A summary report

Transportation in the Texas Coastal Zone

Division of Planning Coordination
Office of the Governor

COASTAL RESOURCES MANAGEMENT PROGRAM

March 1973

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TRANSPORTATION IN THE TEXAS COASTAL ZONE

Prepared for

OFFICE OF THE GOVERNOR
DIVISION OF PLANNING COORDINATION
COASTAL RESOURCES MANAGEMENT PROGRAM
INTERAGENCY COUNCIL ON NATURAL RESOURCES
AND THE ENVIRONMENT
STATE OF TEXAS

by

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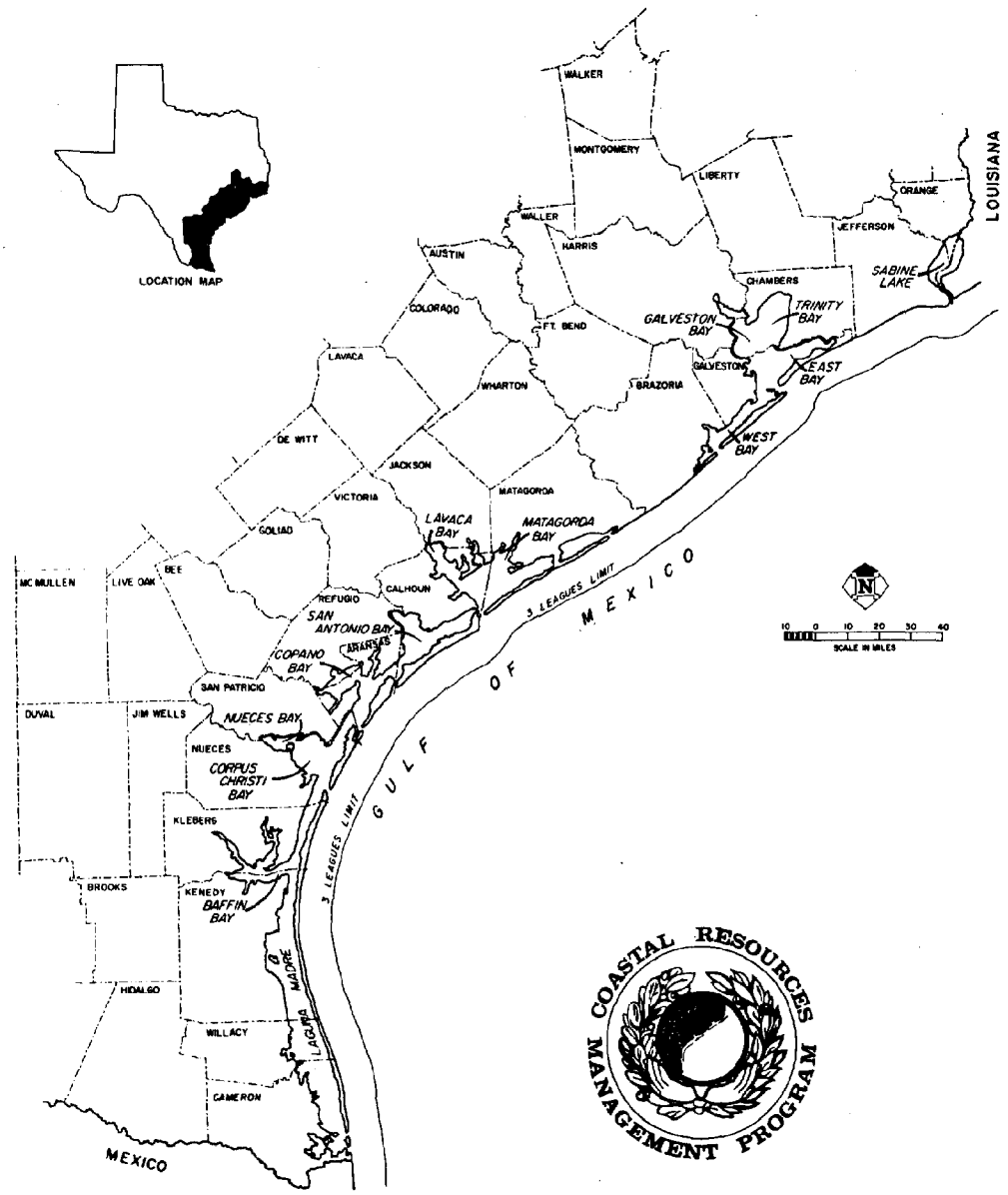
FIGURE 1 THE COASTAL ZONE OF TEXAS



The Coastal Zone of Texas contains the most diverse grouping of valuable natural resources in the State. Three and a half million persons presently live within the Coastal Zone and the population is expected to double by the year 2000 AD. Transportation is an essential element of its development and the demand for transportation is increasing much faster than population. Careful planning and appropriate action by the State is required if such growth is to be accomodated with minimum impact upon the environment.

INTRODUCTION

The Coastal Zone of Texas covers the 36-county area shown in Figure 1 and extends 10.35 miles into the Gulf. This area contains the most diverse grouping of valuable natural resources in the state. Because many of these resources are irreplaceable assets belonging to the people of Texas, they should be conserved, developed and preserved in accordance with the goals of the state. Inevitable pressures of urban, commercial, industrial, and agricultural growth are causing a general degradation of the Coastal Zone environment which will worsen unless steps are taken by state and local governments to safeguard this valuable resource area. Thus, the 61st Legislature of Texas authorized the establishment of the Coastal Resources Management Program. This transportation study is one of several studies sponsored by that program in an effort to identify the actions required to safeguard the environmental integrity of the Coastal Zone for future generations of Texans while fully utilizing coastal resources.

Three and a half million persons, about one-third of the state's population, lived in the Coastal Zone in 1970. It is one of the fastest growing areas of the state-its population has more than doubled in the last 30 years. Recent population estimates for Texas project an increase from 3.5 million in 1970 to 6.0 million in 1990 for the 36 counties in the Coastal Zone. If this expected growth rate actually occurs and the rate continues through the year 2000 AD, the population of the Coastal Zone will double again during the next 30 years (1970-2000 AD).

Historically, the demand for transportation services has grown much faster than the population. During the past twenty years, the nation's population has increased by about 33 percent while intercity freight movement has increased more than 50 percent and intercity passenger travel has more than doubled. Recent studies of urban travel characteristics in Texas cities have revealed that the number of daily auto trips per person has increased about 50 percent over the past ten years. Thus, the demand for transportation in the Coastal Zone could more than triple in the next 30 years.

The transportation system serving the Texas Coastal Zone includes major elements of every existing mode of transportation. Eleven ports serve ocean-going ships, and the Gulf Intracoastal Waterway connects the Texas coast to an extensive inland waterway system serving the heartland of the nation. Eight airports in the Coastal Zone are served by scheduled air carriers. The area is crisscrossed by numerous pipelines carrying crude oil and petroleum products. An extensive network of almost 3000 miles of mainline railroads serves the region and connects it to the rest of the state and the nation. About 12,000 miles of highways form the backbone of the total transportation system serving the coastal Zone.

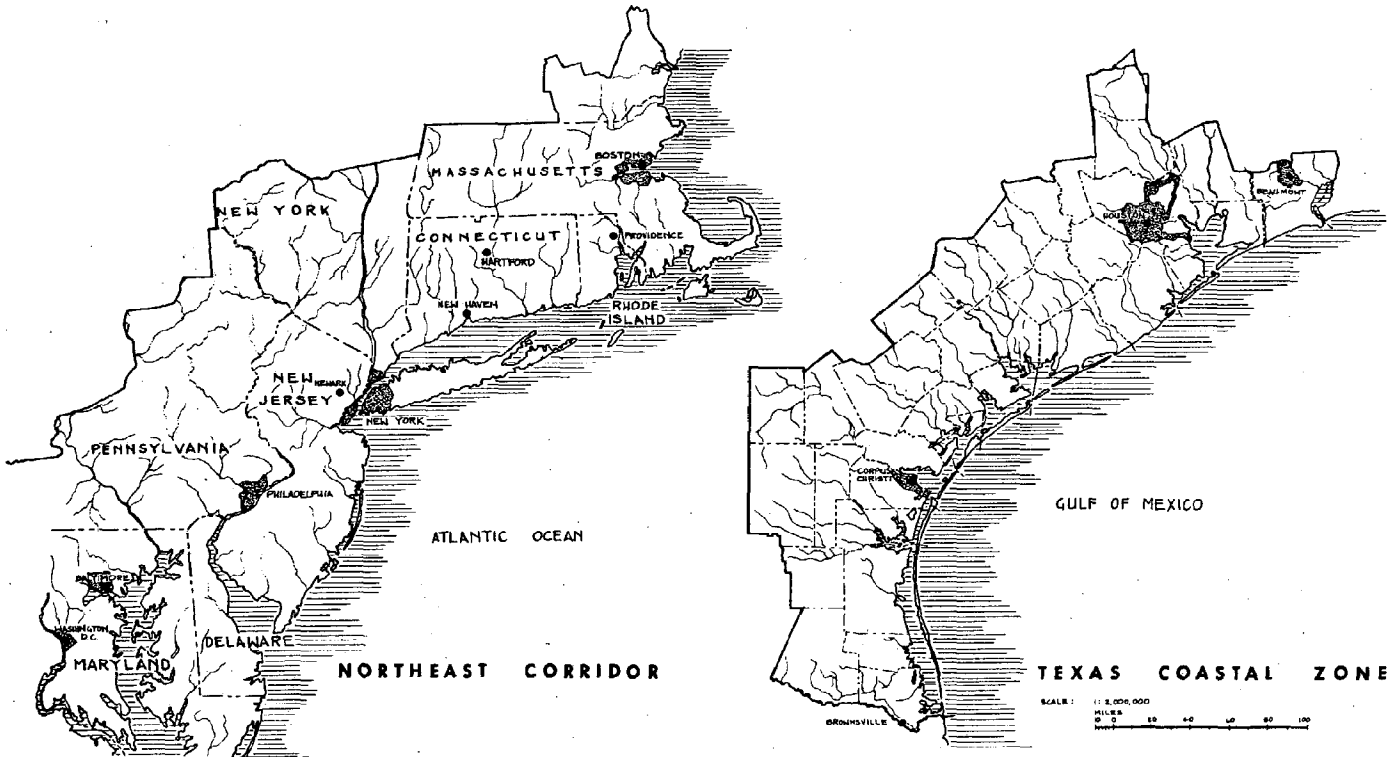
Some of these transportation facilities are presently operating near capacity while others are not utilized to more than a fraction of their ultimate capacity. Thus, the problem is to identify ways to serve the rapidly growing demand for transportation with minimum costs and minimum detrimental effects upon the environment. This implies an effective utilization of the total transportation system serving the Coastal Zone.

This project consitutes an initial planning study, at the macroscopic level, for a total transportation system to serve the Texas Coastal Zone. The primary objectives are:

(1) To identify broad alternatives for future development and transportation systems;

(2) To evaluate the probable consequences of each major alternative;

FIGURE 2 COMPARISON OF NORTHEAST CORRIDOR AND TEXAS COASTAL ZONE



Striking similarities exist between the Coastal Zone of Texas and the Northeast Corridor. The land areas are about the same; distances between major cities are similar; both regions have numerous seaports; and both areas are served by major elements of every mode of transportation. Although the Texas Coastal Zone may never contain 42 million persons, its population is growing enough to create some of the same transportation problems now evident in the Northeast Corridor.

(3) To identify critical relationships between urban form, land use, and transportation systems;
(4) To outline general guidelines that can be used to insure compatible developments in the future; and
(5) To identify specific actions that the state can take to help insure an effective future transportation system which will have minimum impact upon the environment.

Since this is a transportation planning study at the macroscopic level, considering broad alternatives for future development, it does not replace the numerous detailed planning studies for each transportation mode, but rather, it should complement them.

COMPARISON OF THE NORTHEAST CORRIDOR AND THE TEXAS COASTAL ZONE

The Northeast Corridor stretches from Washington, D.C. to Boston and includes such cities as Baltimore, Philadelphia, Newark, and New York City. More than 20 percent of the nation's population is concentrated in this region which includes less than 2 percent of the nation's land area. It is not surprising, then, that the Northeast Corridor is facing some of the most severe urban and transportation problems in the nation. It is surprising, however, to realize that the Texas Coastal Zone resembles the Northeast Corridor in many ways now and might possibly look even more like it in the future. Thus, a comparison of these two regions can provide information that will be useful in helping the Texas Coastal Zone to avoid many of the problems now plaguing the Northeast Corridor.

GENERAL CHARACTERISTICS

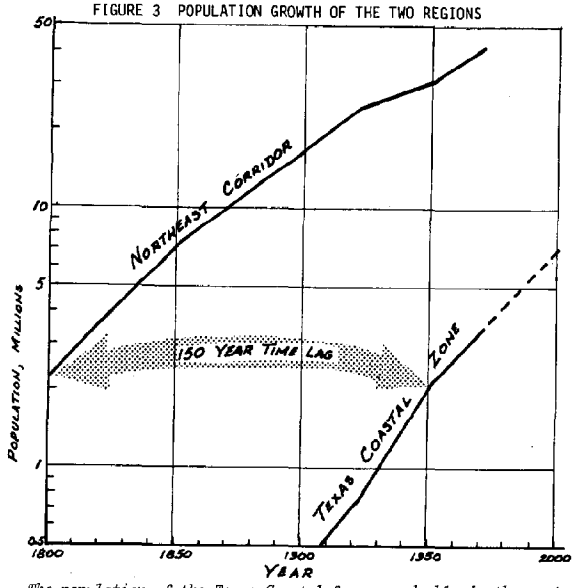
Some of the geographic similarities become apparent when maps of the two areas are drawn to the same scale and placed side-by-side as presented in Figure 2. The two regions are about the same size and shape. The Northeast Corridor, as defined in other studies, encompasses about 57,000 square miles. The Texas Coastal Zone, as defined for this study, includes some 33,000 square miles. Futhermore, the distance between some major cities are equivalent.

Obviously, both regions contain extensive coastlines with bays and harbors serving numerous major seaports. The availability of water transportation has had a great effect on the location and growth of cities in both regions. The cities are major transportation hubs serving a large hinterland. This has resulted in a high level of industrial activities in the cities. Thus, the major developmental forces acting on both regions are similar.

Contrary to popular belief, the Northeast Corridor is not just one huge city. In fact, less than 10 percent of the land area is urbanized. About 3 percent of the land area of the Texas Coastal Zone is urbanized. This means that over 90 percent of the land area in both regions is rural in nature.

The population of the Texas Coastal Zone may double in the next 30 years, increasing from 3.5 million in 1970 to 7 million by the year 2000 AD. The Northeast Corridor experienced a similar rate of growth when it was at the same stage of development. Its population increased from 3.6 million in 1820 to 7.2 million in 1850. Indeed, the data presented in

FIGURE 3 POPULATION GROWTH OF THE TWO REGIONS



The population of the Texas Coastal Zone may double in the next 30 years. The Northeast Corridor experienced a similar growth when it was at the same stage of development. These two regions exhibit similar growth patterns if the Texas Coastal Zone is assumed to be lagging the Northeast Corridor by 150 years.

Figure 3 indicates that these two regions have very similar growth patterns except that the Texas Coastal Zone is about 150 years behind the Northeast Corridor in overall population growth.

The population of Texas Coastal Zone will probably never reach 42 million, but it will increase enough to create the potential for many of the same transportation problems that are now evident in the Northeast Corridor. A closer look at some of these transportation problems, and the types of developments in the Northeast Corridor, can yield information that can be used to avoid them in the Texas Coastal Zone.

INTERCITY TRANSPORTATION

Transportation systems serving both of these coastal regions include major elements of every mode. Considerable rail, highway, and canal networks connect both regions and their extensive ports to large inland areas. Consequently, transportation is especially important to both regions in two ways. First, the transportation industry itself is an important sector of the economy; second, nearly all economic activity of both areas is heavily dependent upon transportation services.

Between 1950 and the mid-1960's, substantial improvements were made in intercity travel conditions in both the Northeast Corridor and the Texas Coastal Zone. Construction of new highways, especially the Interstate system, and improvements in automobiles resulted in a 30 percent to 40 percent reduction in driving times between major cities. The introduction of jet aircraft decreased flying time by a similar percentage. The advent of relatively light-weight diesel-powered passenger trains shortly after WW II also resulted in improvements in intercity rail passenger service. However, these trends toward reduced intercity travel times have already reversed in the Northeast Corridor and they appear to be bottoming out in the Texas Coastal Zone.

Intercity highway facilities within these heavily traveled corridors of the Northeast have been appreciably better than in directions perpendicular to the corridors. Thus, the transportation facilities themselves stimulated growth along the corridor—small communities developed into large communities with economies largely dependent upon the major urban centers. These new urban developments generated more traffic along the corridor requiring more facilities which in turn stimulated more growth in a seemingly never ending cycle. Considering the long lead times between design and construction of major highway facilities today, it appears that intercity travel times in the Northeast Corridor will continue to increase during the foreseeable future.

Aircraft and terminal delays at Northeast Corridor airports increased more than 20 percent between 1968 and 1969. These delays declined somewhat during 1970, but the long term trend indicates that aircraft delays will increase in the future. Such delays, combined with increasing congestion on airport access roads, have drastically reduced the attractiveness of air travel between cities within the Northeast Corridor.

In an effort to counteract the dete-

rioration in intercity travel along the corridor, a new high-speed rail passenger service was inaugurated in January 1969. The Metroliner, using new equipment and improved roadbed, achieved a one-hour reduction in travel time between New York City and Washington D.C. However, the Metroliner equipment cannot achieve its full potential on existing roadbeds due to numerous curves and grade crossings. Nevertheless, this form of intercity travel has diverted many passengers from airplanes and automobiles.

The Texas Coastal Zone has not experienced such severe problems in intercity travel; however, the long term trend toward improvement has bottomed out. Overall intercity travel conditions within the zone are probably better now than they will be at any time in the foreseeable future. As its population increases, the Texas Coastal Zone will begin to experience many of the same problems as the Northeast Corridor.

It is interesting to note that the distance from Houston to Corpus Christi is the same as from New York City to Washington, D.C. In fact, the distances from Houston to San Antonio and Houston to Dallas are also similar. Existing traffic volumes along these corridors are not yet sufficiently high to support a high speed train service like the Metroliner. Eventually, however, these city-pairs may need such a service, so future plans should consider this possibility.

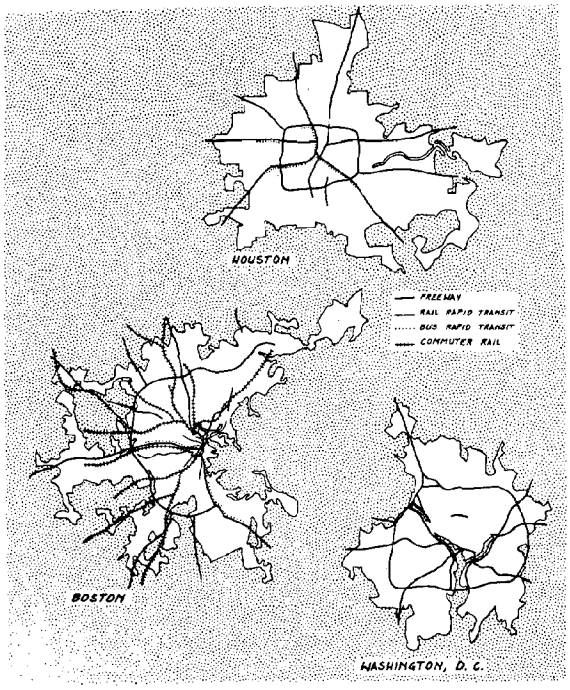
The Texas Coastal Zone is in a far better position to plan for future problems than the Northeast Corridor. All of the Coastal Zone lies within Texas while the Northeast Corridor stretches across 10 states and the District of Columbia. Hence, Texas has an opportunity to apply any lessons that can be learned from the history of the Northeast Corridor.

Probably the most important lesson is the need to recognize the permanency of travel corridors. Both intercity and urban transportation facilities represent a permanent commitment to the movement of persons and goods between areas of major activities. The need for transportation services will continue even though the facilities may change drastically. Thus, a major transportation facility should be considered as a permanent commitment to transportation—not just a highway or railroad. Wherever possible, sufficient right-of-way should be acquired to provide future flexibility for the corridor. This will enable the Texas Coastal Zone to better meet the transportation needs of future generations.

URBAN TRANSPORTATION

The population of the Houston area is now only 1.7 million, but it is expected to exceed 3 million in the next 30 years. Thus, a comparison between Houston and Washington, D.C. (2.5 million) as well as Boston (2.7 million)should provide useful information for future plans in Houston. As shown in Figure 4, Houston presently covers more land area than either Washington or Boston even though its popula-

FIGURE 4 COMPARISON OF THREE URBANIZED AREAS



These three cities provide an interesting contrast in urban forms and urban transportation systems which may prove useful to Houston.

tion is less. This is indicative of the lower overall population density in Houston which is largely determined by the type of housing. More than 70% of the residents in Houston live in single-family houses compared to 50% of those in Washington, D.C. and 40% of the Boston residents.

The population densities of both Boston and Washington, D.C. are about double that of Houston. Perhaps the best way to visualize the differences in these cities is to imagine the changes necessary to make Houston look like the others. Houston would approach the urban form of Washington, D.C. if a city the size of Dallas could be stacked on top of the existing development. The changes needed to make it approach the urban form of Boston are even more drastic. An additional million persons would have to be added to several corridors extending from downtown outward to Loop IH 610.

The automobile is the backbone of the urban transportation system in all three cities; however, the northeastern cities have a much higher dependence upon transit modes. Washington, D.C. is served by three bus companies using a total of almost 1,800 buses. Boston, on the other hand, has a rail rapid transit system, street car and trolley lines, and commuter rail lines in addition a fleet of about 1,200 city buses. Houston's transit company operates a fleet of less than 350 buses. Even with all of its rail facilities, Boston has more miles of freeways (190 miles) than either Washington or Houston (160 miles each).

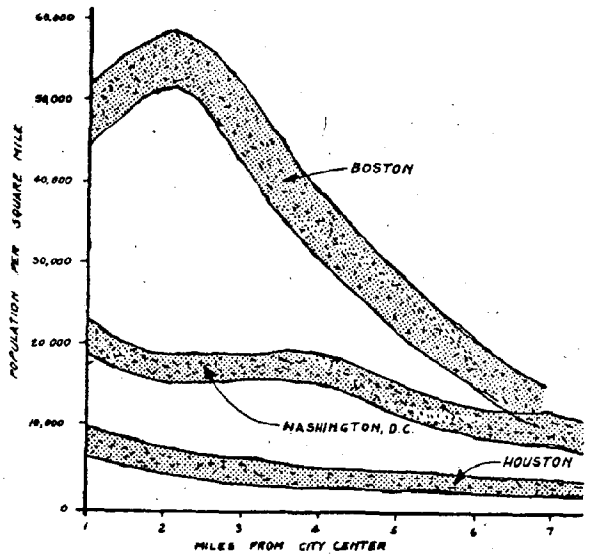
Washington, D.C. seems to be the only one of these three cities with a thriving transit operation. It has the highest level of transit ridership of any city its size in the nation, and all three privately owned bus companies are in sound financial condition. The Massachusetts Bay Transportation Authority, Boston's publicly owned transit company, on the other hand, has experienced severe problems with decreasing ridership and rapidly increasing operating deficits. Its estimated operating deficit for 1971 was $75 million - more than 30 dollars per person in the Boston area. This deficit of $75 million must be covered by state and local tax funds.

Most experts agree that high-density corridors are needed to support a rail-rapid-transit system. If this were the only consideration, Boston should be an excellent location for a rail-rapid-transit system as indicated in Figure 5. Obviously, other factors must be considered.

Boston and Washington, D.C. serve about the same total number of transit riders; however, Boston is splitting their ridership between several modes while Washington uses only buses. This factor may explain some of the financial problems of Boston's transit system. Washington, D.C. is currently building a 98-mile rail rapid transit system at an estimated cost of more than $3 billion. It will be interesting to see if this new system attracts new riders or just diverts passengers from existing bus operations.

Houston's privately owned bus com-

FIGURE 5 CORRIDOR DENSITIES



Most experts agree that high density corridors are needed to support a rail rapid transit system; yet, Boston's transit system is experienceing severe financial difficulties.

pany has managed to maintain a financially sound operation despite a decreasing ridership trend. However, if recent trends in automobile ownership and low density developments continue, the transit company's condition will probably change for the worse. Factors identified in this comparison of cities should be considered in future transit plans for Houston.

ENVIRONMENTAL CONSIDERATIONS

Mechanized transportation is more than just a convenience for man it is essential for the survival of his society. Unfortunately, all modes of transportation must have some impact upon the environment; however, the amount of environmental damage can be minimized. The first step toward improvement is a definition of the major areas of environmental concern. Air quality, water quality, noise, waste heat, drainage, and land-use patterns appear to be justifiable areas of major concern. Other environmental considerations such as visual pollution, litter, and junk yards are valid concerns, but they are not a direct result of the construction or operation of transportation modes.

Most environmental studies have pointed to the highway mode as the most serious polluter of the environment; however, this is partly due to the relative usage of modes. Highways provide for more than 90% of all person movement and 50% of all goods movement in the nation. A comparison of the relative potential of environmental impacts of the various modes operating at the same level of activity shows that most of them are about equal (See Table 1). Pipeline appears to be the only mode that has a significantly lower potential. Corrective actions are already being taken to reduce the severity of most of these environmental impacts so transportation systems of the future will be more compatible with the environment.

TABLE 1 RELATIVE ENVIRONMENTAL IMPACTS OF VARIOUS TRANSPORTATION MODES

Major Areas of	Mode of Transportation				
Environmental Concern	Highway	Air	Rail	Pipeline	Water
Air Quality	High	Medium	Medium	Low	Medium
Water Quality	Low	Low	Low	Low	High
Noise	Medium	High	Medium	Low	Low
Waste Heat	High	High	High	Medium	High
Drainage	High	Medium	High	Low	Low
Land-Use Patterns	High	Medium	High	Medium	High

All modes of transportation have some impact on the environment; however, corrective actions are being taken to minimize the severity of these impacts. Future transportation systems will be more compatible with the environment.

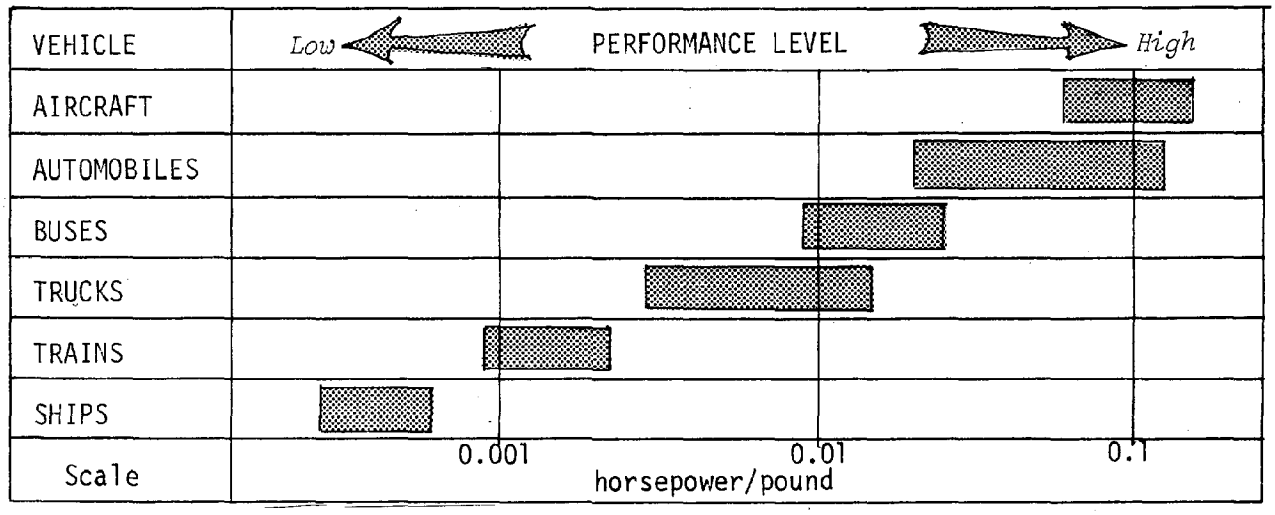
The automobile is the most visible source of air pollution to the general public; therefore, it has been the object of much criticism. Some people have proposed eliminating all automobiles, or at least outlawing the internal combustion engine. However, no propulsion system available today can achieve better thermal efficiencies over the broad range of operating conditions required of the automobile. Reciprocating steam engines, steam turbines, gas turbines, and electrical batteries are all being evaluated as possible prime movers, but none of them offer much promise for the near future.

Meanwhile, emissions from internal combustion engines are being reduced by improved designs and pollution control devices. Indeed, continuing monitoring tests indicate that the total amount of pollution produced by automobiles peaked in 1967 and has been declining since then. Federal standards for 1975-1976 model automobiles require a 90% reduction in air pollutant emissions from the 1970-1971 levels. Experimental models tested in 1971 show promise of meeting these low emission levels. Thus, total emissions from automobiles should continue to decline during the next few years as older cars are replaced by newer models.

Automobile emissions are almost four times greater under stop and go traffic operations than at constant speeds of 45 to 50 miles per hour. Thus cities can reduce automobile pollution by improving traffic operations on city streets. Also, most new cars bought today have much more power than needed for normal urban driving. Indeed, some of today's automobiles have better performance characteristics than the best fighter planes of World War II, as shown in Figure 6. If the individual citizen really wants to do something about air pollution, he can stop buying such over-powered cars.

Thus, it appears that significant progress has been made toward reducing automobile emissions and that even more progress can be expected in the future. However, actions by government and by individual car owners can also be effective in minimizing emissions.

FIGURE 6 PERFORMANCE CHARACTERISTICS OF VEHICLES



Some cars on the streets today have better performance characteristics than the best fighter planes of World War II. If the individual really wants to do something about air pollution, he can stop buying such over-powered cars. Also, he can keep his car well-tuned and timed for efficiency rather than power.

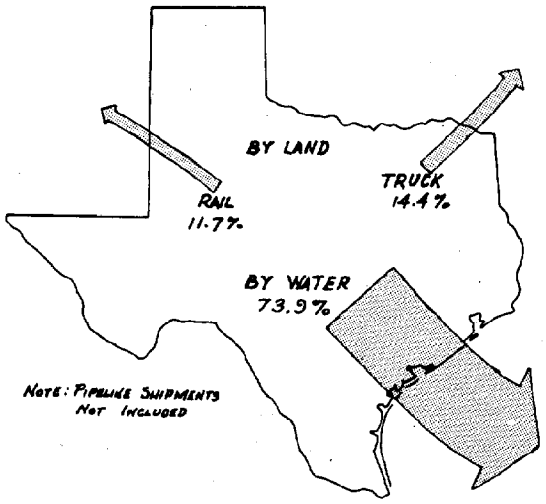
EXISTING TRANSPORTATION IN THE TEXAS COASTAL ZONE

Three of the top four economic sectors in Texas (petroleum refining, petroleum production, and agriculture) are entirely dependent upon transportation for their value. Obviously then, a healthy transportation industry is essential to a healthy economy. The transportation industry in the Coastal Zone is a vital part of its, and the State's total economic activity. More than three-fourths of all the goods shipped from Texas are shipped from the Coastal Zone. In fact, the number of tons of goods per person handled by the Coastal Zone's transportation industry totaled more than 4 times the national average.

WATER TRANSPORTATION

Few Texans realize the importance of water transportation to the State. Almost 90% of all shipments from the Coastal Zone and almost 75% of all goods shipped from the State as a whole travel by water, as shown in Figure 7. Indeed, Texas rivals New York as the premier seafaring state in the nation since Texas ports handled a total of 185 million tons of goods in 1968 compared to 192 million tons in New York. Yet, Texas has a state agency specifically concerned with every other mode except water transportation.

FIGURE 7 MODAL DISTRIBUTION OF GOODS SHIPPED FROM THE TEXAS COASTAL ZONE



Few Texans realize the importance of water transportation to the Coastal Zone and to Texas. Over 120 million tons of goods are shipped by water from Texas ports each year. This represents almost 75% of all goods shipped from the State as a whole.

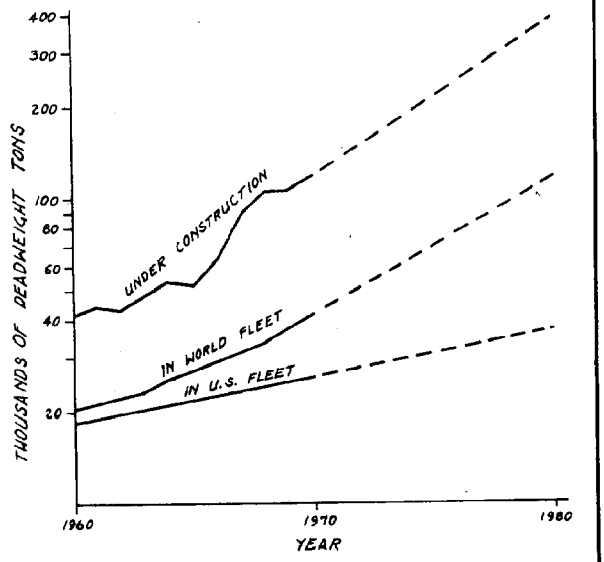
Ocean Transport

Ocean-going ships carry about 120 million tons of goods to or from Texas each year; however, total ocean traffic has not increased in the last ten years. The reasons for this lack of growth are probably many and varied, but problems such as imbalance of traffic, congestion in certain ship channels, and limited channel depths must be contributing factors.

More than 85% of the ocean traffic is outbound; consequently, nearly all of the ships carrying Texas goods out must return empty. Hence, the rates charged for transportation must cover the cost of the entire voyage rather than just half of it. Traffic congestion in some of the ship channels is so severe on occasions that collisions occur. Indeed, the Houston Ship Channel is one of 14 in the nation being considered by the Coast Guard for a traffic control system - after enabling legislation is passed.

Almost half of the nation's petrochemical industry and about one-fourth of its refining capacity is concentrated in the Texas Coastal Zone. Hence, the

FIGURE 8 TRENDS IN AVERAGE SIZE OF TANKER SHIPS



The size of the average tanker under construction increased from 41,000 tons in 1960 to 116,000 tons in 1970. Port depths in Texas are barely sufficient to handle the average size tanker in the world fleet today. Dramatic actions are needed if Texas ports are to be able to serve future ships.

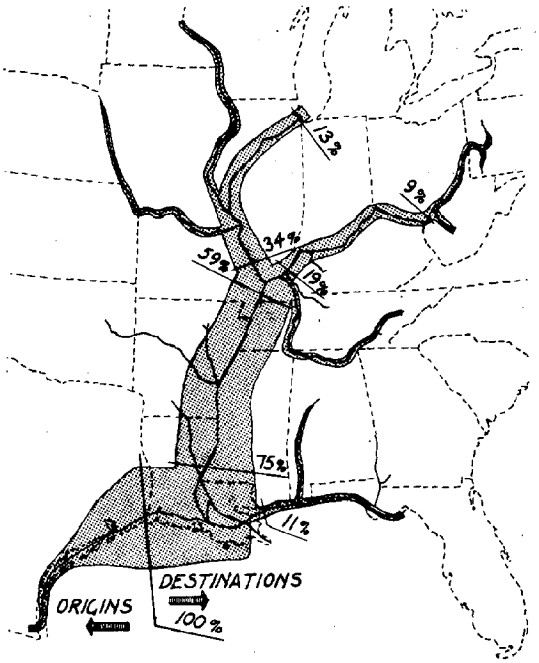
bulk of the tonnage in ocean traffic is carried by petroleum tankers, and the size of tankers has been increasing at astounding rates in recent years. Figure 8 shows that the average size tanker under construction increased from 41,000 deadweight tons in 1960 in 116,000 tons in 1970. Two tankers exceeding 400,000 tons are now under construction and a 500,000 ton tanker is on order. Yet, Texas ports, with a maximum 42 ft. channel depth, can only handle ships up to 45,000 or 50,000 deadweight tons when

they are fully loaded. Obviously, some dramatic actions are needed if Texas ports are to be able to serve future ships.

Inland Waterway

Inland waterway traffic is also a major portion of the water transportation activities in the Coastal Zone. Barges loaded with almost 70 million tons of goods traveled the Gulf Intracoastal Waterway in Texas during 1970. About half of this traffic (36 million tons) crossed the Texas-Louisiana border traveling to or from such far-flung locations as Pittsburgh, Chicago, and Minneapolis (see Figure 9). All of this traffic must pass through the heavily congested portion of the canal in Louisiana. As peculiar as it may seem, conditions in the Louisiana portion of the canal have a strong impact on Texas waterway traffic.

FIGURE 9 MOVEMENT OF TEXAS GOODS ON INLAND WATERWAYS



About 36 million tons of goods crossed the Texas-Louisiana border on the inland waterway in 1970. Shipments from Texas went to such far-flung markets as Pittsburgh, Chicago, and Minneapolis. All of this traffic must pass through several locks between the Mississippi River and Texas which cause severe delays.

The Texas portion of the Gulf Intracoastal Waterway is all at sea level so that no locks are required. However, in order to reach the Mississippi River system, Texas goods must pass through several locks in Louisiana. These locks are severely restricting the flow of traffic - sometimes causing delays of 24 to 30 hours to barges waiting to pass through them. Total delay times at locks can more than double the normal travel time between Texas and the Mississippi River.

Recent industrial expansion in the Coastal Zone has been closely related to the waterway. In fact, more than 4 out of every 5 additional tons of waterborne traffic developed in the past 15 years have been on the canal. The volume of inland waterway traffic in Texas increased rapidly from 1950 until 1967, but then it leveled off. Some of this leveling off may be due to the delays at the locks. Thus, the traffic problems on the Louisiana segment of the waterway can stymie future industrial growth in the Texas Coastal Zone.

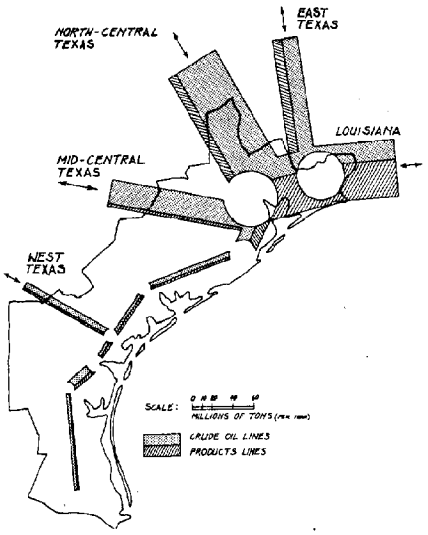
PIPELINES

The Texas Coastal Zone presently has a greater concentration of pipelines than any similar size area in the world. This is not too surprising considering the vast petroleum resources contained within the Coastal Zone. Numerous natural gas pipelines also crisscross the zone. Most of these pipelines range in size from 6" diameter to 12" diameter; however, some are as large as 20" diameter and one is 36" diameter.

These petroleum pipelines transport a tremendous volume of goods every year. The capacity of all pipelines within identifiable corridors is depicted in Figure 10. The total capacity of pipelines entering or leaving the Coastal Zone is sufficient to transport more than 150 million tons of crude oil and petroleum products each year.

Sizeable increases in pipeline capacity will probably be needed if petroleum resources in the offshore areas of Texas are developed in the future. However, as the population of the Texas

FIGURE 10 CAPACITIES OF MAJOR PIPELINE CORRIDORS



The Texas Coastal Zone has a higher density of pipelines than any similar size area in the world. The total capacity of pipelines entering and leaving the Texas Coastal Zone is sufficient to transport more than 150 million tons of crude oil and petroleum products each year.

Coastal Zone increases, locating and constructing additional pipelines will become increasingly more difficult. Of course, additional pipelines can probably be constructed within existing pipeline right-of-ways providing future needs lie within the same corridor.

RAIL TRANSPORTATION

An extensive network of railroads, including almost 3,000 miles of main-line tracks, serves the Coastal Zone and connects it to the rest of the State and the nation. A total of 55 million tons of rail freight is estimated to originate in, terminate in, or pass through the Coastal Zone each year.

Presently, none of the major rail corridors appear to be operating at more than 20% of their basic capacity, and this basic capacity can be greatly increased through signalization and centralized traffic control if future needs require. Hence, available capacity is not a problem for railroads in the Coastal Zone, but the imbalance of traffic is a chronic problem. If the flow of ocean traffic is balanced in the future, it will probably help to balance rail traffic since the railroads play a major role in supporting the ports.

AIR TRANSPORTATION

Eight airports in the Coastal Zone are presently served by scheduled air passenger service. Almost 3 million passengers boarded planes at these airports in 1970, and if recent trends continue, this total could increase to 30 million by 1990. Such an increase in traffic will require numerous improvements to existing airports; however, additional airports probably will not be necessary.

Ground access time to airports has become a significant portion of the total travel time for modern airline trips. Very few areas of the Coastal Zone are now more than 1½ hours driving time from an air-carrier airport; however, this situation will probably worsen as urban areas increase in the future.

Air cargo is the fastest growing form of goods movement, and the projected increase in air cargo traffic is sufficient to require substantial improvements to goods handling facilities at Coastal Zone airports.

HIGHWAY TRANSPORTATION

Highways form the backbone of the transportation system serving the land areas within the Coastal Zone. Most of the 12,000 miles of highways crisscrossing the Coastal Zone are presently operating at less than half of their capacity in rural areas; however, traffic volumes increase sharply as these highways approach urban areas. Extensive highway improvements will be required to adequately serve the projected growth in motor vehicle traffic during the next 30 years.

URBAN TRANSPORTATION

Motor vehicles operating on streets and freeways provide almost all of the urban transportation in Coastal Zone cities. All of these cities have developed

at average population densities that are compatible with an automobile-based transportation system. The demand for urban travel has increased about 50% during the last ten years - much faster than population growth. Hence, major improvements in urban transportation facilities will probably be needed even if the population does not increase substantially during the next 30 years.

Major arterial streets and freeways usually constitute less than 20% of the total street mileage, but they handle more than 80% of the total urban travel. Presently, there are about 2000 miles of arterial streets and 400 miles of freeways in Coastal Zone cities. If their population increases as expected, these cities will need to build an additional 3000 miles of major arterials and freeways as well as 15,000 miles of local and collector streets. Even so, the larger urban areas will probably need some form of mass transportation to supplement their automobile-based system.

FUTURE ALTERNATIVES

Several alternative courses of action are available to Texas in developing the Coastal Zone's future transportation system. The four topic areas discussed below are particularly important because decisions concerning each will significantly influence the character of future development in the Coastal Zone.

SUPER-DRAFT PORT

Maximum ship sizes, especially tankers and bulk carriers, have been increasing at an astounding rate during the last 30 years If these trends continue until 1985, the maximum size tanker will exceed 1,000,000 deadweight tons, and the maximum size bulk carrier will be at least 300,000 tons. These rapid increases in ship sizes are a result of economic considerations in ocean transport. The productivity of a ship can be doubled by either doubling the size of a ship which requires a 42% increase in horsepower or by doubling the ship's speed which requires a 550% increase in horsepower. Thus the trend has been toward larger ship sizes.

The maximum depth of Texas ports today is only 42 feet; therefore, fully loaded ships exceeding 50,000 deadweight tons cannot enter these ports. Depths of 75 feet will be required to serve ships up to 250,000 tons in size, and depths of about 115 feet will be required for the one million ton ships. If minimum economical sizes of tankers and bulk carriers are to be served in the future, much deeper port facilities will be required.

Texas can pursue several alternative courses of action relative to future needs of the ocean-going segment of the total transportation system. These alternatives include the following: (1) No increase in depth; (2) Deeper channels; (3) Offshore terminals; and (4) Superport. Each of these alternatives have some obvious advantages and disadvantages; however, their consequences should be evaluated further before Texas chooses a course of action.

INLAND WATERWAY SYSTEM

The section of the Gulf Intracoastal Canal in Louisiana is an essential element of the Texas waterway system; however, traffic congestion and delays at locks in this segment are deterring the growth of waterway traffic in Texas. A total of 65 million tons of cargo traveled the Louisiana segment of the canal in 1970. Some of this traffic was local in nature, but 36 million tons of it was traveling to or from Texas. Operating under ideal conditions 24 hours a day, 365 days a year, the Vermilion lock can only pass 70 million tons of goods per

year. Thus, Texas traffic alone consumes at least half of the ultimate capacity of this lock.

Transportation services such as those provided by the waterway are essential to the economic livelihood of the Coastal Zone. The alternative approaches that might be considered with regard to the waterway include the following: (1) No waterway improvement; (2) Improved locks; and (3) New constant-level waterway. Here again, obvious advantages and disadvantages of each can be identified, but further study is needed before Texas selects a course of action.

COASTAL HIGHWAYS

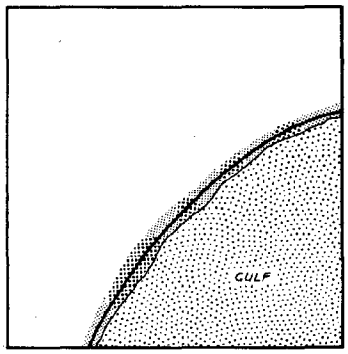
The demand for more recreational facilities along the Texas coast and improved highway access to them is expected to increase in the future. Also, increased intercity travel demands will probably necessitate construction of a freeway facility parallel to the Coast. However, new highways in the vicinity of the coastline can significantly influence the type and extent of land development along the beach areas (see Figure 11). The nature of future development will differ depending upon the location and design of any new highway facilities.

Alternative approaches that might be considered include the following: (1) No new highways; (2) Beach highway; (3) Coastal highway; (4) Inland highway; and (5) Two facilities. Each of these alternatives will have different effects upon the nature of future development. These factors should be considered before decisions concerning highway facilities are made.

URBAN GROWTH

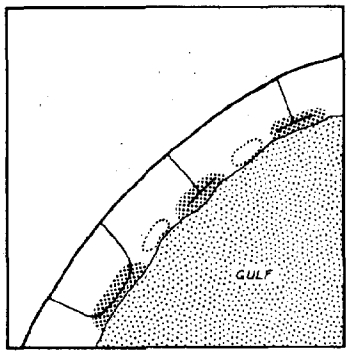
The Urban population of the Coastal Zone has more than doubled in the last 30 years, and it may double again in

FIGURE 11 LOCATIONAL CONSIDERATIONS FOR NEW HIGHWAY FACILITIES PARALLEL TO THE COAST



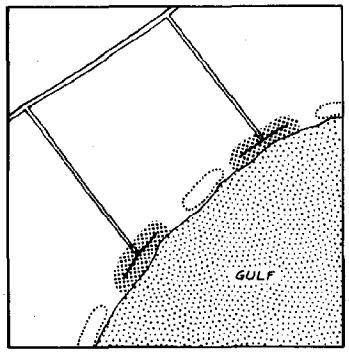
BEACH HIGHWAY

- along beach areas
- varying degrees of development along full length of beach area
- few, if any, natural, isolated beach areas remain



COASTAL HIGHWAY

- up to 15 miles inland from beach area
- nodes of development at access roads
- natural, isolated areas remain



INLAND HIGHWAY

- more than 20 miles inland from beach areas
- nodes of development at access highways
- natural, isolated areas remain but might be forfeited for future beach highway link

New highway facilities in the Coastal Zone can significantly influence the development of recreational facilities along the beach areas. The location of a highway is a critical consideration if any areas of seashore are to remain isolated and relatively untouched.

the next 30 years. Future transportation problems will largely depend upon how well the cities and the State manage to locate and shape new urban developments and transportation systems.

Two or three new urban centers might possibly be developed along the Coastal Zone in order to disperse the population and minimize the amount of redevelopment required in existing cities. However, such a course of action would require aggressive steps on the part of the State to provide transportation facilities and entice industry to locate at the new sites.

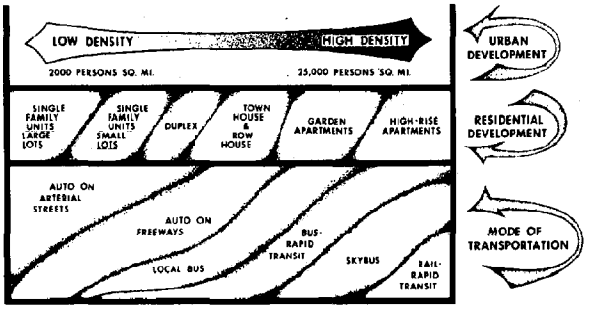
Without stringent external controls, new urban development will tend to occur around existing cities. If this development is carefully planned and properly managed, the net result can be an improvement in existing urban forms. Houston will face some unique problems in that it must try to develop an urban form that can be more effectively served by mass transportation. The Beaumont-Port Arthur area can easily transition into a unified urban area with three focal points. Other cities in the Coastal Zone have a great deal of flexibility providing that new developments are compatible with existing automobile-based transportation systems.

GUIDELINES FOR FUTURE DEVELOPMENT

URBAN TRANSPORTATION

Total urban population of the Coastal Zone may double before the year 2000 A.D.; therefore, careful planning is essential in order to accommodate this growth in a manner that yields desirable urban environments and effective transportation systems. A recognition of the interrelationships between land uses and compatible forms of transportation is the key to proper urban planning (see Figure 12). Land use plans and transportation plans cannot be developed separately because they are, and must be, one in the same.

FIGURE 12 BALANCED TRANSPORTATION SYSTEMS

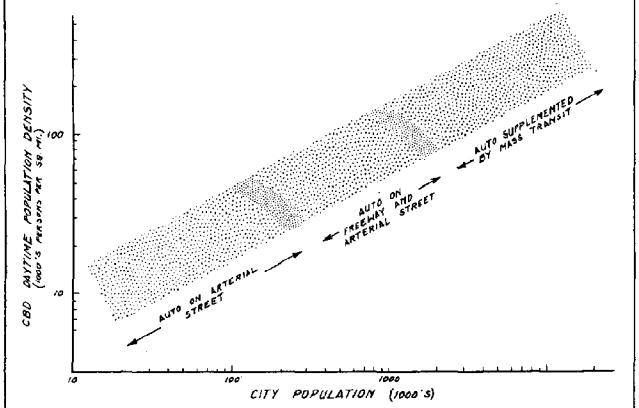


A balanced transportation system can only be achieved through a recognition of the mutual dependence of urban land use and mode of transportation. Single family houses cannot be served economically by rail rapid transit nor can high-rise apartments be served adequately by an automobile-based transportation system. A city can choose either the type of development or the type of transportation system desired but that decision carries with it corresponding limitations concerning the other.

The principal decision concerning future urban development should be the nature and character of urban environment desired. Once this is determined, the transportation system must be designed to be compatible with the desired type of development. All of the cities in the Coastal Zone consist primarily of single-family dwelling units so their transportation systems should continue to be based primarily upon the automobile. However, this places some corresponding constraints upon the city size and extent of development at major focal points (see Figure 13).

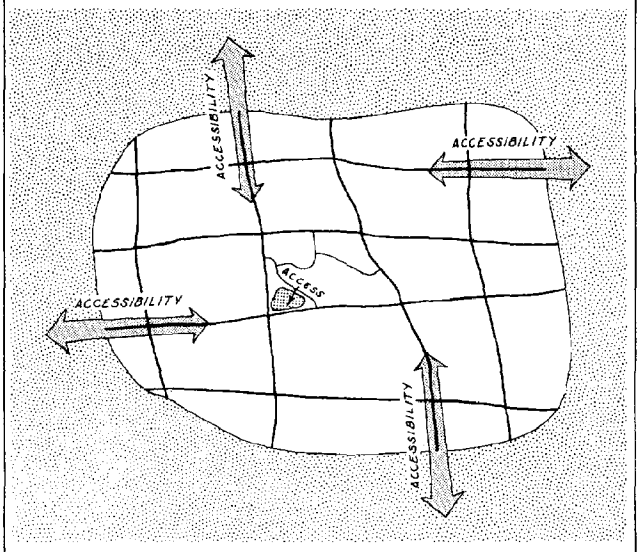
With a properly designed system of arterial streets, a city can grow to a population of about 300,000 persons before an urban freeway system is needed. Once a city is large enough to need a freeway system, the constraints associated with transportation systems serving a single focal point should be considered. Automobiles operating on an ideal arterial street and freeway system can serve a total population of about 2 million persons surrounding a single focal point. Larger urban areas must either develop multiple focal points or face the necessity of supplementing their automobile based commuter system

FIGURE 13 MAXIMUM URBAN POPULATION PER FOCAL POINT SERVED BY VARIOUS TRANSPORTATION SYSTEMS



The central business district (CBD), located at the focal point of a city, is usually the largest traffic generator within an urban area. Different urban transportation systems can serve various levels of development within such a focal point, and the intensity of development within the focal point is related to the total urban population surrounding it. Thus, the type of transportation system needed to serve commuter traffic to and from the focal point varies with population.

FIGURE 14 ACCESSIBILITY VS DIRECT ACCESS



Primary arterials provide good accessibility over a broad portion of the urban area. Direct access points along an arterial street destroy its capability for traffic movement. Commercial firms seek locations with good accessibility to a broad market area. Thus, it is in their best interest to take direct access from other streets near the arterial rather than to destroy the accessibility provided by the arterial.

with some form of mass transportation and providing a people-mover system to aid circulation within the focal point.

Urban streets serve a variety of functions which are important to the overall operation of the city; however, the major functions of movement and access are competitive in nature so a single facility cannot be designed to provide a maximum of each. A classification of streets according to the relative importance of these two functions can be extremely useful in developing plans for urban street systems. The following four classifications, listed in order of decreasing importance of the movement function, are suggested: (1) Primary arterials; (2) Secondary arterials; (3) Collectors; and (4) Local streets.

Access controls are needed along arterial streets in order to protect their primary function of movement. Frequent driveways and street intersections result in numerous turning movements that greatly hinder the flow of traffic. Public opposition to such controls often subsides once the land owners recognize the difference in access and accessibility (see Figure 14). Commercial firms seek locations along primary arterials because of the high level of accessibility that they provide over a broad market area. Access to the commercial sites can usually be provided from streets with lower levels of classifications so that the good accessibility of the arterial is not destroyed in the process of development.

Recent trends toward larger scale residential developments (50 acres or more) have increased the opportunity for implementing the functional classification concept in street design. Modern limited access subdivisions result in better traffic operations on the arterial streets, and they provide a more relaxed atmosphere in the residential area. Future urban developments in the Coastal Zone will provide a better living environment if the suggested guidelines concerning street system plans are followed.

TRANSPORTATION CORRIDORS

Major transportation corridors are a permanent commitment to the movement of persons and goods between areas of concentrated activities. The types of facilities within the corridors might change drastically over the years, but the need for transportation remains as

long as the activity centers exist. The first major transportation facility installed to connect two activity areas is usually located on the most desirable alignment. Thus, subsequent changes in capacity or level of service can best be accomplished along the same route if adequate flexibility is available.

Future transportation needs in the Coastal Zone can be met more effectively if the cities, counties, and the State embrace and apply the concept of permanent transportation corridors. Of course, numerous problems must be addressed before the corridor concept can be applied. These problems include the following: (1) private vs. public ownership of transportation facilities; (2) limited jurisdiction of state transportation agencies; and (3) current constraints on purchase of right-of-way.

A major transportation corridor might serve several different modes, and the facilities might change with time. However, if sufficient right-of-way is acquired and protected, the corridor will have flexibility to meet changing needs in the future. A major intercity transportation corridor today might contain a six-lane freeway, two freight rail lines, a high-speed rail facility, and several pipelines. Thus, right-of-way widths of ¼ mile or more would be appropriate. Major urban corridors might contain a ten-lane freeway, a fixed-way transit line, and some goods movement facilities. Right-of-way widths of 1,000 feet might be considered for such urban corridors.

TRANSPORTATION TERMINALS

A transportation terminal is not necessarily the end of a line but merely a location where two or more modes of transportation can interchange traffic. Terminal facilites are normally oriented primarily toward serving one mode, as the name airport or seaport implies, but the basic function of the terminal is to provide for modal interchanges. Hence, future plans for transportation terminals in the Coastal Zone should give due consideration to all modal interchanges that might need to occur there.

RECOMMENDATIONS FOR STATE ACTION

Specific recommendations for State action relative to Coastal Zone transportation are summarized below.

1. New Transportation Facilities. The location of transportation facilities in the Coastal Zone can significantly influence the type of development that occurs along the beach areas. Therefore, it is recommended that the State require full consideration of these land-use/transportation relationships in the design and location of all new transportation facilities. Actions to achieve this goal should be undertaken by the Interagency Transportation Council in cooperation with the Interagency Council on Natural Resources and the Environment.

2. Water Transportation Agency. Water transportation is important to Texas, yet the State has an agency specifically concerned with every mode except water transportation. The scope of problems facing this sector are too broad to be solved by individual ports; therefore, it is recommended that the State designate an agency to address the problems of water transportation. The role of such an agency should not be to regulate, but rather to serve the needs of State in matters concerning water transportation.

3. Super-Port. Texas ports are barely deep enough to serve the average size tanker today, and ship sizes are increasing rapidly. The Corps of Engineers is presently studying the feasibility of locating a "Superport" in the Gulf of Mexico, but this study will not necessarily address the prob-

blems faced by Texas ports. Hence, it is recommended that the State conduct a study of water depth needs for Texas and further evaluate alternative methods of obtaining such depths in order to formulate a plan of action for Texas.

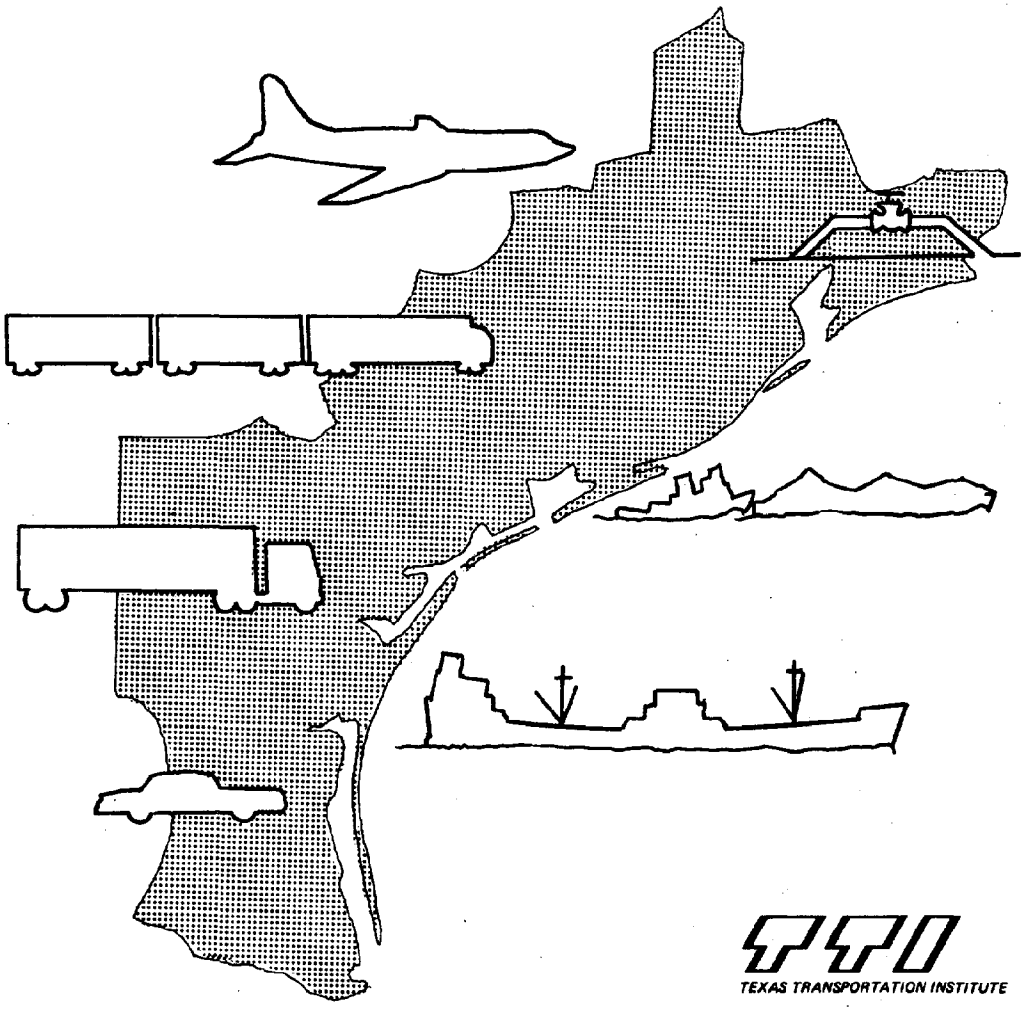
The first offshore deep-water terminal to be built in the Gulf will probably be single buoy mooring system to handle crude oil. This facility should probably be constructed and operated by private enterprise; nevertheless, the State has a valid involvement. Texas should take steps necessary to insure that: (a) deep-water facilities are constructed along the Texas coast as soon as possible, and (b) all possible steps are taken to protect the environment in the design, construction, and operation of these facilities.

(Note: Since this report was written, the Texas Legislature, meeting in special session, has passed legislation creating a special offshore terminal commission which is capable of accomplishing the tasks listed above. However, the creation of this commission does not alleviate the need for a state agency to address other problems of water transportation.)

4. *Intracoastal Waterway.* Traffic congestion and delays at locks on the Louisiana segment of the Gulf Intracoastal Canal are deterring growth of Texas waterway commerce. Steps must be taken to alleviate this problem. Texas should urge the U.S. Congress, the Corps of Engineers, and the State of Louisiana to take all possible steps to upgrade this portion of the waterway.

5. *Environmental Effects.* Very little definitive information is available on the environmental effects of various transportation modes operating in the Coastal Zone. It is recommended that the State conduct a study of these effects and evaluate alternative remedial actions so that effective pollution control policies can be established and implemented. The State should also encourage the development of regional contingency plans to assure quick and appropriate reaction in the event of major transportation mishaps which could create a threat to the sensitive environment of the Coastal Zone.

TRANSPORTATION PLANNING FOR THE COASTAL ZONE OF TEXAS



TEXAS TRANSPORTATION INSTITUTE

The Coastal Zone of Texas is served by major elements of every mode of transportation. The population of the Coastal Zone may double in the next 30 years, and the demand for transportation has been growing much faster than population. Texas must meet the challenge of providing for the rapidly growing demand for transportation with reasonable costs and minimum impact upon the sensitive environment of the Coastal Zone.