INDIRECT ECONOMIC EFFECT FROM GULF INTRACOASTAL WATERWAY COMMERCE IN TEXAS

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FOREWARD

In an effort to evaluate the effect of marine-related activities on the non-basic sectors of the economy, this report "Indirect Economic Effect From Gulf Intracoastal Waterway Commerce in Texas" was prepared.

Emphasis was placed on industrial development as it relates to the extensive yet inexpensive services that water transportation provides. Potential benefits from the waterway can be substantially increased through engineering improvements and more diverse uses as a transportation mode other than the movement of cargo.

Grateful appreciation for their cooperation in providing necessary information is extended to the many individuals, firms, and Federal and State agencies. Particular mention is due representatives of the Port of Galveston, the Bureau of Business Research, University of Texas, Austin, and the U. S. Army Corps of Engineers, Galveston District.

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SUMMARY AND CONCLUSIONS

Evolving from a history of past research relating to coastal zone and marine-related problems, this study evaluates the indirect economic effect of the Texas Gulf Intracoastal Waterway and its tributaries on Texas.

Industrial development in the Texas coast owes much to existing inland water navigation. Although Texas ports initiated and continue to contribute to the growth of coastal communities, the waterways distribute a large portion of the commodities arriving in these ports to locations along the Texas coast and to inland communities. The waterway also provides cheap transportation of predominately bulk commodities in the form of raw material production inputs. The construction or expansion of approximately 23 industrial plants along the Texas waterways during the fourth quarter of 1973 for a total estimated investment of over $1.2 billion gives ample indications of the degree of waterway utilization by Texas industries.

Determination of indirect economic effects was based on an initial calculation of the Gulf Intracoastal Waterway's contribution to the five coastal SMSAs. Galveston-Texas City emerged as the most dependent on waterway traffic with 22.8 percent of total economic activity dependent on waterway commerce. Again, as a percentage of total SMSA output, Houston is least dependent on the waterway with only 5.4 percent followed by the Brownsville-Harlingen-San Benito SMSA with 6.4 percent. Corpus Christi and Beaumont-Port Arthur-Orange were 15.2 and 19.3 percent dependent, respectively. Analysis of employment and income data showed income to rise at a faster rate than

employment. The underlying causes for this were not studied. General observations indicate that inflation, union pressures, government expenditures for defense and social programs, and easy credit in the past resulting from monetary policies by the Federal Reserve Bank combined to bring about this upward spiraling income trend which exceeds individual productivity increases.

The aggregate economic stimulus of both direct and indirect contributions from waterway activities consisting of tax, education, and manufacturing revenues, income, waterway maintenance and industrial construction expenditures came to $3.9 billion, equivalent to 4.5 percent of the Texas State Product. This figure applies only to the waterway and does not describe the total impact of the entire coastal zone.

Other benefits to both consumers and industries pertain to reduced transportation costs offered by marine vessels. With a two-to-one operation cost advantage and low level of pollution emissions, combined with its high bulk capacity and low energy usage, barge traffic affords significant cost savings to industrial users and, eventually, to consumers in the form of reduced prices. Of environmental importance may be the safety aspect barges provide in the movement of hazardous materials.

Passenger service between coastal cities connected by a waterway network can be easily provided by ferries and hydrofoils, as other countries have successfully demonstrated. This type of passenger service would be the cheapest way to provide expanded mass transit movement between urban and rural communities.

Finally, development of the waterway to accommodate different transportation modes and raising traffic capacity are important

considerations in decision making by leaders in government and industry. Among the many possibilities for improvement, four emerge as the most likely alternatives: 1) widening the waterway to reduce traffic accidents, specifically head-on collisions; 2) deepening the waterway to allow for deeper-draft, higher capacity barges; 3) re-routing the path of the canal to eliminate sharp bends; and, 4) constructing two water lanes analogous to divided highways to move traffic in opposite directions. A fifth development, conceived by Russel O. de Castongrene, is to build a large elevated structure directly over the existing water route to accommodate alternate waterway uses aside from marine transportation.

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CHAPTER I

INTRODUCTION

A NEED FOR WATERWAYS

Many links in the inland waterway system currently operate at their saturation point in terms of existing carrying capacity.[1] Yet waterway shipping is predicted to rise three-fold by the year 2000.[2] These considerations point to a definite need for increased efficiency in waterborne transportation. But even more importantly, improvements of the current inland waterway system are necessary to enhance current operations and allow for future expanded cargo movement.

The impact of the waterway to the Texas economy will be demonstrated in this report for the purpose of informing Texas citizens how the waterway benefits everyone. Accomplishment of this task becomes especially important in view of repeated restrictions placed on maintenance, rehabilitation, and expansion activities performed by the U.S. Army Corps of Engineers. With public support, the domestic waterway system may be adequately maintained or expanded where needed to accommodate future demands. As will be demonstrated later, marine transportation is the least energy intensive of all modes while it is the second lowest pollution emitter next to the railroads.

Aside from its advantages, however, a barge is slow, with unpredictable arrival times, subject to weather conditions and severely constrained by geography. Barges are, to some degree, restricted

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[1] The Waterways Journal, "New Waterway Horizons," May 4, 1974.

[2] A. T. Kearney, Domestic Waterborne Shipping Market Analysis: Executive Summary, Chicago, Illinois, 1974.

to carrying bulk commodities of relatively low value. On the other hand, the cost of shipping a bushel of wheat from Minneapolis to New Orleans by river barge is no more than the cost of mailing a first class letter between the two cities.[3]

Among the various bulk commodities moved on inland waterways, approximately 60 percent of our most crucial resources travel by barge. They are coal, crude oil, and refined fuels.[4]

While inflation and rising fuel costs continue to accelerate operation costs and prices, water carriers will remain the least-cost mode simply because higher fuel costs will affect energy intensive transportation modes more extensively.

The waterways are important, having inherent cost advantages for movement of certain cargos. Other transportation modes have advantages depending on the type of cargo and the shipper's purpose. This report does not intend to emphasize modal comparisons, since all modes complement each other and must be combined to perform the basic mission as a transportation network: the timely and safe arrival of a product. This study instead will document the state's dependence on the Texas Gulf Intracoastal Waterway and its tributaries.

BACKGROUND INFORMATION

This study is neither a spontaneous nor an independent effort. The idea evolved from a series of reports describing various facets of the Texas Coastal Zone and the Texas portion of the Gulf Intracoastal Waterway.

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[3] Testimony by Harry N. Cook, Executive Vice President, National Waterways Conference, Inc. before the Subcommittee on Transportation, Committee on Appropriations, United States House of Representatives, Washington, D.C., March 6, 1974.

[4] Ibid.

Realizing that the Texas Coastal Zone is a valuable resource with multiple uses by Texas citizens and industries, it became evident that this scarce resource had to be properly managed. The first step was to identify the many active organizations relating to the Texas marine environment. Entitled, Marine Resources Activities in Texas, this Sea Grant report prepared by the Industrial Economics Research Division in 1969,[4] presented specific projects, programs, individual port activities, educational institutions, research institutes and assorted Federal and State agencies involved in coastal zone activities. Associated fiscal data on individual projects, total annual budgets and expenditures were also enumerated. In setting the stage and describing the coastal zone as it was in 1969, this report alerted both decision makers and research investigators alike to the need for an organized management program preceded by a comprehensive data base.

In June, 1970, John Miloy and Anthony E. Copp responded to this need with another Sea Grant report, Economic Impact Analysis of Texas Marine Resources and Industries.[5] This was the first known effort to assess the economic interrelationship and impact of marine resources and industries in Texas. The authors incorporated aspects of regional economic growth theory and resource economics concepts to marine-related problems. Individual analyses of major marine industry groups and their respective total employment and sales impacts on the Texas economy to include projections to the year 2000 provided the major thrust of this research effort.

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[4]Texas A&M University, Sea Grant Program, Marine Resources Activities in Texas, College Station, Texas, 1969.

[5]Miloy, John and Copp, Anthony E., Economic Impact Analysis of Texas Marine Resources and Industries, Texas A&M University, Sea Grant Publication No. 217, 1970.

Continued interest prompted the Economic Development Study of the Texas Coastal Zone. This Sea Grant report, written by the Industrial Economics Research Division,[6] filled a large statistical data gap. In describing economic, human and natural resources, the report revealed growth patterns and recognized those factors important to future developments in the coastal zone. Other complementary studies within this comprehensive program included bay and estuarine management, legal/institutional arrangements, power plant siting, transportation, and waste management alternatives.

One economically significant but often neglected industry is the recreation industry. When compared to other coastal states, Texas' coast is virtually undeveloped and is the last major source for recreation and tourism. This conclusion emerged from a Sea Grant report drafted by the Industrial Economics Research Division in 1973, entitled, Economic Inventory of Recreation and Tourism Within Texas Coastal Zone.[7] The investigator identified existing and available proposed public and private recreation and tourism units in the Texas Coastal Zone. Its purpose was to determine the economic status of these industries. The second half of this recreation research to be published as a Sea Grant report in the latter part of 1974 will evaluate the impact of recreation activities on the Texas economy.

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[6]Texas A&M University, Sea Grant Program, Economic Development Study of the Texas Coastal Zone, College Station, Texas, 1972.

[7]Ingram, Billie I., Economic Inventory of Recreation and Tourism Within Texas Coastal Zone, Texas A&M University, Sea Grant Publication No. 209, 1973.

Texas ports and the Texas Gulf Intracoastal Waterway are integral parts of the coastal zone both geographically and economically, but relatively little basic data on their status with respect to the coastal zone and the entire state was available. Consequently, a number of port-related studies developed. Among them are:[8] The Economic Impact of a Deepwater Terminal in Texas, The Case for a Deepwater Terminal in Texas, Work Plan for a Study of the Feasibility of an Offshore Terminal in the Texas Gulf Coast Region, Deepwater Terminals for Texas - An Overview and a Plan, and A Survey of the Economic and Environmental Aspects of an Onshore Deepwater Port at Galveston, Texas. At this time, Daniel M. Bragg is also preparing a transcript relating to the effect that offshore ports may have on existing ports.

It was evident from U.S. Corps of Engineers publications that large quantities of waterborne commerce moved through the Texas ports and on the Gulf Intracoastal Waterway. The Texas Transportation Institute analyzed this commodity flow in a Sea Grant report entitled, Texas Waterborne Commerce Commodity Flow Statistics,[9] published in June 1973. It provided information on the importance of waterborne commerce, especially that portion moving over the intracoastal and inland waterway system.

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[8]Series of reports by Bragg, Daniel M., Texas A&M University, Sea Grant Program.

[9]Lamkin, Jack T., Jr. and Lowery, W. R. Texas Waterborne Commerce Commodity Flow Statistics, Texas A&M University, Sea Grant Publication No. 207, 1973.

To round out the coastal zone studies program, the Industrial Economics Research Division evaluated, The Primary Economic Impact of the Gulf Intracoastal Waterway in Texas.[10] It was concluded that industrial users in addition to employing people in the manufacture of goods, also place additional requirements on water transportation. This implies that more construction of barges, tugboats, handling facilities, fuel, and most of all, jobs must be created. Waterway users then add substantially to the indirect economic stimuli attributable to waterway commerce.

Expenditures on maintaining and improving the waterway lead to another round of secondary effects. Again, construction crews require supporting services to perform this maintenance function. They must have tools and equipment to do the job, while their personal needs--food, shelter, clothing--must also be satisfied.

This study then, serves as the basis for the Indirect Economic Effect From Gulf Intracoastal Waterway Commerce in Texas.

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[10] Miloy, John and Phillips, Christian, Primary Economic Impact of the Gulf Intracoastal Waterway in Texas, Texas A&M University, Sea Grant Publication No. 211, 1974.

CHAPTER II

INDUSTRIAL DEVELOPMENT IN THE COASTAL ZONE

INTRODUCTION

The history of industrial development in the coastal zone can be observed through changes in population, industrial growth, employment, and income. In June, 1972, Rapp, French, and Miloy[11] studied in detail the industrial development of the coastal zone. The following section is a partial summary of that study.

HISTORICAL TRENDS

A historic overview reveals that the marine environment has an economically strategic role in the world, as supported by the following facts:

1. All major industrial nations have extensive coastlines;
2. An estimated two-thirds of the gross world product is produced in coastal zones;
3. More than 80 percent of the world metropolitan areas are coastal areas;
4. Of the 25 largest United States cities, 18 are coastal cities;
5. More than 75 percent of the total population of the United States resides in coastal or great lake states;
6. More than 45 percent of the nation's urban population resides in coastal counties; and,
7. All of the major megalopoli now projected for the year 2000 are located in coastal zones.[12]

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[11] Economic Development Study of the Texas Coastal Zone, op. cit.

[12] Marine Science Affairs--Selecting Priority Programs, Annual Report of the President to the Congress on Marine Resources and Engineering Development, Washington, D.C.: Government Printing Office, April, 1970, p. 31.

Discovery of oil and natural gas along the state's coastal region and subsequent development of port and harbor facilities along the eastern half of the Texas coast have provided the primary thrust for industrial growth and population expansion. Increased population, greater industrial diversification, and specialized industrial growth stemming from oil and gas have contributed to the transformation of coastal regions from a rural to an urban industrial complex.

The Texas Gulf Coast currently has the world's largest petrochemical capacity and contains the most important sources of natural gas in the United States with more than one trillion cubic feet.

The Texas marine environment has experienced a development pattern similar to that of other regions of the world. Economic growth in Texas is directly correlated with accessibility to the Gulf of Mexico and to the rich mineral resources found along the Gulf Coast.

The extent of this urbanization process is exemplified by the fact that 50 percent of Texas residents live within a 100-mile radius of the coastline, which reflects the general trend of population concentration in all coastal areas. Population predictions for the year 2000 indicate a continued movement to coastal areas.

THE GULF INTRACOASTAL WATERWAY

The Gulf Intracoastal Waterway is a complex network extending approximately 1,100 miles from Apalachee Bay, Florida to Brownsville, Texas. The limiting dimensions of the main channel are 12 feet depth by 125 feet width, with the exception of areas where locks are located. The length of the Texas portion of the waterway,

Figure 1, is 426 miles and extends from Beaumont to Brownsville.[13] For a comparison of all domestic waterways with regard to lengths and depths refer to Table 1. Waterborne commerce entering or leaving Texas is to a great extent restricted by locks located on the Texas-Louisiana border.

POPULATION

During the period from 1940 to 1970, the population of the coastal zone, as a whole, increased at a faster rate than the state population. On a percent basis, the coastal zone population had increased from 24 percent of total state population in 1940 to 31.3 percent in 1970. Each of the state planning regions in the coastal zone had increased in population during this period by the following percentages: Gulf Coast - 172.2, Southeast Texas - 94.2, Coastal Bend - 87.4, Lower Rio Grande Valley - 63.6, and Golden Crescent - 25.3. For the entire coastal zone, the greatest rate of increase occurred from 1940 to 1950, and continued more slowly through 1970.

Within the coastal zone, the population has shifted toward metropolitan areas. In 1940, 77.4 percent of the coastal zone population inhabited urban centers and Standard Metropolitan Statistical Areas. By 1970 this figure had increased to 87.9 percent.

EMPLOYMENT (1948-1970)

Although the growth rate fluctuated, employment in the coastal zone, as in the state, more than doubled from 1948 to 1970.

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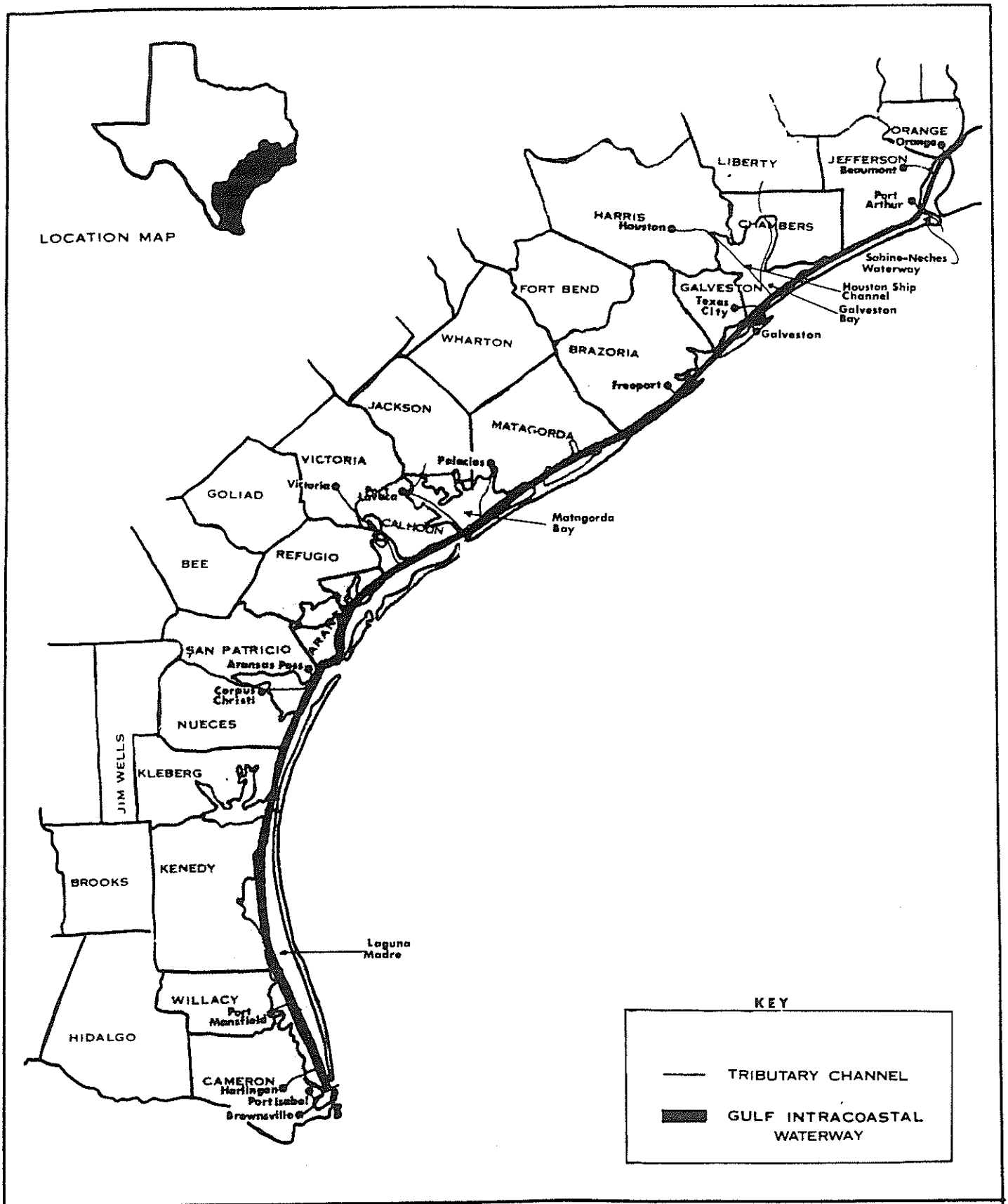
[13] U.S. Department of the Army, Corps of Engineers, The Intracoastal Waterway: Gulf Section, Washington, D.C.: Government Printing Office, 1961.



THE INTRACOASTAL WATERWAY OF TEXAS AND ADJACENT COUNTIES

FIGURE 1

TABLE 1

WATERWAYS OF THE UNITED STATES
NAVIGABLE LENGTHS AND DEPTHS

GROUP	UNDER 6 FEET	6 TO 9 FEET	9 TO 12 FEET	12 TO 14 FEET	14 FEET AND OVER	TOTAL	PERCENT OF TOTAL
Mississippi River System	2,020	969	4,957	740	268	8,954	36
Gulf Intracoastal Waterway and Gulf Coast Waterway	2,055	647	1,133	1,216	378	5,429	22
Subtotal	4,075	1,616	6,090	1,956	646	14,383	58
Atlantic Intracoastal Waterway and Atlantic Coast Waterways	1,426	1,306	649	2,042	1,581	7,004	28
Pacific Coast Waterway	730	498	237	26	2,084	3,575	14
Total Mileage	6,231	3,420	6,976	4,024	4,311	24,962	100

SOURCE: Inland Waterborne Commerce Statistics, 1971, American Waterways Operators, Inc., compiled from information supplied by Corps of Engineers, and A. T. Kearney, Domestic Waterborne Shipping Market Analysis: Inland Waterways Trade Area, Chicago, Illinois, 1974.

During this period, the strongest economic sector in terms of employment was the tertiary sector which increased from 56.4 percent to 60.9 percent. On the other hand, primary and secondary industries showed a net decline in relative employment from 1948 to 1970, although the growth rates were 97.2 percent and 94.6 percent, respectively. Total employment for the coastal zone rose by 118.7 percent during the study period compared to the state increase of 105.2 percent.

INCOME TRENDS (1940-1969)

Per capita income in the coastal zone increased 590.6 percent compared to 737.2 percent by the state between 1940 and 1969. This may have been caused partially by higher population growth rates in the coastal zone. Although the state per capita income exceeded that of the coastal zone as a whole by $281, 75 percent of the coast's population live in planning regions which nearly equaled or exceeded the state level in 1969.[14]

The Lower Rio Grande Valley, the Coastal Bend, and the Golden Crescent Planning Regions are significantly below the state per capita income level due to the limited earning capacities of rural inhabitants and the seasonal nature of agricultural employment. Characteristically low rural income levels and rural migration to urban areas brought the Gulf Coast Planning Region level below the state per capita income level for the first time in 1969. High population and industry density caused the South East Texas Planning Region to continuously and significantly exceed the state's per capita income level.

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[14] Economic Development Study of the Texas Coastal Zone, op. cit.

EFFECTS OF WORLD WAR II

World War II stimulated industrial development in the coastal zone by creating abnormal demands for beef, oil, and synthetic rubber. This gave rise to a more stable and diversified agricultural industry, advances in the oil industry including refining, drilling and machinery, and expansion of the chemical and petrochemical industries. Aircraft manufacturing plants established in Texas during World War II developed into heavy industries such as automobile assembly plants and ship building. Generally, the period from 1940 to 1950 experienced tremendous advances in industrial activity of the coastal zone.

INDUSTRIAL GROWTH

One criterion of growth patterns in industry is the analysis of historical shifts in emphasis among primary, secondary, and tertiary industries. Primary industries are those which involve the extraction of natural resources. Industries which "add value" to the natural resources are considered secondary industries. Tertiary industries provide services to businessmen and consumers.

Primary industries include agriculture, fishing, and mining. Agriculture has evolved from being dependent on cotton in 1930 to a more diversified and stable industry with significant products being feed grains, rice, wheat, vegetables, citrus fruits, cattle and cotton. During the period from 1944 to 1970, agricultural production of the coastal zone increased only slightly from 17.5 percent of the state agricultural income in 1944 to 19.1 percent in 1970. However, the composition of total agricultural production in the coastal zone shifted from 64.5 percent crops in 1944

to 72.5 percent in 1964. In absolute figures, the value of all crops and livestock sold in the coastal zone increased from $175,177,065 in 1944 to $598,721,300 in 1970 or 241.8 percent.

Although the fishing industry is difficult to analyze, it can be observed that the annual catch of finfish and shellfish combined has increased from 19,138,418 pounds in 1938 to 156,300,000 pounds in 1969, or 716.7 percent, primarily due to the expansion of the shrimp industry.

The mineral industry in Texas is one of the nation's foremost, not only in petroleum, but also in 25 other commercial minerals, including natural gas, magnesium, and sulfur. From 1954 to 1969, the coastal zone consistently produced around 31 percent of the state's total minerals.

Relative to agriculture, mining increased more in economic importance from 1940 to 1969, with agricultural earnings increasing 280.5 percent while mining earnings increased 583.1 percent.

Secondary industries consist of manufacturing, processing, and construction. Cotton gins, cottonseed oil mills, and meat-packing houses of the 1940's have evolved into a complex secondary industry consisting of oil refineries, petrochemical plants, chemical plants, food-processing plants, and steel-producing plants. The development of these industries in the coastal zone accelerated with the help of abundant raw materials, particularly oil and gas, and readily available ocean and intracoastal shipping facilities. Manufacturing and construction in the coastal zone have increased from $152,747,000 in 1940 to $3,103,164,000 in 1969.

A significant feature of the secondary industry in Texas is the

shift toward fabrication of consumer products. This is characteristic of a mature economy.

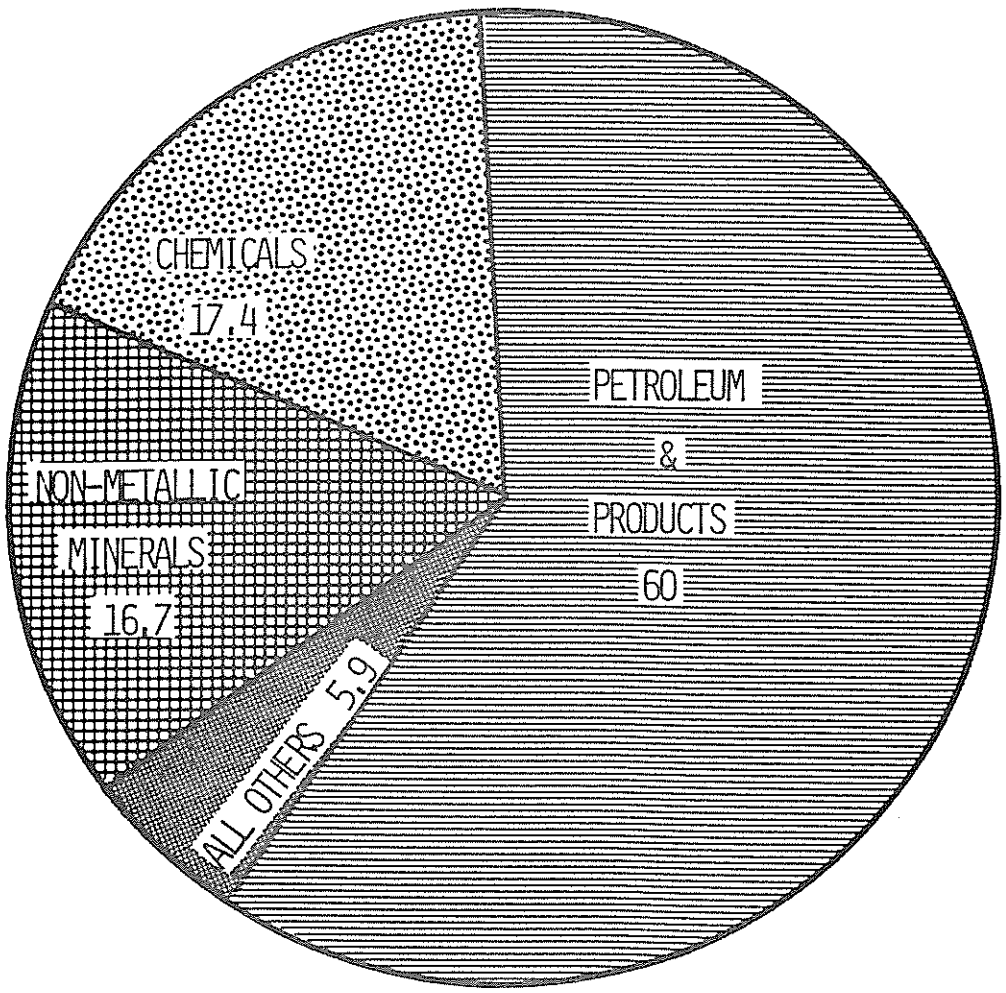
Tertiary industries consist of trade (retail and wholesale) and services. Coastal zone retail sales as a percentage of state retail sales increased from 27 percent in 1940 to 31.2 percent in 1970. Traditionally, the largest expenditures were for food, with automobiles second and building supplies third. In 1940, the coastal zone made up 30 percent of Texas' wholesale trade. By 1958, this figure rose to 34.7 percent.

The service sector increased from $78 million or 30 percent of state earnings in 1940 to $1.4 billion or 38.5 percent of state earnings by 1969.

Overall, primary earnings for the coastal zone relative to the state increased at an average rate of one percent per year from 1940 to 1959 and decreased at an average rate of about three-fourths of one percent from 1959 to 1969. Secondary earnings for the study area remained relatively constant at 40 percent of state earnings from 1940 to 1969.

Industrial Users

In general, water transportation is especially attractive to producers of low-cost bulk goods, since transportation expenses may be a major factor in cost of production and distribution. Therefore, it is not surprising that the major waterway users in Texas consist of petroleum and petroleum refining industries as shown in Figure 2. These two activities account for approximately 60 percent of all waterborne commerce in Texas. Other industries which are major users



PERCENT

MAJOR WATERWAY USERS
FIGURE 2

are the chemical and non-metallic minerals, which account for 17.4 and 16.7 percent of all waterborne commerce in Texas, respectively. The importance of these four industries to Texas' economy is indicated by the fact that in the coastal counties alone, they pay over 700 million dollars in wages, and ship goods valued at over $9.2 billion each year.[15]

Commodity Flows

In terms of commerce, the Gulf Intracoastal Waterway of Texas has experienced steady growth in recent years. The 67 million tons carried by the Texas portion of the waterway in 1971 represent nearly a 90 percent increase over 1961, when approximately 36 million tons were moved.[16]

Commodity flow on the Texas Intracoastal Waterway may be broken down into foreign commerce, intrastate, and interstate flows. Texas is unique in that more goods are exported annually than imported. This is in direct contrast to the United States as a whole, which faces an ever increasing gap between the quantities of goods exported and the amount imported. In Texas, imports are gradually catching up with exports, primarily because of an increased inflow of foreign petroleum and natural gas. Texas' major exports consist of farm products, which amounted to approximately 55.3 percent of all exports in 1971, and chemicals, which accounted for 18.4 percent. Over 25 million tons were exported from Texas in 1971.

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[15] Miloy, John and Phillips, Christian, op. cit., No. 211.

[16] Ibid.

Approximately 42 percent of all Texas imports were non-fuel minerals such as bauxite and iron ore. Crude petroleum accounted for 26.2 percent, and primary metal imports were 10.1 percent of the total. Total imports of nearly 18 million tons in 1971 were handled mostly by the ports of Brownsville, Galveston and Houston.

New Industries Along the Texas Waterways

Commodity flows on America's inland waterways have risen at tremendous rates over the last decade. Preliminary estimates by the U. S. Army Corps of Engineers revealed that more freight was moved in 1973 on the waterways than in any previous year. More than 1.7 billion tons, equivalent to a 7.4 percent increase over total 1972 tonnages, was moved by water. Of this amount, 600 million tons traveled on the inland waterway system. From 1931 to 1971 waterborne commerce increased 3.1 times while the average distance of a ton of cargo moved by barge rose from 51 miles in 1931 to 375 miles in 1971.[17] While unemployment was rising and production in many plants was reduced, 301 new plants and plant enlargements appeared along the waterways for a total investment of $5.5 billion.

To further illustrate the industry's need for water transportation, consider the fact that since 1950 nearly 9,000 waterside plants have been constructed in the United States.

Texas inland waterways are similarly effected. During the fourth quarter of 1973 the following construction and expansions either occurred or are in active planning stages along the Texas waterways according to the American Waterways Operators, Inc.

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[17]A. T. Kearney, Domestic Waterborne Shipping Market Analysis: Inland Waterways Trade Area, Chicago, Illinois, 1974.

"Brazos River--At Chocolate Bayou, Texas, General Crude Oil Company and Monsanto Company are negotiating construction of a $150 million joint venture refinery on General Crude's properties at the above site.

"Galveston Bay--At Galveston, Texas, Todd Shipyards plans to enlarge its Galveston shipyard by dredging an area approximately 1,250 feet along the Galveston Ship Channel and 1,000 feet back from the channel's existing bank.

"Gulf Intracoastal Waterway--Standard Oil Refinery has begun a $1 million expansion to enable the facility to process foreign high-sulfur crude oils. . .At Texas City, Texas, GAF Corporation plans a $2 million expansion program to boost its production of butanediol. . .Union Carbide Corporation plans to construct a multi-million dollar vinyl acetate plant at its chemical complex. . .At Freeport, Texas, Robintech, Inc. and Shin-Etsu Chemical Company of Japan in a joint venture will construct a polyvinyl chloride resin plant. . .At Beaumont, Texas, Goodyear Tire & Rubber Company is expanding the production capacity of resin at a cost of $1.5 million.

"Houston Ship Channel--At Houston, Texas, Newell Salvage Company is moving into a new plant which will house a scrap metal processing operation at a cost of $2 million. . . Chronister Valve Company has moved to a new plant and office building costing about $1 million. . . Atlantic Richfield Company plans to expand the capacity of its Houston refinery 95,000 barrels a day, to a total of 300,000 barrels daily. Cost of the program will be $150 million. . . Power & Propulsion Systems, Inc., a supplier of power systems for offshore tug and supply vessels, has leased a building to be used for a manufacturing operation facility. . .At Bayport, Texas, Hercules, Inc. plans to build a new plant for production of polypropylene. . . Armak Company is building a peroxydicarbonate plant. Mid-1974 is scheduled for completion date for the multi-million dollar hydrodesulfurization catalyst plant. . . Blemer Chemical Corporation, the first joint venture between two major Japanese companies in the United States, Marubeni America Corporation and Nippoin Oils and Fats Company, Ltd., will dedicate a new plant."

To this list, the Southern Industrial Development Council adds the following projects.

Texaco is adding major desulfurization units, including sulfur recovery, to its Port Arthur refinery as part of a $240 million expansion program involving four United States facilities . . . At Channelview, ARCO Chemical

> Company, an Atlantic Richfield subsidiary, is constructing a $200 million petrochemical plant. . .Monsanto Polymers & Petrochemicals Company will erect the largest acrylonitrile plant in the world at Texas City. . .Nearly $100 million will be spent by Mobay Chemical Company to construct five additional plants at its 550-acre Baytown site, almost tripling present capacity there. . .A $50 million, 1,000-man mill to produce steel wire rods will be built across the Neches River from Beaumont by Georgetown Texas Steel Corporation. . ."

The economic stimulus from expenditures as high as $1,253.3 million on the regional economy is significant not only for industrial purposes but also for increasing employment, income, and greater quantities of output to meet ever-growing consumer demands.

SUMMARY

The Texas Coastal Zone has experienced tremendous economic growth. People were attracted to it by the number of amenities and abundant resources peculiar to this geographical area. One of the major attractions of the coastal environment, in addition to abundant raw materials, was, and still is today, the available low-cost, high-capacity, and partially land-protected water transportation artery--the Gulf Intracoastal Waterway. Under these conditions, it is not surprising that industries have relocated in this area and developed at such a rapid pace over the last twenty years. With proper management and regard for its environment, the coastal zone may continue to experience tempered economic growth which will benefit the entire Texas economy.

CHAPTER III

ANALYSIS

INTRODUCTION

A previous Sea Grant report entitled, Direct Economic Impact of the Gulf Intracoastal Waterway (GIWW) on Texas, evaluated the direct contribution to Texas gross state product attributable to activities associated with those that directly involve the waterway. Employment and income generated by the water transportation and water transportation service sectors were the main constituents in addition to actual maintenance and improvement expenditures. It was revealed further that 40 percent of all major port activities resulted from inland water transportation.

But employment and income ramifications of waterway activities extend beyond these initial effects. Initial employment from waterway activities becomes the basis for new jobs in manufacturing, construction, trade, and service industries. Secondary employment arises from supporting the needs of the primary employment sector so that they may properly accomplish their respective tasks.

METHODOLOGY

The foundation for all economic activity is basic employment. Any indirect effects in terms of secondary and tertiary employment and income stem from it. The first step in the analysis of the indirect effect of the GIWW on employment was to estimate the total number employed and the income earned in each Standard Metropolitan Statistical Area (SMSA) along the waterway. Once this was determined, that portion of economic activity attributed directly to waterborne commerce was estimated for each SMSA.

Basic employment data were extracted from published computerized data prepared by the Social and Economic Statistics Division, U. S. Department of Commerce. Based on selected port impact studies and interviews with local entities, an appropriate portion of total economic activity attributable to the waterway and ports was estimated. Data were obtained from 1967 through 1971 to identify possible trends.

Throughout this report, primary employment and its associated income is defined as those jobs that directly relate to the movement of cargo on the waterway. Indirect employment and income refers to those activities that are necessary to support and complement the initial work force. These include the jobs that are created by those industries that are dependent on the waterway for transportation of required production resources.

'Vessel Crew Expenditures' for example is considered as a direct effect because a crew's expenditures on food are directly related to the movement of cargo. Jobs and income induced by crew expenditures such as the construction of a restaurant, hiring of waitresses, cooks, and janitors, and revenues generated by the establishment become a part of the indirect effect.

It is commonly thought that only those cities, counties, and industries located in close proximity of the waterway benefit from its service. Indirect effects, however, include, among other things, the savings due to reduced transportation costs from barge traffic.

In the final analysis both the direct economic impact determined by a previous report[18] and the indirect economic contribution will be summarized and compared to total Gross State Product to show the waterway's importance to Texas.

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[18]Miloy, John and Phillips, Christian, op. cit.

THE PRIMARY ECONOMIC SECTOR

According to Table 2, fifty water-transportation-related jobs are considered to fall under the primary employment classification resulting from waterborne commerce.

Preliminary research of a number of independent Texas port studies revealed that only few selected job classifications were used in estimating port employment. A 1968 Galveston Wharves study showed a total of 7,791 port-related employees from a total labor force of 70,000, as shown in Table 3. A similar Port of Houston study, Catalyst of an Economy: The Economic Impact of the Port of Houston, 1958-1963, concluded as shown in Table 4, that the percentage of port-related workers and their respective incomes with respect to total employment and income remained relatively constant between 1959 and 1963.

It should be noted that the number of basic employment classifications used in the two reports differ. Closer investigation of these two port studies and a third report on the Port of Corpus Christi reveals that the research method in all three varies appreciably. Estimates by the University of Texas, Bureau of Business Research on port-related employment in the Corpus Christi SMSA for 1972 are listed in Table 5. This inconsistency in data is compounded by a lack of similar data for the remaining major deepwater Texas ports.[19]

A limited time and budget constraint prohibited detailed updated port impact studies for each port specifically addressed to barge traffic. Yet for consistency and comparability of final results a common approach was applied to available data sources.

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[19]Since barge traffic usually loads and unloads cargo at the ports, those counties between the ports were omitted in this determination of barge-related economic activity.

TABLE 2

FACTORS OF COMMUNITY INCOME DIRECTLY GENERATED BY SERVICES TO VESSELS AND BY PORT OPERATIONS

I. Vessel Disbursements While in Port

(Marine Services)
1. Tug hire
2. Line running
3. Dockage

(Federal Services)
4. Immigration service
5. Entrance and clearance fees
6. Customs overtime

(Labor)
7. Stevedoring
8. Clerking, checking, watchman
9. Cleaning, fitting, equipment rental

(Repair Service)
10. Repairs
11. Structural alterations
12. Special cargo fitting

(Supplies and Chandlery)
13. Foodstuffs
14. Hardware
15. Lubricants
16. Laundry and cleaning
17. Cordage
18. Medical
19. Miscellaneous

(Fuel)
20. Bunker fuel
21. Water
22. Miscellaneous services

II. Port and Terminal Income

23. Cargo stevedoring
24. Heavy-lift crane service
25. Car loading and unloading
26. Handling
27. Storage
28. Demurrage
29. Top Wharfage

III. Inland Transport

30. Local cartage
31. Local switching
32. Line haul--truck
33. Line haul--rail

IV. Vessel Crew Expenditures

34. Personal items-drugs & sundries
35. Haberdashery and clothing
36. Transportation
37. Tavern, restaurant, entertainment
38. Gift shopping
39. Other

V. Port Services

40. Steamship agency services
41. Customers brokerage
42. Freight forwarding
43. Warehousing
44. Marine insurance
45. Banking
46. Commodity brokerage
47. Marine surveys
48. International trade consultation
49. Advertising and promotion
50. Communications (telephone and telegraph)

SOURCE: Board of Harbor Commissioners, City of Milwaukee, Impact of the Milwaukee Public Port Development on the Community Economy, A Report to Hon. Henry W. Maier, Mayor (Milwaukee, 1962).

TABLE 3

BASIC PORT EMPLOYMENT
FOR GALVESTON WHARVES - 1968

EMPLOYMENT CLASSIFICATION	NUMBER EMPLOYED
Port Authority Employees	450
Stevedores and Longshore Labor	1,860
Towing and Barging	825
Pilotage	24
Freight Forwarders and Custom Brokers	56
Federal, State and Municipal Employees	1,095
Warehouse and Packaging Firms	1,769
Banks	20
Maritime Supply Firms	40
Shipyards	1,514
Steamship Companies, Ship Brokers and Agents	133
Marine Insurance	5
TOTAL PORT SERVICES	7,791
ESTIMATED TOTAL POPULATION OF CITY	70,000

SOURCE: C. S. DeVoy, Manager, Galveston Wharves, Galveston, Texas, 1968.

TABLE 4

DIRECT EMPLOYMENT AND INCOME IMPACT OF THE PORT OF HOUSTON
1959-1963

EMPLOYMENT CLASSIFICATION	1959		1960		1961		1962		1963	
	EMPLOYEES	WAGES & SALARIES ($000)	EMPLOYEES	WAGES & SALARIES ($000)	EMPLOYEES	WAGES & SALARIES ($000)	EMPLOYEES	WAGES & SALARIES ($000)	EMPLOYEES	WAGES & SALARIES ($000)
Deep sea foreign transportation	315	1,068	507	1,774	693	2,409	857	3,518	898	3,683
Rivers & canals transportation	684	3,823	838	4,359	962	5,376	1,097	6,357	1,143	6,609
Local water transportation	1,148	5,728	1,160	5,953	1,127	5,902	1,072	5,933	1,098	6,217
Stevedoring	6,308	11,745	6,372	12,088	6,123	11,418	6,140	11,659	6,218	12,017
Water transportation services N.E.C.[1]	482	2,210	523	2,405	568	2,658	591	3,307	635	3,413
Freight forwarders & brokers	310	1,348	328	1,448	341	1,543	346	1,802	354	1,825
Warehousing	1,892	7,693	2,054	8,641	2,183	9,260	2,351	10,792	2,540	12,004
Trucking[2]	1,844	8,056	1,897	8,450	1,939	8,730	1,992	9,860	2,111	11,126
Railroads[2]	4,518	22,588	4,529	23,099	4,545	24,102	4,603	25,319	4,627	25,457
Government[3]	892	3,835	918	3,948	934	4,105	965	4,658	986	4,920
Contract construction	498	2,107	511	2,248	530	2,385	688	3,162	640	3,072
Retail trade	786	2,359	825	2,554	873	2,794	932	3,079	1,019	3,458
Wholesale trade	506	2,532	524	2,678	542	2,816	561	3,025	597	3,461
Finance and insurance	460	2,304	497	2,551	521	2,713	544	2,939	579	3,308
Ship building and repairing	1,965	9,443	1,982	9,720	1,825	9,125	1,652	8,945	1,733	9,716
Personal services	1,228	4,925	1,277	5,238	1,332	5,549	1,401	5,869	1,463	6,153
Total Selected Classifications	23,827	91,764	24,742	97,154	25,038	100,785	25,792	110,224	26,641	116,439
Total Employment and Income	484,540	2,188,714	503,933	2,353,967	518,560	464,947	524,326	2,595,503	566,375	2,871,466
Percent of Total	4.9	4.2	4.9	4.1	4.8	4.1	4.7	4.2	4.7	4.1

[1] Includes ship chandlers, marine suppliers, towage, and similar activities.
[2] Trucking and railroad employment was estimated on the basis of returned questionnaires and the relationship of employment and revenues derived from port operations.
[3] Include persons employed full time by the Harris County Houston Ship Channel Navigation District as well as federal, state, and local government employees.

SOURCE: U.S. Department of Commerce, Bureau of the Census, County Business Patterns, Part 8B, Harris County, Texas, First Quarter, 1959 and 1962; and Center for Research in Business and Economics, University of Houston.

TABLE 5

PORT-RELATED EMPLOYMENT IN THE CORPUS CHRISTI SMSA
FIRST QUARTER 1972

EMPLOYMENT GROUP	EMPLOYMENT	PERCENT PORT-RELATED	NUMBER PORT-RELATED
Agriculture	4,580	0.0	0
Manufacturing	10,330	68.7	7,097
Mining	4,150	0.0	0
Construction	8,400	37.2	3,125
Printing and publishing	710	37.2	264
Water transportation	505	100.0	505
Transportation services	650	85.0	553
Other transportation, communication and utilities	5,310	37.2	1,975
Wholesale and retail trade	27,050	37.2	10,063
Banking	1,120	46.3	519
Other finance, insurance, and real estate	3,760	37.2	1,399
Services	18,080	37.2	6,726
Government	20,200	37.2	7,514
Total	104,845	37.9	39,740

SOURCE: Texas Employment Commission and Bureau of Business Research, University of Texas, Austin, Texas.

Estimating the total tonnage of waterborne commerce handled by the major ports[20] and evaluating their dollar value seemed to be the most direct method of deriving waterway-related business activities. From 1970 data,[21] 40 percent of the total tonnage handled by ports was multiplied by the appropriate dollar value per ton of cargo as published by the American Association of Port Authorities in 1970. Table 6 specifies the proportionate components of revenues per ton of cargo to the various water transportation and water transportation service occupations. These values differ according to the various cargo types as is shown in Table 7. Based on calculations for 1970, it was determined that 6.4 percent of total Brownsville-Harlingen-San Benito SMSA income was induced by barge traffic on the waterway. Similar computations for the Corpus Christi SMSA reveal this percentage to be 15.2 percent while Galveston-Texas City was estimated at 22.8 percent. Houston's share of total income due to barge traffic came to 5.4 percent followed by 19.3 percent for the Beaumont-Port Arthur-Orange SMSA. These results are displayed in Table 8.

Assuming these proportions remained constant, they were applied to 1970 and 1971 employment and income data published by the U. S. Department of Commerce, Social and Economic Statistics Division.[22] This data includes both covered [23] and non-covered employment along with respective income figures.

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[20]'Major ports' refers to Brownsville, Corpus Christi, Galveston-Texas City, Houston and Beaumont-Port Arthur-Orange.

[21]Miloy, John and Phillips, Christian, op. cit.

[22]United States Department of Commerce, Social and Economic Statistics Division, Washington, D. C.

[23]Covered employment--pertains to those workers employed by companies or firms subject to unemployment insurance.

TABLE 6

METHOD OF DETERMINING A PORT'S ECONOMIC IMPACT AND DOLLAR VALUE OF EARNINGS

COMPONENTS	REVENUE PER TON*
Port and Terminal Expenditures:	
Pilotage, tug hire, line running dockage	$ .92
Government Charges:	
Immigration service, entrance and clearance fees	.03
Labor:	
Stevedoring, clerking, checking, cleaning, carpentering	7.44
Repairs	.03
Supplies:	
Dunnage, doctor, laundry, chandler	1.56
Bunkers:	
Coal, oil, water	.17
Miscellaneous Vessel Disbursements	.18
Port Terminal Income:	
Car loading and unloading, handling and storage, demurrage	2.42
Rail and Motor Freight Revenue Credited to Area	1.93
Vessel Crew Expenditures in Area	.30
Auxiliary Services:	
Steamship agents, foreign forwarders, Customhouse brokers, public warehouse companies, marine insurance companies, foreign departments of area banks	1.23
	$16.21

* 1966 figures.

SOURCE: American Association of Port Authorities, Method of Determining a Port's Economic Impact and Dollar Value of Earnings, February, 1970.

TABLE 7

VALUE OF ONE TON OF CARGO TO A PORT'S ECONOMY

CARGO TYPE	1966	1968	1970
General Cargo	17.71	18.46	19.21
Tanker Cargo (Crude and Refined)	4.20	4.38	4.57
Coal	2.89	3.02	3.14
Grain	6.79	7.06	7.35
Ore	3.36	3.51	3.65
All Other	1.29	1.34	1.40

SOURCE: American Association of Port Authorities, February, 1970.

TABLE 8

ECONOMIC ACTIVITY ATTRIBUTED TO BARGE TRAFFIC

1970

SMSA	TOTAL SMSA INCOME ($000)	BARGE TRAFFIC CARGO VALUE ($000)	PERCENT OF TOTAL INCOME
Brownsville-Harlingen-San Benito	311,591	19,943	6.4
Corpus Christi	850,147	129,094	15.2
Galveston-Texas City	513,932	117,151	22.8
Houston	7,424,792	398,975	5.4
Beaumont-Port Arthur-Orange	1,166,526	225,152	19.3

SOURCE: United States Department of Commerce, Social and Economic Statistics Division and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

Employment and income figures by SMSA to include farm and non-farm proprietors from the U. S. Department of Commerce may be found in Appendix A. Respective totals for the coastal SMSAs are listed in Table 9. Applying the percentages from Table 8 to individual SMSA data produces Table 10 which summarizes that portion of primary economic activity attributable to barge commerce. Although the Houston SMSA shows the largest work force and enjoys the highest associated income, the Galveston-Texas City SMSA is most dependent on barge traffic relative to other ports.

In terms of income, the coastal SMSAs rank in descending order: Houston, Beaumont-Port Arthur-Orange, Galveston-Texas City, Corpus Christi, and Brownsville-Harlingen-San Benito. According to dependence on barge traffic, these same SMSAs rank as: Galveston-Texas City, Beaumont-Port Arthur-Orange, Corpus Christi, Brownsville-Harlingen-San Benito, and Houston.

Based on the West Gulf Maritime Association, Houston, Texas, the total number of actual man-hours worked in the major ports during 1970-71, as described in Table 11, was 8,038,783 hours, which is equivalent to approximately 3,860 full-time employees working a 40-hour week.

The primary labor force which refers to workers utilized in the movement of waterborne cargo, not only receives income but it generates revenues. In 1970, 319 water-transportation-related establishments with 8,400 employees and a payroll of $66.8 million generated $263.8 million worth of revenue. As was mentioned earlier, only about 40 percent of these figures applies to waterway or barge operations or an equivalent of 3,400 employees earning a $26.7 million payroll and generating revenues of $105.5 million as shown in Table 12.

TABLE 9

TOTAL EMPLOYMENT AND INCOME
FOR COASTAL SMSA'S

YEAR	EMPLOYMENT	INCOME ($000)
1967	1,111,684	7,728,146
1968	1,155,459	8,520,213
1969	1,200,976	9,354,251
1970	1,236,961	10,266,988
1971	1,262,767	10,993,699

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Washington, D.C.

TABLE 10

DIRECT EMPLOYMENT AND INCOME
ATTRIBUTABLE TO BARGE TRAFFIC
FOR COASTAL SMSA'S

SMSA	1969		1970		1971	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
Beaumont-Port Arthur-Orange	25,186	208,840	25,492	225,140	25,619	238,044
Brownsville-Harlingen-San Benito	2,871	18,017	2,920	19,942	2,994	21,507
Corpus Christi	16,697	120,181	16,939	129,222	17,122	134,759
Galveston	13,866	104,787	14,277	117,176	14,372	123,231
Houston	46,168	363,982	47,801	400,939	49,010	431,849
TOTAL	104,788	815,807	107,429	892,419	109,117	949,390

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Washington, D.C., and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 11

COMPARATIVE HOURLY WORK DATA
FOR MAJOR TEXAS PORTS

PORT	PERIOD	HOURS	PERCENT OF TOTAL HOURS	NUMBER EMPLOYED
Brownsville	1966/67	135,381	2.0	66
	1967/68	105,527	1.1	51
	1968/69	76,390	1.0	37
	1969/70	80,585	1.0	39
	1970/71	95,140	1.2	46
Corpus Christi	1966/67	292,916	3.7	141
	1967/68	278,775	3.0	135
	1968/69	291,612	3.9	141
	1969/70	279,843	3.5	135
	1970/71	263,273	3.3	127
Galveston-Texas City	1966/67	1,178,634	15.0	567
	1967/68	1,575,801	17.0	758
	1968/69	1,269,387	17.1	611
	1969/70	1,458,647	18.3	702
	1970/71	1,501,167	18.7	722
Houston	1966/67	5,386,338	67.9	2,590
	1967/68	6,382,871	68.8	3,069
	1968/69	4,944,696	66.8	2,378
	1969/70	5,441,728	68.1	2,617
	1970/71	5,521,964	68.7	2,655
Beaumont-Port Arthur-Orange	1966/67	937,992	11.8	451
	1967/68	938,859	10.1	452
	1968/69	821,842	11.1	396
	1969/70	731,263	9.1	352
	1970/71	657,239	8.2	316

SOURCE: West Gulf Maritime Association, Houston, Texas, 1974.

TABLE 12

BARGE TRANSPORTATION INDUSTRY
IN THE COASTAL REGION
1970

INDUSTRY	NUMBER OF ESTABLISHMENTS	NUMBER EMPLOYED (In Thousands)	PAYROLL ($ Million)	REVENUES ($ Million)
Water Transportation	154	2.2	19.5	88.8
Water Transportation Services	165	1.2	7.2	16.7
TOTAL	319	3.4	26.7	105.5

SOURCE: Bureau of the Census, County Business Patterns, Washington, D. C., and John Miloy and E. A. Copp, Economic Impact Analysis of Texas Marine Resources and Industries, Industrial Economics Research Division, Texas A&M University, College Station, Texas.

Another component of the primary economic sector is construction on the waterway itself. Updated construction expenditures on the Gulf Intracoastal Waterway and its tributaries, as shown in Table 13, fall into at least three categories--new work, maintenance and rehabilitation. The grand total for inland waterway expenditures in Texas has risen annually and reached $29.1 million during fiscal year 1972.

Aggregating all direct expenditures, income, and revenues for 1970 results in a sizable economic contribution of over one billion dollars.

INDIRECT ECONOMIC STIMULI

The fertilizer industry can be used to illustrate the number of jobs and the amount of income and revenue generated by one ton of phosphate rock in the mining, processing, manufacture, and distribution of the finished product.

Florida-mined phosphate rock in Houston sells for thirty dollars F.O.B. Florida and is carried mostly by ocean-going barges. Chemical companies in Houston process the phosphate rock in combination with a number of chemical ingredients using a certain amount of capital equipment and labor to produce a ton of fertilizer valued between $125 and $165 F.O.B. Florida.[24] Manufacturers distribute a large portion of the final product by barge. Table 14, for example, lists the tonnage of nitrogen, phosphorus and fertilizer products moved on the Texas waterway between Sabine and Brownsville. An explanation of such terms as inbound westbound, through eastbound, and through westbound may be found in Appendix B. These three commodity classifications represent only the major fertilizer-related products,

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[24]This information was obtained from telephone interviews with a number of fertilizer manufacturers.

TABLE 13

EXPENDITURES ON NAVIGABLE WATERWAYS IN TEXAS*

WATERWAY SECTOR	FISCAL YEAR 1970 ($000)	FISCAL YEAR 1971 ($000)	FISCAL YEAR 1972 ($000)	TO DATE ($000)
Gulf Intracoastal Waterway				
New Work	5	89	123	43,240
Maintenance	2,523	4,609	3,903	62,978
Rehabilitation	--	--	--	1,271
Total	2,528	4,697	4,026	107,488
Sabine Neches Waterway				
New Work	2,824	5,413	4,139	56,118
Maintenance	1,945	2,487	3,062	51,822
Contributed Funds	127	149	176	2,778
Total	4,896	8,048	7,377	110,718
Houston Ship Channel				
New Work	2	158	--	35,760
Maintenance	2,807	1,244	2,178	45,014
Total	2,808	1,403	2,178	80,774
Buffalo Bayou and Tributaries				
New Work	1,087	829	119	50,749
Maintenance	137	156	199	2,948
Total	1,223	985	319	53,697
Galveston Harbor and Channel				
New Work	--	--	--	26,137
Maintenance	532	897	1,458	30,671
Rehabilitation	921	.525	--	7,969
Total	1,453	898	1,458	64,778
Corpus Christi Ship Channel				
New Work	--	32	320	20,593
Maintenance	617	895	1,229	26,957
Rehabilitation	--	--	--	3,577
Total	617	926	1,550	51,126
Matagorda Ship Channel				
New Work	--	3	201	18,042
Maintenance	1,443	342	648	7,831
Contributed Funds	--	3	201	12,260
Total	1,443	347	1,049	38,133

TABLE 13--continued

EXPENDITURES ON NAVIGABLE WATERWAYS IN TEXAS*

WATERWAY SECTOR	FISCAL YEAR 1970 ($000)	FISCAL YEAR 1971 ($000)	FISCAL YEAR 1972 ($000)	TO DATE ($000)
Brazos Island Harbor				
New Work	.133	.381	--	10,472
Maintenance	572	285	683	11,878
Rehabilitation	--	16	495	1,975
Total	573	302	1,178	24,325
All Others				
New Work	2,425	3,773	8,653	34,283
Maintenance	1,440	555	1,324	23,675
Rehabilitation	--	--	--	4,312
Total	3,866	4,328	9,977	62,269
GRAND TOTAL	19,407	21,933	29,111	595,835

* Sum of components may not equal given totals due to independent rounding.

SOURCE: U. S. Army Corps of Engineers, Annual Report, Washington, D.C., 1973.

TABLE 14

MOVEMENT OF FERTILIZER AND RELATED CHEMICALS ON THE GULF INTRACOASTAL WATERWAY (IN SHORT TONS)
1972

GULF SECTION	TOTAL			THROUGH EASTBOUND			THROUGH WESTBOUND		
	Nitrogen Products	Phosphorus Products	Fertilizers & Materials	Nitrogen Products	Phosphorus Products	Fertilizers & Materials	Nitrogen Products	Phosphorus Products	Fertilizers & Materials
SABINE TO GALVESTON	201,962	32,445	186,645	54,745	1,432	323,146	147,217	31,013	94,794
GALVESTON TO CORPUS CHRISTI	95,476	15,991	22,849	3,410*	2,488*	1,226*	92,066	13,503	21,623
CORPUS CHRISTI TO MEXICO	27,999	7,403	9,319	NA	NA	NA	27,999	7,403	9,319

* Inbound westbound
NA: Not Available.

SOURCE: United States Waterborne Commerce Statistics, United States Army Corps of Engineers, 1972.

amounting to a total of 654,834 tons. Other transportation modes move proportional shares of the final product inland.

The Texas Input-Output Model[25]

As the example above illustrates, production processes are often complex and require different production inputs. These inputs may include labor services, transportation, finance, utilities, and specific quantities of raw materials. Each stage in the production cycle needs further advertising, legal and other professional services. Intermediate products are sold to other manufacturers for use in their respective production processes, and so the cycle continues.

The purpose of all this activity is to provide the consumer with a finished good. Consumer groups include local households, government, other states or countries, or the commodity may be applied to capital formation.

Procurement of production factors similar to the sale of products involves trade with establishments--retail and wholesale--throughout local and neighboring regions.

Consumers, or households provide the human resources for production by supplying management and labor skills. In return for services rendered, households receive income from salaries, wages, property and dividends.

Similar to industry which produces marketable goods to consumer groups and government which produces "social goods" (e.g., public education), households may be also considered as a processing sector of the economy.

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[25]The following discussion consists of brief summaries of pages two to six and pages 108 to 111 of Input-Output Analysis: The Structure of the Texas Economy, Volume I, Office of Information Services, Office of the Governor, Austin, Texas March 1973.

The above all too familiar market system is governed by the laws of supply and demand subject to a number of constraints. Such constraints pertain to location of resources, market outlets, transportation facilities, labor supply, services availability, community and environmental amenities, management ability in addition to general price and wage stability, information exchange and availability of production capital.

Collecting those individual establishments that operate in similar environments with regard to the above constraints, the input-output model divided Texas into nine regional economies as shown in Figure 3. The purpose for this division and ensuing analytical procedures is to provide data and interpretations of significant relationships about the Texas economy. Specifically, it provides a means of measuring the economic interdependency among sectors within an economy.

From the vast amount of valuable information released by this model, the investigator will apply only the resultant output multipliers. These multipliers reflect the change in economic activity associated with a one dollar change in a sector's output.[26] Of the two existing types of multipliers, this study will use the one that accounts for the direct, indirect, and induced changes in income resulting from increased output of producing sectors which <u>includes</u> households. The other type of multiplier excludes households.

In determining the 1971 indirect economic contribution to Texas, this multiplier should only be applied to the increase in direct output over 1970 and added to calculated increases from previous years.

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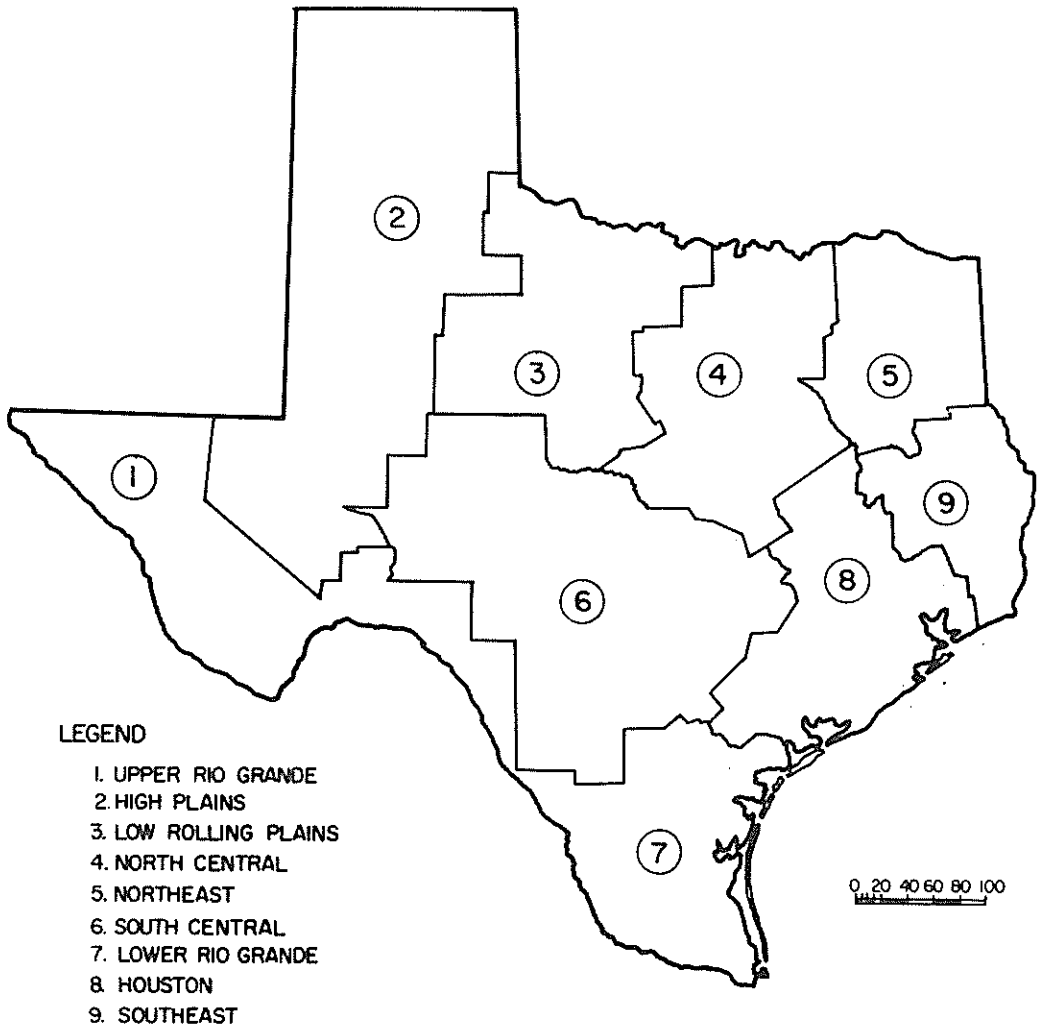
[26]Perrin, John S., <u>Output Multipliers in Input-Output Analysis</u>, Division of Management Science, Office of the Governor, Austin, Texas, August 1972.



SOURCE: HERBERT W. GRUBB, INPUT-OUTPUT ANALYSIS: THE STRUCTURE OF THE TEXAS ECONOMY, VOLUME I. AUSTIN, TEXAS; OFFICE OF INFORMATION SERVICES, OFFICE OF THE GOVERNOR, 1974.

TEXAS INPUT-OUTPUT REGIONS

FIGURE 3

To refrain from calculating output increases on an annual basis and aggregating these over the years, it will be assumed that the output for the previous year was zero, which would classify 1971 output as new output. In that sense, application of the output multiplier to 1971 output will be valid.

Multiplier Application

Referring to Figure 3, region 7 multipliers were applied to Brownsville and Corpus Christi SMSA data. Galveston-Texas City and Houston multipliers are those from region 8, while region 9 multipliers describe the Beaumont-Port Arthur-Orange SMSA.

These regional multipliers pertain to more specific standard industrial classifications (S.I.C.) rather than the broader industrial categories listed on Department of Commerce print-outs. Therefore, the multiplier used for the general class of "agriculture" represented an average of all agriculture related industrial classifications available in the input-output model for each respective economic region.

A listing of multipliers by region may be found in Appendix C. The 2.27 employment multiplier for Corpus Christi determined by the Bureau of Business Research, University of Texas is the most recent one available. Assuming basic employment generates a similar magnitude of indirect employment in other coastal communities, this 2.27 factor was applied to the major ports. When this 2.27 employment factor is applied to the primary employment sector, it must be understood that the resulting employment numbers are not confined to the coastal zone defined in Figure 1. The results actually describe the number of additional jobs that emanate from the basic work force in

the coastal zone. From the basic work force employment linkages flow to virtually all sectors of the Texas economy. In reference to total employment in the Texas coastal area, the combined direct and indirect marine employment figures cited in Table 15 are comparatively large.

Multiplying the employment factor and the primary employment data from Appendix A results in indirect employment approximated in Appendix D. Aggregated for 1969, 1970, and 1971, Table 15 below gives the total direct and indirect employment numbers.

TABLE 15

TOTAL DIRECT AND INDIRECT EMPLOYMENT AND INCOME EMANATING FROM GIWW COMMERCE

YEAR	EMPLOYMENT	INCOME ($000)
1969	2,726,215	22,171,354
1970	2,807,907	24,354,667
1971	2,866,485	26,029,052

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

Total direct and indirect income for coastal port economies is derived through multiplication of basic income from Appendix A by appropriate multipliers from Appendix C. Detailed indirect income and employment data for each SMSA is referenced in Appendix D. A summary of both income and employment data is shown in Table 16.

TABLE 16

TOTAL DIRECT AND INDIRECT EMPLOYMENT AND INCOME
FOR COASTAL SMSA'S

SMSA	1969 EMPLOYMENT (000)	1969 INCOME ($ Million)	1970 EMPLOYMENT (000)	1970 INCOME ($ Million)	1971 EMPLOYMENT (000)	1971 INCOME ($ Million)
Brownsville-Harlingen-San Benito	102	628	104	694	106	749
Corpus Christi	249	1,734	253	1,861	256	1,934
Galveston-Texas City	138	1,104	142	1,234	143	1,291
Houston	1,941	16,453	2,009	18,146	2,060	19,504
Beaumont-Port Arthur-Orange	296	2,252	300	2,420	301	2,552
TOTAL	2,726	22,171	2,808	24,355	2,866	26,030

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

Comparing earnings to employment ratios for the coast during the three years indicates income per worker to have risen 4.87 percent between 1970 and 1971 versus 1.92 percent between 1969 and 1970.

More important are the results on Table 17 which estimate total direct and indirect employment and income attributable to the Gulf Intracoastal Waterway and connecting tributaries. Supporting statistics follow in Appendix E.

Again, the proportional increase in income per worker was greater between 1970 and 1971 with 5.6 percent, than it was between 1969 and 1970 with 2.3 percent.

Although the Corpus Christi SMSA employs more workers and retains a higher primary income level, Galveston-Texas City attained larger indirect economic impacts. This is due to a higher average output multiplier for the Galveston-Texas City SMSA. Closer analysis of the geographical areas for both SMSAs reveals a higher degree of urbanization and, therefore, higher interdependence between industrial sectors in the Galveston-Texas City area which causes its output multiplier to be greater.

In this respect, the impact of an equal amount of waterborne commerce for two different areas may differ significantly depending on a city's relationship or degree of interdependence with its surrounding economic regions.

Overall, the impact of $2.2 billion worth of direct and indirect income in 1971, is impressive. To be comprehensive, revenue and taxes generated by $100,000 of new Texas household income must be considered. Referring to Table 18, we find that in the case of transportation alone, an additional $100,000 of household income will induce transportation

TABLE 17

ESTIMATED DIRECT AND INDIRECT EMPLOYMENT AND INCOME
FROM BARGE TRAFFIC

SMSA	1969 EMPLOYMENT*	1969 INCOME ($ 000)	1970 EMPLOYMENT*	1970 INCOME ($ 000)	1971 EMPLOYMENT*	1971 INCOME ($ 000)
Brownsville-Harlingen-San Benito	6,517	40,205	6,628	44,427	6,796	47,919
Corpus Christi	37,901	263,631	38,451	282,799	38,865	294,007
Galveston-Texas City	31,476	251,646	32,407	359,597	32,623	294,239
Houston	104,801	888,462	108,508	979,876	111,255	1,053,196
Beaumont-Port Arthur-Orange	57,171	434,694	57,869	467,225	58,154	492,526
TOTAL	237,866	1,878,638	243,863	2,133,924	247,695	2,181,887

* Includes farm and non-farm proprietor employment.

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 18

ECONOMIC IMPACT ASSOCIATED WITH AN INCREASE IN TEXAS HOUSEHOLD INCOME OF $100,000

INDUSTRY	INCREASED OUTPUT	INCREASED HOUSEHOLD INCOME	INCREASED HOUSEHOLD EXPENDITURES	INCREASED TAX REVENUES	INCREASED EDUCATION REVENUES	INCREASED MANUFACTURING REVENUES	INCREASED MANUFACTURING EXPENDITURES
Agriculture, Forestry, Fisheries	$ 1,889.564	$ 611.08	$ 658,98	$ 44.41	$ 35.10	$ 286.37	$ 870.79
Mining	3,489.384	979.33	108.51	285.26	73.98	78.44	1,711.51
Construction	917.217	341.00	483.46	38.15	4.15	199.89	124.11
Manufacturing	16,897.900	3,126.35	10,827.13	592.01	85.00	2,351.94	2,351.94
Transportation	3,409.857	1,427.30	2,412.77	229.36	50.88	299.91	504.98
Communications	1,866.807	678.57	1,068.26	362.40	64.40	51.29	54.02
Utilities	3,919.685	569.21	2,406.34	397.42	154.37	89.10	313.11
Wholesale Trade	7,299.074	3,793.41	6,407.97	523.69	64.30	200.23	192.19
Retail Trade	19,244.152	8,870.05	18,473.36	1,031.52	174.04	1,229.30	27.45
F.I.R.E.	8,693.491	4,002.32	5,942.51	450.51	210.95	114.35	133.41
Education	4,212.372	3,036.45	3,187.10	34.50	-0-	409.97	85.00
Services	13,062.486	6,861.74	10,299.42	586.23	108.11	759.97	270.80
Households	100,000.000	6,352.12	6,352.12	14,261.25	3,187.10	10,827.13	3,126.35
Government		59,351.07	14,261.25				592.01
Imports			16,899.93				4,054.47
Savings and Depreciation			210.89				2,485.77
TOTAL	$184,902.989	$100,000.00	$100,000.00	$18,836.71	$4,212.38	$16,897.89	$16,897.91

SOURCE: John S. Perrin, Output Multipliers in Input-Output Analysis, Division of Management Science, Office of the Governor, Austin, Texas, 1972.

output to increase by $3,409.857. It will also increase transportation tax revenues by $229.36 while education revenues will rise by $50.88. Manufacturing revenues relating to transportation will go up by $299.91 and non-manufacturing expenditures will move up by $504.98. In the aggregate, $18,836.71 of additional tax revenue will be realized by the state for every $100,000 of new household income.

Converting these factors from Table 18 to a one-year increase in direct waterway-related income for 1970 to 1971 produces Table 19. Thus, an increase of $56.97 million in household income from barge-related activities during 1970 and 1971 generated $105.3 million worth of output. Although Table 19 lists only four of the eleven major producing activities that compose output, the $105.3 million total output generated by the five Texas coastal SMSAs represents the total of all the eleven producing segments. Tax revenues amounted to $10.7 million. Education revenues rose by $2.4 million while a combined total of manufacturing revenues and expenditures amounted to an additional $19.3 million.

Adding the income, output, and expenditures on waterways and construction in Table 20 and comparing them to the Texas Gross State Product (GSP) of $88.8 billion,[27] reveals that the existing Gulf Intracoastal Waterway alone contributes approximately 4.5 percent to the Texas economy.

SUMMARY

Since this report focuses strictly on the waterway and waterway-related functions to include only that proportion of total economic

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[27] Office of Information Services, Office of the Governor, Austin, Texas.

TABLE 19

TAXES, REVENUES, AND EXPENDITURES
GENERATED BY WATERWAY ACTIVITIES
1970-1971

SMSA	TAX REVENUES ($ 000)	EDUCATION REVENUES ($ 000)	MANUFACTURING REVENUES ($ 000)	MANUFACTURING EXPENDITURES ($ 000)	OUTPUT ($ 000)
Brownsville-Harlingen-San Benito	294.8	65.9	264.5	264.5	2,893.7
Corpus Christi	1,043.0	233.2	935.6	935.6	10,238.1
Galveston-Texas City	1,140.6	255.1	1,023.2	1,023.2	11,195.9
Houston	5,822.4	1,302.1	5,223.1	5,223.1	57,153.5
Beaumont-Port Arthur-Orange	2,430.7	543.6	2,180.5	2,180.5	23,860.0
TOTAL	10,731.5	2,399.9	9,626.9	9,626.9	105,341.2

SOURCE: Perrin, John S., Output Multipliers in Input-Output Analysis, Division of Management Science, Office of the Governor, Austin, Texas 1972; and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 20

AGGREGATE ECONOMIC STIMULUS
OF BARGE-RELATED ACTIVITIES
1971

SOURCE	DOLLARS (000)	MULTIPLIER	TOTAL ($ 000)
Income	2,181,887	--	2,181,887
Output	105,341	--	105,341
Expenditures on the Waterways	21,933	3.09	67,773
Industrial Construction	501,320	3.21	1,609,237
TOTAL	2,737,526	--	3,987,848

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

activity traceable to barge traffic, the aggregate economic impact here is considerably less than initially predicted in the earlier base study, The Primary Economic Impact of the Gulf Intracoastal Waterway on Texas. This base study included the dollar value of waterway cargo under the assumption that this cargo and its associated per ton value to a port economy totalling in excess of $1 billion, would be absent without the waterway.

Other items that could possibly be mentioned to obtain even larger dollar impacts pertain to the effects of capital expenditures and the activities involved in producing, moving, and placing capital equipment. Barge operation expenditures, barge rehabilitation, investment, and interest expenses also add to the impact.

This section points to the reliance placed on the waterway by coastal communities and industry. In addition to current and anticipated commodity flow referenced in Table 21, the existence of the waterway has induced industries to locate along its banks and it has generated jobs for Texas citizens in all employment classifications resulting in household income, industry revenue, and tax revenue. All these factors contribute to the social and economic welfare of Texas.

The following chapter will describe other indirect benefits from waterway usage and will futher discuss the waterway's potential and alternative uses as a transportation route.

TABLE 21

PROJECTED TRENDS IN TOTAL TRAFFIC MOVEMENT ON
THE WEST GULF INTRACOASTAL WATERWAY
1955 TO 1985
(IN TONS)

WATERWAY SEGMENTS	CALENDAR YEAR						
	1955	1960	1965	1970	1975	1980	1985
Mississippi River to Sabine Lake	116,660	131,460	146,260	161,050	175,850	190,647	205,444
Sabine Lake to Galveston Bay	43,572	51,294	59,015	66,737	74,459	82,181	89,903
Galveston Bay to Corpus Christi Bay	23,996	30,540	37,113	43,687	50,261	56,835	63,408
Corpus Christi Bay to Brownsville Terminus	15,412	20,041	24,671	29,300	33,929	38,559	43,188
Total Traffic	199,610	233,335	267,059	300,774	334,499	368,222	401,943

SOURCE: U.S. Waterborne Commerce Statistics, U.S. Army Corps of Engineers.

CHAPTER IV

THE WATERWAY POTENTIAL BENEFITS

INTRODUCTION

It has been established from previous sections and other reports that the waterway is, to a large extent, responsible for the economic development of the Texas Coastal Zone and thereby contributes significantly to the gross state product. But there is another benefit derived from this water transportation route--transportation cost savings.

TRANSPORTATION MODE PROFILES

Without engaging in a detailed analysis of the domestic transportation system, a simple comparison of modal profiles in Table 22 clearly differentiates these transportation modes according to cost, capacity, flexibility, and line-haul speed.

The two closest competitors, both marine and rail transportation, are sensitive to volume where the competitive advantage depends on the type of cargo and the cost of cargo movement. Barge traffic is limited geographically to areas adjacent to the waterways and thus requires transhipment onto other modes for delivery of goods to destinations not directly along the waterway, while rail sidings permit direct service between many inland points. The marine mode has the inherent advantage of transporting high-volume shipments of bulk commodities. Railroads are associated with moving low-volume nonbulk commodities. This follows from the observation that bulk cargos are generally of lower value than nonbulk goods which minimizes the inventory cost disadvantage of barge movements.

TABLE 22

PROFILES OF TRANSPORTATION MODES

MODE	COST (Cents per Ton-Mile)	CAPACITY (Short Tons)	FLEXIBILITY	LINE-HAUL SPEED (Miles per Hour)
Barge	0.1 to 1.1	1,000 to 3,000 per barge	Range of direct service is geographically limited to areas adjacent to a waterway	3 to 12
		5,000 to 55,000 per tow	"Door-to-door" service requires intermodal movement for locations not directly on waterway	
Rail				
Single and Multiple Car	0.8 to 2.5	50 to 100 per car	Rail sidings permit "door-to-door" service between many inland points	25 to 45
Unit Train	0.5 to 1.0	5,000 to 12,000 per train		30 to 45
Motor Carrier	2.0 to 4.0	10 to 25 per truck	Can provide "door-to-door" service to almost any inland point	40 to 60
Pipeline	0.1 to 0.25	30,000[1] to 2,500,000[2]	Can offer direct service only to those mechanically linked to the system	3 to 6
Airline	15 to 20	5 to 125 per aircraft	Cannot provide "door-to-door" service Range of service depends on airport locations	300 to 600

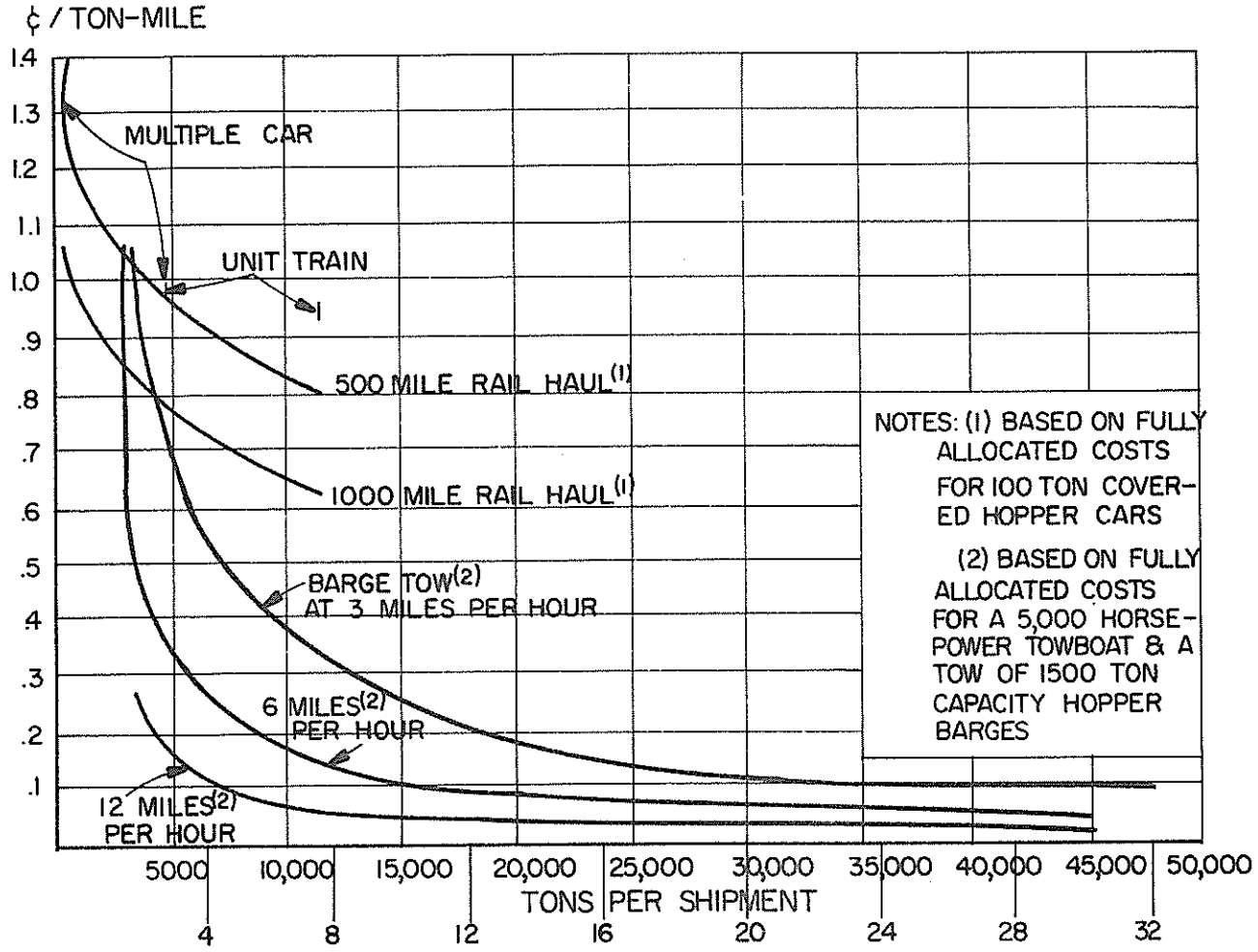
[1]Based on minimum tender of 200,000 barrels.
[2]Maximum daily capacity of 48" pipeline.

SOURCE: A. T. Kearney, Domestic Waterborne Shipping Market Analysis: Inland Waterways Trade Area, Chicago, Illinois, 1974.

In terms of costs, Table 22 shows the per ton-mile cost of 0.1 to 1.1 cents for barge transportation to be about half of rail costs amounting to 0.8 to 2.5 cents.

Low line-haul costs are another cost advantage peculiar to marine transportation. Figure 4 graphically summarizes the line-haul cost relationships between rail and barge. It is again demonstrated how these two modes are responsive to volume. Notice how inelastic rail and barge cost functions are in the range from 0 to 5,000 tons. This means that only a slight increase in volume will induce a greater than proportional decrease in cost. Although barge costs are below rail costs beyond the 5,000 ton load, this sensitive correlation between volume and cost reoccurs. Refer to Table 23 for examples demonstrating the marine cost advantage. Of particular interest, and one that involves the Gulf Intracoastal Waterway, is the stretch between Corpus Christi, Texas to Sheffield, Alabama. Describing the movement of metal ores between these two locations, a barge cost advantage of $4.53 per ton of cargo is realized. Multiplying this per ton savings by the total tonnage of metal ores moved on this route will amount to sizeable savings to manufacturers, a saving which can be passed on to the consumer through lower product prices. When handling costs are included, a $4.78 cost advantage emerges per ton of metal ores moving from Corpus Christi, Texas to Sheffield, Alabama, as is shown in Table 24. Handling costs include feeder and distributor costs and inventory costs.

A similar analysis for the movement of fertilizer and related chemicals described in Table 14 would estimate the transportation costs



SOURCE: A.T. KEARNEY, DOMESTIC WATERBORNE SHIPPING MARKET ANALYSIS: INLAND WATERWAYS TRADE AREA CHICAGO, ILLINOIS, 1974.

LINE-HAUL COST RELATIONSHIP
RAIL VERSUS BARGE

FIGURE 4

TABLE 23

RAIL-WATER LINE-HAUL COST COMPARISONS

COMMODITY	ORIGIN	DESTINATION	DOLLARS PER TON RAIL COST (1)	DOLLARS PER TON BARGE COST (1)	DOLLARS PER TON BARGE ADVANTAGE
Cash Grains	Sioux City	Chattanooga	$ 9.80	$ 6.39	$ 3.41
Grain Mill Products	Chicago	St. Louis	3.46	1.45	2.01
Primary Iron and Steel	Pittsburgh	Louisville	5.12	1.33	3.79
Paper	Vicksburg	Chicago	6.13	3.02	3.11
Fabricated Metal Products	Chicago	St. Louis	4.32	1.45	2.87
Metal Ores	Corpus Christi	Sheffield, Ala.	10.19	5.66	4.53
Nonferrous Primary Metals	Little Rock, Arkansas	Mobile, Ala.	5.89	3.18	2.71
Sugar	New Orleans	Chicago	6.44	3.91	2.53
Coal	Huntington, W. Va.	New Orleans	7.17	4.44	2.73
Total Advantage for Selected Moves					$27.69

(1) Variable costs for line-haul service.

SOURCE: Kearney, A. T., Domestic Waterborne Shipping Market Analysis: Inland Waterways Trade Area, Chicago, Illinois, 1974.

TABLE 24

RAIL-WATER COST COMPARISONS--LINE-HAUL AND HANDLING COSTS

COMMODITY	ORIGIN	DESTINATION	DOLLARS PER TON		
			RAIL COST (1)	BARGE COST (1)	BARGE ADVANTAGE
Cash Grains	Sioux City	Chattanooga	$10.65	$ 7.19	$ 3.46
Grain Mill Products	Chicago	St. Louis	4.31	2.25	2.06
Primary Iron and Steel	Pittsburgh	Louisville	5.72	4.33	1.39
Paper	Vicksburg	Chicago	6.93	5.62	1.31
Fabricated Metal Products	Chicago	St. Louis	6.32	4.45	1.87
Metal Ores	Corpus Christi	Sheffield, Ala.	11.24	6.46	4.78
Nonferrous Primary Metals	Little Rock, Arkansas	Mobile, Ala.	6.49	6.18	.31
Sugar	New Orleans	Chicago	7.64	4.81	2.83
Coal	Huntington, W. Va.	New Orleans	8.52	5.79	2.73
Total Advantage for Selected Moves					$20.74

(1) Sum of line-haul costs displayed in Table 23 and loading and unloading costs.

SOURCE: U. S. Waterborne Commerce Statistics, U. S. Army Corps of Engineers; and Kearney, A. T., Domestic Waterborne Shipping Market Analysis: Inland Waterways Trade Area, Chicago, Illinois, 1974.

that can be served via the Gulf Intracoastal Waterway and its tributaries. Based on the route from Beaumont to Brownsville, the railroad distance measures 441 miles while the same route measures 378 miles by barge.

Comparative rates of Chemical and Petroleum product commodity classifications between these two modes was supplied by the Texas Railroad Commission and the Port of Houston. When the most recent surcharge due to increased fuel costs is included, the railroad average cost per ton over 411 miles is $22.25 opposed to $10.82 per ton over 378 miles for barge transportation.

Applied to a minimum railroad carload of 60,000 pounds, equivalent to 30 short tons, total cost comparisons reveal a transportation cost of $681.51 for railroads versus $342.55 by barge from Beaumont to Brownsville, resulting in $338.96 marine cost advantage.

Although some double counting will result from adding the tonnages for nitrogen, phosphorus and fertilizer and materials from Table 14, it will provide a base from which a modal transportation cost comparison can be made. Application of the above $338.96 marine cost advantage per 30 tons of chemical products to a total of 381,276 tons of fertilizer-related cargo results in a $4,307,910 annual savings in transportation costs. The $11.30 per ton savings in transportation cost is only one example of the great volume of different types of cargo moved by barge. The sum of similar savings over all waterborne commodity groups will amount to sizeable savings to both industrial users and the individual consumer. In 1973 the Tennessee River, for example, saved shippers $71,600,000 in transportation costs according to the annual report by the Tennessee Valley Authority.[28]

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[28] The Waterways Journal, July 20, 1974.

In view of the current energy shortage and intense public environmental concern, marine transportation requires less energy and emits less pollutants during operation. Dr. William Moor of the RAND Corporation estimated energy requirements for movement of cargo per ton-mile by different modes. To move a ton-mile of marine cargo was concluded to take an average of 500 British Thermal Units (B.T.U.'s) of energy compared to 750 B.T.U.'s per ton-mile by rail and 1,850 by pipeline. Trucks and air transportation use 2,400 and 6,300 B.T.U.'s respectively.[29]

Linked with energy usage is pollution emission. Although rail uses 250 more B.T.U.'s of energy to move a ton-mile of cargo than barges, rails emit only 0.5 percent of total pollution emissions versus 1.6 percent for marine vessels according to Table 25. The difference is small enough to cause no significant redistribution of modal shares.

TABLE 25

AIR POLLUTANT EMISSIONS BY TRANSPORTATION MODES

SOURCE	TONS[1] (Millions)	PERCENT OF TOTAL
Motor Vehicles	124.0	86.0
Aircraft	3.8	2.7
Railroads	0.6	0.5
Marine Vessels	2.3	1.6
Non-Highway Use of Motor Fuel	13.2	9.2
Total Transportation Emissions	143.9	100.0

[1]Includes particulate matter, nitrogen oxides, carbon monoxide, hydrocarbons, and sulphur oxides.

SOURCE: Summary of National Transportation Statistics, Department of Transportation, 1973.

[29]National Waterways Conference, Inc., Newsletter, June 1, 1973.

Low capital cost requirements for capacity expension also favor waterways. Department of Transportation estimates the cost of rail facilities expansion of 221 billion ton-miles between 1970 and 1980 to amount to $8.9 billion.[30]

Similar estimates for an expansion of 215 billion ton-miles of waterway costs $1.6 billion. On a per 1,000 ton-mile basis, waterway expansion comes to almost $7.50 and rail expansion costs $39.00.[31] From an economic viewpoint, when expanding transportation network, the waterways should be among the first to be considered.

WATERWAY USES

As railroads contributed much in developing and stimulating new population patterns in the United States, waterways still offer this benefit which has not yet been explored to its fullest potential. Both new and existing navigation systems serve rural and underdeveloped areas by creating job opportunities and generating new income. Aside from the development aspect, the waterway could be used for movement of people. Many water routes are well-suited for this purpose, especially in the case of the Gulf Intracoastal Waterway, which connects five Standard Metropolitan Statistical Areas.

Lulejian and Associates, Inc., a consulting firm near Falls Church, Virginia, completed a study of urban commuter possibilities available from water transportation in the Washington, D.C. area.[32]

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[30] Testimony by Harry N. Cook, Executive Vice President, National Waterways Conference, Inc. before the Subcommittee on Transportation, Committee on Appropriations, U.S. House of Representatives, Washington, D.C., March 6, 1974.

[31] Ibid.

[32] Ibid.

It concluded:

> "The one method of commuter transportation that requires the least new construction and interference with existing roadways, residences and businesses is water transport."[33]

Ferries, hydrofoils and other watercraft could do much to alleviate urban mass transit problems. The report further revealed:

> "There would be no interference with existing or projected land transportation systems, residences, or businesses. The waterway is already in existence and no private owners would have to be evicted, thus eliminating legal problems involving right-of-way acquisitions."[34]

Successful experiments are recorded in many countries. Russia, for example, employs over 1,000 passenger-carrying hydrofoils daily.

A study by Arthur D. Little, Inc. prepared for the Maritime Administration claims that based on ten selected hazardous commodities, barges may be best for moving hazardous substances.[35] In terms of safety, barges involve less urban exposure than either rails or trucks in the event of accidents. With exception of chlorine and benzene shipments, barges have experienced less frequent mishaps and recorded fewer fatalities.[36] Barge traffic currently hauls from 60 to 100 percent of these selected substances.

Utilization of the waterway, in other words, conserves the already limited fuel supplies while the public receives a simultaneous benefit from reduced water, air, and noise pollution.

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[33] Ibid.

[34] Ibid.

[35] The Journal of Commerce, "Study Indicates Barges May be Best for Moving Hazardous Substances," June 17, 1974.

[36] Ibid.

ENGINEERING IMPROVEMENTS AND POTENTIAL USES

The accelerating growth in waterborne commerce in combination with an accident frequency of 800 accidents occurring on the Texas portion of the waterway between 1970 and 1971,[37] call for a number of improvements. These include widening, deepening, or possibly rerouting the waterway. Widening may reduce maintenance dredging requirements and may further reduce accident frequencies from collision and grounding. A deeper canal will allow movement of deeper-draft, higher-capacity vessels and thus increase the waterway capacity. At the same time, larger barges will have reduced maneuverability and will require a longer stopping distance. Maintaining a deeper channel will also require more frequent dredging.

To further reduce the accident rate, rerouting the waterway to eliminate sharp bends and generally improve the geometry of the waterway is a valid consideration.

Since 25 percent of accidents occurred from head-on collisions,[38] construction of two separate canals, one north bound and one south bound, will reduce the number of collisions while the canal's traffic capacity will expand simultaneously.

To reduce erosion of its banks and to restrain rapid sedimentation, towing of barges may be accomplished by devices other than tugboats. Just as mules were used to pull tows in the past, steam or electric tractors and monorail systems, such as the one used along the Erie Canal at one time, can be used on the waterway as well. Direct propulsion to

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[37] David M. French, "A Method for Risk-Level Reduction on the West Gulf Intracoastal Waterway," presented to the National Academy of Science, NRC, July 10, 1973.

[38] Ibid.

barges from overhead lines was successfully tried in England and could also be applied to the GIWW.

Dredged material can be safely disposed by pumping it to desirable locations through a large disposal line built along the length of the canal with intermittent connections for proper distribution.[39] This would be environmentally sound and the cost of operation would be low, although the initial construction expense may be large.

Mr. de Castongrene conceived a system engineering approach to coastal zone transportation which would afford:

1. Handling of a large variety of waterborne transport;
2. Minimum environmental effect;
3. Provisions for growth in capacity;
4. All-weather protection to watercraft;
5. Year-round operation;
6. Commercial, industrial, and recreation interests;
7. Safety;
8. Speed; and,
9. Low maintenance costs

Figure 5 graphically illustrates this concept. It incorporates all the above requirements in a systematic way to allow freedom for movement by all modes. This structure would:

"1. Provide tractor services for barges along the length of the waterway;

2. Provide passenger monorail service;

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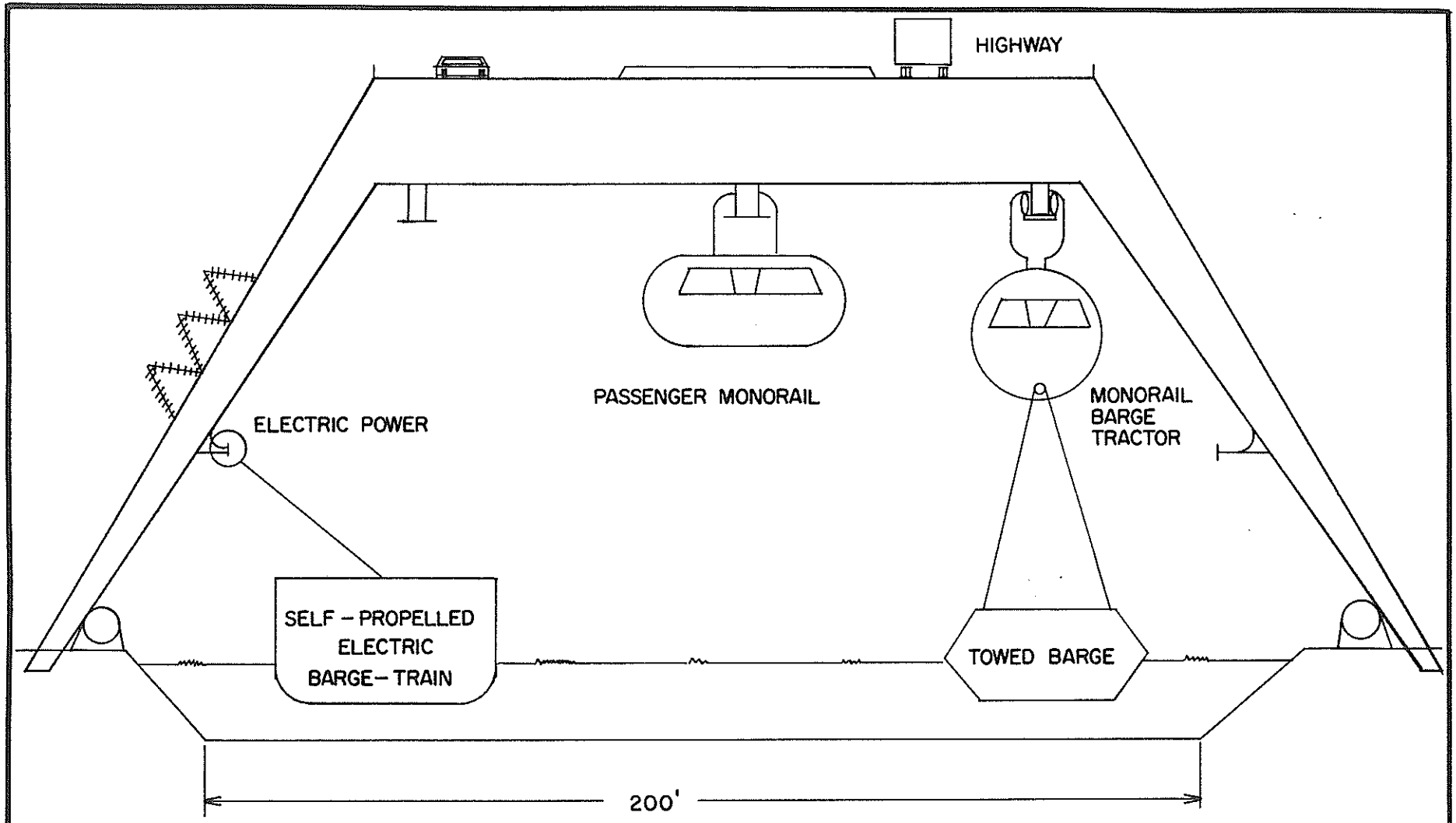
[39]The following ideas and information are extracted from a term paper by Russel O. de Castongrene with his permission. The author presented this paper on May 1, 1974, as a part of a group study for the Texas A&M University course, "Special Topics in Coastal Zone Management."



SOURCE: RUSSEL O. de CASTONGRENE, "ENGINEERING IMPROVEMENTS TO THE GULF INTRACOASTAL WATERWAY," TERMPAPER FOR MANAGEMENT 689. TEXAS A&M UNIVERSITY, COLLEGE STATION, TEXAS, MAY 1, 1974.

POTENTIAL USES OF THE GULF INTRACOASTAL WATERWAY

FIGURE 5

3. Provide a roadway for cars, buses, and trucks;
4. Provide electricity, water, and communication services through attached power lines and pipes;
5. Provide a dredging spoil pipeline; and,
6. Serve yet unidentified purposes due to its versatile and adaptive design."[40]

Although initial construction costs will be high, returns to such an investment to include the low operation cost justifies serious consideration of this idea by appropriate individuals. Mr. de Castongrene is presently calculating approximate cost figures for construction of such a system to include associated benefits resulting from its operation.

An interesting example of a similar project involves the Tennessee Valley Authority (TVA) system of dams. Since 1933, when construction began, federal operating costs for the Tennessee Waterway have come to $167 million. Total benefits to shippers during that period amounted to $755 million according to TVA's annual report.[41] Cost comparisons were relative to rail transportation in the absence of the waterway.

As one of the least developed coasts in the United States, the Texas Gulf Coast, with the assistance of an integrated yet environmentally clean transportation system, can proceed to grow in an orderly manner dictated by proper planning and citizen support.

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[40] de Castongrene, op. cit.

[41] The Waterway Journal, July 20, 1974.

SUMMARY

In the final analysis, the waterway, if properly developed, would have multiple uses. Currently, marine transportation offers shippers of low-value bulk commodities a two-to-one cost advantage over the nearest competitor, rail transportation. Such cost savings could be applied to the movement of people as well. Utilization of the GIWW and its navigable tributaries conserves limited fuel supplies and operates at minimum water, air, and noise pollution levels. Hence, air pollution in the metropolitan centers will diminish as a result of reduced automobile usage.

Improvement of the waterway by any one of five recommended methods will involve high initial costs. In the long run, however, benefits from such improvements may far exceed initial development expenses.

It is recommended that improvement of the GIWW be seriously considered for the benefit of the Texas economy and those states dependent on Texas' products.

APPENDIX A

EMPLOYMENT AND INCOME FOR COASTAL SMSA'S BY INDUSTRIAL SECTORS

TABLE A-1

EMPLOYMENT AND INCOME FOR THE BROWNSVILLE-HARLINGEN-SAN BENITO SMSA

	AGRICULTURE		GOVERNMENT		MANUFACTURING		MINING		CONSTRUCTION		TRANSPORTATION, COMMUNICATION AND UTILITIES	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	2,089	24,913	7,397	36,585	3,793	14,790	1,282	7,394	1,360	8,515	2,564	14,956
1968	2,145	28,021	7,480	40,527	3,908	15,954	1,010	7,977	1,944	12,131	2,324	14,741
1969	2,028	27,090	7,543	43,938	3,944	16,546	773	8,273	2,080	13,721	2,481	16,493
1970	1,951	29,784	7,918	50,120	4,011	17,753	898	8,876	1,965	13,995	2,235	17,331
1971	1,789	31,770	8,289	54,922	4,133	19,840	1,388	9,920	1,978	14,669	2,780	22,279

	TRADE		FINANCE, INSURANCE AND REAL ESTATE		SERVICES		OTHER		TOTAL FARM AND NON-FARM		GRAND TOTAL (Includes Proprietors)	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	9,733	45,046	1,156	8,425	7,480	29,130	941	3,540	37,795	193,294	43,555	241,491
1968	10,205	49,764	1,226	9,515	7,592	30,969	957	4,383	38,791	213,982	44,531	266,604
1969	10,253	52,241	1,378	9,912	7,505	34,522	1,021	4,873	39,006	227,609	44,852	281,520
1970	10,392	57,438	1,372	10,409	7,976	38,597	1,085	7,447	39,803	251,750	45,621	311,591
1971	10,071	59,722	1,452	11,848	7,933	40,756	1,110	7,539	40,923	273,265	46,773	336,043

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Employment and Income by Major Sources and Earnings by Broad Industrial Sector, Washington, D.C.: U.S. Government Printing Office, 1974, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-2

EMPLOYMENT AND INCOME OF CORPUS CHRISTI SMSA

	AGRICULTURE		GOVERNMENT		MANUFACTURING		MINING		CONSTRUCTION		TRANSPORTATION, COMMUNICATION AND UTILITIES	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	2,068	23,255	27,623	154,065	10,294	88,228	4,667	44,987	7,212	49,606	5,645	40,162
1968	2,122	22,853	27,966	172,057	10,459	94,054	4,285	42,529	7,116	48,973	5,896	43,521
1969	2,006	28,663	27,644	179,973	10,987	104,766	4,063	39,596	7,211	54,266	6,047	46,360
1970	1,929	25,710	27,350	196,542	11,347	115,139	3,971	40,297	7,154	59,233	6,130	52,974
1971	1,770	20,002	27,719	209,303	10,952	115,704	3,536	37,603	7,228	62,253	6,049	55,586

	TRADE		FINANCE, INSURANCE AND REAL ESTATE		SERVICES		OTHER		TOTAL FARM AND NON-FARM		GRAND TOTAL (Includes Proprietors)	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	19,725	102,536	3,200	23,886	15,371	78,043	152	2,285	95,957	607,053	106,240	689,720
1968	20,331	109,785	3,396	26,654	15,601	85,155	253	2,576	97,425	648,157	107,804	732,587
1969	21,123	118,354	3,825	29,977	16,307	95,714	211	3,090	99,424	700,759	109,851	790,666
1970	22,425	133,118	3,859	30,213	16,457	104,625	293	3,531	100,915	761,382	111,438	850,147
1971	23,815	148,541	4,178	35,103	16,663	112,157	109	3,705	102,019	799,957	112,639	886,575

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Employment and Income by Major Sources and Earnings by Broad Industrial Sector, Washington, D.C.: U.S. Government Printing Office, 1974, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-3

EMPLOYMENT AND INCOME OF GALVESTON-TEXAS CITY SMSA

	AGRICULTURE		GOVERNMENT		MANUFACTURING		MINING		CONSTRUCTION		TRANSPORTATION, COMMUNICATION AND UTILITIES	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	354	693	12,372	64,543	10,085	102,988	201	2,240	6,066	51,302	6,128	33,800
1968	364	2,564	12,786	73,286	10,516	113,542	235	2,389	5,912	53,785	6,603	38,898
1969	343	1,257	13,033	80,394	10,956	125,487	223	1,826	3,713	36,996	5,319	36,167
1970	331	628	13,644	90,459	11,476	144,753	393	3,584	4,182	45,122	5,821	41,556
1971	304	79	14,415	99,348	11,642	154,098	394	3,805	3,317	37,408	5,704	43,752

	TRADE		FINANCE, INSURANCE AND REAL ESTATE		SERVICES		OTHER		TOTAL FARM AND NON-FARM		GRAND TOTAL (Includes Proprietors)	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	8,541	43,146	3,310	23,315	8,672	41,349	46	776	55,775	364,152	60,827	402,872
1968	8,986	47,517	3,153	24,604	8,984	47,989	150	859	57,689	405,433	62,792	450,544
1969	9,481	52,758	3,213	25,186	9,346	53,286	105	1,056	55,732	414,413	60,818	459,594
1970	9,491	55,786	3,196	26,818	8,865	57,984	95	1,282	57,494	467,972	62,619	513,932
1971	9,778	60,015	3,437	29,661	8,819	62,419	37	1,336	57,847	491,921	63,033	540,488

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Employment and Income by Major Sources and Earnings by Broad Industrial Sector, Washington, D.C.: U.S. Government Printing Office, 1974, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-4

EMPLOYMENT AND INCOME OF HOUSTON SMSA

	AGRICULTURE		GOVERNMENT		MANUFACTURING		MINING		CONSTRUCTION		TRANSPORTATION COMMUNICATIONS AND UTILITIES	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	3,726	24,411	86,129	520,501	131,206	1,131,892	20,997	273,877	58,069	487,651	61,230	429,965
1968	3,829	28,128	90,212	582,609	140,628	1,295,556	22,125	281,978	61,267	540,014	61,752	478,671
1969	3,615	27,235	94,178	641,331	148,980	1,450,971	23,461	296,641	66,392	629,827	61,191	519,984
1970	3,482	30,790	100,875	726,501	150,752	1,554,986	24,247	334,689	68,244	706,584	64,739	586,491
1971	3,195	22,744	108,057	800,476	148,695	1,651,611	25,475	372,650	68,303	736,704	65,515	642,183

	TRADE		FINANCE, INSURANCE AND REAL ESTATE		SERVICES		OTHER		TOTAL FARM AND NON-FARM		GRAND TOTAL (Includes Proprietors)	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	163,531	1,008,488	34,357	279,862	139,636	793,551	8,522	30,430	707,403	4,980,628	773,661	5,434,610
1968	174,294	1,140,981	37,488	320,354	146,572	881,532	6,618	31,330	744,785	5,581,153	811,360	6,063,653
1969	187,190	1,266,708	41,283	355,229	154,839	1,023,612	6,708	32,960	787,837	6,244,498	854,958	6,740,399
1970	194,601	1,391,124	43,358	381,652	160,378	1,152,297	6,818	37,187	817,494	6,902,303	885,200	7,424,792
1971	201,428	1,521,679	46,717	443,355	164,803	1,221,966	6,909	41,405	839,097	7,454,773	907,585	7,997,203

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Employment and Income by Major Sources and Earnings by Broad Industrial Sector, Washington, D.C.: U.S. Government Printing Office, 1974, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-5

EMPLOYMENT AND INCOME OF BEAUMONT-PORT ARTHUR-ORANGE SMSA

	AGRICULTURE		GOVERNMENT		MANUFACTURING		MINING		CONSTRUCTION		TRANSPORTATION, COMMUNICATIONS AND UTILITIES	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	511	5,609	15,030	82,065	36,783	353,704	2,427	23,983	9,108	87,198	9,627	79,860
1968	523	4,409	15,245	89,721	37,272	377,788	2,369	24,935	8,413	77,321	9,429	83,887
1969	496	4,313	15,437	96,623	37,894	419,526	2,053	18,888	8,882	88,060	9,244	81,546
1970	477	4,528	16,178	107,788	37,880	457,237	1,367	16,276	8,434	93,194	9,495	95,833
1971	437	4,494	16,896	116,416	38,262	491,899	1,365	14,580	7,571	91,087	9,552	97,315

	TRADE		FINANCE, INSURANCE AND REAL ESTATE		SERVICES		OTHER		TOTAL FARM AND NON-FARM		GRAND TOTAL (Includes Proprietors)	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	20,220	111,290	2,371	28,463	20,178	101,392	617	1,968	116,872	875,532	127,401	959,453
1968	21,163	121,347	2,945	31,482	20,428	109,316	660	2,014	118,447	922,220	128,972	1,006,825
1969	21,528	129,869	3,234	31,782	20,340	119,101	1,161	1,461	120,269	996,869	130,497	1,082,072
1970	22,249	140,028	3,980	32,354	20,843	129,028	877	1,479	121,780	1,077,745	132,083	1,166,526
1971	22,340	148,772	4,068	35,647	21,138	138,463	680	1,325	122,309	1,139,998	132,737	1,233,390

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Employment and Income by Major Sources and Earnings by Broad Industrial Sector, Washington, D.C.: U.S. Government Printing Office, 1974, and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-6

EMPLOYMENT AND INCOME OF PROPRIETORS
IN BROWNSVILLE-HARLINGEN-SAN BENITO SMSA

YEAR	NON-FARM PROPRIETORS EMPLOYMENT	NON-FARM PROPRIETORS INCOME ($000)	FARM PROPRIETORS EMPLOYMENT	FARM PROPRIETORS INCOME ($000)	TOTAL EMPLOYMENT	TOTAL INCOME ($000)
1967	4,004	27,647	1,756	20,550	5,760	48,197
1968	4,038	29,432	1,702	23,190	5,740	52,622
1969	4,182	31,866	1,664	22,045	5,846	53,911
1970	4,185	35,403	1,633	24,438	5,818	59,841
1971	4,241	36,410	1,609	26,368	5,850	62,778

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Washington, D.C., and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-7

EMPLOYMENT AND INCOME OF PROPRIETORS
IN CORPUS CHRISTI SMSA

YEAR	NON-FARM PROPRIETORS EMPLOYMENT	NON-FARM PROPRIETORS INCOME ($000)	FARM PROPRIETORS EMPLOYMENT	FARM PROPRIETORS INCOME ($000)	TOTAL EMPLOYMENT	TOTAL INCOME ($000)
1967	8,555	63,728	1,728	18,939	10,283	82,667
1968	8,664	66,360	1,715	18,070	10,379	84,430
1969	8,723	66,238	1,704	23,669	10,427	89,907
1970	8,839	68,344	1,684	20,421	10,523	88,765
1971	8,962	71,960	1,658	14,658	10,620	86,618

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Washington, D.C., and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-8

EMPLOYMENT AND INCOME OF PROPRIETORS
IN GALVESTON-TEXAS CITY SMSA

YEAR	NON-FARM PROPRIETORS EMPLOYMENT	NON-FARM PROPRIETORS INCOME ($000)	FARM PROPRIETORS EMPLOYMENT	FARM PROPRIETORS INCOME ($000)	TOTAL EMPLOYMENT	TOTAL INCOME ($000)
1967	4,650	38,766	394	- 46	5,044	38,720
1968	4,714	43,367	389	1,744	5,103	45,111
1969	4,699	44,779	387	402	5,086	45,181
1970	4,744	46,240	381	- 280	5,125	45,960
1971	4,811	49,405	375	- 838	5,186	48,567

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Washington, D.C., and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-9

EMPLOYMENT AND INCOME OF PROPRIETORS
IN HOUSTON SMSA

YEAR	NON-FARM PROPRIETROS EMPLOYMENT	NON-FARM PROPRIETROS INCOME ($000)	FARM PROPRIETORS EMPLOYMENT	FARM PROPRIETORS INCOME ($000)	TOTAL EMPLOYMENT	TOTAL INCOME ($000)
1967	58,562	437,343	7,696	16,639	66,258	453,982
1968	59,141	462,995	7,434	19,505	66,575	482,500
1969	59,901	477,666	7,220	18,235	67,121	495,901
1970	60,604	501,243	7,102	21,246	67,706	522,489
1971	61,491	529,336	6,997	13,094	68,488	542,430

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Washington, D.C., and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE A-10

EMPLOYMENT AND INCOME OF PROPRIETORS
IN BEAUMONT-PORT ARTHUR-ORANGE SMSA

YEAR	NON-FARM PROPRIETORS		FARM PROPRIETORS		TOTAL	
	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)	EMPLOYMENT	INCOME ($000)
1967	9,493	79,379	1,036	4,542	10,529	83,921
1968	9,556	81,377	969	3,228	10,525	84,605
1969	9,312	82,124	916	3,079	10,228	85,203
1970	9,404	85,560	899	3,221	10,303	88,781
1971	9,543	90,220	885	3,172	10,428	93,392

SOURCE: United States Department of Commerce, Social and Economic Statistics Division, Washington, D.C., and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

APPENDIX B

EXPLANATION OF TERMS IN TABLE 12 OF TEXT

APPENDIX B[37]

EXPLANATION OF TERMS USED IN TABLE 12

Eastbound, Westbound: originates and terminates on the waterway.

Inbound East, Inbound West: from a point off canal to a point on canal.

Outbound East, Outbound West: from a point on canal to a point off canal.

Through Westbound, Through Eastbound: from a port off the canal (e.g., Houston) to another port off the canal (e.g., Corpus Christi).

In portions of the text after Table 12, use of the term "through" refers to the movement from one port to another through the Gulf Intracoastal Waterway.

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[37]United States Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 2, (Washington, D.C.: U.S. Government Printing Office, 1961).

APPENDIX C

SUMMARY OF THE ESTIMATED INDIVIDUAL SECTOR MULTIPLIERS FOR COASTAL ZONE REGIONS 7, 8, AND 9

TABLE C-1

MULTIPLIERS FOR THE LOWER RIO GRANDE ECONOMY OF TEXAS
1967
(Region 7)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Irrigated Cotton	2.91	2.89
Irrigated Grains	2.57	2.57
Vegetables, Citrus and Other Irrigated Crop Products	2.77	2.76
Dryland Cotton	2.91	2.90
Dryland Feed Grains	2.65	2.65
Other Dryland Crop Production	2.26	2.21
Range and Feed Lot Livestock Production	3.22	2.67
Dairy, Poultry and Eggs	2.40	2.39
Agricultural Supply, except Farm Machinery	2.48	2.48
Ginning	2.57	2.57
Agricultural Services	2.35	2.34
Fisheries	2.48	2.45
Crude Petroleum, Natural Gas, and Services	2.12	1.92
Residential Construction, Alteration and Repair	2.28	2.28
Commercial, Educational and Institutional Construction	2.13	2.13
Facility and Other Construction	2.46	2.42
Meat Products	2.87	2.80
Dairy Manufacturing	2.27	2.25
Canned, Preserved, Pickled, Dried, Frozen Foods	2.21	2.21
Other Food and Kindred Products	1.80	1.72
Beverages	1.81	1.80
Textile Mill Products, Furnishings and Apparel	2.17	2.11
Wood Furniture and Other Wood and Paper Products	1.50	1.49
Newspapers, Publishing and Printing	2.06	2.03
Chemicals, Drugs and Related Products	2.31	2.25
Petroleum, Refining and Products	2.14	2.11
Clay, Cut Stone and Shell Products	2.58	2.58
Cement and Concrete Products	1.76	1.71
Primary Metals, Foundries and Forgings	2.14	2.13
Fabricated Steel and Other Metal Products	1.78	1.78
Machinery and Processing Equipment	1.67	1.66
Electrical and Electronic Equipment	1.86	1.84

TABLE C-1--continued

MULTIPLIERS FOR THE LOWER RIO GRANDE ECONOMY OF TEXAS
1967
(Region 7)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Transportation Equipment	1.90	1.90
Other Manufacturing	1.94	1.93
Highway Motor Freight, Passenger Service and Warehousing	2.37	2.36
Water Transportation	3.04	2.42
Air Transportation	2.14	1.93
Other Transportation Services	2.68	2.63
Communications	1.63	1.61
Gas Services (public and private)	2.60	2.55
Electric Services (public and private)	1.79	1.77
Water and Sanitary Service Systems (public and private)	2.25	2.06
Wholesale Auto, Parts and Supplies	2.02	2.01
Wholesale Groceries and Related Products	1.84	1.83
Wholesale Farm Products	2.64	2.64
Wholesale Livestock	2.54	2.54
Wholesale Machinery, Equipment and Supplies	2.47	2.45
Wholesale Petroleum and Petroleum Products	2.19	2.18
General Wholesale	1.82	1.79
Retail Lumber Yards	1.26	1.25
Farm Equipment Dealers	1.53	1.53
Hardware, Heating, Electrical, Paint, and Wallpaper	2.75	2.75
Department and Variety Stores	2.28	2.23
Food Stores	1.53	1.51
Automotive Dealers and Repair Shops	2.36	2.28
Gasoline Service Stations	2.50	2.49
Apparel Accessory Stores	2.15	2.14
Furniture, Home Furnishings, Equipment Stores	2.75	2.74
Eating and Drinking Places	1.88	1.86
All Other Retail	2.10	2.07
Banking and Credit Agencies	2.00	1.90
Insurance Carriers, Real Estate and Finance n.e.c.	2.32	2.25
Lodging Services	2.18	2.18
Personal Services	1.96	1.94
Advertising, Duplicating, Addressing and Photographic Services	2.02	1.96

TABLE C-1--continued

MULTIPLIERS FOR THE LOWER RIO GRANDE ECONOMY OF TEXAS
1967
(Region 7)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Motion Picture, Amusement and Recreation Services	1.98	1.97
Auto Rentals and Parking Services	1.76	1.76
Miscellaneous Repair Services	2.10	2.07
Medical and Dental Services	2.05	1.93
Education (public and private)	2.91	2.68
Professional Services	2.02	1.98
Households	2.30	1.71

SOURCE: John S. Perrin, Output Multipliers in Input-Output Analysis, Austin, Texas: Division of Management Science, 1972.

TABLE C-2

MULTIPLIERS FOR THE HOUSTON-GALVESTON ECONOMY OF TEXAS
1967
(Region 8)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Irrigated Cotton	2.51	2.50
Food Grains	2.21	2.15
Feed Grains	2.20	2.05
All Other Irrigated Crops	2.18	2.17
Dryland Cotton	2.19	2.19
All Other Dryland Crop Production, NEC	2.53	2.53
Range Livestock Production	1.97	1.96
Feedlot Livestock Production	2.47	2.47
Dairy	2.39	2.37
Poultry and Eggs	3.28	2.71
Agricultural Supply Except Farm Machinery (retail trade)	2.17	2.17
Ginning and Compressing	2.69	2.69
Agricultural Services	3.24	3.21
Forestry	1.28	1.28
Fisheries	2.39	2.36
Crude Petroleum and Natural Gas	2.20	2.16
Natural Gas Liquids	1.91	1.91
Oil and Gas Field Services	2.80	2.80
All Other Mining and Quarrying	1.56	1.56
Residential Construction	2.29	2.29
Commercial, Educational and Institutional Construction	2.87	2.87
Industrial Construction	3.21	3.21
Facility Construction	3.00	3.00
Maintenance and Repair	3.23	3.18
Meat Products	2.95	2.94
Poultry Products	2.23	2.22
Dairies	2.37	2.32
All Other Grain Milling	2.80	2.70
Animal Feeds	1.90	1.90
Bakery Products	1.53	1.53
Canned, Preserved, Pickled, Dried and Frozen Foods	2.51	2.51
Other Food and Kindred Products	1.23	1.23
Beverages	1.99	1.98
Textile Mill Products	2.37	2.37
Men's and Boy's, Women's, Misses' and Children's Apparel	2.03	2.03
Related Apparel	1.75	1.72

TABLE C-2--continued

MULTIPLIERS FOR THE HOUSTON-GALVESTON ECONOMY OF TEXAS
1967
(Region 8)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Logging, Lumber Mills, and Mill Work	2.45	1.75
Furniture and Fixtures	2.50	2.07
Paper and Paper Mills	1.90	1.90
Paper Products Except Boxes and Containers	2.46	2.45
Boxes and Paper Containers	1.65	1.63
Newspapers and Publishing	2.31	2.30
Printing	2.39	2.28
Other Printing and Publishing	2.22	2.22
Chlorine and Alkalies	1.97	1.97
Chemicals	1.92	1.69
Fibers, Plastics	1.65	1.65
Synthetic Rubber and Other Chemicals	2.02	2.02
Drugs, Soaps, Cleansers and Toiletries	2.39	2.37
Agricultural Chemicals	1.80	1.80
Paints and Varnishes	2.51	2.39
Petroleum Refining and Other Petroleum Products	1.83	1.77
Tires and Fabricated Rubber Products	2.87	2.87
Plastics Products	2.05	2.05
Leather and Leather Products	2.61	2.58
Glass	2.29	2.29
Clay, Cut Stone and Shell Products	2.00	1.98
Cement and Concrete Products	2.29	2.13
Blast Furnaces	2.28	2.23
Primary Steel and Iron	2.01	2.01
Foundries	2.49	2.49
Nonferrous Primary and Secondary Smelting	2.03	1.86
Aluminum and Nonferrous Rolling	1.70	1.69
Castings and Forgings	1.93	1.93
Fabricated Steel	2.40	2.31
Plate Work	1.88	1.88
Sheet Metal and Architectural	1.82	1.82
Metal Doors	2.60	2.59
Fabricated Metal and Plumbing Products	2.61	2.60
Bolts, Nuts and Screws	2.24	2.23
Electroplating, Coating and Engraving	2.14	2.14

TABLE C-2--continued

MULTIPLIERS FOR THE HOUSTON-GALVESTON ECONOMY OF TEXAS
1967
(Region 8)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Valves and Pipe Fittings	2.48	2.42
Other Fabricated Metal Products	2.15	2.09
Farm, Construction and Industrial Machinery	2.65	2.65
Materials Handling Machinery and Equipment and Engines	1.66	1.66
Mining Machinery and Equipment	2.26	2.25
Metal Working Machinery	2.15	2.15
Industrial Processing Machinery	2.08	2.08
General Industrial Machinery	1.90	1.89
Refrigeration Machinery	2.48	2.48
Machine Shops and Miscellaneous Machinery	2.48	2.37
Electric Instruments and Apparatus	1.82	1.81
Electric and Electronic Equipment	2.41	2.40
Transportation Equipment	2.11	2.11
Ship and Boat Building	1.83	1.82
Scientific Instruments	2.06	2.06
Mechanical Measuring Devices	2.24	2.24
Medical Instruments	2.39	2.38
Photographic, Time and Optical Instruments	1.79	1.79
Games and Toys	2.05	2.05
All Other Manufacturing Industries Including Ordnance	1.88	1.83
Railroad Transportation	2.13	2.11
Intercity Bus Lines	2.52	2.52
Motor Freight Transportation	2.38	2.38
Local Trucking, Storage, and Warehousing	2.78	2.75
Water Transportation	2.81	2.77
Air Transportation	2.09	2.09
Pipeline Transportation, Except Natural Gas	1.88	1.88
Local and Suburban Transportation	2.95	2.95
Other Transportation Services	3.09	3.09
Telephone and Telegraph	2.05	2.03
Radio and T.V.	1.68	1.68
Other Communications	2.16	2.16
Gas Services (Private and public)	2.57	2.51
Electrical Services (Private and Public)	1.94	1.92

TABLE C-2--continued

MULTIPLIERS FOR THE HOUSTON-GALVESTON ECONOMY OF TEXAS
1967
(Region 8)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Water and Sanitary Service Systems (Private and Public)	2.33	2.13
Wholesale Auto Parts and Supplies	2.51	2.47
Wholesale Groceries and Related Products	2.40	2.38
Wholesale Farm Products	1.44	1.44
Wholesale Livestock	2.54	2.54
Wholesale Machinery, Equipment and Supplies	2.18	2.18
Wholesale Petroleum and Petroleum Products	2.36	2.35
General Wholesale	2.31	2.28
Lumber Yards	2.81	2.81
Farm Equipment Dealers	2.01	2.01
Hardware, Heating, Electrical, Paint and Wallpaper	2.25	2.25
Department and Variety Stores and Mail Order	2.26	2.20
Food Stores	2.53	2.47
Automotive Dealers and Repair Ships	2.58	2.50
Gasoline Service Stations	2.20	2.18
Apparel and Accessory Stores	2.01	1.99
Furniture, Home Furnishings and Equipment Stores	2.62	2.60
Eating and Drinking Places	2.78	2.72
All Other Retail	1.98	1.94
Banking and Credit Agencies	1.74	1.67
Insurance	1.85	1.83
Finance and Real Estate, NEC	2 51	2.41
Legal Services	3.42	3.14
Lodging Services	2.22	2.21
Personal Services	2.50	2.42
Advertising	1.59	1.58
Duplicating and Addressing	2.10	2.10
Private Employment Agencies	2.52	2.52
Photographic Services	2.19	1.79
Research and Development	2.00	2.00
All Other Business Services	3.34	3.24
Motion Picture, Amusement and Recreation Services	2.83	2.80

TABLE C-2--continued

MULTIPLIERS FOR THE HOUSTON-GALVESTON ECONOMY OF TEXAS
1967
(Region 8)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Automobile Rental Services	1.45	1.45
Automobile Parking	1.68	1.68
Electrical Repair Shops	2.13	2.13
Miscellaneous Repair Services	2.01	2.00
Physicians and Dentists Services	3.46	3.32
Hospital and Laboratory	3.40	3.33
Other Medical Services	3.05	3.03
Education (Public and Private)	3.10	3.10
Colleges and Universities (Public and Private)	3.22	3.22
All Other Educational Services	2.94	2.94
Engineering and Architectural Services	3.20	3.16
Accounting, Auditing and Bookkeeping	2.31	2.30
All Other Professional Services	3.03	3.03
All Other Services	2.80	2.70
Households	2.65	1.93

SOURCE: John S. Perrin, Output Multipliers in Input-Output Analysis, Austin, Texas: Division of Management Science, 1972.

TABLE C-3

MULTIPLIERS FOR THE SOUTHEAST ECONOMY OF TEXAS
1967
(Region 9)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Crop Production	2.75	2.66
Animal and Poultry Production	2.47	2.41
Agricultural Supply and Services	2.41	2.40
Forestry	2.91	2.91
Fisheries	3.12	3.11
Crude Petroleum & Natural Gas	2.69	2.67
Oil and Gas Field Services	2.69	2.63
All Other Mining	2.76	2.76
Residential, Commercial and Industrial	2.70	2.68
Facility Construction	2.58	2.58
Meat & Poultry Products	2.96	2.94
Dairies	1.68	1.55
Grain Products	1.47	1.45
Bakery Products	1.73	1.72
Processed Food & Kindred Products	1.78	1.77
Beverages	1.87	1.87
Textile Products & Apparel	2.24	2.24
Logging	3.05	3.04
Lumber Mills	2.07	2.06
Millwork	2.47	2.10
Furniture and Fixtures	2.50	2.50
Paper Products	1.62	1.57
Printing and Publishing	1.75	1.74
Chemicals	1.37	1.27
Petroleum Products	1.18	1.16
Rubber, Plastic & Leather	1.89	1.78
Glass, Clay and Stone Products	1.97	1.97
Cement and Concrete Products	1.49	1.41
Metal Smelting and Casting	1.70	1.67
Fabricated Metal Products	2.02	2.02
Machined Metal Products	1.65	1.63
Machinery	1.87	1.85
Electrical Apparatus	2.40	2.40
Transportation Equipment	1.58	1.58
All Other Manufacturing	1.64	1.64
Railroad Transportation	2.76	2.62
Motor Transportation	2.15	2.15
Water Transportation	2.57	2.48
Air Transportation	2.96	2.96
Pipeline Transportation	2.22	2.22
All Other Transportation	1.99	1.99

TABLE C-3--continued

MULTIPLIERS FOR THE SOUTHEAST ECONOMY OF TEXAS
1967
(Region 9)

SECTOR	FINAL DEMAND MULTIPLIER	OUTPUT MULTIPLIER
Telephone and Telegraph	1.59	1.59
Radio and TV	2.70	2.70
Gas	1.49	1.45
Electricity	1.54	1.53
Water	2.20	2.09
Wholesale Equipment and Supplies	2.12	2.11
Wholesale Groceries	2.92	2.92
Wholesale Farm Products	2.59	2.59
Wholesale Petroleum Products	2.59	2.57
General Wholesale	2.47	2.46
Lumberyards	2.34	2.34
Automobile and Tractor Dealers	2.26	2.21
Hardware and Home Furnishings	2.58	2.56
Department Stores and Variety Stores	2.27	2.22
Food Stores	2.14	2.08
Gasoline Service Stations	2.68	2.67
Eating and Drinking Places	2.19	2.18
All Other Retail	2.36	2.32
Banking and Credit Agencies	2.71	2.67
Insurance Carriers	2.60	2.58
F.I.R.E. Not Elsewhere Classified	2.47	2.46
Legal Services	2.35	2.32
Lodging	2.39	2.39
Personal Services	1.92	1.91
All Other Business Services	1.94	1.93
Repair Service	2.00	2.00
Medical Services	2.77	2.72
Education Services	3.01	2.95
Bookkeeping Services	2.50	2.49
All Other Services	2.48	2.20
Households	2.28	1.75

SOURCE: John S. Perrin, Output Multipliers in Input-Output Analysis, Austin, Texas: Division of Management Science, 1972.

APPENDIX D

DIRECT AND INDIRECT EMPLOYMENT AND INCOME

FOR THE COASTAL SMSA'S

TABLE D-1

DIRECT AND INDIRECT EMPLOYMENT AND INCOME
FOR THE BROWNSVILLE-HARLINGEN-SAN BENITO SMSA

INDUSTRIAL SECTOR	1969 EMPLOYMENT	1969 INCOME ($ 000)	1970 EMPLOYMENT	1970 INCOME ($ 000)	1971 EMPLOYMENT	1971 INCOME ($ 000)
Agriculture	4,604	70,163	4,429	77,141	4,061	82,284
Government	17,123	96,664	17,974	110,264	18,816	120,829
Manufacture	8,953	34,581	9,105	37,104	9,382	41,466
Mining	1,755	19,111	2,038	20,504	3,151	22,915
Construction	4,722	31,558	4,461	32,189	4,490	33,739
Transportation-Communications-Utilities	5,632	35,790	5,073	37,608	6,311	48,345
Trade	23,274	115,453	23,590	126,938	22,861	131,986
Finance-Insurance-Real Estate	3,128	20,815	3,114	21,859	3,296	24,881
Services	17,036	70,770	18,106	79,124	18,008	83,550
Other	2,318	8,333	2,463	12,734	2,520	12,892
Farm Proprietors	2,079	57,097	2,041	63,294	2,009	68,293
Non-Farm Proprietors	21,138	67,875	21,347	75,408	21,663	77,553
TOTAL	101,815	628,210	103,560	694,167	106,175	748,733

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE D-2

DIRECT AND INDIRECT EMPLOYMENT AND INCOME
FOR THE CORPUS CHRISTI SMSA

INDUSTRIAL SECTOR	1969 EMPLOYMENT	1969 INCOME ($ 000)	1970 EMPLOYMENT	1970 INCOME ($ 000)	1971 EMPLOYMENT	1971 INCOME ($ 000)
Agriculture	4,554	74,237	4,379	66,589	4,018	51,805
Government	62,752	395,941	62,085	432,392	62,922	460,467
Manufacture	24,940	218,961	25,758	240,641	24,861	241,821
Mining	9,223	91,467	9,014	93,086	8,027	86,863
Construction	16,369	124,812	16,240	136,236	16,408	143,182
Transportation-Communications-Utilities	13,726	100,601	13,915	114,954	13,731	120,622
Trade	47,949	261,562	50,905	294,191	54,060	328,776
Finance-Insurance-Real Estate	8,683	62,952	8,760	63,447	9,486	73,716
Services	37,017	196,214	37,357	214,481	37,825	229,922
Other	479	5,284	665	6,038	247	6,336
Farm Proprietors	3,868	61,303	3,823	52,890	3,764	37,964
Non-Farm Proprietors	19,801	141,087	20,065	145,573	20,344	153,275
TOTAL	249,361	1,734,421	252,966	1,860,518	255,693	1,934,249

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE D-3

DIRECT AND INDIRECT EMPLOYMENT AND INCOME
FOR THE GALVESTON-TEXAS CITY SMSA

INDUSTRIAL SECTOR	1969		1970		1971	
	EMPLOYMENT	INCOME ($ 000)	EMPLOYMENT	INCOME ($ 000)	EMPLOYMENT	INCOME ($ 000)
Agriculture	779	2,916	751	1,457	690	183
Government	29,585	176,867	30,972	199,010	32,722	218,566
Manufacture	24,870	268,542	26,050	309,771	26,427	329,770
Mining	506	3,852	892	7,562	894	8,029
Construction	8,429	111,728	9,493	136,268	7,530	112,972
Transportation-Communications-Utilities	12,074	84,269	13,214	96,826	12,948	101,942
Trade	21,522	121,343	21,545	128,308	22,196	138,035
Finance-Insurance-Real Estate	7,293	49,616	7,255	52,832	7,802	58,432
Services	21,215	165,171	20,124	179,750	20,019	193,499
Other	238	2,038	216	2,474	84	2,579
Farm Proprietors	879	932	865	- 650	851	- 1,944
Non-Farm Proprietors	10,667	116,425	10,769	120,224	10,921	128,453
TOTAL	138,057	1,103,699	142,146	1,233,832	143,084	1,290,516

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE D-4

DIRECT AND INDIRECT EMPLOYMENT AND INCOME
FOR THE HOUSTON SMSA

INDUSTRIAL SECTOR	1969 EMPLOYMENT	1969 INCOME ($ 000)	1970 EMPLOYMENT	1970 INCOME ($ 000)	1971 EMPLOYMENT	1971 INCOME ($ 000)
Agriculture	8,206	63,185	7,904	71,433	7,253	52,766
Government	213,784	1,410,928	228,986	1,598,302	245,289	1,761,047
Manufacture	338,185	3,105,078	342,207	3,327,670	337,538	3,534,448
Mining	53,257	625,913	55,041	706,194	57,828	786,292
Construction	150,710	1,902,078	154,914	2,127,844	155,048	2,224,846
Transportation-Communications-Utilities	138,904	1,211,263	146,958	1,366,524	148,719	1,496,286
Trade	424,921	2,913,428	441,744	3,199,585	457,242	3,499,862
Finance-Insurance-Real Estate	93,712	699,801	98,423	751,854	106,048	873,409
Services	351,485	3,173,197	364,058	3,572,121	374,103	3,788,095
Other	15,227	63,613	15,477	71,771	15,683	79,912
Farm Proprietors	16,389	42,305	16,122	49,291	15,883	30,378
Non-Farm Proprietors	135,975	1,241,932	137,571	1,303,232	139,585	1,376,274
TOTAL	1,940,755	16,452,721	2,009,405	18,145,821	2,060,219	19,503,615

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE D-5

DIRECT AND INDIRECT EMPLOYMENT AND INCOME
FOR THE BEAUMONT-PORT ARTHUR-ORANGE SMSA

INDUSTRIAL SECTOR	1969		1970		1971	
	EMPLOYMENT	INCOME ($ 000)	EMPLOYMENT	INCOME ($ 000)	EMPLOYMENT	INCOME ($ 000)
Agriculture	1,126	11,214	1,083	11,773	992	11,684
Government	35,042	212,571	36,724	237,134	38,354	256,115
Manufacture	86,019	688,023	85,988	749,869	86,855	806,714
Mining	4,660	52,131	3,103	44,922	3,099	40,241
Construction	20,162	227,195	19,145	240,440	17,186	235,004
Transportation-Communications-Utilities	20,984	175,092	21,554	191,666	21,683	194,630
Trade	48,869	320,776	50,505	345,869	50,712	367,467
Finance-Insurance-Real Estate	7,341	84,858	9,035	86,385	9,234	95,177
Services	46,172	283,460	47,314	307,087	47,983	329,542
Other	2,635	2,557	1,991	2,588	1,544	2,319
Farm Proprietors	2,079	8,005	2,041	8,375	2,009	8,247
Non-Farm Proprietors	21,138	186,421	21,347	194,221	21,663	204,799
TOTAL	296,227	2,252,303	299,830	2,420,329	301,314	2,551,939

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

APPENDIX E

DIRECT AND INDIRECT BARGE-RELATED EMPLOYMENT AND INCOME FOR COASTAL SMSA'S

TABLE E-1

DIRECT AND INDIRECT BARGE-RELATED EMPLOYMENT AND INCOME
FOR THE BROWNSVILLE-HARLINGEN-SAN BENITO SMSA

INDUSTRIAL SECTOR	1969		1970		1971	
	EMPLOYMENT	INCOME ($ 000)	EMPLOYMENT	INCOME ($ 000)	EMPLOYMENT	INCOME ($ 000)
Agriculture	295	4,490	283	4,937	260	5,266
Government	1,096	6,187	1,150	7,057	1,204	7,733
Manufacture	573	2,213	583	2,375	600	2,654
Mining	112	1,223	131	1,312	202	1,467
Construction	302	2,020	285	2,060	287	2,159
Transportation-Communications-Utilities	360	2,291	325	2,407	404	3,097
Trade	1,490	7,389	1,510	8,124	1,463	8,447
Finance-Insurance-Real Estate	200	1,332	199	1,399	211	1,592
Services	1,090	4,529	1,159	5,064	1,153	5,347
Other	148	533	158	815	161	825
Farm Proprietors	242	3,654	237	4,051	234	4,371
Non-Farm Proprietors	608	4,344	608	4,826	616	4,963
TOTAL	6,517	40,205	6,628	44,427	6,796	47,919

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE E-2

DIRECT AND INDIRECT BARGE-RELATED EMPLOYMENT AND INCOME FOR THE CORPUS CHRISTI SMSA

INDUSTRIAL SECTOR	1969 EMPLOYMENT	1969 INCOME ($ 000)	1970 EMPLOYMENT	1970 INCOME ($ 000)	1971 EMPLOYMENT	1971 INCOME ($ 000)
Agriculture	692	11,284	666	10,122	611	7,874
Government	9,536	60,183	9,437	65,724	9,564	69,991
Manufacture	3,791	33,282	3,915	36,577	3,779	36,757
Mining	1,402	13,903	1,370	14,149	1,220	13,203
Construction	2,488	18,971	2,468	20,708	2,494	21,764
Transportation-Communications-Utilities	2,086	15,291	2,115	17,473	2,087	18,335
Trade	7,288	39,757	7,738	44,717	8,217	49,898
Finance-Insurance-Real Estate	1,320	9,569	1,332	9,644	1,442	11,205
Services	5,627	29,825	5,678	32,601	5,749	34,948
Other	73	803	101	918	38	963
Farm Proprietors	588	9,318	581	8,039	572	5,771
Non-Farm Proprietors	3,010	21,445	3,050	22,127	3,092	23,298
TOTAL	37,901	263,631	38,451	282,799	38,865	294,007

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE E-3

DIRECT AND INDIRECT BARGE-RELATED EMPLOYMENT AND INCOME FOR THE GALVESTON-TEXAS CITY SMSA

INDUSTRIAL SECTOR	1969 EMPLOYMENT	1969 INCOME ($ 000)	1970 EMPLOYMENT	1970 INCOME ($ 000)	1971 EMPLOYMENT	1971 INCOME ($ 000)
Agriculture	178	665	171	332	157	42
Government	6,745	40,326	7,062	45,374	7,461	49,833
Manufacture	5,670	61,228	5,939	70,628	6,025	75,187
Mining	115	879	203	1,724	204	1,831
Construction	1,922	25,474	2,164	31,069	1,717	25,758
Transportation-Communications-Utilities	2,753	19,213	3,013	22,076	2,952	23,243
Trade	4,907	27,666	4,912	29,254	5,061	31,472
Finance-Insurance-Real Estate	1,663	11,313	1,654	12,046	1,779	13,323
Services	4,837	37,659	4,588	40,983	4,564	44,118
Other	54	465	49	564	19	588
Farm Proprietors	200	213	197	- 148	194	- 443
Non-Farm Proprietors	2,432	26,545	2,455	27,411	2,490	29,287
TOTAL	31,476	251,646	32,407	281,313	32,623	294,239

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE E-4

DIRECT AND INDIRECT BARGE-RELATED EMPLOYMENT AND INCOME FOR THE HOUSTON SMSA

INDUSTRIAL SECTOR	1969 EMPLOYMENT	1969 INCOME ($ 000)	1970 EMPLOYMENT	1970 INCOME ($ 000)	1971 EMPLOYMENT	1971 INCOME ($ 000)
Agriculture	443	3,412	427	3,857	392	2,849
Government	11,544	76,190	12,365	86,308	13,246	95,097
Manufacture	18,262	167,674	18,479	179,694	18,227	190,860
Mining	2,876	33,799	2,972	38,135	3,123	42,460
Construction	8,138	102,712	8,365	114,904	8,373	120,142
Transportation-Communications-Utilities	7,501	65,424	7,936	73,792	8,031	80,800
Trade	22,946	157,325	23,854	172,778	24,691	188,993
Finance-Insurance-Real Estate	5,061	37,789	5,315	40,600	5,727	47,164
Services	18,980	171,353	19,659	192,895	20,202	204,557
Other	822	3,435	836	3,876	847	4,315
Farm Proprietors	885	2,285	871	2,662	858	1,640
Non-Farm Proprietors	7,343	67,064	7,429	70,375	7,538	74,319
TOTAL	104,801	888,462	108,508	979,876	111,255	1,053,196

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE E-5

DIRECT AND INDIRECT BARGE-RELATED EMPLOYMENT AND INCOME FOR THE BEAUMONT-PORT ARTHUR-ORANGE SMSA

INDUSTRIAL SECTOR	1969 EMPLOYMENT	1969 INCOME ($ 000)	1970 EMPLOYMENT	1970 INCOME ($ 000)	1971 EMPLOYMENT	1971 INCOME ($ 000)
Agriculture	217	2,164	209	2,272	192	2,255
Government	6,763	41,026	7,088	45,767	7,402	49,430
Manufacture	16,602	132,788	16,596	144,725	16,763	155,696
Mining	899	10,061	599	8,670	598	7,767
Construction	3,891	43,848	3,695	46,405	3,317	45,356
Transportation-Communications-Utilities	4,050	33,793	4,160	36,992	4,185	37,564
Trade	9,431	61,910	9,748	66,753	9,787	70,921
Finance-Insurance-Real Estate	1,417	16,378	1,744	16,672	1,782	18,369
Services	8,911	54,708	9,132	59,268	9,261	63,602
Other	509	494	384	500	298	448
Farm Proprietors	401	1,545	394	1,616	388	1,592
Non-Farm Proprietors	4,080	35,979	4,120	37,485	4,181	39,526
TOTAL	57,171	434,694	57,869	467,225	58,154	492,526

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

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