Evaluation of the Downtown Boston Parking Freeze

An Interdisciplinary Qualifying Project

Submitted by:

Mark Allard

Ben Armato

Keith Barber

Steve Couture

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Authorship Page

**If two names are listed for a particular section, the first person listed is the main contributor to the section.*

Abstract

The goal of this project was to evaluate the role of the Downtown Boston parking freeze in relation to both air pollution control and city development. We provided the Boston Air Pollution Control Commission with a comprehensive system for parking freeze management, merging all existing data with digital map layers of the freeze area. In the process, we analyzed the value of the freeze in terms of the city's growth since the inception of the freeze.

Acknowledgements

We would like to thank all those individuals who helped us along with their guidance and wealth of information. First and foremost, our liaison, Mr. Bryan Glascock of the Air Pollution Control Commission, who provided us with the contacts we needed to gain all necessary materials. Special thanks to Mr. Glascock for all of his guidance and encouragement. Thanks to Ms. Antonia Pollak, director of the Environment Department, as well as the rest of the Environment Department, for allowing us to overrun the office. Thanks to Mr. Martin Von Wyss for supplying us with all digital map layers that were necessary for project completion. Thanks to Mr. David Fargen from the Central Transportation Planning Staff for supplying us with invaluable traffic volume and pollution information as well as orthographic maps of the Boston area. Thanks to Mr. Adam Schulman of the Boston Transportation Department for letting us use the full-sized map plotter and for providing additional parking information. Finally, thanks to Professors James P. Hanlan and Fabio Carrera for their guidance throughout this immense project.

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1 Introduction

In 1976, a parking freeze was implemented in Downtown Boston in an effort to improve air quality by reducing harmful automobile emissions. The freeze came about as a consequence of the 1963 Clean Air Act, which required that cities develop strategies to combat the escalation of air pollution. On paper, the freeze is a limit on the number of commercial, or public, parking spaces (those available for a fee) that can exist in the Downtown area. The premise is simple: decreased parking availability results in decreased traffic volumes, while use of public transportation is increased and air quality is improved. In practice, however, the problem is much more complicated, and while the freeze is a positive step, it can only be one small part of the solution. It is the task of the Boston Air Pollution Control Commission (APCC), a division of the City of Boston Environment Department, to monitor the number of parking spaces in the freeze bank. In theory, every parking facility within the freeze area is either permitted or exempted from the requirements of the parking freeze, allowing the APCC to track every facility. In reality, APCC Executive Director Bryan Glascock faces a glut of parking information in various forms and conditions, with no centralized system for freeze maintenance available. Our project aims to correct that situation in several steps:

1.) Organize and reconcile existing parking data to create a database for parking freeze management;
2.) Visit all parking garages and open-air lots to verify existing data and to collect new and/or missing data;
3.) Produce digital map layers depicting the location and "footprint" of each facility, linked to relevant database tables;
4.) Survey users of parking facilities to determine their reasons for utilizing personal means of transportation instead of public; and
5.) Assess the value of the freeze, in terms of improvements to air quality, effects on development and land use, and its role in Boston's transportation network.

In order to accomplish these goals we needed to obtain background knowledge on the city as well as on all factors leading up to the freeze. A brief history of the city's development, along with information on the public transportation system, air quality, and government agencies affiliated with the parking freeze, provide necessary background information required to understand the reasoning behind the freeze. The methodology chapter proceeds to outline the

procedures employed to accomplish each of the project's major tasks. One of which was to create a Microsoft Access database in order to compile all existing information into a simple, centralized information system. In addition, field verification and reconciliation of existing data were necessary, requiring visits to all facilities within the freeze area. The database will serve to organize all parking data so that they can be searched and updated. In addition, numerous cartographic layers were created using MapInfo and linked to the database to further ease data retrieval. We also administered a survey of parking facility users for the purpose of determining the reasons behind the choice of private transportation into Downtown Boston.

Once the data collection was complete, the presentation and analysis of results could proceed. The point was to identify important trends in the parking facility data and relate them to other trends in the city's development. In short, our analysis will provide context for the parking freeze, identifying its place amongst the city's efforts to reduce congestion. Analysis of the user survey information will provide insight into why people drive into the city and provide ideas on how to encourage more people to use the MBTA transportation system and reduce the amount of traffic flowing into the city. In short, the project provided the APCC with information that is invaluable to parking freeze management, while assessing the freeze's importance in relation to its consequences (both intended and unintended).

2 Background

This background material is provided to give an idea of the origins of the Boston parking freeze. The history of Boston's development through the years provides a general history of the people and the area. As the city developed, transportation also developed in response to the growing need to move large masses of people and goods in and around Boston. A brief history of Boston's transportation network, including some of the problems it has created (as well as possible solutions), is included. Over the years, there has been an increase in automobile use, leading to an increase in air pollution, traffic, and the demand for available parking spaces. The 1970 Clean Air Act (CAA), administered by the Environmental Protection Agency, required cities to lower levels of air pollutants in response to growing concern over air quality due to the increased traffic. One result was the creation of the Boston Air Pollution Control Commission, charged with tracking the number of public parking spaces in Downtown Boston and making sure that the total does not exceed the limit imposed by the parking freeze. With this background knowledge, we can be sure that our evaluation is accurate and that we have considered every aspect of the parking freeze.

2.1 The City of Boston: Physical and Economic Development

Since its founding by the Puritans of the Massachusetts Bay Company in 1630, Boston has been the subject of almost continuous change. At the time of its initial settlement, the area showed little prospect of growing into a significant metropolitan area; the city itself was located on a tiny peninsula with only a narrow neck connecting it to the mainland. However, Boston today is the largest city in New England and at the center of a primary metropolitan area encompassing (as of 1990) 129 cities and towns.[1] Along the way, the city has seen physical change, ethnic dissent, debate over land use, and alternating periods of growth and economic slowdown. Boston is still constantly in transition, but the worries of yesterday about parking continue to haunt the city's planners today, even as the construction of the new Central Artery/ Tunnel nears completion. The issue of parking in Boston has paralleled the growth of the city, and in order to correctly evaluate the parking freeze in the downtown area, one needs to have some background knowledge about the city itself.

2.1.1 Downtown Boston Defined

This study covers the area of Downtown Boston within the jurisdiction of the parking freeze. This is a somewhat vague label that requires some explanation. For our purposes, Downtown Boston includes all of the Downtown area and the North End, as well as portions of the South End and the Fenway/Kenmore neighborhood (Figure 1). To the north, the Charles River serves as the border between the North End and Charlestown. To the southwest, Massachusetts Avenue separates the sections of the South End and the Fenway that are within the domain of our study from those that are not. Extending the inlet southeast of Downtown inland, the border between Downtown, the South End, and South Boston can be approximated. For a clearer picture of the study area, refer to the map in Appendix A.

Figure 1: Boston by neighborhood

2.1.2 Physical Development of the Boston Region

Although they were instrumental in its inception, the location and topography of Boston have long been obstacles to the city's continued growth. Small, crowded, and, in the past, poorly connected to the rest of the region, Boston has faced a continual uphill battle to serve the millions who now come and go each day. When the area saw its first European settlers in the 17th century, Boston was nothing more than a tiny peninsula almost completely surrounded by water. The difference can be seen in Figure 2, which superimposes a recent map over the outline of the original peninsula. It was dominated by three hills, to the point that the area's first Puritan settlers gave it the name Trimountaine. A lesser version of the original Beacon Hill is all that remains of what once was a definitive part of the city's skyline. With seawater, hills, and marshland dominating the local landscape, it was no place to be carving out the beginnings of a sizable city. This was not evident at first; Boston's population (18,038 in 1790) grew slowly enough to allow for the development of a pleasant seaport that had no discernible overcrowding

[1] "Boston," Microsoft Encarta Encyclopedia Online.

problem.[2] Still, the peninsula, with only one narrow path to the mainland, seemed like an island. This began to change in 1786, when the 1,503-foot Charles River Bridge was completed. The bridge, and the other three that would follow it in the coming years, ended this separation and started Boston's development into a larger business and cultural center. The West End in particular saw rapid development as a result of one of the bridges, with the formation of the most direct route to Cambridge through that neighborhood.

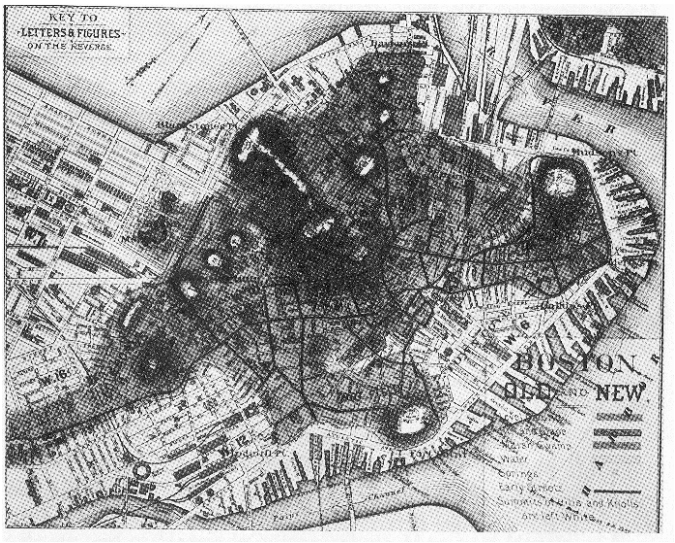

Figure 2: Original peninsula and Boston now

It was inevitable that Boston would begin to outgrow its physical bounds. As the population jumped to 58,277 in 1825, this began to happen.[3] If the city was to become the center it wanted to be, physical changes in the region would have to be realized. Dorchester Neck was annexed to South Boston in 1804 but, due to poor physical connection with the rest of the city, growth was slow. Around this time, planners began to look into other options. The filling of the manmade Mill Pond with earth from Beacon Hill opened up fifty acres for further expansion. The Mill Dam, completed in 1821, sectioned off the Back Bay and turned what had been marshland into developable space. In addition, the dam carried a toll road that offered citizens an alternative route from the peninsula to the mainland. The Back Bay was the centerpiece of Boston's new look, as it was filled with more earth and gravel from the Trimountain around the middle of the century. The reek of the stagnant Bay's flats was replaced by an upper-class neighborhood carefully planned by the state, and the Back Bay section of the city was born. Further filling of the coves along Boston's coastline produced new neighborhoods and a wider neck connecting Central Boston to the rest of the city. With the filling, and the annexation of nearby towns such as Dorchester, Roxbury, and Charlestown, the transformation of the city was clearly visible.

[2] Whitehill, *Boston: A Topographical History*, p. 47.
[3] Whitehill, *Boston: A Topographical History*.

2.1.3 Planning Issues and Economic Expansion

The development of any city is an ongoing process, and one that can involve many issues, from neighborhood dissent to the amount of available parking. Boston's growth has been noticeably concentrated; the city ranked sixth in population density nationally as of 1992, while at the same time coming in at 69th in physical size.[4] From the time of Josiah Quincy's election as the second mayor of Boston in 1823, the direction of the city's development has been a major issue. Quincy had no qualms about utilizing his mayoral power to its fullest extent to get things done. While Quincy did accomplish a great deal, he was often criticized for his methods. Faneuil Hall Marketplace, also known as Quincy Market (in honor of the mayor), is Quincy's most well known project. It also marks Boston's earliest experience with publicly funded urban renewal.[5] In 1824, Faneuil Hall was one of the city's main areas of commerce, and it was badly in need of renovation and expansion. Using the power of eminent domain, Quincy obtained the land necessary for proper expansion of the marketplace. Although his goals were genuinely in the interests of the city, certain residents protested the project because of its effects on their property's value. The mix of public and private sector development at such an early date was remarkable.[6] It was also an early example of criticism and protest of city projects, a situation that would repeat itself many times in Boston's future.

In the following years, Boston would continue to grow and experience its share of problems, many of which have parallels even today. Quincy's son and namesake was among the city's next generation of leaders; among his accomplishments was a successful push to get water supply under control of the city, and away from the private water companies that caused controversy and allowed whole sections of the city to go without service. Streets were widened and new sewers were put into use. However, simple planning issues would soon take a backseat as Boston entered a period of unprecedented growth. Physical changes to the city, annexation of nearby cities and towns, and immigration all led to an eruption in Boston's population and area, which climbed to roughly a quarter million people and 30,000 acres, respectively, by 1870.[7] With so much growth, the city's government began to take a more active role in the direction of development, forming committees to devise plans for improvement of several of Boston's

[4] "Boston," Microsoft Encarta Encyclopedia Online.
[5] Kennedy, *Planning the City upon a Hill*, p. 48.
[6] Kennedy, *Planning the City upon a Hill*, p. 50.
[7] Kennedy, *Planning the City upon a Hill*, p. 53.

sections. Urban renewal took one of its earlier ugly turns here, as the Fort Hill area was cleared for further expansion of the city. The area had declined in previous years as a residential area due in part to its location, close to the business district. It soon became a home to many of the city's new immigrants but, by 1872, Fort Hill had been cleared and its foreign inhabitants forced to move to other sections.[8] It would not be the last Boston neighborhood to fall prey to redevelopment.

In 1872, Downtown Boston was handed an opportunity in disguise in the form of the Great Fire. A fire department strapped for hydrants and horses could do little but watch as fire engulfed many of Downtown's buildings. The fire inadvertently gave the city a chance to start anew in Downtown, and build from the ground up. However, the exciting prospect of street realignment and a facelift for the area soon became embroiled in public as well as political conflict. The extent of government influence in rebuilding the area was a huge issue, as property owners fought vehemently against street realignment that would threaten their former holdings. At the same time, government officials could not agree amongst themselves, and the result was a return to the basic layout that existed before the fire.

As the nation moved into the twentieth century, Boston continued to grow, riding a 25 percent growth rate over the last twenty years of the 1800s to achieve a population of over half a million people by 1900. The city's public services blossomed accordingly, boasting the nation's first subway system as well as an unmatched park system. This did not come without cost; at the time, Boston spent more on its citizens then any other city nationally, and the city budget rivaled and often surpassed that of the state.[9] Fiscal conservatism, however, became the norm as city government moved into the 1900s. With the new century came an increased need for the public and private sectors to work together, and the operations of government soon changed to reflect this.

Boston was beginning to take shape as more recognizable buildings sprang up. Symphony Hall opened in October of 1900, as the Boston Symphony Orchestra was forced from its old home near the Common by proposed street changes. The Museum of Fine Arts, cramped in its Copley Square location by 1899, began a move to Huntington Avenue in that year as the museum's trustees bought up twelve acres in the area. Construction of the new building began in

[8] Kennedy, *Planning the City upon a Hill*, p. 58.
[9] Kennedy, *Planning the City upon a Hill*, p. 74.

1907.[10] The U.S. Custom House got a new look with the addition of the now-famous tower between 1913 and 1915. The tower was criticized at the time, as the federal government did not fall under the jurisdiction of Boston's newly devised regulations concerning building height.

Several political figures were largely responsible for the direction of the city as Boston moved to modernize and renew through the time of the Depression and into the second half of the twentieth century. James Michael Curley was one such figure, the oft-maligned but powerful mayor who brought city planning under more government control. Evidence of his influence can be seen in the sheer length of his political career; he first became mayor of Boston in 1914, and last won election to the position in 1945. Although this does not represent a continuous tenure, Curley found other political outlets when he wasn't mayor, serving four terms in the U.S. House of Representatives and one term as governor of Massachusetts.[11] He was a champion of the poor, instating public works programs and opposing measures that involved destruction of poorer neighborhoods. On the other hand, his upper-class constituents couldn't stand him; several of his proposals, including increases in property taxes and outlandish changes to the Common and Public Gardens, appeared to be direct shots at his opponents. Whatever Curley's legacy, the shift in control of city planning to the government of Boston that occurred during his tenure was a necessary step towards ending the bickering that had plagued earlier attempts at urban renewal.

Following Curley in office were two men, John Hynes and John Collins, who would each bring about urban development projects of significance to this day. Many would question the timing and speed with which these plans were implemented, and whether the "new" Boston was worth the costs, both socially and financially. When Hynes defeated Curley in 1949, the city was entering a different era that marked a change from the old city of the turn of the century. The phrase "New Boston" captures the shaping of the city from 1950-1970 fairly well, but what the phrase fails to capture are the problems that led to its inception. Problems involving traffic congestion in and around the city had developed into a major issue in the years previous to Hynes's first election, and even with new roads constructed during the following decade, the issue only seemed to get bigger. City leaders assured the public that, with the completion of the Central Artery (1959), driving time would be reduced significantly. However, the completion of the Massachusetts Turnpike in 1957 only increased the number of cars coming into the city, and

[10] Whitehill, *Boston: A Topographical History*, pp. 185-186.
[11] Kennedy, *Planning the City upon a Hill*, p. 141.

the question of where to put all the cars remained. Prominent business leaders also wanted assurance that sufficient parking and exit ramps would be available to their patrons. The problem of parking was serious enough to warrant, upon Hynes's recommendation, the formation of the Massachusetts Parking Authority in 1958.[12] The MPA would explore the option of a parking garage under Boston Common, but even that idea faced public and political scrutiny (as well as scandal) before its completion several years later.

Development of the city was happening quickly, but even so, the Hynes administration continued to push for renewal programs with the idea of a city facelift in mind. The Boston Redevelopment Authority was formed in 1957 by the state legislature for this purpose. Redevelopment of the West End, a project that originated in the Boston Housing Authority, gave the BRA its first shot at coordinating a controversial renewal program. Narrow streets and overcrowding were among the worries that the city had for the West End, and it was widely considered a disposable slum area. Many were excited by the prospect of major redevelopment of the area, except, of course, for the neighborhood's residents. By 1960, the West End had been reduced to rubble, and its former inhabitants scattered about the city without much care for their well-being.[13] The ugliness with which the West End redevelopment project had been carried out, coupled with a similar project in the New York Streets area (another multi-cultural neighborhood in the South End targeted by urban redevelopment), gave the BRA a lot to think about in consideration of future programs.

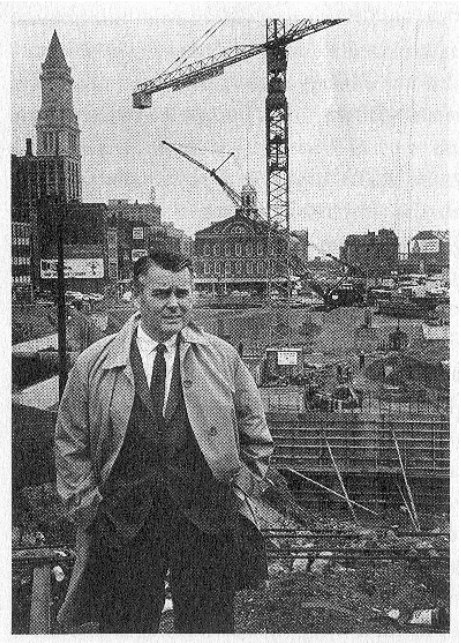

Figure 3: Edward Logue, at the construction site of the new City Hall

While the BRA represents the dark side of development during the period, other, less socially intrusive projects also were born. The polio-stricken Collins became mayor in 1960 and, with new BRA head Edward Logue (Figure 3), set out to make the "New Boston" a reality. Although development during Hynes's tenure was marred by political unrest

[12] O'Connor, *Building a New Boston*, pp. 119-120.
[13] O'Connor, *Building a New Boston*, pp. 127-139.

and poor decisions, the mayor's ambition was sincere, and several projects begun under his leadership would find resolution in the following years. In the late 1950s, the Prudential Insurance Company chose Boston as the site for a northeastern regional office and major downtown investment project.[14] The city's high tax rate, however, and the involvement of the Turnpike Authority, slowed the plans until an arrangement could be struck between the company and the city. Collins would later admit that, although the Prudential Center "was not as nice as it should have been," it was "essential if any of our other plans were to go forward."[15] Indeed, the Prudential was only the beginning of the New Boston, as Collins and Logue announced the "Ninety Million Dollar Development Program for Boston" in September of 1960. The program, which involved renewal of ten separate sections of the city, emphasized the lead of city government in redevelopment and was a huge step in the right direction. Collins's relationship with "The Vault" – named after the group's meeting place at the Boston Safe Deposit and Trust Company – helped win the support of local business leaders, which comprised the group.

The new Government Center (Figure 4) represented the early centerpiece of urban renewal in Boston. Construction began on a $30 million City Hall in 1963, and was completed by 1968, just as Collins was about to leave office. The new City Hall, seen in Figure 5, was a modern structure in what was still regarded as an old city, and the response was, appropriately, passionate on both ends. Some were excited about the modern look and the cleaning up of the old Scollay Square site; others felt the building was too drastic a change and seemed out of place. The new Government Center is a perfect example of development during the time in that it was ambitious and successful, but still left much to be desired in the eyes

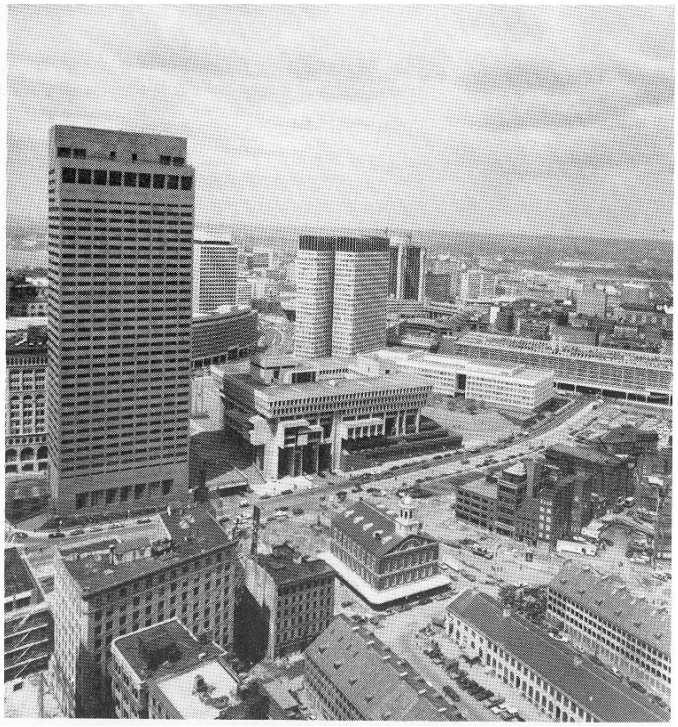

Figure 4: Government Center

[14] Kennedy, *Planning the City upon a Hill*, p. 171.
[15] O'Connor, *Building a New Boston*, p. 175.

of those who felt renewal was occurring more rapidly than necessary. In 1962, a plan to give the waterfront a $70 million facelift was announced. In 1969, Central Wharf saw the completion of the New England Aquarium, also noted for its modern design. By the end of 1966, nearly $2 billion had been spent on the BRA's urban renewal program, which had by then encompassed about a quarter of the city's land area.[16] Hynes, Collins, and Logue had, all told, brought about the most significant period in the reshaping of Boston, and when Kevin White succeeded Collins in 1968, the city had a solid foundation that would lead into the prosperous years of the 1970s and '80s. As Figure 6 depicts, modernization of the old city is visible in the skyline, now defined by the cluster of high-rise office buildings.

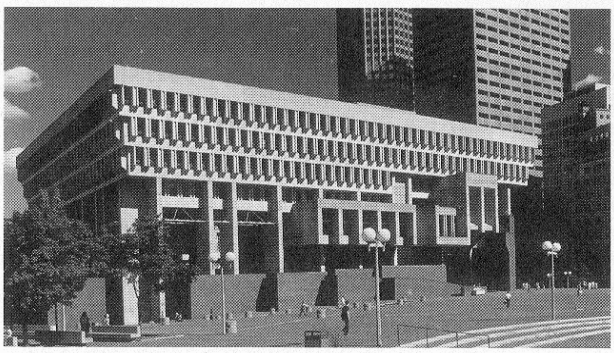

Figure 5: Boston City Hall

With development and city planning at the core of our project, the background included here may prove useful when placing the parking freeze in the context of past events and programs. Although the project is more directly concerned with the effects of the freeze on air quality, it is our responsibility to perform the evaluation in a much wider context. How the city arrived in its present state will provide clues to solutions of future problems, including the one we've been charged with tackling.

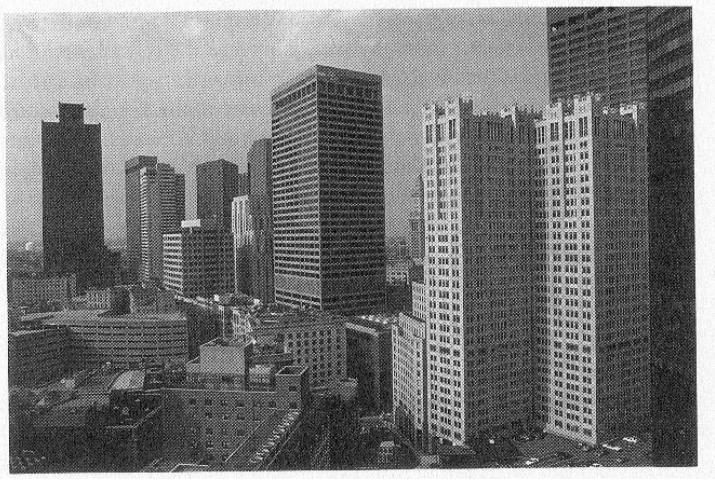

Figure 6: Boston skyline

[16] Kennedy, *Planning the City upon a Hill*, p. 192.

2.2 Boston Transportation

Throughout the years Boston has evolved to help ease the pressure that is felt by the hoards of people trying to get into the city on a daily basis. Boston is not only the birthplace of American liberty; it is also the birthplace of American mass transportation. The first year of public transportation was 1631, when a ferry began to take freight and passengers from Chelsea to Charlestown and on to Boston. The ferry was the first chartered public transportation, being authorized by a document issued by the legislature creating a public or private corporation and defining its privileges and purposes. The Massachusetts Bay Transit Authority (MBTA) was originally named the Metropolitan Transit Authority, which came about in 1941. Boston's form of public transportation has continually changed with advents of new technology. Intended to be only a supplement to the commuters, the public transit system has become a lifeline to the city. Many of the subways are handling more than their intended capacity, and commuters are in massive traffic jams. Today, Boston is facing a serious transportation problem.

2.2.1 Boston's Public Transportation

The need for mass transportation began back in 1630, when Boston was only accessible by a thin strip of land that is now the South End, and the trip from Chelsea to Boston took two days. People walked through the city and rarely left its limits. The Massachusetts Court of Assistants, the Colony's Legislature, wanted to improve access to the mainland and offered to give a charter to anyone who would run a ferry from Charlestown to Boston. Thomas Williams started what is believed to be the first chartered public transportation on the continent.

Horse drawn stagecoaches were used as means of transportation beginning in 1793. By the 1820s, the omnibus, a longer version of the stagecoach, took over the streets. It had seats all along the sides and was ideal for the many stops required by local service. In 1856, horse cars became the new way to travel. They used parallel rails laid in the street and were more efficient than the omnibus.[17]

Other cities were experimenting with other forms of transportation and Boston decided to follow Richmond, Virginia, and turn their horse cars into electric streetcars on January 1, 1889. The underdeveloped suburbs of Boston began to quickly improve. Bankers began to invest money into extending the streetcars into the suburbs, giving suburbanites convenient

transportation into the city.[18] Faced with an even greater need for public transportation, the city decided to build an elevated railway and subway.[19] Boston became the first American city to have a subway in 1897. In 1918, the General Court passed the Public Control Act, which provided public operation of mass transportation at fares that would cover the costs of its service. The first motorbus routes were put into place in 1922. Under the Public Control Act of 1947, the Legislature purchased all of the outstanding stock of the Boston Elevated Railway and named it the Metropolitan Transit Authority. The MTA was renamed the Massachusetts Bay Transportation Authority (MBTA) in 1964. The MBTA continued to expand, and today operates 344 streetcars, 50 trackless trolleys, 980 buses, 55 commuter rail locomotives, and 288 rapid transit cars, and boats. The current subway system is shown in Figure 7. The MBTA states its goals in their mission statement: "committed to excellence, the MBTA strives to provide safe, accessible, dependable, clean and affordable transportation to our valued customers, through the dedication of our diverse and talented workforce."[20]

Figure 7: Subway Map

2.2.2 The MBTA Survey[21]

A survey was conducted by the MBTA in 1989, where 817 MBTA users of at least sixteen years of age from the Boston region answered questions about their use of the MBTA. This survey is helpful in gauging what percentage of the populace sees the MBTA as a reasonable substitute for personal vehicles. Fifty six percent, twenty nine percent, and fifteen percent of the households surveyed have one person, two people, and three or more people who use the MBTA at least once per week respectively. Minority households were more likely to use the MBTA than white households. Most (66%) of the people said that their use of the MBTA remained the same from the previous year, while 22% said it had increased and only 9% said it

[17] A Chronicle of the Boston Transit System, pg 2
[18] A Chronicle of the Boston Transit System, pg 2
[19] A Chronicle of the Boston Transit System, pg 3
[20] http://www.mbta.com/Profile/mission/mission.cfm
[21] All statistics in section were found using Atlantic Marketing Research Co. 1989 Ridership Survey.

decreased. There are several reasons people stated why they choose to use the MBTA instead of driving. The most popular reason (58%) was the parking difficulty and/or cost. The overall convenience was attributed to 44% of the MBTA's use; avoiding traffic (29%) and cost (20%) were also contributors. Factors such as the MBTA is faster, more relaxing, and safer, were also mentioned. MBTA users now seem to be happier with the service than ever before. Overall, the riders were satisfied with the esthetics of all the MBTA forms of transportation, the frequency of the vehicles on the line, the upkeep of vehicles and stations, the cost of riding, the speed with which they got to their destination, ride reliability, and service improvements. Only in the area of personal safety perceptions did serious problems seem evident. Table 1 is compiled from statistics found in the MBTA survey performed in 1989.

All numbers are in percent riders.	**Commuter Rail**	**Blue Line**	**Red Line**	**Green Line**	**Orange Line**	**Commuter Boat**	**Buses**
Regularly use (total is over 100% because some use more than one)	13	7	41	31	26	35	39
Satisfied with service over past year (avg. 92%)	99	-----	88	87	-----	99	-----
Less likely to agree the service is worth the cost (avg. 91%)	96	95		86	94	98	97
Agree that service has improved (avg. 85%)	-----	80	-----	-----	90	92	91
Agree that service is now more reliable (avg. 85%)	90	90	-----	78	-----	95	95

Table 1: MBTA Survey (Abridged)

2.2.3 Boston's Automobile Transportation

Over one million cars are registered in the Boston area and over 540,000 cars come into the city every weekday. While the public transit ridership has increased, public transportation has not been able to keep pace with the increase in jobs and tourism and the recent increase in population. The population of Boston is currently 574,283 people; the population is recovering

from the recession of the early 1990s.[22] The combination of workers, citizens, and tourists on the highways of Boston is creating some large traffic jams. Table 2 shows population and number of jobs for Boston.

	1970	1980	1988	1990	1997	1998
Population	641,071	562,994	-----	574,283	-----	-----
Jobs	559,991	564,312	643,615	597,145	652,799	671,022

Table 2: Jobs and Population

The areas with the most traffic are the five main roads that the majority of people use to get into or pass through Boston. They are Interstate 90, Interstate 93, Routes 1 and 1A, and Storrow Drive. These five roads are so closely connected that they are vulnerable to great lengths of intense congestion. Figure 8 shows the intersection of Interstate 90 & 93. The Central Artery/Southeast Expressway is the center of Boston's traffic problems. This roadway supports approximately 180,000 vehicle-trips every day, over twice the number it was designed to handle. In a Federal Highway Administration (FHWA) ranking of cities according to the severity of 1984 urban highway congestion, Boston came in as the eighth most congested.[23]

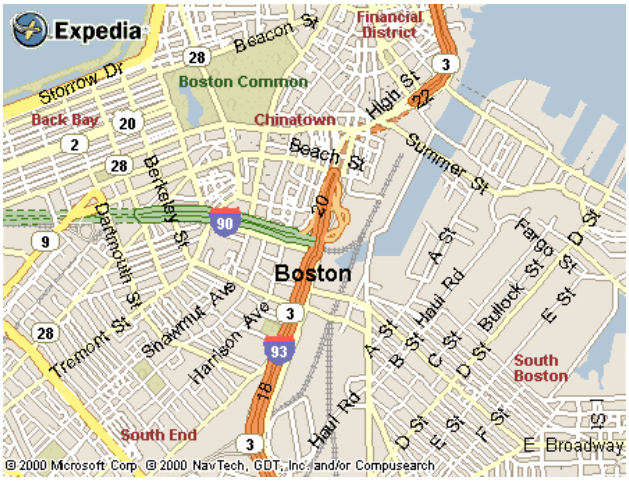

Figure 8: Map of I-90 & I-93 Intersection

Boston drivers experienced 44.8 million vehicle-hours of delay on major highways alone in 1984, according to the FHWA. Even though a cap has been placed on parking in certain Boston areas, the number of cars driving into the city increased by 33% on the Central Artery Bridge from 1977 to 1987.[24] Expanding the roads will not solve the growing pollution or congestion problem; the only way to aid both is to increase use and size of the public transportation system.

[22] http://www.ci.boston.ma.us/bra/publications/pdr529.pdf
[23] Gridlock: Facing Boston's Transportation Dilemma, pg 8
[24] Gridlock: Facing Boston's Transportation Dilemma, pg 9

The MBTA services approximately 522,000 riders per day on its rapid transit system. All four lines of this transit system are either filled to, or beyond, capacity, and their use continues to increase. Also, the parking at the MBTA rapid transit stations is of concern. Twenty-three out of the twenty-seven parking lots are filled to, or beyond, capacity during the business day. The largest complaint of the subway and commuter rail systems is the poor on-time performance, which could be one important reason people decide to commute to work in their own vehicles. Unless aggressive actions are taken to expand public transportation, the Artery/Tunnel project may not be as much help as anticipated.

2.2.4 The Central Artery/Tunnel Project

The Artery/Tunnel project has become known as the Big Dig. The Big Dig came to life in 1982, when the first step, environmental impact review, was completed. Actual construction began in September of 1991 with the Ted Williams Tunnel. The Big Dig will replace the elevated portion of Interstate 93 upon completion. The elevated highway was completed in 1959 and designed to handle 75,000 vehicles. Today it handles 190,000 vehicles and sees approximately eight hours of bumper-to-bumper traffic everyday.[25] It is impractical to tear down more buildings and people's homes to build roads, so the only place left to build is underground, directly below the elevated highway. The current elevated highway only has six lanes, but the new underground expressway will have eight to ten lanes. The underground expressway will be handling about 245,000 vehicles in the year 2010, with just a few hours of rush hour traffic predicted in the morning and afternoon.[26] There will be fourteen on- and off-ramps and 161 lane miles of highway in a 7.5-mile corridor, half of which will be in tunnels, including four major highway interchanges.

[25] www.bigdig.com
[26] www.bigdig.com

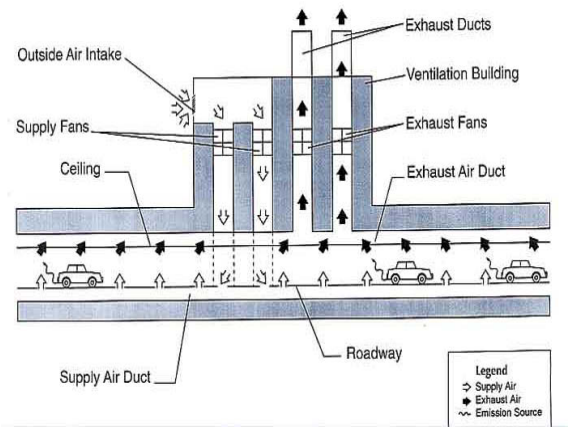

Figure 9: Ventilation Building Set up

Along the tunnels will be seven ventilation buildings, as seen in Figure 9. Moving air in and out of the tunnels is vital to the success of the project. Several buildings have been placed along the tunnel to remove car exhaust and supply fresh air. A two-way process called a full transverse ventilation system will be used throughout most of the tunnels. Fresh air will be blown through ducts under the roadbed or in a tunnel wall and circulated through the tunnels by fans housed in the ventilation buildings. At the same time, vehicle exhaust will be carried out of the tunnel through openings in the ceiling to rooftop exhaust stacks in the ventilation buildings and dispersed high into the atmosphere.

The ventilation systems are computerized to monitor carbon monoxide levels and adjust fan speeds accordingly. When traffic is at a low in the middle of the night, the fans will be at low capacity. Full capacity will only be necessary in the case of an emergency, such as a fire. The system is capable of controlling heat, smoke, and carbon monoxide levels.

Each of the buildings has a different structure in order to be architecturally compatible with the surrounding neighborhood. Some of the buildings will also contain office space or public parking. The buildings underwent wind tunnel studies and were analyzed to conform to both the City of Boston and the city Environment Department noise regulations.

The project will slowly open up to the public, beginning with northbound and finishing with southbound traffic. The northbound lanes should be completed in November of 2002 and completion of the southbound lanes is expected in November, 2003. The southbound lanes have a more complicated construction sequence because of the connection to the already existing Dewey Square Tunnel, which will carry southbound traffic only. Demolition of the elevated Central Artery is expected to begin in December, 2004, creating 27 acres of space for restoration. Three quarters of the space will remain open, and the remaining quarter will be for modest commercial and residential development. A twelve percent reduction in carbon monoxide is expected with the opening of the tunnels, simply from less standstill traffic.[27] Appendix B is a

[27] http://www.bigdig.com/thtml/future.htm#restore

map that shows the percent complete as of April 1, 2000, for the different sections of the Big Dig.

2.2.5 The Silver Line and Urban Ring Development

Many transportation improvements have been made, but they always seem to fill to capacity shortly after opening. The Central Artery/Tunnel will help with some of the traffic flow problems, but how long it will last is a question that no one is capable of answering. An evaluation of the current transportation systems needs to be performed, as well as projections for future transportation need increases and an identification of funding for future solutions.

The MBTA is taking some important steps to help increase the use of public transportation. One project that is currently underway is the development of the Silver Line. The Silver Line will connect the South Station to the new United States Court House and World Trade Center via tunnel and surface routes to Boston Convention and Exposition Center and Logan Airport.[28] There will be three underground stations and two surface stations. The three underground stations will allow for connection to the Red Line, commuter rail, and bus and rail services. The two surface stations will give access to the US Court House and the World Trade Center. Completion of this project is expected in year 2003.

Another project idea is the Urban Ring. The Urban Ring would connect all of the existing subways. An analogy would be the Urban Ring as the 'wheel' that connects all of the 'spokes' of the current subway system. The Ring would consist of a 14-mile peripheral corridor and run through six different cities: Brookline, Cambridge, Everett, Chelsea, Somerville, and Boston.

The Urban Ring would be designed to:

- Provide direct access to many important destinations around the downtown core;
- Connect with regional commuter rails and transit lines;
- Provide higher quality service to areas that need it;
- Reduce congestion and increase capacity in the downtown subway system;
- Improve transit travel time.

[28] www.mbta.com

There are many benefits to building the Urban Ring, but the MBTA may not be capable of putting up enough money. The estimated cost of the project is between $1.2 and $2.8 billion. The federal government would allocate some money because the system would be a "New Start" transit project. A new start project is a major new fixed guideway transit system or an extension to an existing fixed guideway system.[29] Public and private financial strategies are being implemented to provide the local share.

A committee comprised of citizens, environmental organizations, and businesses is working together to guide project decisions. Within smaller communities, public briefings are held throughout the planning process to get community input. The project is in the early stages and is awaiting reports on investments and environmental impacts. The Urban Ring would greatly increase mobility in the downtown area and would maintain, if not stimulate, the businesses of the area.

Even though newer and larger highways are being built to deal with congestion, automobiles are still producing pollution. Automobiles emit hydrocarbons and nitrous oxides, which combine with heat and sunlight to form ozone. Cars that are slow moving because of congestion are larger polluters than free-flowing vehicles, and therefore, as Boston grows and traffic congestion increases, air pollution also increases. The total annual costs of congestion on Boston's highways alone will exceed $2 billion by the year 2005, as calculated by the Conservation Law Foundation.[30] This estimate is based on the calculation of lost work time and wasted gasoline. Another way to view the cost is by the impact on retail sales; sales will go down, because customers will be discouraged by the massive amounts of traffic in the area. The Conservation Law Foundation estimated that, for the MBTA to build a service to give new transportation to the downtown area, it would cost at least $13.80 per gross square foot of office space, but could be upwards of $20 per gross square foot.[31] The Boston Redevelopment Authority has approved of only $0.50 per square foot, an amount that is utterly inadequate.

The Big Dig may ease the traffic on the major highways, but will most likely not reduce air pollution. It all comes down to whether the MBTA, the City of Boston, Massachusetts, and the federal government can provide the money necessary to develop a worthwhile system of

[29] Federal Register/ Vol. 65, No. 236/ December 7, 2000, pg. 76864
[30] Gridlock: Facing Boston's Transportation Dilemma, pg. 31
[31] Gridlock: Facing Boston's Transportation Dilemma, pg. 32

public transit to meet the needs of the people. Once new systems are added or improvements are made to existing systems, the MBTA needs to market it to the people as safe, fast and reliable.

2.3 Transportation and Air Pollution

Along with the growth of the City of Boston came an increased use of transportation, both public and private. This increase in transportation caused an increase of pollution, which led to a rapid decrease in air quality. This increasingly dangerous problem could not be ignored. Laws were needed in order to help control the rate at which pollutants were being released.

2.3.1 Air Pollution Laws and Regulations

After carefully studying the growing pollution problems, Congress passed a law for the purpose of regulating industrial and automobile pollution. The goal of this law was to slow down the rate at which pollutants were being released into the environment. This law became known as the Clean Air Act (CAA).[32] Originally passed in 1963, it was amended several times as more was learned about air pollution. This enabled the government to address these problems and also allowed grants to be awarded for program development. The result was an immediate awareness of environmental issues and a rush to find ways to lower all kinds of emissions in industry and automobiles.

The first major amendment to the Clean Air Act of 1963 was the Motor Vehicle Air Pollution Control Act (1965), which allowed for emission standards to be applied to vehicles.[33] By 1968, all light duty motor vehicles were required to meet the set "emission standard". This amendment also established the National Air Pollution Control Administration (NAPCA) to provide leadership in the country's efforts to control air pollution.

By 1970, concern for air quality and air pollution had increased. The public was now much more aware of the problem and how serious the effects of these pollutants could be. Congress enacted new amendments to the Clean Air Act to broaden its reach and allow for a better control of pollutants. This new amendment made possible:

- National Ambient Air Quality Standards (NAAQS);
- Plans for individual states for implementing the CAA;

[32] Air Quality, Thad Godish, p. 245

- New standards for automobile emissions and fuel additives;
- Citizens' right to sue the government for air quality issues; and
- Federal government power to step in during air pollution emergencies and violations.

In addition, the 1970 amendment to the CAA transferred air pollution control functions from Health Education & Welfare (HEW) to the Environmental Protection Agency (EPA).[34] It required the administrator of the EPA to designate air quality control regions, to publish a list of air pollutants injurious to health and welfare, and within twelve months of that publication to publish criteria for determining ambient air quality standards for listed pollutants.

The Boston parking freeze, which was enacted in 1976, was a re-action to the Clean Air Act. Its goal was to reduce vehicle miles traveled (VMT) for the purpose of lowering the concentration of carbon monoxide and ozone in the air. The National Ambient Air Quality Standards forced Massachusetts to develop the State Implementation Plan (SIP), which outlined a strategy for reaching compliance with the standards by December 31, 1987.[35] The parking freeze was part of SIP and attempts to control automobile emissions by limiting the number of public parking spaces in downtown Boston, therefore limiting the number of automobiles that can drive into the downtown areas. This was also an effort to encourage the use of public transportation as an alternative to private transportation. The parking freeze will be discussed in greater detail in later sections.

2.3.2 Air Pollution

The term air pollution has grown to include a wide variety of pollutants and causes for this pollution. Air pollution is a direct result of energy conversion. It is a by-product of another process, whether it is combustion or some other industrial process. Wind and other natural chemical processes often destroy or dilute many kinds of pollutants but, when these natural processes can no longer keep up with the rate at which these pollutants are released, the term pollution is used.[36] For our purposes, we need only be concerned with the types of pollution that are associated with automobiles and other types of transportation.

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[33] The Automobile, Frank P. Grad, Albert J. Rosenthal, and others, p. 332
[34] The Automobile, Frank P. Grad, Albert J. Rosenthal, and others, p. 395
[35] Boston Transportation Dept., *1987 Inventory*, p. 2.
[36] The Automobile, Frank P.Grad, Albert J. Rosenthal, and others, p. 139

Automobiles produce several different kinds of emissions. Noise pollution, although it should not be ignored, does not produce any long-term environmental damage. Instead it is more of an annoyance. Exhaust emissions are perhaps among the most dangerous emissions produced by cars and also among the most tightly regulated. Ideally, the combustion process in an automobile should produce only 3 different types of emissions.[37] They are carbon dioxide, water, and unaffected nitrogen. In reality, it is nearly impossible at this time to achieve combustion this perfect. Carbon dioxide and water are present, but so are unburned hydrocarbons, nitrogen oxides and carbon monoxide. All of these are potentially damaging to the ozone layer. With the elimination of lead fuel additives, lead emissions have been reduced significantly and are no longer a cause for great concern.

Hydrocarbons are among the most dangerous of the emissions that are released by cars. They are a direct by-product of the combustion process and are produced when fuel leaves the combustion chamber either unburned or only partially burned. Many of these hydrocarbons are toxic and can potentially cause cancer.

Nitrogen oxides are also dangerous, especially when combined with hydrocarbons. They are produced at high temperatures and pressures when nitrogen and oxygen combine. Nitrogen oxide is a significant contributor to the formation of acid precipitation, which is caused when rain or snow pick up airborne pollutants and carry them into the ground. When combined with hydrocarbons, they produce a type of ground level ozone, which is also known as smog. This ozone can irritate eyes, damage lungs, and cause respiratory problems.

[37] EPA 400-F-92-007, August 1994, Fact Sheet OMS-5

Carbon monoxide has its own dangers. Although it does not significantly contribute to ground level ozone, it is harmful to humans. It reduces the oxygen in a person's bloodstream and can be extremely dangerous to people with heart disease. Carbon monoxide becomes hazardous to humans at about 100 parts per million (ppm) when a person is exposed over several hours.[38] Table 3 compares the number of cardio-pulmonary related deaths to the number of automobile related deaths in several major cites in Massachusetts. As you can see the number of deaths due to carbon monoxide is over three times greater than the number of deaths due to car accidents.

Metropolitan Areas	Adult Cardio-Pulmonary Deaths (1989)	Deaths from Auto Accidents (1989)
Boston, MA Lowell, MA Brockton, MA Lawrence, MA Haverhill, MA	15,492	410
New Bedford, MA Fall River, MA	2,319	83
Springfield, MA Chicopee, MA Holyoke, MA	2,811	83
Worcester, MA Fitchburg, MA Leominster, MA	3,024	96

Table 3: Estimated Annual Cardiopulmonary Deaths

Carbon monoxide is also a product of combustion and is produced when fuel is partially oxidized instead of fully oxidized into carbon dioxide. Carbon dioxide is not directly harmful to the human body but is still considered a pollutant that needs to be monitored and controlled. This gas is one of the main causes of the "greenhouse effect", which is slowly causing global warming. This will eventually cause a chain reaction that will lead to a number of other environmental problems if it is allowed to get out of control.

Another type of automobile emission is evaporative emissions of unburned fuel. This type of pollution is responsible for the majority of hydrocarbon pollution. Evaporative emissions are released in several ways. As the daily temperature increases, fuel in a gas tank is heated and some evaporation occurs. These hydrocarbons are then released through the venting system in the fuel tank. Another type of this emission is associated with vapors burning off a hot engine

[38] Pollution and Public Policy, Edited by David F. Paulsen and Robert B. Dernhardt, p. 131

while the car is running. Even after the car is shut off, the engine remains hot and gas continues to evaporate for the next few hours. Lastly, while refueling, hydrocarbons and other vapors can escape through the gas tank vents and refueling door as gas displaces vapors that have built up in the tank.

Catalytic converters and other emission control devices are required by law on all automobiles and are extremely effective in reducing automotive emissions. Still, this is not enough. Although emissions have been reduced, the number of automobiles on the road has increased so significantly that automobile emissions are still a significant environmental concern. Other types of engines are being researched in order to find an alternative fuel that will have fewer damaging effects on the environment, but few have been successful thus far.

2.4 Air Pollution in Boston

With an understanding of how Boston's development led to millions of people traveling in and through the city, it's time to look at the departments directly in charge of lowering the pollution. The department that enforces the parking freeze is the Air Pollution Control Commission, so a little history on the APCC and its associated municipal agencies is in order.

2.4.1 Environment Department

The Environment Department is a division of The Boston city government, composed of eight different agencies, each in charge of a different issue dealing with the environment in the city of Boston. These agencies are:

1. Boston Archaeology Program
2. Boston Conservation Commission
3. Boston Environmental Strike Team (BEST)
4. Boston Harbor Islands National Park Area
5. Boston Landmark and Historic Districts Commission
6. Central Artery/Tunnel Environmental Compliance Team (CAT)
7. Massachusetts Environmental Policy Act (MEPA)
8. Air Pollution Control Commission

The first division within the department is the Boston Archaeology Program. The archeology program connects the residents to the city's rich prehistoric and historic past. The main purpose of this program is to study and organize all Archeological remains found in the

City and to allow Boston's students to learn about the past through hands-on sessions with the city's archeologist.

The second is the Boston Conservation Commission, which aims to protect and preserve the city's open and/or natural areas. This includes helping to keep Boston harbor clean by regulating the amount of sewage pumped into the bay.

The third commission is the Boston Environmental Strike Team, also known as BEST. This team consists of different inspectors from all the city's inspection agencies as well as the special prosecution unit of the Corporation Counsel's office. The focus of this team of inspectors is to coordinate public health, safety, and environmental law enforcement throughout the city of Boston.

The fourth subsection of the department is the Boston Harbor Islands National Parks Division. There are about thirty islands located within Boston harbor that are protected by Congress. Currently there is work in progress to set up a commission that would help to care for the islands in order to preserve their natural and cultural resources.

The fifth is the Boston Landmark and Historic Districts Commission. This commission helps keep the city's past alive. It does this by identifying and preserving the city's historic properties, such as old historical buildings like the Old North Church. They also review demolition and development activities that are proposed within the city to make sure that no historical sites are damaged. It also helps support local historic districts by providing staff, technical assistance, and public information as needed.

The sixth division of the environment department is the Central Artery/Tunnel (CAT) Environmental Compliance Team. This commission helps protect the quality of life surrounding the construction of the Big Dig, particularly by enforcing regulations that help the residents who live near the work site to be protected from excessive noise and dust.

The seventh is the Massachusetts Environmental Policy Act (MEPA) Review Team. This division of the Environment Department sends out a MEPA Reviewer to analyze current development projects looking for any potential environmental impacts to the city.

The eighth and final commission is the Air Pollution Control Commission (APCC) and is concerned with parking issues in the downtown area. This commission enforces the city's air and noise regulations, particularly by limiting the growth of parking facilities, promoting

commuter mobility programs, adding vanpool parking to places that need more room, and planning facilities for bicycle storage.

This commission is the primary sponsor of our project. In the next few sections, we provide a short history on the APCC's responsibilities and how it became involved with parking issues.[39]

2.4.2 Air Pollution Control Commission

The United States Environmental Protection Agency published the final amendments to the Transportation Control Plan for the Metropolitan Boston Intrastate Air Quality Control Region on June 12, 1975. The plan set the standards to implement the Clean Air Act in the Boston region. These requirements were to be met and maintained from that point on.[40] The plan called for a decrease in the air pollution in the downtown area and, because it was believed that the main cause was automobile traffic, the city decided to institute a parking freeze rather than shut off downtown to cars, as is done in some cities in Europe.[41]

In order to reduce car pollution, a "freeze" on the creation of new commercial parking facilities open to the general public was instituted throughout the downtown area. The city of Boston wanted to discourage the use of automobiles downtown; it also wanted to lower the total amount of miles that people drove around the whole city. Simultaneously, the city was trying to promote a greater use of the public transit systems. Even though the parking freeze is an effort to lower the amount of air pollution created by cars traveling in and around the downtown area, a beneficial side effect was that it stopped building owners from tearing down their buildings and creating parking lots in their place. These buildings were empty, but the owners still had to pay the taxes on them. The taxes and liability insurance costs on empty buildings are much higher than that of an open-air parking lot, which is why many of the owners would knock down their own buildings and build such lots. Also, the owners were able to make money by selling these spaces for use. Not only were the taxes lower, they still owned the parcel of land, which they could build another structure on at a later point in time. Without for the parking freeze, many

[39] All information from section taken from Guide to City of Boston's Environment Department, Pg. 1-20
[40] APCC Procedures and Criteria, pg. 1
[41] Fabio Carrera, Personal Communication

more buildings would have been demolished and downtown Boston would look more like Providence, Rhode Island or Hartford, Connecticut.

By encouraging the use of prime office, commercial, and residential real estate, the vitality of the city remains intact, rather than having a city full of parked cars. The parking freeze helped Boston keep most of the vitality that it still has to this day.

If people driving cars have no place to park, or have to pay extremely high prices to park in garages, they will simply use more public transportation, which is exactly what the city intended. These measurement and enforcement of the Parking Freeze fell under the jurisdiction of the Air Pollution Control Commission.

In order for the freeze to work, the commission must keep track of how many public spaces are available for use each year. According to this number, the commission decides whether or not to give out permits to allow for more spaces to be constructed. These permits help the commission keep accurate track of who owns what spaces and where they are. These permits are for the owners of the parking area and, without such permits in their possession, it is illegal to build parking spaces in Boston.

2.4.3 The Boston Parking Freeze

The main responsibilities of the APCC, as stated in the Air Pollution Control Commission's *Procedures and Criteria* manual, are to keep accurate and complete records of the current commercial parking facilities located in the specified area designated by the freeze. The information that should be on record for each facility includes the number of spaces, location, and any other pertinent information regarding the specified parking facility. The commission is also in charge of processing and issuing all parking freeze permits and exemptions, as well as providing an annual report to the Regional Administrator of the EPA and to the Commissioner of the Massachusetts Department of Environmental Protection. There is a specific number of permits that can be issued, which is in direct relation to the 35,503 available public spaces set forth by the parking freeze in 1976.

The two main types of facilities involved within the parking freeze limit are garages and lots. Each of these two types of parking facilities can be either public or private. Public facilities can be used by the general public to park for a temporary amount of time for a fee. Private facilities only allow selected individuals or groups to park and have no spaces available for

public use. If, however, a private garage allows some spaces to be used by the public, those spaces are treated as if they were in a public facility.

When a parking facility is built, either a permit or exemption is granted to the facility. If construction of public spaces is proposed, then these spaces must come from the "freeze bank". The freeze bank contains information on each parking facility within the freeze area for which a permit or exemption exists. When planned development includes the construction of new parking spaces, the developer must obtain the proper documentation from the APCC. If the proposed spaces are for public use, then the developer must apply for and obtain a parking freeze permit that grants spaces from the freeze bank. The total number of spaces available in the bank (in relation to the 35,503-space limit) is then lowered to reflect the new spaces. Parking spaces that are available only to members or employees of specific organizations or to neighborhood residents must be exempted from the requirements of the freeze. Even though the APCC has no direct control over the number of these private spaces that can be constructed, it can greatly influence this number due to the fact that proposed private spaces must receive a freeze exemption. While the freeze imposes no ceiling on the number of private parking spaces, the APCC still maintains the total number of private spaces within the freeze area for purposes of development and air quality control.

In order to be issued a parking facility permit, there must be enough spaces within the "freeze bank" available for allocation to the new facility. If there are enough spaces available, then the facility must also agree to follow the objectives set forth in the criteria for issuance of freeze permits. These objectives are that the proposed parking facility

a) Will not add new commercial off-street parking to an area that is already adequately served with parking or mass transit access;
b) Will not add to traffic during peak traffic periods;
c) Will be located where surrounding sidewalks and streets are sufficient to handle the pedestrian and vehicle movements;
d) Will have satisfactory access to the major highways in the area;
e) Will directly serve the developments in the surrounding area; and
f) Will be similar to its surrounding buildings and aesthetically pleasing.[42]

These objectives must all be met in order to receive a permit. Meeting all the above criteria does not guarantee the issuance of a parking freeze permit; the decision is at the commission's

[42] APCC Criteria for Issuing Permits, pg. 7

discretion. The commission also provides a hearing to allow any and all neighborhood landowners near the newly proposed building site to object to its construction.

The maximum total number of parking spaces that can be allowed in the downtown area is 35,503. These spaces are located within the public garages and lots that charge a fee for usage. Even though the commission has no direct power over how many private spaces can be built, it does the best it can to try to discourage their creation. Since the freeze's implementation in 1976, only 20,000 parking spaces were created to service the over twenty million square feet of office space created.[43] This boils down to about one space for every thousand square feet of office floor space. Since so few private spaces were created, approximately half of the work force commutes via mass transit, with about 40% traveling by car and the remaining 10% of the people walking or biking. A beneficial side effect of having more office space than parking is that there are more stores in the area, some of which stay open late. This means that at 5 o'clock the whole city doesn't shut down, instead there is a constant fluctuation of businesses opening and closing. This is much better for the economy than if there were parking lots all throughout the city. Good examples of these businesses are bars, restaurants, nightclubs, etc.[44]

The reasons why the freeze was put into place, as stated above, are fairly easy to see, but what isn't as noticeable is how well the freeze actually works, which is why some studies were performed in the past.

2.4.4 Past Studies on the Parking Freeze

In the years since the parking freeze was started, two studies have been performed in Boston, one in 1991, the other in 1999. These studies were performed by groups contracted by the APCC to find out how many parking spaces there were in the downtown area. The data collected is organized in an Excel spreadsheet. These two studies were used as a starting point for our project. These studies provided the necessary information that we needed to know about the parking facilities within the downtown area. Also, a 1987 City of Boston (COB) map of the parking facility locations accompanied these data. This COB map was the basis of our project, as many of our study methods were based off of this map, as will be explained in chapter three. Each facility on the map had a number that corresponded to the information provided in the studies. The studies collected the street address, name, total number of private and public

[43] Mr. Bryan Glascock, Personal Communication

spaces, rate structure, as well as occupancy rates taken at 9am, noon, and 2pm for each facility. These data, however, were inconsistent with the information gathered about each parking facility.

The two studies mentioned above do not contain information about every parking facility in the downtown Boston area and, for the ones they do have, there are significant pieces of information missing.

Due to fact that the APCC's information regarding the parking freeze facilities was spread out throughout multiple forms of data, as well as physically in many different places, it was difficult to gain specific facility information quickly. These problems were the main focus of our project in the beginning. Our goal was to collect all the parking freeze information and assemble it into one place. We did this with a database system, and a series of digital maps.

To summarize, Boston began as a small peninsula that was connected to the mainland by only a small neck. As a result of growth in both population and size, transportation in and around the city needed to change as well. As new means of transportation became available for use, the pollution and overall congestion in the city became more and more of a problem. In 1970, the Clean Air Act was passed, which set specific guidelines and rules that were to be followed throughout the coming years. Part of this act resulted in the creation of Boston's Air Pollution Control Commission (APCC), which monitors noise and air pollution in the city. The APCC was placed in charge of implementing the 1976 parking freeze, which capped the number of public parking spaces that could be permitted by the Commission to 35,503. Even as regulations concerning car emissions have tightened, the APCC still has its share of problems to worry about, among them the need for a more organized and strict permitting system that will allow for the tracking of public and private parking facilities.

[44] Interview with Liaison, Mr. Bryan Glascock

3 Methodology

The intention of this project was to assist the Boston Air Pollution Control Commission in organizing and integrating all existing parking facility data for the purpose of managing the Downtown Boston parking freeze, which places a ceiling on the number of commercial (public) parking spaces in the area. In addition to the organization of existing data, a significant field campaign was also necessary to ensure that all facilities on file still exist and, if so, that the existing data for those facilities were accurate. Once again, the objectives of the project were:

1.) Organize and reconcile existing data to create a database for parking freeze management;
2.) Visit all parking garages and open-air lots to verify existing data and to collect new and/or missing data;
3.) Produce digital map layers depicting the location and "footprint" of each facility, linked to relevant database tables;
4.) Survey users of parking facilities to determine their reasons for utilizing personal means of transportation instead of public; and
5.) Determine the results of the freeze, in terms of improvements to air quality, effects on development and land use, and its role in Boston's transportation network.

Our goal was to provide the APCC with a comprehensive, accurate, and easily updateable system for the tracking of all parking facility data. Such a system enables the commission to identify facilities that are in violation of the freeze so that they may be properly permitted or penalized. With such a system in place, we were able to determine how effective the freeze has been at controlling public parking and, ultimately, at preventing the further escalation of air pollution.

3.1 Domain of Inquiry and Definitions

The freeze applies to different types of parking, and careful tracking of these facilities is necessary for the APCC to manage the freeze effectively. This section defines the different facilities and parking types needed to provide the main focus of this project. Some important terms are defined below.

- **Public parking:** Open to the general public for a temporary period of time for a fee

- **Private parking:** Available only to specified employees and/or residents; access is restricted from the public by some form of identification
- **Garage:** Any number of parking spaces with a covering
- **Lot:** Open space with lines drawn to delimit parking spaces
- **Permit:** Issued to public facilities; contains number of spaces from the freeze bank that have been granted to the facility
- **Exemption:** Issued to private facilities; contains number of spaces that have been exempted from the freeze

Both facility types are prevalent in the freeze area, from the massive multi-story garages of Government Center and the Prudential Center to the much smaller residential lots of the North End and other neighborhoods. During our tour of Downtown Boston's parking facilities, we realized that the differences between the two run deeper than the existence of a roof. Lots are much easier to check for compliance with permit conditions. Garages are usually more aesthetically pleasing because the cars are not in clear view. Lots are sometimes difficult to track because of their ability to appear in open spaces (although increasing development is reducing this concern). The variety in facility types is only one aspect of the complexity of the situation.

Understanding the different types of parking and parking facilities is central to the project. Although public parking is directly limited by the freeze, tracking of private spaces is just as important in order to understand possible trends between the two types of parking. As a result, spaces must be recorded according to type. Has construction of private parking boomed as a result of the freeze on public parking? This is one of several questions that surfaced during our evaluation.

3.2 Study Area

The study area for the project is Downtown Boston, Massachusetts. However, the APCC's definition of Downtown Boston consists of the North End, Central Boston, Back Bay/Beacon Hill, and the northern sections of the Kenmore/Fenway and South End neighborhoods. The major boundaries are Massachusetts Avenue to the southwest, the Charles River to the northwest, Boston Harbor and Four Point Channel to the north and east, and Route 3 and Interstate 93 off-ramps to the southeast. Our area of interest is the shaded region of the map in Figure 10.

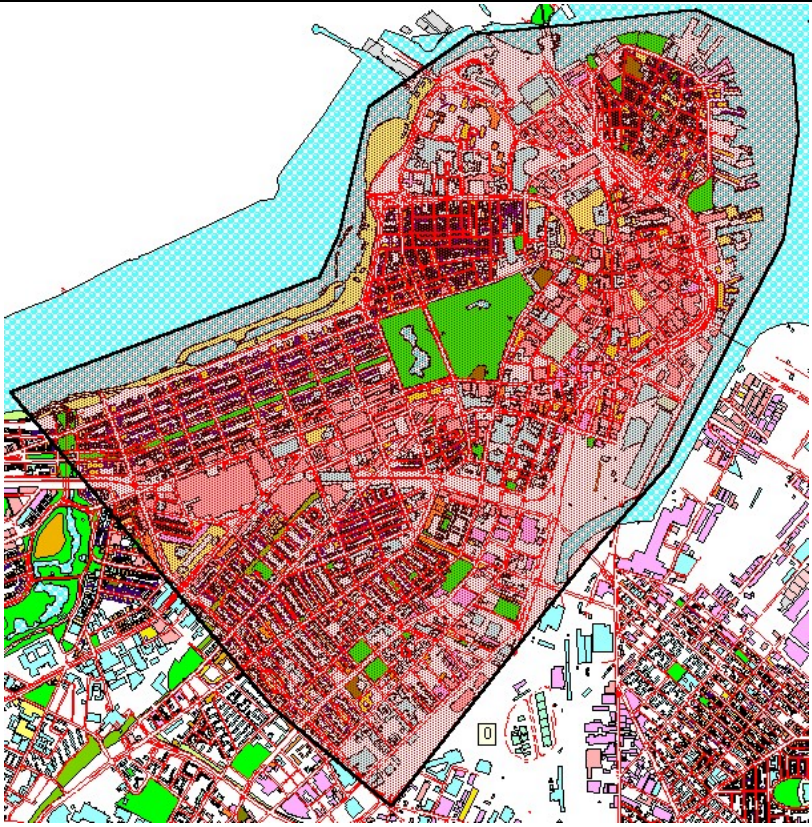

Figure 10: Parking freeze boundary

3.3 Organization and Integration of Existing Parking Facility Data

This project was highly dependent on multiple types and forms of freeze-related data. These were gathered into a single place and archived into a medium that allows for easy access and manipulation. Once all the data can be controlled easily from one place, the task of updating and incorporating newly collected field data becomes much simpler.

Upon our arrival, the APCC was limited by the format and condition of its data. The most common source for data was the parking freeze permit for each facility. Files have been kept for every possible parking facility, dating back to the inventory performed before the institution of the freeze. Each file includes (or is supposed to include) the parking freeze permit for the facility in 1976. These permits, however, only exist for facilities that applied for new or

additional parking spaces after the freeze was initiated. This means that any facilities that were exempt due to the "grandfather" clause do not have a permit on file. The 1977 parking inventory is better known as the "Redbook," a binder that contains a listing of all facilities as of 1977 and a breakdown of the spaces at each one. The Redbook has been one problem area for the APCC in terms of freeze bank maintenance in that it has allowed many facilities that predate the freeze to elude the scrutiny of the APCC. With our work, Mr. Glascock hopes to be able to correctly permit and track the spaces contained in the Redbook.

Each APCC executive director has had his or her own format for granting permits, another problem facing the appropriate permitting and tracking of spaces today. Although the permits are similar, some were issued improperly or are missing important information. Currently, Mr. Glascock's system involves the start of a paper file for the facility upon the issuance of a permit, with the files organized by street address. Ultimately, the file should contain a permit, the layout of the facility, and all correspondence between the APCC and the owner(s) of the facility. Unfortunately, many files are missing permits, further necessitating a field inventory. The current system of granting permits is fairly simple. If the facility had spaces registered in the Redbook and applies for more commercial parking spaces, the once exempt spaces are now counted towards the parking freeze. This means that, if a garage is grandfathered for 30 spaces and requests 15 additional spaces for a total of 45, those 30 spaces that were once exempt are no longer protected under the grandfather clause and must come from the parking freeze space bank (along with the 15 new spaces). Each facility can contain any combination of exempt or permitted freeze spaces; the count for each is contained within the permit. The permit also contains any conditions that have been set forth by the APCC, including how access to the facility is granted, any signs that may need to be posted, programs that promote awareness of alternate transportation services, and fines that the facility may incur due to permit noncompliance. We have created a binder that contains a photocopy of all permits available and scanned all the permits into Microsoft Word format so that there is also an electronic copy where updates can be easily made and issued to the facility.

In addition to all the permits, we have two spreadsheets containing parking facility data acquired during past studies. One is from the Central Transportation Planning Staff. This spreadsheet contains data about occupancy and parking rates for each facility, based on 1990 census data. The other, which has been Mr. Glascock's main source of facility information for

the past several years, contains a space count performed in 1991 by the Boston Transportation Department (BTD) combined with information from the Redbook and the freeze files. At the start of the project this file only properly existed in paper form. There are separate columns for the 1991 and 1977 counts of parking spaces. A sample of the spreadsheet can be found in Appendix D. The data fields that are most important to us are the address information, City Of Boston (COB) number, and permitted public and private spaces for each facility. The COB number contained within the spreadsheet is related to a map produced in 1987 by the BTD. The map is titled "Off-Street Parking Inventory within Boston Proper," and depicts the location of each parking facility containing at least 10 spaces (as of 1987). The map has been critical to our study because, even though out of date, it is still a fairly accurate representation of the parking freeze area.

Transferring this data over into electronic form was the easiest way to organize and integrate it at the same time, while also making it possible to notice and correct errors. Each of the data sets we acquired has been entered into an Access database; with all data for individual facilities linked together using a common code that we created. This code also links all information with the objects in our MapInfo layers. The code that we created consists of the COB map number, a V, P, or B (denoting private, public, or both public & private, respectively), a G or L (denoting garage or lot), and the first four letters of the street name for each facility. For example if there is a private garage located at 134 Tremont St. with a COB number of 450, then the APCC code for this facility would be 450VGTREM. The goal is to integrate all data with one code, while maintaining previous codes for compatibility. The next section will outline the procedures involved in our field study, introducing new data that complements the existing data described in this section.

3.4 Field Validation and Integration of Parking Facility Information

Working with the Air Pollution Control Commission, Boston Redevelopment Authority (BRA), and Central Transportation Planning Staff (CTPS), we have been able to obtain a significant amount of information, as detailed in the previous section. However, the nature of the project alone suggested that a significant field inventory was necessary, due to the fact that the data the APCC used for freeze maintenance was either notably outdated or in a format that was difficult to use. Our main resource for locating parking facilities, the 1987 BRA City of Boston

(COB) map, was a perfect example; the map was over 14 years old and nearly illegible in places. Obviously, if the APCC is to be able to enforce the freeze, then facility data must be up to date and in a format that allows for easy access. The first part was where our field campaign came in. As mentioned before, the BRA parking inventory map was the basis for our field efforts, as it depicts the location and size of every facility in Downtown Boston, as they existed in 1987. The map was still extremely useful in that the vast majority of facilities have remained the same or changed little. However, many have been altered or wiped out altogether and, combined with the construction of many new facilities, requiring a field survey of every facility to either verify or correct existing data.

The field inventory was completed over several days, weather- and schedule-permitting. The basic format of the field inventory was simple. After pinpointing an area of the city for inspection, we would set out with the corresponding section of the 1987 map as a guide. Color-coding the map appropriately, we would determine whether the facility was still in existence. If so, the next task was to reconcile the existing data on the facility with the condition of the actual facility. This was done by recording the pertinent information on a data sheet, a copy of which is attached as Appendix E. The data sheets allowed for straightforward recording of each facility's address, COB map number, whether the facility is a lot or garage, a count of parking spaces, and which digital photograph corresponds to that facility. (Digital photos were taken of the entrance(s) to each facility, for later connection to map layers and databases.) A Microsoft Excel spreadsheet depicting (more or less) the situation on the COB map was used as another basis for data collection. Specific counts at several facilities did not prove possible, so an estimated count based on this spreadsheet was often necessary. As mentioned, the section of the COB map in which the facility appears was color-coded to indicate either the existence or nonexistence of the facility, or that the area is a source of confusion, possibly due to new construction or significant alteration of the existing facility.

With field verification complete, mapping and entering of information into a database now became possible, as described in the following section.

3.5 Creating a Geographical Information System

The key to this project was having a map that would clearly label all the parking facilities within the downtown area, with information linked to each one. This was accomplished using MapInfo, a popular GIS mapping program, and Microsoft Access.

We decided to have six major map layers for depicting all the parking facilities within the downtown area. Since there are four possible types of parking facilities, it was easiest to have a Private Lot, Private Garage, Public Lot, and Public garage layers. Having separate layers for each allowed us to manipulate data with greater ease. A zoomed in version of the map displaying all four facility layers can be seen in Figure 11. As can be seen from the map, each facility has a different color-coding scheme to allow for easy recognition and is also readable if printed in black & white.

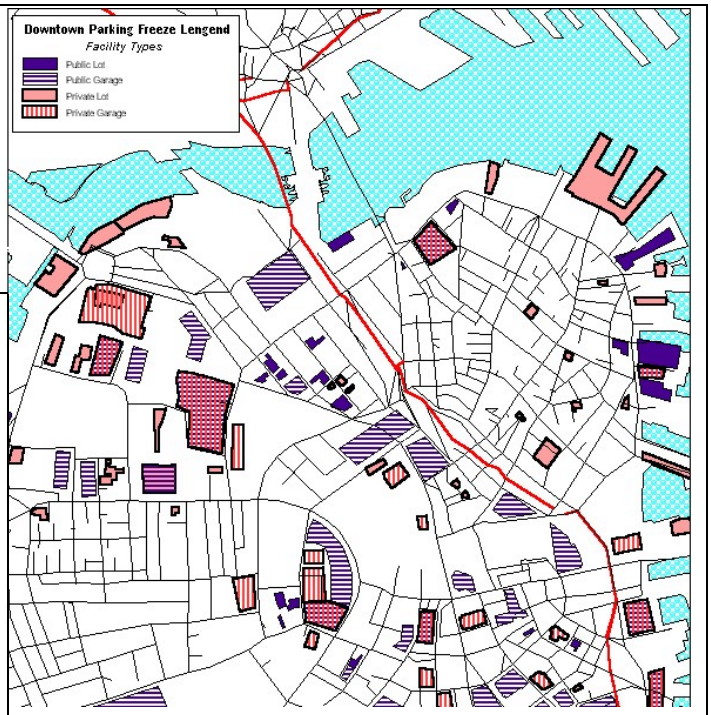

Figure 11: Section of 2001 facility map

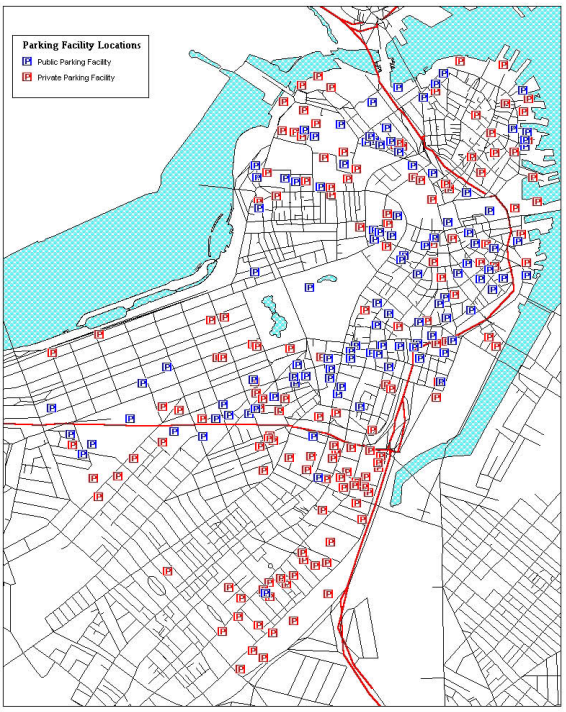

Figure 12: 2001 Parking facility locations map

Along with these four layers, we created two facility location layers. These layers only show the locations of the parking facilities denoted by the common parking symbol, a P within a square. We created separate layers for the private and public locations, and this map is shown in Figure 12. Each of the "P" labels represents a parking location, color coded red for private and

blue for public. This symbol was usually placed in the center of the actual facility and has the code numbers linking the facility to our and other departments' databases.

After the location of each parking facility was placed, other layers were constructed containing the actual outlines of the parking facilities. Each footprint of the parking facilities allows the user to see exactly how big each garage or lot is compared with the others. This is a result of MapInfo using real-world coordinates and distances in its mapping techniques. The information that is stored under each of the parking facility footprints provides the user with the necessary information that connects it to a series of databases. Each facility will have the APCC code, described in section 3.3, which is an alphanumeric uniquely defined key linking each facility to a database. The COB map number was also stored, allowing for compatibility with paper versions of the past parking freeze maps. By keeping this number, we will be ensured that past maps using this numbering system continue to be valid. The Boston Transportation Department also issues permits for open-air parking lots; the BTD permit number has been stored where applicable, allowing the BTD to easily use our maps in conjunction with their databases. The ward and parcel number associated with each parking facility was transported from the annual ward and parcel data maps into each footprint, allowing for easy connection to the city assessor's information regarding ownership. This will help the APCC to create mass mailings to the facilities as needed. The CTPS number for each facility, as stored in the "P" layers was also stored in the facility footprint. The location layers have potential to be placed over an orthographical picture of the city, allowing for easy overhead sighting of the different facilities.

Having all the different codes used by each municipal division allows for use of the mapping system data by all within City Hall. Each code corresponds to a different database kept by each agency, but the most important code, as far as we're concerned, is the APCC code that we have created. This code links our database, which holds different groups of information regarding each parking facility. We also created three other map layers to show the parking facility types and locations as they existed in 1973, 1981, and 1987. These maps were recreated from paper copies that were not known to exist in digital form anywhere. They were created simply to show the change in facility locations and facility types over time so that a further analysis could be done to find patterns or trends in these changes.

3.5.1 Database Information

The database created for the parking freeze maintenance allows for all different types of information to be displayed in one place and sorted through easily. A screenshot of what the database looks like is shown in Figure 13.

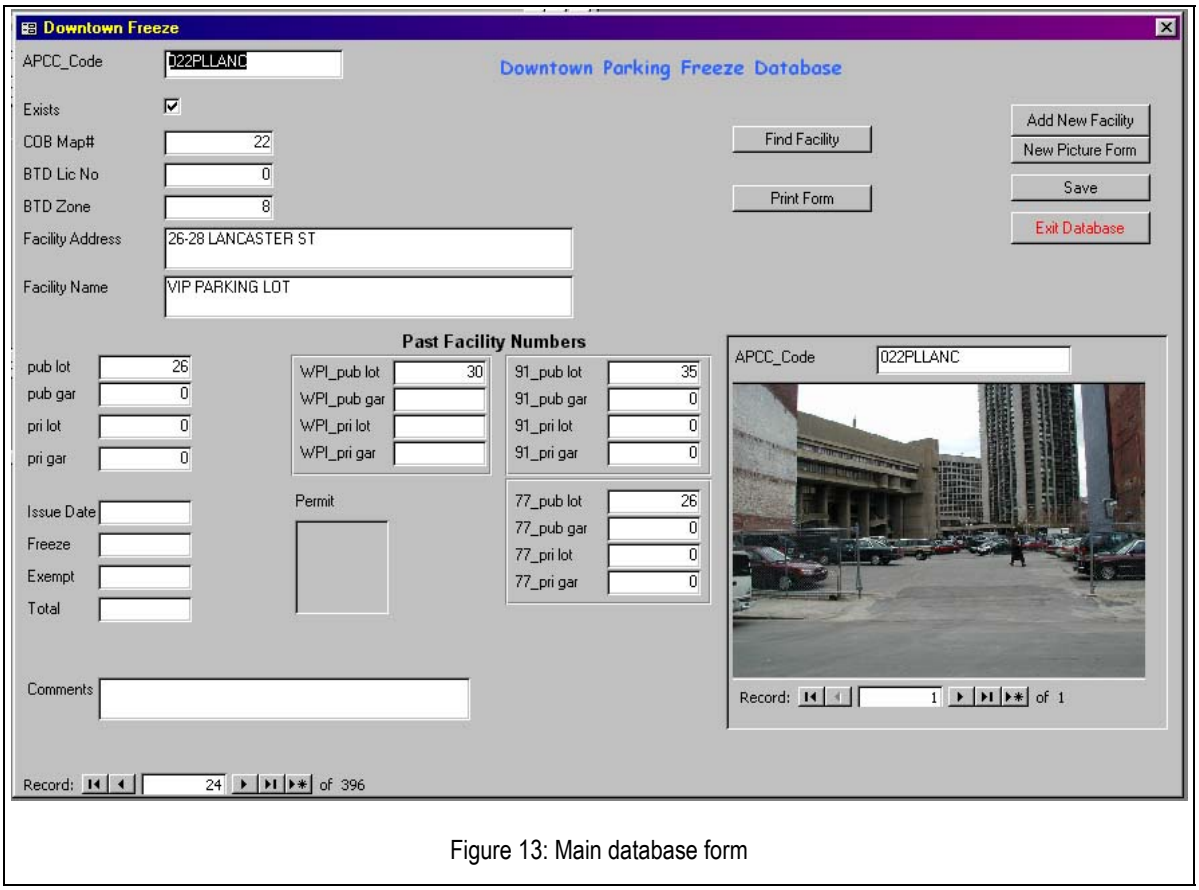

Figure 13: Main database form

All the fields located on the left-most wall of the form are editable and where any change or addition of data would be entered. The groups of three fields in boxes labeled "Past Facility Data" are not editable since they are counts of historical data that will not change.

The comment box allows for the entry of anything that may be important to note but does not fit into any of the database fields. Along with all the data for each facility, a picture of the entrance to each facility is linked by the APCC code, allowing for easy recognition of each facility.

The composite data and permit data are essentially the same but the permit data are meant to have the exact number stated on the permit for freeze, exempt, and total spaces for the facility.

The database also includes the permit date. Composite numbers should match the permit data, and depict what type of facility it is and how many spaces there are for each type of facility.

Facility inventories include space counts at all facilities within the freeze area. Inventories were performed in 1973, 1981, and 1987. In addition, we performed a rough lot space count as part of our field study. Other existing data includes an unofficial 1991 BTD space count and the original Redbook inventory count (1977).

3.6 Survey of Private Transportation Users

The analytical section of the project dictated that we conduct a survey of private transportation users in order to gain a better understanding of why people drive alone into the city instead of utilizing some form of mass transit. The survey could also help to understand what improvements are necessary to the current MBTA service to increase ridership. We were able to survey about 40 drivers, and discovered some interesting trends. We went out into the field on Tuesday, April 24, 2001, between the hours of 7:30AM and 9:00AM. The survey took place in the Financial District at the exit of the Post Office Square garage. Two disclaimers are attached: a) The number of subjects prevents extrapolation of any sort, and b) the location of the survey has a significant effect on the results (Post Office Square is an upper-class section of the Financial District, and so the results are skewered to reflect the habits of those employees). The point of the survey was to obtain some initial results to prompt discussion and future surveys.

We asked the drivers a set of eight questions. The full survey form can be found in Appendix F, but the questions we asked are:

- How many times do you drive into the city per week?
- What city are you driving from?
- How long is your total traveling time?
- How long does it take for you to walk to your destination and in what direction are you heading?
- How many people ride in your car, including yourself?
- Does you company reimburse your parking fee?
- If you weren't reimbursed, would you still drive into the city?
- Why don't you use the MBTA service?

We hoped that the answers to these eight questions would provide some insight into why people are still driving into the city. A few of the questions that we had hoped to answer with this survey are:

- Is there adequate MBTA service near the subjects' homes and where they work?
- What is preventing people from using the MBTA service?
- How could the MBTA service be improved?
- What is the difference in time between driving into the city and using the MBTA service to get into the city?

Survey results are discussed in the following chapter.

4 Results and Deliverables

As detailed in the Methodology chapter, reconciliation, validation, and manipulation of data were necessary for us to provide an analysis. Taking into consideration both the amount and variety of information at our disposal, it was apparent that clear presentation of results was critical if any worthwhile conclusions were to be drawn from our work. The intention of this chapter is to describe the several forms that our data took in an effort to depict clearly (a) what we provided our liaison and (b) how we formed the basis for our analysis.

In order to provide the clearest picture possible of what the Boston Air Pollution Control Commission will gain from the project, the following is a comprehensive list of what we have physically given to the APCC.

4.1 Deliverables

1. **MapInfo layers.** Given the importance of spatial relationships to the project and the need to provide an accurate picture of the parking situation in Downtown Boston, mapping was an appropriate way to present the data due to its visual accessibility. For example, instead of listing facility addresses in a chart, a map shows where they are in relation to the rest of the city, to each other, and to potential users of the facilities. Are there any T stations nearby? Does the facility include any commercial parking spaces? These and other questions can be answered with only a glimpse of a map. Map layers we have produced are:

    - Public lots
    - Public garages
    - Private lots
    - Private garages
    - All public parking locations
    - All private parking locations
    - Digital recreations of the 1973, 1981, and 1987 inventory maps

2. **Tables in Microsoft Access.** With so much information included in the map layers described above, a database was still necessary. When linked appropriately, database tables complement the information contained in maps nicely. By linking tables of information to different maps, a system was created that allows for easy access to specific information as desired by the user. Data tables we have created include:

    - Name and address information

- Data from Central Transportation Planning Staff study
- Data culled from our own field study
- Permit information
- Redbook information
- Picture database holding one or more pictures of each facility
- Links to actual permit files of each facility

3. **Binder and digital folder for permits.** One of the major obstacles faced by the APCC is the lack of an organized system for storage of permits. Such a system would enable the commission to access permit data quickly and easily, important for parking freeze maintenance. With an organized binder containing all permits and a digital folder containing scanned copies, the APCC now has two ways to search and retrieve permits.

4. **Facility photographs.** During our visits to each of the parking facilities within the Downtown area, we took digital photographs of the entrance to each facility. These photos, intended for linking to MapInfo layers, provide a visual picture of each facility and may allow for tracking of some permit conditions.

While the benefit to the APCC of the above items is fairly straightforward, the benefit to our project may not be as apparent. To reiterate, the goal of this project was to determine the worth of the parking freeze. As has been previously stated, the main objective behind the institution of the freeze was a reduction in automobile emissions and a subsequent increase in the level of air quality around Boston. While this statement is true, it does not mean to imply that air quality is the *only* variable that has seen a change as a result of the freeze, or even that it has seen the most marked change. Parking availability and downtown development has certainly been affected. Or have they? Are some areas of the city lacking sufficient parking as a result of the freeze? The remainder of this section is dedicated to presenting our results in formats that answer questions like these, while providing background for the analysis that appears in the following chapter.

4.2 Mapping of the Freeze Area

Location and spatial relationships are a critical part of this project. The address of a facility is important, but more important is its location relative to the rest of the city. For example, where is the nearest 'T' station? Is it within reasonable walking distance? How close is the facility to one of the city's major roads? These are only a few examples; the potential is

nearly endless for others. At the conclusion of our field study of parking facilities, we produced several map layers for the purpose of understanding how the parking situation in the freeze area has progressed over the last three decades. Figure 14 illustrates the freeze area as it is today.

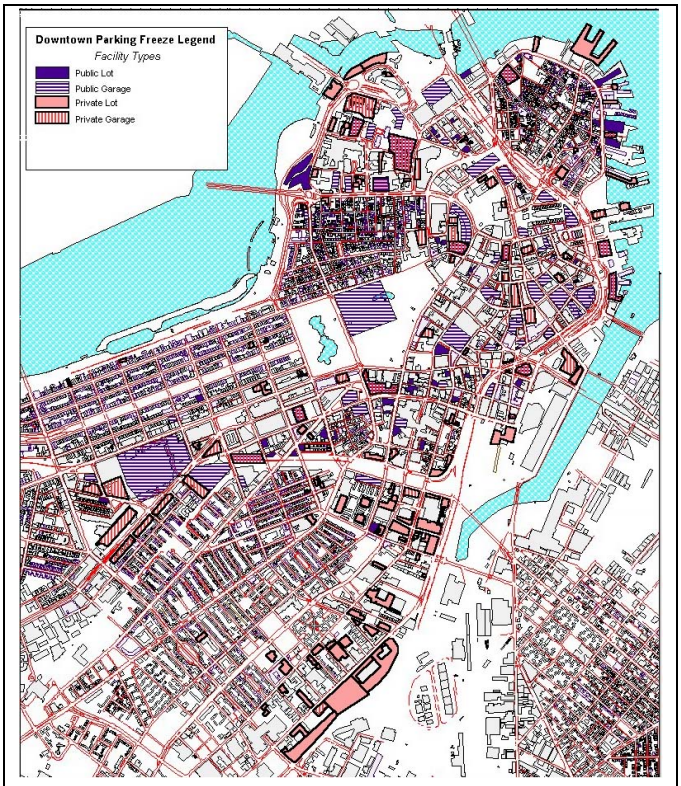

Figure 14: 2001 Parking freeze map

The map is composed of several individual layers, each of which contains a separate facility type. There are different layers for public lots, public garages, private lots, and private garages, and each has its own color scheme to make distribution clear. Although it required a significant effort, a map like this may not mean much at this point, with only familiar facilities such as the Boston Common and Prudential Center garages standing out among the shapes. However, a complete breakdown of the map's layers, in addition to comparison with similar maps from past years, will yield a better understanding of how the freeze has affected parking development.

One trait that is noticeable at first glance is parking distribution. Observe, for example, that parking facilities are sparse in the more residential neighborhoods such as the South End (below the Massachusetts Turnpike) and the Back Bay. In these areas, on-street private parking for residents makes up the bulk of the spaces. Why is this true? In the Back Bay in particular, property values are so high that parking facilities would be considered a waste of extremely valuable real estate. In both neighborhoods, the residential setting frowns upon centralized parking areas. This is only one example of how deep the parking situation runs, and a sign of things to come in the analysis chapter.

In addition to the 1987 off-street parking inventory map, there are similar maps available from 1973 and 1981. Along with the 2001 inventory map we produced (Figure 15), these three

maps serve to illustrate how parking has shifted in response to demand, development, and construction, particularly that of the Central Artery/Tunnel project. In order to make this task easier, we recreated the three older paper maps in MapInfo, making it possible to superimpose different layers upon one another and making changes much more noticeable. Figure 16 is the 1973 version of the off-street parking inventory. Note that 1973 is three years before the institution of the freeze.

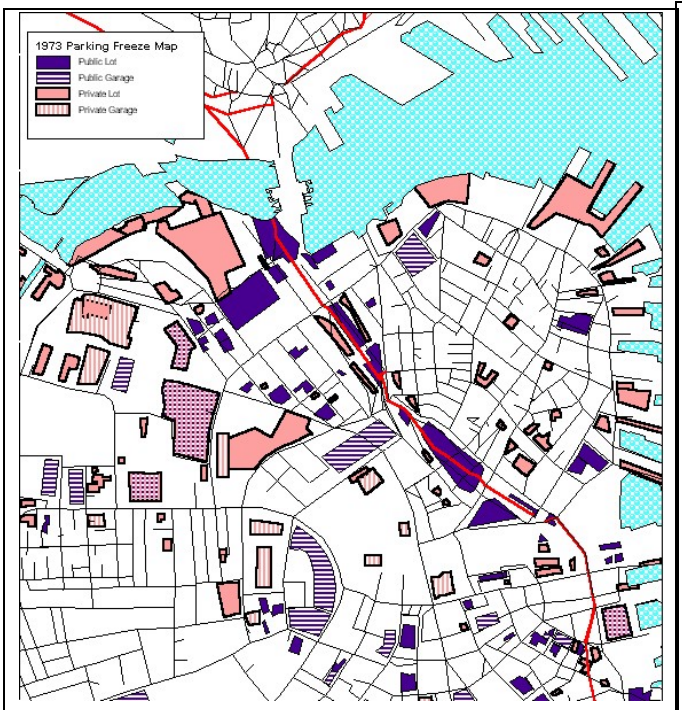

Figure 16: Section of 1973 facility map

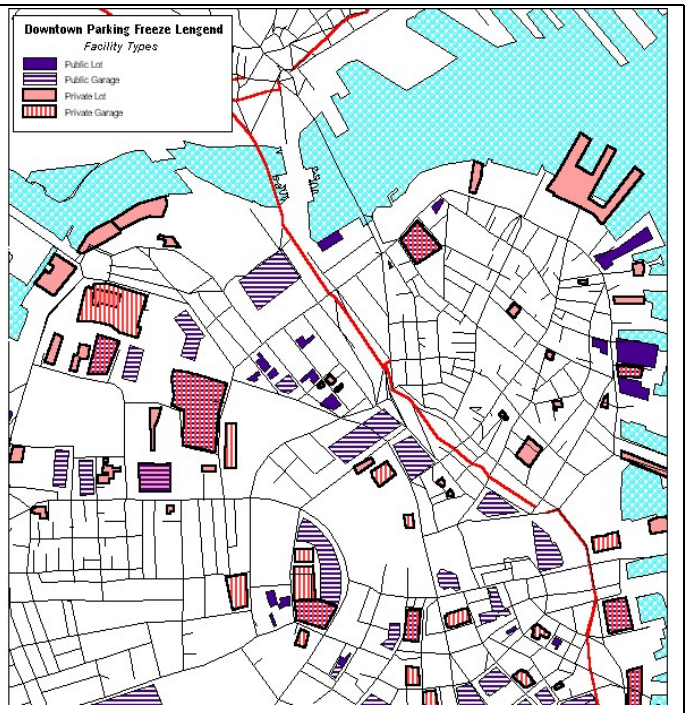

Figure 15: Section of 2001 facility map

The differences between this map and the previous (2001) map may not be evident at first glance, but they are there. Some areas of more obvious change are located along the surface artery and near North Station. (These areas have been focused on to show detail.) With the ongoing construction of the new Central Artery/Tunnel, several lots under the present elevated highway have been eliminated. These lots are represented on the 1973 map by the dark shapes that follow the expressway through the North End. The 2001 map, on the other hand, illustrates the clearing around the present highway that has taken place as a result of construction. The area around North Station is another area of noticeable change; with further Artery construction and

the completion of the Fleet Center (and the accompanying underground garage), the existence of the nearby lots in 1973 is no longer feasible. A closer look at both maps will show that many other facilities have been altered, eliminated, or added as well. Note how some facilities have switched between public, private, and parking for both.

4.3 Survey of Private Transportation Users

Though we were not able to extrapolate the results to the overall driving population, we did notice a few key trends from the answers we did receive. We noticed that about 70% of the people we surveyed were not carpooling, and that over 50% of the people were being reimbursed by their employers for parking costs. These trends were the most surprising and interesting that we saw. We feel that this survey has great potential for finding some more answers as to how it would be possible to convince more people to consider alternate forms of transportation.

5 Analysis

This chapter will serve to outline the process from the end of data collection to a breakdown of all data, and finally to an analysis that will make possible an assessment of the parking freeze's role in air quality improvement, development, and the city's transportation network.

5.1 Trends in Space Breakdown

Where the maps of the previous chapter fall short is an area of critical significance to our analysis: showing trends in parking distribution and development. The maps show where parking has responded to need (and where it has been cleared to make way for the Central Artery and other development), but they fail to show, say, the extent that development of private parking has responded to the limits imposed by the freeze. Figure 17 shows how the simplest balance, between public and private, has changed since the pre-freeze year of 1973.

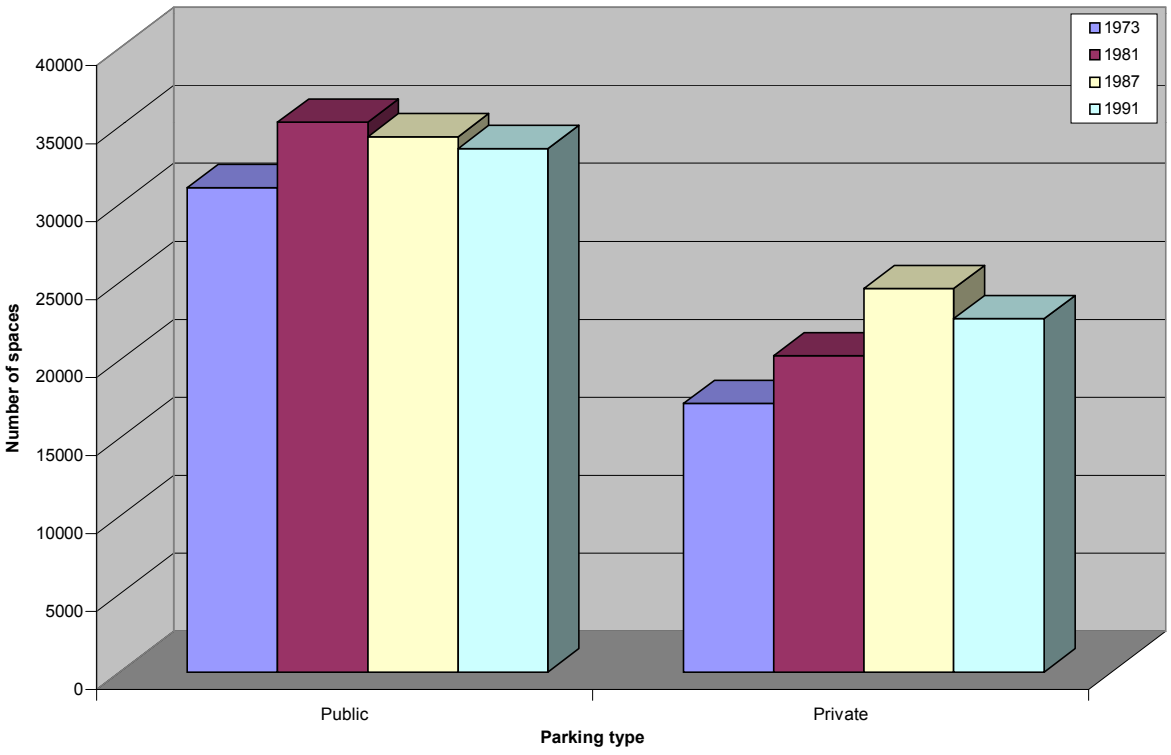

Figure 17: Public vs. private parking, 1973-91

First-order analysis supports our hypothesis that construction of private parking has increased significantly, while public parking has hovered just below the 35,503-space limit imposed by the freeze. This graph may suggest to some that because the number of public parking spaces has never been above the freeze ceiling, the freeze it not actually having any effect. However, this is the goal of the freeze. When the freeze was first put into practice, the number of public parking spaces was below the freeze limit, which was calculated by adding ten percent to the 1976 levels. The job of the APCC is then to maintain the number of public parking spaces safely below the limit. It appears, from Figure 17, that the Commission has been successful and that the freeze has been able to prevent unchecked construction of public parking. Hopefully we've been successful in convincing you that the parking freeze is not that simple, and that several other factors are involved. For now, however, Figure 18 breaks down the total number of spaces by facility type, with data from the three freeze inventories and 1991 space count.

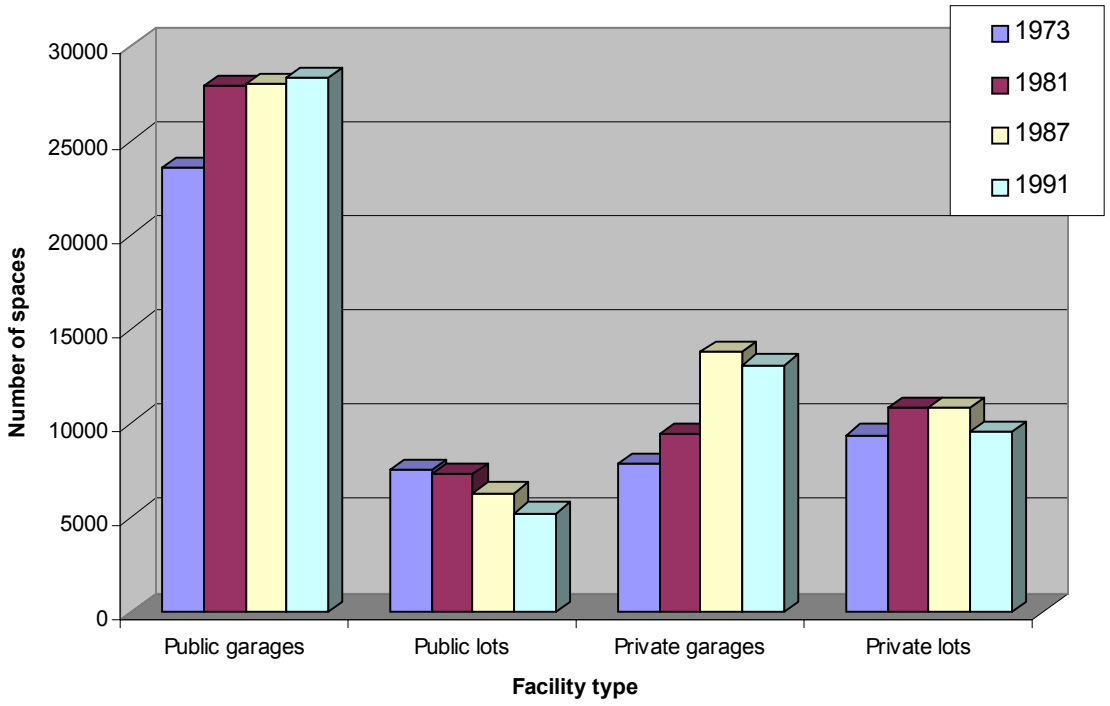

Figure 18: Facility breakdown, 1973-91

After an initial jump, public garage and private lot spaces have seemingly leveled off, while public lot spaces have seen a noticeable downward trend. Figure 19 shows the percentage of the total number of Downtown spaces that each facility type made up in 1987.

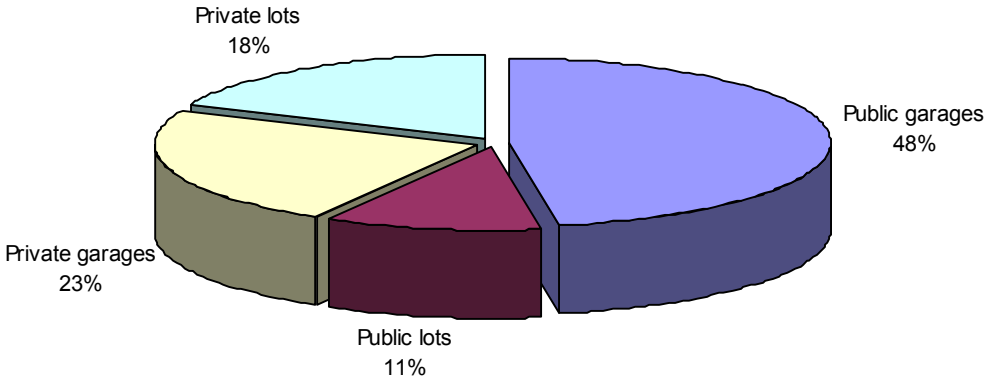

Figure 19: Facility breakdown, 1987

Private garage spaces, on the other hand, have increased to the point that they made up approximately 23% of all off-street spaces as of 1987. The downward trend in public lot spaces can be attributed, again, to the large-scale Central Artery construction, but also to increased Downtown development. It simply is no longer as feasible to keep valuable space open for parking spaces. The increase in private garage spaces can be attributed to the fact that public space construction is far outpaced by increases in employment and commercial development. Currently, the development approach for Downtown calls for 0.4 spaces per 1,000 square feet of new development. Even though this seems like a miniscule number already, one solution that has been suggested is stricter limitations on development of private parking. Since the parking freeze only requires private facilities to obtain an exemption from the APCC, one obvious solution is to start a separate freeze bank for private spaces. Unfortunately, a vicious circle develops in which tight regulation of private parking leads to somewhat of a stranglehold on

economic growth. The idea of a private freeze, although delicate, is becoming increasingly necessary and is discussed further in the Recommendations chapter. The delicacy of the balance between economic and environmental interests and transportation needs is becoming clear.

5.2 Air Pollution Estimation

The parking freeze in Downtown Boston was an action taken to lower air pollution by lowering the total vehicle miles traveled (VMT) to meet air quality standards set by the Clean Air Act. This section explains our calculations regarding the amount of pollution that is created within the city. The air pollutant amounts produced were calculated by breaking down the types of trips into two different categories, city and highway. City trips further break down into vehicle trips starting or ending within the freeze area (including Storrow Drive), while Interstate-90 and Interstate-93 trips fall under the highway category.

We know that vehicles are constantly traveling on roads producing pollution, but we wanted to know exactly how much pollution they were creating and how city and highway trips contribute individually to this amount. After estimating pollutant amounts for the city, we can then extrapolate what kind of effect the parking freeze is having in regards to air pollution. Vehicles drive both inside and through the city, but since the freeze can only somewhat control the number of cars coming into the city, we needed to know the number of cars simply passing through the city each year.

We received a traffic volume study from CTPS for the sections of I-90, I-93, and Storrow Drive that are inside the parking freeze area. Accompanying the car volume we also received the average speed of cars on those roads during peak usage, taken every half hour from 6AM till 10AM and from 3PM till 7PM. The average speed of the cars is important to have because cars create different amounts of pollution dependent upon their speed. The average speeds combined with the average fleet emission ratings for the 2000 year allowed us to find the amounts of volatile organic compounds (VOC), nitrogen oxides (NOx), and carbon monoxide (CO) for both summer and winter intervals. These average fleet emission ratings is created by the EPA by taking into account the number of old and new cars still on the road.

The way we calculated the amount of pollution produced per day in the parking freeze area was by finding what parts of the roads are in the parking freeze area. After that, we added up the distance of each section and calculated the average speed over each road during the

morning peak and the evening peak hours, the speed was used to find how much pollution was being produced at that speed for VOC, NOx, and CO. We assumed that the number of cars traveling at each peak period in each direction was exactly one-fourth of the total vehicles per day. The length of the road multiplied by the number of cars traveling that distance, multiplied by the average emission of each pollutant, produces the grams of each pollutant per day. For intra-city trips made within the parking area, we assumed a city speed of twenty miles per hour and an average trip of two miles. The distance of two miles came about because it is smaller than the largest possible trip and larger the smallest possible trip within the freeze area. When we compared highway travel to city travel, we included Storrow Drive with city roads; because it is not a road that people take to simply pass through the city, it is more of a road used to go on or off the highway. The simplistic version of how these values were calculated can be seen below.

*Distance * (Pollution per Mile) * (Number of Cars per day) = Tot. Pollution per Day*

We also felt it was necessary to find out how many vehicles on the highway are simply passing through the city and not traveling entering into the city at all. In order to find this number we calculated the maximum number of cars that could come and park within the parking freeze area and subtracted this number from the total number of cars traveling on the highways. The total number of available parking spaces was calculated by adding up all the public parking spaces and multiplying them by a factor of 2.5, which is an average turn over rate for public parking spaces[45], total number of private parking spaces, and an estimate of 10,000 on street residential and meter parking spaces[46]. The number of cars calculated to just pass through the city on I-90 and I-93 are 155,500 vehicles, leaving 114,500 cars to travel through the city. The simplistic version of how we calculated these numbers is below.

*Total Public Spaces * 2.5 + Total Private Spaces + 10,000 = 114, 500*

[45] Provided by our liaison, Mr. Bryan Glascock
[46] Provided by our liaison, Mr. Bryan Glascock

	AM Peak	PM Peak	AM Peak	PM Peak	
I-93	South	South	North	North	**Total**
VOC	142294.05	241473.15	133560	287028	804355.2
NOx	286353.9	285471	241164	266490	1079478.9
Sum. CO	829043.1	1821128.4	822906	2115918	5588995.5
Win. CO	1329941.7	2897089.2	1311660	3335220	8873910.9
Mass Pike	East	East	West	West	**Total**
VOC	30253.05	30359.7	26615.03	26708.85	113936.63
NOx	74548.35	72557.55	65583.675	63832.3	276521.875
Sum. CO	169360.2	169218	148994.1	148869	636441.3
Win. CO	267193.8	267051.6	267193.8	234937.8	1036377
Storrow Drive	East	East	West	West	**Total**
VOC	32897.1	50883.5	46114.67	49676.4	179571.67
NOx	64757.8	64222.87	90776.54	89698.6	309455.81
Sum. CO	194941.99	376945.8	273266.9	306072.05	1151226.74
Win. CO	310282.4	600137.8	434949.4	487859.45	1833229.05
Intra-city trips					**Total**
VOC	N/A	N/A	N/A	N/A	1426950
NOx	N/A	N/A	N/A	N/A	1744956
Sum. CO	N/A	N/A	N/A	N/A	10754220
Win. CO	N/A	N/A	N/A	N/A	17119776

all calculations are in GRAMS/DAY

Table 4: Calculation of air pollution

Table 4, above, shows the calculations of air pollution broken-down into the direction of traffic and AM or PM peak hours. The calculations are in grams per day. The carbon monoxide values were broken down into a summer and a winter value because the rate of carbon monoxide production is different between the two seasons. If one wanted to calculate the amount of carbon monoxide over the entire year, multiply the summer and winter values by half a year and add those new values together. Even with the total values for the year of city and highway pollution one could easily see the difference. Figure 20 shows these values all at once with the different types of pollution next to each other.

Out of the total cars driving on I-90 and I-93 combined, 57% of them just go through the city without getting off the highway. The amount of pollution these cars produce driving through the city is less than those driving inside the city. This is because inside the city the speeds at which people are driving are much lower than those on the highway. This causes the engine to be less efficient in its combustion process. This can be easily seen from the graph in Figure 20. Even though the Carbon Monoxide (CO) amounts between city and highway driving are the most prevalent, the Volatile Organic Compounds (VOC), and Nitrous Oxides (NOx) are also more than doubled in amounts created when driving in the city versus on the highway.

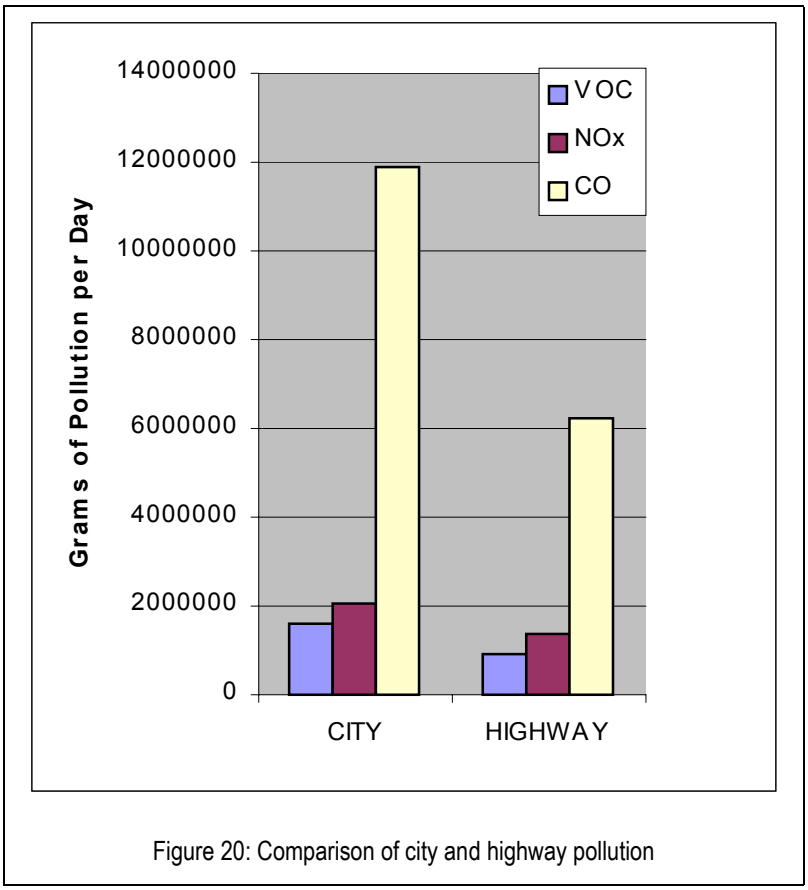

Figure 20: Comparison of city and highway pollution

On road vehicles are large contributors to air pollution, but they are not the only contributor. Pollution sources have been broken down into four categories. Figure 21 is a chart that shows the categories and a couple of examples of each.

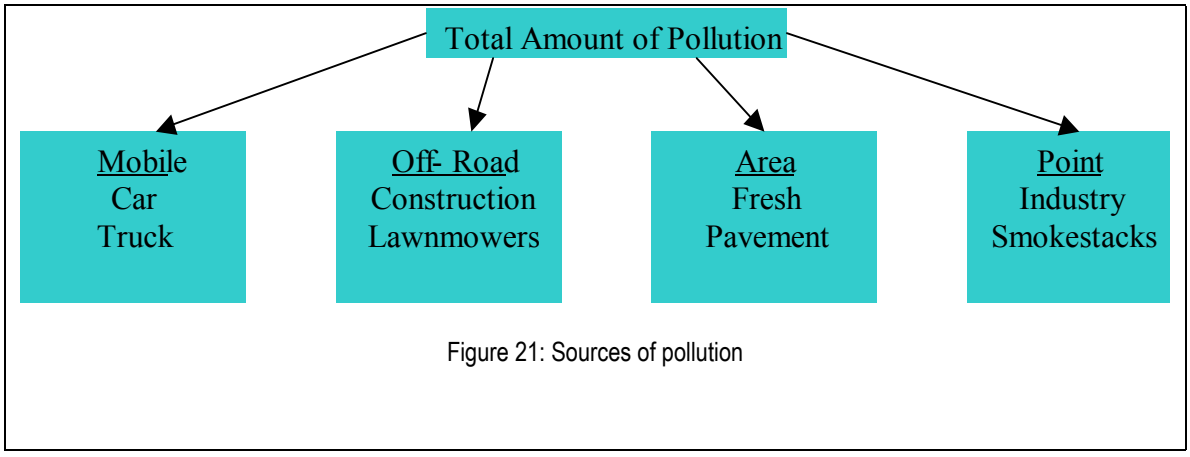

Figure 21: Sources of pollution

When looking at the total pollution produced throughout the state of Massachusetts, mobile vehicles are by far the largest contributors to air pollution, contributing 52%. Figure 22 shows the total breakdown for the state. Off-road vehicles are the second largest contributors to the state's pollution. Point source pollution only accounts for 2% of the total pollution, this is because they are already highly regulated. This makes us think that perhaps mobile vehicles could be more strictly regulated.

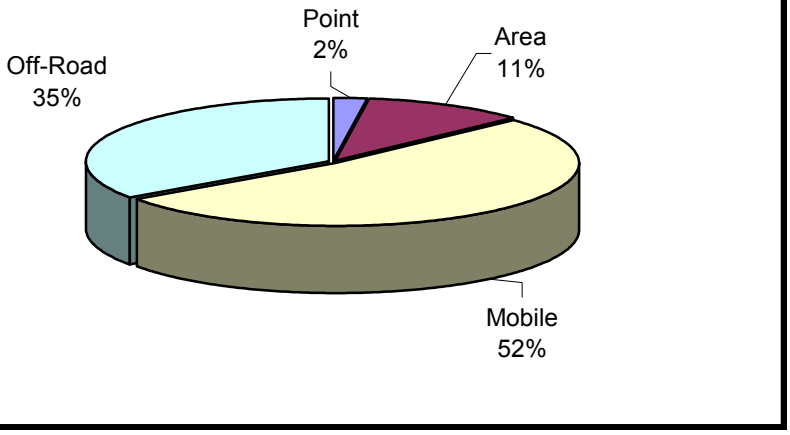

Figure 22: Breakdown of Massachusetts's sources of pollution

To put the amount of pollution created by a car into perspective, the amount of pollution removed by the average tree is 0.02632 pounds of carbon monoxide per year and 0.09315 pounds of nitrogen oxides per year.[47] According to the amounts of air pollution created by city driving, it would take 31 trees to remove the NOx created by one vehicle and 825 to remove the amount of CO produced by one vehicle.

With this information on air pollution in Boston, including the contribution of different vehicle trips, we can conclude that the freeze has at least a worthwhile effect on air pollution. The freeze also influences city development, as detailed in the following section.

5.3 Development and the Parking Freeze

Another facet of city planning that is influenced by parking availability and, as a result, by the parking freeze, is land use and development. Transportation systems evolve in response to growth of employment and office space, resulting in immense strain on the parking supply. The problem, unfortunately, is a vicious circle. The city encourages economic growth, which boosts the number of jobs, increasing the number of people coming into the city on a daily basis. It is the task of the APCC to minimize this number, while the Boston Redevelopment Authority is encouraging new development and new jobs. It's clear that some intermediary, possibly a new committee altogether, is necessary to keep the balance between new development and the parking supply. This possibility is discussed further in the Recommendations section. In the meantime, Figure 23 depicts the completion of new office space over the last four decades.

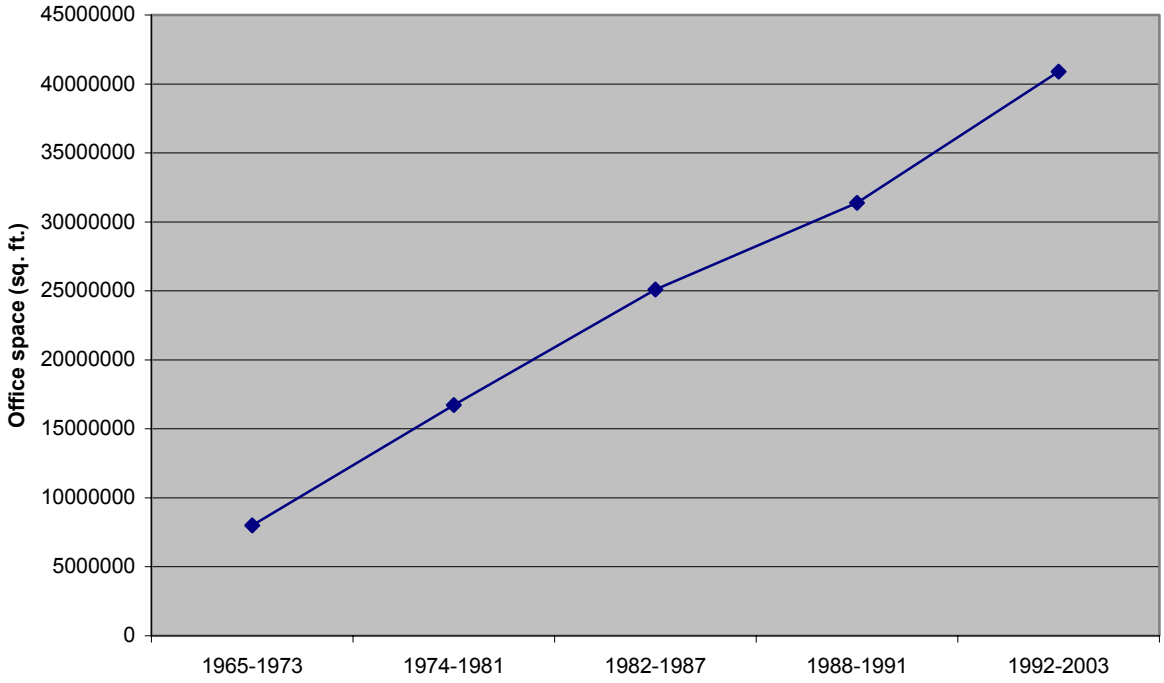

Figure 23: Completion of new office space

The graph shows how much office space was completed during successive time periods in the city's history. For example, approximately 25 million square feet of office space were

[47] *Reengineering Tree Management: The Benefits Provided by Updated Tree Management Techniques in Cambridge*, E. Creps, P. Hiremath, R. Pantozelos, and D. Stefanik, WPI IQP report, 2001.

completed between 1965 and 1987. (Values for 2001-2003 are currently under construction.) This graph clearly shows a continuously strong growth trend in the amount of Boston office space. The vacancy rate, or percentage of the total office space that is unused, is also important to note, as empty space does not contribute to parking availability. In the early 1990s, for example, the city was mired in an extended economic recession that resulted in nearly 17 percent of office space going unused. By 1996, however, the vacancy rate dropped below 7 percent, and was down around 2 percent by 2000. As a result, additional office space is either under construction or in the planning stages. Although new space makes sense economically, it will place additional stress on a parking supply that is already at its limit. Figure 24 compares the growth of office space with that of parking spaces.

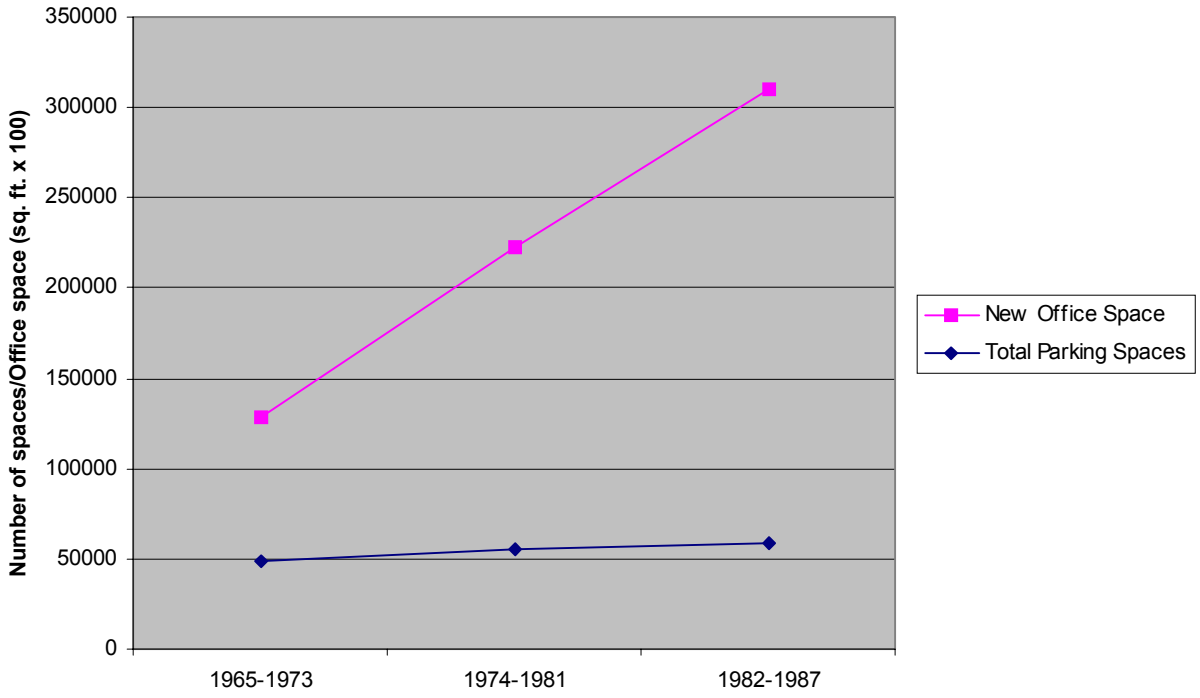

Figure 24: New office space vs. parking supply

Although the graph only tracks growth through 1987 (the year of the last parking freeze inventory), an alarming trend is visible. (The office space numbers are for the entire city, but

since a vast majority of this is located downtown, the trend still applies.) While development has continued at a rapid pace, the total number of parking spaces has barely responded. What has happened instead is a shift in the breakdown of the spaces, as detailed in section 5.1. Basically, the overall public parking supply has decreased, while the number of spaces in private garages has increased accordingly. As a result of the imbalance, parking has become a significant factor in determining property value. When new development is proposed, the proximity of the building to available parking (either nearby or within the proposed plan) is a huge factor in determining property value and even if the proposal will be accepted at all. Currently, the development scheme for Downtown Boston calls for 0.4 spaces per 1,000 square feet of space. Again, the vicious circle resurfaces. If the parking freeze is extended to include private parking, many worry that development will be scared away to the suburbs, affecting the city economically as well as moving the air pollution problem instead of fixing it.

6 Recommendations

In the course of the project, we were able to come up with several recommendations that would assist the commission in its managing of the parking freeze. In addition, implementation of these suggestions will help the city to obtain a better understanding of the transportation network. With this knowledge, planning of road and transit improvements could better reflect the current needs of the city. The following recommendations are categorized into general and freeze-specific.

6.1 General Recommendations

- *Greater resource sharing* among all city departments involved with parking and transportation. We feel that if a committee was formed to include individuals in charge of parking-related issues, then a common form of data storage could be agreed on. Currently there are at least four separate municipal divisions that all deal with parking in a different way, making it nearly impossible to share information easily.

- *Completion of survey of private transportation users.* We conducted an initial survey of commuters who still drive into the city. The survey produced some surprising trends, even with the small number of subjects. We feel that a more in-depth and accurate survey would show useful trends among private transportation users, which might allow for better tailoring of transit improvements and programs to promote alternate forms of transportation.

- *Yearly parking space inventory* of the parking freeze area. Only four space counts exist, even though the parking freeze has been in effect for over 25 years. The last was conducted ten years ago. If an accurate count of the total number of parking spaces in the freeze area was performed annually, then a great deal more would be possible in terms of accurate planning and analytical work, such as tracking of the separate parking designations against land use and development.

- *Encouragement of Commuter Choice programs.* Many creative ideas aimed at discouraging driving alone already exist. Promotion of these programs should increase. Employers have options such as discounted T passes, passes funded with pre-tax wages, Cash Out (money in exchange for a private space), and encouragement of high occupancy vehicle (HOV) use. If more companies were to get involved in these types of programs, rather than encouraging auto use by reimbursing employees for public parking, then more commuters who drive alone may be forced to consider alternate means of getting to work.

6.2 Freeze-Specific Recommendations

- *Inclusion of private spaces in the requirements of the parking freeze.* This is perhaps the most obvious solution to the problem, but also the most delicate. Reversal of the current trend, which suggests that more private spaces are being constructed in an effort to circumvent the requirements of the freeze, is definitely necessary. However, the balance between an ample parking supply and encouragement of a healthy economy is fragile. Available parking has become so intertwined with proposed development that a private freeze may have far-reaching ramifications. If a strict freeze on private parking is implemented, development (as well as the local economy) may suffer. Pushing business space out of the city to suburban office parks only moves the pollution, rather than helping to reduce it. Keeping private space levels reasonable is the only feasible way to reduce vehicle miles traveled (VMT) within the freeze area while maintaining a healthy development scheme.

- *Increased high occupancy vehicle (HOV) parking.* If parking spaces were guaranteed to those who carpooled every day, then more people may be convinced to do so. Rates can also be structured to encourage HOV use. Freeze permit conditions already exist that require parking facilities to set aside spaces for HOVs and offer reduced rates to carpoolers and vanpoolers. Continuation of this practice on a larger scale would further reduce single-passenger vehicles.

- *Standardized parking freeze permits.* Since the inception of the freeze, several individuals have held the position of APCC Executive Director. Without standardized freeze permits, each director has had their own format for issuing them. Unfortunately, the permits don't match, which means that some are missing pertinent information or granted spaces in a manner inconsistent with the intent of the freeze. With standardized permits, every parking facility would have the same permit format, stating only the necessary information in regards to their parking permit conditions. This will also insure that as the years progress and new directors come and go, the important information continues to stay on the permits.

- *Annual renewal of freeze permits, with a fee.* Since the APCC has no budget, it is extremely difficult to properly manage the parking freeze. If facility owners were required to renew their permits annually, and a fee was attached to the granting of permits, then the APCC would be able to start generating much-needed revenue, allowing the director to hire someone to help manage the parking freeze. Through many discussions with Mr. Glascock, we came up with a possible permitting fee of $10 per space per year as a reasonable expense for the facility owner. For example, a 75-space parking facility that makes $300 per month per space (a conservative estimate) would bring in $270,000 for a base income. Using the fee of $10/space/year, that facility would need to pay $750 a year for its permit,

> which is 0.27% of their earnings. We feel that this is a reasonable amount of money for the facility owner. We understand that this is not an accurate account of how much many they make due to taxes and city fees, but the point is still valid. A fee system doesn't just bring in money for the commission; it also helps the director keep track of what facilities do and do not exist. This happens as a result of having to renew the permit each year, because if a facility is no longer operating, the owner(s) will not want to continue paying for a parking permit. With every facility permitted or exempted annually, the freeze bank can be adjusted accordingly to reflect new facilities and ones that have shut down.

With the correct mix of economic instruments (fees, rate structuring, and taxes), a well-devised development scheme, appropriate transit improvements, and an extension in the influence of the parking freeze, the efficiency of Boston's transportation network can be maximized. The city's continued economic growth may soon become dependent upon this happening.

7 Conclusion

Throughout this project, we have seen a common theme in the crossed paths of air pollution control, city development, and parking. As Boston grew as a city and new forms of transportation evolved, more pollutants were released into the atmosphere. Different methods to help curb pollution were implemented following the Clean Air Act of 1970, which influenced the creation of the Downtown Boston parking freeze. The freeze, now in its twenty-fifth year, has undoubtedly had an influence, but in what capacity and to what extent are still somewhat clouded.

Before the freeze began in 1976, building owners would often clear their land to make room for parking lots in an effort to save money and retain ownership of the land space. Once the freeze was put into effect, buildings were not demolished because new parking facilities were restricted without proper APCC documentation. In the meantime, Boston was experiencing a shift in development – the old city saw the completion of around 15 million square feet worth of new office space between 1965 and the early 1980s. These new office buildings were creating their own private parking because they could no longer count on outside parking to be available for their employees. As the level of public parking spaces was maintained below the limit imposed by the freeze, private parking responded to fill the void. With more people coming into the city now than ever, the imbalance between the parking supply and development trends can't be ignored any longer. The impending completion of the new Central Artery/Tunnel, while a necessary improvement, is not the solution to the problem.

The role of the parking freeze in air quality improvement is complicated. With our estimation that approximately 57 percent of Boston vehicle trips continue through the city without stopping, the contribution of city trips vs. that of highway trips is virtually a wash. Therefore, it is worthwhile to limit parking and, effectively, limit city trips. While the parking freeze alone has not had a remarkable effect on air quality, it has helped to prevent uninhibited escalation of air pollution in association with other programs. In addition, its side effects have helped to keep the vitality and uniqueness of the city intact, preventing Boston from going the way of cities such as Hartford, Connecticut and Providence, Rhode Island.

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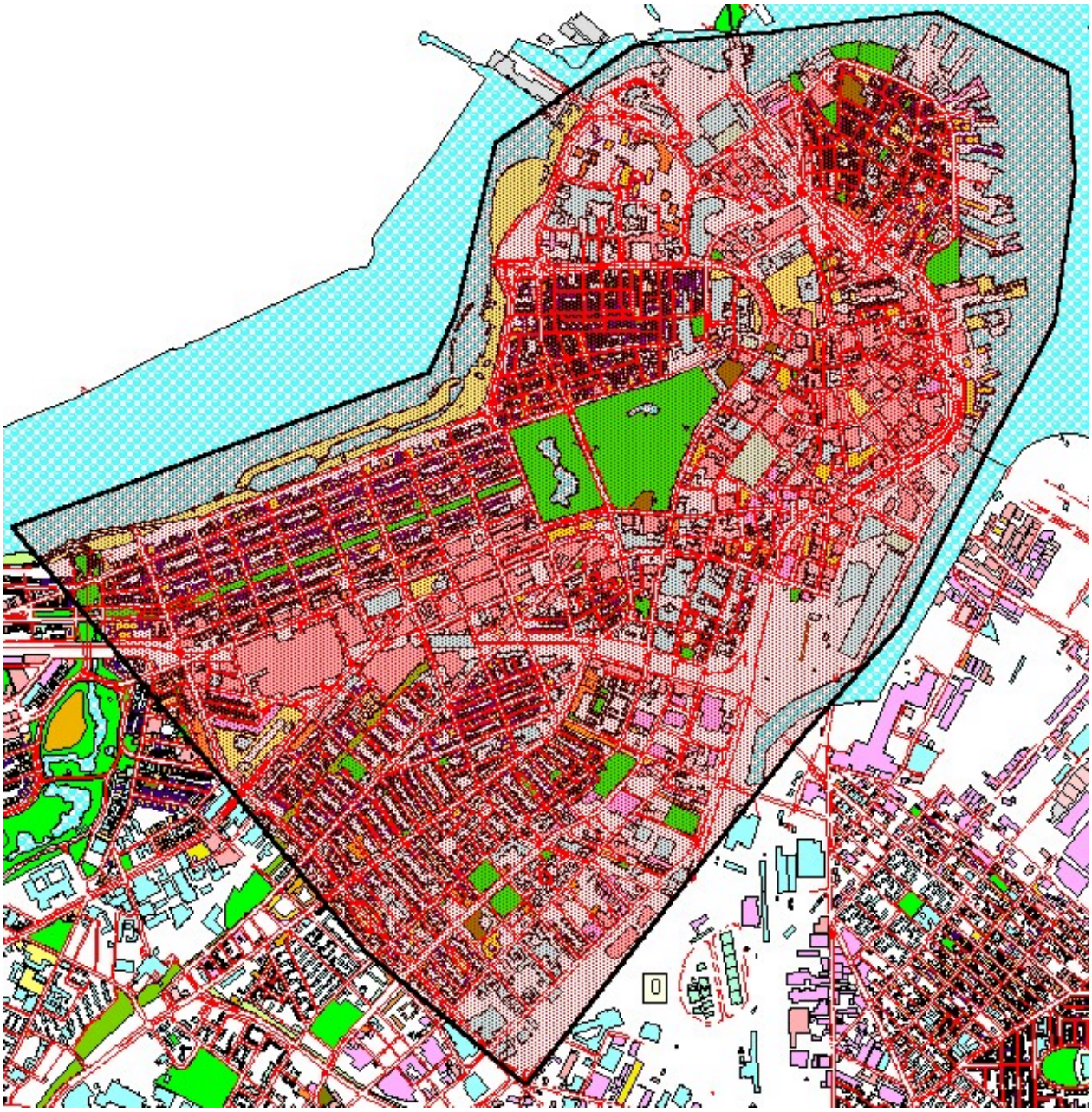
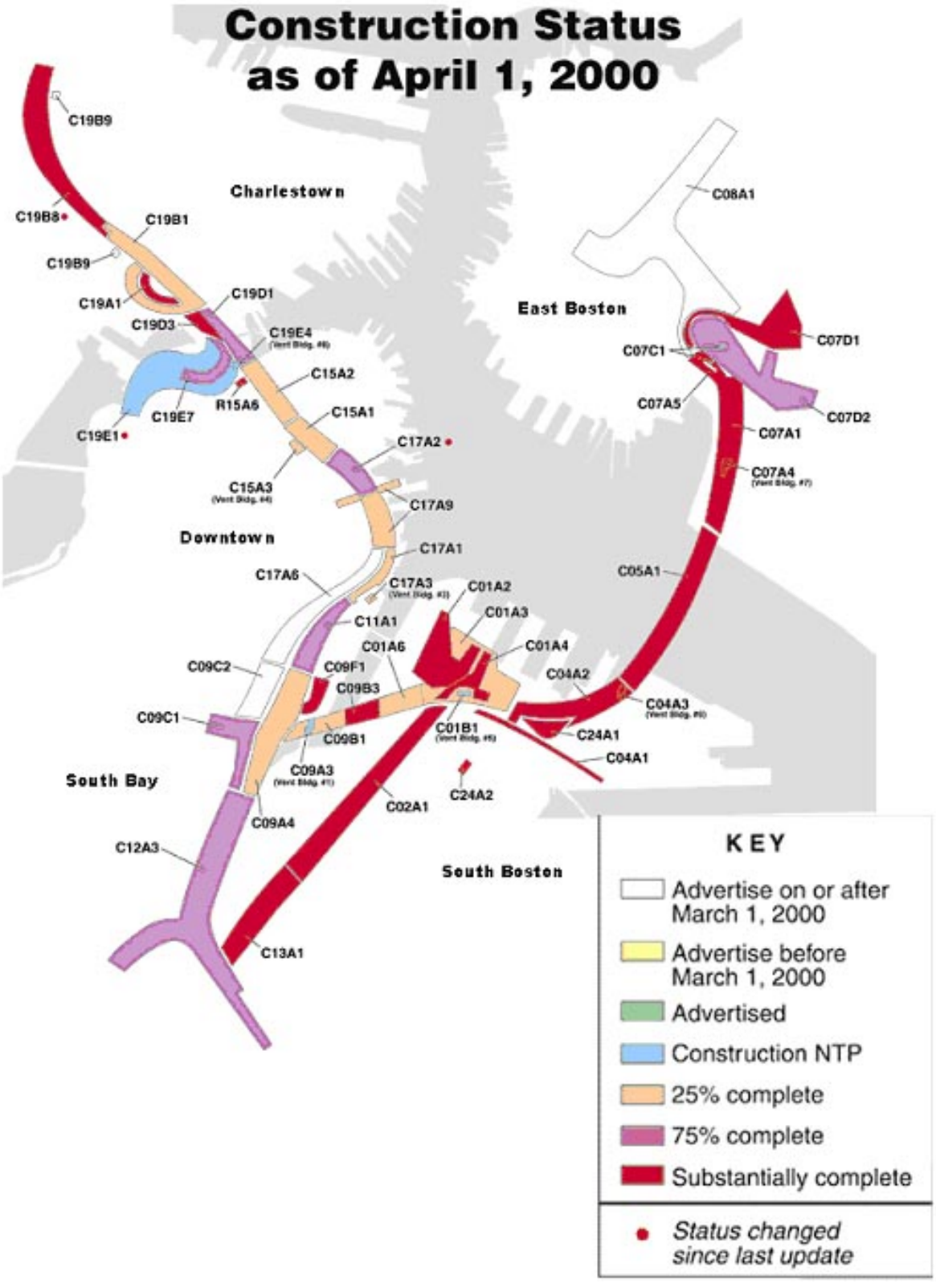
Appendix A: Boundaries of Parking Freeze (Downtown is the Enclosed Area)



Appendix B: Big Dig Construction Status Map




CHARLESTOWN
EAST BOSTON
CENTRAL
ALLSTON/BRIGHTON
BACK BAY/BEACON HILL
FENWAY/KENMORE
SOUTH BOSTON
HARBOR ISLANDS
JAMAICA PLAIN
NORTH DORCHESTER
SOUTH DORCHESTER
ROSLINDALE
MATTAPAN
WEST ROXBURY
HYDE PARK

Appendix D: Part of Parking Freeze Master File

KEY	Exists Yes/No	BTD LIC. NO.	COB MAP #	BTD LOT PERM #	BTD ZONE	ADDRESS OF FACILITY	NAME OF FACILITY	1991 COUNT NUMBERS pub bt	pub gar	pvt bt	pvt gar	pub lot
003VLCHAR	YES		3		9	4 CHARLES RIVER DAM	MDC LOT	0	0	63	0	0
004AVLCHAR	YES		4.1		9	395 CHARLES ST	WHITTIER PLACE LOT	0	0	101		0
004BVGCHAR	YES		4.2		9	395 CHARLES ST(comb.w/4.1)	WHITTIER PLACE GARAGE	0	0	0	269	0
005VLEMER	YES		5	155	9	10 EMERSON PLACE	10 EMERSON PLACE LOT	0	0	21	0	0
006AVLEMER	YES		6.1	157	9	ONE EMERSON PLACE	CHARLES RIVER PARK LOT	0	0	29	0	0
006BBGEMER	YES		6.2		9	ONE EMERSON PLACE	CHARLES RIVER PARK GARAGE	0	0	0	309	0
007PGBLOS	YES		7		9	BLOSSOM COURT	HAWTHORN PLACE GARAGE	0	619	0	0	0
008APGLOMA	YES		8.1		9	35 LOMASNEY WAY	CHARLES RIVER PARK GARAGE	0	650	0	0	0
008BBGSTAN	YES		8.2		9	60 STANIFORD ST	LONGFELLOW GARAGE	0	0	0	590	0
009VLNASH	YES		9		8	NASHUA ST	SPAULDING REH HOSPITAL LOT	0	0	178	0	0
009AVLNASH	YES		9.1		8	NASHUA ST	MASS GENERAL HOSPITAL BROW	0	0	121	0	
011VLNASH	NO	338	11	338	8	99 NASHUA ST	MASS GENERAL HOSPITAL LOT	0	0	471	0	0
014VLNASH	NO		14		8	100 NASHUA ST	R M V LOT	0	0	40	0	0
019APLCAUS	NO		19.1			140-150 CAUSEWAY ST	NORTH STATION AUTO PARK					57
020VLMDCE	NO		20		8	MDC EMPLOYEE	MDC EMPLOYEE LOT	0	0	140	0	0
021PLBEVE	NO	33	21	33	8	151 BEVERLY ST	CHARDON-REALTY PARKING LOT	100	0	0	0	53
022PLLANC	YES		22	71	8	26-28 LANCASTER ST	VIP PARKING LOT	35	0	0	0	26
025PLFRIE	YES		25	323	8	235-239 FRIEND ST	J & O LOT	30	0	0	0	27
026PLFRIE	YES		26	176	8	302-320 FRIEND ST **see rb	FRIEND ST LOT	41	0	0	0	41
027VLFRIE	YES		27		8	200-204 FRIEND ST	204 FRIEND ST LOT	0	0	12	0	0
028PLMERR	YES		28	26, 73, 246	8	37 MERRIMAC ST	RAPIDS PARKING LOT	96	0	0	0	45
029VLFRIE	YES		29		8	193 FRIEND ST	193 FRIEND ST LOT	0	0	16	0	
029AVLFRIE	YES		29.1		8	169 FRIEND ST	169 FRIEND ST LOT	0	0	13	0	0
030PLCANA	NO		30	MBTA	8	89-91 CANAL ST	CANAL ST LOT	6	0	0	0	10
031APLHAVE	NO		31.1	RPD	8	HAVERHILL ST	ALLRIGHT PARKING LOT	92	0	0	0	0

PARKING FACILITY FIELD STUDY FORM

Facility Name:_____ Date: _____

Picture#_____

Facility Address: _____

COB # _____

LOT / GARAGE (circle one)

Private Spaces: _____

Public Spaces: _____

Comments:

Boston Private Transportation Survey

1. How many times do you drive into the city per week?
2. What city are you driving from?
3. How long is your total traveling time?
4. How long does it take for you to walk to your destination and in what direction are you heading?
5. How many people ride in your car, including yourself?
6. Does your company reimburse your parking fee?
7. If you weren't reimbursed for your parking fee, would you still drive into the city?
8. Why don't you use the MBTA service?

			answer 1	answer 2	answer 3	answer 4	answer 5	answer 6	answer 7	answer 8
	Sex	Age	# of days	City	time-travel	time-walk	# of people	Y N	Y N	Use Code
People	M / F									
1										
2										
3										
4										
5										
6										
7										
8										
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30										

Expected responses for question 7:

1. Cost
2. Frequency of vehicles too low
3. Service not available near home
4. Not enough parking at MBTA stations
5. Poor safety
6. Poor cleanliness
7. Overall trip is too slow/faster to drive in
8. Use different form of mass transportation, ie. Carpooling
9. Simply prefer to drive/parking is avaliable to me
10. Stuff to carry
11. Overall convenience
12. Other

Approx Age:

20-30
30-40
40-50
50+

Approx Times:

less than 10
10-20.
20-30
30-40
40-50
50+

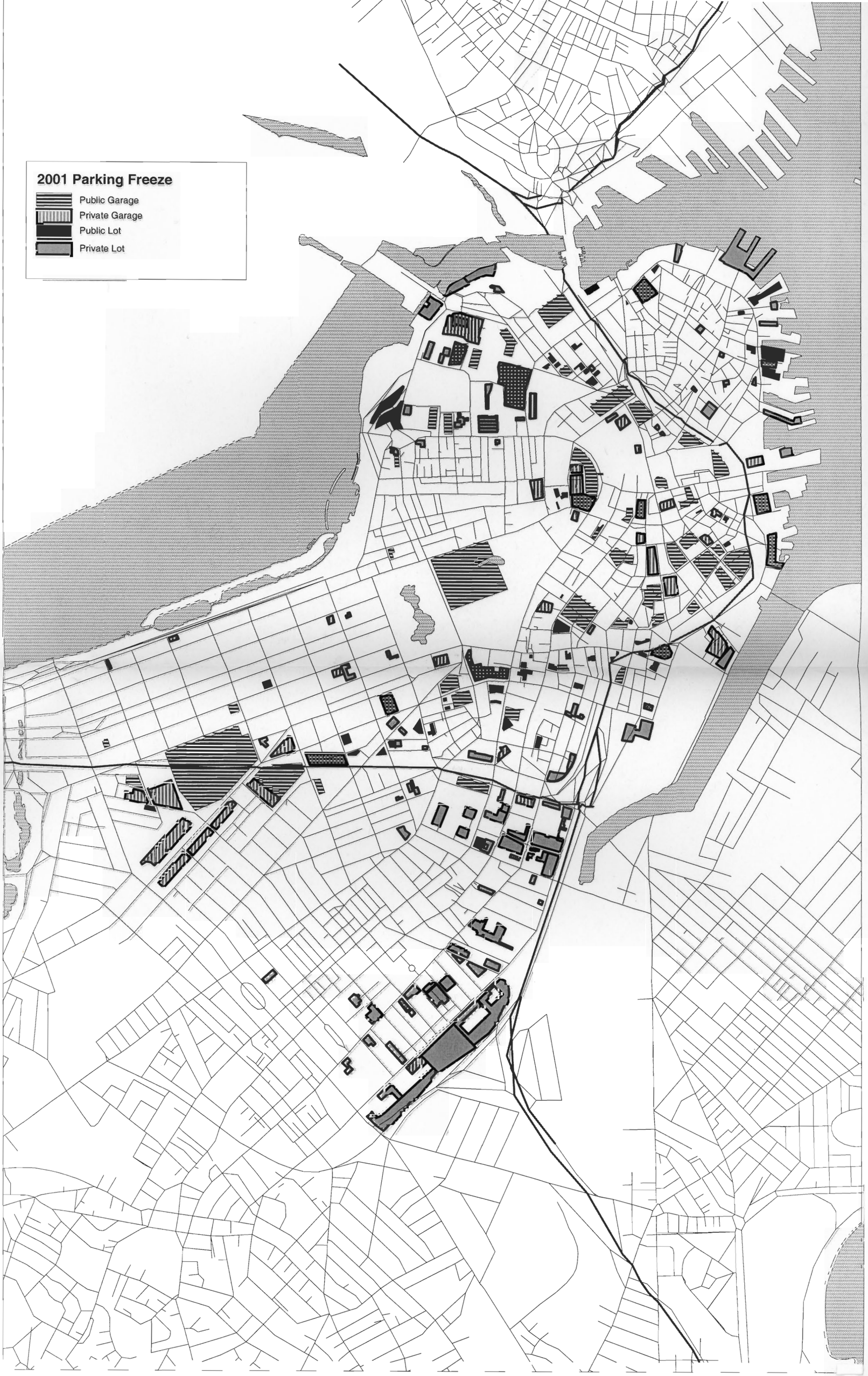
People survey form thing

- Put in the pollution speed chart
- intra-city trip data sheets
- fold outs of 73, 81, 87 and 2001 facility maps
- database manual (has to be printed separate)


1973 Parking Freeze
Public Garage
Private Garage
Public Lot
Private Lot


1981 Parking Freeze
Public Garage
Private Garage
Public Lot
Private Lot


1987 Parking Freeze
Public Garage
Private Garage
Public Lot
Private Lot


2001 Parking Freeze
Public Garage
Private Garage
Public Lot
Private Lot