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Planning for Container Growth along the Houston Ship Channel and Other Texas Seaports

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1. Introduction and Background

1.1 Introduction

This study is intended to further the Texas Department of Transportation's goal of understanding how changing patterns of containerized trade are impacting the state transportation network, and the likely implications for transportation planning and programming. Project 0-5068 complements earlier Center for Transportation Research (CTR) work into containership size and port operations (0-1833: Infrastructure Impacts of Containerships—including mega-containerships—on the Texas transportation system) and container flows (0-4410: Containerized Freight Movement in Texas).

1.2 Background

In 2005/6, the Texas transportation system carried an increasing volume of intermodal traffic comprising (a) Asian commodities entering via West Coast ports and double-stack rail service, (b) NAFTA trade by truck, (c) domestic containers from all parts of the nation and (d) all-water containership services from Europe, Asia and Latin America calling at Texas deep water marine terminals. Rail corridors, which can offer competitive service with trucking at distances over 650 miles, are now being seen by state planners as a means to complement the established highway interstate system. The promotion of rail corridors to take containers off congested highways at marine terminals has been most successfully implemented at the Ports of Los Angeles and Long Beach. This success is best exemplified by the Alameda corridor, a depressed rail system linking the port terminals with Union Pacific (UP) and Burlington Northern Santa Fe (BNSF) yards. This facility, which took 20 years to plan and construct, now services over 60 trains a day and is financed by fees charged per container for each trip.

Study 0-5068 was initially designed to answer a fairly straightforward question— based on the growing number of planned container sites on the southern edge of the Houston Ship Channel does Houston need a rail corridor like that in southern California? The research focus was then broadened, before work began, to examine corridor improvement initiatives of all Texas seaports contemplating future container operations, but its primary focus remained on rail systems and their ability to take containers off state highways.

This is the second and final report detailing the work and findings of the research team. The first report, 0-5068-1, entitled “Planning for Container Growth along the Houston Ship

Channel and Other Texas Seaports: An Analysis of Corridor Improvement Initiatives for Intermodal Cargo” was published in November 2005. It included a chapter on the Port of Beaumont rail system and recommended that a new, faster, turnout be built into the port from the Sunset Limited track which would remove the need to block the main line when a train needed to enter or leave the port. It also recommended the construction of a new rail bridge across the Neches River, which would provide an opportunity to move the rail line out of downtown Beaumont, raise bridge speed, and so improve capacity on a major Texas rail corridor.

A chapter on the Port of Corpus Christi reported efforts to attract an operator for its proposed La Quinta container terminal, together with a strategic review of the various rail segments that would serve the port when containers began to be routed through the proposed facility. Another chapter examined the feasibility of containerization at the Port of Brownsville, its close links to Mexico, and the need for improved rail facilities at that portion of the border. Finally, a macro view of the rail system serving the Port of Houston Authority (POHA) was undertaken, reflecting its importance as the current locus of container traffic along the Texas Gulf. In 2005-2006, HNTB Inc. was undertaking a detailed analysis of Houston rail traffic using operating models and UP data, so the CTR team kept its focus on general rail system issues relative to its ability to serve the Port of Houston Authority (POHA) terminals. Several general conclusions were reached on rail access to all the major state marine container terminal initiatives, and an appendix on the ownership of, and trackage rights on, the major rail corridors in and around Houston illuminated the challenges facing planners addressing the improvement of rail access to Houston port terminals. Finally, the study report laid out the steps to be accomplished in the second year when work was focused on the Port of Houston Authority (POHA) container terminals, rail service on the Port Terminal Railroad Association (PTRA), dray services in Houston, highway corridors serving container terminals and finally the logistics sector processing imported containerized commodities. This report addresses these issues and its structure is now presented.

1.3 Structure of this Report

Chapter Two estimates the volume of containers that could be handled by the Port of Houston (POHA) terminals during the next two decades. The chapter also describes the factors driving these projections and the sensitivity of the estimates to external factors.

Chapter Three provides a description of the Port Terminal Railroad Association (PTRA), which operates over its own network and provides rail service to more than 173 major industrial sites and terminals along the Houston Ship channel. PTRA staff accompanied the project members on a hi-rail inspection of the network, concentrating on those sections serving near-dock container double-stack service. The improvement of this system is key for expanding rail container movements from the Barbours Cut (and ultimately Bayport) container terminals to the major Class One railroads who then transport these containers to state and regional intermodal yards. The chapter looks at the history of the system, the role of intermodal movements compared with other commodities, recommended improvements to the system and possible constraints on the system's expansion. The chapter corresponds with research performed in the first year, covering the major rail corridors serving Texas's current and future container ports. Photographs of the PTRA hi-rail inspection are provided in Appendix B.

Chapter Four examines issues related to over-the-highway movement of containers from the Barbours Cut and the future Bayport terminal. The chapter begins with an examination of Barbours Cut Boulevard, which is the primary corridor used by trucks to access the terminal complex from SH 146 and is slated for substantial rehabilitation in the near future. The chapter then examines the other highway corridors (SH 146 and 225) used by the majority of container carrying trucks to access Houston and points beyond.

Chapter Five then examines the pattern of distribution centers (DCs) in the Houston network that serve as the most common first landside destination for containers emanating from Barbours Cut. Some serve as the initial Texas logistics point where containers are unloaded and transferred (transloaded) to larger highway trailers for onward movement along the supply chain. While some DCs have been established for years, the development of large centers generating many truck trips is of primary interest to the TxDOT District.

Chapter Six examines the Houston dray industry and its driver workforce. The CTR team conducted a feasibility study on dray operations and their drivers, and compared the findings with a similar study conducted at the Ports of Long Beach and Los Angeles. Operations in Houston are found to be quite different from those in southern California. Houston drivers exhibit relative stability in employment, a characteristic rarely noted in the current US port drayage literature.

Chapter Seven recognizes that other deep-water locations may be chosen to site container terminals in future and considers the potential intrastate diversification of Texas container handling if proposed terminals at Corpus Christi and Texas City come online.

Chapter Eight summarizes the conclusions and recommendations from the two-year study, emphasizing those issues most likely to impact transportation planning and programming in Texas.

2. Houston Ship Channel Container Forecast

2.1 Introduction

This chapter, based on a variety of trade data conversations with POHA officials and secondary sources, examines the growth in the POHA container business from a “macro” perspective. It briefly reviews recent literature on the topic before describing how the Port’s containerized trade has changed in recent years. The chapter identifies the major causes of these changes. It also examines current and potential factors that may affect growth, such as congestion at the Panama Canal. Project 0-5068 includes the provision of a statistical forecast for container growth at the Houston Ship Channel. While this chapter does not suggest new techniques to develop container forecasts, it provides projections using statistical and non-statistical methods, with a brief discussion of the assumptions that apply to each.

Currently, a discussion of container transport on the Houston Ship Channel necessarily means the POHA. This could change, as several ports have nascent container businesses and have expressed ambitions of growing these. However, for the moment, these are ambitions only, and therefore this chapter deals principally with the POHA.

2.2 Review of Recent Literature

Forecasting container movements has proven a daunting task to researchers worldwide. Despite the broad interest in container forecasting, researchers and practitioners have not converged on common effective methodology. Approaches include regression analysis of commodity and economic variables and macro-economic modeling aimed at estimating future commodity demand.

Despite maritime transport’s vital role in world trade, the body of publicly available work attempting to produce forecasts of port specific seaborne container trade is modest. The primary reason for this is a lack of statistical techniques, advanced economic models and research designs capable of producing accurate estimates of container cargo volume. In much of the reviewed work, the authors showed a degree of uncertainty regarding the real value of forecasting container cargo volume. Shashi Kumar (1999) believes that this uncertainty derives from political bias and lack of information. For others, such as Seabrooke et al. (2003) the uncertainty derives from limitations to econometric methods and research modeling issues.

This uncertainty has led researchers to explore a variety of analytical methods. Shashi Kumar (1999), Comtois (1999), and Chou (2002) used qualitative case studies integrated with exploratory data analysis (EDA) techniques. Seabrooke *et al* (2002), Dagenais and Martin (1987) and Ma *et al* (2005) used quantitative economic modeling techniques to produce forecasts of containerized cargo. Seabrooke *et al* (2002) applied linear regressions to commodity data in an attempt to derive an accurate model of commodity trade. Dagenais and Martin used the volume of commodities traded, trading partner characteristics, containerization effect, and the hinterland effect as predictors of the containerized cargo volume, with different equations accounting for regional variation. Ma *et al* (2005) uses a database comprised of input-output matrices of commodity trade. These matrices are used in an applied general equilibrium (AGE) model called the Global Trade Analysis Project (GTAP) model that accounts for the impact of trade to cargo flows, government and private consumption, and regional welfare.

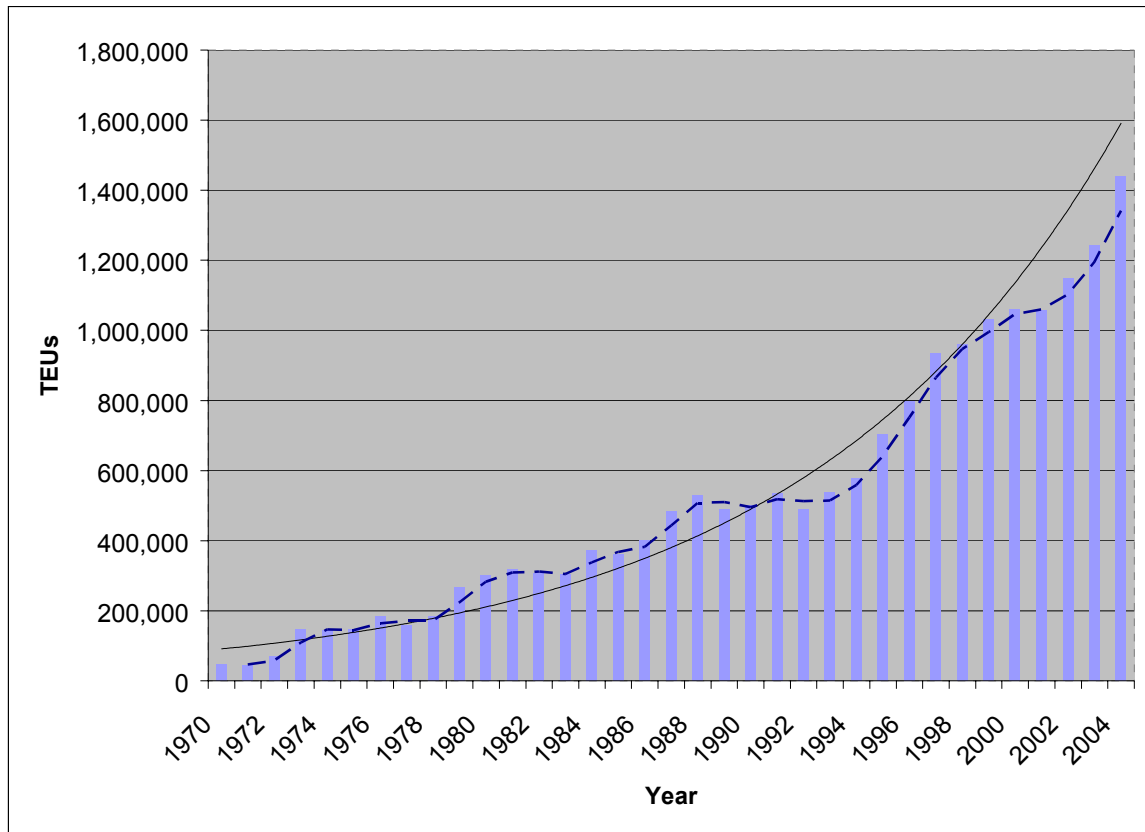
The POHA itself engages in short term forecasts, generally looking forward 12-18 months and looking at disaggregated commodity and product data. Through analysis of recent commodity prices and consumption data, they hope to uncover trends that will indicate the volume of trade that they should expect in that period. This method yields forecasts in goods, but not in containers and if data on containers is sought, assumptions must be made about how the goods will be distributed in containers.¹

Although there many methodologies to choose from, the scope of this chapter necessitates a fairly simple and transparent approach. As such, it seeks to use both analytical and descriptive statistics to illustrate recent trends in Texas that affect its containerized trade.

2.3 Characteristics of Containerized Trade at Port of Houston

Contextualizing projections of container growth requires an understanding of the trends and factors that have led to today's container business at POHA. Over the past thirty years, container shipments through the POHA have grown strongly. Handling less than fifty thousand containers in 1970, the Port has expanded its operations dramatically, moving more than 1.4 million in 2004. Fig 2.1 shows the growth in containers handled at the Port of Houston between 1970 and 2004. Each bar represents the total number of containers handled in that year.

¹ Brian Reeves, Market Development Manager, Port of Houston. Multiple conversations with Peter Siegesmund, Center for Transportation Research. Houston, Texas. April 2006 and August 2006.



*Figure 2.1: Growth in containers handled at the Port of Houston between 1970 and 2004
The dotted trend line represents the yearly moving average while the solid line is an exponential trend line that suggests the magnitude of the growth rate at POHA. Source: Port of Houston (includes imports and exports).*

This dramatic increase reflects several trends. The Texas economy, its population, and the greater Houston area have all grown rapidly in recent decades. This has led to increased demand that has spurred an increase in trade. Over the same period, there has been wide spread adoption of shipping containers to transport many types of goods. Today, shipping containers moved aboard containerships are the standard means of transporting goods that once had to be shipped break-bulk or in special custom-built boxes.

Texas' growth has coincided with broader growth in international trade. The dismantling of trade barriers and the seismic political shifts of the past two decades have created new markets and opened old ones. Changes to the United States economy have led to a strong and increasing demand for goods from abroad. The deindustrialization of certain sectors of the American economy, as well as the migration of manufacturing abroad has meant that a wide range of goods that were once manufactured domestically are now imported.

Finally, the hinterland that the POHA serves is growing. Wal-Mart recently established a large distribution center at Cedar Crossing, near Houston. As seventy percent of the goods that Wal-Mart ships through the POHA are destined for other states, this trend may accelerate.² Wal-Mart's impact on the Port's container trade will be discussed later in this and later chapters.

2.4 Port of Houston's Trading Partners

In the past decade, as the total volume of container handling services has increased, the distribution of trade among POHA's trading partners has changed significantly. The increase in Chinese trade has also shifted the overall distribution of POHA's international trade. Figure 2.2 shows the POHA's top trading partners in 2005. Over the past six years, Chinese containers have grown from a fraction of one percent, to around 12 percent of the Port's total trade.

Until recently, POHA's containerized trade was primarily transatlantic. This means that most goods processed at POHA container berths did not transit the Panama Canal and were not moved overland from the West Coast. In six years, however, the Atlantic's share of POHA trade declined from 89 percent to 74 percent. Figure 2.3 illustrates that the share of trade with South and Southeast Asia [defined here as the area from Vietnam to the Middle East] has remained relatively static. It is East Asian trade that has caused the reduction in the *relative* share of transatlantic trade.

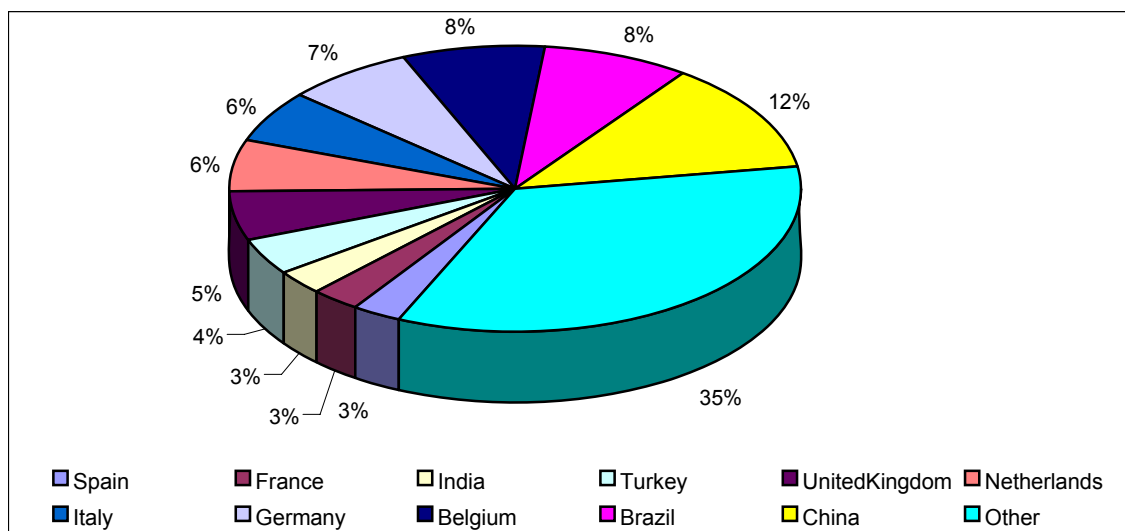
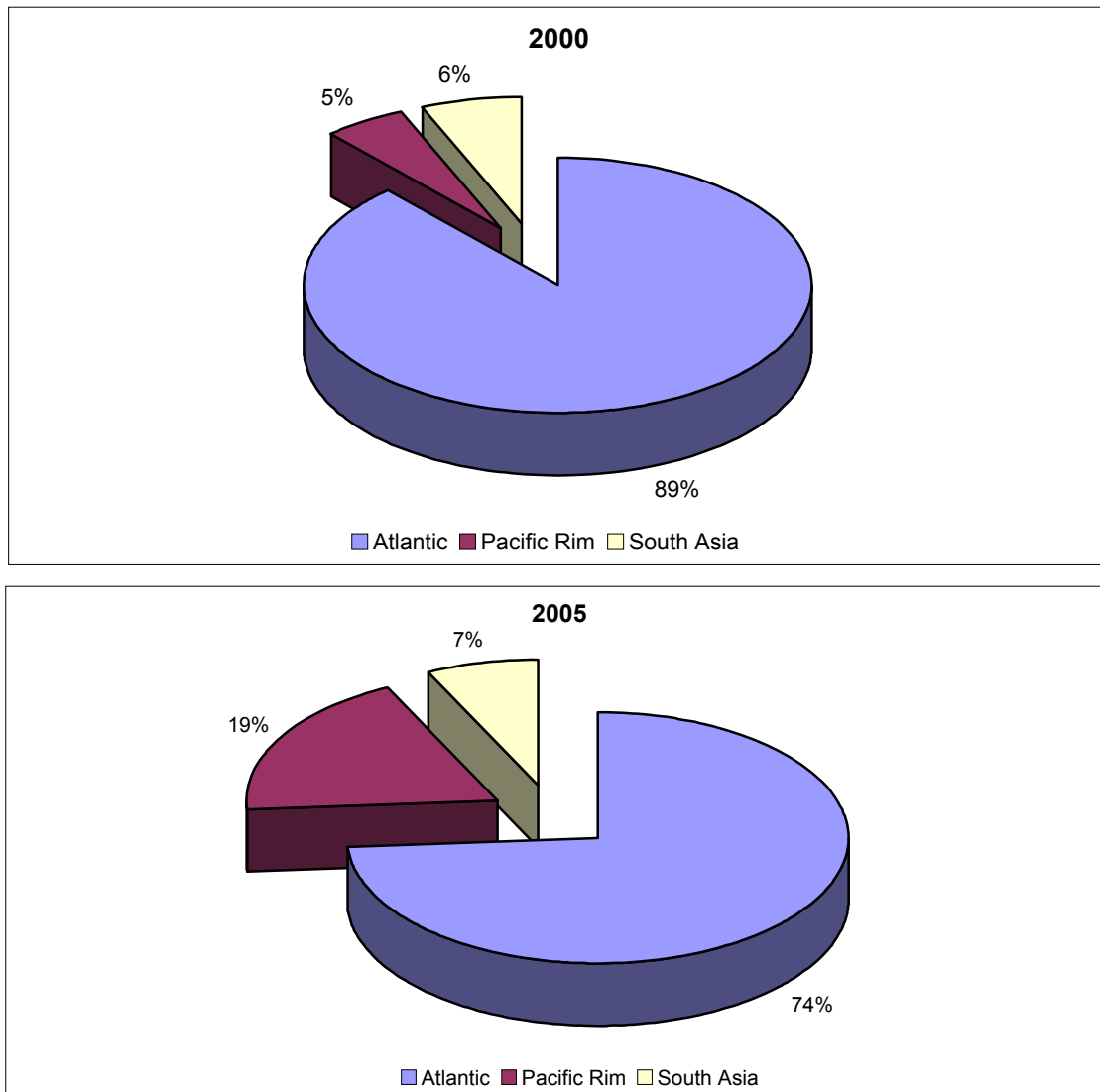


Figure 2.2: Top Trading Partners 2005, Port of Houston
Source: Port of Houston, PIERS

² Lynn Root, UTI Logistics. Interview by Jason West, Center for Transportation Research. Austin, Texas, August 1, 2006



*Figure 2.3: Top: 2000 Port of Houston container trade by region.
Bottom: 2005 Port of Houston container trade by region.
Source: Port of Houston, PIERs.*

2.5 The Emergence of Chinese Trade at the Port of Houston Authority (POHA)

Containers from China have been the force driving the increase in East Asian trade. Figure 2.4 illustrates the dramatic growth in Chinese trade at POHA. It is instructive to note the low levels of Asian trade prior to 2001. Although Chinese trade was trending upward in 2002 and 2003, a significant portion of the subsequent increase is attributable to the 2004 establishment of a Wal-Mart distribution center near Baytown.

Distribution centers such as those of major retailers like Wal-Mart have a proportionally larger impact on demand for container services than simple population or economic expansion, as they attract goods with end destinations dispersed over a larger area, thus expanding the hinterland served by the Port.

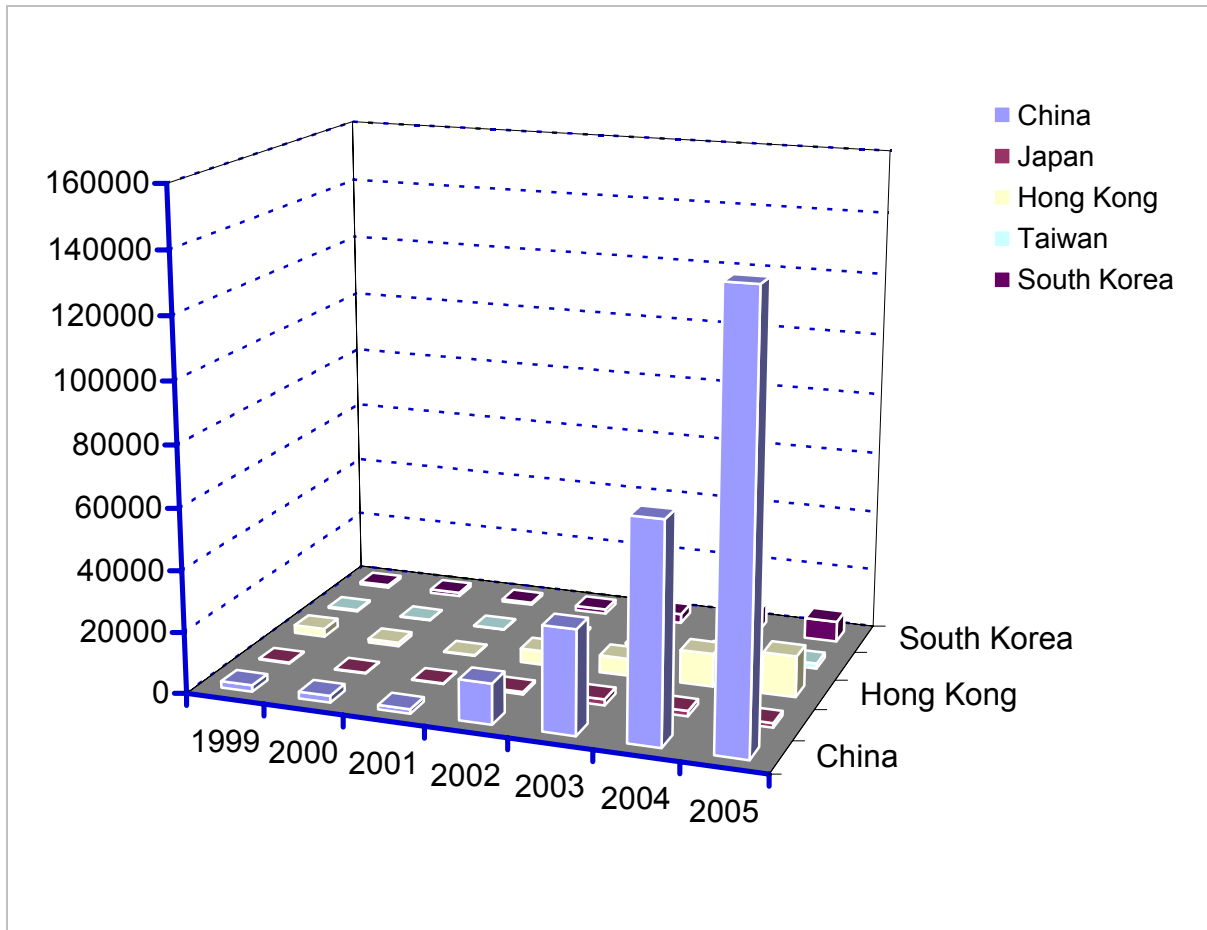


Figure 2.4: Growth in East Asian trade at the Port of Houston
Source: derived from POHA, PIERs

As container shipments between the Texas and China have steadily risen, the relative distribution of Asian trade at POHA has been upended. Fig 2.5 illustrates that Chinese trade, only recently making up roughly one third of Asian trade at the Port, now accounts for around 85 percent.

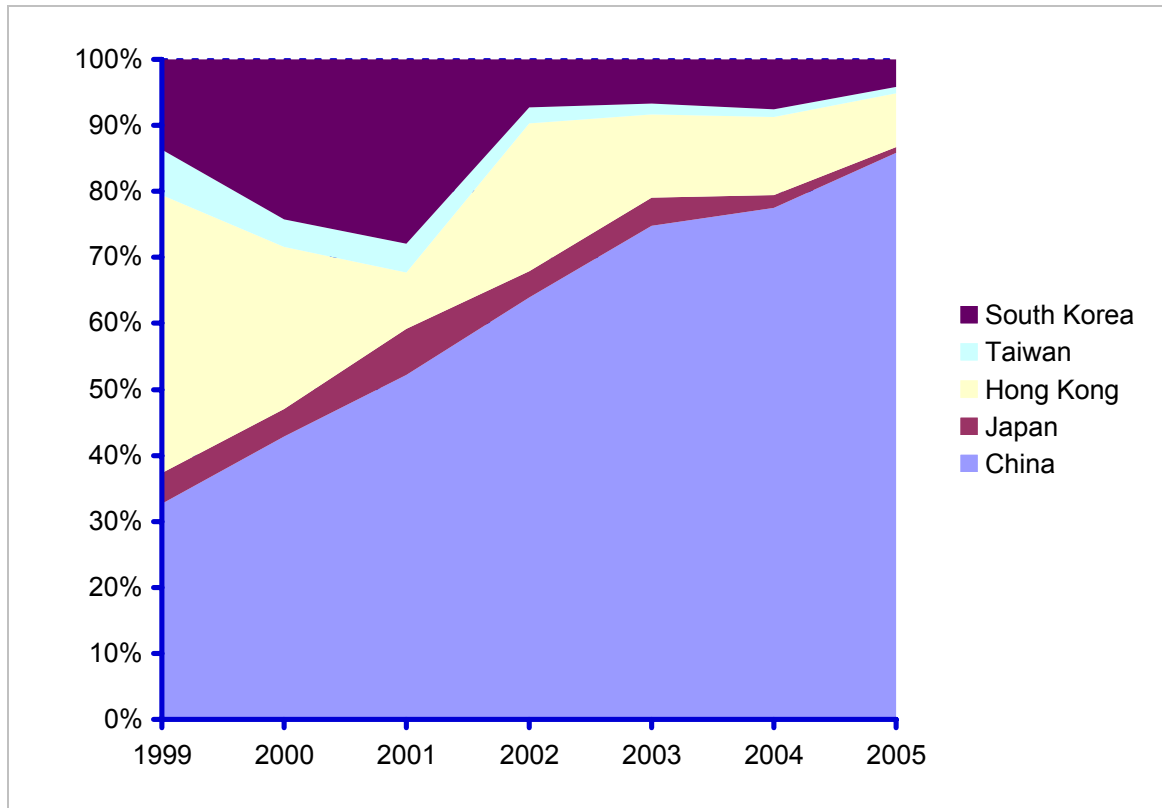


Figure 2.5: The shifting composition of East Asia trade at the Port of Houston
Source: POHA, PIERS

2.6 Causes of Container Trade Growth at the Port of Houston

In much of the available container forecasting literature, container forecasts are complicated by market structures brought about by geographic and political factors. These include national borders that divide a port's hinterland and can create strong direct competitors. In contrast, POHA's container business occupies a commanding position on the western end of the Gulf of Mexico, serving Houston, the state of Texas and to a lesser but growing extent, neighboring states. Although this could change in the future, it has no real competitor for shippers seeking to move large amounts of containerized goods into South Texas. Containerized goods shipped to the Port typically end their seaborne journey at Houston, rather than being loaded from one ship to another en route to their final destination.

Previous studies have established that a large percentage of containerized freight that enters Texas through POHA remains in Harris County–Houston Metropolitan Area (56 percent)

and that an overwhelming percentage (80 percent) remains in Texas.³ This suggests that a strong driver of container growth in Texas is economic activity in Texas itself. In turn, a significant driver of this growth has been Texas' population growth over the past thirty-five years. Within the state, growth has been focused on the "Texas Triangle," the area between and around DFW, San Antonio, and Houston.

Figure 2.6 shows population growth in Harris County since 1970. Forecasts by the Office of the State Demographer suggest that the Houston-Baytown-Sugarland Metropolitan Statistical Area (MSA) encompassing an area that overlaps, but is somewhat larger than Harris County, could swell to eleven million people by 2040—from four million in 2000.

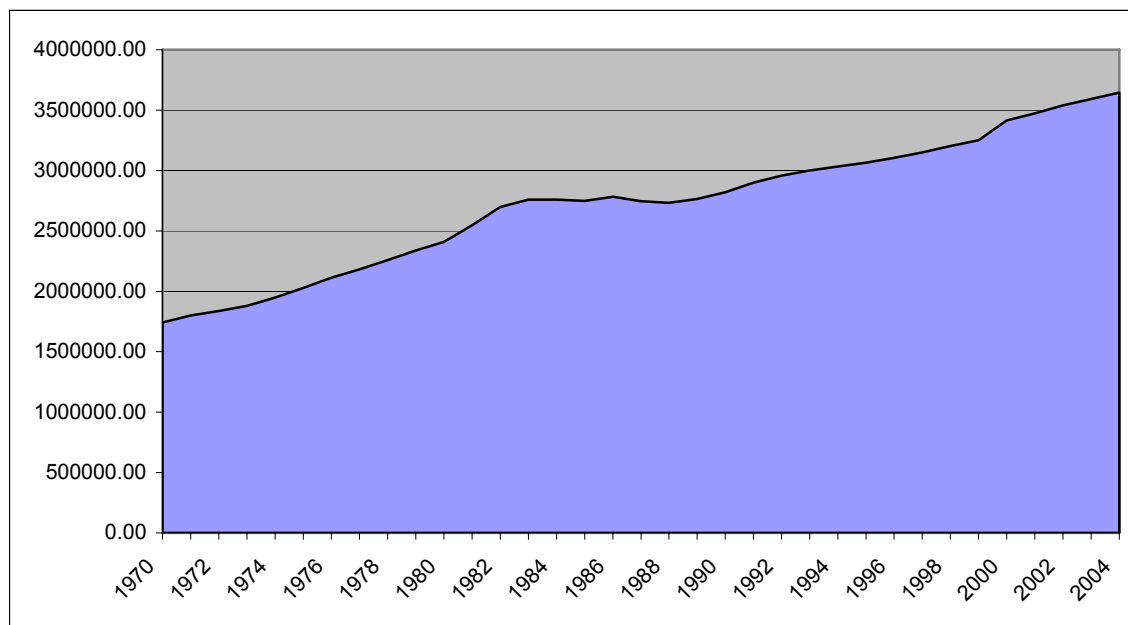


Figure 2.6: Population growth in Harris County, Texas

Population forecasts developed by the Office of the State Demographer are shown in Fig. 2.7. Four different growth projections are presented for the Houston-Baytown-Sugar Land MSA with Scenario .5 considered the most plausible estimate. Scenario .5 estimates that the MSA population will reach 6,451,138 by 2020.

³ Prozzi, Jolanda; Spurgeon, Kellie; Harrison, Robert; Roop, Stephen S. *What We Know About Containerized Freight Movement in Texas*, Austin: University of Texas at Austin. Center for Transportation Research (CTR) 2003. http://www.utexas.edu/research/ctr/pdf_reports/0_4410_1.pdf

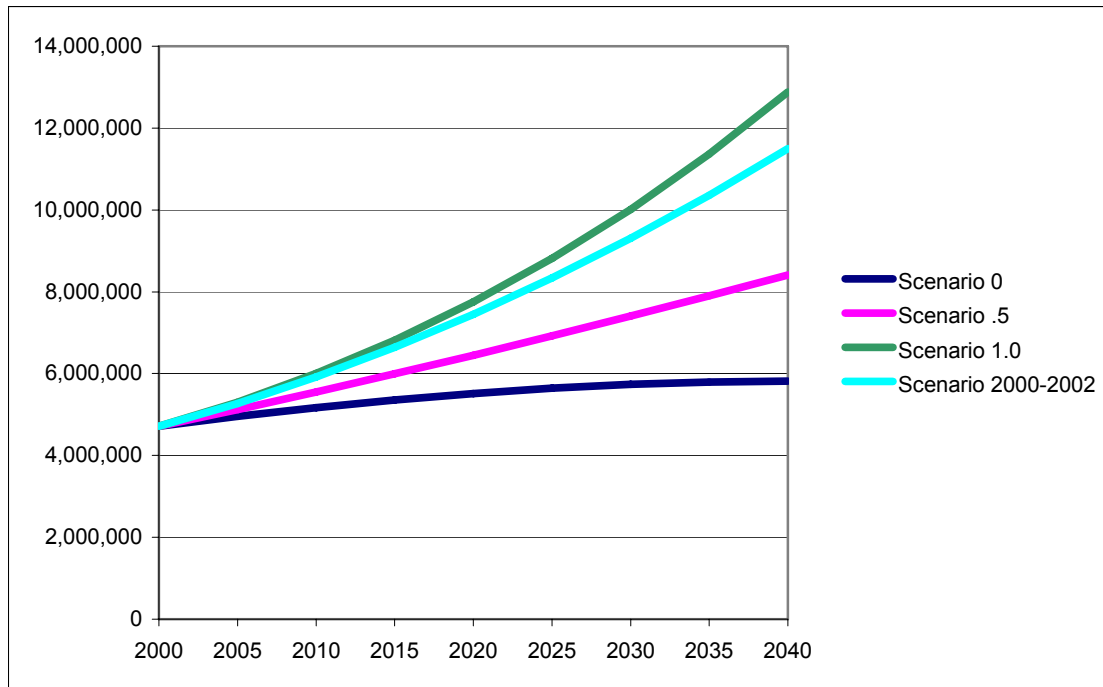


Figure 2.7: Population Growth 2005-2040, Houston-Baytown, Sugar Land MSA
Source data: Office of the State Demographer

Before evaluating a regression based forecast method, it is instructive to note the effect of differing compound growth rates on today's POHA container business. Fig 2.8 shows three projections of the number of containers processed at the POHA between 2005 and 2020. The first assumes continued growth in the overall number of TEUs at the average of the rate seen between 1999 and 2004. The second assumes a slowing of this average, to 4 percent and the third assumes an acceleration of growth, to an average of 10 percent per year. The choice of growth rate is clearly sensitive when compounded over the 2004-2020 period and produces values between 3 and 6.5 million TEUs for the values specified in Figure 2.8. Great care is therefore required when selecting a single growth rate.

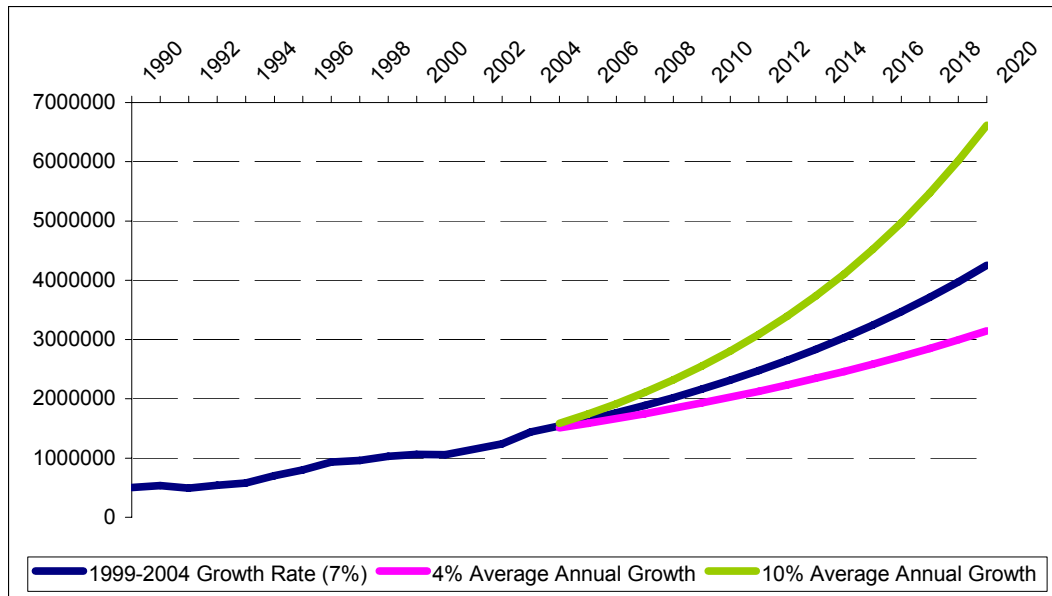


Figure 2.8: Current and hypothetical growth rates projected to 2020

2.7 Regression-Based Container Forecast

In the course of analyzing POHA container flows, a number of models were evaluated. These differed by independent variables and functional form. Variables analyzed included relative price levels, import price indices, and economic variables specific to the Houston area as well as the state economy. Variables of local and regional interest include energy prices, employment figures, and industry data. This data was related to container flows—both aggregated and disaggregated by trading partner—in a number of ways, incorporating linear and non-linear forecasting methods to account for the characteristics of the data set.

After back-testing each data set and evaluating their statistical characteristics, it became clear that within the scope of the current study and with regard to the data available, the simplest approach—relating basic variables such as population and Houston’s share of U.S. trade to container flows through regression analysis—yielded a result that was theoretically coherent and often more consistent with the qualitative evidence assembled than were more complicated formulations. It also simplified the task of developing scenarios by relying, in part, on forecasts generated by the Office of the State Demographer. This simple model provides insight into the order of magnitude of container growth that should be expected when the effects of forecast population growth are incorporated into the analysis. In this way, the findings are as qualitative

as quantitative; that is, the forecast presented here is meant to show trends and relationships rather than discrete numbers of TEUs at a point in time.

Economic and population growth in Harris County and in Texas are highly correlated with growth in Port of Houston's container trade and are regarded as strong drivers of this growth. Here, the focus is on population for several reasons. First, there is a strong relationship between population and economic output. Indeed, they are frequently collinear and special care is usually needed to treat this issue. Population was used in lieu of economic data for two reasons. First, economic time series were not available at the county level. At the state level, the method for estimating gross state product changed in 1997, and this precludes linking the pre-1997 and post-1997 data into a continuous series for analysis.

Fig 2.9 illustrates projected values based on a statistical analysis of the relationship between population growth and container growth at the Port of Houston between 1984 and 2004. The estimates were calculated using the Office of the State Demographer's .5 scenario as depicted in figure 2.7, to 2020. This estimate was regarded as the most likely. Table 2.1 shows the numerical forecast estimates of container volumes at 5-year intervals to 2020. Growth of this nature would produce a rough doubling of container volumes by 2015 and a figure well over the four million mark by 2020, as illustrated in Figure 2.10.

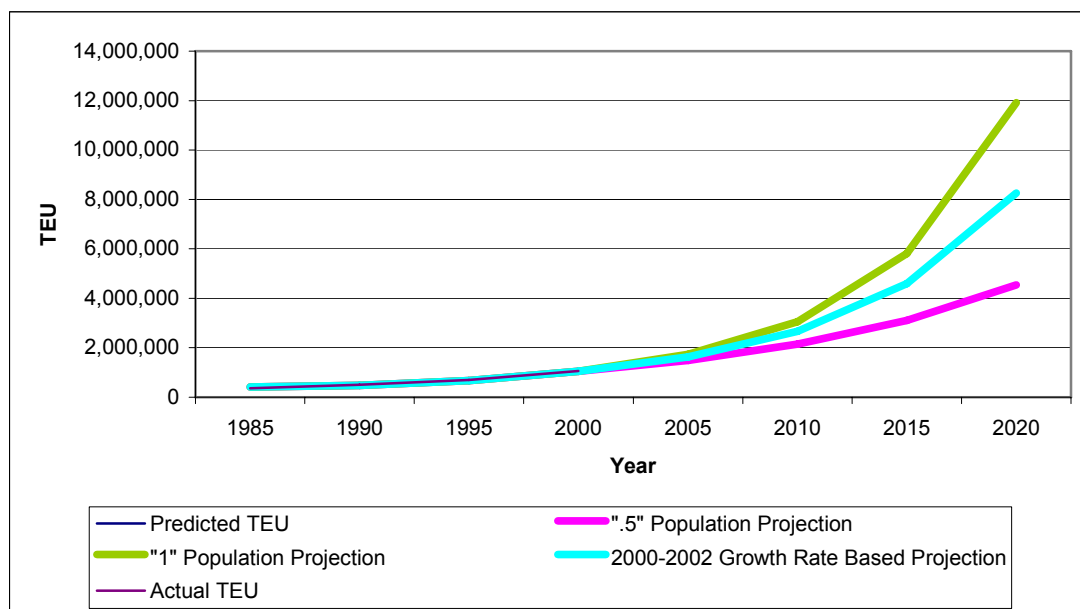


Figure 2.9: A regression of projected population on container volumes

Table 2.1: Container Forecasts 2005 to 2020

Year	Forecast TEUs
2005	1,491,839
2010	2,142,663
2015	3,110,434
2020	4,536,482

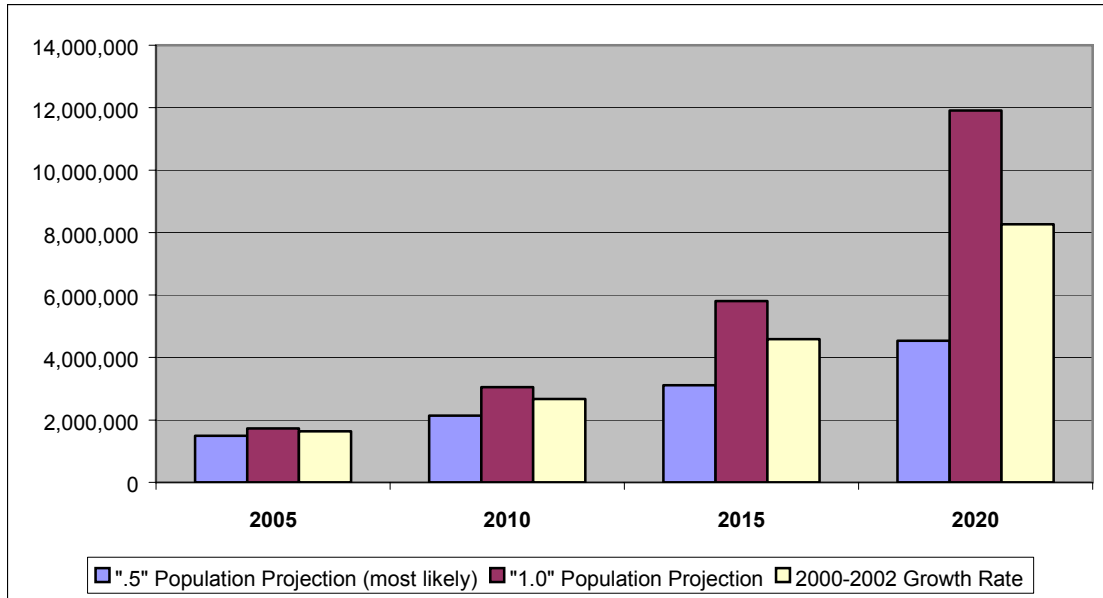


Figure 2.10: A detailed illustration of population based projections

Accounting for increases in containerized trade caused by growth to the state, as with the regression model in Figure 2.9, suggests a substantial expansion in trade at POHA in coming years. However, these methods may underestimate total container trade growth by failing to account for latent demand as well as the ability of the POHA to aggressively market their services as additional capacity comes online. Indeed, as illustrated in Figure 2.11, POHA believes that demand already exceeds the capacity of the first phase that Bayport will provide when it comes online.

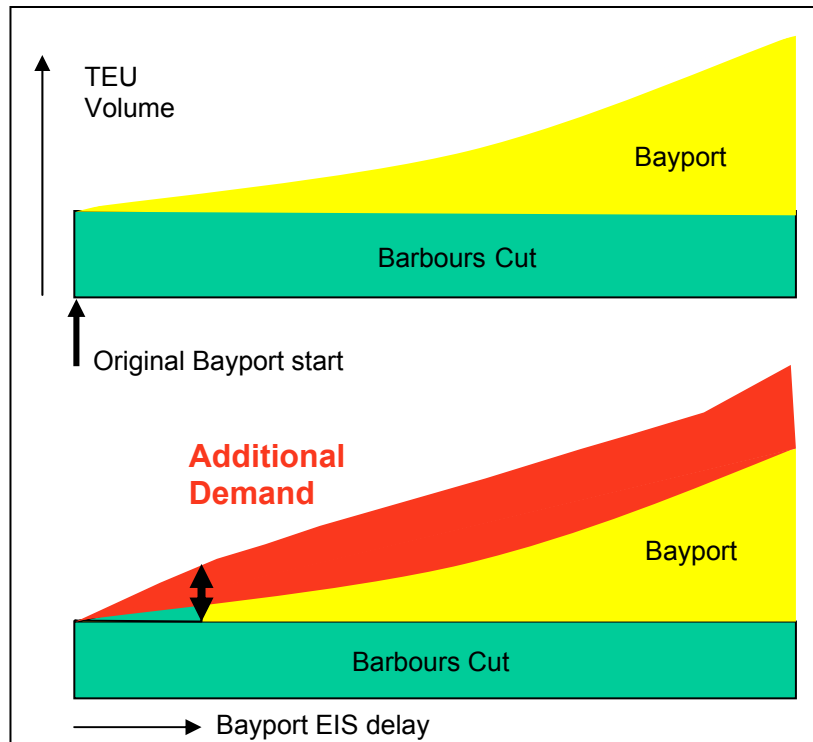


Figure 2.11: Current demand outstrips capacity, according to POHA. Source: POHA

2.8 Port of Houston's Projections

If *current* growth rates continue, POHA can reasonably be expected to break the 2 million TEU mark around 2010, as shown in Figures 2.8 and 2.9. However, POHA has been operating at capacity for several years, accommodating additional business through a series of policy changes and efficiency improvements. It is widely believed that there exists a significant degree of latent demand for container services at the port. POHA officials have stated that with the first phase of Bayport handling cargo, they expect the number of TEUs handled to grow at an average of 11 percent in the near-term.⁴

Figure 2.12, characterized as *conservative* by the port, suggests that the 2-million-TEU mark may be reached as early as 2008 (estimate specifics are presented in Table 2.2). Moreover, this rate carried forward, implies that the POHA will handle 3 million TEUs as early as 2012.

⁴ Jim Edmonds, Chairman of the Port of Houston, *State of the Port*, Presentation to the Greater Houston Partnership, October 19, 2006.

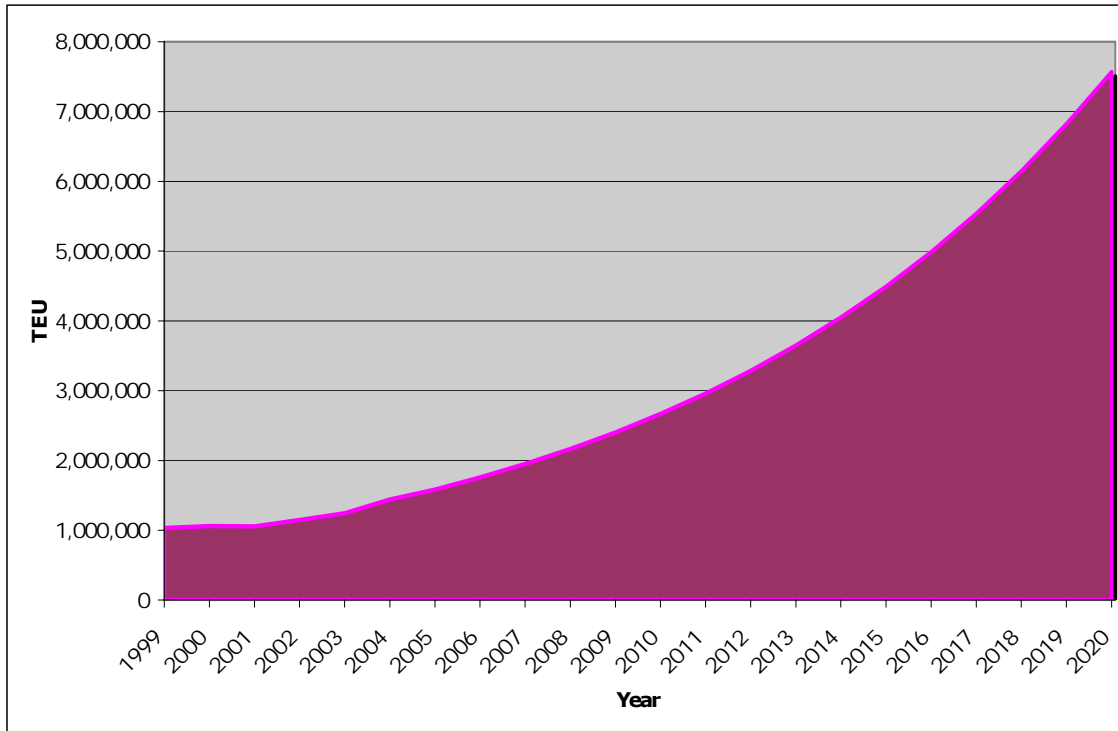


Figure 2.12: Port of Houston's own near-term estimate of 11 percent annual growth through 2020

Table 2.2: Containers at POHA Terminals under an 11 percent assumption

Year	TEU Forecast
2000	1,061,525
2001	1,057,869
2002	1,147,489
2003	1,243,866
2004	1,440,478
2005	1,582,081
2006	1,756,110
2007	1,949,282
2008	2,163,703

Port of Houston growth estimates suggest that successive phases of the Bayport Terminal will be fully utilized as they are brought online. When Bayport is fully completed, it will be able

to accommodate 2.3 million TEUs⁵. As Bayport’s maximum capacity is likely to display the same elasticity of Barbours Cut, POHA’s future maximum capacity may be larger. The most recent projections for container (not TEUs—an important distinction, as many containers are larger than twenty feet) volumes have been produced by Martin Associates and are shown in Table 2.3. A conversion factor of 1.6 is used to account for the variety of container sizes.

Table 2.3: Bayport Container Volumes from 2005⁶

Year	TEUs
2005	96,000
2006	158,400
2010	440,000
2015	881,600
2020	1,443,200
2025	2,080,000
2030	2,080,000

Over the long term, under all forecast scenarios, the Texas Gulf Coast is likely to see more containerized trade than the current and planned POHA facilities will be able to accommodate. Other Texas ports are currently in various phases of investing in container infrastructure, but currently, these ambitions and investments are unrealized.

2.9 Handling Future Container Growth

The POHA has been operating at, and above, its nominal container capacity for several years. Therefore, the magnitude of projected container growth, even under the most conservative assumptions, will push demand for container services well beyond the ability of the Barbours Cut and Bayport facilities to maintain reasonable levels of service.

Barbours Cut—and presumable Bayport—is not fully operational on a 24-hour basis, although ships can dock and containers can be loaded and unloaded at any time, with management and stevedoring approval. However, for most customers, the gates that control

⁵ *Bayport Terminal Facts*, Port of Houston. Provided by Brian Reeves, Market Development Manager, Port of Houston, August 2006.

⁶ *The Potential Economic Impact of the Proposed Bayport Terminal*, Martin Associates, Lancaster, Pennsylvania, November 15, 2002.

access to the container yard are open only between the hours of 7:30 and 5:00 p.m., meaning that cargo can only be removed from the port by truck during daylight business hours.

There is, however, one important exception to this rule. In May 2005, the world's third largest container shipper, CMA CGM, began their "third all-water service via Panama to Houston and Savannah, primarily to handle Wal-Mart imports from China." This stressed a port that was already working near capacity. Ultimately, the liner service was made feasible at Barbours Cut only by CMA CGM guaranteeing its ship's arrival times.⁷ In order to accommodate the large volume of containers introduced by the new liner service, the Port has designated one gate exclusively for the use of Wal-Mart's dray drivers. This gate opens on Thursdays with the arrival of the ship and remains open until the goods have been unloaded and removed from the Port. This arrangement is made feasible by the volume of trade that Wal-Mart can guarantee and their willingness to pay the higher costs associated with their operational cycle.

In addition to the modification of gate policies, the POHA has introduced other measures in an attempt to avoid turning away business amidst surging demand. Among these are policy changes at the facility aimed at ensuring that containers follow a more direct path from ship to intermediate or final destination, spending less time in the Port's yard. POHA has reduced dwell time by reducing the number of free days a container may remain in the Port's container yard. Additionally, truckers delivering containers for export now have a narrower window to deliver their loads prior to the ship's scheduled departure.

The POHA has been building the Bayport Terminal facility to accommodate future trade growth. When fully operational, the Bayport facility will increase the Port's capacity by 1.4 million TEUs per year, a dramatic increase over today's nominal capacity. When completed, seven ships would be able to load and unload simultaneously at Bayport and a 378-acre container yard will ease the space constraints that have hampered Barbours Cut in recent years.⁸ Bayport will also feature an 88-acre cruise ship terminal facility as well as a 123-acre intermodal yard. The first phase of Bayport is scheduled to come online in November 2006.

⁷ Peter T. Leach, "Here they come; All-water services from Asia to the East Coast will increase during the next year." *Journal of Commerce*. July 4, 2005: 12.

⁸ "Port Authority Delivers Favorable Outlook on Bayport" Press Release by Port of Houston Authority, May 16, 2003.

2.10 Summary and Conclusions

This chapter has examined a variety of trade statistics and container metrics. The Port of Houston's container business has grown exponentially over the past 35 years. This has been due to increasing containerization, growth of Texas' population and increasing international trade. Recently, Port of Houston has become a destination for large numbers of Chinese containers. The rapidly growing number of containers from China is rapidly making Asia a primary trading partner of Port of Houston and is pushing the total number of TEUs further upward.

Chapter 2 has presented several ways of viewing future container growth. The first is by projecting current container growth rates into the coming years. If current trends hold, Port of Houston will see 2,000,000 TEUs before 2010 and will handle over 4,000,000 TEUs by 2020. However, Texas' changing demographics and growing congestion in the national transportation network suggest that current trends may not hold. CTR researchers performed non-linear regressions of the effects of Texas population growth on container volumes. The state demographer publishes a range of scenarios for population growth, and these were used to create container forecasts. Under all scenarios, the 2,000,000 mark is reached by 2010, and by 2020 the number of TEUs is projected to be at least 4,500,000. Finally, the chapter examines Port of Houston's own projections. The Port itself projects 11 percent annual growth in container volumes. If this forecast holds, it will see 2,000,000 containers before 2008 and could see demand well over 7,000,000 by 2020.

There is no way to validate which forecast is the most correct, and the forecasts described in this chapter should be viewed as a range of alternate outcomes. However, barring a severe economic disruption or a long-term disruption to the transport network that delivers containers to Texas, the likelihood of a sustained decline in container volumes seems very remote. Indeed, all indicators, including a very significant amount of investment capital, confirm that expectations are of rapid growth. Therefore, it is reasonable to see 4,000,000 TEUs as a lower boundary for the number of containers to expect by 2020. Above that, the number of TEU that Texas should expect will be limited only by handling capacity and demand. The Port of Houston is growing their handling capacity with the imminent opening of their Bayport Terminal. Other ports have expressed an interest in growing their own container businesses. Additionally, demand will grow not only with Texas' economy and population, but also as the port increasingly serves regions outside of Texas.

2.11 Directions for Future Research

As this chapter's literature review suggests, forecasting container flows pose significant challenges to researchers. Trend-based forecasts, statistical or otherwise, inherently rely on past data, and thus can fail to capture future changes. These methods typically perform poorly in periods of significant structural change and incomplete data, and incorporating factors such as Wal-Mart's Baytown distribution center (particularly the introduction of additional, similar facilities over a 15 year forecast period) into the analysis is impossible. Equally difficult is projecting the impact of the dramatic capacity increases that are expected to come online in late 2006 at POHA's Bayport Terminal. The research in this chapter will be pursued in greater detail in the current TxDOT research project 0-5538. In the course of project 0-5538, more sophisticated, powerful tools will be available to examine, in detail, the nature of commodity demand. Additionally, the potential exists, and is being investigated, to link these commodity demand estimates with bilateral trade forecasts. This capability will be available through the use of several Computable General Equilibrium (CGE) models.

3. The Houston Port Terminal Railroad Association Rail System

3.1 Background

The Houston PTRA is classified within the railway industry as a “terminal” train operating company, meaning it operates as a switching railway, making freight car deliveries and pick-ups within the market served by its track system. It was formed in July of 1924 and has the legal status of an unincorporated terminal company. The goal was to operate a railway system that could provide the local Houston port area customer base with equal access to all regional railways wishing to serve the port. An important founding equity participant was the City of Houston, and two other participants with rail tracks or land needed at inception were a) the Galveston, Harrisburg and San Antonio Railway Company and b) the Harris County-Houston Ship Channel Navigation District—which today is the POHA.

Five years after its creation, the PTRA was operating its freight switching services over fifty-seven miles of track and sidings. It currently maintains 154 miles of track, 46 miles of which can be classified as main line track—some double-tracked. It also operates over another 25 miles of other railroad company track, using rights they obtained through various trackage right agreements and contracts. The owning railroad company maintains these tracks, not the PTRA

One of its first incremental expansions occurred at the end of 1930 when the PTRA Board of Directors agreed to lease the Northside Belt.⁹ The PTRA serves a large customer base in a relatively small area, along both sides of the Houston Ship Channel.¹⁰ As of 2005, it serves more than 150 customers within the immediate port area. PTRA originates and terminates a total of about a half-million rail cars a year in port and industrial related traffic. Therefore, the PTRA alone accounts for more than one-third of the Houston total origin/destination rail freight traffic.¹¹

The PTRA now uses more than 34 of its own modern diesel electric locomotives to serve these commercial customers. The freight cars that the customers require for their products are provided either by the “associated” railway main line carriers like Union Pacific (UP) or

⁹ Background about PTRA in part from material by George C. Werner and other sources

¹⁰ <http://www.houstonhistory.com/decades/history51.htm>

¹¹ Houston rail 2004 data analysis—July 2006.

Burlington Northern Santa Fe (BNSF), or by the customers themselves. The railway must classify these cars into trains at a series of local yards that it operates. On the south side, the railroad operates two very large yards at Manchester (more than 750-car capacity per day) and at Pasadena (more than 1,000 cars). On the north side of the Port, PTRa operates four industry yards. PTRa also operates a 2,300-car capacity facility called North Yard located near the western end of the Port Channel and US Highway Alt. 90 to expedite interchange to participating Class 1 railroads.

Table 3.1 summarizes a typical day of PTRa train movement along its tracks to its port and industrial customers.

Table 3.1: Daily Train Movements 2005

Carloads a day	PTRa—all	3,300
Trains a day	North PTRa area	26
Trains a day	Manchester PTRa area	27
Trains a day	Pasadena PTRa area	37

Table 3.2 gives a breakdown of the major commodities handled at the POHA in 2005.

Table 3.2: Port of Houston Commodities 2005

<u>Commodity</u>	<u>Year 2005</u>
Chemicals	30%
Plastics	22%
Grains	14%
Coke	11%
Industrial & Steel	11%
Intermodal	3%
Finished Autos	2%
Sub total	93%
All Other Freight	7%

While intermodal is the fastest growing segment of port traffic, the rail related volume has to be seen in perspective. While PTRA handled approximately a half million large rail cars in 2005, only about 100,000 containers were moved during the same period. This means that about 60,000 intermodal railway cars are currently used when double-stacked containers are factored into the analysis.

Intermodal rail traffic is likely to grow as the POHA develops new customers outside the state. However, the proposed new rail intermodal yard at Bayport will not come into full use under current port strategy until sometime after 2012/14. That means that PTRA rail investments need to be first focused on existing Barbours Cut intermodal requirements, plus the service and growth needs of the conventional industrial rail carload shippers in the port district, most of which are related to the chemical industry—a profitable sector for Class 1 railroads.

3.2 PTRA and the Class 1 Rail Network

An attempt to improve PTRA planning and rail investment requires that a comprehensive view be taken of how its rail system relates to the Houston region railway network. Figure 3.1 shows the location of the PTRA core track network in relationship to the navigable waterways and the central Houston track corridors. It should be assumed that virtually the entire Figure 3.1 rail network is heavily used by rail freight trains. It also shows the nearby major highway road network that serves the POHA and the industrial plants, which are the subject of a later chapter in the report.

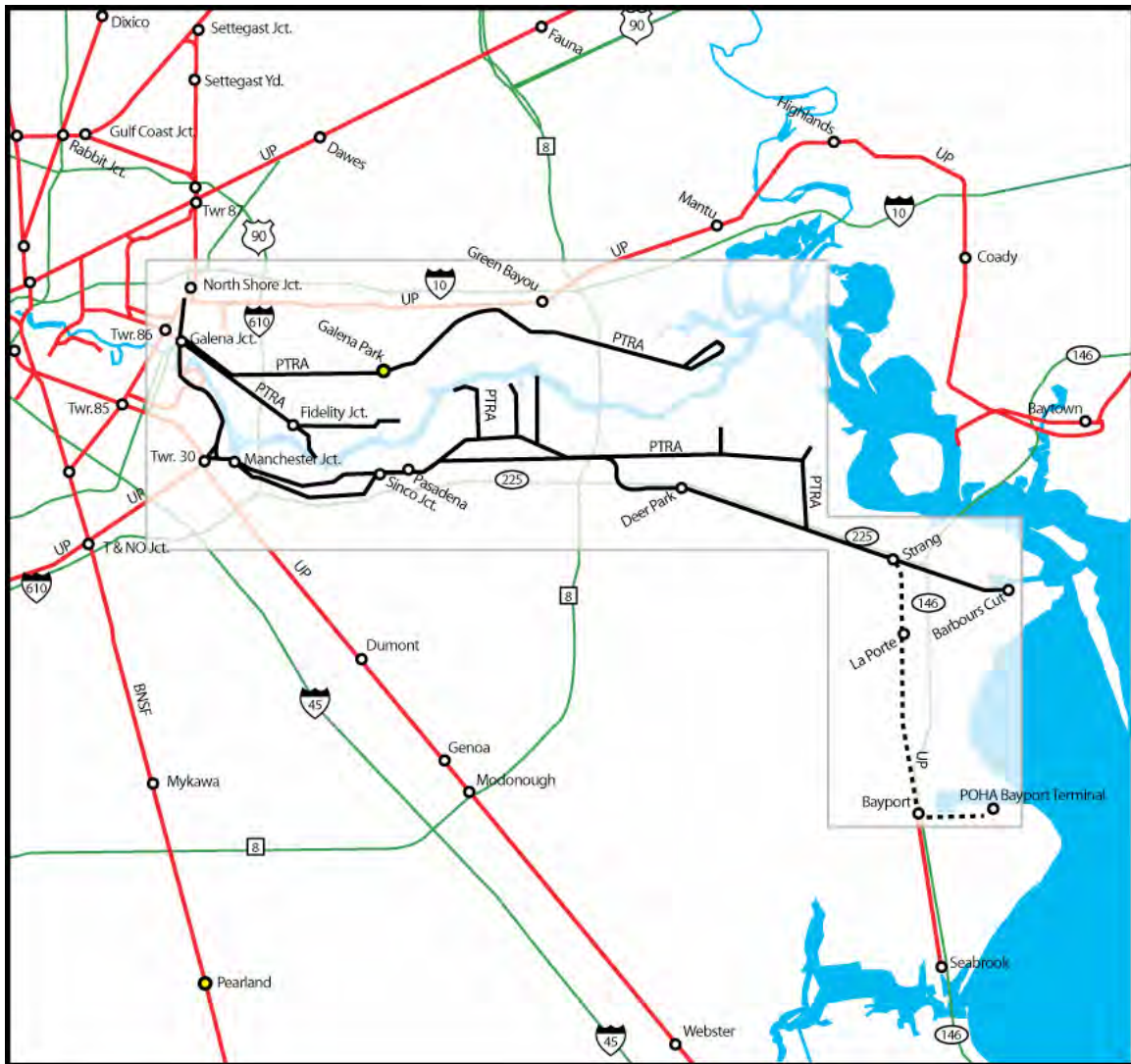


Figure 3.1: PTRA System and the Houston Rail Network

The PTRA southern route towards Barbours Cut and Bayport passes in turn west to east through the following local points called:

- Manchester Junction
- Manchester Yard
- Sinco Junction
- Pasadena Junction
- Deer Park
- Strang
- Barbours Cut

This PTR A line to Barbours Cut is located to the north of the Pasadena Freeway (Highway 225). A north to south, new track parallel to the existing Union Pacific Strang line will eventually connect the PTR A operating tracks to the new Bayport intermodal terminal.

To the north of this PTR A west/east line are various industrial switching tracks that serve large chemical facilities and other plants within the port district along the southern shore of the Ship Channel.

The PTR A northern main extension towards North Yard connects PTR A's Manchester Yard and the Barbours Cut line to PTR A's west to east line located to the north of the Channel. The northern extension crossing Buffalo Bayou also links the southern PTR A west to east line and to the Union Pacific main track network near North Yard and Galena Junction. These points are all located near the intersections of the following roads:

- I-10
- Alt 90 (McCarty St)
- Market St
- N Wayside St

The PTR A northern west to east line towards Jacinto Port passes in turn west to east through Galena Park.

3.2.2 PTR A Field Inspection 2006

The 0-5068 team spent four days on technical interviews and field inspections during 2006. This gave the team hands-on access to key operating personnel of not only the PTR A railway but also of the two major main line Class 1 traffic participants—the BNSF and the UP. The inspected PTR A trackage is generally in excellent physical condition. The tracks are very heavily used by both “local” freights and by through freights. The main line is double track in some locations along the southern west to east line towards Barbours Cut but does have some single track and overhead clearance restrictions that effectively cut operating capacity—certainly for double-stack and auto cars. A few key capacity “bottlenecks” should be improved to accommodate both industrial and intermodal container growth, and these improvement options are given at the end of this chapter.

Photographs taken during the track inspection with PTRA staff appear in Appendix A and describe both the geography and assets along the PTRA southern railway line moving west to east towards Barbours Cut. A fundamental study objective was to address the question of identifying potential ways to improve efficiency on the PTRA network serving the POHA customers. The research team, using detailed technical interviews, market data analysis, and field inspections as the basis, determined that the optimum strategy is to improve rail transportation fluidity within the POHA boundaries. The key objective is to preserve the important industrial employment base and support further economic growth of both the Port and its surrounding industrial neighbors.

There are two PTRA and POHA resource requirements. The first is to improve internal port district railway fluidity, which can be achieved by making a small number of specific improvements to raise train movement efficiency within the Port's maritime service boundaries. The second resource requirement is for improved external POHA "approach and depart" route fluidity. This can be accomplished by making very specific, modest cost passing siding improvements on the strategic corridors that link the port to its hinterland of markets and DCs via the regional Houston track network.

PTRA and POHA strategic resources need to be urgently deployed on a small number of critical siding improvements, although the specific regional investments are incremental changes and not exceptionally expensive.

3.2.3 PTRA and Port Area Improvements

There are five suggested internal Port area railway projects requiring relatively modest investments. Each project is focused on improving railway efficiency within the port area. The suggestions are based upon the research team investigations during the spring and summer of 2006.

The following table describes the core railway projects that could significantly improve the PTRA internal railway operating performance. The *A to E* reference in the table indicates the project location on the accompanying map shown in Figure 3.2.

These five projects are known to PTRA and their order in Table 3.3 is not a ranking of either potential return on investment or cost-benefit ratio.

Table 3.3: Potential PTRA Improvement Projects—Summer 2006

Strategic Investment	Internal Port Location	Reason
Added second main line	(A) Across Buffalo Bayou	Improve N/S Port Access
Add missing second track section to reach two intermodal port areas	(B) Tower 81 and 30 between Harrisburg Junction, Pasadena Junction, and Deer Park Junction	Eliminate train delays within the Port complex from existing limits of single track operation
Increase car handling capacity of key customer support yard	(C) PTRA Pasadena Yard	Insufficient space to handle bulk and chemical customer traffic growth
Near-by yard support for Barbours Cut maritime terminal	(D) Just west of Barbours Cut	Increase “forward storage” support for Barbours Cut intermodal yard customers
Construction of second main line to serve Bayport new intermodal yard	(E) Strang Yard area south within the Union Pacific r-o-w	Enable earlier access at lower construction costs to new Bayport maritime area

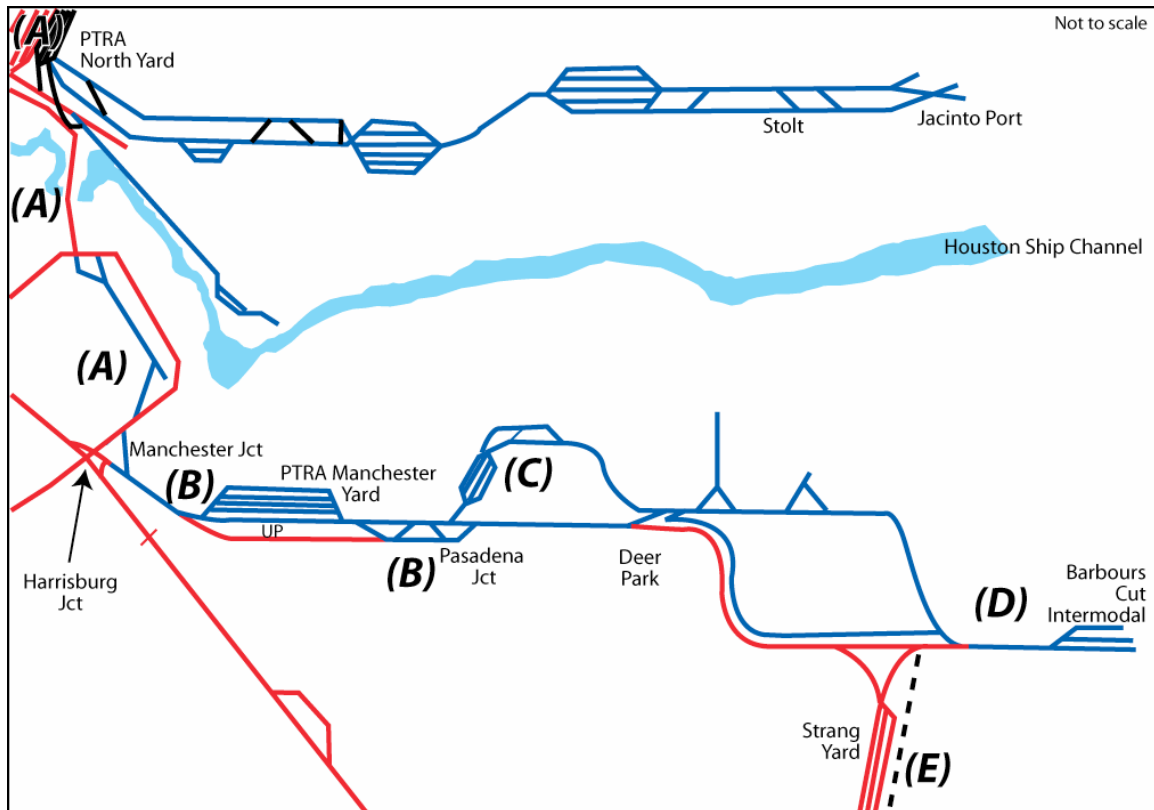


Figure 3.2: Schematic of Houston PTRA Investment Projects

3.3 Train Congestion on Approach/Departure to the PTRA and Port Area

Technical interviews in June 2006 determined that there is an observed decrease in the average speed approaching the PTRA system. Trains that in previous decades might have been expected to approach Houston at average speeds in the 20 to 35 mile per hour range are now approaching at overall averages significantly less than 20 miles per hour. That statistic, and potential remedies, will be examined more closely by the current HNTB Houston area study.

The operational and marketing interviews by the CTR-Zeta Tech research team resulted in a unanimous expert-based conclusion that POHA customers suffer from increasing patterns of train delays after reaching or leaving the port areas. There are extreme examples where inbound empty intermodal platforms needed for container loading in the Barbours Cut terminal have been forced to wait for multiple days. A recurring reason is that when there is a lack of a cleared route for a train to use, both locomotive power and train crews may be reassigned to move other freight trains while the empty cars are set out beyond Rosenberg on an empty passing siding. Only when those resources could be programmed and reassigned to the original cars can the train be moved to its final destination. While it is certainly not a normal condition, it is an emerging pattern that requires a local capital investment to correct.

Frequently, the delay occurs when train congestion on a joint-use Houston area route becomes extreme. The immediate causes on any given delay could be:

1. poor weather,
2. random grade crossing accident,
3. a broken air line,
4. trains delayed ahead, for example when trains are currently crossed over the main to enter Beaumont,
5. train delays during a two-thousand mile route to reach Houston from California,
6. surges in maritime container arrival because of delays in ship arrivals, or
7. random events that affect daily rail operations.

The point is that a single track distant siding spacing network “approach” designed more than a half century ago often will clog—sometimes severely—when these events occur and create network congestion.

Table 3.4 illustrates the typical congestion issues that require investment on one main line approach route providing critical access to the PTRA. It shows the major fluidity physical characteristics on the jointly used Union Pacific main line between SW Houston near Rosenberg Texas and the Port access gateway near Harrisburg Junction in SSE Houston.

Table 3.4: Summary of Passing Sidings and Current Deficiencies

Passing Sidings Available in 2006 for Port Bound Intermodal Trains	RR Mile Post Location	Technical Operational Observation
Rosenberg BNSF Junction	36.3	No Siding—BNSF trains must “hold” blocking the BNSF main line track
Harlem	32.4	17,880 feet
Sugarland	24.6	3,156 feet
Missouri City	18.8	7,890 feet
Stella	10.6	7890 feet
Tower 30 and Harrisburg Junction to Port of Houston	0.0	No Siding—just the junction point between lines

The study team’s technical conclusion is that the “effective” dispatching control distance for planning the movement of opposing train movements on the Glidden subdivision main track to or from the port of Houston is about 14 miles. Given the slow movement speeds and allowance for passing siding approach and depart, the current historical siding spacing reduces capacity to fewer than three trains an hour. This assumes first, a perfect operational environment and secondly that no trains ahead are delayed.

A consequence of delay is that port-bound, intermodal trains are often rerouted. The resulting reroute train delays can (and often do) exceed 12 hours or more. The cost of this delay is measurable and, as reported in 0-5068-1, train delay can exceed \$500 per hour. That amount excludes the cost incurred to shipper logistics supply chains by the delay and over time, if uncorrected, rail delay costs may result in a change of shipper routing choices. That, in turn, will mean either fewer containers using the POHA terminals or shippers turning away from inland rail intermodal movements to favor trucking.

3.4 Estimated Approximate Cost Magnitudes to Improve PTRA Efficiency and Port of Houston Access

While costs have not yet been measured in detail, the rail consultant estimated the reasonable range of low to high costs required to execute the capital plan that would make the internal port rail routes more efficient. Costs range from approximately \$38 million at the low end of project design and associated construction costs, to a high exposure of \$85 million (Table 3.5). The higher costs signify a prudent allowance at this stage of available information for the unknown costs associated with relocation of underground pipes (there are a number of chemical pipelines in PTRA ROW), environmental drainage correction, and costs for any associated grade crossing separation that might accompany passing siding construction or siding lengthening.

**Table 3.5: Estimated Cost Range for PTRA Port Related Rail Investments (\$ millions)
Pre-Feasibility Analysis Stage—2006**

Port – Rail Capital Project	Location	Low Cost	High Cost
Internal Double Track for high-stacked container trains	CTC E/W main track in Pasadena Area	\$7	\$ 16
North Channel Passing Sidings	Luria to Stolt area	\$3	\$ 5
Forward train Storage Track or Siding	West of Barbours Cut	\$3	\$6
Strang Yard to Bayport Intermodal Approach Second Track	5 to 6 CTC Miles N/S from Strang Yard Area to New Port E/W Yard Tracks	\$12	\$25
Port approach to/from the joint North Yard area and UP's Englewood Yard	4 to 6 miles of parallel CTC second track main line	\$7	\$15 to \$18
Port approach via Rosenberg Junction	2 New CTC Sidings and extension of existing sidings	\$4	\$8
Port approach via BNSF Main	1 to 2 new CTC sidings	\$2 to \$4	\$5 to \$7
Total Port PTRA Project Range		\$38	\$85

3.5 PTRA Conclusions

Three major conclusions can be drawn from the work completed in this chapter. First, the PTRA requires some modernization of track and improvement in train movement capacity if it is to continue to effectively serve growing traffic at the POHA terminals and the industrial customers served by the PTRA system. There are five projects that should accommodate most of

the traffic demand projected for the port area, both in the short term and over the coming two decades. These five internal near-to-port capacity requirements are relatively modest in their cost in terms of the very high volume of port served freight traffic.

Second, the restrictive freight train speeds over two strategic rail corridors entering the Houston PTRA service area need to be addressed. The current HNTB study of the larger Houston region rail network will obviously address these slow port approach issues. In the meantime, PTRA field investigations to correct problems serving the port's critical customer base has highlighted that a few strategic improvements could greatly increase the attractiveness of the POHA to shippers—both current and those considering relocation. The two port approach capital requirements are for short sections of double tracking or passing sidings in two approach areas to the POHA, namely:

- Between Rosenberg, TX and the PTRA main line access in the Harrisburg and Manchester area; and
- South of the junction of Long Dr/ Griggs Rd/and Mykawa Road and north of Alvin, TX along the BNSF main line that parallels Mykawa Road.

Finally, even under the most optimistic projections, railway intermodal business will not make up more than about 15 percent of the future total market share. Therefore, a massive dedicated corridor to service the port on the scale of the Alameda Corridor is not economically justified. Instead, industrial demand for rail service appears to favor a series of integrated smaller railway projects that can increase railroad operating performance at a reasonable level of investment. These investments could quickly be met by either single companies or multi-entity partnerships.

4. Planning for Container Growth on Houston Road Corridors

Discussions of long term planning for freight corridors in Houston are complicated by the fact that Houston has no zoning ordinances; therefore, assumptions about long-term land use patterns are somewhat speculative. Added to this, many of the features of current patterns of freight movements in the Houston area are what could be described as anachronistic. The first year report discussed in detail how the freight rail network that currently exists in Houston is really an archeology of past operator networks that have been patch worked into a operational system that is barely able to serve its traditional customer base, let alone handle the predicted volume of future rail business. Though not as dysfunctional as the rail network, highways are also under stress at certain points. Many of major Distribution Centers (DCs) that exist today in Houston have been in those locations for decades and are far more centrally located than could be expected if they were to be constructed today.

4.1 Container Truck Traffic

Concerns and policy actions over container traffic, both its impacts on highway infrastructure and its contribution to a various social costs (such as congestion, accidents and air quality), have been largely driven by activities at the Ports of Los Angeles and Long Beach. It is important therefore to record that there are substantial differences between the two regions. The container throughput at the Ports of Los Angeles and Long Beach is about ten times that of Houston. Moreover, the road system feeding the Southern California Terminals is more restrictive than those serving the POHA terminals (Barbours Cut and Bayport). Assuming that the POHA handles 1.5 million TEUs in 2006, it can be estimated that around 120,000 TEUs would be moved by on-dock rail, leaving 1,380,000 TEUs. If around 15 percent are 20 ft units, they would generate 207,000 trips, leaving 586,500 40 ft container trips (there will be a number of 45 ft boxes, but this is ignored). The total number of trips is therefore around 794,000 per year. If we further assume a five-day work week and a 51 week liner schedule, the daily truck trips generated by the POHA terminals on the Houston highway system are around 3100 per weekday.

A number of caveats need to be attached to this number. First, it is a simple arithmetic “back of the envelope” calculation that obviously needs refining if precise numbers are needed.

For example, the 1.6 rule employed by Martin and Associates in their calculations of predicted TEU increase the forecasted trips by about 9 percent. Moreover, the researchers are now convinced that dray activities, to be addressed in a subsequent chapter, are more diverse than a simple aggregation of inbound and out bound moves. Containers arriving or leaving POHA terminals by highway might generate a number of additional miles of travel, to pick up a chassis or to take an empty container to an export site for loading, so this figure should be regarded as an initial estimation. Nevertheless, the current volumes suggest that even if they were higher, say by 50 percent, the dray volumes would still not come close to any of the volumes seen at either Los Angeles and Long Beach terminals, or the next biggest U.S container complex at New York and New Jersey.

If the volumes are unlikely to overwhelm Houston arterials and freeways, they are still large enough to generate bottlenecks and contribute to congestion, especially close to port terminals and large DCs handling containers. The remainder of this chapter, therefore, considers first the main bottle neck—Barbours Cut Boulevard, which is the main link from SH 146 to the POHA terminals—together with the two arterial links, SH 146 and SH 225. These links distribute container trucks, full and empty, onto the Houston highway system for onward delivery or pick-up within the city, county, or state.

4.2 Barbours Cut Boulevard (BCB)

Barbours Cut Blvd is currently the only means by which heavy trucks can access the Barbours Cut Container terminal gates. Therefore, despite the fact that the road is the property of Harris County, it represents one of the most critical components of the Port's de facto infrastructure. The road is currently in a deteriorated condition due to the high volumes of heavy truck traffic it carries and the poor sub-base on which the pavement is built.

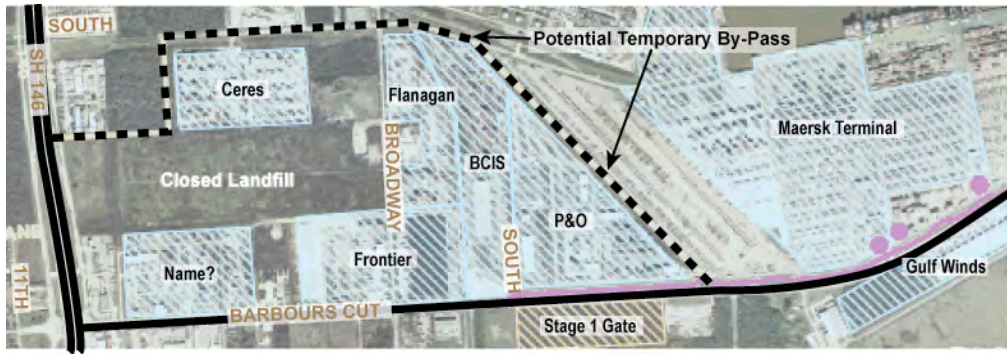
Barbours Cut Boulevard will need substantial rehabilitation if it is to continue to serve as the primary access road to the largest container port in the Gulf States. While the planning has been headed by the Harris County commissioner's court, TxDOT became a partner in the project after the road received a federal earmark in the latest transportation reauthorization. Sargon Youhannazad, who has headed the Barbours Cut rehabilitation study for the last year, stated that the engineering design component of the project was 60 percent complete as of August 2006. The basic surface of the road will be changed from jointed concrete, which has proven unsuitable

for the heavy terminal truck traffic, to continuous reinforced concrete pavement (CRCP). The new design will upgrade the road to TxDOT standards and should be far less susceptible to damage from overweight trucks. Under the current Transportation Improvement Program (TIP) \$9.8 million dollars has been allocated by Harris County to begin the reconstruction of four lanes of BCB from SH 146 to the Barbours Cut terminal although additional funding may become available. The project's environmental clearance was completed in August 2005. This contract is currently scheduled to be let in February 2007.¹² Construction should begin in August of 2007 and terminate in August 2009. Therefore, by the time construction commences in 2007, the first phase of the Bayport terminal should be fully operable.

LAN Engineering Inc. was retained by the county to develop and analyze strategies for accommodating traffic in and out of Barbours Cut during the construction window. The secondary goal of the project was to see what actions could be taken prior to the beginning of construction in order to ameliorate the situation, particularly with regard to damage that trucks are incurring. LAN has examined several short-term surface treatments for BCB that would be aimed primarily at reducing the damage to trucks and cargo. These options include substantial asphalt patching and laying down crushed limestone. At present, LAN engineers believe that the benefits from either of these temporary solutions would be minimal at best.

The near-term option that may prove more useful, in terms of reducing truck back-up and giving truckers a less hazardous route option, would be to open an unpaved two-lane road that would serve as a reliever route. This route, as depicted on LAN maps (Figure 4.1), would lead north from BCB and then west to 146. It could be expected in particular to help the bottleneck where 146 meets BCB. The current plan calls for the establishment of this reliever route, which would combine one abandoned road (that had been used by a light bulb factory in the past, and is referred to unofficially by port officials as "Light Bulb Lane"), prior to construction. The road surface would be crushed limestone for the immediate future. The port would then have the option of making this road permanent by paving it at some point in the future if the need remains.

¹² Houston Galveston Area Council, 2025 Regional Transportation Plan
http://h-gac.com/HGAC/Departments/Transportation/Regional_Transportation_Plan/default.htm



*Figure 4.1: Construction area for Barbours Cut Boulevard
Arrows show locations of new reliever routes. Source: LAN*

Construction will begin on the eastbound lanes of BCB, west of Broadway. Westbound traffic will use a temporary lane constructed between George Altwater Drive, which is the port-owned road used by hostler trucks that runs alongside the rail line, and BCB. This temporary lane will be abandoned as soon as construction is completed. It is not expected to interfere with rail operations. With these two temporary reliever routes in place by the end of next summer, major construction can commence, at the earliest, in August of 2007.

The road will be upgraded from two lanes in each direction, currently, to three lanes in each direction west of Broadway. This should speed truck flow through the Broadway bottleneck. The flow of traffic will be altered by a POHA plan to move the check-in gate for inbound trucks out of the terminal complex and across the road near the Gulf Winds container freight station. By splitting the check-in process into these two locations, the POHA hopes to prevent the significant truck back-up that occurs while trucks wait at the gate for their paperwork to be completed. Construction on this project began in summer of 2006.

The POHA will also take the lead on an additional rehabilitation project for BCB to improve signage and replace a four-way stop with a traffic signal at the intersection of Barbours Cut and Broadway. This would replace the current use of off-duty police officers to manage traffic at the stop. This project is expected to be let in October of 2008 with work commencing after the main road construction has finished. The pattern of traffic at this stoplight is highly irregular given the dominance of east-west truck traffic. Nevertheless, the use of traffic police to regulate traffic flow at this intersection is a second best solution when compared with an actuated traffic signal system. One contributing factor is that the police officers currently controlling the intersection have a limited vantage point and cannot see the full dynamics of the queue length.

Therefore, the installation of an actuated system should speed traffic through this intersection. Although BCB, after rehabilitation, will become far more tolerant to overweight trucks than under the current construction, it will still be important to prevent overweight trucks from leaving the port area and taking dangerously heavy loads onto the highway network.

At present, officers from the City of La Porte monitor truck weight and check for other violations on the trucks passing between the BCB and SH 146. In 2005, the City of La Porte received authorization to acquire weighing equipment to more regularly monitor truck traffic. In the first month of operation, La Porte officers performed 132 inspections and found 160 violations (one truck can have up to four violations).¹³ These inspections were not random. Rather, trucks were selected that appeared problematic. According to Sergeant Rod Davis of the La Porte Police force, overweight vehicles are still a serious problem that not only cause excessive road damage but also degrade the efficiency at the Port as seriously overweight trucks cannot accelerate properly and worsen traffic. As of June 2006, Sgt. Davis commits two motorcycle officers per day to help smooth the traffic flow on BCB and the entrance to 146. This is in addition to the off-duty officers hired by the TMTA and who work the main stop sign at BCB and Broadway. As of early 2006, the police were still performing spot inspections on BCB at a rate of around 100 per month (347 in the first three months of 2006). Officer Jeff Tippit, who commonly performs inspections on BCB, stated that the violators are far more likely to be imports rather than exports and are more likely to be headed to a Harris County location than to another city.¹⁴

While the port will not receive overweight containers for export, dray drivers who receive overweight imports are given the choice of accepting or refusing the container. If the driver accepts the overweight container, the liability for that container belongs fully to the driver and not to the port should the police pull the truck over for weighing. In some cases, based on the policy of the shipper, the driver may also have the ability to have the overweight container stripped or lightened at an in-terminal warehouse or at the Gulf Winds facility across BCB. In the majority of cases, drivers who receive overweight containers simply accept them as is. The choice from the driver's perspective is problematic, with the certainty of a lesser financial penalty, if he leaves empty-handed after spending significant time and fuel getting to the pick-up

¹³ Portable scales help keep La Porte streets Drivable, Carol Christian, The Houston Chronicle, November 10, 2005.

¹⁴ Interview with Sgt Rod Davis and Officer Jeff Tippit, 6-13-06

point inside the port gates, and only the possibility of a more severe penalty from the police if he accepts as shown in Table 4.1.

Table 4.1: Decision Matrix for Drivers Receiving Overweight Containers

	Police Inspect Driver	Police Do Not Inspect
Driver Accepts Overweight Container	Driver loses (big)	Driver wins
Driver Declines Overweight Container	Driver loses (small)	Driver loses (small)

The decision of the driver to accept the container can be further skewed if the driver does not incur the full cost of the penalty. Some interviewed firms reported that they would always cover their driver's tickets for overweight containers. In these cases, the driver has essentially no incentive to refuse the container. In theory, the trucking firm will pass the fine on to the shipper who may then make adjustments in its practices so that it no longer sends overweight containers. However, in reality, this connection is too indirect for the penalty to be effective.

4.3 SH 146

After leaving BCB, most trucks hauling containers follow SH 146 to SH 225 or 330. Highway 146 is one of the most critical corridor segments for accommodating container growth along the Houston ship channel, as it will serve Barbour's Cut, Bayport, and the Cedar Crossing Industrial Park. Hwy 146 may also be used by container trucks from a container port constructed at Texas City. The addition of several new sources of truck movements on highway 146 could complicate estimates of total truck volumes that will need access to the corridor in the next decade. A major investment study on SH 146, which commenced in 1999 and was completed in 2003, took into account SH 146's role as a strategic hurricane relief route as well as planned increase in truck traffic tied to the ports of Houston, Galveston, and Texas City. The "No-Build" option for the corridor was deemed unacceptable in part because it did not meet the minimum threshold for evacuation capabilities. The study did not cover the whole of SH 146, only the section linking Texas City to La Porte (see Figure 4.2). This study area would, however, include the segment of 146 that trucks leaving Bayport would use on the way to Barbour's Cut. Traffic level increases along the corridor were estimated by TxDOT as between 60 percent to 100

percent through the study horizon—from 50,000 vehicles per day on the northern section in 2000 to 74,000 vehicles in 2022.¹⁵



Figure 4.2: Study Area for SH 146

Traffic flow on SH 146 is highly seasonal with higher-than-average traffic on the most heavily trafficked section between Fairmont and Redbluff, peaking on weekends and during the summertime. The most recent TxDOT traffic count, from September 2005, demonstrates this seasonality. Annual Daily Traffic (ADT) volumes for the northbound main lanes between Redbluff and Fairmont were 15,737. Southbound was 15,272 giving a total ADT of 31,000. This is significantly *below* the annual average estimated by the Department in 2000.

Truck traffic, as a percentage of total traffic on this facility is already high. In 2005, trucks make up roughly 15 percent of total traffic on the Redbluff to Fairmont section. This

¹⁵ “State Highway 146 Major Investment Study” <http://www.dot.state.tx.us/hou/mis/sh146/index.htm>

percentage is expected to surge in the next decade. In 2015, trucks are estimated to make up 28 percent of the total (see Table 4.2). This would mean 3800 trucks on the northbound main lanes during the AM peak and 2250 trucks on the southbound main lanes during the PM peak. Therefore, a surge in truck volumes, tied to the opening of Bayport and possibly Texas City, will be occurring at the same time that construction to widen SH 146 is planned.

Table 4.2: Projected Truck traffic on SH 146 between Fairmont and Redbluff

	Truck Percentage	Northbound	Southbound	AM Peak	PM Peak
2005	15%	15,737	15,272	3800	2250
2010	28.30%				
2015	36.60%				

The planned improvements to SH 146 would provide six general-purpose freeway lanes with frontage roads for the segment of the corridor linking Red Bluff road to Fairmont Parkway. The corridor would leave space for the future construction of HOV lanes. The remaining segments would receive six arterial lanes with grade separations at major intersections. This would drop to four grade separated lanes south of Dickinson. The study estimates that these capacity expansions, estimated at \$352,000,000 should be sufficient to handle expected demand from car and truck traffic through the year 2022. Construction is expected to begin in 2010 with full build-out by 2020. Container-related congestion on SH 146 between Bayport and Cedar Crossing could possibly be alleviated by the establishment of a container-on-barge service.

4.4 SH 225

The SH 225 corridor is a critical route for trucks carrying containers to various intermodal and rail yards or attempting to access 610 or IH 10. SH 225 is also the route used by many who work in the Houston petrochemical complex. Population along the route is expected to increase by 34 percent in the next 20 years, far less than the comparative percentage for most areas of the metropolitan area. Planning decisions are thus driven primarily by the forecast for industrial development rather than residential development.

Corridor usage is highest at the interchange of 225 and 610. In 2002, this interchange was already significantly over capacity. However, corridor utilization drops quickly as the corridor

moves east. After passing Beltway 8, the volume to capacity ratio drops to .61 and remains at a low level until the corridor intersects SH 146. Therefore, once traffic has cleared the intersection of 146 and 225, container-carrying trucks have few constraints in accessing the city center until they approach 610. In the CTR poll of dray drivers at the POHA, only 3 percent cited SH 225 as the corridor where they experience the worst congestion when making deliveries.

TxDOT examined several options for improving the SH 225 corridor over the next two decades. It was clear that the first issue that needed to be addressed was the intersection of 610 and 225 where the worst bottlenecks occur. In the current arrangement, trucks exiting 225 onto southbound 610 must use a left lane exit. This system is problematic because the truck traffic, on average, moves more slowly than the auto traffic, yet it must enter the high-speed left lane in order to exit. For most of the corridor, trucks are banned from using the left lane as part of Houston's successful traffic segregation regimen.

In addition to eliminating the left-hand exit bottleneck, TxDOT planners examined other options for the corridor, including adding additional general use lanes or HOT/HOV lanes. Also considered was whether the existing facility should be converted into a toll facility for reasons of revenue generation or traffic control. TxDOT estimates showed that toll road conversion could lower the expected demand/capacity ratio on the SH 225 corridor in 2025. For example, usage was expected to drop by 15,000 vehicles per day for the Scarborough section of the corridor, thereby dropping the demand/capacity ratio from .95 down to .87. The true value of this option may be greater if variable pricing could be used to squeeze demand further in peak periods. Conversion to a toll facility, along with construction of a commuter rail, were the only options considered that would actually decrease traffic volume along the corridor. Obviously, in the case of toll conversion a percentage of this traffic would merely shift onto other corridor options. Demand along the corridor is relatively inelastic as most of the traffic along the corridor is tied to commuting and industry. Toll conversion was ultimately not selected as a viable option.

Because the eastern sections of the corridors remain significantly under capacity for the entire study period, the viability of an HOT lane in which single occupant vehicles would pay a premium to avoid traffic along the main lanes, could not be expected to garner much use. The study predicts that in the year 2025, HOV/HOT lanes along SH 225 would run at under 20 percent of its capacity east of Beltway 8. Furthermore, it is likely that the vehicles with the highest value of time would often be heavy trucks that may be barred from using such as facility.

The study also points out that right-of-way along the SH 225 corridor is constrained in the Deer Park region, which would make such a project extremely costly.

4.5 Summary

Highways serving both POHA terminals are in good shape and dray trucks working the facilities move at acceptable speeds for much of the day. Congestion is location specific and results in bottleneck problems (like at BCB) which are more likely to be resolved under current funding constraints. At this time, there does not appear to be a strong case for tolled solutions, such as a managed lane system, though this could change if the POHA container volume exceeds 5 million TEUs. More needed to be collected on dray truck vehicle miles of travel and the emerging, dynamic container distribution sector to fine-tune truck activities of use on Houston highways. This is the subject of the next chapter.

5. Impact of International Trade Distribution Facilities in Houston

5.1 Background

Supply Chain Logistics methods began to make a major impact on improving freight distribution systems with the development and implementation of Operations Research (OR) techniques by U.S. companies in the 1960s. Emphasis was first directed towards improving methods of moving products from their point of manufacture, typically domestic at that time, to the final customer, and is best represented by work on warehouse location and the routing of salespeople. Work then extended to the manufacturing side, particularly as more inputs were imported from global locations. The notion of a supply channel, the multi-modal transportation corridor moving goods to final customers, emerged during this period. This then manifested itself in “just-in-time” (JIT) systems that carefully positioned the numbers of warehouse and consolidation points and took into account the inventory value of goods moving along the supply channel.

In the last decade, increasing numbers of single DCs and the emergence of inland ports (typically built around a key modal portal and serving several DCs) have combined to change the way in which goods, retail in particular, are distributed in metropolitan areas. Inland ports at Alliance (Fort Worth), Wilmer (Dallas), and Kelly (San Antonio) are now part of the Texas freight distribution network. These inland ports complement the overland border ports of entry, where consolidation and NAFTA-related trade transfers take place, and the POHA, which is responsible for handling over 90 percent of the international containerized trade, moved through Texas deep-water terminals.

Distribution centers processing international containerized trade play a role in determining Houston’s current freight system. They are responsible for reconsolidating and repackaging maritime cargo, preparing cargo for export and redistributing imports to their intended customers. The size, location, and function of DCs exert a strong impact on the pattern of intermodal truck and rail movements seen in the Houston area. While DCs used to function primarily as warehouses that adjusted their businesses around the needs of shipping and rail lines, in recent years this has changed, particularly where they now reflect the need to handle

large volumes of global trade for large retail companies and, at times, add value to the commodities processed.

In the last ten years, as consumer demand drove up the box numbers that moved across the global trade lanes, the modal systems handling international freight have been “super-sized” to take advantage of larger economies of scale. Container ships have substantially increased in capacity, rail double-stack trains now reach over a mile in length and are constrained only by passing siding lengths, and large air freighters are being put into service on key trade routes. The average size of new DCs, in keeping with the rest of the supply chain, is also growing rapidly. Centers exceeding a million square feet (dubbed “mega-boxes”) are being established at key locations on the supply chain to service retail outlets of companies such as Wal-Mart, Target, Home Depot, and Lowes. It is therefore important that transportation planners understand how the emerging pattern of DCs in Texas may drive the origins and destinations of future container movements and what this means to highway demand forecasts. This chapter provides a framework for classifying distribution sites that primarily process containers in terms of their ownership, location, and truck generation; the latter usually expressed in terms of vehicle miles of travel (VMT).

5.2 Survey Classification Method

The researchers aimed to develop a distribution center classification system for the Houston area that would be useful to Houston planners when determining the impacts of these facilities in the metropolitan area. Several steps were needed to gather a sample of the DCs serving the POHA. The Port releases a directory of affiliated companies segregated into a variety of categories such as Warehousing and Storage, Motor Freight Lines, Drayage, Cargo Handling, Export Packers, Trucking, Transportation Services, Privately Owned Terminals, and Intermodal. Obviously, there is substantial overlap in these categories with several firms listed in different categories due to the range of services provided. Though the Port directory provided a list of contacts helpful in documenting the types of distribution facilities serving the POHA, the researchers decided to develop a specific study classification that would center on trip generation.

Table 5.1 details both the facilities designated as container trip generators for greater Houston and the transportation modes used, together with comments on each facility identifying the key cargo flow and trip generation characteristics.

Table 5.1: Containerized Cargo Distribution Facilities

Facility	Mode ¹	Comments
Consignee	DR-TL	1. Located in port metro area 2. Intercity trip to consignee
Transloading / Container Freight Stations	DR-DR DR-TL DR-R	Cargo unloaded but rarely stored, moved out on 53' trailers [DR,TL] or double-stack rail [R]
Warehouse / Distribution Center	DR-TL	Goods stored until taken to final user
Import Distribution Center	DR-TL	New concept, large scale, serves other regional distribution centers
On or rear dock rail terminals	DR-R	Double-stack service to rail terminal near consignee

¹ Notes: DR = dray, TL = 53' truck load, R = double-stack rail

One problem encountered was the tendency of freight operators to use different terms for the same activity, in the hope, presumably, of suggesting something innovative and attractive to shippers. Five categories were eventually chosen—some an amalgam of terms—and details on each are now given.

1. Consignee. Many containers are delivered directly to the consignee either in the metropolitan area or in other locations in Texas—such as the Dallas-Fort Worth area. The containers are opened on the consignee's premises, unloaded, and may either then be returned to the POHA terminal, taken to a local storage area, or moved directly to an exporter for loading. The trips are made by dray or truckload carriers although the distinction is increasingly blurred as dray companies operate newer over-the-highway tractors that can reliably deliver containers to any location in Texas.
2. Transloading or Container Freight Stations. These, together with the term “Inland Empire” as used in California, related to facilities close to the port that unload the

steel 20/40 or 45-ft container and consolidate the cargo into either a 53-ft trailer for highway delivery or 53-ft domestic container (which differs from the ISO container in material and dimensions) for onward movement (usually trans-regional) by double-stack rail service. Cargo is not stored at these facilities, which function primarily to lower landside costs by using larger capacity container/trailers for the final step in the supply chain. The use of strategically placed facilities in this category can be useful for terminals in boosting total throughput density per acre. An analysis by JWD Associates on the comparative density of Bayport compared with other major container terminals cited “numerous container freight stations (CFS) to support the marine and intermodal terminals” as a key strategy to be employed by the POHA in boosting the overall density of Bayport.¹⁶

3. Warehouse or Distribution Center. These are the traditional facilities where cargo is unloaded, stored and then consolidated for transfer to a final destination (for example, a retail store) by highway. The differentiation, if there is one, relates to size, and DCs are much larger and service a wider range of products. They also generate more truck trips and so drive up truck VMT in the areas where they are located.
4. Import Distribution Centers. These are somewhat experimental at this time and are limited to those retail companies that handle large volumes of containers that serve a national network of outlets. These centers are best described by the Wal-Mart model, which uses them to serve regional DCs with imported goods. The containers are drayed to the facility, which means they have to be located close to the port container terminal, where the goods are unloaded, stored, and then consolidated into 53 ft trailers for onward movement to regional centers.
5. On or Near Dock Rail Terminals. These are traditional intermodal transfer points where containers are loaded on double-stack rail routes for trips that generally exceed 700 miles, although efforts are being made to reduce that length and become more competitive with trucks on shorter routes. This would clearly benefit TxDOT since it would take traffic off heavily trucked corridors. The POHA has a near-dock terminal that currently moves about 8 percent of its container throughput, most from the Maersk terminal. Containers are also drayed to BNSF and UP rail terminals in the

¹⁶ “U.S. Container Terminal Throughput Density,” JWD Group, February 12, 2003.

Houston area. This traffic is likely to grow in the next decade as both Class 1 railroad companies are now actively seeking new and larger, intermodal terminals in the greater Houston area.

Truck depots and dispatch centers are omitted from this classification. They do not handle or store freight, although they are important to Houston planners because they act as truck VMT generators. Truck depots serve as staging areas for truckers, primarily those involved in metropolitan drayage, between trips. The structure and function of truck dispatching centers is discussed in greater detail in the next chapter on dray operations.

Managers of facilities that fall in the categories of Table 5.1 were contacted to assist the research team in discerning the factors that influence facility classification. The methodology for data collection therefore had to be flexible to accommodate the various levels of openness encountered when interviewing managers at different centers. Because only a small number of DCs were interviewed in the survey, the analysis is intended to be only preliminary and structured to give direction for future research. The Container Freight Stations (CFS) and Import Distribution Centers were of particular interest to researchers and their details (with the omission of one company, Tristar) are given in Table 5.2. In addition, two warehouses were also interviewed to provide an input from the more traditional supply chain element.

Table 5.2: Sampled Distribution Facilities Utilizing the Port of Houston Container Terminal

Facility Type	Facility Name	Thousand Square Feet	Truck Bays	Truck Trips
Container Freight Station (CFS)	Gulf Winds International	360	107	240
	Overland Distribution	150	18	50
	Southwest Freight	110	48	NA
	St. George Warehouse	NA	NA	NA
	World Trade Distribution	200	65	200
Import Distribution Center (IDC)	Home Depot	750	NA	NA
	UTi Logistics	4,400	320	150
Warehouse	Contramar	NA	NA	NA
	GMI Mann Warehouse	NA	NA	NA

Companies listed in the POHA directory were contacted based on the category under which the facility was listed and tools that provide maps and satellite images on the internet were then used to estimate the cargo handling capability. Interview data from facility managers was also coupled with data collected from organizations that promote commerce. Managers who agreed to participate in the study were asked questions about the physical characteristics of the building, the type and volume of cargo handled, and shipping trends. Information was collected on facility size, operational strategy and operations, location factors, truck trip generation, and shipping trends and these are now reported.

5.3 Distribution Center Surveys

5.3.1 Size and Operational Strategy

Distribution centers are built in varying sizes and operated with different policies to best suit customer needs. Size and operational strategy greatly impact freight throughput. A common classification of a distribution center is its floor area, with suggested categories starting at 100,000 square feet and below (small-box), 100,000 to 400,000 (mid-box) and anything larger than 400,000 square feet as a big-box.¹⁷ Borrowing a morphological signifier from the containership industry, it also may make sense to further designate DC's with over 1 million square feet as mega-box. Discussion with Wal-Mart staff suggested that the "building block" of their mega-box facility is around 2 million square feet and the Houston Bayport facility has two such blocks, identical in size, facing each other and served by a common entrance and exit. Generally, small-box facilities will only distribute to local markets, while the mid-box and large box facilities are used to deliver goods to a number of area outlets, often retail in nature. A mega-box facility, such as Wal-Mart's Baytown DC, does not make deliveries directly to Wal-Mart stores, but is responsible for feeding regional DCs in Texas and five other states. When deliveries are intended for another state, consolidation is often utilized to reduce transportation costs. Nationwide, the most popular size category for current new DC sites is between 200,000 and 500,000 square feet although this may change in future.¹⁸

¹⁷ Atkinson, William. "Supply and Distribution: Location Logistics." *Plant Sites & Parks*. January 2003. <http://www.bizsites.com/2003/jan/article.asp?id=221>. Accessed March 23, 2004.

¹⁸ 'White-hot market'; Growth of big-box chains and containerized imports create a boom in distribution centers near seaports, Bill Mongelluzzo, *Journal of Commerce*, March 27, 2006

5.3.2 Operations

Distribution centers can be operated either by a shipper or by a third party logistics provider. Home Depot and Wal-Mart, owners of two of the largest DCs in the Houston Area, employ different strategies: Home Depot runs its own operations while Wal-Mart does not manage activities at the Baytown facility, even though it does control operations at regional distribution sites. Third party logistics providers, of the type employed by Wal-Mart at Baytown, also own and operate DCs that handle import containers from Barbours Cut Terminal, but these facilities are public terminals that serve multiple customers. For example, Gulf Winds International, Inc. is a third party logistics provider that owns and operates a distribution center not committed to one customer. It has a public terminal that is located off BCB, and is undergoing an expansion to 250,000 sq feet. The second Gulf Winds station is located adjacent to BNSF's Pearland intermodal rail yard.

Container freight stations, which specialize in cargo consolidation, tend to be operated by third party logistics providers. The private DCs that are not operated by shippers handle both imports and exports while the DCs owned by major shippers included in the survey (Home Depot and Wal-Mart) handled only imports. Outbound shipments from private and shipper owned DCs include intermodal shipments to be delivered by rail or truckload shipments

5.3.3 Distribution Center Location Factors

Several factors play into the location decisions chosen by those operating a distribution center. All DCs that do business with the POHA seek convenient access to road corridors leading to the port. Some may also need convenient road access to a key supplier. Access to major rail yards is also an important consideration for some centers. Given the size of these centers, they can be quite sensitive to small changes in rental or building cost per square foot. This is especially true for warehouses engaged in medium- to long-term storage. With faster turn times and more intensive truck trip generations, DC's that are closer to the container freight model may be able to tolerate higher rents per square foot if these locations provide ready access to major highway and rail interchanges. Space for new DC's is presently in short supply in the Houston area with vacancy rates currently running at only 7 percent.¹⁹

¹⁹ 'White-hot market'; Growth of big-box chains and containerized imports create a boom in distribution centers near seaports, March 27, 2006, *Journal of Commerce*, Bill Mongelluzzo

The location of distribution facilities in the POHA is factored on the age of the center and the operating strategy. Several DCs active in Houston centers have been in operation for over 20 years and are typically located in East Houston, near the 610 loop. World Trade Distribution, a CFS, for example, has owned its 200,000 sq ft facility just to the east of downtown I-10 for ten years and has existed in its current location for over 20 years. The company's internal fleet of 30 tractors generates three million VMT in the Houston area per year, while the company's 20 leased owner-operators generate another one million miles. This does not include intercity deliveries that originate from World Trade but are outsourced to another trucker. The company president stated that it would be difficult to envision a new CFS of similar size opening up and turning a profit in a similar location, given the increase in land values since the date the facility was first purchased. World Trade delivers exclusively to the Houston metro area (network of 250 customers) with its privately owned fleet, and the central location is critical to World Trade's business model.

Another CFS with a similar business model to World Trade is Southwest Freight Inc. This facility, which has been in business since 1967, began as a warehouse and later moved to the Container Freight station model. It has 100,000 square feet and 48 docking bays. Like *World Trade*, Southwest uses a leased, owner-operator dray fleet of 40 vehicles for delivery from the port and other suppliers to the station and a company owned fleet for deliveries from the station to the customer. This facility generated approximately 80 pick-ups per day and receives approximately 40 drop-offs, of which approximately 30 are from the port. In total, the facility generates five million VMT per year. This figure is higher than some other facilities because Southwest also performs intercity deliveries with its internal fleet, half of which are equipped with sleeper cabins.

Private DCs that have been constructed over the past few years (Wal-Mart Import Distribution Center and Gulf Winds International, Inc) are largely reflective of recent patterns of traffic and land use in the Houston area with locations further from the city center but still with convenient access to major road corridors.²⁰

The most common response from managers of DCs serving the POHA when asked about factors that contribute to site selection was location. On a macro scale, the POHA region has been selected by an increasing number of shippers as a preferred area in which to locate an

²⁰ Leach, Peter T. "Land, Labor, Location." *The Journal of Commerce*. vol. 6, July 18, 2005. pp. 11-12

import distribution center because of its efficient transportation corridors, comparatively low cost of land, availability of labor and demographic growth forecasts. The fastest growth area in the Houston region at present is the 15,000-acre Cedar Crossing Business Park located near Baytown, Texas. It is here that Home Depot opened a mega-box import distribution center in 2001. The Wal-Mart distribution center, a four-million-foot JIT DC operated by UTi Logistics, was opened in 2004. More major shippers are expected to open DCs at Cedar Crossing in the next few years. Most of the shippers expected to use Cedar Crossing will depend on Bayport for a substantial part of their container moves. This expectation has clear implications for truck demand of the highway corridors serving the Bayport terminal, although there is the potential for a future container on barge service if Osprey, which is rumored to be interested in building a Bayport berth, or another company, provides an all-water link.

5.3.4 Truck Trip Generation from Distribution Centers

The second factor to assist in classifying these facilities is size in square footage or the number of truck bays or docks. Managers were queried about their square footage and the number of loading bays to determine possible correlations between these two variables and truck trip generation. The distribution facilities receiving import containers from BCT ranged in size from 150,000 to over four million square feet with 18 to 320 truck berths.

As mentioned previously, a container freight station can turn a high number of trucks with significantly less space. Although containers are consolidated at the facility, truck bays and storage for inventory is limited. Import Distribution Centers may need a higher number of truck berths to allow trailers to sit at the dock until the load being prepared for shipment to a regional distribution center is complete. The short turnaround time for freight at Container Freight Stations is one of their defining characteristics and has an impact on the number of truck trips generated.

5.3.5 Shipping Trends at Distribution Centers

The next component of the interviews focused on commodities being shipped and their characteristics. The DCs serving one customer will move cargo handled through the single, specific supply chain developed by that company. For example, UTi Logistics has a relatively simple current business model to operate Wal-Mart's import distribution center—it ships consolidated cargo from Asian containers to regional DCs. In contrast, a CFS or public

distribution center will handle a variety of freight from multiple customers. In the Houston area, many of these shipments originate in South America or Europe. Some CFS centers in the POHA receive freight from the Far East, but most of those shipments will arrive to the facilities by rail from Los Angeles. Only the major shippers like Wal-Mart are receiving freight directly from China by all-water service to Barbours Cut Terminal. The arrival of imports at a distribution facility normally occurs during the hours of 8:00 AM and 5:00 PM, which is strongly impacted by the hours of operation at Barbours Cut Terminal. Outbound shipments at a distribution center can occur at any time as long as the facility is open. CFS centers normally share similar hours to both the POHA terminals and their key customers.

The inquiry of facility managers supported the notion that most imported container cargo is staying in Texas. The responses indicated that 70 percent to 80 percent of all imported freight stays in Texas and is shipped by motor carriers. They report that only small percentages of the consolidated freight are transported by rail (3 percent to 5 percent) although the sample is small and this figure needs further corroboration. A change in the conventional logistics pattern, however, may be emerging. A much smaller amount—30 percent—of the freight handled by the new large UTi Logistics managed Wal-Mart distribution center at Baytown is bound for Texas. If more sites with a regional scope similar to this facility begin to locate at Cedars Crossing, more shipments could be handled through intermodal rail if service is available.

5.4 Conclusions

Distribution centers serve a unique role consolidating the freight arriving in imported containers and so facilitating the movement of containerized traffic in the POHA. Extra-urban sites, such as Cedar Crossing at Bayport, show the fastest rate of growth but may have a lower than expected impact on the pattern of Houston VMT since their outbound deliveries are destined outside the county, and in many cases, the state. Most of these new centers are expected to serve one customer. The emerging role of Container Freight Stations will also contribute to moving containers for customers other than the major shippers. Cargo throughput at these facilities varies with management policy. The site's classification as a warehouse, Import Distribution Center, or CFS seems to have an impact on truck trip generation rates (trucks per 1,000 square feet). Distribution center locations near the POHA are the result of a favorable regional climate, the overall efficiency of the port, increasing local demand, taking advantage of

transloading from marine steel boxes into larger (cheaper ton-mile) aluminum trailers and the viability of inter-regional distribution.

Planners can gain greater insight into possible future trends in this dynamic industry by classifying DC's according to their size, function, and market. Given the rate of change and current lack of limitations on land use in the Houston area, new DC's and their associated impacts on VMT can arise quite quickly. It is important to understand, however, that this pattern is not random. Rather, it is a response to market conditions that dictate the size and type of facilities that can survive in given locations.

Finally, the key impact on the Houston highway system remains unknown at this time. The system of collecting, moving, transloading (where appropriate) and delivery produces a variety of vehicle miles of travel (VMT) on the greater Houston highway network. If more were known about this impact, then the viability of potential highway corridors to the container terminals, whether built with traditional funding or toll lanes, could be made easier and accurate. Accordingly, the researchers decided to address that part of the trucking sector—the dray industry—in greater detail and this is the subject of the next chapter.

6. Houston Dray Truck Companies and Drivers

From the public's perspective, a primary manifestation of container growth at the Port is simply more trucks on the roadways. Planners would greatly benefit from a better understanding of the characteristics of these trucks and their drivers to properly assess what impact this growth will have on the metropolitan region with regard to congestion, safety, and air quality issues. A current profile of the POHA dray industry could also assist the Port and private operators in making better investment decisions.

While a major container terminal may operate with only a handful of crane operators, the same facility will require the labor of hundreds of dray drivers to run smoothly. Therefore, improving dray operations can substantially improve the overall efficiency of a container port. It is often reported that container growth along the Houston ship channel will put thousands of additional trucks on the road each year, but to appropriately accommodate this growth, TxDOT must know more about where these trucks are going, how many miles they are driven, as well as their age and emissions profile. Given the importance of container movements to Texas economy, TxDOT should also be interested to learn what improvements might improve the overall efficiency of the drayage system within the Houston area, especially if these improvements will also assist in other goals such as air quality, noise reduction, safety, or greater economic opportunity.

Because port dray trucks operate primarily in urban environments, they have a proportionally greater impact on urban congestion and air quality when compared with long-haul trucks. As a case in point, the goal of learning more about the composition of the drayage fleet in Los Angeles factored heavily into the recently released San Pedro Bay Ports Clean Air Action Plan.²¹ In Houston, many of the major rail yards and DCs that dray drivers access are located near the center of the city, which means that dray trucks have extensive interaction with passenger traffic at certain times of the day at specific locations. Furthermore, from a logistics perspective, the drayage component of the total intermodal cost can be quite significant. Research by Morlock and others in the 1990s clearly demonstrated how high drayage costs have

²¹ The Port of Long Beach. San Pedro Bay Ports Clean Air Action Plan Technical Report: Performance Standards for On-Road Heavy-Duty Vehicles. June 2006.
www.polb.com/civica/filebank/blobdload.asp?BlobID=2967. Accessed July 28, 2006.

limited the penetration of short-haul rail intermodal.²² This was confirmed by a further study by Resor and Blaze examining short haul rail competitiveness and the constraints imposed by terminal and drayage costs.²³ Congested conditions at port gates and other bottlenecks in the routes taken by dray drivers can drive up costs and squeeze profitability. Drayage costs may also be driven up by endogenous industry characteristics, such as suboptimal dispatching and inefficient allocation of capital.

At present, a disproportionate share of the literature on port container drayage comes from the Los Angeles and Long Beach (LA/LB) areas. One recent analysis on drayage at the Port of LA/LB by Monaco and Grobar collected data from 175 drivers as they waited to enter the port gates. This survey, which included 36 questions on topics ranging from rates of pay, demographic characteristics, and safety practices, found that most drivers are able to earn acceptable annual salaries, but do so by working exceptionally long hours under difficult conditions.²⁴ On average, dray drivers at these Ports reported that they spent 48 percent of their total trip time waiting to get in and out of the port terminals. However, researchers must be cautious in applying the characteristics of LA/LB to the rest of the nation. In other words, not every trend encountered by LA/LB will be reflected in other large container ports around the country. It was therefore agreed that a preliminary investigation of the Houston dray industry should be undertaken as part of study 0-5068 to identify the specific characteristics of that trucking sector and to better understand their operations, needs, and concerns as they address the growth of container demand at POHA terminals.

6.1 Dray Industry Survey

Barbours Cut staff first provided researchers with a list of transportation firms that are registered to do business at the port. As of January 2006, there were 583 truck companies registered as drayage operators by the POHA. Several of these firms were contacted by the researchers for phone and personal interviews.

²² Morlock, Edward K., and Lazar N. Spasovic. *Approaches For Improving Drayage In Rail-Truck Intermodal Service*. August 18, 1994.

transportation.njit.edu/nctip/final_report/approaches_for_improving_drayage.pdf. Accessed July 28, 2006.

²³ Resor, Randy, and Blaze, James. *Short-Haul Intermodal: Can it compete with Trucks?* Transportation Research Record, Issue Number: 1873, p.45-52. 2004

²⁴ Monaco, Kristen, and Lisa Grobar. *A Study of Drayage at the Ports of Los Angeles and Long Beach*. AR 04-01. December 15, 2004.
www.metrotrans.org/research/final/AR%2004-01_final_draft.pdf. Accessed July 28, 2006.

Interviews with local drayage firm managers suggested that the port drayage industry in the Houston area in 2006 could generally be described as healthy. First, business is good with strong demand from the growing number of containers moving across the Metroplex area, some unconnected with POHA operations. There is also currently a strong demand for drivers with several companies indicating they have been able to raise driver rates in the last three years after long periods of stagnation. One informant stated that many of his newer drivers had previously worked at the Ports of Los Angeles and Long Beach but had moved to Houston to avoid the gate congestion that was inhibiting their profitability. He had even taken to advertising in Los Angeles newspapers to recruit more LA drivers.²⁵

Most firms have also enacted fuel surcharges in the last two years. The net impact of higher fuel costs on driver profitability is varied with some drayage managers reporting that truckers are actually able to earn higher profits due to surcharges and others reporting that the surcharges only partially compensate the drivers for higher costs. Fuel surcharges are added to the base rate of compensation. For example, in summer of 2006 most firms had fuel surcharges of approximately 25 percent. Therefore, the base dray rate is multiplied by 1.25.

Dray drivers who work for firms typically own their own truck but depend on the firm to organize deliveries and dispatch. While the ultimate responsibility for the truck lies with the owner-operator, firms have a strong incentive to discourage their drivers from using trucks that are too old to be reliable or safe for reasons of reputation, service reliability, and potential liability. Some firms also reported that they place a maximum age limit on trucks that their owner-operators can drive. Firms that were interviewed generally reported that wait times at the port gates have actually decreased in recent years thanks to improved customer service, despite the fact that TEU volumes have soared during this period. It was impossible to verify these reports scientifically due to an absence of historical data. Several managers reported that bottlenecks at the port gates in which drivers need an hour or more to enter the facility do still occur on occasion.

Despite the prevalence of firms that aggregate drivers under definite companies, the port drayage industry is still far more decentralized than most other types of transportation workers. According to the Teamsters, 80 percent of all port drivers nationwide are non-unionized owner-

²⁵ Interview with Rick Maddox, President of Canal Cartage

operators.²⁶ In this environment, there is no substitute for speaking to drivers directly. POHA staff suggested that the best time to survey drivers would be after they had pulled past the gate while they are waiting for their paperwork to be completed, a process that takes about ten minutes on average.

As a trial run, the researchers conducted an initial round of surveys on June 5, 2006, at one of the largest drayage firms in Houston with the permission of the firm management. This initial round of surveys generated 15 valid responses and also allowed the researchers to interview the drivers to make sure they interpreted the questions correctly for both the English and Spanish versions. Following success of the initial round of surveys, the researchers proceeded to interview drivers at the port on the following day, June 6. Between the hours of 9-12 Noon and 2-4 PM, 88 drivers were surveyed at Gates C1-C5 of the Barbours Cut terminal.

6.1.1 Survey Results

The POHA driver survey consisted of twenty questions covering a range of topics including driver demographics, driver working conditions, truck and route characteristics, and port operations. The survey was provided in both English and Spanish in a self-administered format with surveyors available to answer questions that drivers may have about a particular question. The survey produced 103 valid results and had a response rate of 87 percent. In total, 39 of the 103 respondents chose to complete the survey in Spanish (37 percent).

6.1.2 Driver Demographics

The first section of the survey asked drivers questions (listed in Table 6.1) about their age, education, and years of experience. Most (48 percent) of drivers were found to be between 35 and 44 years old, with 23 percent in the 25 to 34-year-old age group and 26 percent in the 45 to 54 group. The age profile of the drivers is consistent with the results found at the Ports of LA/LB and supports the hypothesis that middle-aged drivers will be comparatively more attracted to intracity delivery jobs because they can spend more nights at home with families. Monaco and Grobar found that the mean age of dray drivers operating at the Ports of LA/LB was 40.4 with 10 percent of drivers 30 or younger and another 10 percent 52 or older.²⁷ With regard

²⁶ Gillis, Chris. Teamsters Mack Attack: Port Division Continues Drive to Organize Container Drayage Operations. *American Shipper*, Vol. 45, 2003, pp. 88-90.

²⁷ Monaco, Kristen, and Lisa Grobar. *A Study of Drayage at the Ports of Los Angeles and Long Beach*. AR 04-01. December 15, 2004.

to educational attainment, the POHA survey found that a relatively small percentage (16 percent) of drivers did not have high school equivalency, while one-third (34 percent) reported having some college training. This is again consistent with the Monaco and Grobar findings at the Ports of LA/LB, where 17 percent of respondents did not have a high school degree and a combined 29 percent had either a vocational or technical degree, associates, or some college experience.

Dray drivers at the POHA have worked in the trucking industry for an average of 12 years. On the whole, drivers tend to be highly experienced with the vast majority of drivers having more than six years of experience (80 percent). This suggests that in Houston, the port dray profession cannot easily be described as a transitory profession for drivers who are simply trying to enter a more lucrative level of the trucking industry—a feature that others have argued.

Table 6.1: Survey Questions and Results: Driver Demographics

<i>Question, (Number of responses)</i>	<i>Category</i>	<i>Result</i>
What is your age? (102)	24 and under	2
	25-34	23
	35-44	48
	45-54	26
	55 and over	3
What is the highest educational level that you have completed? (102)	Less than HS	16
	HS degree or GED	51
	Some College	30
	College Degree	5
How many years have you worked as a truck driver? (103)	Mean	12
	Median	10

6.1.3 Driver Working Conditions

The next set of questions in the survey asked drivers about the number of hours worked per day and week, health insurance coverage, truck ownership, and membership in a trucking company (see Table 6.2). Hours of service are a critical element in trucking operations and are enforced through the Texas Department of Public Safety (DPS). They can impact the productivity of the dray operations and set the boundaries for safe operations on the public highways. A driver collecting a container from Barbours Cut and taking it to a distribution center

or warehouse in Houston or other destinations in the state, operates under interstate regulations because the commodity has crossed state or international boundaries. Interstate trucking laws currently permit a driver to work 11 hours after a 10-hour break and no more than 70 hours in an 8-day period. A driver may work more than 12 hours per day but is not allowed to drive for the entire 12 hours. A driver can drive 11 hours and then spend 3 hours doing non-driving activity, totaling a 14-hour day, but must rest 10 hours before driving again. Waiting for a container at the POHA terminal does count against the 11 driving hours.²⁸

The survey found that, on average, drivers work 10-hour days and 50-55 hour weeks. POHA container terminal gates operate a five-day week, with some limited weekend working related to one shipper. In these circumstances, trucks are unlikely to exceed the total weekly hours rule, though they may at times work hours in the 11 to 14 period. For example, 17 percent of drivers stated that they worked exactly 12 hours per day and 5 percent reported working over 12 hours per day.

Table 6.2: Survey Questions and Results: Driver Working Conditions

<i>Question, (Number of responses)</i>	<i>Category</i>	<i>Result</i>
How many hours do you work per day? (95)	Mean	10.2
	Median	10
How many hours do you work per week? (76)	Mean	54.5
	Median	54.5
Do you own your own truck? (102)	Yes	78
	No	24
Do you belong to a trucking company? (98)	Yes	88
	No	10
Do you have health insurance? (102)	Yes	34
	No	68

Despite the fact that most drivers were middle-aged men working in a relatively high-risk profession, only a third (33 percent) had health insurance. The majority (76 percent) owned their own truck. Nevertheless, the vast majority of the drivers (90 percent) reported that they belonged

²⁸ Further information concerning these rules can be found at www.txdps.state.tx.us/lw/Publications/mcs9/cover.pdf

to a trucking firm. This is an interesting finding given that port dray drivers are typically assumed to be “independent” owner-operators. While it is technically possible for a driver to be a one-man shop, most drivers apparently find it more beneficial to belong to a firm. A firm can serve a number of important functions that can benefit both the drivers and the port. For example, a firm can help its drivers engage in at least a modest amount of collective bargaining while a fully independent driver is forced to be a pure price-taker. Furthermore, firms can use their influence to press the port or the surrounding urban area to take steps to improve efficiency. As an example, at the POHA a group of dray firms pooled their resources to hire off-duty police officers to speed operations at a four way stop near the port that had become a bottleneck. After the port saw the positive impact of this change, it agreed to finance a portion of the cost. As mentioned previously, firms can also help planners by discouraging the use of older or less safe trucks.

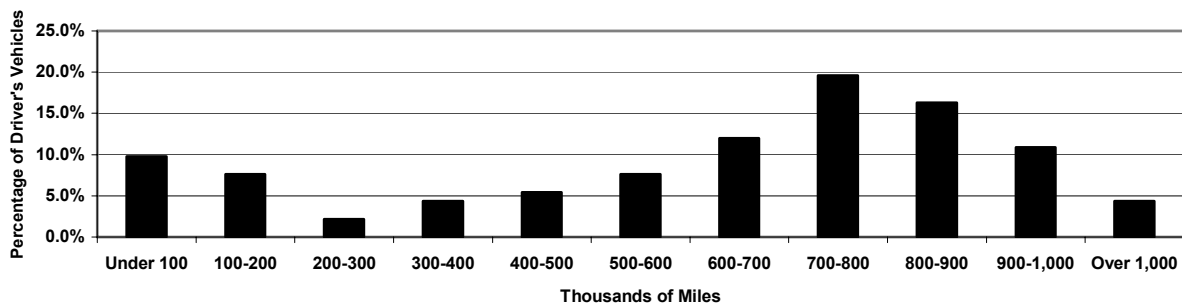
6.1.4 Truck Characteristics

Given that most drivers purchase their own vehicle, the research team was interested in learning more about the profile of vehicles dray drivers selected. Thus, the survey asked questions (shown in Table 6.3) about the make, age, and mileage of the trucks that are being used to conduct dray operations at the port. Generally speaking, the vehicles used for container drayage at the POHA are not substantially different in make from the long-haul fleet comprised of Class 8 trucks. Freightliner held a substantial percentage of the total market, followed by Kenworth, International, Volvo, and Peterbilt. Due to the fact most dray drivers buy used vehicles, the vehicles they use are often tailored more to suit over-the-highway hauls rather than intracity deliveries. For example, the majority of drivers were observed to have trucks with sleeper cabins, which in this context would not only create dead weight but would lengthen the tractor wheelbase, potentially reducing overall permitted vehicle length. Officials at the Port of Los Angeles and Long Beach have also reported the prevalence of sleeper cabins amongst the drayage fleet (21).

Table 6.3: Survey Questions and Results: Truck Characteristics

<i>Question, (Number of responses)</i>	<i>Category</i>	<i>Result</i>
What is the make of your truck? (97)	Freightliner	52
	International	13
	KW	15
	Other	13
What is the year of your truck? (101)	Mean	1997
How many miles are currently on your vehicle? (93)	Mean	637,115
	Median	724,456
Roughly, how many miles did you drive your truck last year? (69)	Mean	123,000
	Median	60,000

The trucks in the sample were relatively old, but not as old on average, as those reported by the LA/LB fleet. A modern diesel engine has a useful life of over one million miles if properly maintained. As illustrated in Figure 6.1, the bulk of the vehicles had significantly fewer miles. The average truck was nine years old (see Figure 6.2) with 637,000 miles. In comparison, a 2004 analysis by Starcrest Consulting Group found that the average truck serving the Ports of Los Angeles and Long Beach was 12.9 years old.²⁹ Houston respondents who were identified as primarily intracity drivers reported that they drove their truck, on average, 61,000 miles last year. The total sample average was 123,000 miles per year; however, this figure also includes drivers who were primarily long haul truckers. The median of 60,000 miles per year matched the estimates provided by Houston dray industry managers.

*Figure 6.1: Vehicle mileage in the Houston sample*

²⁹ Starcrest Consulting Group LLC. *Port-Wide Baseline Air Emissions Inventory*. June 2004. www.portoflosangeles.org/DOC/REPORT_Final_BAEI_ExecSum.pdf. Accessed July 28, 2006.

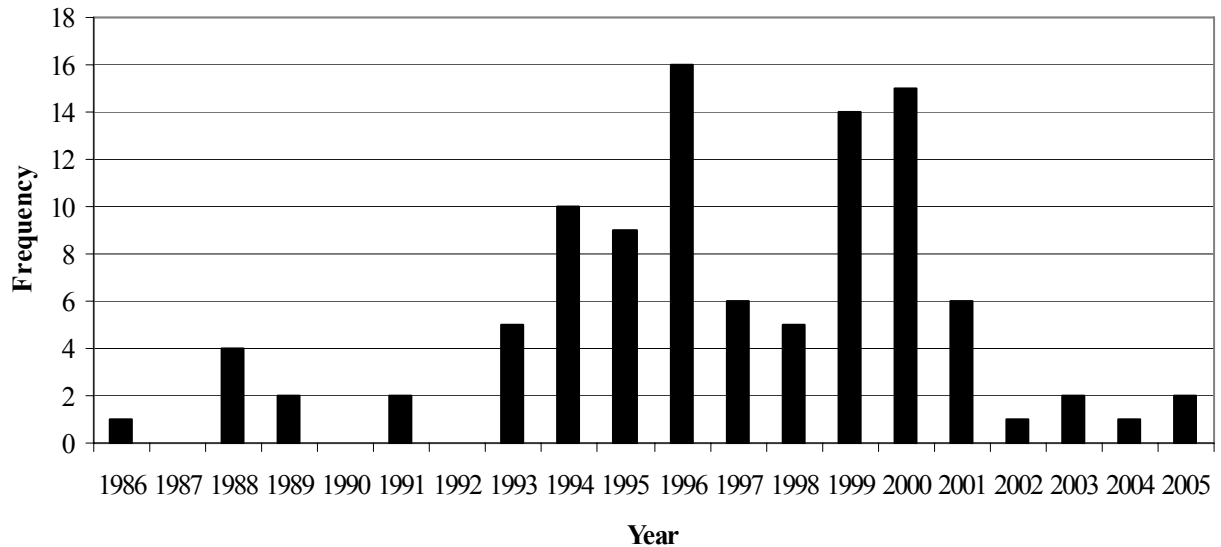


Figure 6.2: Truck model year in the Houston sample

6.1.5 Route Characteristics

Increasing congestion levels threaten to undermine the productivity of dray haulers. While long-haul truckers can often plan their trips to avoid the worst urban congestion, dray haulers must make deliveries during standard business hours since their schedules are tied to the port operating hours. With this concern in mind, the survey asked drivers about the average length of their hauls, the number of trips to the port they were able to make in a typical day, and the frequency with which trucks carrying inbound containers left without return cargo (see Table 6.4). Since drivers are paid per delivery, the number of port trips per day is highly salient in determining profitability. The survey also asked where drivers run into the worst traffic along their routes, and most frequent cause of their delay. According to the port drivers, the median dray distance, defined as one haul from either a pickup point to the port or from the port to a delivery point, was 60 miles. The mean of 199 miles is again skewed by data from intercity drivers. If the subset of drivers who reported an average dray distance of 100 miles or less are analyzed separately, the average dray haul was 47.5 miles and the average number of trips to the port per day was 3.2. Some drivers are employed directly by DCs or by firms that exclusively serve one distribution center. These drivers will drive an identical route every day. Other drivers will service a series of locations. These drivers will have more dynamic trip chains. In the Houston metro area, drivers reported that they run into the worst traffic along BCB leading to the port complex, followed by I-10 and Loop 610 North. According to the port drivers, the top three

causes of traffic delay, from first to third, were construction zones, an inadequate number of lanes, and accidents/stalled vehicles. The drivers were queried as to their use of toll lanes because Houston has several toll facilities that provide close substitutes for free alternative routes and would likely be used more frequently if congestion on their routes became more burdensome. It would appear that drivers do make some use of Houston toll roads, which is of interest since the generally held view is that truckers, particularly dray truckers, will not use any toll facility.

Table 6.4: Survey Questions and Results: Route Characteristics

<i>Question, (Number of Responses)</i>	<i>Category</i>	<i>Result</i>
What is the average length of each drayage haul (from either a pickup point to the port or from the port to a delivery point)? (96)	Mean	199
	Median	60
		47.5
How many trips do you make to Barbours Cut Terminal (gates C1-C5) in a typical day? (103)	Mean	2.6
<i>Subset of drivers with average dray distance of under 100 miles</i>		3.2
On this trip, will you leave the terminal empty or loaded? (81)	Empty	42
	Loaded	39
Where do you run into the worst traffic along your route? (82)	Multiple responses	
What is the primary cause of your traffic delay?	Freeway interchange	12
	Access ramp	3
	Inadequate # of lanes	25
	Incidents	22
	Construction zone	35
How often do you use a toll facility for your dray hauls? (97)	Other	14
	Daily	8
	Once a week	9
	2-3 times a week	10
	Rarely or never	70

6.1.6 Port Operations

Finally, the research team wanted to gather drivers' opinions as to what actions the port could take to improve the efficiency of the drayage system. Port drivers were asked to identify the length of the wait times entering the Barbour's Cut terminal gates operated by the POHA. Additionally, port drivers selected their satisfaction level with port efficiency from a list of options and then identified what could be done to improve port efficiency. Table 6.5 lists the results.

Drivers entering the C1-C5 gates reported that they experienced wait times of 70 minutes on average. On their most recent trip to the port, (Tuesday, June 5, the day the surveys were conducted) drivers reported waiting an average of 27 minutes. Self-reported wait times such as these do not carry the same level of accuracy as would a direct observational study conducted over a period of randomly selected sampling periods. What can be concluded from the data is that the selected sample period represented a below average wait time. This is likely due to the fact that there was no ship in dock on the day of the survey. Given the fact that export containers are required to be dropped off in advance of a ship's departure, this factor may not have had a significant effect on the sample. Still, POHA officials remarked that the survey day had been a relatively slow day at the port. Drivers identified the top three actions that could be taken to improve port efficiency as increasing the number of booths at terminal entrances, offering extended port operating hours, and improving terminal yard operations.

Table 6.5: Survey Questions and Results: Port Operations

<i>Question, (Number of Responses)</i>	<i>Category</i>	<i>Result</i>
How long is your average wait time entering Barbours Cut Terminal (gates C1-C5) in minutes? (88)	Mean	70
How long was your wait time entering Barbours Cut Terminal (gates C1-C5) in minutes on this trip? (88)	Mean	27
How pleased are you with the efficiency of Barbours Cut Terminal (gates C1-C5)? (94)	Very Satisfied	5
	Satisfied	17
	Neutral	29
	Unsatisfied	43
What would be the most effective action to improve efficiency of Barbours Cut Terminal (gates C1-C5)?	Offer extended port operating hours	30
	Provide scheduled container pick-up times	10
	Increase the number of booths at terminal entrances	38
	Improve terminal yard operations	29
	Streamline driver and ship carrier operations	9
	Other	1

6.2 Strategies to Improve Dray Efficiency

The most salient factor in whether or not a dray driver can turn a profit is the number of trips that can be made to the port in a day. Lowering the time drivers spend in any queue—terminal, highway or customer—would increase this average. A reduction in queuing would also carry substantial air quality benefits as well as decreasing fuel costs. As mentioned previously, dray firms in the Houston area have engineered innovative solutions with their own money to speed traffic around the port terminals such as hiring off-duty police officers. The port has also recently extended gate hours to smooth the peak traffic. It should be noted that the port itself does not have full control over the peak situation as drivers are constrained not only by port hours but also by the hours of operation at their metropolitan destinations. One area of air quality concern amongst policymakers in the Houston area has been the comparatively advanced age of

the drayage fleet. While the use of second-hand semi-trailers is in many ways an economically efficient allocation of private capital, the financial factors that make the allocation of capital within the industry logical at the micro (i.e., company or firm) level are not always appropriate when considering societal costs, such as safety, congestion, and pollution.

Modernizing the composition of the drayage fleet is another way to positively impact long-term profitability while lowering the societal impact of dray operations. The average truck in our sample, a 1996 Class 8 tractor semi-trailer, was estimated to produce an average of 17.2 grams of NOx per mile while a 2007 model-year truck is expected to produce only 3 grams per mile.³⁰ Therefore, with an average usage of 60,000 miles per year, each 1996 truck that is replaced by an equivalent 2007 model would lower Houston NOx emissions by .95 tons per year. For the past several years, substantial federal Congestion Mitigation and Air Quality (CMAQ) funding has been made available to the City of Houston to subsidize the scrapping and replacement of older engines. However, according to officials at the Houston-Galveston Area Council, few dray drivers have applied despite the fact that port drayage trucks generally fit the profile of vehicles that would be eligible for substantial grants. Another source of grants is the Texas Emissions Reduction plan, which uses a similar scoring method to allocate funding to improvements in on- or off-road equipment, based on the capability of NOx reductions. Air quality grants are only one possible method by which the dray fleet in Houston could be improved. The dray industry would also be a natural venue for the introduction of diesel-electric or diesel-hydraulic hybrid technologies into the US trucking fleet, given the large percentage of a dray's engine cycle spent in idle or creep idle mode, thereby producing additional gains in fuel-efficiency and emissions.

The results suggest that despite the rapid increase in TEU volumes at the POHA in recent years, the drayage industry has managed to maintain relative stability. Several possible reasons for this performance exist. For example, the drayage industry is not as subject to some of the constraints that impede market responsiveness of other transportation industries such as high upfront capital costs or unionization. The researchers did not directly query drivers on their profitability, nevertheless the information collected from Houston dray managers suggested that there has been a relatively low rate of market exit since compensation rates have increased in

³⁰ Houston-Galveston Area Council. The Clean Cities / Clean Vehicles Program. www.houston-cleancities.org. Accessed July 28, 2006.

recent years. Port drayage is a difficult and physically demanding profession. Still, the researchers found that most firms were able to attract sufficient numbers of qualified drivers despite a nationwide trucker shortage that has affected all areas of the trucking industry.

7. Current and Future Container Volumes at Other Texas Ports and the Roles of the Panama and Suez Canals

In 2007, the POHA terminals will continue to dominate container business at Texas Gulf ports. Currently, the only other location that registers as a regular Texas container handling port is Port Freeport, although the container handling operation there is different because it uses geared ships with shipboard cranes. The same is true of ports such as Galveston and the Port of Beaumont, which in 2005 processed almost 5000 TEUs, almost all of which was military shipments to Iraq.³¹ The opening of the new Bayport Terminal in December of 2006 will allow POHA business to continue to grow, as reflected in Chapter 2. It is therefore likely that the POHA Texas market share will be substantially unchallenged until 2010 at the earliest, even if other competing terminals were to open.

7.1 Other Texas Ports

7.1.1 Corpus Christi

At the time of the 0-5068-2 report submission, the Port of Corpus Christi was still negotiating with Dragados S.P.L. regarding their La Quinta project. If work on the facility was to begin in 2007, it is unlikely to be open for business much before 2009. A study undertaken for the Port of Corpus Christi's La Quinta Container terminal estimated a market *potential* for 426,000 inbound and outbound TEUs by 2009, which would represent around 15 percent of the POHA forecast developed earlier in this report.

The capacity of the Corpus Christi's phase one terminal is 300,000 TEUs although Dragados SPL has projected an opening year (2009-2010) volume of 140,000 TEUs, presumably reflecting the challenge of establishing a container service in a new region of the Texas Gulf coast. The terms of the current proposal requires Dragados to begin construction of the next phase of the terminal when the first phase reaches 90 percent of its capacity and upon full build-out, the capacity of La Quinta terminal is currently 1.2 million TEUs.

These planned numbers could change substantially and therefore cannot be incorporated into state planning at this time. This task will become easier once the facility moves toward construction and steamship company intentions are made clearer. However, Port of Corpus

³¹ Port of Beaumont 2005 Ship Arrival and Departure list

Christi management plans are likely to benefit from a growing need for a container terminal located off the Houston ship channel.

First, the port has an excellent link with San Antonio, either by I-37 or the UP line through George West and Pleasanton, currently in good condition and carrying few trains. This line fits well with the planned intermodal UP facility to be built at San Antonio, the Toyota plant and the associated Inland Port to be managed by the Allen Group.

Second, a new local distribution facility to serve port customers was recently proposed at Robstown, which will almost certainly handle containerized commodities. Port of Corpus Christi Chairman Ruben Bonilla, Robstown Mayor Rodrigo Ramon and U.S. Rep. Solomon Ortiz, D-Texas, signed an agreement solidifying a partnership to build what is termed the Inland Port of the Americas. At least 12 other governmental and private agencies are also participating and, like many other inland ports proposed in recent years, it seeks to combine logistics operations with Customs inspections and a Free Trade Zone status.

Demographic changes in Texas over the next 20 years will make it difficult to move all containers through Houston and major population centers will move closer to the Corpus Christi port “radius of efficiency” with respect to transportation costs.

Strategically, Texas needs another major terminal located away from the Houston ship channel, especially given the likelihood of a major Hurricane striking Houston and temporarily disabling POHA terminals.

7.1.2 Texas City

Stevedore Services of America (SSA) still plans to construct a container terminal on a dredge disposal site across from the Rail Port of Texas City on the Houston ship channel. Final environmental clearance to construct the terminal was issued by the Army Corps of Engineers in 2003. Initially, officials at SSA sought to work with the POHA in developing the terminal, perhaps in lieu of Bayport. Some opponents of the Bayport project also sought to encourage the construction of the Texas City facility as a more innocuous substitute.³² After the Bayport terminal received final clearance, development on the Texas City based facility has continued with SSA maintaining a full time manager in Texas City to prepare the ground for construction.

³² “Alternate port site at issue; Texas City location suitable, foes argue,” Bill Hensel, The Houston Chronicle, February 27, 2004.

The engineering phase of the terminal construction at Texas City was scheduled for completion in July of 2006, at which point construction bids were to be issued. At the time of writing, CTR was unable to confirm the status of the SSA process. SSA is attempting to partner with a steamship line to finance the planned 30-month construction window. Construction is expected to take longer at Texas City, compared with the Bayport schedule, because the land comprises of dredged material and will therefore take more time to solidify.

There are other engineering differences between the Texas City Project and Bayport. Due to the soft land of the planned construction site for the terminal, SSA will construct a patio yard made of concrete paving stones rather than a solid Portland cement as in Bayport. The use of paving stones will raise the initial construction cost although maintenance can be performed faster and more easily. The driving lanes for the terminal cranes and equipment will be solid concrete.

Officials at SSA currently predict that phase one of the terminal will be completed in the first quarter of 2009. The first phase will have a 150-acre yard with a throughput capacity of 4,500 TEUs per acre or capacity of 675,000 TEUs per year. SSA expected a first year volume of 300,000 TEUs per year. It should be noted that this estimate is preliminary and may change if and when financing is secured.

SSA plans to have no on-dock rail in the first phase. Since the port is being built on an offshore island with only limited truck access, container-on-barge (COB) options may be of interest. SSA has spoken with Osprey Lines and tug operators about establishing a COB service that would link the Shoal Point terminal to the Cedar Crossing barge terminal at Baytown. The biggest constraint at present to such an operation would be the draft restriction at Baytown. The depth along dock at the Cedar Crossing facility is only nine feet. A profitable COB operation, however, would need to match that of the Intracoastal Waterway, which is twelve feet of draft.

7.1.3 Galveston

As Texas's oldest major port, the Port of Galveston remains an important commercial deep draft port and has one of the most diverse cargo handling profiles of any port in the state. The ports traditional cargos include grain, dry chemicals, and cotton. The POHA continues to lease Galveston's East End container terminal, which the port utilized in the late 1990s to relieve congestion at Barbours Cut. This terminal, which has a 45-acre dock with two berths and three cranes, is now largely dormant and the cranes are in a state of disrepair. While containers do still

arrive at Galveston, they are now unloaded exclusively with shipboard cranes. Galveston handled 5226 TEUs in 2005.³³

Despite the congestion at Barbours Cut, there is currently little interest expressed by the POHA in re-establishing container operations at the current East End terminal location due to the high capital costs that would be necessary to repair or replace the cranes and other yard equipment. In addition, the current location is not favorable from a landside perspective as it does not offer shippers easy rail access and is close to the city's commercial center.

A more realistic possibility would be the establishment of a container dock on the city's West End near the main rail yard. Hutchinson Port Holdings has expressed interest in redeveloping piers 36 through 41 as a container facility. This would entail destroying a series of warehouses and filling in the slips to create a solid dock. Such a facility would have far more efficient truck and rail access than the current container facility. The port has a significant BNSF rail switching yard located near the docks that is used primarily for the handling of grains and chemical fertilizers, such as urea, but could also be used for containers.

7.1.4 Freeport

Port Freeport was also included in the study due to its experience handling significant volumes of refrigerated containers, especially bananas which make up Port Freeport's primary containerized product at 65 to 70 percent by volume. In 2005, the port handled 53,553 TEUs. In late October 2006, the port began work on the Velasco Terminal—the first major addition to Port Freeport in 40 years. This, when finished, will add 1,200 feet of docking area to the port, cost almost \$50 million and take two to three years to construct. The new terminal also will have almost 100 acres to support the anticipated increase of 800,000 to 1 million containers the port could handle every year. The port projects annual container growth rates of 18 percent per year for the next few years.

The first phase of the project, dubbed "Berth 7," could see construction begin by January 2007 and ending possibly by June 2008. A new dock currently under construction will allow it to handle both large container and liquid natural gas (LNG) ships. Theoretically, once Berth 7 is operational, it will have an annual capacity of 640,000 TEUs although liquid natural gas handling is a key element in the port's long-term strategy.

³³ www.marad.dot.gov

The port hopes to capitalize on the rapid growth in container volumes that is currently occurring along the Houston ship channel. Landside connections to Houston may be a constraint if the road is not expanded, depending on the success of the new container operations. The port has a rail connection on the UP system and staff has expressed public concerns over the blocking of the main line by UP cars serving another customer. UP counters that train numbers are light (around 3 per day) and that should railroad demand rise at Freeport, they will insure that train movements are not impacted.

7.2 The Panama Canal

As this report has detailed, Asian trade is a now rapidly growing part of the North Atlantic and Gulf container business. The reliance of East Coast and Gulf of Mexico Ports on the Panama Canal for Asian trade has caused transportation planners and policymakers to become increasingly concerned about capacity constraints at the Panama Canal.

There are two primary ways that oceangoing containerized cargo is currently transported between North America and East Asia. The first, by which most cargo is currently shipped, is across the Pacific to the West Coast or to the Gulf of Mexico and East Coast of North America via the Panama Canal. The second way is through the Indian Ocean, to the Mediterranean and finally the Atlantic Ocean via the Suez Canal. Currently, the Suez route from Northeast Asian origins such as China, Korea, and Japan is less competitive economically for serving the Gulf Coast than the Panama Canal route. Figure 7.1 depicts the Panama Canal.



Figure 7.1: Computer-generated 3D map of the Panama Canal
Source: www.canalmuseum.com

Currently, the overwhelming majority of Asia-US trade that enters the country through East Coast or Gulf Ports passes through the Panama Canal. Completed in 1914, the canal has not seen a major upgrade to its capacity since it opened. Sixty-five percent of the total cargo and seventy percent of containers that pass through the canal result are related to US trade.³⁴

Recent years have actually seen a decline in Canal transits, due to changes in the makeup of the fleet that passes through its locks. As a higher percentage of larger ships traverse the canal, they replace multiple smaller vessels and the total number of transits decreases. In 2004, there was a sharp reversal upward in the degree of canal utilization. Usage of the facility averaged 100 percent, with an average of 38 vessels per day traversing the isthmus, 10 of which were containerships.³⁵

To address this problem, the canal has implemented a number of measures. Channels have been widened and new tie-ups added to maximize the number of vessels that can traverse the locks daily. A new tie-up was established on the east side of Gaillard Cut that reduces idle time at the Pedro Miguel locks and will allow an additional daily transit by a Panamax ship. Another tie-up station is being built on the west side of the locks, which will handle two Panamax vessels and so eliminate the idle time.³⁶

Scheduling canal transits can also increase capacity. The Panama Canal Authority recently added two reservation slots, for a total of 23 scheduled transits per day. The canal has also extended the hours that pre-booked ships can move through the canal.³⁷ Finally, several measures have been taken to allow more large ships to pass during night hours. The Gaillard Cut has been widened to better accommodate Panamax class ships. This, combined with additional lighting, helps the big ships navigate the locks in darkness.³⁸

Opinion is divided on exactly how close to maximum capacity the canal is operating. Jorge Quijano, Director of Maritime Operations at the Panama Canal believes that measures currently being implemented will allow the canal to absorb forecast growth in traffic for the next

³⁴ Donald Urquhart, "Capacity shortage imminent: study," *The Business Times, Singapore. Shipping Times*. November 21, 2005.

³⁵ Ibid.

³⁶ Peter T. Leach, "In the All Water Mix; Panama, Suez gear up for more US-Asia ship capacity," *Pacific Shipper*. March 9, 2006.

³⁷ Ibid.

³⁸ Peter T. Leach, "Here they come; All-water services from Asia to the East Coast will increase during the next year." *Journal of Commerce. Container Shipping*, July 4, 2005: 12.

five years. Other, less optimistic estimates place the Canal within 5 transits per day of capacity.³⁹ In the face of these capacity questions, the canal is increasing tolls 67 percent in 3 stages by '07.⁴⁰ On July 14, 2006, Panama's National Assembly unanimously approved a proposal to expand the Panama Canal by a third set of locks that would be capable of accommodating the largest containerships currently in existence. A referendum held on October 22, 2006, confirmed this plan.

With or without a program of expansion, these toll increases could actually increase the number of containers that move through the canal. This is because the Panama Canal route will likely remain the most economical route for a wide range of higher value containerized goods, while ships carrying lower value, bulk goods will be forced by the increased cost to find alternate routes.

Precisely when the canal will reach capacity is in dispute. However, if current trade trends between North America and Asia continue, most experts agree that it will reach capacity within the next decade. Whether the canal is at capacity or not, the issue may be deemphasized as shippers continue explore moving East Asian cargo through the Suez, and if goods from countries like Vietnam, Thailand and India grow as a total proportion of U.S. imports.

7.3 Alternatives to the Panama Canal

7.3.1 The Suez Route

Should the Panama Canal reach capacity, the principal alternative—other than trans-continental railway—for transporting seaborne cargo between Asia and the East/Gulf Coast of North America is the Suez Canal route. The Suez route is longer from Northeast Asia to the Gulf, but the canal itself does not present a bottleneck as it does not have locks, has a 58 ft draft and permits passage of the largest containership yet built.

Drewry Shipping Consultants in 2005 estimated the break-even point for the Suez route to be somewhere south of Hong Kong. With 50 percent of North America-bound, Chinese cargo originating from Shanghai, this currently poses an important impediment to potential Suez liner

³⁹ Peter T. Leach, "In the All Water Mix; Panama, Suez gear up for more US-Asia ship capacity," *Pacific Shipper*. March 9, 2006.

⁴⁰ Ibid.

services⁴¹ although the costs were presumably based on the then limits of containership size. As of January 2006, there existed no East-Asia—ECNA regular liner services utilizing the Suez route, with the exception of two “Around the World” services (Figure 7.2) that circle the globe with each trip.⁴²



Figure 7.2: Sample round-the-world service map
Source: www.chinashippingna.com

The Chinese shipping line COSCO had previously offered regular North American service via the Suez route, but that service was cancelled.⁴³ This is likely to change with the introduction in 2007 of the ten Maersk SX class containerships currently being built in Denmark. These vessels, with a capacity in the 11,000-plus range will run on an Asia-Europe string, stopping only five times en route. This will place containers in Rotterdam at a low cost and it is likely that Maersk will hub and spoke to selected Atlantic ports. In addition, it is expected that as many as three new, regular container services will begin using the Suez route to call on American ports in 2006. These could take business from Panama Canal services and, in doing, reduce potential congestion described earlier—in much the same way that U.S rail corridors have benefited from container diversion from Los Angeles and Long Beach terminals.

⁴¹ Donald Urquhart, “Capacity shortage imminent: study,” *The Business Times, Singapore. Shipping Times*, November 21, 2005.

⁴² Peter T. Leach, “In the All Water Mix; Panama, Suez gear up for more US-Asia ship capacity,” *Pacific Shipper*, March 9, 2006.

⁴³ Ibid.

8. Conclusions and Recommendations

8.1 Overview

Global trading is now an integral part of the Texas economy, with over 30 percent of the gross state product (GSP) now related to international trade activities. Containerization accounts for a substantial share of the non-bulk commodities traded internationally, and the growth of containers and their potential for non-highway moves has made them a subject of interest to TxDOT planners for the last decade. This study examined the impact of the recent growth of marine-borne intermodal containers at Texas Gulf ports and the resulting landside issues, both rail and highway, that are created by such growth. It should be recorded; however, that container volumes are currently modest by U.S. West Coast port standards and policies emanating from southern California ports may not be appropriate or necessary to mitigate any negative impacts created by the growth of Texas Gulf port container volumes.

Although it is difficult to estimate with precision, the Texas economy receives over 5 million international TEUs from various directions and modes—US West Coast ports (rail), US East Coast ports (rail and truck), Texas ports (most through the POHA) and some from NAFTA locations. In addition, there is a growing domestic container segment driven by intermodal competitiveness and larger box sizes, making them more attractive to shippers than the current International Standards Organization (ISO) international limits. However, domestic containers are excluded from this study since the project focus is on all water services for containerized international cargo arriving at Texas ports.

This year, the POHA will process around 1.5 million TEUs, giving the port about a 30 percent share of the international TEUs consumed by sectors in the Texas economy. Moreover, in recent years, a number of organizations and authorities have argued that container growth will continue to grow strongly over the next two decades and transportation planners should therefore develop strategies and infrastructure to accommodate this growth. The study team was asked to examine the need for such investments on the landside of Texas port container terminals, especially if a major project was needed that would take substantial time and resources to plan and implement. The magnitude of both factors prior to the opening the Alameda corridor—which took 20 years—was a reminder of how long a major project now takes to bring to completion.

8.2 Forecasting Houston Container Volumes

In 0-5068-2, the team addressed the issue of forecasting growth at the POHA, because it currently handles most of the Texas Gulf containers, to estimate the magnitude of the challenge.

The findings can be briefly summarized as follows:

8.2.1. Houston container volumes have increased by more than 100 percent between 1996 and 2006.

8.2.2. Trade from China has accelerated dramatically in the past several years, even as trade with other nations has grown or held steady. Between 2002 and 2005, container volumes from China grew by almost 1000 percent.

8.2.3. Container volumes have grown at 7 percent annually between 1999 and 2004, despite limited capacity at the POHA. Bayport will ease this capacity constraint, allowing higher volumes. If this rate of growth continues, POHA will move 2,000,000 containers per year by 2009 and over 4 million by 2020.

8.2.4. The POHA estimates an 11 percent annual rate of growth for container volumes and this implies that they will exceed the 2,000,000 TEU mark by 2008.

8.2.5. Under all scenarios envisioned, container volumes in Texas will exceed 4,000,000 by 2020 and may be considerably higher, particularly if other ports like Corpus Christi begin container terminal operations. Researchers therefore confirm that container volumes will continue to grow strongly to 2020 and beyond.

The question then arises as to what impacts these findings have on the Houston metropolitan and state transportation systems. Two million TEUs equates to around 1.25 million containers (allowing for some 20 ft boxes) which generates a number of trips, by truck or rail, at landside and this was examined in subsequent chapters of the report.

8.3 Rail Systems

The team looked at rail issues over the study period because the mode offers an opportunity for shippers to take loads off highways and so preserve service life and reduce congestion. Major rail findings of the first year study (0-5068-1) were:

8.3.1. A majority of containers are destined for counties within a 150 mile radius (especially Harris county) so making them infeasible for rail delivery.

8.3.2. There are two types of rail services, one near-dock at Barbours Cut served by the Port Terminal Railroad Association (PTRA), and second offering services from both UP and BNSF terminals, thus requiring a dray move. Near-dock volumes comprise less than 10 percent, but have the potential to grow if the PTRA system is improved.

8.3.3. The Houston rail corridors serving the port are inadequate for PTRA traffic and will create bottlenecks in the future when moving more containers out by rail from POHA terminals.

8.3.4. The rail network serving all Texas marine ports needs only a modest investment, with the exception of Houston, to improve capacity and service levels. Excluding Houston, this coastal investment would focus on more and longer sidings on key segments of the system to allow higher speeds, some investment in heavy rail to make the system coherent and small projects to improve port access.

8.3.5. Rail will become more important as Texas Gulf terminals receive containers destined for inland ports in other states, so modest investments in rail assets are needed and can be sequenced over a multi-year period to match the growth in business.

In the study period covering second year activities, major findings focused on the PTRA and found:

8.3.6. PTRA handled over 3,300 carloads each day; chemicals and plastics dominated the commodity types carried. Over 170 customers were served, many of which were billion dollar chemical facilities producing highly profitable rail business generating county, state, and national economic impact. Intermodal comprised only three percent of the business in 2005, mostly hauled by BNSF.

8.3.7. Five major investments are needed to raise PTRA operating efficiency. Details on location and investment type were provided, together with a range of costs for each investment, with the program totaling between 38 and 85 million dollars. This modest amount could be sequenced to undertake the highest cost-benefit impact first.

8.3.8. Two slow and restrictive Houston rail corridors serving the PTRA should be improved as quickly as possible. The two comprise one between the Port and Rosenberg and the second between the Port and Alvin. The two could be improved by the provision of double tracking or improved passing sidings.

8.3.9. Rail serving the Bayport terminal is not due until 2012 at the earliest, which means that all containers until that date will be moved by truck, with a possibility that some might move by barge if this service is offered. However, steamship lines needing rail service could still call at Barbours Cut, which will continue to have capacity provided that the requisite investments are made to the PTRAs system.

8.3.10. Researchers believe that it is unlikely that rail intermodal will exceed a 15-20 percent market share of the total TEUs entering the POHA terminals. However, chemical movements are expected to grow strongly and create high demand on the PTRAs network, negatively impacting intermodal services if improvements are not made to raise system capacity.

8.3.11. An important finding is therefore that a dedicated rail corridor on the scale of the Alameda corridor is not economically justified nor needed. The rail problems are best approached through a series of integrated, modest, and sharply focused projects aimed at improving operating performance and reliability.

8.4 Houston Highway Impacts

Highways serving both POHA container terminals are in good shape and the dray industry serving these facilities move at acceptable speeds for much of the working day. They do not contribute excessively to congestion except at a few locations, the most severe of which is BCB, which is being addressed at the time of writing. At this time, and perhaps over the next five years, there does not appear to be a strong case (or need) for tolled lanes serving the terminals although this should be re-examined once POHA terminal volumes reach the 4-5 million TEU range. This range could create congestion, especially if on or near-dock rail is not used to ship part of the growth in container volumes.

8.5 Distribution Centers

Distribution centers play an important role in facilitating the flow of containers leaving POHA terminal(s) and entering the Houston highway networks. A critical part of the study for Houston planners turned out to be the impact these centers and the dray industry have on truck flows. The researchers recommend that further work be undertaken to establish a method of broadly classifying both truck trips and vehicle miles of travel per trip. Currently, this area of logistics—DCs and truck volumes—is dynamic and changes likely to impact highway performance should be carefully monitored.

Planners can gain greater insight into future needs by classifying centers according to their size, function, location, and the markets served. It is important to re-emphasize that this change is not random but rather a response to market (economic) conditions. As an example, trans-loading has already begun around the POHA for cargo traveling beyond Harris county boundaries. The cost of performing a transloading or consolidation operation is set against the benefit of carrying a larger load per truck. The breakeven point for this tradeoff depends on factors such as fuel and labor costs. The recent rise in fuel costs increases the share of shipments in which transloading would be profitable. The container market has already seen a reduction in the number of 20-ft containers and a move to 40 and 45-ft has taken place. Even so, it can be profitable to unload three 40-ft containers and place the cargo into two 53-ft domestic containers or truck semi-trailers once the trip distance exceeds the break-even point.

The key impacts containers have on the Houston highway system is not known at this time. The system of collecting, moving, transloading, and delivering containers and their cargoes creates a variety of VMT which is worthy of further study. As a contribution to this subject, the team conducted a survey of Houston dray companies serving the Barbours Cut facility.

8.6 Houston Dray Trucks and Drivers

The port dray industry does not have a good reputation, and is often characterized as having overworked, unskilled, underpaid drivers using old, poorly maintained trucks in a poorly paid sector of the trucking industry. So powerful are these beliefs that they contributed to the postponement of the NAFTA clause permitting contiguous border state bi-national trucking in 1995 and are still strongly held by some U.S. state policy makers today. In this study, researchers decided to survey the Houston dray industry and collect information on the companies, operations, drivers, and trucks.

The results of the survey and company interviews for the dray industry in Houston yielded a different picture than might otherwise be expected. First, a variety of dray operations were identified rather than a single type, because no single model fits the shape and nature of all the supply chains adopted by the shippers using POHA facilities. Dray companies have responded to the new demands of the different chains by tailoring their operations to fit the characteristics of the service needed by shippers. Dray companies now offer two distinctly different types of operation—inter-city trips (Houston to Dallas-Fort Worth for example) and the

traditional shorter dray trip, serving centers located closer to the POHA terminals (Harris county destinations, for example). This results in company fleets having two different vehicle age spectrums, with younger vehicles making the longer trips and the older tractors the shorter trips, which is the most efficient use of vehicle types. The dray industry itself is in a state of flux, with owner-drivers working for large established companies, supplementing the company fleet and benefiting from working under the umbrella of the larger company. The final, and possibly most important development, is the incursion of larger, publicly quoted, trucking companies into the drayage industry through purchase. As an example, American Port Services, which serves Wal-Mart import distribution centers in several locations, is now part of the Schneider trucking empire, so it is likely that its dray sector will become better financed, better managed (using GPS driver systems, for example) and more professional in cost controls, pricing and staff conditions. The old model of drayage therefore seems on the way out in Houston, and perhaps at other medium-sized port container terminals in the U.S.

Details on truck ages, driver hours of work, and port gate strategies were investigated but more substantive work is needed to explore the various subjects more deeply. At the moment, based on the preliminary work, Houston seems to have a dray industry that is healthy and reasonably profitable for its drivers and owner-operators. Proof of these two features is seen first in the evidence that dray drivers and owner-operators are moving to Houston from other locations like southern California. Drivers contacted in the survey have been working in the industry for a number of years and when moves occur, they move within the dray industry and not into other trucking sectors, as has been opined. The results of the survey suggests that the Houston drayage industry has been able to keep up with the growth of container arriving at POHA facilities without encountering, or producing, some of the negative features reported at other large container facilities. Investigation into the dray industry will continue as part of a new TxDOT project examining dray operations at the Texas border, ports and rail terminals.

8.7 Containers at other Texas Ports

Container terminals will be built at other Texas locations along the Gulf within the next 15 years, but in all cases, they are likely to start modestly and ramp up only as favorable transportation links to growing metropolitan areas in the state and region. Planners should maintain an awareness of the Texas port plans in this regard and respond to the strategic

milestones stated in the plans. It would appear that at least a period of between two and three years is needed to complete a terminal of any significant size (300,000 TEUs seems a popular first phase for many such plans) which provides a window for transportation planners to respond to any need that the plan might create. Private-public partnering may also be an appropriate funding source at this time, especially where rail investments are needed. A Texas City terminal would require more transportation investment than the Corpus Christi La Quinta project, since rail and highway links already exist at the latter and the need may be more institutional, rather than financial.

8.8 Final Recommendations

Texas planners considering planning needs for container movements have a number of advantages over their colleagues in state agencies in the New York-New Jersey and California regions. Volumes are still relatively modest and present opportunities for effective planning ahead of the growing volumes predicted over the next 15 years. The sequence of needs seems to start in the Houston area with highway bottlenecks that can be mitigated within the current planning cycles. Rail bottlenecks are more difficult, especially in the Houston area, and it is critical that a distinct rail corridor emerges from the current rail planning to serve the port. As part of the rail investment needs, the PTRAs improvements should show good cost-benefit ratios and be attractive candidates for rail investment. It is likely that a majority of containers entering Texas through its Gulf terminals will be carried by truck and the improvements noted in the Houston dray industry can be given further support by the adoption of cleaner diesel truck engines for older tractors and the purchase of 2007 standard low sulphur, diesel-burning engines for the longer state trips. Finally, while no project on the scale of the Alameda Corridor is needed to serve POHA facilities, it is nevertheless important to upgrade the Houston and PTRAs systems so that they can take a larger share of the growing number of containers predicted to arrive at Houston ship channel terminals over the next ten years.

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Appendix A: PTR A Supplementary Graphics

The following photographs were taken by Jim Blaze on July 6, 2006 during the high-rail tour of the southern segment of the network serving Barbours Cut. Figure A.1 shows the location of the PTR A core track network in relationship to the navigable waterways and the central Houston track corridors.

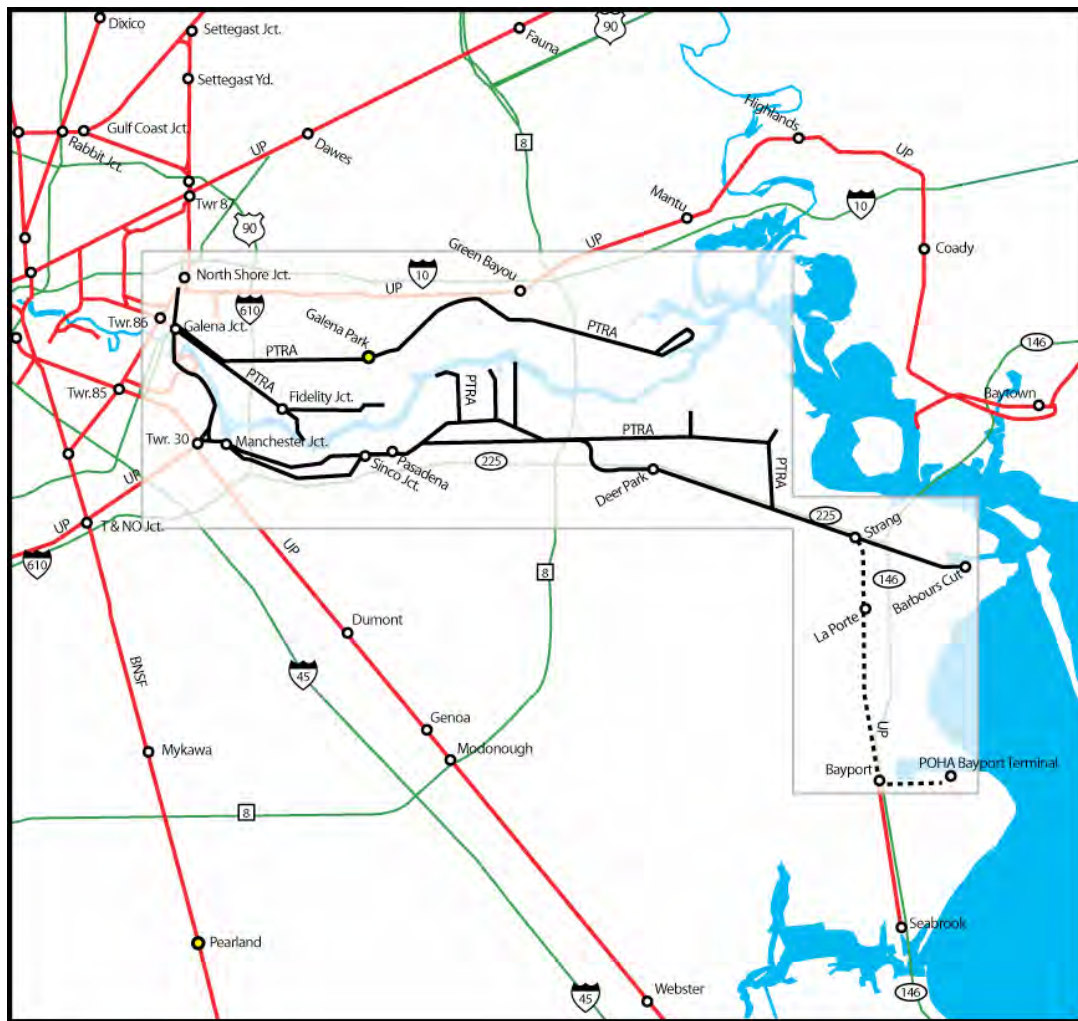


Figure A.1: Port Terminal Railroad Association Network



Figure A.2: Manchester Junction

Figure A.2 provides a view looking southeast towards PTRA Manchester Yard and the route east towards Barbours Cut. The track on the right leads to Union Pacific route and on the left to the PTRA route. Beyond the photograph, the track to the left leads north across Buffalo Bayou to the important interchange at PTRA's North Yard.



Figure A.3: Harrisburg Junction

From BNSF western and northern markets and from Union Pacific western markets, long freight and intermodal trains will enter the PTRA and the Port area via Harrisburg Junction in the small southeastern community of Harrisburg.

Figure A.3 shows an approaching train waiting for dispatching clearance to proceed east through Harrisburg Junction and onto the Union Pacific port area main line or onto the PTRA main line into Manchester Yard.

BNSF doublestack intermodal Maersk trains will also enter the PTRA and port district using these same tracks.

Delayed trains trying to enter across essentially single-track junctions are often delayed—thereby resulting in delays both for motorists on highway crossings that are at-grade and for rail trains. The cost of a train delay differs by train commodity type but often runs to more than \$500 per hour.

The cost of delayed customer inventory on these trains is an additional expense of train delays. Customer delays, in the long run, result in lost business to either substitute ports or to other modes, such as trucking.



Figure A.4: Union Pacific Train near Barbours Cut and Strang

The port area trackage also supports freight service to the vast Houston area petrochemical industry. In Figure A.4, a Union Pacific train is moving chemical and petroleum customer rail cars to and from customers near Barbours Cut and Strang. These local freights compete with the intermodal trains for available track capacity, train crews, and locomotive power.



Figure A.5: Refinery pipelines at a plant to the west of Pasadena Junction

The PTR A main line between Manchester Yard and Pasadena passes well to the north of the corridor used by the Union Pacific and the doublestack trains between Manchester Junction and Pasadena Junction. One of the reasons is that the PTR A route has overhead clearance problems, which will not allow passage of double-stack cars. Figure A.5 provides an example of overhead clearance problems: refinery pipelines at a plant to the west of Pasadena Junction. As intermodal train volume grows in the next decade, this route probably needs to be improved to handle its share of the added intermodal trains.



Figure A.6: Northbound trains destined for the PTRA North Yard

In Figure A.6, northbound trains head slowly for the PTRA North Yard and an interchange of the railway cars with other railroads that serve the Houston area. These other cars, however, reach PTRA customers only using PTRA network and services. This track to the north is restricted in capacity, which makes the route congested. The train on the right in Figure A.6 is a delayed northbound train using Canadian locomotives trying to reach the port. Three trains were backed up over a four-mile stretch along the Mykawa highway on the BNSF main line north of Alva and south of I-610. The solution is to add more passing sidings or some double track sections to this part of the PTRA network.



Figure A.7: A typical main line passing siding along the BNSF

Adding sidings along the most critical approaches to the PTRA port area is an incremental cost approach that can quickly help reduce port approach and departure train delays. The sidings can even allow forward positioning of trains or just “cuts” of critical freight cars or so-called industry “hot shipments” for later overnight delivery in and out of the port. Figure A.7 shows a typical main line passing siding, which requires a width of only about 40 feet (plus a clearance allowance).



Figure A.8: PTRA approach track to Barbours Cut

Figure A.8 provides a view of the PTRA approach track and the railway doublestack container train entrance to Barbours Cut. The track on the left allows locomotives to run-around the delivered train and prepare to pull the departing train out in the westbound direction. The new Bayport intermodal yard will be located about 5 miles to the south of the Barbours Cut rail intermodal terminal.



Figure A.9: Loaded double-stack train at Barbour's Cut, west end of terminal

In Figure A.9, the trucking and container storage areas are located to the left, as is the maritime dock. About 15 percent of the maritime container trade currently moves to or from inland Port of Houston markets via rail intermodal. The balance is trucked.

Appendix B. Trends in Containerization and Status of the Global Shipping Market

Background

All the issues being debated within the United States on how best to accommodate the growth of containerized trade and its corresponding impacts on traffic, the environment, domestic industry, safety and security are simultaneously being debated in most other countries around the world. International trade creates shared benefits, and it consequently produces shared problems. While substantial investments in infrastructure for container handling are occurring in many areas of the world, no other region can match China in the speed at which its maritime infrastructure is growing and maturing. The crown jewel in China's maritime expansion is the Yangshan deepwater port, a 52-berth port island city that is being constructed to the south of Shanghai in Houshang Bay. The first phase of the Yangshan, which is expected to become the world's largest container-ship port in the world when completed, came online in 2005.⁴⁴ China will increase its total port capacity for all cargos by 80 percent in the next 5 years. Megaport projects are also underway or recently completed in Egypt's Suez City, Dubai, Malaysia, and Indonesia.⁴⁵ Even Germany, which has not seen high economic growth rates in recent years, is planning to more than double the capacity of the Port of Hamburg to 18 million TEUs in the next decade.⁴⁶

World container growth was roughly matched in 2005 by world capacity growth. There was, however, a less than perfect match between where new capacity was most needed and where it was added. An analysis of the generation of containerized trade worldwide when examined against rates of economic growth shows that port capacity has not kept pace with growth in several areas of the world, most notably India and Southeast Asia, which have developed a substantial infrastructure deficit when compared to China. India is currently attempting to reverse this trend by inviting in private investors such as DP Ports World to accelerated new port construction, such as the new offshore container transshipment facility at Vallarpadam Island near Kerala.⁴⁷ It is clear that as long as the Chinese economy continues to expand at its current rate, other developing countries will emulate the Chinese model of development, which stresses the facilitation of robust exports and manufacturing through

⁴⁴ "Big China's Build Out." John McClenahan, *Industry Week/IW*, May 2006, Vol. 255 Issue 5, p28-32

⁴⁵ "The World's Top Super Projects." By: Conway, McKinley; Lyne, Laura. *Futurist*, May/Jun 2006, Vol. 40 Issue 3, p32-39

⁴⁶ "Major container expansion planned for Port of Hamburg", Peter Leach, *Journal of Commerce Online*, January 30, 2006

⁴⁷ Vallarpadam box terminal to be ready by early 2009, Shirish Nadkarni, June 14, 2006
Lloyd's List

strategic investments in transportation infrastructure. This will produce tremendous global inertia for a continuance of trade growth in the near future.

As a country whose maritime imports far outstrip its exports, the United States is primarily a reactive player in this worldwide phenomenon. Increasingly, U.S ports and channels are being designed around the needs of Chinese and Korean made containerships. The impacts of Asian containerized exports to the United States are no longer confined to the West Coast. When Norfolk, Virginia opened a 50 ft channel in 2005, East and Gulf coast ports came a step closer to West Coast ports in their ability to attract and serve post-Panamax liner services from Asia.⁴⁸ Several ports on the east coast are now racing to catch up with Norfolk's current depth status and hoping to attract mega-containerships on reverse pendulum routes from Asia through the Suez Canal. Several new services through the Panama Canal have started up recently to service Houston and other East Coast ports directly.

The trend towards larger containerships is continuing with Maersk taking delivery of an 11,000 TEU vessel constructed at Denmark's Odense Shipyard in August of 2006.⁴⁹ Korean firms Samsung and Hyundai are also currently developing ships with capacity of over 10,000 TEUs for delivery in 2007. In 2005, steamship companies around the world were preparing to acquire new capacity, either under construction or in the planning stages, that equaled 59 percent of the then-currently active fleet. One third of this new capacity is ships with capacity of over 7,500 TEUs.⁵⁰

There is an economic question as to how large container vessels will grow on the global lanes. As Brian Cudahy describes in a new comprehensive analysis of the container industry, it is unlikely that the size of containerships will ultimately be limited by engineering constraints.⁵¹ Rather, containership size will be checked by the decreased flexibility in potential ports of call that mega-containerships can serve. A Lloyd's register study examined the dimensions of a theoretical Ultra-Large Container Ship (ULCS) that could still be accommodated by a handful of major load centers in the world. The ship would have a capacity of 12,500 TEUs and a draft of 60 feet⁵²—the size of the new Maersk SX Class vessels. If container ships are to exceed the

⁴⁸ Big Boats, Big Loads, Small Channels, Seaports Press Review, June 7, 2006

⁴⁹ "Maersk launches largest container ship" Frank Kennedy, Gulf News, <http://archive.gulfnews.com/articles/06/08/28/10063150.html>

⁵⁰ Cudahy, Brian *Box Boats: How containerships changed the world*

⁵¹ Ibid p 241

⁵² Ibid p 243

ULCS threshold, the traditional port-to-port system of delivery would be possible only over few seal lanes. Rather, at this point the container shipping system would begin to resemble the world maritime oil trade in which supertankers too large to enter harbors are lightened at sea by smaller vessels, which then make the delivery to a final port of call. Such open sea transfers would be far more difficult and costly for containerized cargo than they are with liquid cargo.

Advances in Ship, Port, and Terminal Technology

The growth in container demand is driven in part by the advent of new technologies that lower transportation costs, thereby making containerized imports comparatively more attractive. In recent years, increasing average ship size has brought with it higher economies of scale and lower costs. However, there are a series of other technological advances, along with innovative procedures that are being implemented at the more modern container facilities around the world that show promise for further reductions in cost.

Crane Double Cycling

Crane double cycling is a technique for handling imports and exports to a container ship simultaneously. In a typical crane operation, a box is lifted from the deck of a container ship and loaded on to a yard truck, at which point the unloaded crane head returns to the ship to retrieve the next box. This empty deadheading presents an inefficiency in the box unloading process that is particularly expensive to port operations given that quay cranes are the most expensive component of container handling equipment at a port.⁵³ In addition, inefficient crane utilization means that a ship must stay docked at a port longer, creating a significantly higher cost for the shipper. Pioneering research on crane double-cycling has been performed by Anne Goodchild at the University of Washington who has shown that the technique could be used to reduce transportation costs on average by \$65 per container.⁵⁴

⁵³ Crane Double Cycling in Container Ports: Affect on Ship Dwell Time, Anne V. Goodchild Carlos F. Daganzo
<http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1082&context=its>

⁵⁴ Crane Double Cycling In Container Ports:
Planning Methods And Evaluation, Anne Goodchild,
<http://www.metrotrans.org/nuf/documents/Goodchild.pdf>

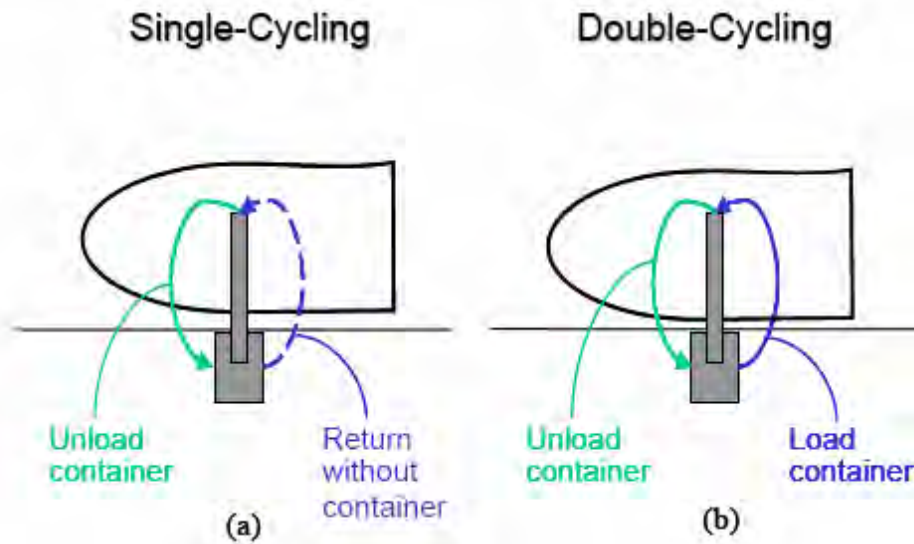


Figure B.1: The advantage of double cycling⁵⁵

Substantial advance planning is required in order for crane double cycling to work properly. Container ports already must take into account several constraints governing where containers can and cannot be placed. Software has been developed that factors in container type and ship stability requirements.⁵⁶ The logistical needs for double cycling operations in essence place a second dimension of complexity onto this process.

Double cycling improves the effectiveness of yard equipment for the similar reasons. In an effective double cycling operation, yard tractors spend little time unloaded. Rather, a yard tractor can pull onto the dock with an export container and leave with an import container. This means that the tractor can make more deliveries per hour and also means that the tractor is less likely to cause yard congestion. Finally, double cycling can help a port maintain more of its yard space, an issue of particular relevance to Houston, due to the fact that the ship serves a more effective warehousing function, i.e. rather than first being fully emptied and then filled, it is always mostly full, allowing the yard to be less so.

Obviously, the benefits of double cycling are higher if ships are handling both inbound and outbound cargo. If a ship merely wants to unload its cargo and leave, it cannot take

⁵⁵ Crane Double Cycling In Container Ports: Planning Methods And Evaluation, Anne Goodchild, <http://www.metrotrans.org/nuf/documents/Goodchild.pdf>

⁵⁶ Crane Double Cycling in Container Ports: Affect on Ship Dwell Time, Anne V. Goodchild Carlos F. Daganzo <http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1082&context=its>

advantage of double cycling. The applicability for Texas ports in this light would tend to be favorable given that export volumes at the POHA are roughly equal to imports. Furthermore, double cycling can be utilized even when the return cargo is mainly empty containers. It is not a new idea since it was evaluated in the late 1960s and has been plagued by the problem of actual time benefits turning out smaller than the theoretical estimates.

In 2003, a large-scale experiment that used crane double cycling along with a similar technique for expediting rail deliveries was showcased at the Port of Tacoma's Washington United Terminal. In this experiment, the dual loading operation took longer on average per cycle (2 minutes 50 seconds) than a comparable single cycle operation (between 1 minute 30 seconds and 1 minute 45 seconds). Therefore, the gain in crane utilization efficiency was between 10 and 25 seconds per cycle, far lower than the theoretical maximum efficiency gain but still quite significant for a large container ship.

Double-Lift Quay Cranes

Container quay cranes capable of lifting two 20' containers at a time have become quite common. However, until recently even the largest cranes were not able to lift more than one 40' container at a time. The vast majority of maritime containers handled at US ports of 40'. Recently, cranes with twin 40' lift capacity have been developed by Shanghai based Zhenhua Port Machinery with the first deliveries to the Port of Shanghai in 2005. Twin lift quay cranes such as these have the ability to significantly speed the loading and unloading of large container ships.



*Figure B.2: Crane with twin 40' lift capacity unloading containers at the Port of Dubai
Source: Shanghai Zhenhua Port Machinery Co.*

In-Terminal Automation

The logistics community has long been split about the economic viability of automating processes at container ports. When compared with the labor requirements of pre-containerization ports, the labor requirements of modern container ports are minimal. For example, quay cranes representing a capital cost of sometimes more than \$10 million dollars each usually require only a single operator at a time. The same is true for the Rubber Tired Gantry (RTG) Cranes. The cost to operate the small yard trucks as pictured above is a more labor-intensive process. In addition, the labor requires a lower skill level, necessitating drivers to circle continually between the dock and a designated pick up point in the container yard. For a decade, container terminals in Europe have experimented with automating yard equipment. The Port of Hamburg, for example, uses robotically controlled RTG's as well as 270 automated yard trucks, some of which have been in service for over 15 years.⁵⁷

Gottwald Port Technology is currently the leading world supplier of automated container handling equipment. Gottwald Automated guided vehicles (AGV) are controlled by transponders embedded in the pavement.⁵⁸ The navigation system functions by comparing the actual position

⁵⁷ "Robotics coming to U.S. ports, says tech exec", Journal of Commerce, April 26, 2004

⁵⁸ "Automated Guided Vehicles AGV – The Future is Already Here"
<http://www.gottwald.com/gottwald/site/gottwald/en/products/agv.html>

of the vehicle at one moment to the pre-defined reference position emanating from the transponder. They operate according to a set of pre-programmed patterns that is unique to each port. Laser scanners surrounding the vehicle check for obstructions. POHA officials have thus far not seriously examined the possibility of acquiring automated yard equipment. The process of replacing workers with automated yard equipment in the United States would likely be made more difficult by organized labor demands.

The rush to improve container-handling capacity within the United States has been met by a series of challenges. Gaining approval for major infrastructure project in an era of high levels of national indebtedness is never an easy process. Securing funds for maritime expenditures is especially challenging since port expansions are viewed by some as enabling even greater dependence on cheap imports thereby undermining domestic industry. Yet in truth, failure to adequately maintain and improve the nation's maritime assets will inevitably create transportation bottlenecks that would jeopardize the success of the entire US economy.

Container Security Issues

Security is another subject that has tempered enthusiasm on some fronts for further expansions of US container handling capacity. Critics have argued the United States does not have adequate information about all of the cargo entering US ports and therefore should not be adding additional capacity until it can better monitor existing throughput. However, one of the best ways to improve cargo handling capacity at most US ports is to invest in systems that improve information transfer, a feature that would also boost security. Shippers at all stages of the supply chain are already making substantial investments in information technology that will allow them to better track cargo shipments from origin to destination. These investments are primarily being driven for reasons of logistic efficiency rather than security. However, once such technologies are installed, they will have substantial positive externalities for container security. The 109th Congress presented a series of possible bills on container security. Texas Senator Kay Bailey Hutchinson introduced the "Intermodal Shipping Container Security Act" in February of 2005. The bill mandated the spread of "Smart Box" tracking devices to a substantial percentage of containers entering the United States.

S. 376

“(b) SMART BOX TECHNOLOGY.--Under regulations to be prescribed by the Secretary, beginning with calendar year 2007 no less than 50 percent of all ocean-borne shipping containers entering the United States during any calendar year shall incorporate ‘Smart Box’ or equivalent technology developed, approved, or certified by the Under Secretary of Homeland Security for Border and Transportation Security”⁵⁹

A similar bill, the “Green Lane Maritime Cargo Security Act,” S.2459, was introduced by Senator Collins in March of 2006 and was co-sponsored by six democratic and four Republican Senators. This bill would require all containers entering the United States to be examined for radiation and would establish a port security grant program to correct port security vulnerabilities. As of the report submission date, this bill was pending on the legislative calendar.⁶⁰ Other related initiatives submitted in the 109th congress include the “Secure Domestic Container Partnership Act of 2005” [[H.R.163.IH](#)], the “Sail Only if Scanned Act of 2006” [[H.R.4899.IH](#)], “SAFE Port Act” [[H.R.4954.IH](#)], the “Anti-Terrorism and Port Security Act of 2005” [[H.R.173.IH](#)], and the “Reducing Crime and Terrorism at America's Seaports Act of 2005” [[H.R.2651.IH](#)].

At the time of this report, the issue of security remained confused, and Texas ports were encountering difficulties in planning and implementing the various programs—many of which appeared driven by politicians and their interpretation of events occurring in the industry, such as the Dubai Ports furor over their ownership of P&Os assets in the U.S. Another important issue to be addressed by ports is the implementation of the Transportation Worker Identification Credential (TWIC), which will require all port workers—both employed by the port and those outside workers who regularly enter port terminals (like dray drivers). The Transportation Security Administration (TSA) states that “TWIC Program will enhance security at U.S. transportation facilities while boosting (it is claimed) the efficiency of commercial activity. Up to 850,000 maritime port transportation workers are expected to participate in the initial rollout of the program over eighteen months starting by the end of 2006.”⁶¹ This initial effort will include enrollment centers in 125 different ports located in 38 states.” The POHA staff claim that the type of TWIC card is not yet decided, nor its readers or where they should be situated at the port,

⁵⁹ <http://thomas.loc.gov/cgi-bin/query/z?c109:S.376>:

⁶⁰ <http://thomas.loc.gov/cgi-bin/bdquery/z?d109:s.02459>:

⁶¹ http://www.tsa.gov/what_we_do/layers/twic/index.shtm

so much remains unclear at this time. However, it is obvious that in the coming five years a substantial change will take place in container administration and port personnel certification (which will drive up costs) to meet current and future security policies at U.S terminals.