9 per cent, which is a similar value to both sections of the Northern Highway.

3.3 POSSIBLE CONSTRUCTION MATERIALS

There are sources of good construction materials along the entire length of the road from Roaring Creek to the Guatemalan Border and these are discussed below.

3.31 MARL AND LIMESTONE

Through the hilly areas the road runs through marl-covered limestone hills. The covering of marl varies from a low inch to several feet thick and the underlying limestone becomes harder with depth. The main construction problem is the winning of the harder limestone without blasting. Generally the limestone becomes too hard to rip at a fairly shallow depth but because of the abundance along the route of less hard deposits it should be possible to win sufficient quantities of suitable material for construction without blasting. The marl limestone is very similar to that used by the Secretaria de Obras Publicas in Quintana Roo, Mexico and is stouter than the marls found on Section A. The marl within possible borrow areas is likely to be very variable ranging from a white stoney marl, with a low plasticity, to a much darker clayey marl. This is demonstrated by tests carried out by the Crown Agents on the marls from the borrow area at Mile 49.7 on the Western Highway, the results of which are shown in Table 3.2.

3.32 GRAVELS

There is an abundance of well-graded river gravel in the Belize River which runs roughly parallel to the line of the road. The gravel is available on most beds of the river within two miles of the road and is likely to be suitable for use as a sub-base and base material although for the latter crushing may be required.

Table 3.2: Results of Tests carried out by the Crown Agents on Marl From Mile 49.7 on the Western Highway

<table>
<thead>
<tr>
<th>COLOUR OF MARL</th>
<th>M.D.D (lb/cu.ft)</th>
<th>O.M.(%)</th>
<th>P.I. (per cent)</th>
<th>C.B.R. (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>130</td>
<td>11</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Brown-white</td>
<td>117</td>
<td>10</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>Greenish brown</td>
<td>109</td>
<td>20</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Black brown</td>
<td>103</td>
<td>23</td>
<td>34</td>
<td>4</td>
</tr>
</tbody>
</table>

NOTE: * C.B.R. values on samples compacted at 98 per cent of BS-Roof Compaction and soaked for 4 days.
<table>
<thead>
<tr>
<th>MILE</th>
<th>SURFACING</th>
<th>BASE/SUB-BASE</th>
<th>TOTAL THICKNESS OF CONSTRUCTION (inches)</th>
<th>SUBGRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belmopan Link Surfacings</td>
<td>Marl and broken limestone</td>
<td>6</td>
<td>Sandy clay</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Unsurfaced</td>
<td>Marl and broken limestone on well graded gravel</td>
<td>8</td>
<td>Gravelly clay</td>
</tr>
<tr>
<td>51</td>
<td>Surface dressing</td>
<td>Marl and broken limestone</td>
<td>6</td>
<td>Marl</td>
</tr>
<tr>
<td>52</td>
<td>Unsurfaced</td>
<td>Marl and broken limestone on sandy gravel</td>
<td>20</td>
<td>Clay</td>
</tr>
<tr>
<td>53</td>
<td>&quot;</td>
<td>Stone pitching on gravelly clay</td>
<td>10</td>
<td>Clay</td>
</tr>
<tr>
<td>54</td>
<td>&quot;</td>
<td>Marl and broken limestone</td>
<td>16</td>
<td>Clay</td>
</tr>
<tr>
<td>55</td>
<td>2&quot; grouted macadam</td>
<td>Marl on gravel</td>
<td>13</td>
<td>Sandy clay</td>
</tr>
<tr>
<td>56</td>
<td>Unsurfaced</td>
<td>Limestone and quartz gravel on 24&quot; rockfill</td>
<td>30</td>
<td>Clay</td>
</tr>
<tr>
<td>57</td>
<td>Surface dressing</td>
<td>3&quot;marl on 3&quot; grouted macadam on 6&quot; crushed limestone</td>
<td>12</td>
<td>Sandy clay</td>
</tr>
<tr>
<td>58</td>
<td>Unsurfaced</td>
<td>Marl and broken limestone</td>
<td>6</td>
<td>Clay</td>
</tr>
<tr>
<td>59</td>
<td>&quot;</td>
<td>Marl and broken limestone on clayey gravel</td>
<td>14</td>
<td>Clay</td>
</tr>
<tr>
<td>60</td>
<td>&quot;</td>
<td>Well-graded gravel</td>
<td>4</td>
<td>Clay</td>
</tr>
<tr>
<td>61</td>
<td>&quot;</td>
<td>Gravel on marl</td>
<td>18</td>
<td>Clay</td>
</tr>
<tr>
<td>62</td>
<td>&quot;</td>
<td>Marl and broken limestone</td>
<td>9</td>
<td>Clay</td>
</tr>
<tr>
<td>63</td>
<td>&quot;</td>
<td>&quot;</td>
<td>36</td>
<td>Marl</td>
</tr>
<tr>
<td>64</td>
<td>&quot;</td>
<td>Well graded gravel</td>
<td>12</td>
<td>Silty clay</td>
</tr>
<tr>
<td>65</td>
<td>&quot;</td>
<td>&quot;</td>
<td>10</td>
<td>Clay</td>
</tr>
<tr>
<td>66</td>
<td>&quot;</td>
<td>Marl on well-graded gravel</td>
<td>17</td>
<td>Clay</td>
</tr>
<tr>
<td>67</td>
<td>1½&quot;grouted macadam</td>
<td>Gravel</td>
<td>7</td>
<td>Clay</td>
</tr>
<tr>
<td>68</td>
<td>Surface dressing</td>
<td>Crushed limestone on gravel</td>
<td>7</td>
<td>Silty clay</td>
</tr>
<tr>
<td>69</td>
<td>&quot;</td>
<td>Marl</td>
<td>9</td>
<td>Clay</td>
</tr>
<tr>
<td>70</td>
<td>Unsurfaced</td>
<td>Gravel on marl</td>
<td>12</td>
<td>Marl</td>
</tr>
<tr>
<td>71</td>
<td>1&quot; grouted macadam</td>
<td>Marl on stone pitching</td>
<td>10</td>
<td>Silty clay</td>
</tr>
<tr>
<td>72</td>
<td>3&quot; grouted macadam</td>
<td>Clayey gravel</td>
<td>9</td>
<td>Clay</td>
</tr>
<tr>
<td>73</td>
<td>Unsurfaced</td>
<td>Marl</td>
<td>17</td>
<td>Clay</td>
</tr>
<tr>
<td>74</td>
<td>&quot;</td>
<td>Marl and broken limestone</td>
<td>16</td>
<td>Marl</td>
</tr>
<tr>
<td>75</td>
<td>&quot;</td>
<td>Marl</td>
<td>14</td>
<td>Clay</td>
</tr>
<tr>
<td>76</td>
<td>&quot;</td>
<td>Marl and gravel</td>
<td>3</td>
<td>Marl</td>
</tr>
<tr>
<td>77</td>
<td>&quot;</td>
<td>Gravel</td>
<td>2(varies)</td>
<td>Clay</td>
</tr>
<tr>
<td>78</td>
<td>&quot;</td>
<td>Marl and broken limestone</td>
<td>8</td>
<td>Clay</td>
</tr>
<tr>
<td>79</td>
<td>3&quot;grouted macadam</td>
<td>Well-graded gravel</td>
<td>11</td>
<td>Clay</td>
</tr>
<tr>
<td>80</td>
<td>Unsurfaced</td>
<td>Gravel</td>
<td>12</td>
<td>Clayey marl</td>
</tr>
<tr>
<td>81</td>
<td>&quot;</td>
<td>Gravel</td>
<td>5(varies)</td>
<td>Clay</td>
</tr>
<tr>
<td>82</td>
<td>&quot;</td>
<td>Gravel and broken limestone</td>
<td>16</td>
<td>Gravel</td>
</tr>
</tbody>
</table>
CHAPTER 4 – TRAFFIC STUDIES

4.1 INTRODUCTION

Section C runs from Belmopan to the Guatemalan border. Between the entrance to Belmopan from the Hummingbird Highway, and the Roaring Creek junction of the Western and Hummingbird Highways at Mile 50, is a 1/2 mile stretch of road which should be improved as part of any scheme for Section C. No traffic studies were undertaken on this short section of road, but vehicle operating cost benefits from its improvement were included in the economic analysis on a proportionate basis discussed in Chapter 7 of this Volume. For the purposes of the traffic studies and subsequent analysis the road from Mile 50 to Mile 82 on the Western Highway was divided into four sub-sections: Mile 50 to Georgetown; Georgetown to San Ignacio; San Ignacio to Benque Viejo; and Benque Viejo to the Guatemalan border. Annual traffic volumes on the four sub-sections were assessed by vehicle category for 1974 by derivation from the traffic surveys and the PWD National Census records.

The procedures followed in the traffic surveys for Section C are similar to those already stated in respect of Sections A and B and hence the descriptions of the surveys will be confined to reporting the main results and referring the reader to the Appendices in which the full results are set out.

4.2 PWD NATIONAL CENSUS

PWD National Census points are located on the Western Highway at Miles 4, 18, 35, 51, 69 and 76. The table below gives the historic growth rates in percent per annum from 1969 to 1974 for these points and compares them with the average for the 25 points on the Northern and Western Highways, or on roads having junctions with them. The locations of the census points are shown on Figure 8.1 in Volume 1 and full details of the historic growth rates are given in Appendix E.1.

<table>
<thead>
<tr>
<th>Location at Mile</th>
<th>Census point No.</th>
<th>All vehicles</th>
<th>Light vehicles</th>
<th>Heavy vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>21</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>35</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>51</td>
<td>20</td>
<td>11</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>69</td>
<td>22</td>
<td>12</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>76</td>
<td>24</td>
<td>25</td>
<td>8</td>
<td>31</td>
</tr>
</tbody>
</table>

* Affected by construction traffic on Western Highway

4.3 TRAFFIC SURVEYS

4.31 REGISTRATION NUMBER SURVEY

Survey points were chosen at Teakettle, Central Farm and Chia, and the Customs Post provided a fourth. The survey took place between Saturday and Tuesday, May 18-21, for 18 hours per day, 5 am to 11 pm. The survey results are recorded in Appendix E.6. The locations of the survey points for the Registration Number survey and for the other Section C surveys are shown on Figure 8.3 in Volume 1.

4.32 ORIGIN AND DESTINATION SURVEY

The Registration Number survey was concluded on Tuesday May 21 with an OD survey during the daylight hours of 8 am to 6 pm. The local Police assisted in stopping drivers for the answering of the questionnaire. The location for the survey was Central Farm, again chosen as on Section A and B on grounds of suitability, with adequate road width and a flat road surface. The results of the survey are given in Appendix E.7.

4.33 WHEEL LOAD SURVEY

The Wheel Load survey was made during the Registration Number survey on Tuesday May 21. All buses and trucks were weighed, and the results are shown in Figure 4.1 (see also Appendix E.8).

4.34 AUTOMATIC TRAFFIC RECORDER

One automatic traffic recorder (ATR) was used on Section C at Teakettle. As was the case on Section B of the supervision of the ATR was given to a local man. This was especially necessary in this location which was a long distance from the study team's base office in Orange Walk Town. The result was once again very satisfactory and in the month of its use the ATR was not damaged in any way. The record of results is given in Appendix E.9.

4.4 ANALYSIS

4.41 ANNUAL FLOWS IN BASE YEAR

Flows from the PWD National Census data and the survey results were used in the compilation of the sub-section flows. The table below gives the flows estimated for Base Year 1974.

<table>
<thead>
<tr>
<th>Sub-section</th>
<th>Buses</th>
<th>VEHICLE CATEGORY</th>
<th>VEHICLE FLOW</th>
<th>AVERAGE DAILY TRAFFIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mile 50 to Georgetown</td>
<td>4,500</td>
<td>20,000</td>
<td>41,000</td>
<td>39,000</td>
</tr>
<tr>
<td>Georgetown to San Ignacio</td>
<td>4,500</td>
<td>10,000</td>
<td>63,000</td>
<td>53,000</td>
</tr>
<tr>
<td>San Ignacio to Benque Viejo</td>
<td>1,900</td>
<td>8,500</td>
<td>30,500</td>
<td>54,200</td>
</tr>
<tr>
<td>Benque Viejo in Border</td>
<td>1,300</td>
<td>0,800</td>
<td>18,900</td>
<td>18,900</td>
</tr>
</tbody>
</table>
NUMBER OF COMMERCIAL AXLES

WHEEL LOAD SURVEY RESULTS

(Derivation of Standard Axles based on Table 3 in LR 279(6))

SECTION C CENTRAL FARM

Fig. 4.1

Sample size 57 vehicles

BUSES AND TRUCKS: 52 standard axles per 100 commercial vehicles
FUTURE TRAFFIC GROWTH

The growth rates established in Chapter 9 of Volume 1 are used on all sub-sections of Section C as best estimates. These growth rates compare with the historic rates of growth on Section C during the years 1969-1974 of 11 per cent per annum at Mile 51 and about 20 per cent per annum near San Ignacio. The improvement of Section C will not significantly open up the route beyond the Belize border with Guatemala, but it is assumed that when Section B is improved, one third of the postulated tourist traffic on the Northern Highway will travel on the Western Highway, whether or not Section C is improved.

CHAPTER 5 – ROAD DESIGN

5.1 GENERAL

The general design considerations are discussed in Chapter 7 of Volume 1, but the design standards and requirements which apply specifically to the road from Belmopan to the Guatemalan border are discussed in this Chapter.

The poor operating conditions on the existing road arise because the road is unsurfaced and insufficient has been spent on maintenance to keep the running surface in good condition. Reconstruction of the base and the provision of a waterproof surfacing would remove potholes and overcome the dust problem.

5.2 GEOMETRIC DESIGN

The existing alignment of the flat sections of the road is good and no major realignments are required to achieve the desirable design speed of 50 mph. For the sections of the road through the hilly areas, however, particularly from Mile 54.8 to Mile 63.8, and from San Ignacio to the Guatemalan border, the safe operating speed based on the road geometry is well below 50 mph. Improvements to the alignment to a design speed of 50 mph would require major reconstruction and large expenditure on earthworks. Two alternatives have been considered. First, major reconstruction by an International Contractor to a design speed of 40 mph, and, secondly, a series of PWD improvements to a design speed of 30 mph. The required improvements to the vertical alignment for a design speed of 40 mph are shown in the 1 to 10,000 series of Drawings in this Volume. The proposed design standards for the PWD improvements and major reconstruction are given below:

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Minimum Widths (feet)</th>
<th>Maximum Widths (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum (feet)</td>
<td>Maximum (feet)</td>
</tr>
<tr>
<td></td>
<td>Absolute</td>
<td>Desired</td>
</tr>
<tr>
<td></td>
<td>General (per cent)</td>
<td>Absolute (per cent)</td>
</tr>
</tbody>
</table>

**PWD Improvements**

(i) Flat sections: 50 75 1200 4 7 34 22
(ii) Hilly sections: 30 25 400 8 12 28 22

**Major Reconstruction**

(i) Flat sections: 50 75 1200 4 7 34 22
(ii) Hilly sections: 40 50 800 6 10 28 to 34 22
Table 5.1: CUMULATIVE STANDARD AXLES – SECTION C

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Assumed growth rate (one way)</th>
<th>Annual flow (one way) 1974</th>
<th>Vehicles per day (one way) 1974</th>
<th>Vehicles per day (one way) 1978</th>
<th>Cumulative no. of commercial vehicles 1978-87</th>
<th>No. of standard axles per 100 commercial vehicles 1978-87</th>
<th>Cumulative no. of standard axles 1978-87</th>
<th>Cumulative no. of standard axles 1978-87</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roaring Creek to Georgeville</td>
<td>Buses 3%</td>
<td>2,250</td>
<td>6.18</td>
<td>9.25</td>
<td>38,860</td>
<td>90,670</td>
<td>52</td>
<td>20,210</td>
</tr>
<tr>
<td></td>
<td>Trucks 5%</td>
<td>10,000</td>
<td>27.40</td>
<td>44.40</td>
<td>199,810</td>
<td>532,820</td>
<td>52</td>
<td>103,900</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>124,110</td>
<td>324,220</td>
</tr>
<tr>
<td>Georgeville to San Ignacio</td>
<td>Buses 3%</td>
<td>2,250</td>
<td>6.18</td>
<td>9.25</td>
<td>38,860</td>
<td>90,670</td>
<td>52</td>
<td>20,210</td>
</tr>
<tr>
<td></td>
<td>Trucks 5%</td>
<td>9,500</td>
<td>28.03</td>
<td>42.18</td>
<td>189,810</td>
<td>506,170</td>
<td>52</td>
<td>98,700</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>118,910</td>
<td>310,360</td>
</tr>
<tr>
<td>San Ignacio to Benque Viejo</td>
<td>Buses 3%</td>
<td>950</td>
<td>2.60</td>
<td>3.91</td>
<td>16,400</td>
<td>38,280</td>
<td>52</td>
<td>8,530</td>
</tr>
<tr>
<td></td>
<td>Trucks 5%</td>
<td>4,250</td>
<td>11.64</td>
<td>18.87</td>
<td>84,920</td>
<td>228,450</td>
<td>52</td>
<td>44,160</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52,690</td>
<td>137,860</td>
</tr>
<tr>
<td>Benque Viejo to Border</td>
<td>Buses 3%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12,900</td>
<td>34,630</td>
<td>52</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Trucks 5%</td>
<td>650</td>
<td>1.78</td>
<td>2.89</td>
<td></td>
<td></td>
<td>52</td>
<td>6,750</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,750</td>
<td>18,010</td>
</tr>
</tbody>
</table>

NOTE: Generated traffic following reconstruction by an International Contractor in 1978 has been taken as 33 per cent of the 1978 flows. The cumulative number of Standard Axles for PWD improvements will be slightly less than the figures above because generated traffic is delayed until 1980.
At San Ignacio and Benque Viejo the existing road passes through areas of relatively dense population. New alignments were investigated through both towns. At San Ignacio the alignment is fixed by the Hawkesworth Bridge, a suspension bridge 480 feet long with a roadway 12 feet wide, which crosses the Belize River (see Photograph Nos. 15 and 16 in Volume I). Without large expenditure on a new bridge and earthworks further upstream it is not possible to improve the present alignment significantly. At Benque Viejo through traffic has to pass along narrow streets from one corner of the village to leave at the opposite corner (see Photograph No. 18 in Volume I). A bypass was investigated to the south of the village and a possible route selected (see Drawing No. C.1).

5.3 PAVEMENT DESIGN

The details of the traffic studies carried out on the existing road are given in Chapter 4. The road has been divided into four sections and traffic flows and growth rates have been determined for these sections which are as follows:

- Roaring Creek to Georgeville: 15 miles
- Georgeville to San Ignacio: 7 miles
- San Ignacio to Benque Viejo: 8 miles
- Benque Viejo to Guatemalan Border: 2 miles

Using the method of pavement design discussed in Chapter 7 of Volume I the cumulative number of standard axles for the design life of 10 years and the economic evaluation period of 20 years have been calculated and are shown in Table 5.1. The generated traffic at the end of the construction period has been taken as 33 per cent for both PWD improvements and major reconstruction.

Assuming a subgrade CBR value of 10 per cent the required pavement thickness for a design life of 10 years for all sub-sections is about 10 inches using the Pavement Design Chart given in LR 27(2).

The cumulative standard axles does not reach 0.5 million for any of the sub-sections during the economic evaluation period of 20 years and strengthening of the pavement is not likely to be required during this period.

Details of typical proposed pavement cross-sections are shown on Drawing No. C.11.

5.4 SURFACING

Our traffic studies (see Chapter 4) show total vehicle traffic flows on the four sections in 1974 as follows:

<table>
<thead>
<tr>
<th>Section</th>
<th>Total V.P.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roaring Creek to Georgeville</td>
<td>280</td>
</tr>
<tr>
<td>Georgeville to San Ignacio</td>
<td>384</td>
</tr>
<tr>
<td>San Ignacio to Benque Viejo</td>
<td>290</td>
</tr>
<tr>
<td>Benque Viejo to border</td>
<td>74</td>
</tr>
</tbody>
</table>

As discussed in Chapter 7 of Volume I bituminous sealing is considered justified for the traffic flows on the road from Belmopan to Benque Viejo and it may be considered politically desirable to surface the short length of road between Benque Viejo and the Guatemalan border.
CHAPTER 6 – COST ESTIMATES

6.1 CONSTRUCTION COSTS

6.11 METHOD OF CONSTRUCTION

As discussed in earlier Chapters two methods of construction have been considered for improvements to the Western Highway from Belmopan to the Guatemalan border. Minor improvements by a Management Team using PWD plant and major reconstruction by an International Contractor have been costed. A construction period of 24 months is envisaged for the major reconstruction and 4 years for the PWD improvements.

The different aspects of the costs are discussed briefly in the following paragraphs and a summary of the costs is given in Table 6.1. Detailed bills of quantities are given in Volume 3.

6.12 PWD IMPROVEMENTS

In the case of a programme of PWD improvements the quantity of earthworks would be kept to a minimum and only the very dangerous standard sight distances improved.

No replacement or duplication of the existing bridges would be allowed for but allowance should be made for the provision of guard-rails on the approaches to the steel truss bridges at Mile 57 and mile 64. Major culverts would be constructed at Mile 56 and Mile 60 and minor culverts installed where necessary. The existing culverts would be cleaned and repaired.

The existing running surface would be improved by adding new courses of marl sub-base and river gravel base except through the villages where the existing surfacing is in good condition. Sealing would be carried out from Belmopan to the Guatemalan border using a prime cost and single surface dressing.

The cost estimates have been prepared using the current (May 1974) PWD plant and labour rates as charged externally in the calculation of the unit rates, except that the rate for the hire of trucks has been increased to BZE $ 80 per day. The costs of the general items, such as the preliminary items and the provision of offices and transport for the supervising staff, have been taken as 5 per cent of the cost of construction.

6.13 MAJOR RECONSTRUCTION

Major reconstruction of the road by International Contractor would involve major earthworks on the hilly sections to improve the road geometry to a design speed of 40 mph and to increase the existing road width to allow for the construction of shoulders. It has been assumed in the estimates that half the quantity of excavation required would be in rock which would require blasting.

The Hawkesworth Bridge at San Ignacio and the Springfield arch bridge at Roaring Creek are considered acceptable for the axle loads and traffic flows envisaged over the economic evaluation period of 20 years. The two steel truss bridges would be replaced or duplicated and major culverts would be required at Mile 58 and Mile 60 where local flooding occurs. Minor culverts would be required along the road and repairs to existing culverts would also be necessary.

The existing pavement would be strengthened with crushed river gravel from the Belize River along the entire length of the road. Shoulders 6 feet wide through the hilly sections would make this prohibitively expensive. On these sections the width of shoulder could be reduced to 3 feet but a 22 feet wide carriageway would be maintained on all sections. Sealing would be carried out from Belmopan to the Guatemalan border using a prime cost and single surface dressing.

The costs of the general items have been taken as 10 per cent of the cost of construction.

6.2 MAINTENANCE COSTS

As discussed in Chapter 8 of Volume 1 maintenance costs have been assessed for the With and Without Improvement situations. The maintenance costs for the road from Belmopan to the Guatemalan border are given below.

Without Improvement: The maintenance costs for the Without Improvement situation are intended to be sufficient to maintain the road in its present condition such that vehicle operating costs remain the same, and also sufficient for such road widening or other improvements as may be necessary to permit the increasing traffic to maintain present dry speeds. The annual maintenance cost adopted for the road from Belmopan to the Guatemalan border is BZE $ 4,800 per mile in 1974 increasing at 6.5 per cent per annum.

With Improvement: The annual maintenance cost for the road after either PWD Improvements or major reconstruction has been taken as BZE $ 2,000 per mile (not increasing annually). The cost includes for resurfacing every 5 to 8 years. Strengthening of the pavement is not likely to be required during the economic evaluation period of 20 years.
<table>
<thead>
<tr>
<th>Description</th>
<th>PWD Improvements</th>
<th>MAJOR Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. General</td>
<td>124,300</td>
<td>508,100</td>
</tr>
<tr>
<td>B. Site Clearance</td>
<td>7,000</td>
<td>80,000</td>
</tr>
<tr>
<td>C. Earthworks</td>
<td>498,300</td>
<td>2,528,500</td>
</tr>
<tr>
<td>D. Drainage</td>
<td>36,200</td>
<td>356,400</td>
</tr>
<tr>
<td>E. Pavement</td>
<td>1,924,300</td>
<td>2,085,900</td>
</tr>
<tr>
<td>F. Compensation</td>
<td>20,000</td>
<td>50,000</td>
</tr>
<tr>
<td>G. Contingencies</td>
<td>281,000</td>
<td>558,900</td>
</tr>
<tr>
<td>H. (i) Addition for PWD/Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team overheads and for design</td>
<td>287,100</td>
<td></td>
</tr>
<tr>
<td>and supervision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Addition for Contractor’s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>overheads, risks and profit and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for design and supervision</td>
<td>1,229,500</td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS BZE</strong></td>
<td><strong>3,158,200</strong></td>
<td><strong>7,377,300</strong></td>
</tr>
</tbody>
</table>

NOTE: All prices refer to May 1974
CHAPTER 7 – ECONOMIC ANALYSIS

7.1 INTRODUCTION

The analysis of the two Section C alternative schemes, major reconstruction and PWD improvements, was confined to the economic comparison of the schemes with fixed assumptions regarding growth, and without recourse to sensitivity analysis. The benefit to be gained from the major reconstruction would be greater than that from the PWD improvements, but due to the former scheme's considerably greater construction costs the PWD improvement has a higher Net Present Value and is the preferred scheme. The major reconstruction alternative would be constructed by International Contractor during 1978 and 1977, while the PWD improvements would be constructed over the four year period 1978 to 1979. The evaluation period was the 20 year period 1978 to 1997, but in each scheme additional benefits would arise from part completion in 1977, and these are included.

The calculation of savings was based on the reduction in vehicle operating costs to traffic using the Western Highway between Mile 50 and the Guatemalan border. Benefits from improvement to the 1% miles of road between Mile 50 and the entrance to Belmopan were not calculated due to lack of traffic data, but have been included in the economic evaluation by increasing the benefits for the Western Highway in proportion to the extra length of road.

7.2 MAJOR RECONSTRUCTION

7.21 VEHICLE OPERATING COSTS

Construction of this scheme would take place over the years 1978 and 1977. It is assumed that the road between Belmopan and Georgeville would be reconstructed by 1977 and the whole road by 1978. The costs of travel Without Improvement to the road over the evaluation period are assessed from the VOC indices of the sub-sections of the road. These are:

<table>
<thead>
<tr>
<th>WITHOUT IMPROVEMENT</th>
<th>WITH IMPROVEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1977</td>
</tr>
<tr>
<td>Mile 50 to Georgeville</td>
<td>1.588</td>
</tr>
<tr>
<td>Georgeville to San Ignacio</td>
<td>1.805</td>
</tr>
<tr>
<td>San Ignacio to Benque Viejo</td>
<td>1.823</td>
</tr>
<tr>
<td>Benque Viejo to border</td>
<td>1.611</td>
</tr>
<tr>
<td>Mile 50 to border</td>
<td>1.844</td>
</tr>
</tbody>
</table>

The calculation of vehicle operating costs for each vehicle type is explained in Chapter 9 of Volume 1 (see also Appendix C).

7.22 GENERATED TRAFFIC

Generated traffic may be expected from improvement to Section C when costs of travel are lowered. The costs of typical journeys using Section C after improvement expressed as a proportion of the costs on the unimproved road, are shown below:

| Mile 50 to Guatemalan border | 65% |
| Belize City to Guatemalan border | 82% |

It was assumed that the average journey using an improved Section C would cost 75 per cent of its former price, leading on the assumption of unitary price elasticity to an increase in traffic of 33 per cent.

7.23 MAINTENANCE AND CONSTRUCTION COSTS

The annual cost of maintaining a sealed road was assessed to be BZE $ 2000 per mile. The cost of maintaining the road without improvement was calculated to be BZE $ 4900 per mile increasing in real terms at 5.5 per cent per annum if further deterioration and increased vehicle operating costs were to be avoided. Savings from reducing maintenance are calculated after discounting to be BZE $ 2,177,000.

The construction costs of BZE $ 7,377,000 incurred in 1976 and 1977 total BZE $ 6,090,000 after discounting.

No strengthening of the pavement is required within the evaluation period.

7.3 PWD IMPROVEMENTS

7.31 VEHICLE OPERATING COSTS

The PWD improvements would take place over a period of four years from 1978 to 1979, from Belmopan to the border. The VOC indices of each sub-section of road through the evaluation period are shown below:

<table>
<thead>
<tr>
<th>WITHOUT IMPROVEMENT</th>
<th>WITH IMPROVEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mile 50 to Georgeville</td>
<td>1.588</td>
</tr>
<tr>
<td>Georgeville to San Ignacio</td>
<td>1.805</td>
</tr>
<tr>
<td>San Ignacio to Benque Viejo</td>
<td>1.823</td>
</tr>
<tr>
<td>Benque Viejo to border</td>
<td>1.611</td>
</tr>
<tr>
<td>Mile 50 to border</td>
<td>1.844</td>
</tr>
</tbody>
</table>
Table 7.1: ECONOMIC ANALYSIS — SECTION C  
COSTS AND BENEFITS (In BZE $ 000’s at May 1974 prices, discounted to Present Value Year 1974)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Reconstruction</td>
<td>6,721</td>
<td>145</td>
<td>1,015</td>
<td>7,884</td>
<td>10,061</td>
<td>6,090</td>
</tr>
<tr>
<td>PWD Improvement</td>
<td>5,157</td>
<td>122</td>
<td>779</td>
<td>6,058</td>
<td>1,993</td>
<td>8,051</td>
</tr>
</tbody>
</table>

NOTES: VEHICLE OPERATING COST BENEFITS

a. Columns 1 and 2 refer to "normal" traffic, non-tourist and tourist respectively, while column 3 refers to "generated" traffic.

b. Columns 1 and 3 have been obtained by increasing the savings to traffic using the Western Highway by the factor $33.5 \over 32$ to make allowance for the road between Mile 50 and the entrance to Belmopan.
The VOC indices for the improved road are higher than for the major reconstruction because lower design standards are employed. Calculation of actual vehicle operating costs on the sub-sections of road is explained in Chapter 9 of Volume 1.

7.32 GENERATED TRAFFIC

Estimation of generated traffic is based on similar assumptions to those in section 7.22. Expected generated traffic is again 33 per cent, based on an assumed reduction of journey cost of 25 per cent.

7.33 MAINTENANCE AND CONSTRUCTION COSTS

The costs of maintenance are the same for the PWD improvement as for the major reconstruction in the Without and With improvement conditions. However the longer construction period of the PWD improvement delays maintenance savings in the first years of evaluation. As a result total discounted maintenance savings are at BZE $1,993,000 slightly less than for the major reconstruction. The construction costs of BZE $3,158,000 are much lower, and after discounting are BZE $2,421,000.

7.4 RESULTS OF THE ANALYSIS

The comparison of the economic evaluations for both schemes is shown in Table 7.1. As noted above maintenance benefits are greater in the major reconstruction because greater savings will result from a higher standard road. The greater cost of the major reconstruction more than eliminates its advantage from high VOC benefits.

The PWD Improvement is seen to have a higher Net Present Value at BZE $5,630,000 with a Benefit/Cost ratio of 3.33. With its much lower costs of construction it is the obvious choice.

CHAPTER 8 – CONSTRUCTION PHASING

As discussed in Chapter 1 there are two proposals for improvements to Section C. The first involves major reconstruction by an International Contractor over a period of 2 years starting in 1978. The second is for a series of improvements by the PWD over a period of 4 years also starting in 1978.

The recommended method of construction is the PWD series of improvements. On the assumption that Section B of the Northern Highway is constructed by an International Contractor, the work on Section C would start in 1978 using the plant and labour which had been employed on the reconstruction of Section A during 1975.
APPENDIX 6

Potential Land Use Map
BRITISH HONDURAS
POTENTIAL LAND USE MAP

Scale 1:250,000

This map is NOT an authority on the delimitation of international boundaries

Original soil survey by A.C.S. Wright, D.H. Romney, R.H. Arbuckle, F.C. Darcel, A.C. Williamson on basal data obtained from the British Honduras Survey, Forestry and Geological Departments

REFERENCE

International Boundary
Reef
Village or Camp
Built-up area
Prominent Ridge
Railway, existing
, , proposed
All Weather Road, existing
, , , proposed
Dry Weather Road, existing
, , , proposed
Land Use Type
, , Sub-region boundary
, , number 20
### LEGEND

#### ADAPTED TO FOREST USE

<table>
<thead>
<tr>
<th>Protection Forest</th>
<th>Sustained yield logging</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>Mahogany Forest</td>
<td>Reafforestation after milpa</td>
<td>2A</td>
</tr>
<tr>
<td></td>
<td>Assisted regeneration</td>
<td>2B</td>
</tr>
<tr>
<td>Pine Forest</td>
<td>Sustained yield logging</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Natural regeneration</td>
<td>3A</td>
</tr>
<tr>
<td></td>
<td>Reafforestation : intercropping</td>
<td>3B</td>
</tr>
<tr>
<td></td>
<td>: no intercropping</td>
<td>3C</td>
</tr>
</tbody>
</table>

#### ADAPTED TO AGRICULTURAL USE

| Orchard Crops | Cacao | Under planted banana shade | 4 |
|              |      | Under natural forest shade | 4A |
|              | Citrus | Interplanted when young | 5 |
|              |       | With permanent grass | 5A |
|              | Palms | Coconut | 6 |
|              |       | African oil | 6A |
| Coffee       | Beef |          | 8 |
| Long Rotation Pasture | Dairy |          | 8A |
|              | Range : beef and pine forests | 8B |
| Short Rotation Pasture and Arable Crops | Leys with corn, beans | 9A |
|              |          | upland rice | 9B |
|              |          | swamp rice | 9C |
|              |          | planainain, banana, ground food | 9D |
|              |          | cassava, pineapple | 9E |
|              |          | pineapple, peanuts, tomatoes | 9F |
|              |          | tobacco, peanuts, onions, castor oil | 9G |
| Swamp Rice | Suitable for early development | 12 |
| Market Gardening | Restricted by engineering problems | 13 |

### Problem Soil

These will become useful agricultural or silvicultural areas only if main drainage or desalinisation projects are expedited.

Land Use Type.
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