Portfolio Management: A Tool for Strategically Planning Infrastructure Development

by

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Submitted to the Department of Civil and Environmental Engineering
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Overall investment in public works has slowed considerably over the last three decades in relation to the demands of growth and the enormous backlog of infrastructure needs. During this period and since WWII, the federal government has been the primary source for infrastructure funding while the process used to deliver projects has been to separately contract design, construction and operation services. Inherent in this financial and contractual method are inefficiencies which result in higher capital and life-cycle costs, reduced competition for technology selection and reliance on federal spending patterns.

This thesis will investigate whether alternative delivery methods can be used to strategically plan infrastructure by analyzing portfolios of projects, otherwise known as capital construction programs. Three case studies will be examined which present differing strategies toward the utilization of alternative delivery and financing methods for procurement of their portfolios. Analysis and lessons from the case studies will help to make recommendations on a strategy for the Intermodal Transit Connector (IMTC) program, a planned transit link connecting downtown Boston, South Boston and Logan International Airport. Several options exist which can capitalize on public/private financing structures and alternative procurement packages. The feasibility of these options are investigated through the study of scenarios based on preliminary construction and ridership estimates.

A prototype computerized decision support tool called CHOICES will further aid in the evaluation of strategies for the IMTC program. The model compares quarterly spending profiles with budget profiles to determine the timing of cash surpluses or shortfalls.

Evaluation of the case studies and the IMTC program conclude that a strategic and sustainable planning strategy must utilize a portfolio mixture of delivery and financing methods. Two of the three case studies which combine conventional procurement with

alternative methods show that enhanced value can be achieved through experience and technology based selection criteria, reducing design and construction duration, lowering initial and life-cycle cost, and lowering cash outlay by utilizing public/private financing arrangements. Several steps which can aid in intelligent portfolio structure and delivery method selection are also presented to help provide strategies for planning infrastructure development.

Thesis Supervisor: John B. Miller
Title: Assistant Professor, Department of Civil and Environmental Engineering

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Chapter 1

Introduction

1.1 Context

The cost of existing infrastructure in the United States is quite large. Of the $6.9 trillion of total capital stock, $2.5 trillion is publicly owned, with $2 trillion of these assets going towards non-military infrastructure.[1] The magnitude of several systems is illustrated as follows:

- 3.9 million miles of urban and rural roads
- 581, 862 bridges
- 18,224 airports (including 471 major airports)
- 470,000 miles of oil and gas pipelines
- 200,000 miles of mainline railroads
- 26,000 miles of commercial waterways[2]

Investment in new infrastructure and maintenance of existing assets are very costly. $16 billion is needed annually to maintain highways, bridges and transit systems. $8.5 billion is needed to maintain the integrity of our national airports and modernize the national air traffic control system. Furthermore, about $500 million is necessary to dredge waterways yearly.[3]

The investment requirements over the next two decades remain just as ominous. Improvements in wastewater treatment and drinking water systems will cost at least $275

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[1]Munsell, Alicia H. "How Does Public Infrastructure Affect Regional Economic Performance," New England Economic Review, Sept/Oct 1990, page 12-Data presented are 1988 figures.

[2] From a presentation by James F. Hinchman, Acting Comptroller of the United States at a conference entitled The Future of American Infrastructure Development: From Projects to Portfolios in Cambridge, MA, December 1997.

[3] Presented by James F. Hinchman, Acting Comptroller of the United States, Cambridge, MA, December 1997.

billion. Deferred maintenance and reconstruction of the national parks and forests is expected to cost more than $5 billion. Amtrak's intercity passenger rail system in the Northeast Corridor is estimated to cost $6.5 billion. Also, the Department of Energy has a backlog of renewal projects estimated at $1.3 billion.[4]

As investment requirements are increasing, government spending in public works over the last three decades has been decreasing. Since 1960, public works investment as a percentage of gross national product (GNP) has declined. Recently, Congress has been making efforts to balance the budget and eliminate the deficit. In order to do this, the President has proposed extreme spending cuts for most infrastructure programs. Funds for surface transportation, water supply and wastewater treatment have been drastically reduced.[5] Cuts are expected to continue through 2002, the year targeted for balancing the budget.

While cuts in spending are being made at the federal level, our state's and city's needs for increased infrastructure investment remain. Cities are continuing to grow in population and the economic competitiveness between regions is escalating. Thus, state and local governments must find creative ways to make-up funding shortfalls for their capital programs. Often, these programs consist of several large and extensive projects, which could be considered as portfolios.

This thesis will examine alternative delivery and financing method strategies which governments and public sector agencies could utilize to maintain and improve infrastructure portfolios given constrained public budgets. The current system of procurement which exclusively uses public money and segments the contracting of design, construction, and operation services can be inefficient. Myriad alternatives are available which could incorporate better technology, save substantial capital and life-cycle costs, reduce public expenditures by utilizing private sector financing, and quicken design and construction time

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[4] Presented by James F. Hinchman, Acting Comptroller of the United States, Cambridge, MA, December 1997.

placing the project in-service much sooner. Capitalizing on these strategies is where the future paradigm of infrastructure procurement lies.

1.2 An Historical View Of Infrastructure Procurement And Development

Local governments and authorities have relied heavily on federal spending for infrastructure needs for much of the second half of this century. Large public works spending programs, such as the Interstate Highway Program of the fifties and the Environmental Protection Agency's (EPA's) Construction Grants Program for waste water facilities of the seventies, have a procurement strategy exclusively financed by the public sector. Recent examples such as the $8 billion Central Artery/Tunnel project in Boston illustrate the dependence on public funding for infrastructure programs.

Another impediment to the procurement of design and construction services has been the public sector's reliance on design/bid/build (DBB) sequencing. After a project is initially designed by an architect and/or an engineer, it must go out to bid to a pool of contractors. The bidder who comes in with the lowest price and meets the qualification criteria (licenses, bonding, state and local requirements, etc.) is awarded the project. Once construction of the project is completed, the government agency becomes responsible for operation or contracts this service to another company.

The DBB strategy can be very successful in many cases. Often, a preferred design comes from an owner's team of designers who have expertise in construction administration. Another example may be a project in which the design is very sensitive and may require flexibility. In this case, the option to use DBB may actually be more costly. Therefore, DBB must be given full consideration during evaluation of viable options. However, based on procurement paradigms throughout the last several decades, it has been given exclusive priority, therefore precluding the advantages of alternative delivery strategies.

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[5] "CBO Papers-Public Infrastructure Spending and an Analysis of the President's Proposals for Infrastructure

From an historical view, this has not been the method used for procurement of much of America's early infrastructure development. In fact, most of the early infrastructure projects from the late 18th Century to the early and mid 20th Century were funded through private franchises. During this era, bridges, tunnels, roads, railroads, telegraph, water power and ferries were procured using private sector financing strategies.[6] Based on a set of evaluation criteria which included factors such as the available budget, cost, ability to self-support, and technological implications, options were available to franchise projects to the private sector in which a team would finance, design, construct, and operate an asset, or, a team would be awarded a franchise to design, construct, and operate the asset while the financing would be arranged through the government.

Between 1850 and 1875, the Union Pacific, the Illinois Central, the Southern Pacific, and dozens of other railroads were financed, designed, constructed and operated by private franchises.[7] The federal government granted land to franchisees but no public capital was expended. Additionally, a similar franchise strategy was introduced to procure several other infrastructure projects after the disastrous results of the financing of a few road and canal projects by Congress.

The decision to tender projects to the private sector was often based on economic revitalization. The notion that infrastructure development was essential for the country's economy was assumed. The effective utilization of a combination of public sector and private sector funding strategies proved that certain projects can support themselves with a project-generated revenue stream while others could not. Therefore, projects such as dams, ferry services, railroads, bridges, and telegraph services were franchised to the private sector. Non-revenue generating projects such as breakwaters, buoys and river clean-ups were financed by government.

Spending From 1996 to 2000," Congressional Budget Office, June 1995, page ix.

[6] Miller, John B. "Toward A New American Infrastructure Development Policy for the 21st Century," Infrastructure, Vol. 1, No. 3, 1996, page 5.

[7] Miller, John B. "Toward A New American Infrastructure Development Policy for the 21st Century," Infrastructure, Vol. 1, No. 3, 1996, page 6.

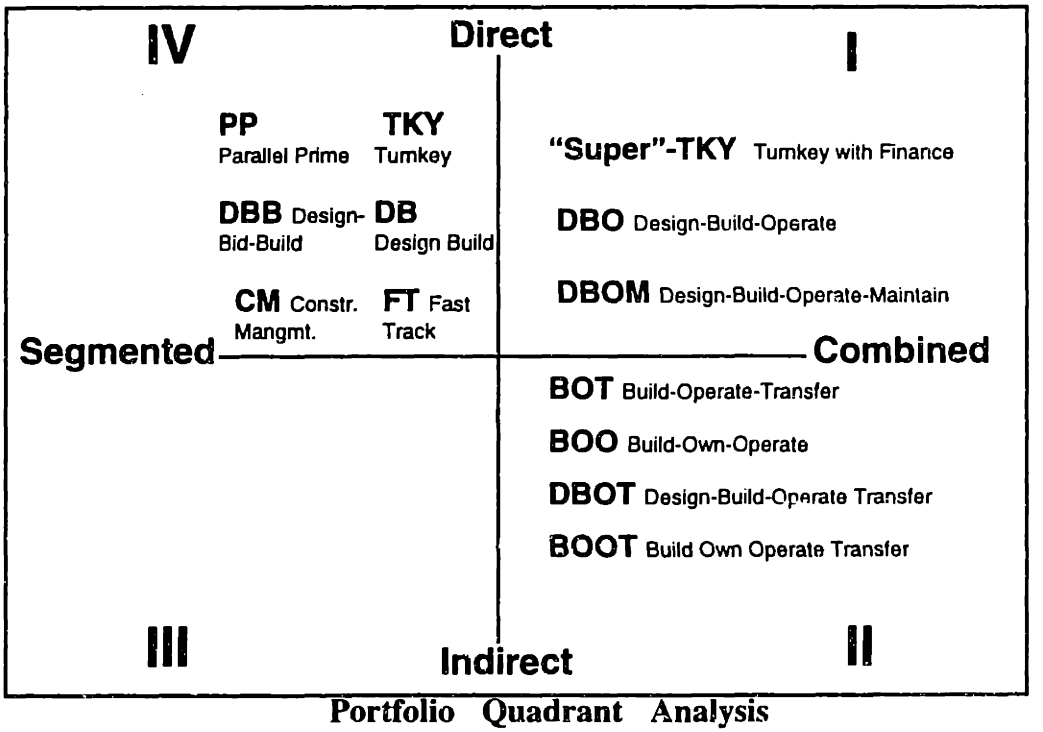
Understanding the available procurement options is important for infrastructure planners of today. The long-term advantages of alternative delivery methods are often overlooked. With limited availability of funds from the federal government, comprehensive planning must prevail in order to capture the full benefit of development programs. An old but effective method to accomplishing this is by utilizing alternative delivery methods to manage portfolios of projects.

Chapter 2

Portfolio Management-A Strategic Planning Tool

2.1 Alternative Delivery Methods

In the early history of infrastructure development in the United States, an alternative delivery strategy was utilized. This systemic approach to infrastructure procurement has been used infrequently during the last several decades. Large capital expenditures have been spent by the government to fund projects which segment planning, design, construction and operation, a process which looses the advantages of reduced life-cycle costs, reduced design and construction time, reduced public capital expenditure and enhanced technologies. Figure 2.1 presents a portfolio quadrant analysis of alternative delivery methods.[8]



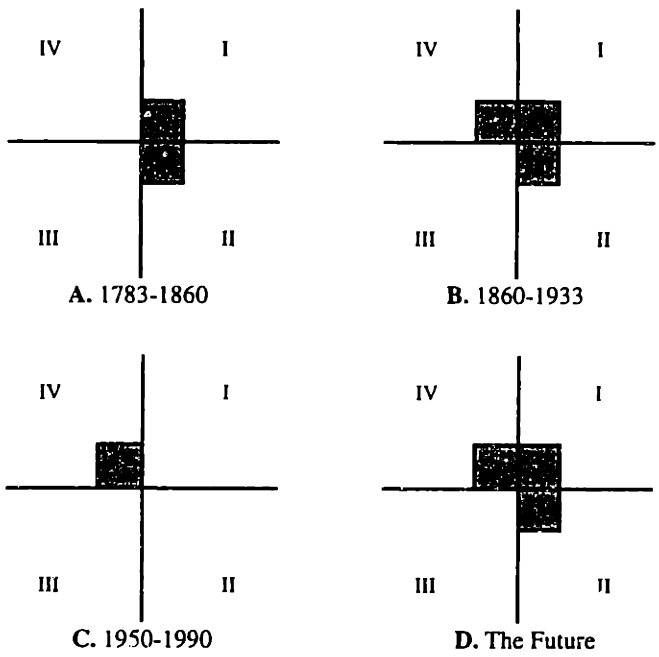
Portfolio Quadrant Analysis

Figure 2.1

[8] Miller, John. "Aligning Infrastructure Development to Meet Current Public Needs," from doctoral dissertation, June 1995.

The analysis delineates projects by using two axes; the horizontal axis differentiates a segmented procurement approach versus a combined approach while the vertical axis differentiates funding allocations coming directly from public sources versus indirect contributions from the private sector. This analysis tool is useful in quickly identifying the type of procurement method selected for a project or for a portfolio of projects.

Quadrant I projects combine design, construction, and operation, but use direct funding from the public sector. Quadrant II projects combine design, construction, and operation, and additionally include private sector financing. Quadrant IV projects use combinations of segmented design and construction from operations. Financing for these projects come from public sector sources.



American Portfolio Analyses-1783-Future

Figure 2.2

Figure 2.2 uses the quadrant analysis to evaluate procurement strategies for different eras in American infrastructure development. Figure 2.2A shows that a combined system with both direct and indirect funding sources was utilized through 1860, placing this era exclusively in Quadrant I and II. Then, a combination of segmenting design, construction

and operation prevailed during the next era through 1933 when engineers separated their practices from constructors (Figure 2.2B).[9] A combined system in Quadrants I and II was still heavily used during this time, however, many projects were also procured using Quadrant IV methods. Figure 2.2C shows that from the 1950's to the early 1990's, dependence on delivery and funding source has shifted to Quadrant IV, a clear divergence from earlier practices. In fact, almost all public projects since W.W.II have exclusively used DBB. Figure 2.2D shows a more stable strategy for the future of infrastructure procurement. A combination of strategies in Quadrants I, II, and IV is imperative for providing the infrastructure improvements necessary to sustain local economies and provide the needed services for its citizens.

2.2 Recent Applications of Private Development of Infrastructure

Privatization is a word heavily used today by governments and private companies attempting to capitalize on the need to develop infrastructure in a time when public resources are constrained. The most commonly used term when privatization is applied to civil engineering is the build-operate-transfer (BOT) delivery method. The term was first coined by Turkish Prime Minister Turgut Ozal in 1984 as part of that governments efforts to raise off-balance-sheet financing for infrastructure and industrial projects.[10] Since then, it has seen several successes and failures, nonetheless, it remains the hottest innovation in project financing.

The rudimentary structure of a typical BOT is as follows: 1) A government evaluates a project typically completing five to 15 percent of the design, 2) Financial analyses are calculated to determine if the project is viable for the private sector, 3) Request for Qualifications (RFQ's) are issued to companies ensued by Request for Proposals (RFP's),

[9] During the late half of the 19th Century, the services of architects and engineers became recognized as distinct professions distancing themselves from builders and constructors. Hence, a paradigm occurred where complete drawings and specifications were issued and priced by builders prior to commencement of construction work. Thus, the emergence of a Quadrant IV alternative begun.

4) Based on evaluation criteria, a winner is selected to complete design, construct, and operate the facility for a specific term, 5) Once the term is expired, the facility returns control over to the government. The government could then renew a contract with the same operator, re-compete operations to bidders or take over operations themselves.

2.2.1 International Applications of the BOT

The BOT concept has been widely used in the procurement of international projects. Almost 1000 projects worth $700 billion dollars are under consideration with over 350 projects worth $145 billion already completed or under construction.[11] In developing countries, the concept is especially advantageous due to the lack of governmental funds available. Projects such as power plants, bridges, tunnels and highways are heavily documented in academic journals describing international BOT projects.

Of the hundreds of BOT projects started in the eighties, the overall success cannot accurately be determined for years to come. The term for a typical BOT can be as short as 10 years or as long as 55 years, thus, it cannot be pre-forecasted what type of event may happen down the line to jeopardize the project's success. However, evaluation of current progress can be made to illustrate the complexity of these projects. Two well known BOT's which have differing levels of success are the Channel Tunnel project linking England and France and the Sydney Harbor Tunnel project in Australia.

The Channel Tunnel project was started in 1986 as a BOT concession organized jointly between the French and English governments. The original cost of the project was estimated at $9.2 billion, 20% coming from equity sources and 80% coming from debt. The franchise term of the project is 55 years and the project owner is Eurotunnel, a consortium of French and English banks and contractors.

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[10] Tiong, Robert L.K."Comparative Study of BOT Projects," Journal of Management in Engineering, January 1990, page 107.

[11] Public Works Financing, Vol. 89, October 1995.

The project was modeled as the dream and essence of privatization. However, the dream turned into a nightmare as construction costs escalated out of control. When the 50-km tunnel was finally completed in 1994, the debt and interests costs were unmanageable. In September 1995, the company in effect declared bankruptcy when it announced an 18-month moratorium on paying its interest. Debt had tripled, and interest alone skyrocketed twice as fast as revenues.[12] The project has completely failed, even with heavy marketing attempts and financial restructuring. The failure generated serious concern in the ability to franchise a project of this size by the private sector. It is by far one of the largest single BOT projects in history.

Conversely, the Sydney Harbor Tunnel project in Australia has operated smoothly since its 30-year concession was signed in 1986. The winning bidder on the $550 million project was the Sydney Harbor Tunnel Company, a joint venture by two construction companies, Japan's Kumagai Gumi and Australia's Transfield. The 2.3-km tunnel connects Sydney to the North Shore by a submerged connection.

Negotiations between the franchisee and the government achieved a much improved opportunity for success on the Sydney Tunnel project than the Channel Tunnel. The government allocated an interest free loan in the amount of $125 million (about 23% of total project cost) to cover preliminary construction costs.[13] Further, the government guaranteed a minimum traffic toll income to protect against unanticipated increases in electricity costs, wages and unforeseen cost rises beyond its control. Additionally, the government conceded operation of the Sydney Bridge to the franchisee. To repay the debt, toll fees were increased from $.25 to $2.00 per car, the same toll cost of the tunnel.

The concessions and guarantees of the Australian government demonstrate their commitment to making the project work. Risks are shared by both the public and the private sector, but, common goals were aligned which increased the chances for success.

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[12] Winninghoff, Ellie."Anatomy of a Failure," International Business, July/August 1995, page 11

[13] Tiong, Robert L.K."Comparative Study of BOT Projects," Journal of Management in Engineering, January 1990, page 110.

2.2.2 American Applications of the BOT

The early part of this decade has led to increased interest in the use of BOT for American infrastructure projects. State DOT's and other agencies have spent millions of dollars studying the possibility of franchising pieces of their infrastructure, all with the common notion that private financing equals reduced public expenditure. In some cases, states have issued RFP's for teams to come up with their own ideas for projects. Both Minnesota and Washington attempted this very concept of "free-for-all" infrastructure development, without much avail.

While the second-coming of privatization is still picking up steam, several examples of failed projects cast a dubious light on the ability of private sector companies to provide certain types of infrastructure. The Dulles Greenway project is indicative of the difficulty toll road projects face when revenue streams do not reach expected levels.

For years, the connection between Dulles Airport in Virginia and Washington DC was troubled by the poor condition and alignment of its access road. During the eighties, Magalen O. Bryant led her family-owned investment firm, Lochnau Ltd., in a campaign to provide the first major BOT toll road project in decades. The $326 million-14.1 mile extension would connect the airport with Leesburg, a Virginia suburb of Washington.

The project was delayed several years due to the difficulty in obtaining financing. Original investment by the Bryant family was expected to be $15 million, however, this amount was ultimately increased to $68 million, 21% of the total project cost.[14] A consortium of international lenders provided the remaining amount of project capital.

On September 29, 1995, the greenway was opened for traffic to less than a thunderous roar. By the end of the first operating year, ridership was at a disappointing average of 10,500 daily travelers, well below the expected level of 34,000.[15] One-third of the toll

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[14] Korman, Richard."Bryant family puts down a $68 million bet," Engineering News Record, November 15, 1993, page 13.

[15] Ichniowski, Tom."Light traffic chills Dulles debut," Engineering News Record, January 1, 1996 page 8.

collection staff has already been laid-off while the company continuously struggles to find ways to repay its loans.

The Dulles project has heightened concerns about the future of private toll road projects all over the country. At the same time, another major toll road, State Route 91 in Orange County, California, opened for traffic in December of 1995. This $126 million project consists of a 4-lane facility set in the median of the existing Riverside Freeway.

Thus far, it has fared much better than Dulles; 24,000 daily travelers pay as much as $2.75 to ride in the express lane. The public benefit the project has had is that it has relieved a large amount of congestion on that stretch of highway, making the commute more enjoyable for express lane users and free lane users.

Privatizing infrastructure is a very involved process which takes in-depth analysis and negotiation from both sides to achieve a successful project. The above mentioned projects focus on toll roads which are very precarious. In fact, highway and transit infrastructure are generally two of the most difficult types of infrastructure to privatize. Conversely, power, waste water, aviation, telecommunications, and rail have been proven to work extremely well in private sector hands. The revenue streams are predictable and sufficient enough to support operations and provide a hefty return. Other types of infrastructure need creative strategies to capitalize on the advantages of alternative delivery methods, which often cannot solely be accomplished by the exclusive use of private funds. A comprehensive strategy combines different procurement methods that most effectively apply to individual circumstances of each project.

2.3 An Alphabet Of Delivery Options

The portfolio quadrant analysis presented in Figure 2.1 illustrates the availability of several delivery and financing strategies for projects. Within each method identified in Figure 2.1 are numerous variations which can affect the process of a project differently. The quality, capital cost, operation cost, time schedule, technology, and financing are all

variables which can be affected by the selection of delivery method. It is critical for governments to understand these variables so they can establish an appropriate procurement strategy.

Within Quadrant IV, the prevalent constant is that financing is directly funded by government. However, several alternatives to the segmented design-bid-build (DBB) method are available, with substantial time, cost, and quality implications present. The design-build (DB) and fast-track methods place emphasis on design and construction duration by completing the project in a substantially shortened amount of time. Turnkey capitalizes on the advantages of a combined design and construction, with the additional risk of turning over a fully-operational facility to the owner on time and on budget.

Within Quadrants I and II, a constant throughout most delivery strategies is that the design, construction, and operation are combined to capitalize on a verification of project feasibility, selectivity in technology choice, reduction in life-cycle cost, and verification of contractor experience. Variables exist in the way financing is arranged. For example, a pure BOT or BOOT is financed completely by the private sector, however, combinations of private and public sector financing can be structured for DBO's or DBOM's.

In the end, the acronyms used to describe a project are less important than the actual way the project is structured. Global consensus has not yet been achieved on the proper way to name a certain project structure. Furthermore, projects may begin as one delivery method, and through negotiations with the franchisee, the structure may completely change. Nonetheless, key to understanding procurement alternatives, beyond the confusion of the delivery method alphabet, is that numerous options are available which can be tailored to meet the specific requirements of that project. Knowledge of these types of procurement is essential in planning strategies to accomplish development programs.

2.4 Developing Competitive Regional Economic Strategies

Finally, infrastructure development must be used as a basis for competitive regional economic strategy. Studies have shown that cities and states which have invested more in infrastructure tend to have greater output, more private sector investment and more employment growth.[16] All of these factors contribute towards improving the quality of life of the areas citizens, as well as sustaining capacities for growth and development.

An evolution of the conventional process for providing infrastructure services is occurring. Competition on a regional, national, and international level is pushing rapid innovation in services to keep pace with quickly moving markets and potential growth opportunities. Regional strategies which capitalize on joint public and private sector development will achieve necessary integration of goals with combined efforts and resources. Manipulation of these portfolios will help agencies sift through their "public needs" lists to better allocate and more efficiently stretch resources. The case studies presented in the next two chapters will offer examples of this process.

[16] Munsell, Alicia H."How Does Public Infrastructure Affect Regional Economic Performance," New England Economic Review, Sept/Oct 1990, page 12.

Chapter 3

Case Studies

3.1 Introduction

Three case studies have been selected to investigate the utilization of alternative delivery and financing methods for the procurement and management of infrastructure portfolios. The three portfolios selected are Hong Kong's regional infrastructure development strategy, New York's John F. Kennedy International Airport Redevelopment Program, and Boston's Logan 2000 Program at Logan International Airport.

Selection of these programs for analysis in this thesis was based on several notions. First, all three programs represent entirely different scales. Hong Kong's program is estimated to cost far in excess of $16 billion (1989 dollars). Kennedy Redevelopment is $4.4 billion and Logan's program is approximately $1 billion. Second, each program involves mixtures of delivery methods for the procurement of transportation infrastructure. Last, all three examples illustrate opportunities for regional strategic economic advantage.

Analysis of these programs will give insight into a fourth case which is still in its planning stages. The Intermodal Transit Connector project, originally conceived as part of Logan 2000, will be individually evaluated to determine alternative procurement strategies for its design, construction, operation and financing. Recommendations will be made based on lessons learned from Hong Kong, JFK Redevelopment and Logan 2000.

3.2 Hong Kong's Territorial Development Strategy

3.2.1 Background

Hong Kong has experienced phenomenal growth over the past few decades to the extent of where the tiny territory located in the southern area of China is the world's 11th largest trading nation.[17] In addition to being Asia's major tourist destination, the area is an international commercial, financial and industrial center for Asia's Pacific region. The territory, which was recently released back to China after a century of government rule under the United Kingdom, is considered to be the gateway to China for trade, investment and tourism.

Maintaining Hong Kong's status as a leader in Asia has forced the territory to compete with other Asian nations. For instance, early this decade, Hong Kong lost its title as the world's leading container port for two years to Singapore, only to win it back with increased investment in port facilities. To sustain their advantage, Hong Kong launched a HK$127 billion (US$16 billion-1990 dollars) program that will provide a new airport, a series of new port facilities, and several rail and road transportation links. The program, entitled the Port and Airport Development Strategy (PADS), is considered one of the world's most significant engineering projects. In addition to PADS, several more billions of dollars are being spent on other infrastructure projects including tunnels, landfills and roads. These projects are expected to lead Hong Kong into the next century as the international transport hub.

3.2.2 Infrastructure Development-An Imperative for Economic Development

The Hong Kong government sees infrastructure as the cornerstone of its efforts to bolster business confidence. This ideology explains the relationship the government has

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[17] Robinson, David."Hong Kong's launching PADS for the 21st century," Professional Engineering, December 1992, page 18.

with the private sector in providing a foundation for entrepreneurial success and creative thinking. Conversely, the United States has often stymied creative economic opportunities in infrastructure development during much of this half of the century by mandating delivery methods which fragment design, construction and operation of facilities, and preclude opportunities for long-term economic development.

Both Hong Kong and the greater southern China region believe that an investment in infrastructure is imperative for attracting and sustaining business development. Anson Chan, Hong Kong's Secretary for Economic Services, commented in regards to the necessity of a new airport at Chek Lap Kok that, "If we can not provide adequately for our air traffic, we will incur substantial economic dis-benefits, amounting to HK$101 billion between 1996 and 2010."[18]

Efforts in the southern provinces of China to invest in infrastructure have been slow but the government is firmly committed to build. An extensive program of toll roads, rail systems, and power plants are planned to create a parity between itself and the development of its neighbor to the south, Hong Kong, which will collectively place the region in a long-term strategic position.[19]

3.2.3 Hong Kong's Portfolio Procurement Strategy

The Hong Kong government has been very strategic in capitalizing on the advantages of alternative delivery methods for its extensive infrastructure development portfolio. Utilization of DB, DBO, and BOT has achieved the following benefits:

- Time savings
- Better technology
- Decreased governmental spending

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[18] Robinson, David."Hong Kong's launching PADS for the 21st century," Professional Engineering, December 1992, page 19.

[19] "Development in China: A single step," The Economist, August 13, 1988, page 62.

- Increased innovative thinking and competition.
- Single source responsibility for design, construction and operation

Key to the success of the portfolio has been the government's insight into selecting the appropriate projects for each delivery method. This selection process requires extensive study and investigation; the government has been very smart in researching these options before offering invitations to bidders. I have categorized Hong Kong's portfolio into three areas for evaluation:

1) Airport Core Program (ACP)

2) Container Port Development

3) Miscellaneous DBO and BOT Projects

The areas listed above do not cover the full extent of Hong Kong's entire public works program, however, key packages are discussed which underscore the process Hong Kong has used for planning and delivering its infrastructure program.

3.2.4 The Airport Core Program

The Airport Core Program (ACP) consists of 10 inter-linked projects focused around the construction of a new airport at Chek Lap Kok, the replacement to Hong Kong's saturated airport at Kai Tak (Figures 3.1 and 3.2). In addition to a new airport, the program consists of 34 kilometers of new highway, a new railway, more than 350 hectares of land reclamation and a new town.[20] The HK$112.2 billion (March 1991 figures) program is scheduled to be completed in 1998.

Several governmental agencies are coordinating work on the program in conjunction with the private sector. The New Airport Projects Coordination Office (NAPCO), an integrated project management team covering the ACP, has strategically structured the program to utilize and encourage private sector development in two ways. Within the ACP

[20] "Building for the future," Hong Kong Airport Core Program Brochure, Produced by the New Airport Projects Coordination Office, July 1994, page 1.

scope, the government has tendered BOT franchises for approximately 20% to 30% of the entire program. The remainder are projects awarded under design/build and design/bid/build methods (Figure 3.3). Outside of the ACP scope exists several private sector residential and commercial development opportunities strategically located to capitalize on the alignment of rail and highway links.

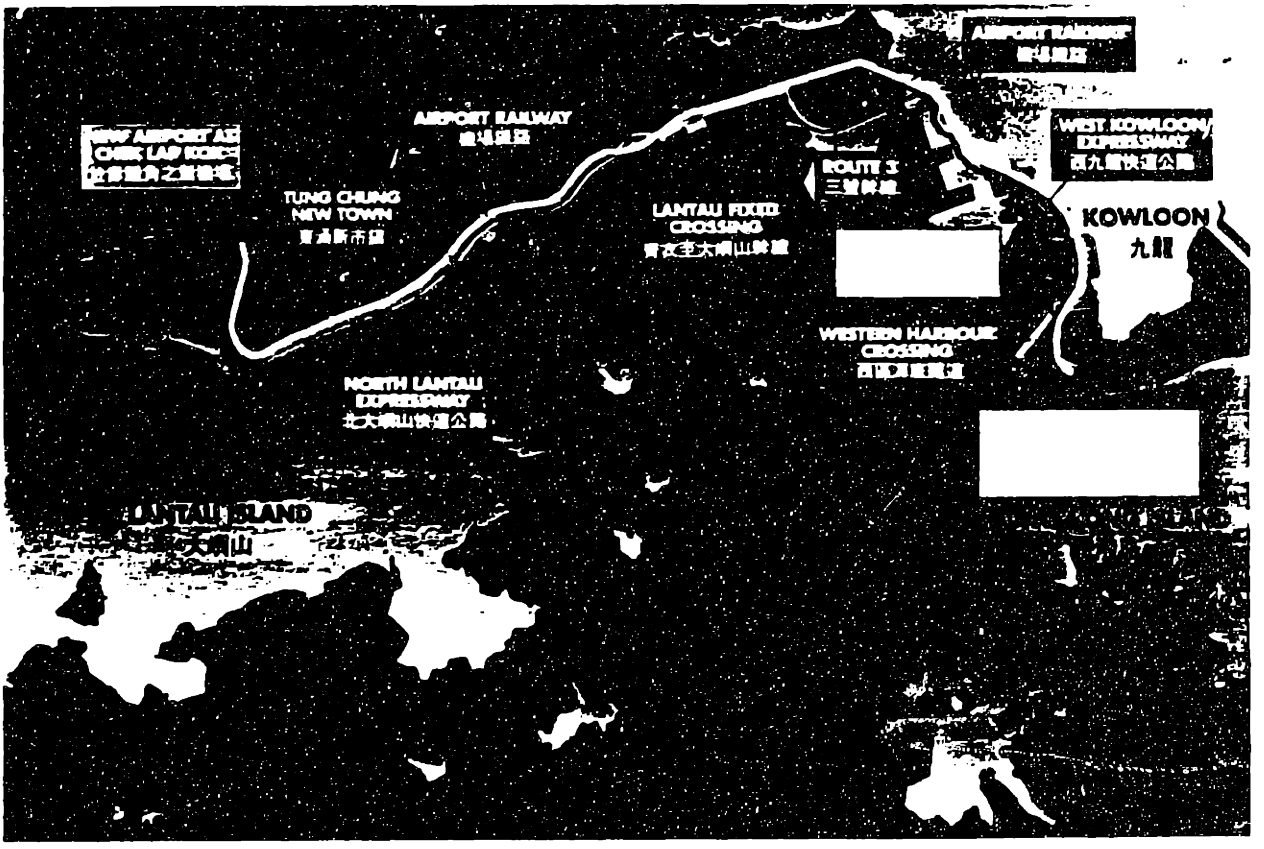


Figure 3.1

Map-Airport Core Program

Figure 3.2

Airport Core Program

10 inter-linked projects focused around the completion of the new airport in the Spring of 1998.

1. New Airport at Chek Lap Kok
The new airport will open with one runway and have an initial capacity of 35 million passengers and three million tons of cargo per year. A second phase will expand the capacity to 87 million passengers and nine million tons of cargo a year by 2040.
The Airport Authority, the government body created to plan, design, and build the airport, is responsible for construction of the airport island, its runways and airfield, the passenger terminal complex and all on-island infrastructure. The private sector will substantially contribute to the airport's HK$49.8 billion cost (forecasts range private sector contributions from 25% to as much as 40%) in the form of franchise and license agreements for individual businesses on the island. Three real estate clusters on the island will provide further opportunities for private sector businesses.

2. Lantau Fixed Crossing
This crossing consists of two bridges, the Tsing Ma Bridge and the Kap Shui Mun Bridge, and a viaduct carrying both vehicular traffic and rail lines.

3. Airport Railway
The airport railway will be 34 kilometers of line starting in Hong Kong Island and terminating at the new airport.

4. Western Harbor Crossing
This BOT tunnel will be the third crossing under Victoria Harbor and the only project in the ACP outside of the new airport and the New Town procured with private financing.

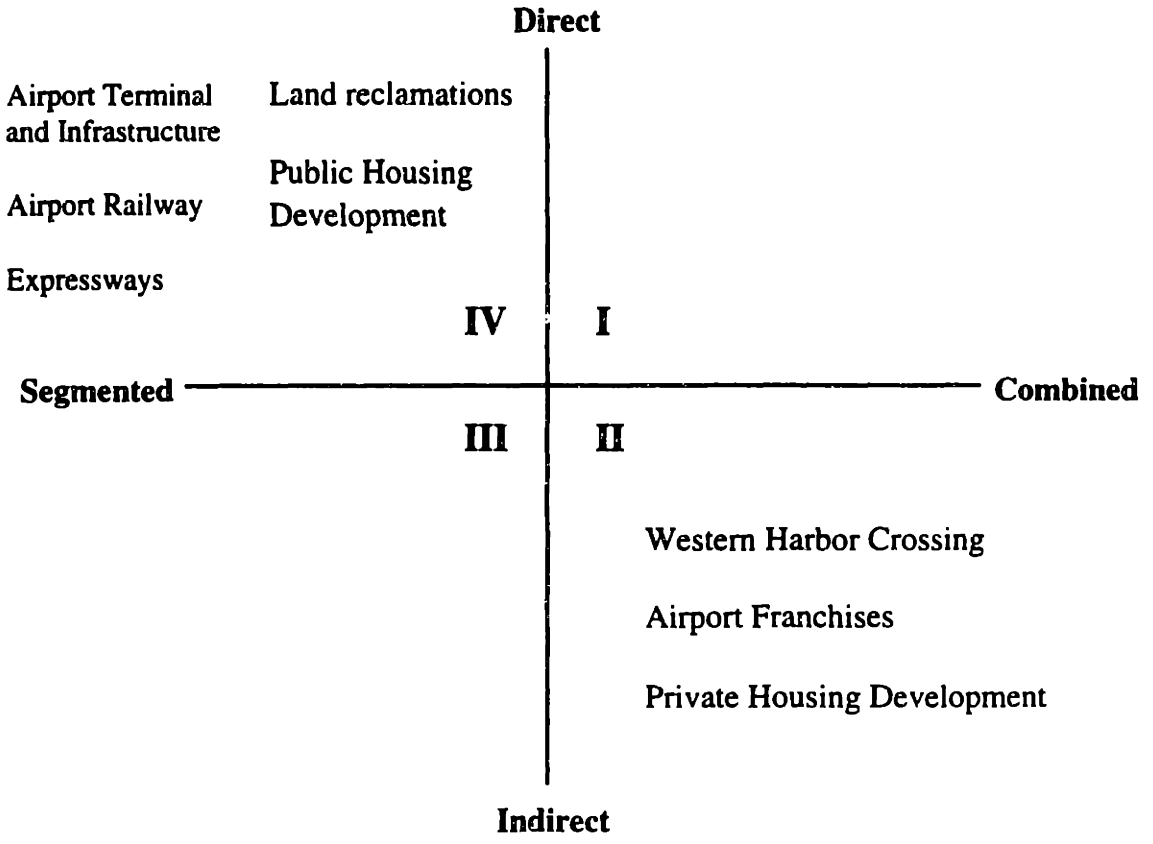
5. North Lantau Expressway
This expressway will run along the northern coast of Lantau Island linking the airport and the Tung Chung New Town with the Lantau Fixed Crossing.

6. Route 3
This expressway will link the Lantau Fixed Crossing to the West Kowloon Expressway through the island of Tsing Yi to the city of Kwai Chung.

7. West Kowloon Expressway
This major North-South link (also part of Route 3) will connect the Western Harbor Crossing to Kwai Chung, relieving much of the traffic on the western side of New Kowloon.

8. & 9. West Kowloon Reclamation and Central and Wanchai Reclamation
The West Kowloon Reclamation is 330 hectares of infilled land providing surface for the West Kowloon Expressway. The Central and Wanchai Reclamation's are 20 hectares of infill in Victoria Harbor providing a terminus for the Airport Railway.

10. Tung Chung Development
This development will primarily serve as a support community for the new airport which will have an initial work force of approximately 35,000 people.(8) The island will mix public and private housing and commercial development. A population of 120,000 is expected to be reached in 2006.



Portfolio Analysis-Airport Core Program

Figure 3.3

3.2.4.1 Airport Franchises and Private Sector Opportunities

Governmental resistance from China and the unique circumstances around the territory's return to China in 1997 both led heavily in the decision for the Hong Kong government to financially support much of the ACP. The increased uncertainty in the project moving forward and the lack of endorsement from the capital in Beijing created a difficulty in acquiring large amounts of private sector capital. The recent example of Bangkok's Second Expressway fiasco has undoubtedly caused some apprehension in the minds of infrastructure developers. In Bangkok's case, the political turn of the government near the construction completion of a BOT tendered expressway left the developer with a project that was shut down by the government.

To circumvent any delays in completing the airport, the government financed and delivered the construction of land reclamation, the runways and airfield, the passenger terminal complex, the roadways and the island utilities. The cost of these packages is approximately 70% to 80% of the airport's total cost. To utilize private sector capital, several franchises and development opportunities have been created by the Provisional Airport Authority, the governmental body responsible for planning, designing and constructing the airport. Airport projects have been tendered which are self-supporting, specialized, and operate more efficiently by private companies and are not in jeopardy of cancellation. Once work on the island and the infrastructure of the airport is underway, the certainty of the airport becoming realized is more definite, thereby increasing the attractiveness of private sector development.

The Airport Authority has structured private sector developments in three categories:[21]

- Airside Support Service Franchises (Figure 3.4)
- Retail Licenses (Figure 3.5)
- Airport Related Developments

The Airport Authority has planned 83 hectares of land on Chek Lap Kok for private commercial use on three sites. The 45 hectare North Commercial District is envisaged as the new commercial center of Hong Kong. The area is identified as a medium density office, hotel and retail development area.[22] Potential ferry lines could connect this area with Hong Kong and the Pearl River Delta, ideally capitalizing on the future commercial growth of southern China.

The eight hectare East Commercial District will be developed as a low density office and hotel site. The low development heights of the area foster an opportunity for the site to become a business park.

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[21] From Hong Kong Airport web page: www.hkairport.com, October 1997.
[22] From Hong Kong Airport web page: www.hkairport.com, October 1997.

Figure 3.4

Franchises For Airside Support Services

Franchise	Franchisee	Franchise Term
Ground support equipment maintenance services	Ground Support Engineering	10 years
	Dah Chong Hong-Dragonair Airport GSE Services Ltd.	10 years
Into-plane fueling services	AFSC Refueling Ltd.	10 years
	AMR Airline Services fueling Ltd.	10 years
Airside petrol & diesel filling services	Mobil Oil Hong Kong Ltd.	10 years
Air cargo services	Hong Kong Air Cargo terminal Ltd.	20 years
	Asia Airfreight Terminal Co. Ltd.	20 years
Aircraft catering services	LSG Lufthansa Service Hong Kong Ltd.	15 years
	Cathay Pacific Catering Services Ltd.	15 years
	Gate Gourmet Hong Kong Ltd.	15 years
Aircraft maintenance services	Pan Asia Pacific Aviation Services Ltd.	10 years
	China Aircraft Services Ltd.	10 years
	Hong Kong Aircraft Engineering Co. Ltd.	20 years
Aviation fuel service system	Aviation Fuel Supply Company	20 years
Ramp handling services	Ogden Aviation Hong Kong Ltd.	10 years
	Hong Kong Airport Services Ltd.	10 years
	Jardine Air Terminal Services Ltd.	10 years

Figure 3.5

Agreements For Airport Related Development

Development	Developer	Sub-Lease Term
Telephone exchange	Hong Kong Telephone Co. Ltd.	30 years
	Hutchinson Communications Ltd.	30 years
	New World Telephone Ltd.	30 years
Airline headquarters, flight training center and stores	Cathay Pacific Airways Ltd.	50 years
Landside petrol filling stations filling services	Shell Hong Kong Ltd.	15 years
Freight forwarding center	The Airport Freight Forwarding Center Co. Ltd (A consortium)	20 years
Hotel and car park	Bauhinia Hotels Ltd.	25 years
Airline headquarters	Cathay Pacific Airways Ltd.	50 years

Retail Licenses Awarded

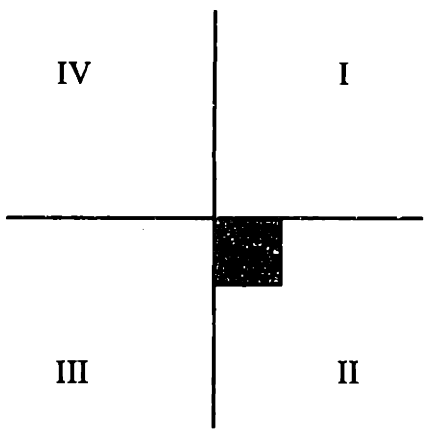
License	Licensee	License Term
Duty Free liquor & tobacco	Sky Connection Ltd.	62 months
Perfumes & cosmetics	Nuance-Watson (HK) Ltd.	60 months
Airside general merchandise	Nuance-Watson (HK) Ltd.	64 months

The 30 hectare South Commercial District will comprise both commercial and warehouse developments. The site which is adjacent to the cargo facilities makes the location ideal for freight related businesses. Several franchises for this site have already been awarded (Figure 3.5).

The Authority has strategically capitalized on the growth opportunities of the region by planning for extensive private sector development. With the recent signing of leases and the estimated future growth, these areas will generate substantial incomes for the Authority through ground leases and other negotiated arrangements.

3.2.5 Container Port Development

The other major component to PADS is the expansion of Hong Kong's container port facilities. By contrast to the ACP, 100% of the container port development is tendered by BOT (Figure 3.6). Also differing from PADS is that the port can be developed incrementally by demand as opposed to one big lump like the airport. Approximately HK$50 billion (1990 dollars) is estimated to be spent on port development throughout the 1990's.[23]



Container Port Strategy

Figure 3.6

[23] Selwyn, Michael."Launching PADS for confidence," Asian Business, July 1990, page 35.

The main element of port development is centered around the consolidation of container facilities at Kwai Tsing, the main area for container operations. The commissioning of Terminal 8 at Stonecutters Island is a four berth facility tendered as a BOT. The government invites bids, then appoints an operator for a fee. The operator is responsible for total development, from dredging to installation of equipment, and runs the facility under an agreement for a specified term.

Future facilities planned are to include a ninth terminal at Kwai Chung, and terminals 10 and 11 off the north side of Lantau Island. Concerns about the growth of port traffic in the Hong Kong area place skepticism on the necessity for terminals on Lantau. China is also concerned about getting in on the action. Several proposals are currently circulating about negotiating deals with China to build facilities in Shenzhen, closer to where much of the business leaving Hong Kong's ports is generated.

The demand for new facilities in Hong Kong can only be determined over time. However, the business of container transport is lucrative enough that when and if the currently operating facilities become saturated, operators will be heavily competing for the award of a new concession.

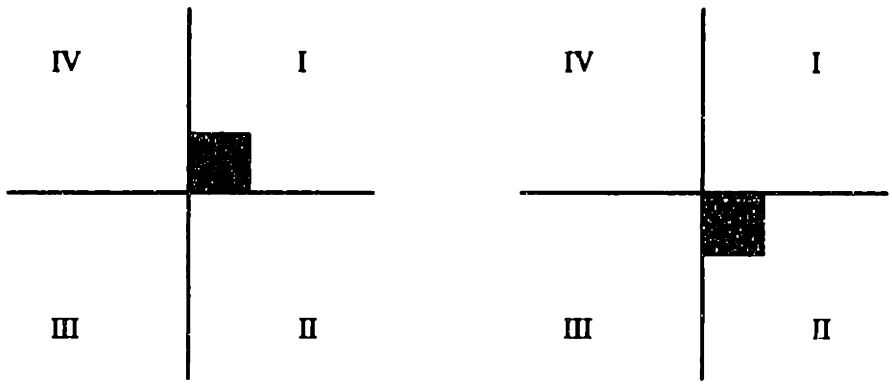
3.2.6 Miscellaneous DBO and BOT Projects

The government has successfully arranged a number of landfill and environmental projects utilizing DBO strategies (Figure 3.7A). User fees are collected to pay for the operations of the facility by the franchisee; the term can last as long as 50 years. An interesting fact the government has noticed through this procurement approach is that while the quality and operation of the facilities is considerably superior to their predecessors, the costs have actually gone down.[24]

Two major BOT tunnel projects already in operation are the Tate's Cairn Tunnel and the Eastern Harbor Tunnel (Figure 3.7B). Both of these franchises have reduced congestion to

[24] "Environment Hong Kong 1994," Hong Kong Environmental Protection Department, 1994, page 57.

and from New Kowloon and Hong Kong Island respectively. Additionally, they have been successful in reducing government spending, obtaining current technologies, and cutting overall design and construction time, placing the project in-service much faster than with conventional methods.



A.Environmental Landfill Strategy B.Harbor Tunnel Strategies

Figure 3.7

The Eastern Harbor Crossing was envisaged to follow the same success as its BOT predecessor, the Central Harbor Crossing. The demand for a new tunnel spawned by continued growth on Hong Kong Island led to the tendering of this tunnel. The Kumagai/Marubeni joint venture, awardee of the franchise and proposer of an earlier unsolicited proposal for private operation of the facility, constructed the tunnel ahead of schedule and are now operating the facility under a 30 year term. The facility was opened in 1989.

The planning of the Tate's Cairn Tunnel responded to growth in the New Territories located north of New Kowloon, over a range of mountains. Only two connections linked New Kowloon with Sha Tin, a rapidly growing city on the other side of Lion Rock and Tate's Cairn peaks. The BOT franchise, awarded to a joint venture of Gammon Construction Ltd. and Nishimatsu Construction Co. Ltd. in 1988, also has a term of 30 years.

3.2.7 Interim Conclusions

Hong Kong's example illustrates an effective strategy to manage a large portfolio of projects while utilizing a variety of delivery methods from all three quadrants. The government has utilized as much as 40% of private sector capital on PADS alone, the heart of the territorial development strategy. Several individual projects outside of PADS have successfully utilized DBO and BOT methods for procurement and financing as well. The tunnel procurement examples alone have illustrated the impressive market for privately funding these capital-intensive projects which would otherwise be too constraining on the governments budget.

Key to the success of this strategy has been the successful coordination among varying governmental agencies. Efficacy on a program of this size could only come about through active communication early and throughout the entire process. The involved agencies have been very strategic and creative in their approach to bring together multiple disciplines and to work progressively with private sector companies.

Also, the focus of a long-term economic strategy based on infrastructure development has provided the region numerous opportunities for growth, employment and entreprenurialship. In addition to the multitude of service and construction industry jobs directly related to the program, several economic centers have been incorporated for future planning and development . This long-term strategy will enhance Hong Kong's chances of becoming the premier transport hub of the Asia-Pacific region.

3.3 John F. Kennedy International Airport Redevelopment Program-New York City

3.3.1 Background

John F. Kennedy International Airport is located in the southern area of the Borough of Queens, New York. The airport, which covers 4,930 acres, is situated on Jamaica Bay and is under lease from the City of New York. The Port Authority of New York and New Jersey operates the facility which opened on July 1, 1948 under the name "New York International Airport at Idlewild."

On March 10, 1955, the Port Authority began construction of a "Terminal City" - a mile long oval of passenger terminals. The 837 acre area was designed to have a terminal for every major US airline. The center piece was the International Arrivals Building (IAB), which was conceived as a showcase of the air age.[25] The entrance contained a grand boulevard with fountains and open spaces, creating a gracious and elegant arrival into New York City-the gateway to America. Soon after the IAB's opening in 1957, the following airlines opened their terminals: United and Eastern in 1959, American in 1960, Northwest in 1961 and Pan American and TWA in 1962. The British Airways terminal was opened in 1970.

Over the years, JFK needed to respond to several issues which were testing its flexibility. These issues included heightened security requirements, larger aircraft and increased passenger levels. Several "on the spot" renovations and additions were made to handle the rapid growth, however, none sustainable for long term-growth. By the mid-1980's, passenger traffic at JFK had increased to 30 million annually, twice the airport's original design capacity. By the end of the century, an estimated 35 million annual passengers will fly through the facility.[26]

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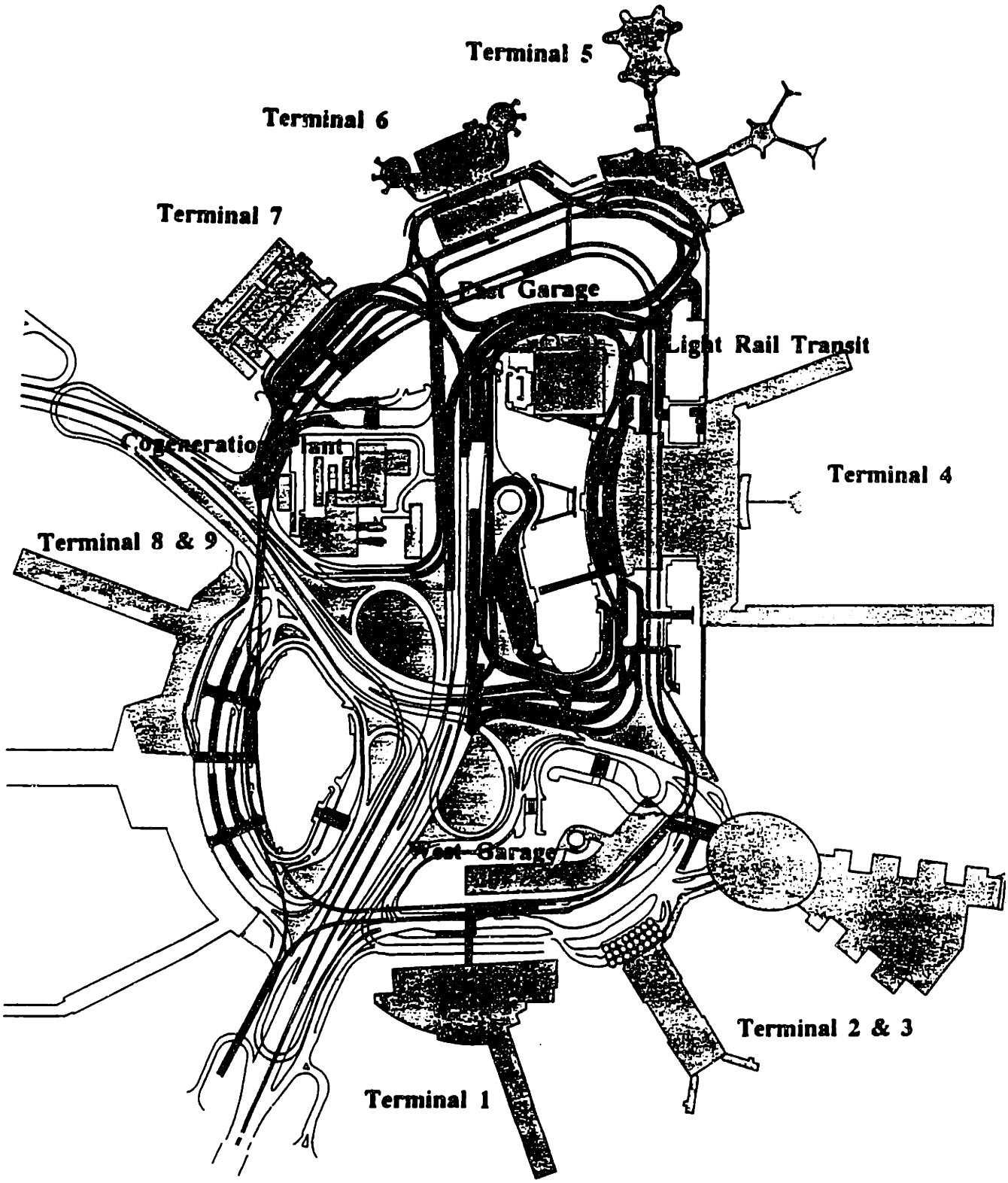
[25] "John F. Kennedy International Airport Redevelopment Program-Third Quarter 1997," The Port Authority of New York & New Jersey, page 2.

[26] "John F. Kennedy International Airport Redevelopment Program-Third Quarter 1997," The Port Authority of New York & New Jersey, page 3.

Figure 3.8

Map-JFK Redevelopment Program



3.3.2 The JFK Redevelopment Program

By the mid-1980's, infrastructure decay to JFK's roadways, utilities, and terminals dubbed it as the gateway into the unpleasantness of New York City life.[27] The strategic advantage of JFK, which is extremely vital to the economic sustainability of New York City was slipping fast. Given the projected number of users to the facility nearing the turn of the century, an extensive program originally entitled JFK 2000, now called The JFK Redevelopment Program, was envisaged to essentially rebuild the airport and restore functionality.

The JFK Redevelopment Program has three specific objectives: [28]

1) To develop and implement a landside access plan (roadways, terminal buildings, parking lots, and an inter-terminal transfer system that will provide access to the region's extensive mass transit network) capable of serving the 35 million annual passengers expected to use JFK by the end of the century.

2) To plan, design and construct improvements that optimize the safety and security of passengers, cargo, tenants and employees while maintaining ongoing operations.

3) To contribute positively to the long-term economic growth and vitality of the region.

The JFK Redevelopment Program consists of Port Authority and tenant construction and expansion programs (Figure 3.8). Total investment is projected to be $4.4 billion by the end of the decade. $1.6 billion is money contributed by the Port Authority while $2.8 billion, almost two-thirds, is funded from private sources (Figures 3.10A and 3.10B).[29]

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[27] Jacobs, Karrie."Plane and Simple," New York Magazine, August 25, 1997, page 38.

[28] "John F. Kennedy International Airport Redevelopment Program-Third Quarter 1997," The Port Authority of New York & New Jersey, page 1.

[29] "John F. Kennedy International Airport Redevelopment Program-Third Quarter 1997," The Port Authority of New York & New Jersey, page 1.

Figure 3.9A

JFK Redevelopment Program

Port Authority Projects-Design/Bid/Build

1. Airport Traffic Control Tower
A new 321 foot high state-of-the-art traffic control tower began construction in 1988 and was in service in 1994. It replaced an outdated tower which was demolished after completion of the new facility. The Federal Aviation Administration granted $7.3 million toward the construction of the $55 million tower.(7)

2. Airport Roadway and Utilities
Construction of the roadway and utility work began in 1989 and is estimated to be completed in 1997. The roadway system configuration divides the network into four quadrants, eliminating the need to loop the entire airport to arrive at a particular terminal. A total of 32.3 land miles of road and terminal frontages are being built or reconfigured. A new directional signage system, a new computer-based traffic signal system and a new central taxi hold are under this package. Financing of this package is from Port Authority funds.

3. Light Rail Transit System/Rail Access
Planning is under way for a new fully automated Light Rail Transit System which will provide a convenient connection between terminals. The plan will decrease transfer time and reduce congestion on roadways. The elevated system will loop the central terminal area and ultimately connect to the city's subway system and the Long Island Railroad. The central terminal area scheme will be procured using Port Authority money while private developers are being sought for the external connections. Cost for the central terminal alignment is $300 million.

4. Parking Garages
The Port Authority is constructing two new garages named the East Garage and the Green Garage. Total cost for both of these projects is $101 million.

5. Taxi Hold
A consolidated remote taxi hold was constructed outside of the central terminal area to relieve congestion and competition of taxi cars at terminals. Taxis will be dispatched as needed from terminal stations-arrival of cars to the terminal should be within minutes. Cost for this facility is $7 million.

6. Airport Rehabilitation Projects
Several miscellaneous rehabilitation projects are scheduled for the airside which include the following: Construction of new taxiways; Installation of mechanical ventilation systems; Installation of new runway and taxiway guidance signs in accordance with updated Federal Aviation Administration standards.

Figure 3.9B

JFK Redevelopment Program

Private Sector Projects

1. Terminal 1
Air France, Japan Airlines, Korean Air, and Lufthansa have joined to design and construct Terminal 1 on the site of the former Eastern Airlines Terminal. Completion on the new 11 gate terminal is scheduled for 1998.

2. Terminal 2 & 3
Delta Airlines has a $150 million program to renovate Terminal 2 and 3 by redesigning first and business class lounges, adding new ticket counters, and improving lighting and interior finishes. Delta also plans to replace all jet bridges, modernize its baggage facilities, and add additional gates.

3. Terminal 4
The new International Arrivals Building (IAB), tendered as a BOT for a 19-year term, will dramatically improve passenger service through the use of separate levels for arriving and departing, consolidated ticketing and baggage operations, and enhanced retail amenities, among several other improvements. The cost of the new facility is $1.1 billion.

4. Terminal 5 & 6
TWA is installing a new security screening system and refurbishing the terminals.

5. Terminal 7
In 1991, British Airways completed a $120 million expansion to Terminal 7 which included the addition of six gates with joint tenant United Airlines.

6. Terminal 8 & 9
American Airlines is nearing completion of a $220 million program to consolidate and upgrade its facilities at Terminals 8 and 9. The renovation program increased the size of its federal Inspection Services to accommodate increased passenger levels. Other work includes a new international ticketing hall, expansion of ticketing counters, an expanded lobby, an upgrade to all concourses, new concession and retail spaces, and a new Admirals Club.

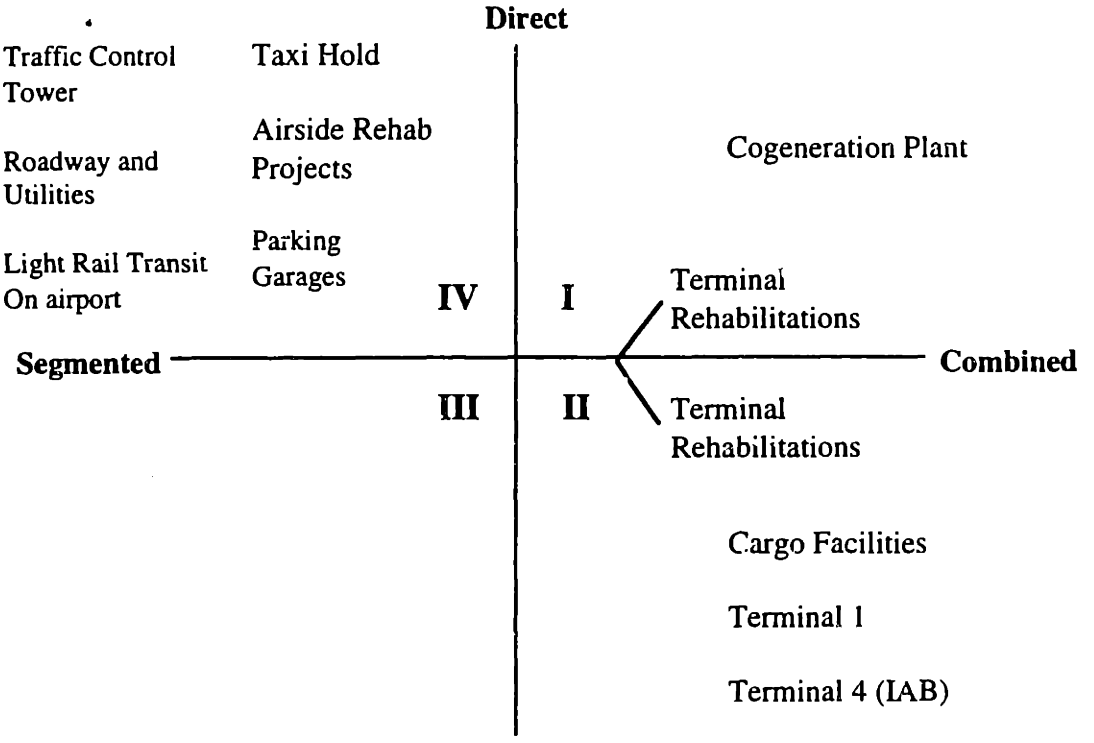
7. Other Private Investments
The following is a list of other private projects which are part of the JFK Redevelopment Program:

- •Japan Airlines/Building 14 Development
- •The Cogeneration Plant
- • Korean Airlines Cargo Facility
- • Air Express International Cargo Facility
- • Polar Air Cargo Lease
- • United Airlines Air Cargo/Maintenance/Administration Facility

3.3.3 The Port Authority Strategy

3.3.3.1 Delivery Method Selection

The Port Authority is mandated like many other public and quasi-public agencies to use design/bid/build systems for procurement of construction projects, even though substantial benefits could be achieved by utilizing other methods. In fact, for the JFK Redevelopment Program, all of the Port Authority run projects are procured using design/bid/build methods.



Portfolio Analysis - JFK Portfolio

Figure 3.10

Although the Port Authority has not achieved the benefits of combined procurement for the projects they are running, they have achieved substantial cost savings due to the structure of the JFK portfolio (Figure 3.10). The Port has used a mix of DBO and BOT for many of the terminal and cargo projects, which consist of nearly two-thirds of the entire capital cost of the redevelopment program. In fact, nearly all of the projects which could be

pushed to the private sector have been done so. As a result, the Port Authority has saved considerable costs by combining delivery methods which enable procurement of its extensive project list.

3.3.3.2 Port Authority Lending and Grants

While the entire redevelopment of the cargo facilities at JFK is 100% privately funded, the Port Authority has used creative methods to encourage private terminal operators to renovate and construct new terminals. The approach has been accomplished in various forms, from lending and granting operators money, to negotiating special deals which improve facility aesthetics and functionality. The following examples show ways in which the Port has collaborated with the private sector within the JFK Program.

As previous tenants of the International Arrivals Building, Lufthansa, Air France, Korean Air and Japan Airlines joined together to form a consortium to build the 11-gate Terminal 1 on the former site of the Eastern Airlines terminal. The company, known as TOGA (Terminal One Group Association), designed and constructed the $414 million terminal which is scheduled to open in the Spring of 1998.

The Port Authority used monies from its redevelopment program budget to grant TOGA $4 million toward construction of the terminal. This grant was offered to entice the airlines

to move into a new facility.[30] In addition to the grant, the Port used procedures similar to a commercial bank to loan money to TOGA. Through TOGA's lease agreement, the borrowed principle and interest amounts will be repaid monthly through ground lease payments. Although the lending amount is small relative to the total project cost, it will tend to make seeking additional debt financing simpler.

This type of lending arrangement is common practice for the Port Authority. Tenants have often drawn down monies to cover capital expenses which have been repaid through their leases. Delta, operator of Terminal 2 and 3 has drawn down $36 million for its $150 million renovation project.[31] American Airlines and TWA are both in negotiations regarding borrowing money for improvements to their terminals.

Another negotiating tool the Port used with terminal operators regards roadway and frontage work to the terminals. The Port designed the roadway, utility, landscaping and terminal frontage schemes for the entire JFK complex. However, two terminal operators, British Airways and LCOR/Schiphol (developer for the IAB), both approached the Port Authority with creative deals to improve the original design by amending roadway patterns, landscaping options and other frontage issues to better suit the functionality of their facilities. The additional cost to make the improvements would be incurred by the operator; the Port Authority would only provide capital up to the original design amount. Review of the plans must still meet approval of the Port Authority, but, the private operators could control and determine the most efficient layout for entrances to their facilities and provide the desired aesthetics to optimize the buildings appearance.

3.3.3.3 The International Arrivals Building-The Showcased BOT

[30] From an interview with Robert Fishman-Financial/Systems Manager for O'Brien-Kreitzberg Associates-JFK Redevelopment Program, September 1997.
[31] From an interview with Robert Fishman-Financial/Systems Manager for O'Brien-Kreitzberg Associates-JFK Redevelopment Program, September 1997.

Of all the JFK Redevelopment projects, the most attention has been given to the new Terminal 4-IAB project. It has a $1.1 billion price tag, an alternative procurement structure, and is the largest privatized airport deal in US history.

Plans for improvements to the IAB started in 1990. It was determined that the terminal was antiquated and could not meet the passenger levels expected in the near future. Several schemes were planned from renovation to a new terminal with costs ranging from $600 million to $1.1 billion. Financial analysis of short and long-term consequences led to the Port's decision to construct a new terminal.

Capital constraints on the Port Authority forced consideration of alternative strategies for construction, operation and financing of the facility, which was approaching a 25% design level by a team of consulting engineers working with the Port Authority.[32] A final decision was made by the Port Authority Board of Commissioners to combine all aspects of the development, including finance, into a single procurement. On April 25, 1996, a deal was reached between the Port and JFKIAT, a consortium led by LCOR/Schiphol USA, for a BOT franchise for 19 years.

Schiphol USA, a subsidiary of the company that owns and operates Amsterdam's exceptionally efficient airport, is experienced in the operation of international hub airports and is determined to turn the IAB into a success similar to its counterpart in Amsterdam. By introducing creative retail and commercial spaces into the design of the facility, the team intends to capitalize on travelers' urges to spend money. Amsterdam's airport, equipped with a shopping mall carrying designer boutiques and even a casino, generates an average of $35 a passenger, while JFK receives just half that amount per head.[33] The advantages of enhanced technology and creativity by the private sector are clearly evident in their undertaking of the IAB. Additionally, a substantial amount of capital has been relieved from the Port Authority's budget enabling this major project to go forward.

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[32] Vigniola, Dennis and Smyth, Richard J."Redeveloping the JFK International Arrivals Building: A Public-Private Partnership," Public Works Financing, June 1997, page 2.
[33] Jacobs, Karrie."Plane and Simple," New York Magazine, August 25, 1997, page 39.

3.3.4 Interim Conclusions

The revenue streams of airlines are more steady and predictable than other types of infrastructure. The opportunity to tender projects to the private sector are much greater and therefore create a portfolio with increased options for alternative financing structures. The Port Authority selected good revenue generating projects like the terminals, the cargo facilities, and the cogeneration plant to tender to the private sector. Projects such as the roadways and utilities, the control tower and the inter-terminal light transit rail, which have low or unpredictable revenue streams, were funded through their own resources.

The Port Authority's extensive property holdings combined with the competition for capital to fund projects all over the region increases the necessity to manipulate the JFK portfolio in a fashion which does not drain its available capital. The Port runs two other major airports in the region, La Guardia International and Newark International, both with capital projects of their own. Further, the Port owns several bridges, tunnels and buildings which require needed improvements. Achieving a program of the magnitude of JFK Redevelopment, within a larger context of capital programs, requires utilizing a portfolio strategy which combines a variety of procurement methods.

3.4 Logan International Airport's Logan 2000 Program-Boston

3.4.1 Background

Logan International Airport is located on reclaimed land in Boston Harbor, just a mere three miles from downtown Boston, making it one of only a few major cities with such proximity between an airport and the city's central business district. Logan is the country's 16th busiest airport with 24 million passengers arriving in 1993. This number is expected to reach 37.5 million by 2002 and 45 million in 2010.[34]

The Massachusetts Port Authority, also known as Massport, owns the airport and is responsible for coordinating all improvements and rehabilitations. The airport is planned similarly to New York's JFK International Airport with separate terminals built around a looped roadway configuration. Also, similar to JFK is the rail transit access to Logan. The Metropolitan Boston Transportation Authority (MBTA) Airport Station is about 2000 feet from the terminals. Access is provided via shuttle buses which come regularly and drop passengers off in front of the terminals.

A plan to provide a seamless connection from the MBTA system to the airline terminals is one of the projects originally envisioned in the new capital program Massport has launched. The program, entitled Logan 2000, will increase passenger service and convenience, and create a more efficient airport as the demand on the facility increases into the next century.

3.4.2 The Logan 2000 Program

The entire Logan 2000 program consists of 13 projects which total approximately $1 billion (Figure 3.11).[35] The plan addresses the immediate and long-term needs of the airport and the passengers. Terminal expansion and modifications, roadway reconfiguration, utility improvements, a new hotel, and an automated people mover system

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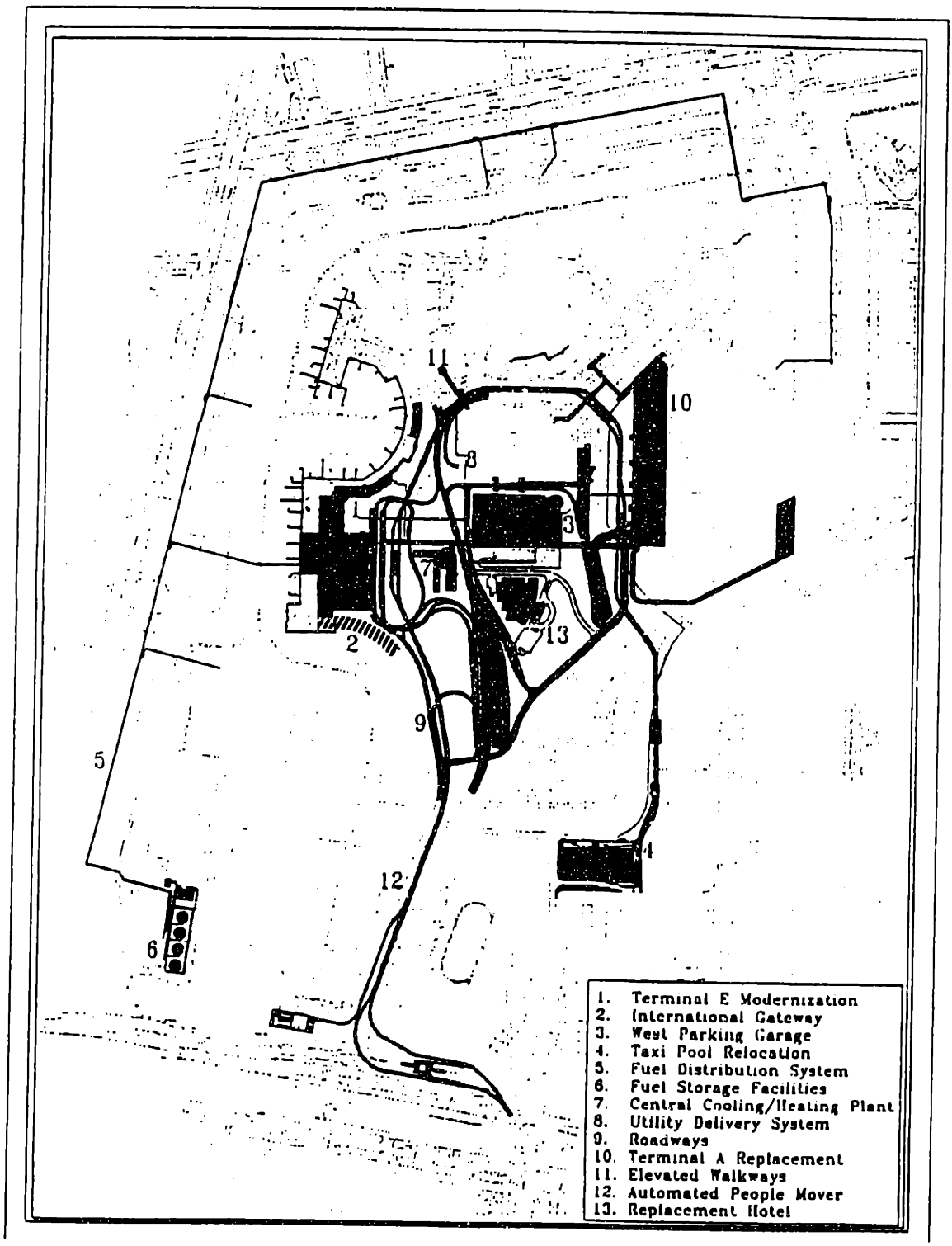
[34] "Logan 2000 People Mover Project-Boston Logan International Airport," Massachusetts Port Authority, page II-14.

Figure 3.11

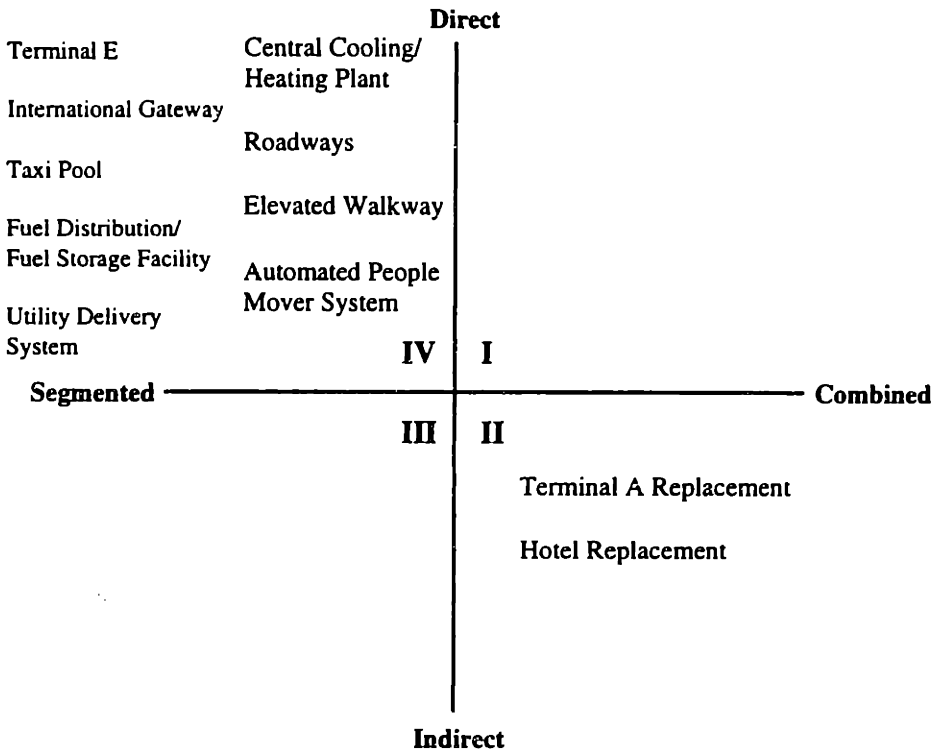
Map-Logan 2000 Program



[35] "Logan 2000 Terminal Area Projects Report-2nd Quarter 1996," Massachusetts Port Authority, page 9.

are all components of the plan. Much of the program is scheduled around construction completion by 2000, however, some projects continue into the first few years of the next century.

The portfolio analysis presented in Figure 3.12 shows that much of the Logan 2000 program is procured using segmented systems located in Quadrant IV. The replacement



Portfolio Analysis-Logan 2000 Program

Figure 3.12

hotel and the Terminal A redevelopment are the only projects procured with private sector financing. The remainder of the Logan 2000 portfolio is procured by DBB, with the exception of the West Parking Garage which utilizes a fast-track approach.

3.4.3 Massport's Procurement Strategy

By placing much of its delivery methods in Quadrant IV, Massport has decided to finance the program from resources in its cash reserves, Passenger Facility Charges (PFC's), or from the further sale of bonds. In March, 1996, Massport unsuccessfully

attempted to sell $321.9 million in revenue bonds for the funding of the West Garage, Central Garage, Roadway Betterments and Circulation Roads.[36] The inability to do so resulted in the delay of the program schedule. Furthermore, cost escalation ensued increasing the cost of the overall program. More difficulties arose in 1996 with the delay in approval of an airline PFC application. The combination of these delays to the program financing make it extremely difficult to maintain an accurate schedule and to stay within budget. As a result, several projects including the Fuel Distribution System, the Fuel Storage Facility, the Bus/Limo Pool Relocation, and the People Mover project (discussed later in this chapter), have been transferred out of Logan 2000 to Massport's capital programs.

3.4.3.1 Terminal A Replacement

One of the two projects considered to utilize private sector financing is the redevelopment of Terminal A, similar to the way Terminal 1 and Terminal 4 at Kennedy Airport was procured. Massport is looking for a consortium to design, build, operate and finance the new facility under a BOT agreement. Logan 2000 monies are currently used to study integration opportunities the facility has with other Logan 2000 projects, including the new roadways, elevated walkways and the People Mover system. In addition, feasibility study for privatization of the facility is also budgeted.

Massport has experienced difficulty in attracting private sector companies to bid on the project. A key difference between Terminal A and the two privately financed terminals at Kennedy is the lack of concession revenues available. Both Terminal 1 and Terminal 4 at Kennedy serve international flights. Passengers must often spend several hours at the airport prior to connecting with other domestic flights. The retail features, which take the form of mini-shopping malls, are very popular places to spend this interim time. Passengers often do not resist the temptation to spend, resulting in fully leased out spaces

[36] "Logan 2000 Terminal Area Projects Report-2nd Quarter 1996," Massachusetts Port Authority, page 23.

for the developer. This luxury would not be available at the Terminal A building, which currently serves domestic flights. Continental Airlines is the facility's major tenant.

The plans for a BOT at Terminal A are quickly fading. With little interest in the private sector due to the substantial risks associated with the project, procurement may have to be restructured. A DBO method could be more appealing to the private sector because equitable risks exist on both sides. A competition could be formed based on awarding a franchise to a team needing the least subsidy amount. Analysis of these types of options could lead to finding a more appropriate procurement strategy for the project.

3.4.3.2 The People Mover Project

The new automated People Mover project is another highlight of the Logan 2000 program. Massport originally budgeted $18.2 million for the preliminary design, permitting, and construction of critical foundations for the system with the intention of developing the design and commencing construction during a later phase of Logan 2000. The project has currently been transferred out of Logan 2000 and placed in capital programs.

Given the constraints on space at the airport, a freeze on parking, and the estimated increases in passenger levels over the next 12 years, Massport conceived the People Mover project. The project involves the design and construction of a fully automated People Mover system which would connect the Metropolitan Boston Transportation Agency (MBTA) Blue Line Airport Station with the airline terminals in a looped configuration. Future expansions would include extension of the guideway to the car rental facility, the proposed park and fly area and the Hyatt Hotel/water shuttle terminal.

The project's purpose is to improve service and convenience for airport passengers, employees and visitors accessing Logan via the Blue Line.[37] Additionally, the convenience and attractiveness of the system is expected to increase transit ridership to the airport. With a seamless system such as the People Mover, MBTA mode share is estimated to reach 10% by 2002 and as much as 20% by 2010.

3.4.3.3 From The People Mover To The Intermodal Transit Connector Program

A major impediment to the progress of the People Mover project is in acquiring funds to procure final design and construction services. The construction estimate of the base phase is slightly over $300 million; additional extensions total the project to over $400 million.

The Central Artery/Tunnel (CA/T) project, an extensive civil engineering program in Boston which will re-route an elevated expressway underneath downtown as well as provide several tunnels and bridges, is the preeminent project in the region. The $8 billion project is heavily funded by the federal government and is considered one of the biggest single urban transportation projects in US history.

Seeking to obtain another large amount of federal capital for the People Mover project given the backdrop of the CA/T proved impossible. Thus, in early 1997, Massport decided to forego the People Mover project in favor of a bus system that would link the airport terminals with South Boston, a developing area adjacent to downtown, and South Station, a major transit station connecting MBTA lines, Amtrak and other bus services. The new plan was presented in March in front of a panel in Washington DC by Massport Executive Director Peter Blute. Seeking $29.9 million for beginning the project, Massport indicated that the original high-tech monorail People Mover project was too expensive.[38]

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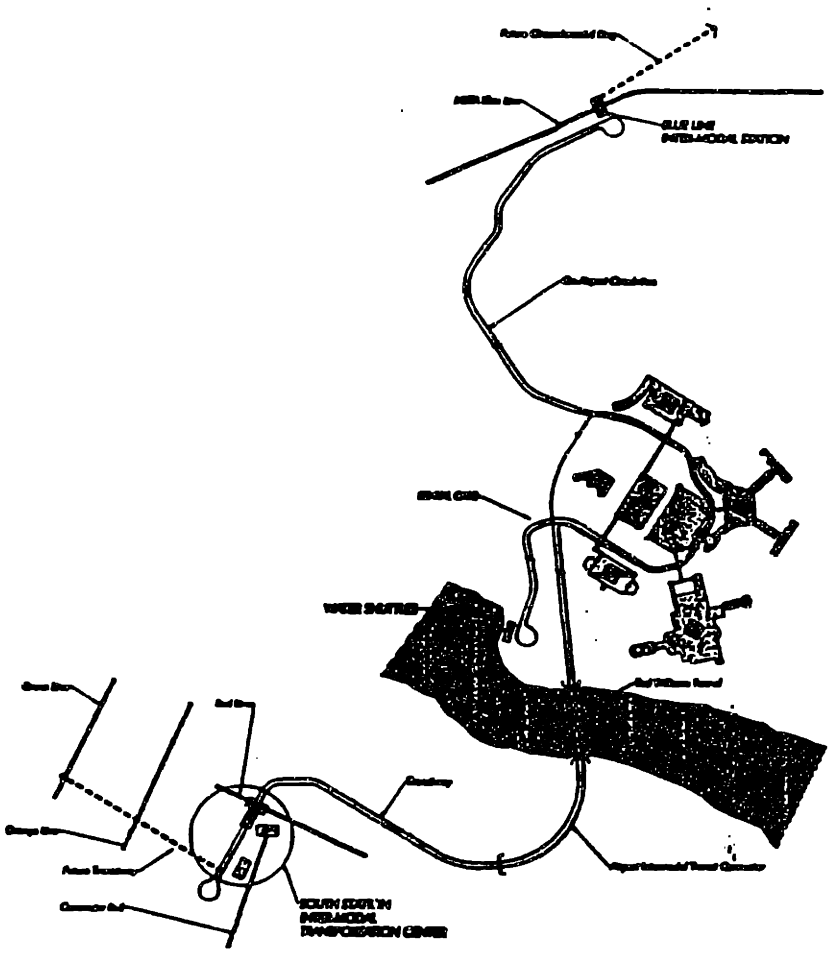
[37] "Logan 2000 People Mover Project-Boston Logan International Airport," Massachusetts Port Authority, page IV-2.

[38] Black, Chris."Massport scraps people mover project at Logan," The Boston Globe, Wednesday, March 12, 1997.

Figure 3.13

Map-Intermodal Transit Connector

Massachusetts Port Authority



On February 25, 1997, Massport officially submitted its proposal to the Committee on Transportation and Infrastructure. The new title of the program was changed to the Intermodal Transit Connector (IMTC) (Figure 3.13). Outlined in the proposal explains Massport's three-phased approach in which it is seeking funding for Phase 1 and design costs for Phase 2. The approach is as follows:

Phase 1- Start-up, Route Configuration and Information System Development:

Cost- $37.4 million

Phase 2- Airport Exclusive Guideway:

Cost- $221 million

Phase 3- Automated Operation:

Cost- $185 million[39]

Implementation of Phase 1 is straight forward. It includes the continuation of environmental review and design, vehicle procurement, construction planning and Phase 2 design. Procurement of Phase 2 and Phase 3 work still remains complicated. The costs are quite high differing from the original People Mover project only by the replacement of an elevated train to an elevated bus. Procurement of these services will remain challenging for Massport when they decide to move from surface buses to guideway and automated systems.

3.4.3 Interim Conclusions

Logan 2000's portfolio strategy is more reliant on Quadrant IV than either Hong Kong or JFK Redevelopment. Massport has limited its delivery options and has taken responsibility for financing much of the program. As a result, difficulties in raising cash have extended completion dates while escalating program costs. Furthermore, attempts at using BOT to procure Terminal A have yet to materialize. Only the hotel replacement has proven to be a viable project to deliver in Quadrant II.

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[39] "Logan International Airport Intermodal Transit Connector," Massachusetts Port Authority, page 4.

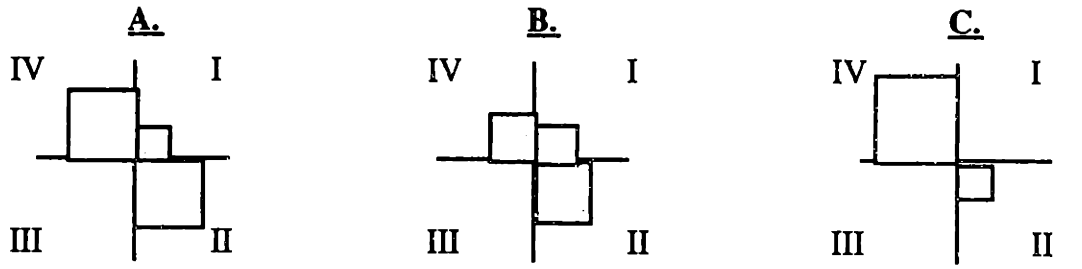
Adjusting the Logan portfolio to intelligently increase private sector capital could enhance opportunities to procure major portions of the program. The terminal projects, including the International Gateway and the Terminal E modernization, could potentially utilize a DBO method, which combines design, construction and operation of the facility. Advantages would consist of decreased cost, faster design and construction time, and single responsibility for life-cycle issues. A DBO or BOT approach may be obtainable for the Fuel Systems and Storage Facilities as well. Revenues are determinable and predictable based on fuel charges assessed to the airlines. This alternative could save over $100 million in program costs if financing was arranged through a franchisee. Considering these types of options could help Massport achieve a more diverse portfolio and lessen the cash requirements from their budgets.

3.5 Analysis/Lessons Learned-Case Study Portfolios

These case studies show the benefits of a procurement strategy which accomplishes a mix of delivery and financing methods. Both Hong Kong and JFK Redevelopment show enhanced opportunities for accomplishing their portfolios by utilizing methods in multiple quadrants. Conversely, Logan 2000 relies heavily on Quadrant IV, and as a result, is experiencing several procurement, schedule and cost problems (Figure 3.14).

The resurgence of portfolio strategies similar to those used in early American infrastructure development show they remain viable and efficient processes for achieving capital programs large or small. Even when operating budgets may not be completely exhausted, consideration of all alternatives can provide increased opportunities for comprehensive and long-term strategic planning.

Paramount to the execution of the portfolio is its intelligent evaluation of achievable delivery methods. The private sector is becoming more sophisticated at selecting projects



Hong Kong Portfolio Analysis | **JFK Redevelopment Portfolio Analysis** | **Logan 2000 Portfolio Analysis**

Figure 3.14

which are profitable and which will work. Past failures have caused companies to become more conservative and deliberative in their investment decisions. For example, Logan 2000's difficulty in procuring the Terminal A replacement by the BOT method illustrates an unsuccessful attempt to force a project into a particular delivery method. The lack of potential for substantial concession revenues makes private financing of this project unattractive.

Conversely, the Hong Kong government was wise in deciding not to privatize major components of the Airport Core Program. The potential for delays or complete cancellation, due to the political circumstances of the government, could have caused catastrophic effects on the future uses of BOT. Instead, design/build was extensively used to speed construction and reduce long-term maintenance and operation obligations for the government. A similar assessment of financing options was done by the Port Authority of New York and New Jersey at JFK by deciding not to BOT the inter-terminal Light Rail Transit system. Ridership could not be accurately determined and the desire not to assess a passenger user fee eliminated this revenue stream possibility.

Careful selection of projects to franchise and which to keep is also critical in formulating a portfolio which exercises all alternatives. Similar examples stem from both JFK Redevelopment and Logan 2000 in their decisions to construct new parking garages with capital from their own budgets. Typically, parking garages generate very high

revenue streams due to their high rates for short and long term parking coupled with their tendency to be full. These would appear to be good projects to franchise given the predictability of cash flows. The excessive revenue streams could also benefit the Port Authorities in helping to pay for operating costs associated with other non-revenue generating projects.

For example, the roadway and utility packages in both JFK's and Logan's programs do not directly generate revenue streams. Therefore, coverage of their operation and maintenance (O&M) costs must come from elsewhere. Funding sources for these costs as well as other projects which do not generate sufficient O&M coverage could be derived from the excess cash flows of the parking garages. In fact, Massport uses parking garage revenues to subsidize several of their on and off-airport properties.

Evaluating this trade-off between capital cost and project revenue stream is key in deciding how to package a project. The above example illustrates that holding these assets were wise decisions. Capital expenditures for the garages at JFK and Logan are slightly over $100 million each, but the return is predictable and substantial. A different strategy may result from evaluation of procurement options for the Terminal 4-IAB project at JFK. The capital cost of the project is approximately $1.1 billion, which is a substantial amount of capital to raise considering additional project obligations from the remainder of the JFK portfolio. Furthermore, project revenue streams are not as predictable as those generated by the parking garages. Franchising the project would be more advantageous due to the experience, creativity and efficiency of a private developer.

Analysis of the three case studies have illustrated several lessons on portfolio management. They include the following:

- Consideration of all options should be made to maximize the benefits of alternative procurement methods. Deliveries from all three quadrants should be evaluated to determine compatibility with each project.

- Prior to spending monies on RFQ's/RFP's soliciting DBO/BOT projects, carefully analyze cash flows to determine the robustness and viability of the project. Sending "dog" projects to the private sector may ultimately result in wasted funds or a failed project.
- Involve collaborative master planning with other agencies to coordinate planning efforts. Overlapping projects may result in decreased project costs.
- Unstable or marginal revenue streams may suggest the need for a strategy shift from a BOT to a DBO where lacking cash flows could be subsidized. More interest could be gained by sharing financial risk with the private sector.
- Special grants or loans can act as enticing agents to encourage more companies to bid on a project and in return, achieve increased competition.
- Align portfolio efforts with a greater long-term regional economic strategy which can incorporate increased opportunities for private sector activity and competitive advantage.

These lessons can assist in providing a framework for structuring an infrastructure development portfolio. All of these ideas will be applied in the next chapter to the Intermodal Transit Connector (IMTC) program, formerly called the People Mover project. The program has many opportunities for integration with regional transportation systems throughout the Northeast Corridor and with strategic economic development opportunities in the Boston area. Furthermore, numerous procurement options are available which can capitalize on alternative delivery method and financing strategies.

Currently, the IMTC is still in its planning phase without any funding strategies to procure its Phase 2 and Phase 3 concepts to convert the bus system procured in Phase 1 to an automated system on a guideway. This thesis will provide recommendations and strategies for its planning, delivery, and financing based on research conducted throughout 1997.

Chapter 4

The Logan International Airport Intermodal Transit Connector Program-Boston

4.1 Introduction

The concept of a fixed rail system connection from downtown Boston to the airport is becoming increasingly critical to slowing the high levels of on-airport surface congestion, reducing emissions levels and increasing passenger convenience. Currently, using the MBTA system to reach the airport entails between one and two inter-train transfers downtown and a transfer to a bus at the airport, after climbing about 30 steps. The excessive number of transfers coupled with general transit inconvenience are major reasons travelers use other modes of transportation to reach the airport. Currently, only 6% of airport passengers use the MBTA system.[40]

The sleekness of a heavy rail line directly linked to the terminals with improved MBTA Red, Orange, and Green Line connections is a real attractiveness which could pull people from their cars and taxis. Reduced transfer times and the avoidance of traffic could potentially rival the automobile as a mode for travel to the airport. Procurement of this system remains costly nonetheless. Typically, transit systems have not been projects procured privately due to the inordinate capital and maintenance costs. Furthermore, ridership is commonly lower than estimates. Appendix A presents data on 10 heavy and light rail projects illustrating the disparities between forecasts and actual numbers for ridership, capital cost and operating cost.

In almost all cases, actual ridership is lower and actual capital and operating costs are higher. A major reason for this result is the use of Quadrant 4 delivery for these systems. The planning of system alignments are not well coordinated with private sector

[40]"Logan 2000 People Mover Project-Logan International Airport,"Massachusetts Port Authority,pageIV-2.

development to maximize ridership draw. Furthermore, the design and construction are segmented, typically causing extensive cost overruns and delays. The operation is generally handled by a local transit agency which often experience internal inefficiencies due to out-dated practices and indifference to innovation.

Making a transit project work in the private sector would entail finding solutions to maintaining costs to their original estimate and achieving substantial revenue streams to cover the costs of the system. Combining the planning, design, construction, and operation would help to achieve this. Strategic alignment and joint development with planned or on-going projects are additional solutions which could help maximize ridership.

The original People Mover scheme focused solely on issues at Logan Airport and did not address much of the regional developments occurring around Boston. The $413 million Transitway project, which provides underground electric-powered bus connections between South Station and the World Trade Center, was not addressed in Massport's concept. Also, plans were not coordinated with the CA/T project to include rail access through the now completed Ted Williams Tunnel, which connects South Boston and Logan.

Integration with these projects would have created tremendous advantages, including reduced costs for Massport and a larger draw for increased system ridership. However, the opportunity has been lost and several millions of dollars which could have been saved will not. The following section describes what I call a strategic approach toward the concept of an intermodal transit connector system. Evaluation of local and regional influences will aid in finding procurement opportunities which capture the benefits of alternative delivery and financing methods.

4.2 A Strategic Planning Approach For The Intermodal Transit Connector Program [41]

4.2.1 South Boston Developments

Boston's near and long-term economic future are dependent on whether it can effectively maintain and attract businesses to the area. As illustrated in previous chapters, an efficient infrastructure is imperative to achieve this. Boston has several prospective developments which directly affect the IMTC and which the IMTC can directly affect.

South Boston is by far the hottest area for long-term growth in Boston. The proximity to downtown and the waterfront, the spectacular views, the relatively inexpensive land and the mere size of the undeveloped and unbuilt land make it the logical choice for future development within the city. Already, several projects are scheduled to be completed or under construction by the year 2000.

The Transitway project is an underground trackless trolley connection from the Red Line's South Station to the World Trade Center, with a second phase extension to the Orange Line's Chinatown Station and the Green Line's Boylston Station (Figure 4.1). The one-mile tunnel has stops at the new Federal Courthouse and the new World Trade Center Hotel, two projects discussed below. The Transitway is planned to handle 60% of the peak hour trips to South Boston.

Adjacent to the World Trade Center and strategically planned at one of the Transitway's stations is the World Trade Center Hotel and Office Building development. The development entails a 427 room hotel and two adjacent office towers with almost 500,000 square feet of commercial and retail space each (Figure 4.2).

Three other major developments in South Boston are in design stages or under construction. The Federal Courthouse project located on Fan Pier is expected to bring 800

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[41] Much of the information described in this section was researched by the Infrastructure Development Research (IDR) Group at MIT during the Spring and Fall of 1997. The group is funded by Massport to study financing and procurement options for the Intermodal Transit Connector (IMTC) program at Logan Airport. Members of the IDR Group are Roger Evje, Matt Dietrich, Brian Moore and the author of this thesis. Professor in charge of the research is John B. Miller.

employees and 2,200 visitors a day. A new Children's Museum is expected to bring 391,000 visitors per year while the Boston Marine Industrial Park will have 1,500 employees.[42]

Several other projects in South Boston are expected to be completed by 2010 which include the following:

- Fan Pier/Pier 4
- McCourt Property
- Massport's Fish Pier
- Summer Street Office and Industrial Park
- Convention Center
- Cruise Terminal

Additionally, speculations about a South Boston location for a new Fenway Park baseball facility for the Red Soxs have been floating around Boston.

The potential for this area is enormous, with rapid transformation already under way. Providing a system to capitalize on this transformation would be strategic for Boston's economy.

4.2.2 The Northern Connections And The Urban Ring

The long-term developments to the north of the airport are also important to consider in planning the IMTC. Currently, little activity is happening to the north relative to South Boston. However, a substantial percentage of air travelers come from the northern suburbs. A better connection to the airport is necessary to draw even more riders and attract business development to those areas. The modifications to Wood Island Station, which will replace the Airport Station, are key toward allowing a rail system to ultimately connect at that location with the Blue Line.

The location of a maintenance facility for buses, and ultimately trains, is most reasonable north of the airport in Chelsea. Locating facilities which do not need to be on the airport's constrained site enable the potential to draw airport-related services to other

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[42] "South Boston Piers Transitway Project Brochure," Massachusetts Bay Transportation Authority, pages 5-8.

Figure 4.1

The Transitway Project

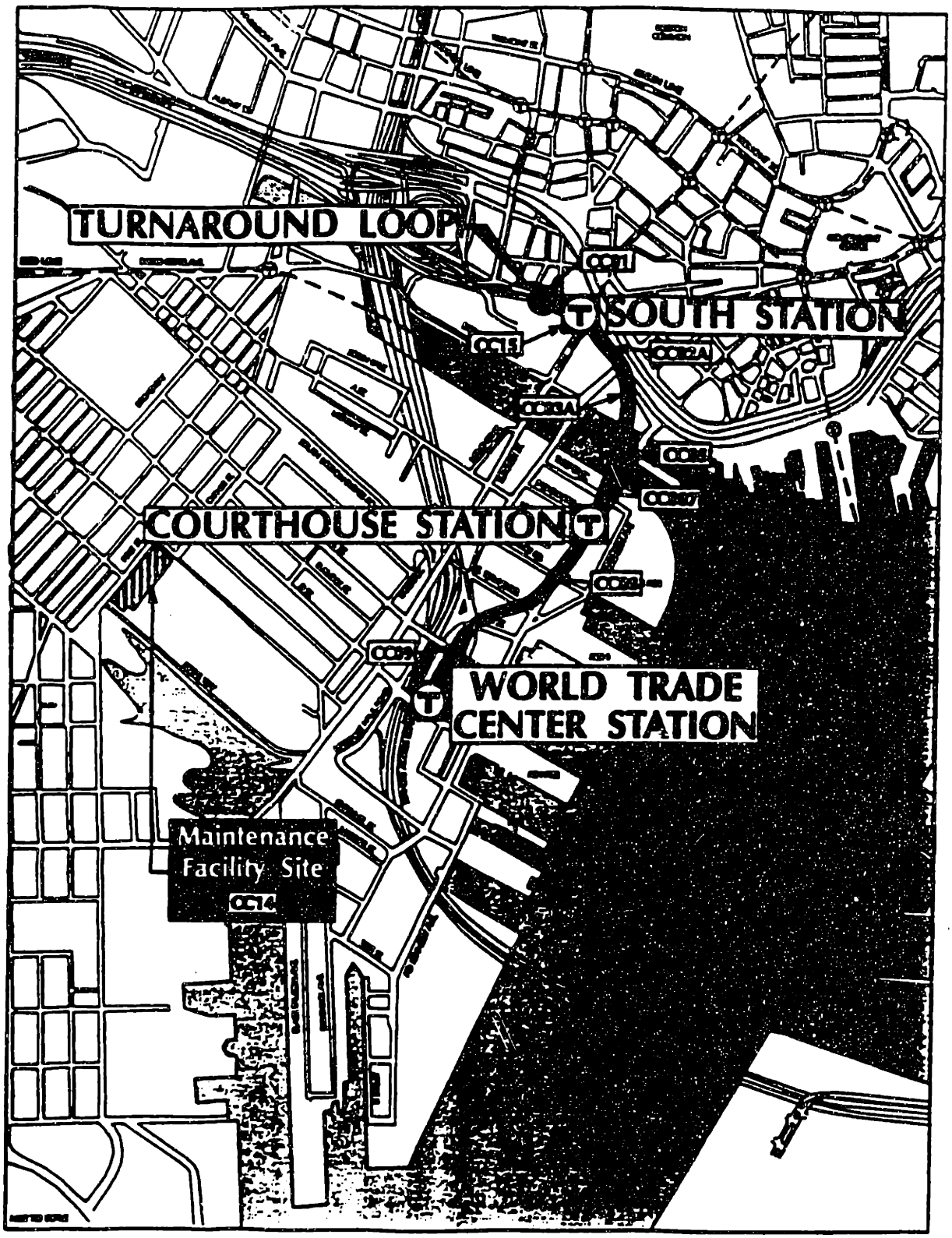
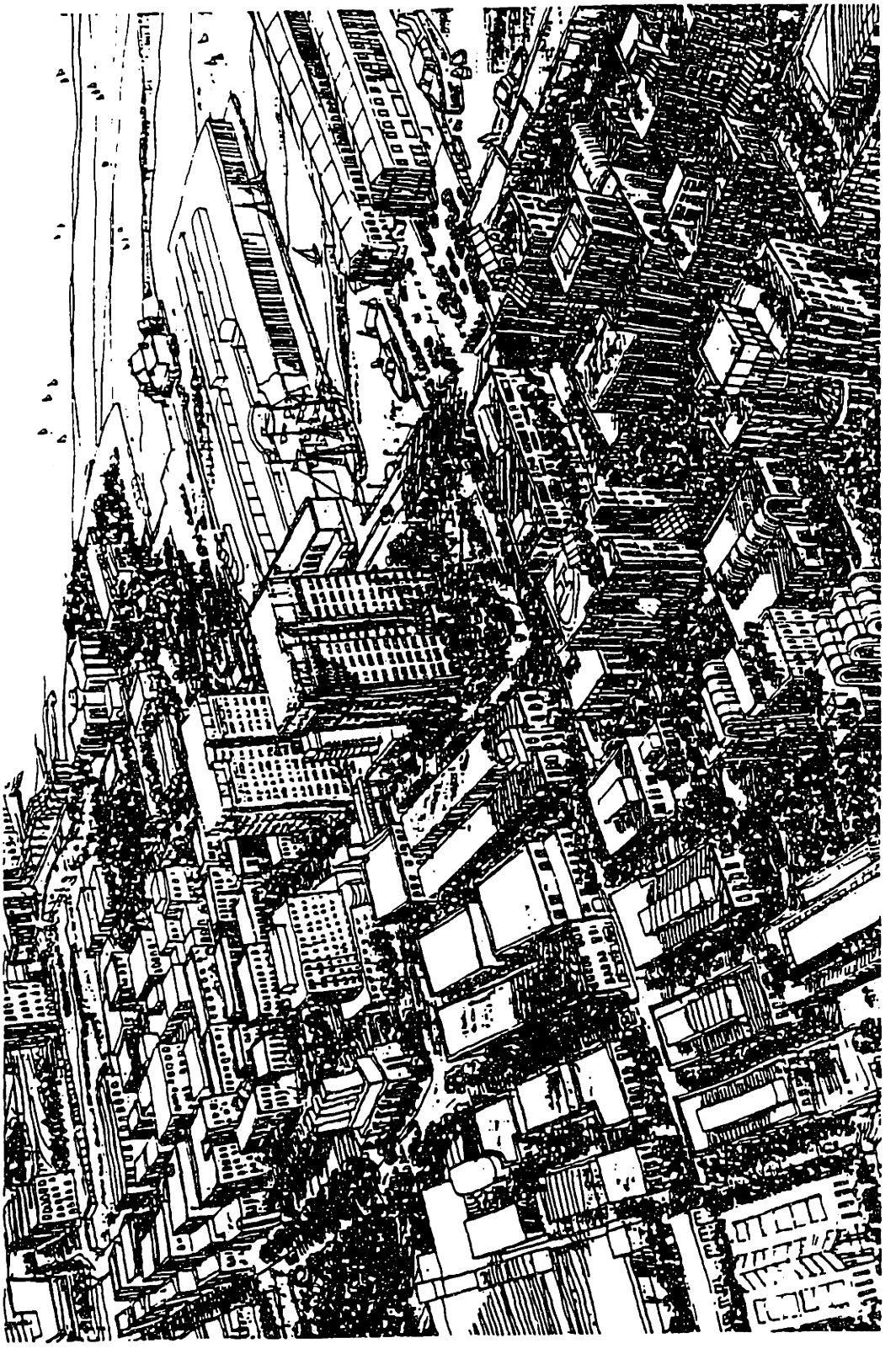


Figure 4.2

South Boston Development



areas, perhaps developing into industrial centers. Chelsea has a supply of vacant land which could adequately serve this type of development.

Continuing north past the potential site of a maintenance facility is the strategic connection with the MBTA commuter rail line. This connection can serve as a major transfer point for riders from the north heading to the airport.

Finally, the Urban Ring project adds another dimension to the notion of a regional intermodal system of transportation infrastructure for Boston. The urban ring will provide access circumferentially around the downtown area serving adjacent communities to Boston. Possible connections from the north to the IMTC can be made through Chelsea and Wood Island Station. Connections from the south can be achieved through either South Station or South Boston. The realization of the Urban Ring and its connection with the IMTC can truly achieve a regional intermodal network.

4.2.3 A Phased Strategy Utilizing Alternative Delivery & Financing Methods

Based on current and expected developments around Boston, the potential for a heavy rail extension to the MBTA's current transit system is advantageous from both a regional economic view and from a public convenience and service view. Procurement of this program is too large and costly to rely solely on public funds. A strategy is needed which capitalizes on appropriate delivery method options and investigates a variety of funding sources from both the public and the private sector.

To attract interest from private sector companies, a reliable and sufficient ridership is needed to take on the risks of a DBO or BOT franchise. An inherent problem is that transit ridership is very difficult to model accurately. Even with the expected boom in the South Boston area, attracting private investors could prove difficult without hard data to support forecasts. An efficient and low cost approach would be to phase the project by testing the

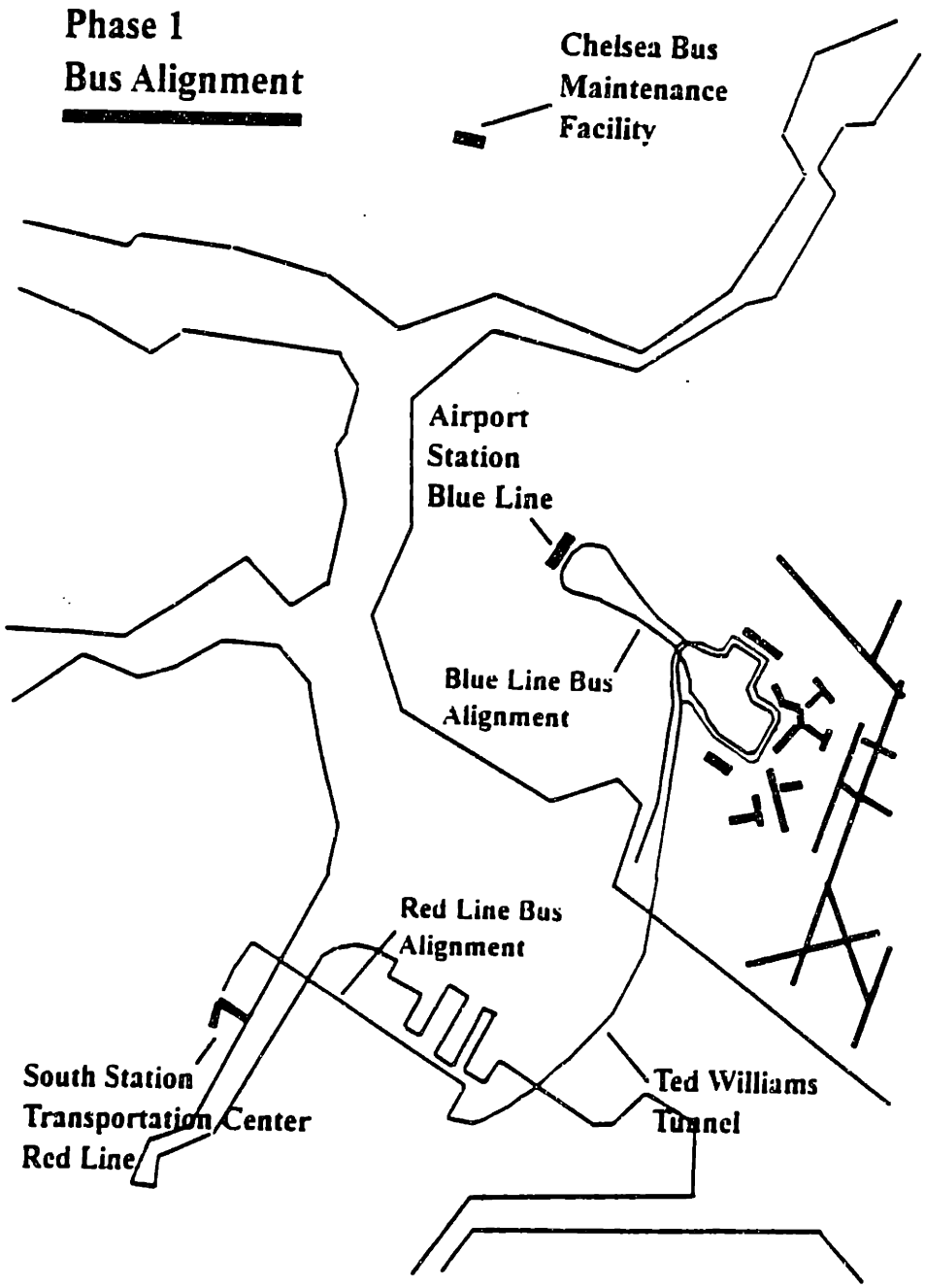
ridership with buses on a similar alignment. Once evaluation of ridership can be assessed, a subsequent phase could be initiated which converts the system to fixed rail. It could then be determined whether it is justifiable to expend capital on a costly heavy rail system and whether opportunities to attract private sector capital can be incorporated into a procurement strategy.

The following sections investigate a phased strategy for procurement of the IMTC program using preliminary construction estimates provided to the Massport Infrastructure Development Group by Frederic R. Harris, Inc., consultant to Massport for design and construction management of the People Mover project and ridership projections offered by Jim Jarvis, Senior Transportation Planner for Massport. This information has been used to evaluate a three-phased approach, starting with buses in Phase 1 and Phase 2, then analyzing the potential for a fixed rail system in Phase 3.

Numerous opportunities are available for procurement of this system beyond those presented in the following sections. I have investigated one strategy which breaks the program into 17 smaller projects and combines delivery methods from Quadrant I and Quadrant IV. Five cash flow analyses are presented based on information from the above and on assumptions which are noted later. This analysis is presented to aid Massport's efforts in finding solutions to procure the IMTC program.

Figure 4.3

Phase 1 Alignment



4.2.3.1 Phase 1 And 2

Phase 1 and 2 work similarly to Massport's plan for a bus system between South Station and the airport and between the airport and the Blue Line. The system can operate as a premium bus service run on a fare basis.[43] Also, passenger information systems with advanced capabilities should be utilized to apprise riders of arrival, departure and travel times.

Phase 1 should begin in the first quarter of 1998 and last until 2002 (Figure 4.3). An estimate for the cost of this phase is $14.7 million (1997 dollars), which in addition to bus and display acquisition, includes providing an access ramp to the Ted Williams Tunnel at D Street and includes the construction and operation of a bus maintenance facility (Figure 4.4).

Phase 1 1997-2002				
Smart Bus Acquisition	ls	15,000,000		5,500,000
Bus Maintenance Facility Contract	$/yr.	800,000	4	3,200,000
AVI Display Technology	ls	5,000,000		2,500,000
WTC Airportbound Tunnel Access Road/Ramp	ls	3,500,000		3,500,000
Total Cost Phase I				14,700,000
Phase II 2002-2012				
Bus Maintenance Facility Contract	$/yr.	800,000	11	8,800,000
Total Cost Phase II				8,800,000

Phase 1 and 2 Costs

Figure 4.4

The MBTA's Transitway is scheduled to open in 2002 which will enable buses to travel from South Station to the World Trade Center.[44] The opening of the Transitway will begin Phase 2 which should last through 2012 when a potential Phase 3 may start (Figure 4.5). Phase 2 entails the continuance of bus operations and bus maintenance. The additional cost for maintenance facility operations during Phase 2 is estimated at $8.8 million.

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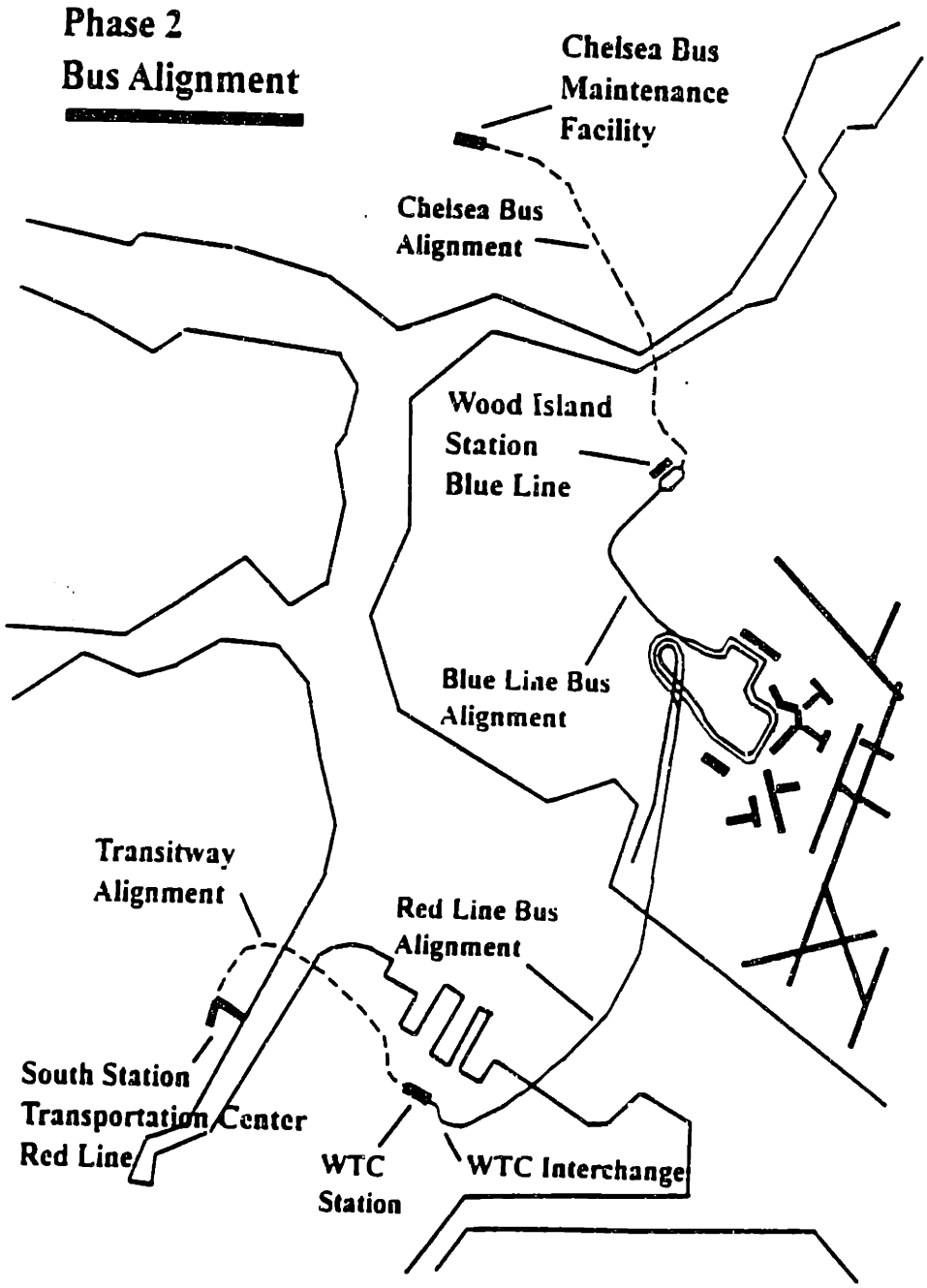
[43] A user fee of $6.00 has been established from Massport ridership models and is used as a basis for revenue forecasts presented in this thesis.

[44] Modification to the Transitway may be necessary under current designs for the system regarding ventilation. The catenary system designed for the tunnel does not require venting. Installation of such a system would be necessary for buses.

Figure 4.5

Phase 2 Alignment



Analysis of ridership during Phase 2 will determine whether it is viable to expend capital on a fixed heavy rail system. This evaluation period, between 2002 and 2008, will determine the possibility of whether South Boston will develop as planned, whether the Transitway will go ahead with its second phase connecting Boylston and Chinatown, and whether air travel demands continue as forecasted. If the previous mentioned does not materialize, continued bus operations may be the most feasible and viable alternative.

4.2.3.2 Financing Strategies For Phase 1 and 2

Phases 1 and 2 have been separated into five separate projects to help evaluate the most effective procurement strategy for Massport. Figure 4.6 shows a list of the projects with assumptions given for potential construction durations, operation and maintenance (O&M) costs, discount rates, available delivery methods, user fee receipts and funding sources. Analysis of these factors can lead to determining a procurement strategy which could potentially reduce the cash outlay requirements of Massport.

A pro forma for Phases 1 and 2 is illustrated in Appendix D. Three public funding sources have been identified to potentially contribute capital toward construction costs. These include the State of Massachusetts and NexTEA[45] for the buses and the display technology (Phase 1 and 2), while the Massachusetts Highway Department, through the CA/T project, will provide the D Street ramp. The revenues generated by a $6.00 user fee show a potential profit in the first year of $261,600. This amount steadily increases to $1.5 million in 2012.

Numbers used in the pro forma assume a Quadrants I and IV portfolio structure (Figure 4.7). This strategy, which utilizes DBO, could provide substantial benefits for Massport, including technology improvements, operating cost reductions and single source

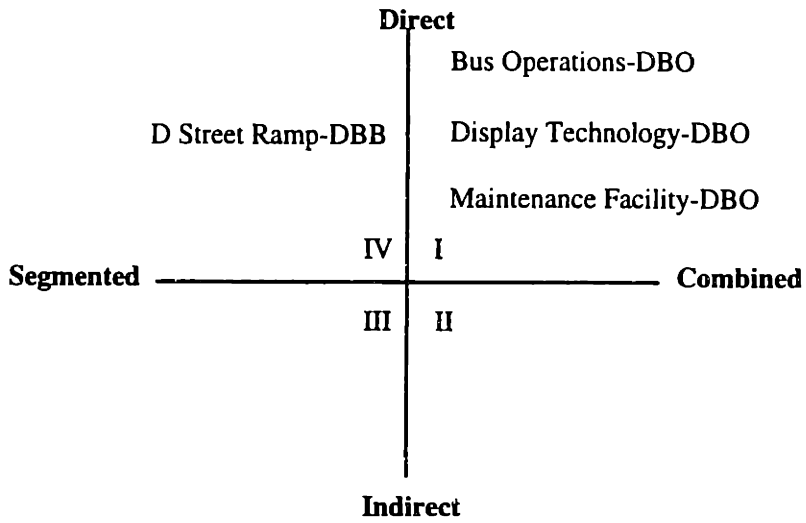
[45] NexTEA is successor to ISTEA-the Intermodal Surface Transportation Efficiency Act of 1991 authorizing $5 billion for new start intermodal projects. NexTEA federal funding is assumed for purposes of this research at 80% of construction cost while Massachusetts State funding is assumed at 20% of construction cost.

Figure 4.6

Phase 1 and 2 Project Data

Logan Intermodal Transit Connector				
Bus Scenarios				
Project Identifier (Description)	1	2	3	4
Project Name	Displays	Bus Maint. Facility Chelsea	Buses & Operation	D Street Ramp
Phase	I & II	I	II	I
Qtr. to Start Profile	5	5	21	17
Qtr. to End Profile - In Service Qtr.	5	9	21	20
Const./Initial Capital Cost ($K)	$2,500,000	$800,000	$5,500,000	$3,500,000
M&O as % of Const. Cost (Default 18%)	2%	100%	18%	
Discount Rate Public (%)	8%	8%	8%	8%
Discount Rate Private (%)	10%	10%	10%	10%
Available Project Delivery Methods (1=Yes, 0=No)				
DBB	1	1	1	1
DB	1	1	0	0
DBO	1	1	1	0
BOT	0	0	0	0
In service Receipts as % of M&O (Default 0%)				
DBB	100%	100%	100%	
DB	100%	100%	100%	
DBO	110%	100%	110%	
BOT				
Massport Bond	0%	0%	0%	0%
Massport Budget	0%	0%	0%	0%
Mass Hwy Sources (CA/T)	0%	0%	0%	100%
MBTA Sources	0%	0%	0%	0%
Mass State Funding (Max 20%)	20%	20%	20%	0%
NexTEA (Max 80%)	80%	80%	80%	0%
Private Sources	0%	0%	0%	0%

responsibility. Several companies would be interested in competing for a franchise to provide buses and infrastructure for this high-tech system, especially given the enticement



Portfolio Analysis-Phase 1 and 2

Figure 4.7

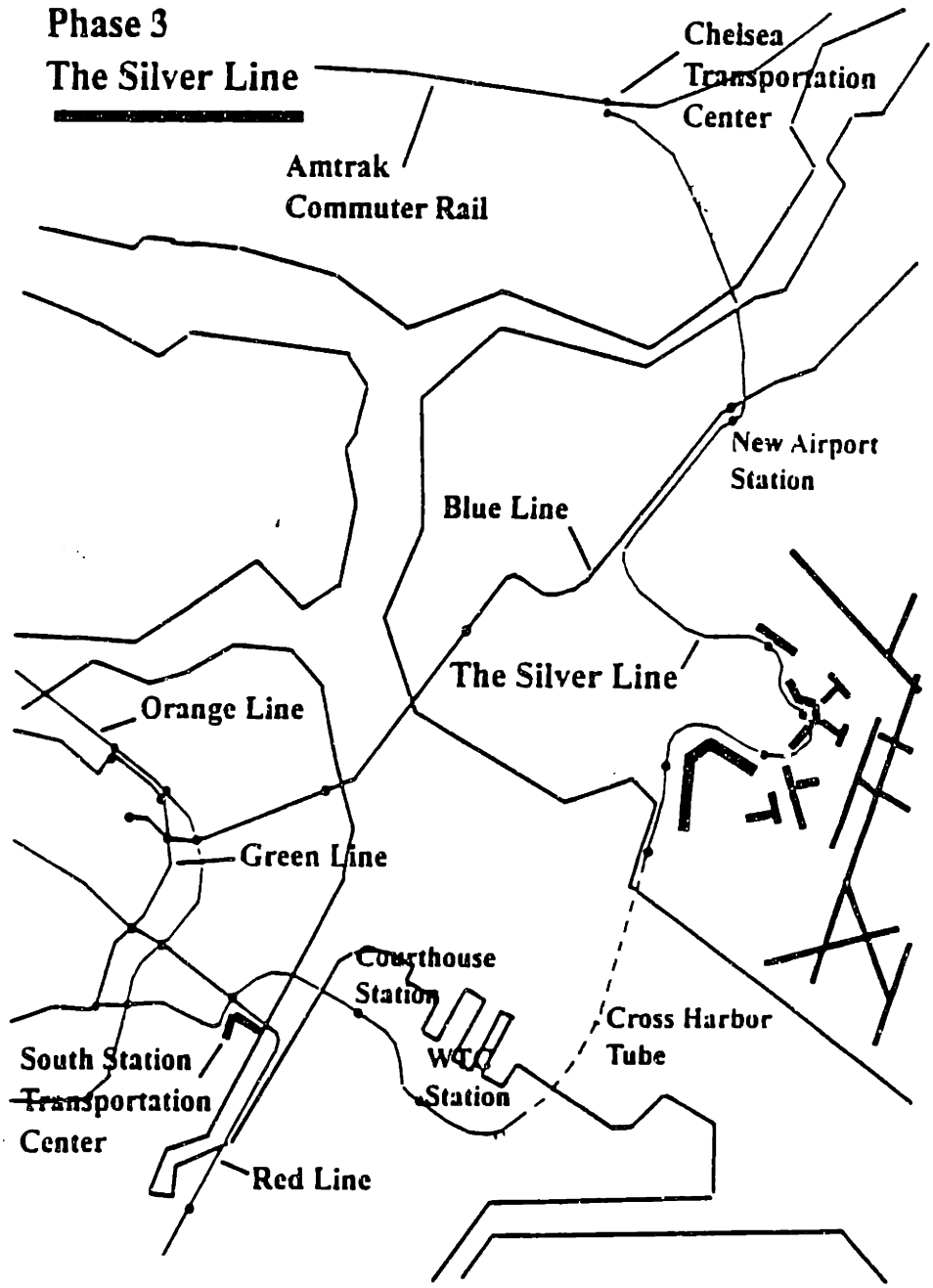
by the public sector for providing the capital cost of the buses and the display infrastructure. Instead of segmenting design, manufacturing, and operation, consortia could bid on a combined package to deliver all three components, even suggesting optimal headway and fleet sizes. The efficiency gained utilizing this approach results in additional cash flow for other Massport programs.

4.2.3.3 Phase 3

The full-build program for the IMTC includes an upgrade to a fixed rail system from Boylston Street, connection point with the MBTA Green Line, to Chelsea, connection point with the MBTA Commuter Rail system (Figure 4.8). Elements of this system in downtown and South Boston include completion of the Transitway tunnel and stations from South Station (SSTC) to Boylston, conversion of the completed Transitway to fixed rail, and a new cross harbor tube connecting South and East Boston. On-airport elements include an elevated and on-grade guideway and stations at the Logan Hyatt Hotel/water shuttle stop, the rental car area, Terminal A/B, Terminal C, Terminal E and Wood Island.

Figure 4.8

Phase 3 Alignment



Elements in Chelsea include the guideway alignment and the conversion of the bus maintenance facility into a facility for trains.

A preliminary estimate for the capital cost of Phase 3 is $855,291,657 (Figure 4.9). This new alignment, termed the Silver Line, should add significantly to the regional transportation network within and around Boston. The system would compliment the existing MBTA alignment and finally achieve a direct link to the airport.

Phase III-Elevated Alignment at Terminals 2013				
Stations				
Boylston-SSTC Transitway Station and Track Cc	ls.	152,811,259		152,811,259
Hyatt/Water Shuttle	ls	5,370,000		5,370,000
Car Rental Consolidation Station	ls	5,370,000		5,370,000
Terminal A/B Station	ls	5,370,000		5,370,000
Terminal C Station	ls	5,370,000		5,370,000
Terminal E	ls	5,370,000		5,370,000
Wood Island Station improvements	ls	5,000,000		5,000,000
Total Station Costs				184,661,259
Equipment & Systems				
Vehicles	ea	1,815,000	9	16,335,000
Guideway Equipment	ls	65,956,000		65,956,000
Power Distribution	ls	56,724,000		56,724,000
Command Control Communications	ls	56,896,000		56,896,000
Station Equipment	ls	6,696,000		6,696,000
Maintenance Equipment and Supplies	ls	24,850,000		24,850,000
Supplier Proj. Management & Design	ls	104,676,000		104,676,000
Subtotal				332,133,000
Vendor contingency	%	10%		33,213,300
Sub-Stations	ea(min)	460,000	16	7,360,000
Total Equipment & Systems Cost				372,706,300
Guideway Systems-Full length dual lane				
Elevated Guideway	lane-ft	4,046	5000	20,230,000
At Grade Guideway	lane-ft	2,700	6200	16,740,000
Guideway From WTC thru Tube	lane-ft	4,046	7100	28,726,600
Guideway Extension in Transitway - WTC & SST	lane-ft	4,046	5280	21,362,880
Subtotal				87,059,480
Mobilization	%	4%		3,482,379
M&PT	%	6%		5,223,569
Utility Relocation	%	12%		10,447,138
MBTA Track Support/Protection	Allow.	4,099,748		4,099,748
Landscape	%	3%		2,611,784
Total Guideway Costs				112,924,098
Maintanence Facility	ls(min)	5,000,000		5,000,000
Cross Bay Tube	ls	180,000,000		180,000,000
Total Guideway Systems Cost				297,924,098
Total Phase III Cost				855,291,657

Phase 3 Preliminary Cost Estimate

Figure 4.9

4.2.3.4 Financing Strategies For Phase 3

The Silver Line has several opportunities for creative financing strategies. Cash flow analyses have been studied to provide a procurement strategy for Massport based on potential IMTC cash flows. The construction and operational costs of this program are enormous. By the time Phase 3 may become realized, the capital cost could exceed $1 billion and the yearly operation costs may reach $50 million. Utilizing an alternative procurement approach could help to reduce these costs, put the system in service much faster, competitively select the best technology and reduce the cash outlays by Massport.

In an attempt to come up with strategies for packaging components of the IMTC (see Appendix B for ridership source), five scenarios have been studied which alter passenger levels, user fee amounts, and overall system revenue amounts. The overall program has been divided into 13 projects. Similar to the way Phase 1 and 2 utilized delivery methods for procuring the bus system, Phase 3 provides several opportunities to do the same.

The following assumptions have been made during the analysis of Phase 3:

- General Assumptions

  -Annual O&M Costs as % of Construction Cost

Guideway	5%
Equipment and Systems	5%
Stations	2%
Vehicles and Systems	18%
Cross Harbor Tube	2%
Maintenance Facility	.5%

  -O&M Breakdown by Delivery Method

Design/Bid/Build	100%
Design/Build	90%
Design/Build/Operate	86%

Build/Operate/Transfer 0%

- Inflation rate is set constant at 2%

-Passenger levels are at 45 million in 2010 and will rise constantly at 2.3%

-The rental car companies and the Hyatt Hotel will contribute $9.5 million annually (escalated at inflation rate) toward replacement of O&M costs for their bus fleets

-State of Massachusetts and NexTEA will contribute 20% and 80% respectively toward capital costs for the harbor tube

-The MBTA will fund the capital cost toward the guideway from Boylston through the harbor tube, and from Wood Island through Chelsea

-The rental car companies and the developers of Terminals A/B and Terminal E will provide the capital cost of stations at these locations[46]

- Scenario 1 Assumptions

  -Ridership and Fares

    General ridership set at 6,719,955/yr- Blended fare of $1.50 assessed

    Rental car users set at 2,766,430/yr-$1.00 airport fee assessed

- Scenario 2 Assumptions

  -Ridership and Fares

    General ridership set at 6,719,955/yr- Blended fare of $2.50 assessed

    Rental car users set at 2,766,430/yr-$1.00 airport fee assessed

- Scenario 3 Assumptions

  -Ridership and Fares

    General ridership set at 11,759,461/yr- Blended fare of $2.50 assessed

    Rental car users set at 4,015,817/yr-$1.00 airport fee assessed

- Scenario 4 Assumptions

[46] Due to the improvements made at Terminals A and E, construction cost for the stations at these locations is assumed to be included in the package given to the developers. The additional cost for these stations is expected to be between 1% and 2% of Terminal cost.

-Ridership and Fares

Numbers are same as those used for Scenario 2

$1 Passenger Facility Charge (PFC) assessed to all arriving and departing passengers

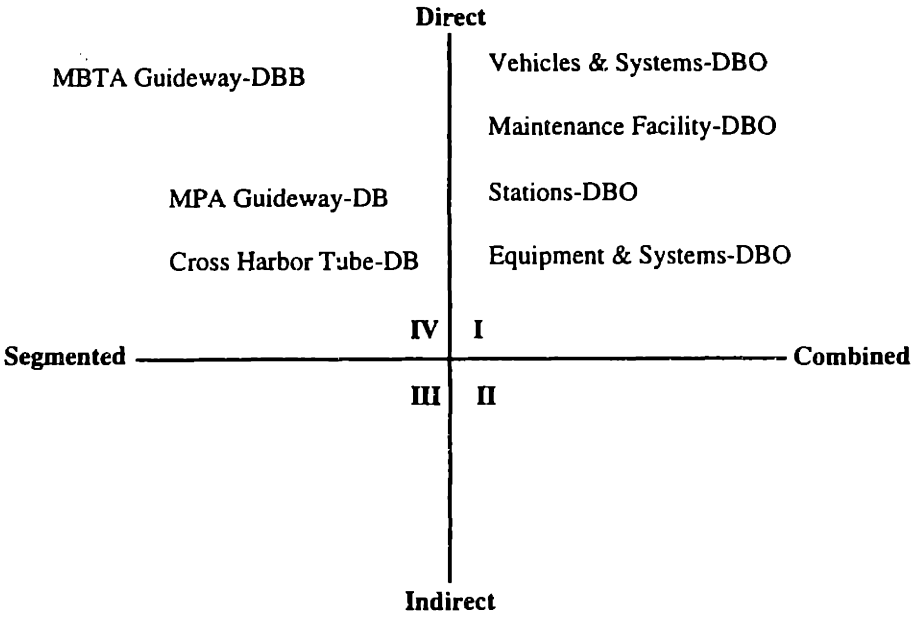
- Scenario 5 Assumptions

-Ridership and Fares

Numbers are same as those used for Scenario 2

$3 Passenger Facility Charge (PFC) assessed to all arriving and departing passengers

The approach taken in each scenario has been to encourage the franchising of projects as either DBO or DB whenever possible. The benefit of using DBO is to gain the advantages of a combined procurement while the advantage of DB is the increased time and cost savings. Figure 4.10 illustrates a quadrant analysis of the IMTC portfolio.



Portfolio Analysis-IMTC Program

Figure 4.10

The next step taken in the analysis has been to determine projects which can be franchised using the revenue streams generated by the project. For instance, if the

revenues would allow franchising the vehicles, the maintenance facility and the stations, Massport could competitively award a franchise to provide these components. Also, a franchise could be awarded to a team to design, manufacture, install and operate the equipment and electrical systems, instead of having a separate engineering team design the system, a separate contractor construct it and a separate company operate it. Manipulating the potential revenues and sources will provide helpful insight into these possibilities for packages. The results from CHOICES, a computer model designed to aid the user in the management of infrastructure portfolios, will help to determine when and in what amounts capital will need to be raised. Results from running data through CHOICES will be discussed later in this chapter.

4.2.3.5 Analysis of Cash Flow Scenarios

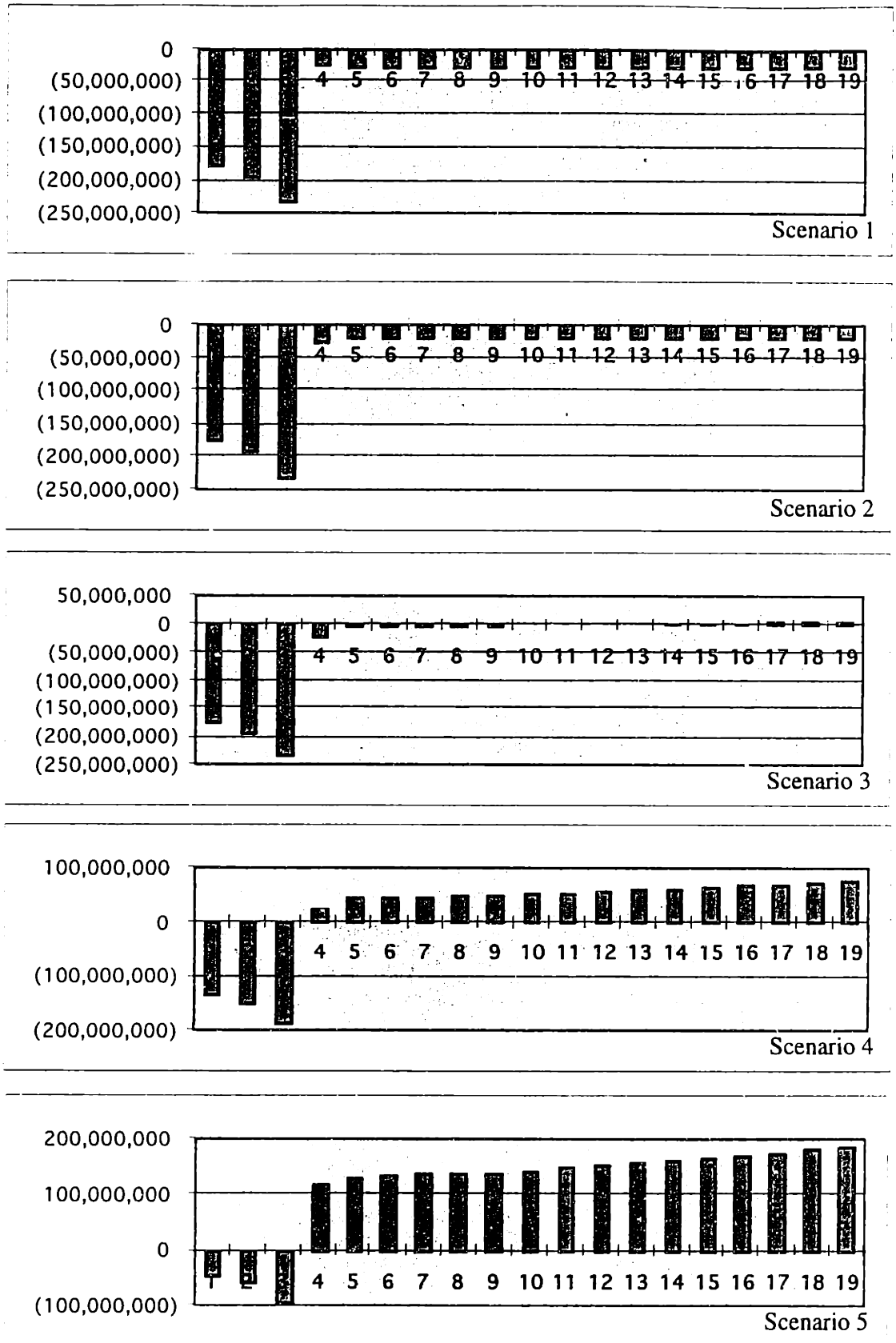
Pro formas for the five test scenarios are presented in Appendix D. Partial summary of data are illustrated in Figure 4.11 below while profit/loss profiles are presented in Figure 4.12. This analysis will test the viability of the IMTC under the conditions and assumptions mentioned previously.

The table below shows negative NPV amounts for Scenarios 1 through 4 for costs over the entire project (from construction through 15 years of operation). Scenario 5, the only cash flow which shows a positive NPV, uses a $3 PFC assessed to all airline travelers using Logan.

Scenario #	NPV-Project	NPV-Revenues	NPV-Oper. Costs	Rev/Cost Coverage
Scenario 1	(660) million	202 million	421 million	48%
Scenario 2	(617) million	265 million	418 million	63%
Scenario 3	(528) million	396 million	418 million	95%
Scenario 4	(83) million	811 million	397 million	206%
Scenario 5	682 million	1.509 billion	397 million	384%

Project and Operation Phase Data-Phase III

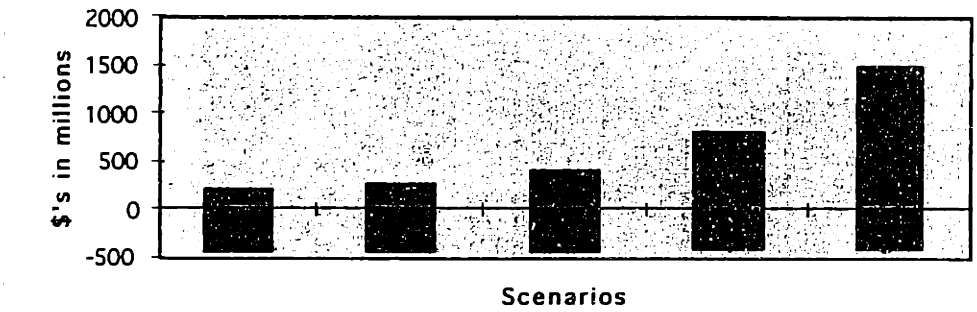
Figure 4.11



Profit/Loss Profiles For Phase 3-Scenarios 1-5

Figure 4.12

Analysis of the cash flows during the operation phase would prove helpful in attempting to find procurement alternatives for the IMTC. Examining the ratio of the revenue coverage to the operation costs, illustrated in the last column of Figure 4.11, shows that each successive scenario presents improved revenues to cover the overall cost of operations. Scenario 1 cash flows show that revenues generated over the first 15 years of the life of the project cover just under one-half of the operation costs. By contrast, Scenario 4, which capitalizes on a $1 PFC, is able to cover more than 200% of the operation costs over the same 15-year life. Figure 4.13 shows the increase in revenue to O&M cost with each



Revenue vs Cost Profile-Phase 3

Figure 4.13

successive scenario, illustrating the increased opportunities for the IMTC's procurement with cash flows matching those amounts. Above the x-axis are revenue amounts while below the x-axis are O&M costs.

Conclusions drawn by the results from the cash flow analysis illustrate clearly that Scenario 1, the most conservative in terms of both ridership numbers and fare prices, is unfeasible. The exorbitant cost would be too great to justify moving from the profitable bus scenarios to a fixed rail system. A similar conclusion could be reached in Scenario 2. This scenario uses a higher fare amount than Scenario 1, however, the increase in total NPV revenue amount is only 30% over Scenario 1. Furthermore, coverage of O&M cost

rises only to 63%, 15% more than that covered in Scenario 1.

Scenarios 3, 4, and 5 show improved opportunities due to the higher ridership numbers used in Scenario 3 and to PFC's used in Scenarios 4 and 5. Recovery of O&M cost from these scenarios range from just under 100% to 384%. All three of these scenarios could provide a basis for convincing private consortia to bid on a procurement strategy like that shown in Figure 4.10's portfolio analysis. Competitively awarded DBO franchises could be tendered to design, construct, and operate the vehicles and systems, maintenance facility, stations and equipment and systems. User fees and PFC's, if applicable, would be paid to the franchisee from Massport. Winning criteria would be based on various factors such as type of technology, construction schedule, cost, and least subsidy amount needed. High levels of competition could be achieved by companies trying to tap this recently popular market.[47]

The additional benefits of the passage of an airline PFC enable the further allocation of revenues for the repayment of bonds and interest for the capital cost of the system. This element will be explored more in the analysis of the scenarios in CHOICES, however, the capital cost burden is nonetheless immense. Scenario 3 has a nominal balance of $638 million for construction cost. Scenarios 4 and 5 have nominal balances of $446 million and $82 million respectively. Only Scenario 5 has sufficient internal revenues to cover both capital and operating costs for the entire system. Therefore, the other scenarios will require monies to be raised to cover the balance of the outstanding costs.

4.2.4 Applying CHOICES Toward The IMTC Portfolio - A Computerized Decision Support Tool [48]

The application of CHOICES to the analysis of the IMTC portfolio is a further level of

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[47] The Federal Transit Administration's (FTA's) success with the Baltimore MTA rail extension project and the New Jersey Hudson-Bergen light rail project illustrate promise in competition for alternative delivery of rail systems.

[48] CHOICES was designed in 1997 by Research Assistant Roger Evje and Professor John B. Miller of MIT. A prototype version of the model is used in analysis of the IMTC program.

investigation toward finding the most effective strategy for procurement and financing. CHOICES uses pro forma discounted cash flows for each project in a portfolio for each available delivery method. The cash flows which are divided into periods, typically quarters, are then matched versus budgets to determine if monies are sufficient to cover the costs. If the cost exceeds the budget for any given quarter, capital must be raised or the project cannot be procured.

CHOICES was developed from the perspective of the public sector. In the case of the IMTC, Massport can use CHOICES to analyze their program and investigate strategies for procurement against their budget constraints. Detailed information about the project is necessary to input into CHOICES, as well as an understanding about appropriate delivery method options, a process which takes acute awareness of potential revenue streams.

The first step in CHOICES is to enter project data into the Data Master sheets as shown in Appendix E-1. The Seed and Stretcher sheets which are used in this step accept the project information including construction cost, duration, O&M amounts, user fee amounts and funding sources. A pro forma in nominal value and net present value (NPV) is generated listing all the revenue and cost sources. Once data are entered for each available delivery method for each project, the information is automatically collected into the "Chooser Function."

From the Chooser, analysis of the entire portfolio can be made. The quarterly cash flows from the Data Master are linked to this sheet which uses graphics to assist the user in understanding the profiles of the project (Appendix E-2). The user can sift through different delivery methods for each project to generate the best profile for procurement.

Data for the IMTC program has been entered into CHOICES as described in Appendix

	NPV $'s in millions				
Scenario #	Bond	Interest	O&M	User Fees	Bal. Acct.
Scenario 1	193.3	105.5	211.9	159.1	52.9
Scenario 2	193.3	105.5	211.9	187.1	24.9
Scenario 3	193.3	105.5	211.9	265	-53
Scenario 4	193.3	105.5	211.9	187.1	-191.3
Scenario 5	193.3	105.5	211.9	187.1	-608.7

CHOICES Summary Results

Figure 4.14

F. Five scenarios for Phase 1, 2, and 3 are modeled matching those used in the cash flow analysis mentioned previously. Available delivery methods have been pre-determined based on analysis of potential cash flows. In the Chooser Function, projects have been set to utilize either DBO or DB when available. Again, this has been done to capitalize on all advantages of time savings, cost savings and enhanced technologies. Figure 4.14 presents a summary of NPV results from CHOICES' analysis of the IMTC scenarios (Figures 4.15A and 4.15B and Appendix G illustrate full output from CHOICES).[49] Shown in the first two columns are totals for the bond and interest amounts necessary to cover the remaining cost of construction, once contributions from outside sources have been made. These amounts remain the same for all scenarios since the construction costs are equal for each. From the chooser graph presented in Appendix G, quarterly totals for bond and interest amounts can be assessed to determine how much capital is needed in any particular quarter. Almost $300 million in total bond and interest amounts are necessary to cover construction for the IMTC program.

The last two columns in Figure 4.14 illustrate revenue amounts which together must equal or total less than the O&M amount of $211.9 million for each project. The balance accounts column in CHOICES is used to show additional funding amounts which must be recovered during the operation phase. Scenarios 1 and 2 show user fee amounts which do

[49] Variance in Net Present Value amounts between the cash flow scenario analysis and the CHOICES analysis results are due to the differences in the starting year calculation. The cash flow analysis begins NPV calculations in 2009 when the decision to procure this system is made. CHOICES begins analysis in 1998, thus presenting NPV calculations which are 11 years early.

Figure 4.15A

CHOICES NPV Calculations-IMTC Portfolio-Scenarios 1,2&3

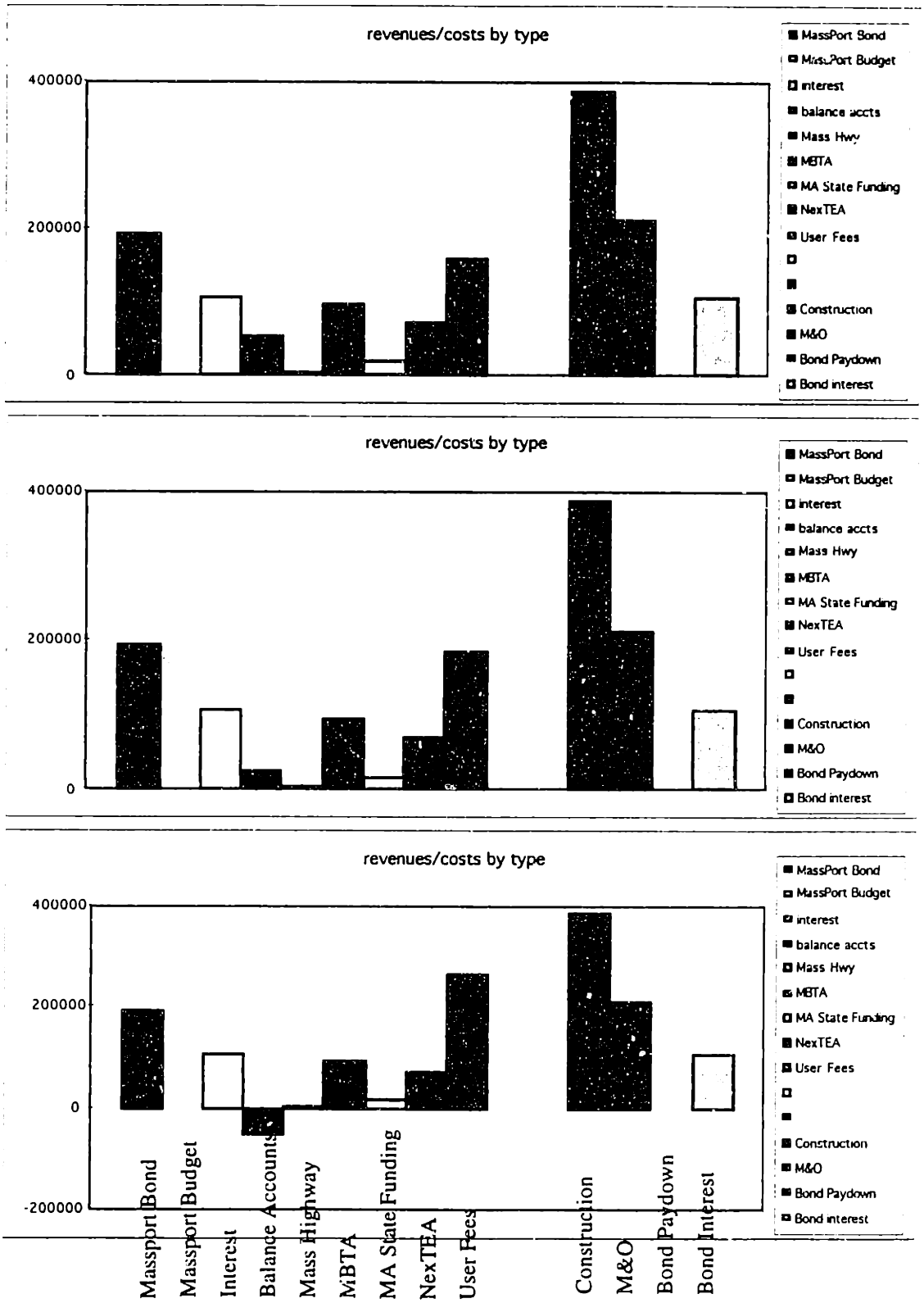
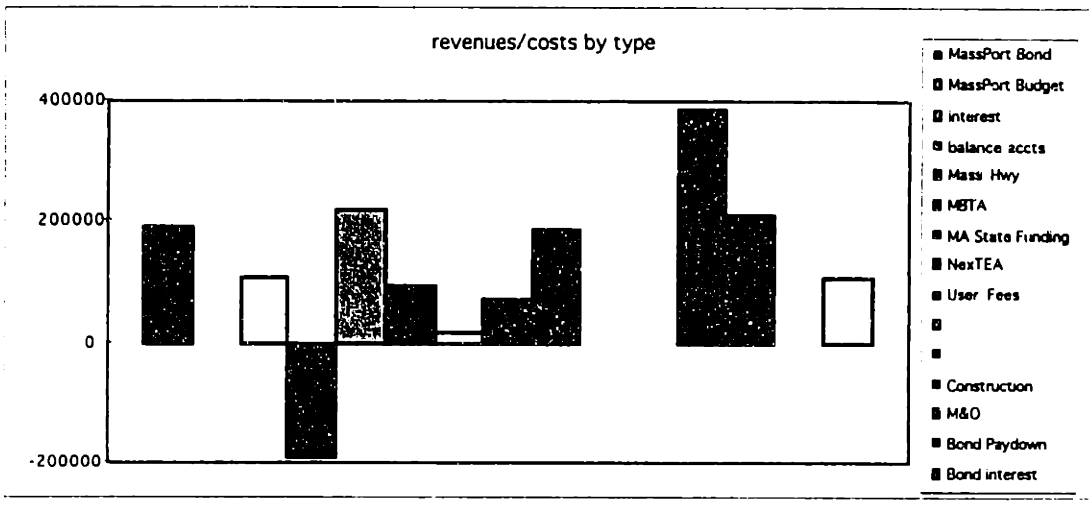
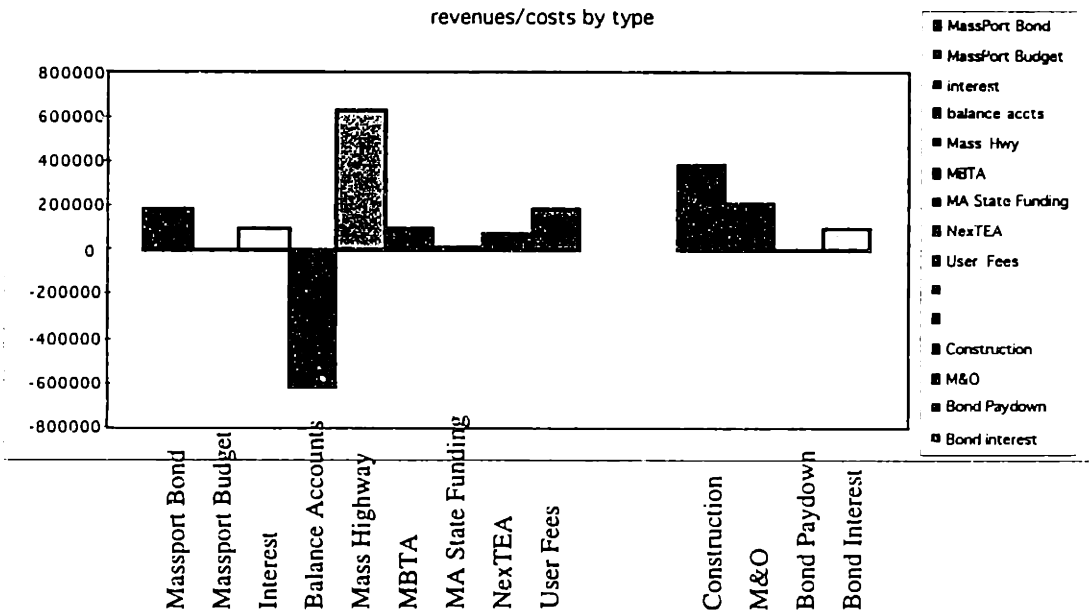


Figure 4.15B

CHOICES NPV Calculations-IMTC Portfolio-Scenarios 4&5





	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Massport Bond	$193,299,500	$193,299,500	$193,299,500	$193,299,500	$193,299,500
Massport Budget					
Interest	$105,455,800	$105,455,800	$105,455,800	$105,455,800	$105,455,800
Balance Account	$52,849,000	$24,889,300	($53,026,000)	($191,285,400)	($608,726,200)
Mass. Hwy. Dept.	$3,017,500	$3,017,500	$3,017,500	$219,192,200	$636,633,000
MBTA	$95,680,000	$95,680,000	$95,680,000	$95,680,000	$95,680,000
Mass. State	$18,711,300	$18,711,300	$18,711,300	$18,711,300	$18,711,300
NexTEA	$72,517,900	$72,517,900	$72,517,900	$72,517,900	$72,517,900
User Fees	$159,103,100	$159,103,100	$159,103,100	$159,103,100	$159,103,100
Total Revenues	$702,961,400	$702,961,400	$702,961,400	$702,961,400	$702,961,400
Construction	$385,553,400	$385,553,400	$385,553,400	$385,553,400	$385,553,400
M&O	$211,952,200	$211,952,200	$211,952,200	$211,952,200	$211,952,200
Bond Interest	$105,455,800	$105,455,800	$105,455,800	$105,455,800	$105,455,800
Total Costs	$702,961,400	$702,961,400	$702,961,400	$702,961,400	$702,961,400

not cover the operating costs of the system. Thus, Scenario 1 must recover $52.9 million while Scenario 2 must recover $24.9 million. Conversely, Scenarios 3, 4, and 5 show full coverage of operation costs resulting in negative balance accounts. In Appendix G, these amounts are shown on the cost side of the horizontal axis. These additional monies could be used to repay bond costs or to fund other projects by Massport.

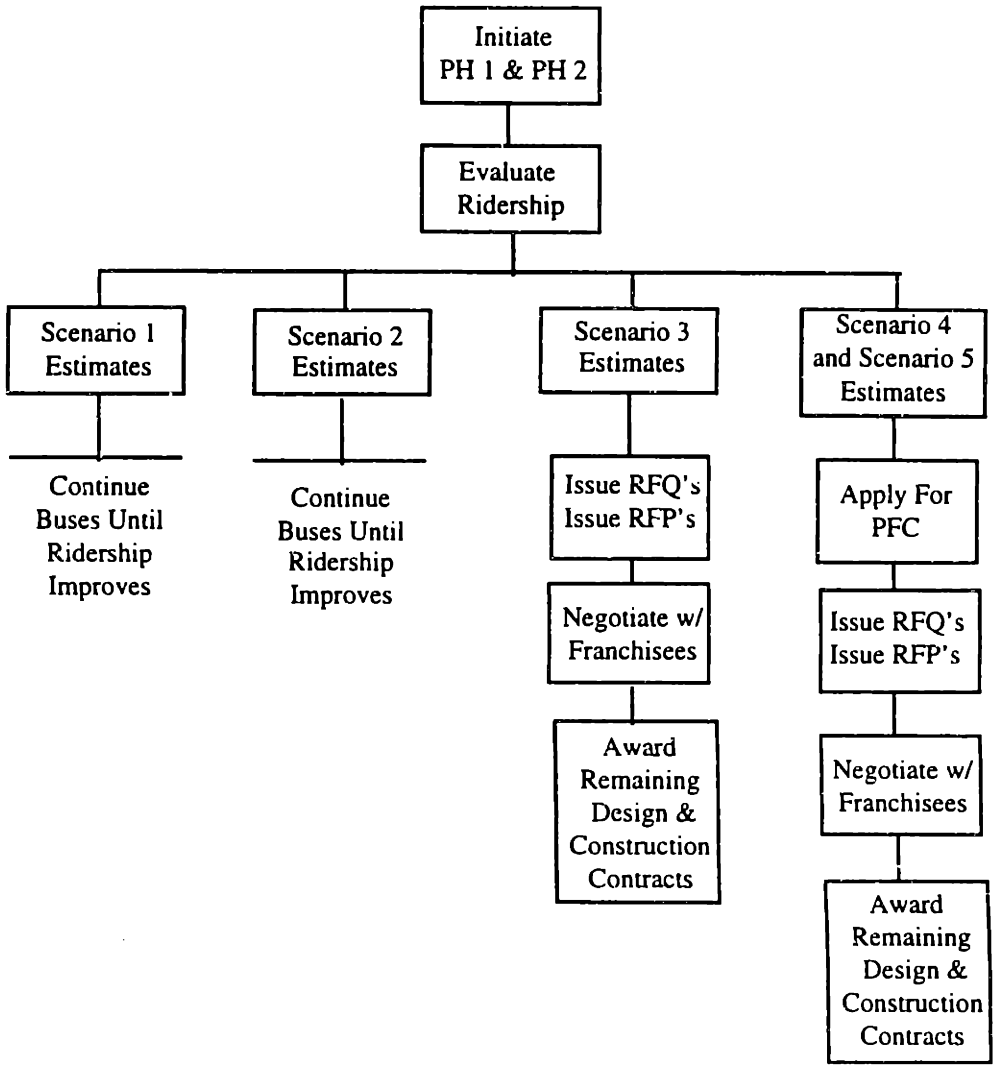
4.3 Conclusions

Based on analysis of the IMTC program in CHOICES, similar conclusions to those presented in the cash flow analysis can be drawn about the viability of the program under sensitivity of revenue streams. Once again, numbers from Scenarios 1 and 2 do not justify the expense of a fixed rail system. Based on project cash flows, the shortfalls of O&M coverage and the extensive amounts of project bonding render the project unattractive for any type of procurement.

Scenarios 3, 4, and 5 show improved numbers which could justify a decision to proceed with a fixed rail system. Coverage of O&M costs is achieved, and with Scenarios 4 and 5, substantial amounts of additional capital are generated. Pre-qualified teams could compete for the components of the IMTC potentially driving the cost of the system down even further.

Accurate evaluation of ridership can not be done until Phase 2 is well underway. The bus system in this phase is similar to the type of travel one would experience on a train. The same Transitway alignment is used, and while in the Ted Williams Tunnel, special HOV lanes are used to circumvent traffic delays. Therefore, demand at that time should be relatively indicative of what to expect with a rail system.

Figure 4.16 presents five alternatives based on investigation of cash flows using the assumptions listed previously. If ridership remains lower than the expected levels of 10% MBTA, continued bus operations may be the best solution even with the passage of a



Massport Alternatives For IMTC Procurement

Figure 4.16

Passenger Facility Charge. Monies from that charge could be better used on other Massport improvements instead of subsidizing a system undervalued by travelers and the public. However, ridership levels which do reach between 10% and 20% MBTA should justify proceeding with procurement of the system. Additionally, the passage of the PFC at either a $1 or $3 amount would substantially help recover costs of bonding and operations.

Chapter 5

Conclusion

5.1 Introduction

One of the world's most envious infrastructure systems has been built by past generations throughout the cities and countrysides of the United States. These enormous facilities have supported the growth of our burgeoning economies over a span of two centuries. In many cases, this growth was directly related to the opportunities government offered private consortia to deliver this infrastructure. Although many projects were capital intensive, they generated substantial returns which attracted companies to invest in these facilities. Projects which could not attract private consortia, due to the inadequacy of a revenue base, were funded directly by government to integrated teams of designers, constructors and operators. This dual track strategy, combining direct and indirect funding, provided many of the great projects of our past; the transcontinental railroads, dams, canals, bridges, and roads are just a few of the public/private joint development projects procured by this strategy.

After two centuries of use, the decrepit condition of our infrastructure bring risk and hardship to daily life, and impede growth and economic competitiveness. Reinvestment in these services is desperately needed, and a strategy similar to the one which originally provided us with these assets can most effectively accomplish this. Keeping pace with the increasing demands for improved infrastructure will not be met with the single-quadrant approach used since WWII. A diversified strategy which incentivizes private sector companies to invest will help restore our facilities and services back to levels which create a competitive advantage to America's economies, when compared with those of our economic competitors.

1.3.2 A Strategic Process For Infrastructure Development

Most state and local governments have become familiar with the advantages and benefits of alternative delivery and financing methods. Many have attempted to capitalize on its advantages by structuring procurements which utilize private financing sources and reduced public money. However, the difficulty and complexity of making these projects work is immense, especially for certain categories of infrastructure.

The four case studies presented in this thesis show that numerous procurement options are available for infrastructure planners. Several combinations and variances can be structured to most effectively apply to the circumstances of each particular project. Important is the understanding that each project has its own set of circumstances and criteria. A BOT project that works successfully in one case may absolutely fail in another location. Thus, careful analysis on a project by project basis must precede any capricious expenditure of funds attempting to attract bidders.

While the circumstances of a delivery method is specific to that project, a common paradigm defines the process for strategically planning infrastructure development. Through analysis of the portfolios studied in this thesis, six points have been identified which can effectively help public infrastructure providers strategically achieve their programs with a mixture of intelligent delivery method selections. Managing this portfolio involves a strategic process described below:

1. Critical Assessment of Needs for the Near and Long-Term

   A strategy considering the economic growth potential of the region must entail a vision into the future.

2. Compilation of Projects

   A "wish-list" of desired projects must be generated to guide the agency in its efforts toward seeking strategies for procurement.

3. Conceptual Studies

Through analysis, assessment could be made of current and future technologies, intermodalism, alternative delivery and financing methods, information technology and human resources.

4. Multi-Agency Coordination

   Communication among various agencies must be accomplished to coordinate similar project goals and tap additional funding sources.

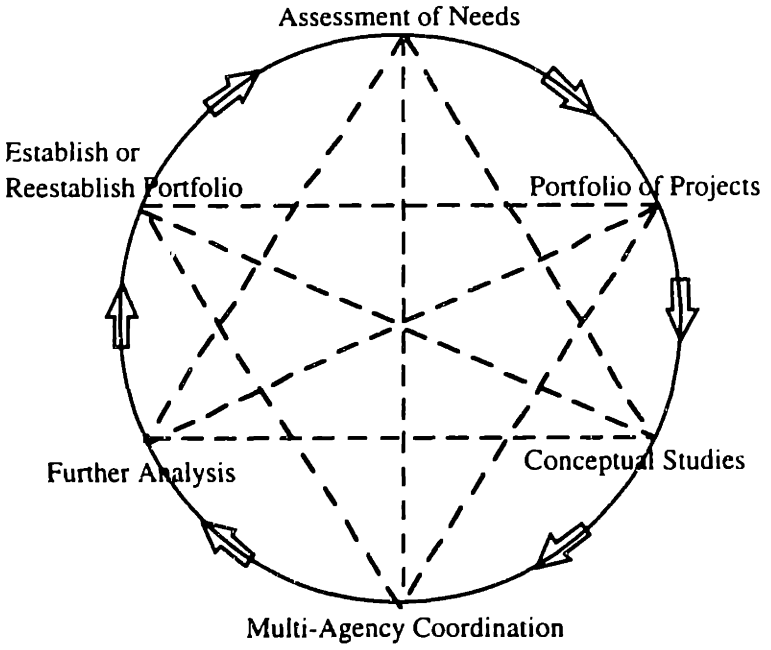
5. Further Analysis

   More financial analyses of potential private projects should be made to determine if a project is viable enough to franchise.

6. Establish or Reestablish Portfolio

   Through analysis of the above points, a portfolio can be arranged which will guide efforts toward realizing the program.

Figure 5.1 illustrates that this process for planning infrastructure development is not always linear. Re-evaluation of factors may take place if issues change. For example,



Infrastructure Development Process

Figure 5.1

suddenly available resources may enable a completely different strategy which was not possible when planning began. Or, the activity and planning of a project from one agency may create opportunities for procurement of a project from another agency's portfolio. Therefore, continual iteration and reevaluation of all of these factors are necessary to uncover all potential avenues for procurement.

5.3 Looking Ahead To The New Century

With their backs against the wall financially, most local and state agencies will need to revamp their strategies and practices for infrastructure delivery as we enter the new century. Portfolio management will aid this process as we attempt the ambitious goal of restoring old and investing in new infrastructure. Support tools such as CHOICES can easily provide scenarios which can assist in making intelligent decisions for procurement of these facilities.

Achieving this will not be done in a short time. Sudden large amounts of capital will not satisfy the long-term needs of our cities and states. Success will only be achieved through a sustained effort of government and private sector and through a utilization of cost and quality effective deliveries.

Without long-term strategies, the competitive edge the US has had will start to decline as other economies will pull opportunities away from us. International markets in Europe and in the Asia-Pacific region are currently making large strides toward infrastructure investment as a means for economic sustainability. Presented in Chapter 3 was Hong Kong's and southern China's aggressive attempts toward developing their infrastructure systems. Paramount effects on our present and future quality of life and economic potential are integrated into our plan of action over the next few decades.

Clearly, we have the technological and creative capabilities to solve these problems. The problem does not lie within this area of concern. What we need to amend is a process for better orchestration between public and private entities such that a playing field can be

set where ideas can flourish and opportunities can successfully become realized.

Appendix A- US Urban System Rail Performance

Source: Prickrell, Don, "Urban Rail Transit Projects: Forcast Versus Actual Ridership and Costs," US Department of Transportation, Urban Mass Transportation Administration, 1989.

City	Type of Rail System	Actual Passengers Compared to Projection	Capital Cost Overrun	Operating Cost Overrun	Cost per Each New Transit Ride	Cost per Annual Commuter
Atlanta	Heavy Rail		+58%	205%	$29.47	$15,030
Baltimore	Heavy Rail	-59%	+60%		$13.56	$6,916
Buffalo	Light Rail	-68%	+61%	12%		
Detroit	Automated	-83%	+50%	47%		
Miami	Automated	-74%	+58%	84%		
Miami	Heavy Rail	-85%	+33%	42%		
Pittsburgh	Light Rail	-66%	-11%		$34.64	$17,666
Portland	Light Rail	-54%	+55%	45%	$9.49	$4,840
Sacramento	Light Rail	-71%	+13%	-10%		
Washington	Heavy Rail	-28%	+83%	202%	$11.97	$6,105
Average		-59%	+46%	+78%	$19.83	$10,111

Don Pickrell, *Urban Rail Transit Projects: Forecast Versus Actual Ridership and Costs* (Washington, DC: US Department of Transportation, Urban Mass Transportation Administration, 1989).

Appendix B - Logan 2000 People Mover- Preliminary Annual Ridership Estimate

Source: Jarvis, Jim, Massachusetts Port Authority, Transportation Planning Office.

TABLE 1
LOGAN 2000 PEOPLE MOVER
PRELIMINARY ESTIMATE OF ANNUAL RIDERSHIP MARKET GROUPS

RIDER GROUP	37.5 MAP 10.2% MBTA		45 MAP 10.2% MBTA		45 MAP 20% MBTA	
	NUMBER (000)	%	NUMBER (000)	%	NUMBER (000)	%
MBTA	4,195	43.1	4,997	43.1	9,797	61.5
Inter-terminal	1,072	11.0	1,286	11.0	1,286	8.1
Rental Car	3,441	35.3	4,129	35.3	3,751	23.5
Park-and-fly	338	3.5	406	3.5	369	2.3
Water Shuttle	692	7.1	830	7.1	737	4.6
TOTAL	9,738	100.0	11,648	100.0	15,940	100.0

Cash Flow Analysis-Phase 1 & 2 Bus Operations

Base Case

Assumptions-Phase 1 & 2:	Costs	O&M % of Cor	Annual Users	
Buses	5,500,000	18%	326,000	$6.00 User Fee
Display Tech.	2,500,000	2%	O&M Breakdown by Alter. Delivery Method	
Bus Maint. Fac.	800,000/yr	100%	DB	90%
D Street Ramp	3,500,000	0%	DBO	86%
			BOT	0%

O&M Escalation percentage 2%
Bus User Escalation Percentag Phase I- 4% Phase II- 2.3%
Fee Increase 2%

Scenario 1
Cash Flow Analysis

Year	1998	1999	2000	2001	2002	2003
Year Index	1	2	3	4	5	6
Period	5 to 8	9 to 12	13 to 16	17 to 20	21 to 24	25 to 28
Mass Highway Department				3,714,228		
MBTA						
Mass. State Fund	1,600,000					
NexTEA	6,400,000					
Private Contribution-Bus Replacement						
Private Sta. Contribution-RAC/Term. A-B/E						
User Revenues	1,956,000	2,074,925	2,201,080	2,334,906	2,435,472	2,541,318
Annual Passenger Level	326,000	339,040	352,602	366,706	375,000	383,625
User Fee	6.00	6.12	6.24	6.37	6.49	6.62
Sub-total Revenues	9,956,000	2,074,925	2,201,080	6,049,134	2,435,472	2,541,318
Construction & Pre-Const. Cost	8,000,000			3,714,228		
Maintenance Facility Costs	800,000	816,000	832,320	848,966	865,946	883,265
O&M Costs	894,400	912,288	930,534	949,144	968,127	987,490
Sub-total Costs	9,694,400	1,728,288	1,762,854	5,512,339	1,834,073	1,870,755
Balance	261,600	346,637	438,226	536,795	601,399	670,563

Net Present Value-Project
5,341,057

2004	2005	2006	2007	2008	2009	2010	2011	2012
7	8	9	10	11	12	13	14	15
29 to 32	33 to 36	37 to 40	41 to 44	45 to 48	49 to 52	53 to 56	57 to 60	61 to 64
2,651,764	2,767,009	2,887,264	3,012,744	3,143,678	3,280,302	3,422,864	3,571,622	3,726,844
392,448	401,475	410,709	420,155	429,818	439,704	449,817	460,163	470,747
6.76	6.89	7.03	7.17	7.31	7.46	7.61	7.76	7.92
2,651,764	2,767,009	2,887,264	3,012,744	3,143,678	3,280,302	3,422,864	3,571,622	3,726,844
900,930	918,949	937,328	956,074	975,196	994,699	1,014,593	1,034,885	1,055,583
1,007,240	1,027,384	1,047,932	1,068,891	1,090,269	1,112,074	1,134,315	1,157,002	1,180,142
1,908,170	1,946,333	1,985,260	2,024,965	2,065,464	2,106,773	2,148,909	2,191,887	2,235,725
743,594	820,676	902,004	987,779	1,078,214	1,173,529	1,273,955	1,379,735	1,491,120

Cash Flow Analysis-10% MBTA

Scenario 1

Assumptions-Phase 3:	Nominal	Escalated	O&M %-Const.
Guideway-MPA	71,438,318	96,007,126	5%
Guideway-MBTA	194,297,039	261,118,973	5%
Equip & Systems	274,625,300	369,037,153	5%
Stations	31,850,000	42,803,215	2%
Vehicles & Systems	73,231,000	98,416,340	18%
Cross Harbor Tube	180,000,000	241,904,948	2%
Maintenance Facility	29,850,000	37,857,018	0.5%
Totals	855,291,657	1,147,144,773	

Annual User Breakdown-201

6,719,955	$1.50	General Rider Fee
2,766,430	$1.00	Rental Car Fee
9,486,385	Total Riders	

O&M Breakdown by Alter. Delivery Method

DB	90%
DBO	86%
BOT	0%

Scenario 1
Cash Flow Analysis

Year	2009	2010	2011	2012	2013	2014	2015	2016
Year Index	12	13	14	15	16	17	18	19
Period	49 to 52	53 to 56	57 to 60	61 to 64	65 to 68	69 to 72	73 to 76	77 to 8
Mass Highway Department								
MBTA	52,223,795	78,335,692	104,447,589	26,111,897				
Mass. State Fund		14,514,297	24,190,495	9,676,198				
NexTEA		58,057,188	96,761,979	38,704,792				
Private Contribution-Bus Replacement					9,407,300	9,595,446	9,787,355	9,983,102
Private Sta. Contribution-RAC/Term. A-B/E				16,110,000				
User Revenues					12,594,364	13,141,715	13,712,854	14,308,815
Annual Passenger Level					9,486,385	9,704,572	9,927,777	10,156,116
User Fee					varies	varies	varies	varies
Sub-total Revenues	52,223,795	150,907,176	225,400,063	90,602,887	22,001,664	22,737,161	23,500,209	24,291,917
Construction & Pre-Const. Cost	229,428,955	344,143,432	458,857,909	114,714,477				
O&M Costs					49,282,562	50,268,213	51,273,578	52,299,049
Sub-total Costs	229,428,955	344,143,432	458,857,909	114,714,477	49,282,562	50,268,213	51,273,578	52,299,049
Balance	(177,205,160)	(193,236,256)	(233,457,846)	(24,111,590)	(27,280,898)	(27,531,052)	(27,773,369)	(28,007,132

NPV-Project	NPV-Revenues	NPV-Oper. Costs	Internal Rate of Return
(660,220,428)	201,514,987	417,552,557	NA

2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
20	21	22	23	24	25	26	27	28	29	30
81 to 84	85 to 88	89 to 82	83 to 86	87 to 90	91 to 94	95 to 98	99 to 102	103 to 106	107 to 110	111 to 11
10,182,764	10,386,419	10,594,148	10,806,031	11,022,151	11,242,594	11,467,446	11,696,795	11,930,731	12,169,346	12,412,733
14,930,676	15,579,563	16,256,651	16,963,165	17,700,384	18,469,643	19,272,333	20,109,909	20,983,886	21,895,845	22,847,439
10,389,707	10,628,670	10,873,129	11,123,211	11,379,045	11,640,763	11,908,501	12,182,396	12,462,591	12,749,231	13,042,463
varies	varies	varies	varies	varies	varies	varies	varies	varies	varies	varies
25,113,440	25,965,982	26,850,799	27,769,196	28,722,535	29,712,237	30,739,780	31,806,704	32,914,617	34,065,19?	35,260,171
53,345,030	54,411,931	55,500,169	56,610,173	57,742,376	58,897,224	60,075,168	61,276,672	62,502,205	63,752,249	65,027,294
53,345,030	54,411,931	55,500,169	56,610,173	57,742,376	58,897,224	60,075,168	61,276,672	62,502,205	63,752,249	65,027,294
(28,231,590)	(28,445,948)	(28,649,371)	(28,840,977)	(29,019,841)	(29,184,987)	(29,335,389)	(29,469,967)	(29,587,588)	(29,687,058)	(29,767,123

Cash Flow Analysis-10% MBTA

Scenario 2

Assumptions-Phase 3:	Nominal	Escalated	O&M %	Const.	Annual User Breakdown-201	
Guideway-MPA	71,438,318	96,007,126	5%		6,719,955	$2.50 General Rider Fee
Guideway-MBTA	194,297,039	261,118,973	5%		2,766,430	$1.00 Rental Car Fee
Equip & Systems	274,625,300	369,037,153	5%		9,486,385	Total Riders
Stations	31,850,000	42,803,215	2%		O&M Breakdown by Alter. Delivery Method	
Vehicles & Systems	73,231,000	98,416,340	18%		DB	90%
Cross Harbor Tube	180,000,000	241,904,948	2%		DBO	86%
Maintenance Facility	29,850,000	37,857,018	0.5%		BOT	0%
Totals	855,291,657	1,147,144,773				

Scenario 1

Cash Flow Analysis

Year	2009	2010	2011	2012	2013	2014	2015	201
Year Index	12	13	14	15	16	17	18	19
Period	49 to 52	53 to 56	57 to 60	61 to 64	65 to 68	69 to 72	73 to 76	77 to 8
Mass Highway Department								
MBTA	52,223,795	78,335,692	104,447,589	26,111,897				
Mass. State Fund		14,514,297	24,190,495	9,676,198				
NexTEA		56,057,188	96,761,979	38,704,792				
Private Contribution-Bus Replacement					9,407,300	9,595,446	9,787,355	9,983,102
Private Sta. Contribution-RAC/Term. A-B/E				16,110,000				
User Revenues					19,146,320	19,978,419	20,846,682	21,752,67
Annual Passenger Level					9,486,385	9,704,572	9,927,777	10,156,11
User Fee					varies	varies	varies	varies
Sub-total Revenues	52,223,795	150,907,176	225,400,063	90,602,887	28,553,620	29,573,865	30,634,036	31,735,78
Construction & Pre-Const. Cost	229,428,955	344,143,432	458,857,909	114,714,477				
O&M Costs					49,282,562	50,268,213	51,273,578	52,299,04
Sub-total Costs	229,428,955	344,143,432	458,857,909	114,714,477	49,282,562	50,268,213	51,273,578	52,299,04
Balance	(177,205,160)	(193,236,256)	(233,457,846)	(24,111,590)	(20,728,942)	(20,694,348)	(20,639,541)	(20,563,26

NPV-Project	NPV-Revenues	NPV-Oper. Costs	Internal Rate of Return
(616,938,295)	264,884,358	417,552,557	NA

2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
20	21	22	23	24	25	26	27	28	29	30
81 to 84	85 to 88	89 to 82	83 to 86	87 to 90	91 to 94	95 to 98	99 to 102	103 to 106	107 to 110	111 to 11
10,182,764	10,386,419	10,594,148	10,806,031	11,022,151	11,242,594	11,467,446	11,696,795	11,930,731	12,169,346	12,412,73
22,698,050	23,684,507	24,713,836	25,787,899	26,908,641	28,078,091	29,298,364	30,571,671	31,900,316	33,286,704	34,733,34
10,389,707	10,628,670	10,873,129	11,123,211	11,379,045	11,640,763	11,908,501	12,182,396	12,462,591	12,749,231	13,042,46
varies	varies	varies	varies	varies	varies	varies	varies	varies	varies	varies
32,880,814	34,070,926	35,307,983	36,593,930	37,930,792	39,320,685	40,765,811	42,268,466	43,831,047	45,456,049	47,146,07
53,345,030	54,411,931	55,500,169	56,610,173	57,742,376	58,897,224	60,075,168	61,276,672	62,502,205	63,752,249	65,027,29
53,345,030	54,411,931	55,500,169	56,610,173	57,742,376	58,897,224	60,075,168	61,276,672	62,502,205	63,752,249	65,027,29
(20,464,216)	(20,341,005)	(20,192,186)	(20,016,243)	(19,811,584)	(19,576,539)	(19,309,358)	(19,008,205)	(18,671,158)	(18,296,200)	(17,881,21

Cash Flow Analysis-20% MBTA

Scenario 3

Assumptions-Phase 3:	Nominal	Escalated	O&M %-Const.	Annual User Breakdown-2013	
Guideway-MPA	71,438,318	96,007,126	5%	11,759,461	$2.50 General Rider Fee
Guideway-MBTA	194,297,039	261,118,973	5%	4,015,817	$1.00 Rental Car Fee
Equip & Systems	274,625,300	369,037,153	5%	15,775,278	Total Riders
Stations	31,850,000	42,803,215	2%	O&M Breakdown by Alter. Delivery Method	
Vehicles & Systems	73,231,000	98,416,340	18%	DB	90%
Cross Harbor Tube	180,000,000	241,904,948	2%	DBO	86%
Maintenance Facility	29,850,000	37,857,018	0.5%	BOT	0%
Totals	855,291,657	1,147,144,773			

Scenario 1

Cash Flow Analysis

Year	2009	2010	2011	2012	2013	2014	2015	2016
Year Index	12	13	14	15	16	17	18	19
Period	49 to 52	53 to 56	57 to 60	61 to 64	65 to 68	69 to 72	73 to 76	77 to 8
Mass Highway Department								
MBTA	52,223,795	78,335,692	104,447,589	26,111,897				
Mass. State Fund		14,514,297	24,190,495	9,676,198				
NexTEA		58,057,188	96,761,979	38,704,792				
Private Contribution-Bus Replacement					9,407,300	9,595,446	9,787,355	9,983,102
Private Sta. Contribution-RAC/Term. A-B/E				16,110,000				
User Revenues					32,679,503	34,099,754	35,581,730	37,128,112
Annual Passenger Level					15,775,278	16,138,109	16,509,286	16,888,995
User Fee					varies	varies	varies	varies
Sub-total Revenues	52,223,795	150,907,176	225,400,063	90,602,887	42,086,803	43,695,200	45,369,085	47,111,214
Construction & Pre-Const. Cost	229,428,955	344,143,432	458,857,909	114,714,477				
O&M Costs					49,282,562	50,268,213	51,273,578	52,299,049
Sub-total Costs	229,428,955	344,143,432	458,857,909	114,714,477	49,282,562	50,268,213	51,273,578	52,299,049
Balance	(177,205,160)	(193,236,256)	(233,457,846)	(24,111,590)	(7,195,759)	(6,573,013)	(5,904,493)	(5,187,835

NPV-Project	NPV-Revenues	NPV-Oper. Costs	Internal Rate of Return
(527,538,272)	395,774,931	417,552,557	NA

2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
20	21	22	23	24	25	26	27	28	29	30
81 to 84	85 to 88	89 to 82	83 to 86	87 to 90	91 to 94	95 to 98	99 to 102	103 to 106	107 to 110	111 to 11
10,182,764	10,386,419	10,594,148	10,806,031	11,022,151	11,242,594	11,467,446	11,696,795	11,930,731	12,169,346	12,412,73
38,741,699	40,425,414	42,182,302	44,015,545	45,928,461	47,924,512	50,007,311	52,180,628	54,448,399	56,814,726	59,283,89
17,277,446	17,674,828	18,081,349	18,497,220	18,922,656	19,357,877	19,803,108	20,258,580	20,724,527	21,201,191	21,688,81
varies	varies	varies	varies	varies	varies	varies	varies	varies	varies	varies
48,924,463	50,811,833	52,776,450	54,821,576	56,950,612	59,167,106	61,474,757	63,877,424	66,379,130	68,984,072	71,696,62
53,345,030	54,411,931	55,500,169	56,610,173	57,742,376	58,897,224	60,075,168	61,276,672	62,502,205	63,752,249	65,027,29
53,345,030	54,411,931	55,500,169	56,610,173	57,742,376	58,897,224	60,075,168	61,276,672	62,502,205	63,752,249	65,027,29
(4,420,567)	(3,600,098)	(2,723,719)	(1,788,597)	(791,764)	269,882	1,399,589	2,600,752	3,876,925	5,231,823	6,669,33

Cash Flow Analysis-$1 Passenger Facility Charge

Scenario 4

Assumptions-Phase 3:	Nominal	Escalated	O&M %	Const.
Guideway-MPA	71,438,318	96,007,126	5%	
Guideway-MBTA	194,297,039	261,118,973	5%	
Equip & Systems	274,625,300	369,037,153	5%	
Stations	31,850,000	42,803,215	2%	
Vehicles & Systems	73,231,000	98,416,340	18%	
Cross Harbor Tube	180,000,000	241,904,948	2%	
Maintenance Facility	29,850,000	37,857,018	0.5%	
Totals	855,291,657	1,147,144,773		

Annual User Breakdown-2013

11,759,461	$2.50 General Rider Fee
4,015,817	$1.00 Rental Car Fee
15,775,278	Total Riders

O&M Breakdown by Alter. Delivery Method

DB	90%
DBO	86%
BOT	0%

Scenario 1

Cash Flow Analysis

Year	2009	2010	2011	2012	2013	2014	2015	2016
Year Index	12	13	14	15	16	17	18	19
Period	49 to 52	53 to 56	57 to 60	61 to 64	65 to 68	69 to 72	73 to 76	77 to 8
Mass Highway Department								
MBTA	52,223,795	78,335,692	104,447,589	26,111,897				
Mass. State Fund		14,514,297	24,190,495	9,676,198				
NexTEA		58,057,188	96,761,979	38,704,792				
Airport Passenger Facility Charge-$1.00	43,965,000	45,000,000	46,035,000	47,093,805	48,176,963	49,285,033	50,418,588	51,578,216
Private Contribution-Bus Replacement					9,407,300	9,595,446	9,787,355	9,983,102
Private Sta. Contribution-RAC/Term. A-B/E				16,110,000				
User Revenues					32,679,503	34,099,754	35,581,730	37,128,112
Annual Passenger Level					15,775,278	16,138,109	16,509,286	16,888,999
User Fee					varies	varies	varies	varies
Sub-total Revenues	96,188,795	195,907,176	271,435,063	137,696,692	90,263,766	92,980,233	95,787,673	98,689,430
Construction & Pre-Const. Cost	229,428,955	344,143,432	458,857,909	114,714,477				
O&M Costs					46,378,426	47,305,994	48,252,114	49,217,156
Sub-total Costs	229,428,955	344,143,432	458,857,909	114,714,477	46,378,426	47,305,994	48,252,114	49,217,156
Balance	(133,240,160)	(148,236,256)	(187,422,846)	22,982,215	43,885,340	45,674,239	47,535,559	49,472,273

NPV-Project	NPV-Revenues	NPV-Oper. Costs	Internal Rate of Return
(83,364,409)	810,784,512	392,946,905	7%

2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
20	21	22	23	24	25	26	27	28	29	30
81 to 84	85 to 88	89 to 82	83 to 86	87 to 90	91 to 94	95 to 98	99 to 102	103 to 106	107 to 110	111 to 11
52,764,515	53,978,099	55,219,595	56,489,646	57,788,908	59,118,052	60,477,768	61,868,756	63,291,738	64,747,448	66,236,63
10,182,764	10,386,419	10,594,148	10,806,031	11,022,151	11,242,594	11,467,446	11,696,795	11,930,731	12,169,346	12,412,73
38,741,699	40,425,414	42,182,302	44,015,545	45,928,461	47,924,512	50,007,311	52,180,628	54,448,399	56,814,726	59,283,89
17,277,446	17,674,828	18,081,349	18,497,220	18,922,656	19,357,877	19,803,108	20,258,580	20,724,527	21,201,191	21,688,81
varies	varies	varies	varies	varies	varies	varies	varies	varies	varies	varies
101,688,978	104,789,932	107,996,045	111,311,221	114,739,519	118,285,158	121,952,525	125,746,180	129,670,867	133,731,519	137,933,26
50,201,500	51,205,530	52,229,640	53,274,233	54,339,718	55,426,512	56,535,042	57,665,743	58,819,058	59,995,439	61,195,34
50,201,500	51,205,530	52,229,640	53,274,233	54,339,718	55,426,512	56,535,042	57,665,743	58,819,058	59,995,439	61,195,34
51,487,479	53,584,402	55,766,405	58,036,988	60,399,802	62,858,646	65,417,482	68,080,437	70,851,809	73,736,080	76,737,91

Cash Flow Analysis-$3 Passenger Facility Charge

Scenario 5

Assumptions-Phase 3:	Nominal	Escalated	O&M %	Annual User Breakdown-2013	
Guideway-MPA	71,438,318	96,007,126	5%	6,719,955	$2.50 General Rider Fee
Guideway-MBTA	194,297,039	261,118,973	5%	2,766,430	$1.00 Rental Car Fee
Equip & Systems	274,625,300	369,037,153	5%	9,486,385	Total Riders
Stations	31,850,000	42,803,215	2%	O&M Breakdown by Alter. Delivery Method	
Vehicles & Systems	73,231,000	98,416,340	18%	DB	90%
Cross Harbor Tube	180,000,000	241,904,948	2%	DBO	86%
Maintenance Facility	29,850,000	37,857,018	0.5%	BOT	0%
Totals	855,291,657	1,147,144,773			

Scenario 1

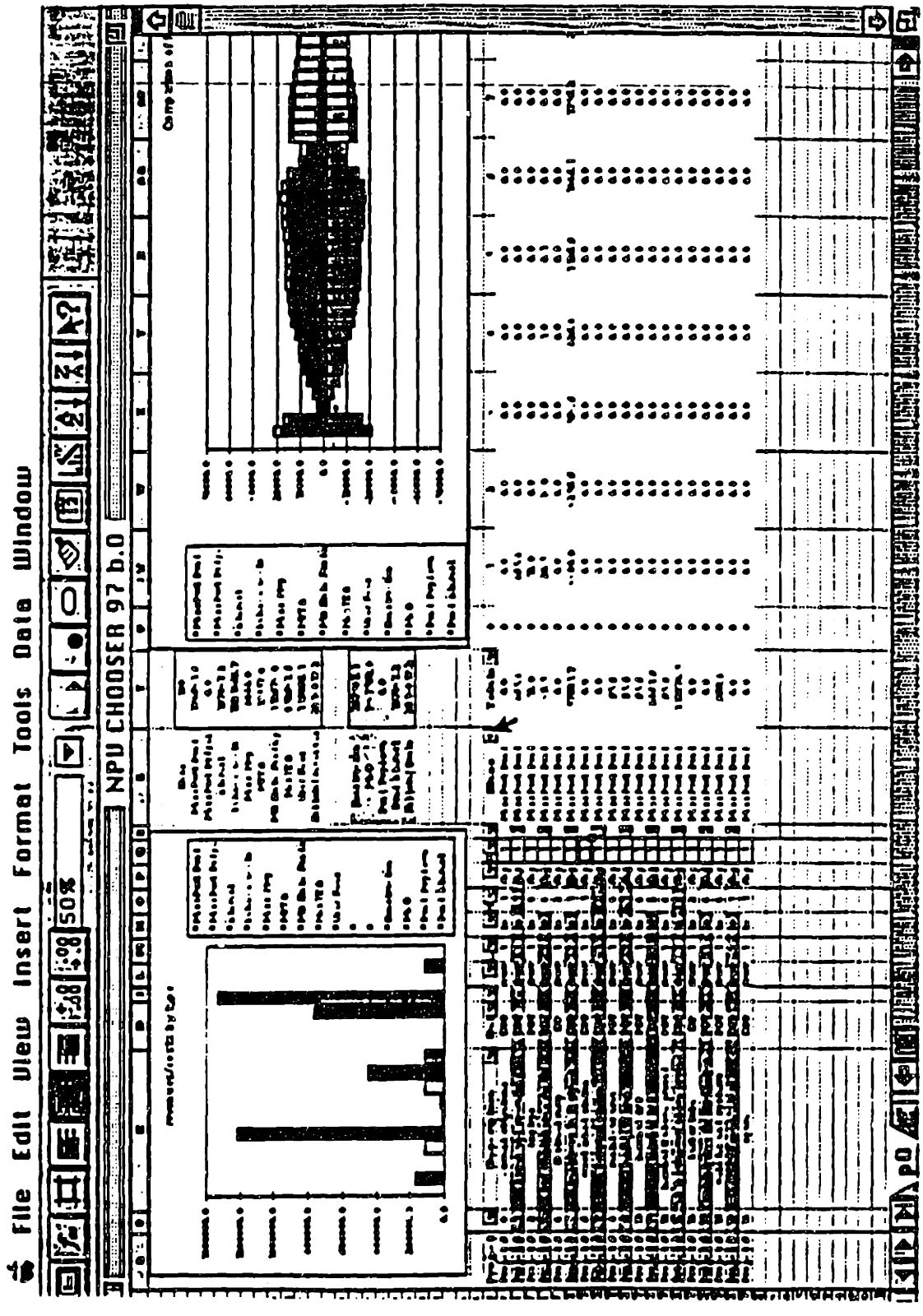
Cash Flow Analysis

Year	2009	2010	2011	2012	2013	2014	2015	201
Year Index	12	13	14	15	16	17	18	19
Period	49 to 52	53 to 56	57 to 60	61 to 64	65 to 68	69 to 72	73 to 76	77 to 8
Mass Highway Department								
MBTA	52,223,795	78,335,692	104,447,589	26,111,897				
Mass. State Fund		14,514,297	24,190,495	9,676,198				
NexTEA		58,057,188	96,761,979	38,704,792				
Airport Passenger Facility Charge-$3.00	131,895,000	135,000,000	138,105,000	141,281,415	144,530,888	147,855,098	151,255,765	154,734,64
Private Contribution-Bus Replacement					9,407,300	9,595,446	9,787,355	9,983,102
Private Sta. Contribution-RAC/Term. A-B/E				16,110,000				
User Revenues					19,146,320	19,978,419	20,846,682	21,752,67
Annual Passenger Level					9,486,385	9,704,572	9,927,777	10,156,11
User Fee					varies	varies	varies	varies
Sub-total Revenues	184,118,795	285,907,176	363,505,063	231,884,302	173,084,508	177,428,963	181,889,802	186,470,42
Construction & Pre-Const. Cost	229,428,955	344,143,432	458,857,909	114,714,477				
O&M Costs					46,378,426	47,305,994	48,252,114	49,217,15
Sub-total Costs	229,428,955	344,143,432	458,857,909	114,714,477	46,378,426	47,305,994	48,252,114	49,217,15
Balance	(45,310,160)	(58,236,256)	(95,352,846)	17,169,825	126,706,082	130,122,969	133,637,688	137,253,27

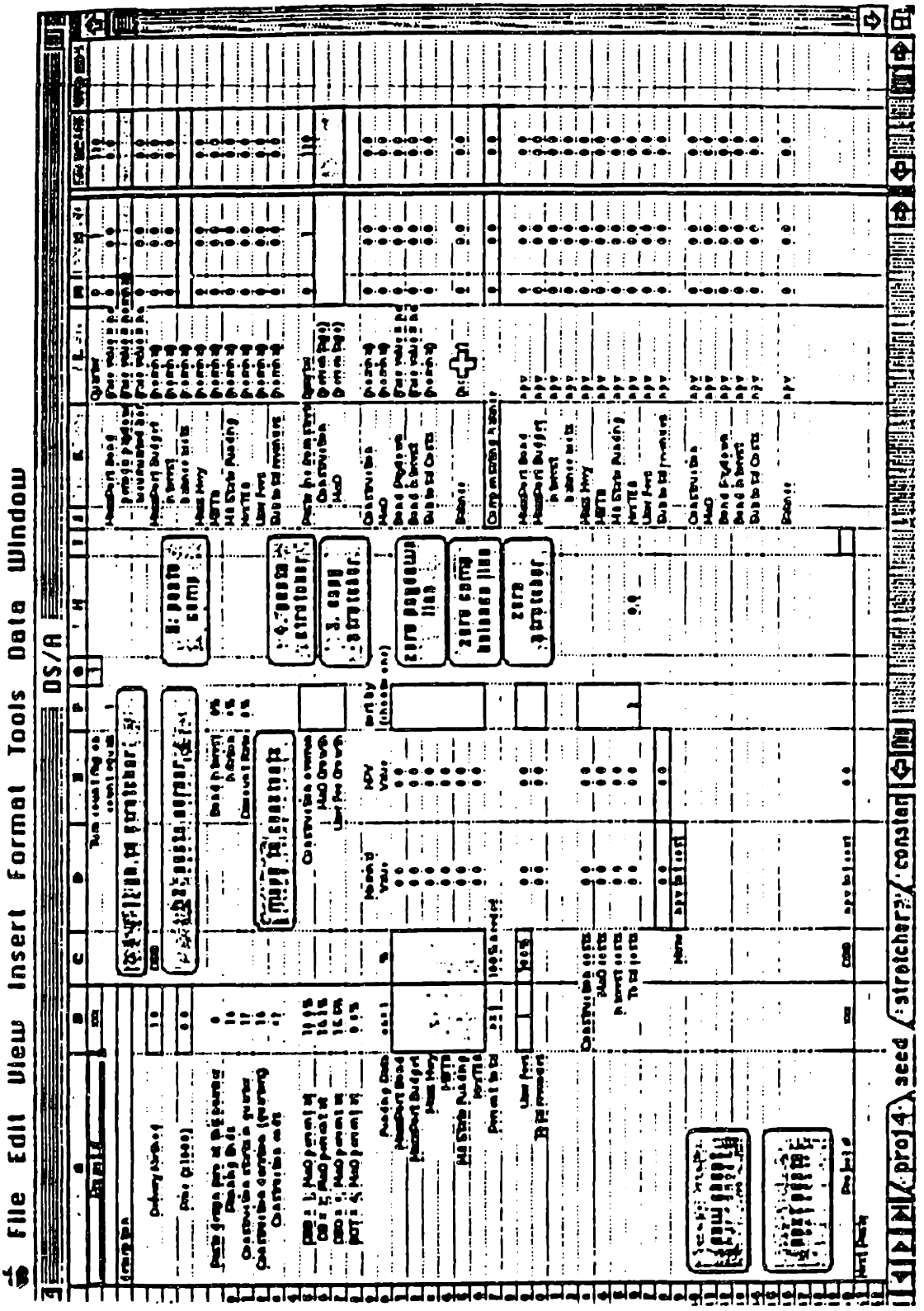
NPV-Project	NPV-Revenues	NPV-Oper. Costs	Internal Rate of Return
681,971,311	1,509,913,100	392,946,905	46%

2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	202
20	21	22	23	24	25	26	27	28	29	30
81 to 84	85 to 88	89 to 82	83 to 86	87 to 90	91 to 94	95 to 98	99 to 102	103 to 106	107 to 110	111 to 11
158,293,545	161,934,296	165,658,785	169,468,937	173,366,723	177,354,157	181,433,303	185,606,269	189,875,213	194,242,343	198,709,91
10,182,764	10,386,419	10,594,148	10,806,031	11,022,151	11,242,594	11,467,446	11,696,795	11,930,731	12,169,346	12,412,73
22,698,050	23,684,507	24,713,836	25,787,899	26,908,641	28,078,091	29,298,364	30,571,671	31,900,316	33,286,704	34,733,34
10,389,707	10,628,670	10,873,129	11,123,211	11,379,045	11,640,763	11,908,501	12,182,396	12,462,591	12,749,231	13,042,46
varies	varies	varies	varies	varies	varies	varies	varies	varies	varies	varies
191,174,358	196,005,222	200,966,768	206,062,867	211,297,515	216,674,842	222,199,113	227,874,735	233,706,260	239,698,392	245,855,99
50,201,500	51,205,530	52,229,640	53,274,233	54,339,718	55,426,512	56,535,042	57,665,743	58,819,058	59,995,439	61,195,34
50,201,500	51,205,530	52,229,640	53,274,233	54,339,718	55,426,512	56,535,042	57,665,743	58,819,058	59,995,439	61,195,34
140,972,859	144,799,693	148,737,128	152,788,634	156,957,797	161,248,330	165,664,071	170,208,992	174,887,202	179,702,953	184,660,64

Appendix E-1 - CHOICES Chooser Function Layout



Appendix E-2 - CHOICES Data Master Layout



Logan Intermodal Transit Connector
Scenario 1

Project Identifier (Description)		**1**	**2**	**3**
Project Name		Displays	Bus Maint. Facility Chelsea	Buses & Operation
Phase		I & II	I	II
Quarter to Start Profile		5	5	21
Quarter to End Profile - In Service Quarter		5	9	21
Construction/Initial Capital Cost ($K)		$2,500,000	$800,000	$5,500,000
M&O as % of Construction Cost (Default 18%)		2%	100%	18%
Discount Rate Public (%)		8%	8%	8%
Discount Rate Private (%)		10%	10%	10%
Available Project Delivery Methods (1=Yes, 0=No)				
	DBB	1	1	1
	DB	1	1	0
	DBO	1	1	1
	BOT	0	0	0
In service Receipts as % of M&O (Default 0%)				
	DBB	100%	100%	100%
	DB	100%	100%	100%
	DBO	110%	100%	110%
	BOT			
Massport Bond		0%	0%	0%
Massport Budget		0%	0%	0%
Mass Hwy Sources (CA/T)		0%	0%	0%
MBTA Sources		0%	0%	0%
Mass State Funding (Max 20%)		20%	20%	20%
NexTEA (Max 80%)		80%	80%	80%

4	5	6	7	8	9	10
D Street Ramp	Transitway Boylston to SSTC	Wood Island Station-Trains	Terminal A/B Station-Elev.	Rental Car Area Station	Terminal E Station-Elev.	Hyatt Hotel Watershuttle Sta
I	I	III	III	III	III	III
17	51	61	61	61	61	61
20	63	64	64	64	64	64
$3,500,000	$153,000,000	$5,000,000	$5,370,000	$5,370,000	$5,370,000	$5,370,000
	5%	2%	2%	2%	2%	2%
8%	8%	8%	8%	8%	8%	8%
10%	10%	10%	10%	10%	10%	10%
1	1	1	1	1	1	1
0	0	1	1	1	1	1
0	0	1	0	0	0	0
0	0	0	1	1	1	0
		100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
		110%	110%	110%	110%	110%
0%	0%	100%	0%	0%	0%	100%
0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	0%	0%
0%	100%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%

11	12	13	14	15	16	17
Terminal C Station-Elev.	Guideway Massport	Guideway MBTA	Harbor Tube	Maint. Fac. & Equip Chelsea Yard	Vehicles & Syst.	Equip & Systems
III	III	III	III	III	III	III
60	53	53	51	58	56	53
63	64	64	63	64	64	64
$5,370,000	$71,438,318	$41,485,780	$180,000,000	$29,850,000	$73,000,000	$274,600,000
2%	5%	5%	2%	0.5%	18%	10%
8%	8%	8%	8%	8%	8%	8%
10%	10%	10%	10%	10%	10%	10%
0	1	1	1	1	1	1
0	1	0	1	1	1	1
0	0	0	0	1	1	0
1	0	0	0	0	0	0
100%	0%		0%	0%	0%	12%
100%	0%		0%	0%	0%	13%
110%				0%	0%	
100%	100%	0%	0%	100%	100%	100%
0%	0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%
0%	0%	100%	0%	0%	0%	0%
0%	0%	0%	20%	0%	0%	0%
0%	0%	0%	80%	0%	0%	0%

Logan Intermodal Transit Connector
Scenario 2

Project Identifier (Description)		**1**	**2**	**3**
Project Name		Displays	Bus Maint. Facility Chelsea	Buses & Operation
Phase		I & II	I	II
Quarter to Start Profile		5	5	21
Quarter to End Profile - In Service Quarter		5	9	21
Construction/Initial Capital Cost ($K)		$2,500,000	$800,000	$5,500,000
M&O as % of Construction Cost (Default 18%)		2%	100%	18%
Discount Rate Public (%)		8%	8%	8%
Discount Rate Private (%)		10%	10%	10%
Available Project Delivery Methods (1=Yes, 0=No)				
	DBB	1	1	1
	DB	1	1	0
	DBO	1	1	1
	BOT	0	0	0
In service Receipts as % of M&O (Default 0%)				
	DBB	100%	100%	100%
	DB	100%	100%	100%
	DBO	110%	100%	110%
	BOT			
Massport Bond		0%	0%	0%
Massport Budget		0%	0%	0%
Mass Hwy Sources (CA/T)		0%	0%	0%
MBTA Sources		0%	0%	0%
Mass State Funding (Max 20%)		20%	20%	20%
NexTEA (Max 80%)		80%	80%	80%

4	5	6	7	8	9	10
D Street Ramp	Transitway Boylston to SSTC	Wood Island Station-Trains	Terminal A/B Station-Elev.	Rental Car Area Station	Terminal E Station-Elev.	Hyatt Hotel Watershuttle Sta
I	I	III	III	III	III	III
17	51	61	61	61	61	61
20	63	64	64	64	64	64
$3,500,000	$153,000,000	$5,000,000	$5,370,000	$5,370,000	$5,370,000	$5,370,000
	5%	2%	2%	2%	2%	2%
8%	8%	8%	8%	8%	8%	8%
10%	10%	10%	10%	10%	10%	10%
1	1	1	1	1	1	1
0	0	1	1	1	1	1
0	0	1	0	0	0	0
0	0	0	1	1	1	0
		100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
		110%	110%	110%	110%	110%
0%	0%	100%	0%	0%	0%	100%
0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	0%	0%
0%	100%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%

11	12	13	14	15	16	17
Terminal C Station-Elev.	Guideway Massport	Guideway MBTA	Harbor Tube	Maint. Fac. & Equip Chelsea Yard	Vehicles & Syst.	Equip & Systems
III	III	III	III	III	III	III
60	53	53	51	58	56	53
63	64	64	63	64	64	64
$5,370,000	$71,438,318	$41,485,780	$180,000,000	$29,850,000	$73,000,000	$274,600,000
2%	5%	5%	2%	0.5%	18%	10%
8%	8%	8%	8%	8%	8%	8%
10%	10%	10%	10%	10%	10%	10%
0	1	1	1	1	1	1
0	1	0	1	1	1	1
0	0	0	0	1	1	0
1	0	0	0	0	0	0
100%	0%		0%	0%	0%	31%
100%	0%		0%	0%	0%	33%
110%				0%	0%	
100%	100%	0%	0%	100%	100%	100%
0%	0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%
0%	0%	100%	0%	0%	0%	0%
0%	0%	0%	20%	0%	0%	0%
0%	0%	0%	80%	0%	0%	0%

Logan Intermodal Transit Connector
Scenario 3

Project Identifier (Description)		**1**	**2**	**3**
Project Name		Displays	Bus Maint. Facility Chelsea	Buses & Operation
Phase		I & II	I	II
Quarter to Start Profile		5	5	21
Quarter to End Profile - in Service Quarter		5	9	21
Construction/Initial Capital Cost ($K)		$2,500,000	$800,000	$5,500,000
M&O as % of Construction Cost (Default 18%)		2%	100%	18%
Discount Rate Public (%)		8%	8%	8%
Discount Rate Private (%)		10%	10%	10%
Available Project Delivery Methods (1=Yes, 0=No)				
	DBB	1	1	1
	DB	1	1	0
	DBO	1	1	1
	BOT	0	0	0
In service Receipts as % of M&O (Default 0%)				
	DBB	100%	100%	100%
	DB	100%	100%	100%
	DBO	110%	100%	110%
	BOT			
Massport Bond		0%	0%	0%
Massport Budget		0%	0%	0%
Mass Hwy Sources (CA/T)		0%	0%	0%
MBTA Sources		0%	0%	0%
Mass State Funding (Max 20%)		20%	20%	20%
NexTEA (Max 80%)		80%	80%	80%

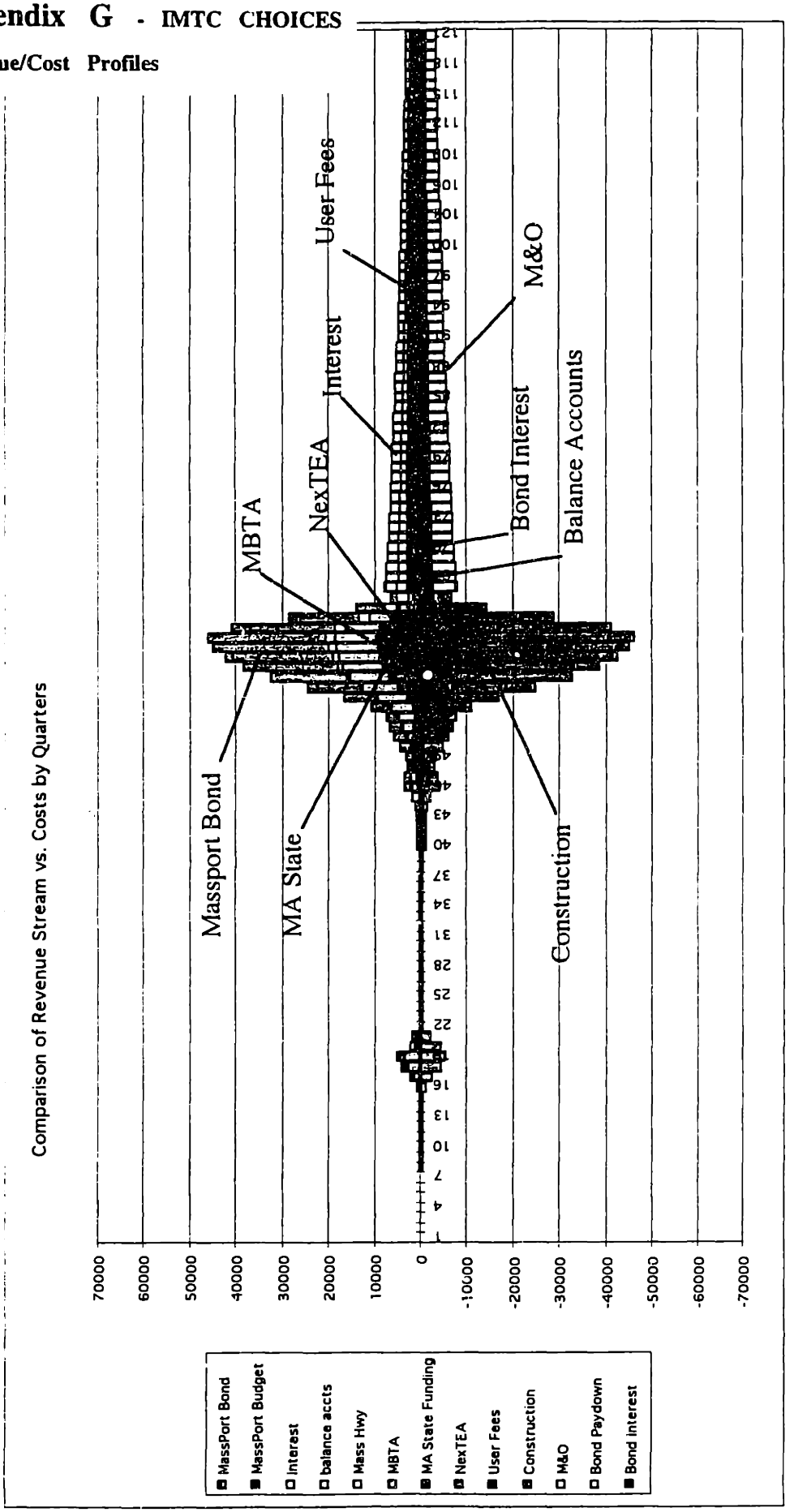
4	5	6	7	8	9	10
D Street Ramp	Transitway Boylston to SSTC	Wood Island Station-Trains	Terminal A/B Station-Elev.	Rental Car Area Station	Terminal E Station-Elev.	Hyatt Hotel Watershuttle Sta
I	I	III	III	III	III	III
17	51	61	61	61	61	61
20	63	64	64	64	64	64
$3,500,000	$153,000,000	$5,000,000	$5,370,000	$5,370,000	$5,370,000	$5,370,000
	5%	2%	2%	2%	2%	2%
8%	8%	8%	8%	8%	8%	8%
10%	10%	10%	10%	10%	10%	10%
1	1	1	1	1	1	1
0	0	1	1	1	1	1
0	0	1	0	0	0	0
0	0	0	1	1	1	0
		100%	100%	100%	100%	100%
		100%	100%	100%	100%	100%
		110%	110%	110%	110%	110%
0%	0%	100%	0%	0%	0%	100%
0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	0%	0%
0%	100%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%

11	12	13	14	15	16	17
Terminal C Station-Elev.	Guideway Massport	Guideway MBTA	Harbor Tube	Maint. Fac. & Equip Chelsea Yard	Vehicles & Syst.	Equip & Systems
III	III	III	III	III	III	III
60	53	53	51	58	56	53
63	64	64	63	64	64	64
$5,370,000	$71,438,318	$41,485,780	$180,000,000	$29,850,000	$73,000,000	$274,600,000
2%	5%	5%	2%	0.5%	18%	10%
8%	8%	8%	8%	8%	8%	8%
10%	10%	10%	10%	10%	10%	10%
0	1	1	1	1	1	1
0	1	0	1	1	1	1
0	0	0	0	1	1	0
1	0	0	0	0	0	0
100%	0%		0%	0%	0%	74%
100%	0%		0%	0%	0%	76%
110%				0%	0%	
100%	100%	0%	0%	100%	100%	100%
0%	0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%	0%
0%	0%	100%	0%	0%	0%	0%
0%	0%	0%	20%	0%	0%	0%
0%	0%	0%	80%	0%	0%	0%

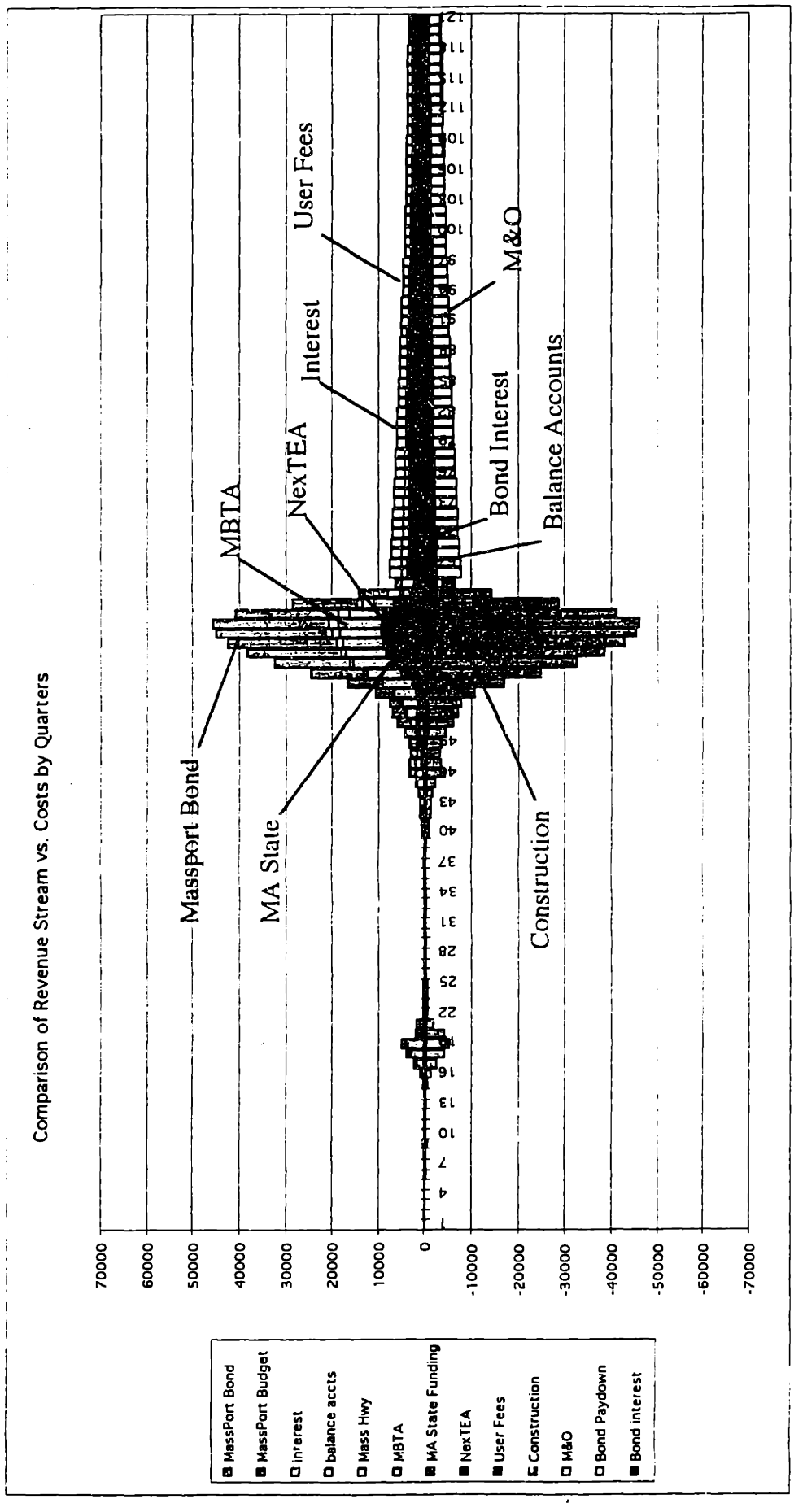
Appendix G - IMTC CHOICES

Revenue/Cost Profiles

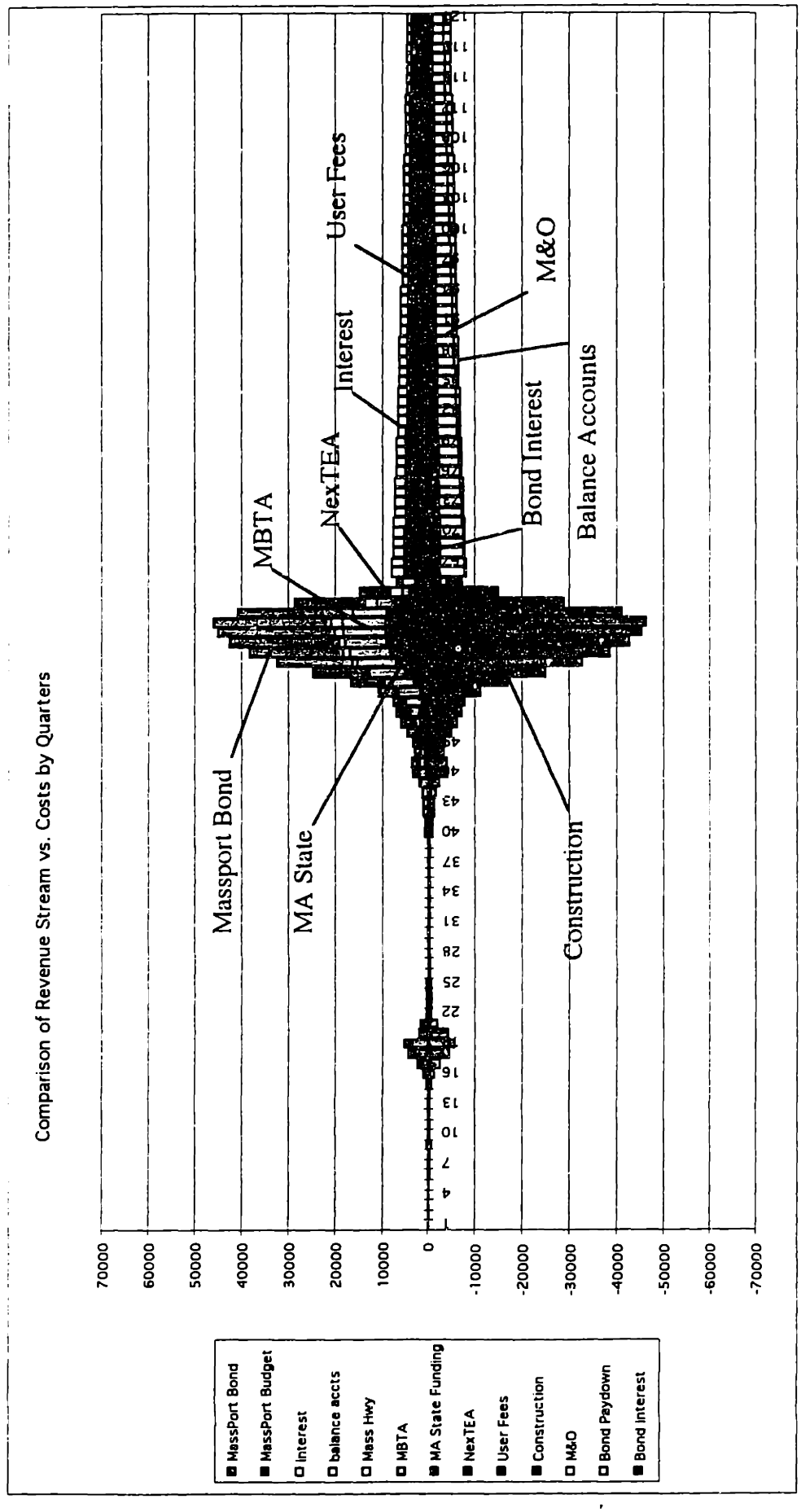
Scenario 1



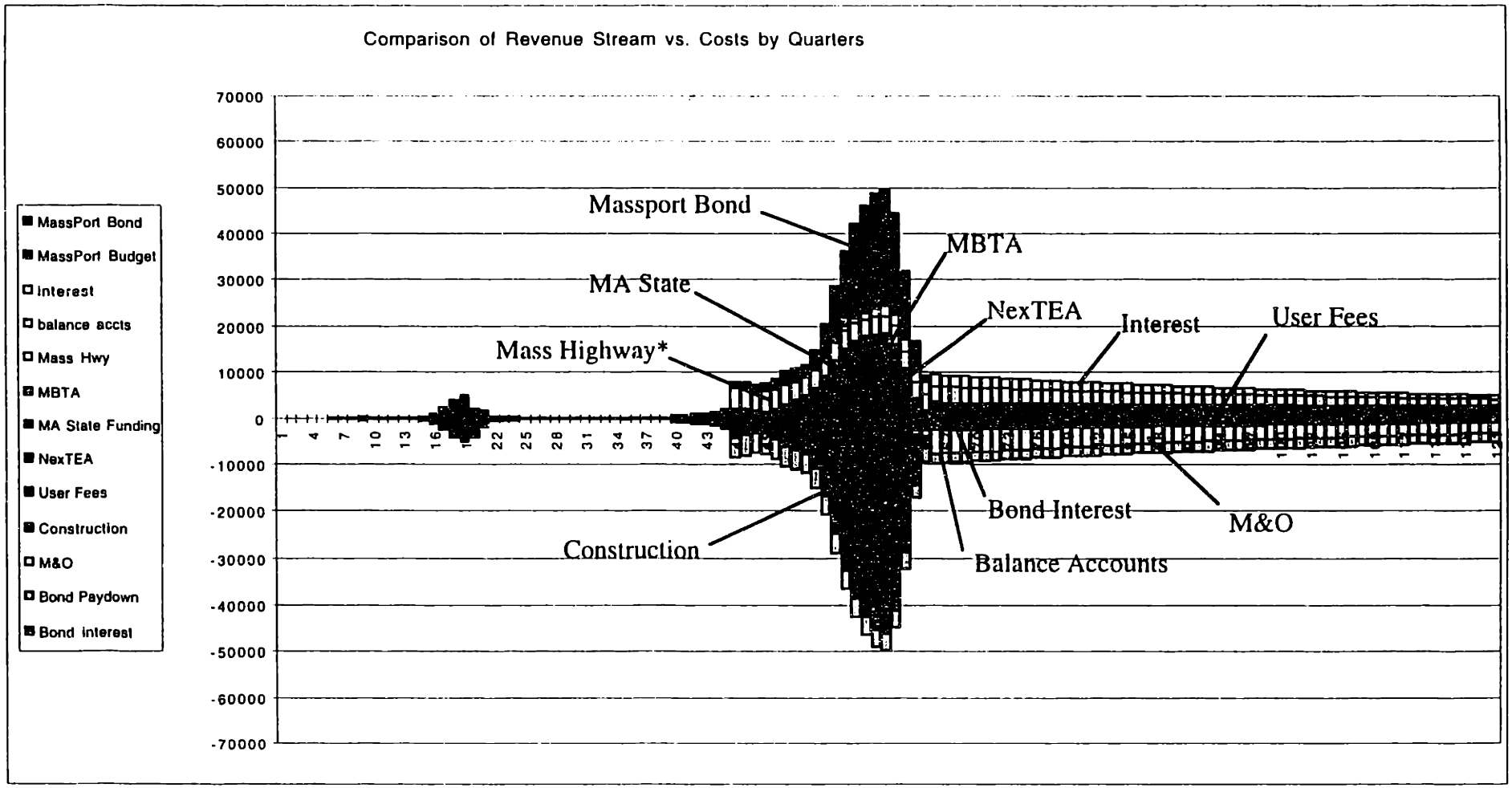
Scenario 2


Comparison of Revenue Stream vs. Costs by Quarters
MassPort Bond
MassPort Budget
interest
balance accts
Mass Hwy
MBTA
MA State Funding
NexTEA
User Fees
Construction
M&O
Bond Paydown
Bond interest
Massport Bond
MBTA
NexTEA
Interest
User Fees
M&O
Bond Interest
Balance Accounts
MA State
Construction

Scenario 3

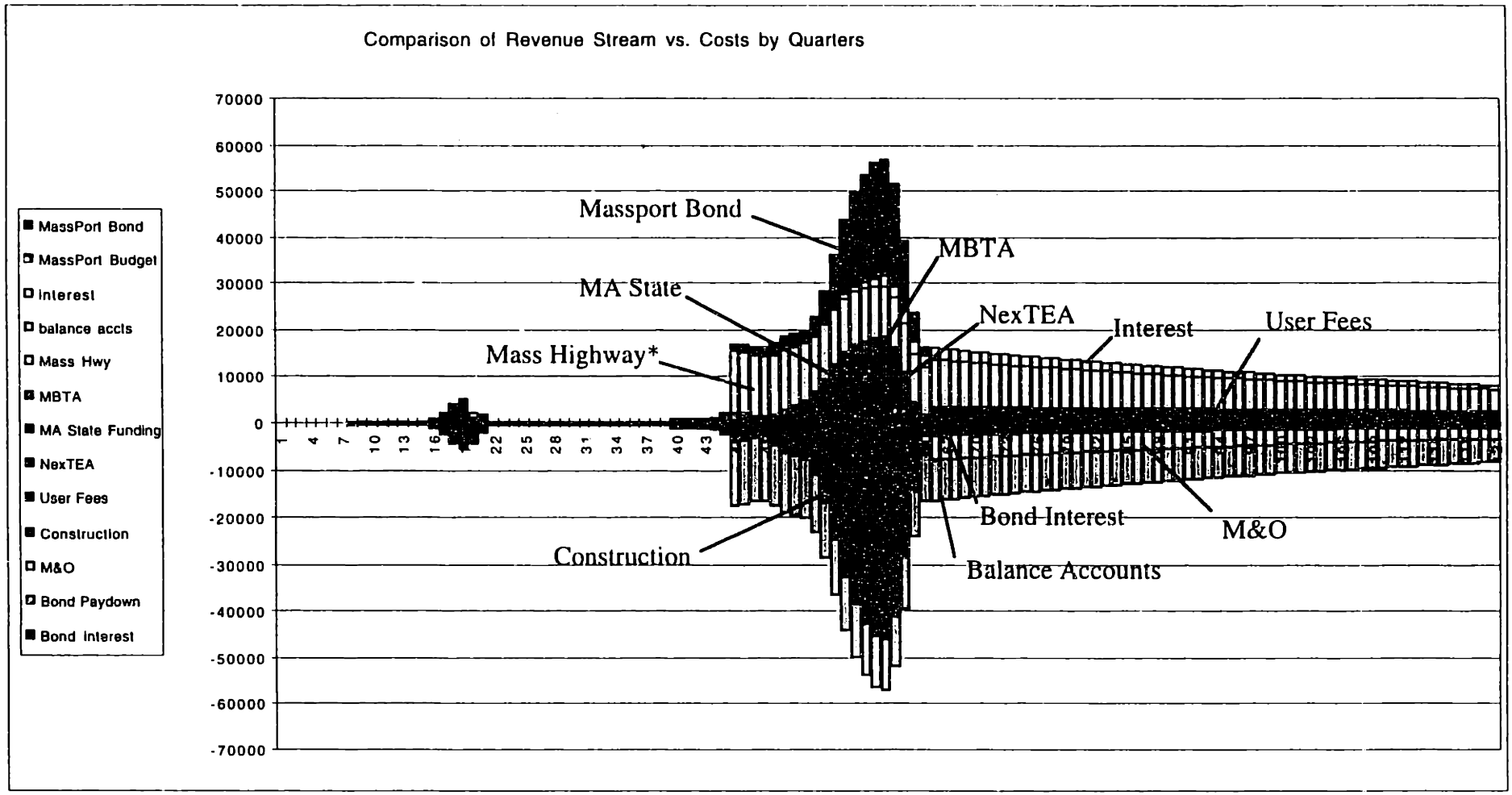

Comparison of Revenue Stream vs. Costs by Quarters
MassPort Bond
MassPort Budget
Interest
balance accts
Mass Hwy
MBTA
MA State Funding
NexTEA
User Fees
Construction
M&O
Bond Paydown
Bond Interest
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
-60000
-70000
Massport Bond
MA State
MBTA
NexTEA
Interest
User Fees
Construction
Bond Interest
M&O
Balance Accounts

Scenario 4



* Mass Highway entry for Scenarios 4&5 use Passenger Facility Charges as well the $3 million contribution from the Mass. Highway Department.

Scenario 5



* Mass Highway entry for Scenarios 4&5 use Passenger Facility Charges as well the $3 million contribution from the Mass. Highway Department.

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