Boston Mapping
Archaeological Resources

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Interactive Qualifying Project

Sponsored by the Environmental Department

of the City of Boston

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APPENDIX F.. TJG

Reference/Users Manual & Glossary of Terms

Historical Research...ALL

Initial Mapping Projects.. TJG

Included Aligning Basemap, Wards, and MapInfo Research (extensive work)

Final Mapping Project.. SGM

Included Registering All Historical Maps (extensive work)

Initial Mapping of Overlays.. PPC

Included Some Historical Maps & Filling Projects

Final Mapping of Overlays.. SGM

Included Remaining Historical Maps & Filling Projects

Design and Creation of Access Database.. TJG

Included Access Research & Preliminary Data Entry

Data Entry.. ALL

Map Collection... ALL

Map Scanning... SGM

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ABSTRACT

This report is designed to document the production of computerized maps and overlays of all existing archaeological information regarding the City of Boston and to create a corresponding database that will depict site-specific land-use history in Boston. This database and map will facilitate city, state, and agency planning, policy, and the identification of research priorities. The report also describes the project's methodology and provides information about initiating the project, information about MapInfo, Access, GIS, and introductions about how the maps and database can be used.

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EXECUTIVE SUMMARY

This Interactive Qualifying Project was conducted for The City of Boston's Environmental Department. The product and result of this project is a single source for information essential to the archaeologists within the Environmental Department. This source is a CD containing information such as digitized maps depicting shoreline changes, harbor lines, and filling episodes. Also included on this CD is a corresponding database, which includes information about these digitized maps. This type of information management is known as a Geographical Information System (GIS).

Previous methods of extracting information from the documents that have been computerized in this project were tedious and less efficient. The historical maps that have been digitized were formally scattered in various departments in Boston. This required archaeologists to travel to these locations to view these maps. Many of them had to be signed out and returned by certain dates. Some older maps were not allowed out of the department at all. This puts more time constraints on the city archaeologist's schedules and can sometimes result in a bit of hunting. Even once locations were known, archaeologists still had to return to the place that the maps resided to look at them.

Many of these maps are now digitized and can easily be viewed in ways that were never possible before, all in one location to minimize any time that would be wasted from going to various departments within Boston. Some of the maps that are included on this CD are maps of the earliest known shoreline of Boston, Stimpson Maps of 1835, 1837, 1838, 1839, and 1841, Harbor Lines of 1889, and Perkins Map 1785-1895. Using the capabilities of computers, and mapping programs these maps can be overlapped to view

them in ways that are not possible with paper maps. The digitized maps can be drawn upon, and zoomed in on to investigate and concentrate on specific areas of the map. Information such as shoreline changes, harbor lines, wards can all be displayed at once using this GIS system. The maps can be viewed over satellite images of Boston that are included on the CD as well. Different combinations as to how the maps are overlapped can prove to be a great research tool for archaeologists. As mentioned these maps can be drawn upon and once this is done, information can be attached to the objects drawn.

All the historical maps that have been computerized have been outlined in some way during this project. Different maps depict different things and which features were to be outlined was at the discretion of the project team members. Information as map name and date was attached to these maps and can easily be accessed by clicking on the map itself. All this information is called up from a database of landmaking projects and maps.

A 1994 dissertation at Boston University by Ms. Nancy Seasholes was the source for information within the database. The dissertation was read and outlined by members of the project team to gather information on landmaking projects for the database. Included in the database is information such as project name, type of fill used, where fill was taken from, and purpose of the various projects.

One hundred and fourteen landmaking projects were drawn over digitized maps. All these landmaking episodes are in a database as well. Maps of landmaking projects are connected to the database in the same manner as the historical maps are. Again, users can click on various landmaking projects and have information from the database extracted and displayed as in Figure-ES1 (Example of GIS capabilites). Information for the landmaking projects is within the same database of the maps. Organizing the data in this fashion provides a way for users in the Environmental Department to display both historical maps and landmaking in any combination he/she wishes by overlaying them upon each other.

Included within the final product are queries and workspaces defined and created by the students. The workspaces are specific arrangements of the historical maps and landmaking projects overlapped. Workspaces were defined by talking to members of the Environmental Department to decipher which combinations of maps would be used most often. Queries were defined in the same manner and display information by time periods and locations. This will further improve the efficiency of researching these maps and landmaking projects.

INTRODUCTION

The Environment Department of the City of Boston has a mandate to identify and preserve the archaeology and known landmarks of the city. By combining what is known from historical documents with archaeological discoveries, one can have a better understanding of the overall history of the city. The city archaeologist serves to manage the archaeological records for Boston. The archaeologist is also responsible for assessment of sites and also proper methods of restoration for found artifacts.

Most recently, in 1996, the position of City Archaeologist was reinstated. The City Archaeology Laboratory, located at 152 North Street, was stabilized and updated. The laboratory is used to investigate all archaeological findings and also to propose potential sites for preservation through research. It is also the duty of the laboratory to prevent amateur archaeologists and everyday people from finding sites and destroying potential artifacts.

As archaeologists prepare to investigate the land-use history of a particular parcel, they come upon difficulties when trying to use the utilities resources, such as maps and reports. Currently, there is no common repository for these resources, and they are kept in different locations across the state. For instance, if an archaeologist is studying a specific site in East Boston, and he or she needs to find out characteristics of that parcel, many different locations will have to be visited. The documents housed at these different locations become useful to the archaeologist in his or her attempts to locate sites, types of material that maybe found, (i.e. soil, rocks, artifacts), and the possible origin of such material.

As more site information is gathered, that need for a concise system that can store, retrieve, analyze, manipulate, and display this information intensifies. The city's environment department proposes that a database be created that can facilitate research procedures. A computerized base map and a series of overlays of historical maps and related information is also to be designed. This system of maps will allow for the archaeologist to look up any information needed with minimal effort, which will make his or her work more rapid and efficient.

In the 1950's, a new type of technology was designed to facilitate the proposed need for a mapping system that would more efficiently and thoroughly analyze geographical data. This computer technology is called Geographical Information Systems (GIS). After decades of development, GIS has become a useful research tool among the geo-spatial profession. Another technology that has improved digitized cartography is the Universal Transverse Mercator (UTM). UTM is used to set all the data that the system has acquired to a common coordinate system. This will allow more accurate overlays that are properly put to scale. UTM also allows the use of overlay information so that maps are coordinated in actual latitude/longitude Earth coordinates.

Research has shown that people interpret and respond to data more effectively in a visual fashion, particularly in cases where the data is keyed to different areas or geographic locations (Hearnshaw and Unwin, 1994). GIS relies heavily on computer graphical user interface to assist with the understanding of spatial information. For this project, GIS is an effective means to implement every need that the department has identified.

Throughout this project, a great amount of research on the various documents, provided by the Boston Landmarks Commission, was required. General knowledge of the history of Boston, including past filling episodes, and archaeological sites and discoveries insured that the mapping system can facilitate all the needs of the environmental department and its professional archaeologists..

This project completes a degree requirement at Worcester Polytechnic Institute known as the Interactive Qualifying Project (IQP). The main objective of the IQP is to gain a better understanding of how culture, society and technology interact with each other. The system that we will produce will allow archaeologists and historians to research a large database and make effective use of maps and overlays. This process will be less cumbersome and extremely more efficient than the system that now exists.

LITERATURE REVIEW

This literature review presents background information needed to get a better understanding of Archaeological Mapping of the City of Boston and all that the project entails. Understanding what an archaeological site is and everything it has to offer should be understood. Knowledge of the site specific land-use history of Boston is essential, including how Boston was formed, known natural and man-made archaeological sites, and how potential sites might be identified. Background information about Geographical Information Systems (GIS) is equally important in the understanding of this project.

ARCHAEOLOGY

Archaeology is the scientific study of past human life through the systematic observation and analysis of the material remains of human activities (Henry, 1993). For many archaeologists, though, archaeology is simply an adventure and a mystery. Being able to hold objects that have not been touch by human hands for hundreds of years is a thrill.

The archaeological site is a place where human activity occurred. Sites include places such as farmsteads, stores, mills, mining complexes, craft stores, wharves, canals, villages, taverns, schools, and urban centers. The actual area of the site can vary quite considerably, from sites that are only a few feet wide and right on top of the ground, to sites that are acres wide and several feet deep.

Archaeological sites are made up of many different elements that represent different activities. Each element of an archaeological site contains the data that archaeologists study. There are three major types of elements that are found at sites: artifacts; features; and ecological evidence.

Artifacts are objects manufactured by hand or machine, such as clay bowls, metal hinges, glass bottles, and stone projectile points. Features are immovable manufactured objects, larger than artifacts, such as buildings, walls, trash pits, and wells. Ecological Evidence, or Ecofacts, provides information about the site's environment. This evidence can include soils, seeds, pollen or other plant remains, animal bones, shells, and charcoal.

Archaeologists try hard to preserve these sites, but because of certain factors that damage sites, preservation can be difficult. Such factors as Natural Forces, Human Actions, Institutional Actions, and Legal and Regulatory Procedures are typical problems for preservation (Henry, 1993).

Natural Forces are the forces that deal with anything in nature. Erosion, earthworms, flooding, freezing, thawing, vegetation, earthquake, fire, and landslide are all types of natural occurrences. Human Actions can be things such as theft, vandalism, recreational activities (off-road vehicles), and lack of knowledge. Institutional Actions are the precise methods that archaeologists must undertake when excavating a site. Archaeologists must be sure not to disrupt any soil or surrounding objects that may cause them to lose important information. Legal and Regulatory Procedures are laws and regulations that may require or prohibit personal or corporate actions that unintentionally cause archaeological damage or loss.

Some of the laws and regulations that protect archaeological sites are as follows: Antiquities Act of 1906; Archaeological Resources Protection Act of 1979; Abandoned Ship Act of 1987; and many others (Henry, 1993). These laws help archaeologists in their attempts to preserve archaeological sites, but archaeologists must also gain knowledge in the proper manner in which sites are escavated. A variety of different books, pamphlets, and Internet sites are consulted to ensure correct procedures and some other general information. Appendix C is a bibliography of the different documents and Internet sites that are important to preservation. Archaeologists also try to assert their knowledge whenever applicable, so that the government and local residents do not overlook the importance of the sites.

HISTORY OF BOSTON: FILLING PROJECTS

Boston, as it exists today, is a huge metropolis, but of course, the city has developed through a number of discrete phases. Boston was one of the first North American areas to be settled by Europeans. The first settlers arrived north of Boston in Salem. Since shipping was to be the biggest business, the settlers moved south to find the Shawmut Peninsula. The peninsula made for great ports with easy access to the ocean.

Boston Proper, which was originally the Shawmut Peninsula, covered only 786 acres in 1630. The map in Figure-L1 drawn by Samuel Clough, is based on Boston in 1630. The map is a good depiction of how the peninsula first appeared. The majority of the land surrounding the Shawmut Peninsula was sodden regions of salt marshes and mud flats. Over time the peninsula was leveled in some places and filled in other places. There have been extensive projects conducted by Massachusetts investment companies

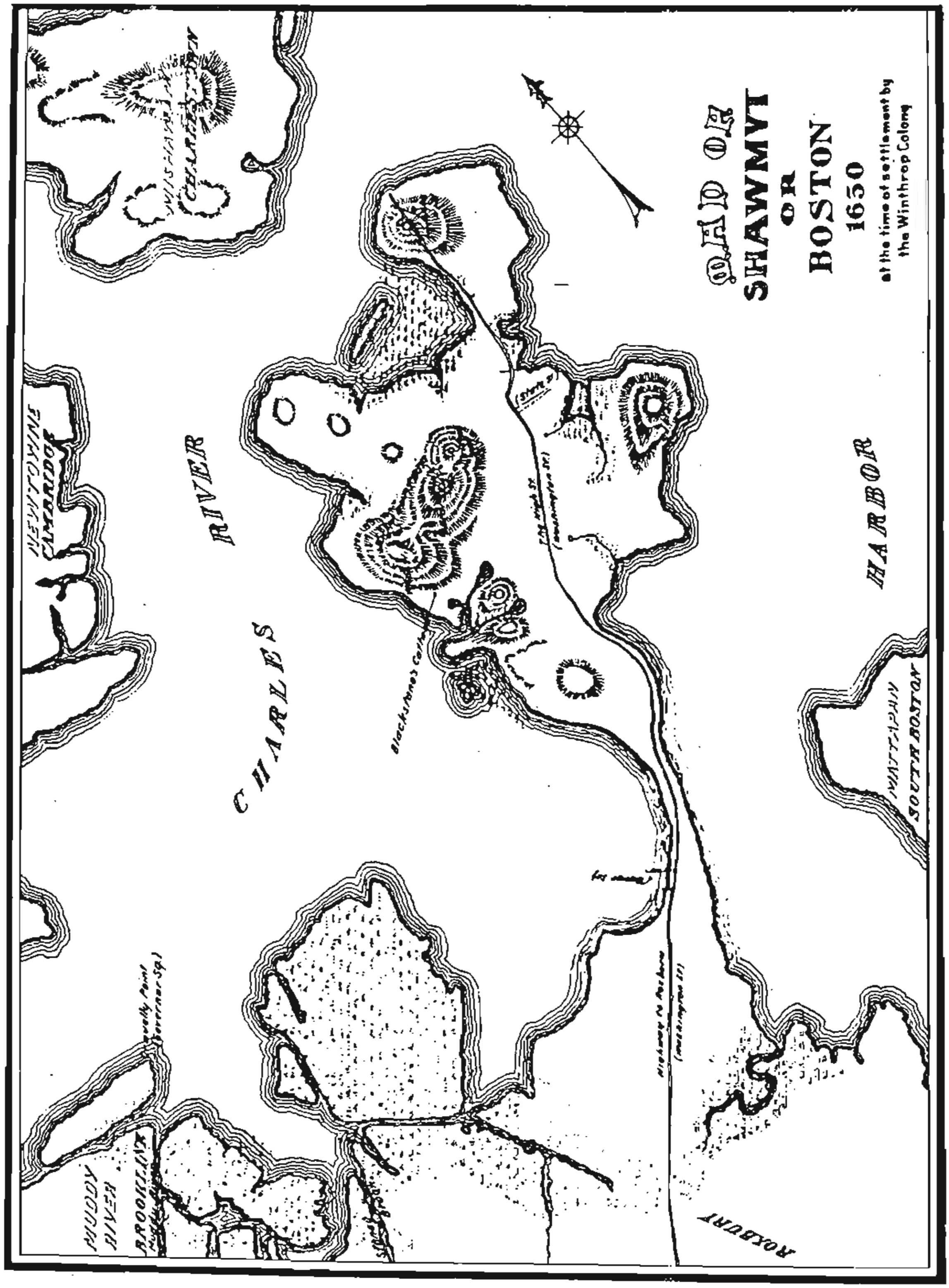

Figure 1: Shawmut Peninsula (Clough, 1630)

that have filled the marshes and formed them into dry land. Today, Boston covers 23,700 acres, or about thirty-seven square miles (Winsor, 1881).

The Shawmut Peninsula was made up of three prominent hills, or the Trimountains. They were Centry Hill, Cotton Hill, and Mount Whoredom, now known as Beacon Hill, Pemberton Hill, and Mount Vernon. Pemberton and Mount Vernon have completely disappeared as a consequence of various filling projects. By 1824, Beacon Hill was lowered to its present height, about sixty feet lower than its original height (Freeman, 1970). The majority of Mount Vernon was removed and dumped into the Charles River to make Charles Street. Pemberton Hill was cut down and used to fill an area north of Causeway Street. Also, some of Pemberton Hill was deposited into Mill Pond. Beacon Hill, which today is a national historical landmark (Freeman, 1970), was lowered to its present height by the use of its gravel to fill Mill Pond. Beacon Hill was said to have "clean earth or gravel" which was necessary for filling because of sanitation laws (Seasholes, Ph.D. 1994).

Landmaking started shortly after Boston was established in 1630. The most common type of landmaking that took place in early Boston was something called "Wharfing Out". Wharfing out, which is the building of ports for shipping reasons, began in 1634 (Seasholes, 1994). The map in Figure-L2 represents the shoreline and the changes it went through in each decade. The first filling project was done at the town-landing place in the Town Cove. By 1638, a group of 14 proprietors had built a wharf, crane, and warehouse at the landing place, which became known as Town Dock. The wharf was to make it easier for small boats and cargo ships to land and be tied up.

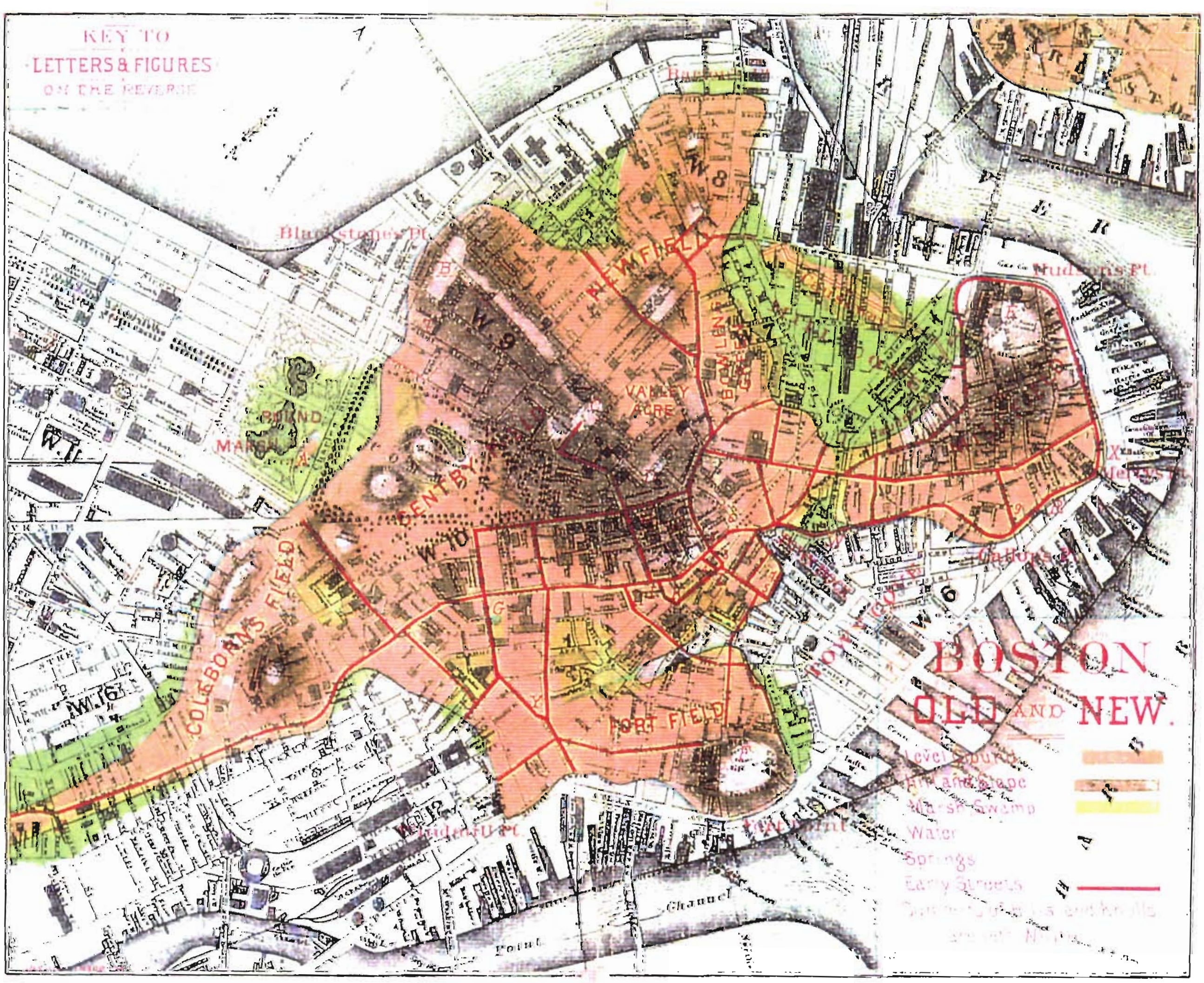

Figure 2: Shoreline Changes (1600, 1700, 1800,Present)

In 1639, Edward Bendall acquired an interest in the wharf, crane, and warehouse and for many years thereafter the dock was known as Bendall's Dock. Then in 1641, the town granted the entire cove to Valentine Hill and other proprietors. In return for £100, the proprietors received the right to build wharves and warehouses for nine years. Along with the right to build, they were allowed to charge wharfage, a charge for the use of the wharf, a charge per ton of cargo (Seasholes, Ph.D. 1994).

In addition to Bendall's Dock, another public dock was to be created. In 1643, at the request of some townspeople, a creek was to be dug in the marsh south of Bendall's Dock. The purpose of the other dock was to give the area another harbor. The newly created harbor became known as Oliver's Dock.

A third docking area was also to be built in the mid-seventeenth century to give small shallow draft ships an area to dock. In 1652, Joshua Scottow, a merchant, bought a half interest in Mill Creek and in the drawbridge over it from William Franklin, a Mill Pond proprietor (Seasholes, Ph.D. 1994). Then, in 1653, Franklin sold Scottow a half interest in a cove on the south side of Mill Creek. In 1654, Scottow began to dig out the cove and make it into a dock, which became known as Scottow's Dock.

Another form of landmaking that became significant in the seventeenth century was the construction of shoreline batteries. Boston, being a major port and an English colony, feared attacks from England's enemies. Fortifications were built on Fort Hill and Castle Island, but shoreline batteries were needed. In 1646, the North Battery was built at the end of Walter Merry's Wharf on the northeast point of the North End. In 1666, the Sconce, or the South Battery, was added at the base of Fort Hill on the point at the south tip of the Town Cove.

In 1673, selectmen were asked to consider a wharf on the tidal flats across the Town Cove. The wharf was to protect the town from cannon fire. The public was against the wharf, so the selectmen had to get private wealthy citizens to build small sections and own them for themselves. Each citizen would be granted the flats 200 feet deep and permission to build wharves and warehouse on these flats. By 1681, the wharf known as the Barricado was almost finished (Seasholes, Ph.D. 1994).

Then, in 1709, Captain Oliver Noyes and Daniel Oliver proposed to a town meeting that they would build a wharf that had been proposed in 1707. The construction of Boston Pier, or as it came to be called Long Wharf, started in 1711 and was completed by 1715. The Long Wharf was built to facilitate access to the Barricado and enable ships to load and unload directly from or onto a wharf without the use of lighters, or small ships (Seasholes, Ph.D. 1994).

In the eighteenth century many of the docks were beginning to be filled in because of decay and lack of use. Oliver's Dock was filled after the town had inspected the drawbridge that it had. The townspeople decided it was unsafe for public transportation, so the dock was closed and, in 1725, part of the dock west of the bridge was filled in. The entire dock was to be filled in during this project, but, because it would have cut off both a natural spring and a sewer that drained into the dock, the townspeople decided to stop filling. But Oliver's Dock was finally filled in about 1798 for safety reasons. (Seasholes, Ph.D. 1994)

In 1711, Town Dock was partially filled in because the town decided to repair and extend the dock. Then, in 1728, the town committee decided to extend the dock east to the mouth of the dock so that the south part of the dock could be filled in. Low shops were to be built on the filled in south side and, by 1729, the town began leasing the shops. Figure-L3 represents different wharves and docks that were built.

In 1740, a merchant, Peter Faneuil, offered to build a new market place on top of the recently filled Town Dock. Faneuil Hall was constructed and opened in 1742. Then, in 1775, a recommendation to fill in Town Dock completely was brought before the town. In 1783 it was passed and the project was completed in 1784. (Seasholes, Ph.D. 1994)

In the post-Revolutionary period, the North and South Batteries ceased to exist. Part of South Battery was sold to John Rowe in 1785 and became Rowe's Wharf. North Battery was sold in 1788 and became Jeffrey's Wharf, later Battery Wharf.

Two other landmaking projects took place at the end of the eighteenth-century. The first was motivated by the town's efforts to stop erosion on the Neck leading to the mainland. In 1785, a stone wall was built on the east side of the Neck, from the fortification (now East Berkeley Street) to about 1400 feet south. On the west side of the Neck, a variety of strong pickets or pilings were placed in front of an existing wall. The intervening area was filled with gravel and chips of Roxbury puddingstone. (Seasholes, Ph.D. 1994)

The final landmaking project in the eighteenth-century was for the use of industries. In 1794 the Ropewalks on Fort Hill burned down. So the town granted an area of about 300 feet of marsh and flats at the bottom of the common to fill in and build on.

As the peninsula grew, more and more area was being filled and leveled. The filling of the Back Bay was another extensive project that took many years to complete.

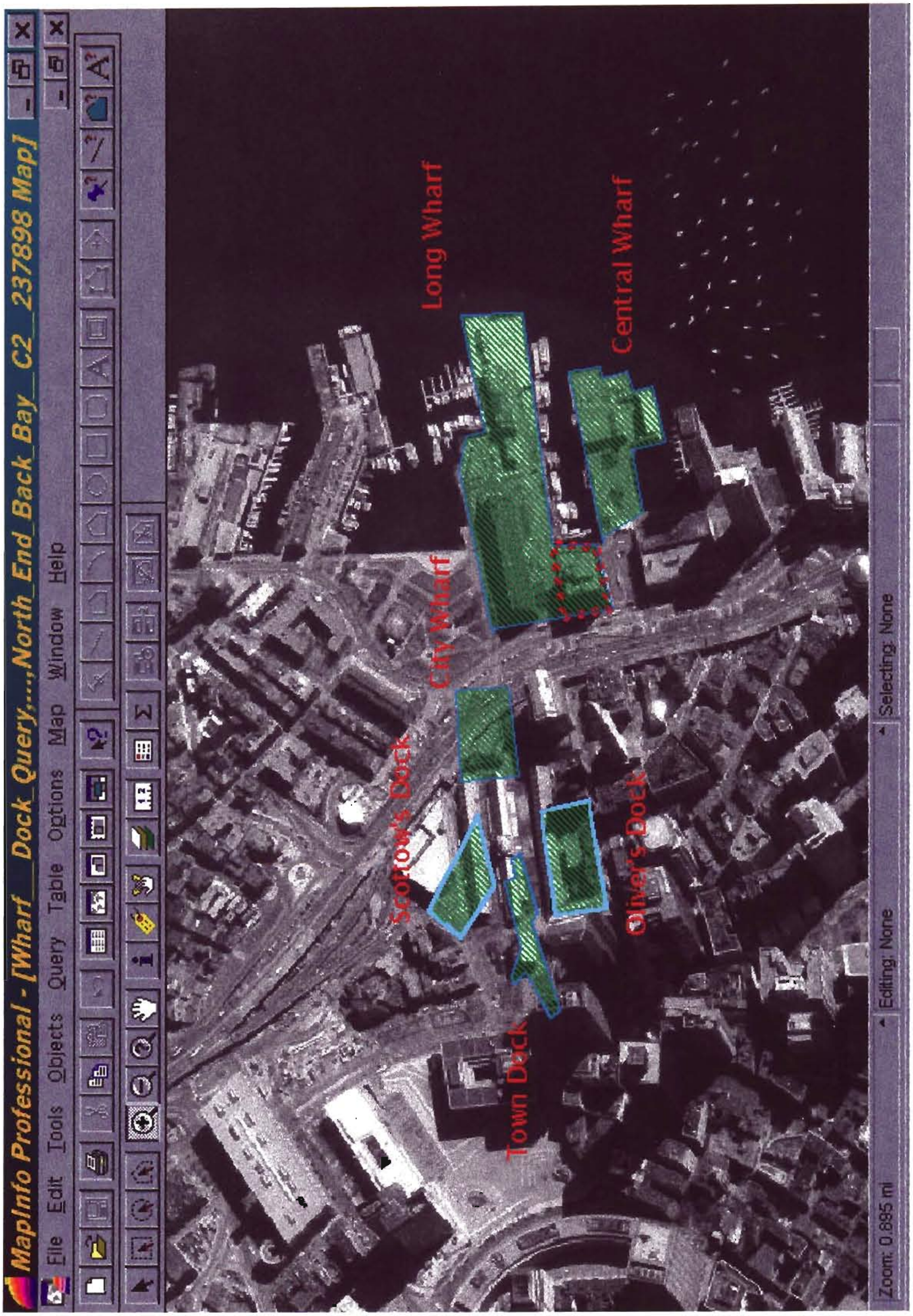

Figure-L3 Wharves and Docks

The project was chartered by the Boston and Roxbury Corporation in 1814. The Boston and Roxbury Co. were to construct a mill dam in the Charles River that cut off the tidal flats from the main channel of the river. The main dam was to run from the end of Beacon Street, at the corner of Charles Street, to Sewall's Point in Brookline. A cross dam was to be built from Gravelly Point in Roxbury to the main dam. This constituted a problem because Boston was draining sewage into the harbor and the tide was to sweep the discharge out to sea. So, in 1849, the Health Department demanded that the city fill the area because of public health concerns (Freeman, 1970). The city began to fill in the area with "clean earth, gravel, and sand" from Needham, which was nine miles away (Seasholes, Ph.D. 1994). The fill was transported to the Back Bay by train. Three trains were continually running, bringing in fill every forty-five minutes. A total of 2500 cubic yards of fill was placed each day and, by 1875, the Back Bay project was completed (Freeman, 1970).

Mill Pond, which was one of the most striking features of old Boston, took the longest time to fill completely, specifically over a 25-year period from 1805 to 1830. Fill was brought from Beacon Hill, some from Pemberton Hill, and Copp's Hill, which was completely leveled. An agreement was made before the project began, which gave the city of Boston one eighth of the all the land filled in twenty years. The total area filled was about seventy acres, of which only fifty acres was allowed to be built on.

East Boston, which is a major part of Boston today, was once an island with only one homeowner, J. Williams, to occupy it. J. Williams had lived on the island for forty years and became rich by being a tenant farmer (Winsor, 1881). In 1833, the East Boston Company was chartered and took ownership of the island. The island comprised

663 acres of marsh and upland, and several hundred acres of flats (Winsor, 1881). The island was to be used for public purposes, according to laws set by the company. This was the first planned neighborhood in Boston.

The South Cove was filled in for the purpose of the Boston & Worcester Railroad, to give a terminus and yard room for the railroad. At the end of the project, the company had taken fifty-five acres from the dock tide waters and given the city a total of seventy-seven acres. The majority of the fill that the company used was from its own gravel pits in Roxbury and Dorchester, but some was brought in from Brighton. Also in addition to its filling, the company built a sea wall, which was known as Coffer Dam, three hundred and eighty feet in length (Winsor, 1881).

In 1888, the Charles River Embankment project was complete, except for a proposal to expand the area. This marked the end of landmaking in Boston Proper during the nineteenth century. Many more developments have taken place in the years that followed but none as extensive as the prior projects. In the twentieth century, the South Bay was filled in, the remainder of the Charles River Embankment was completed, and more filling done to the vicinity of Nashua Street. This process led to the present area encompassed by Boston (Seasholes, Ph.D. 1994). The map in Figure-L4 is of Boston today. As can be seen, the original size of the Shawmut Peninsula has greatly increased. Not a trace of the original shoreline remains (Winsor, 1881), but the original shoreline has been identified within an archaeological context.

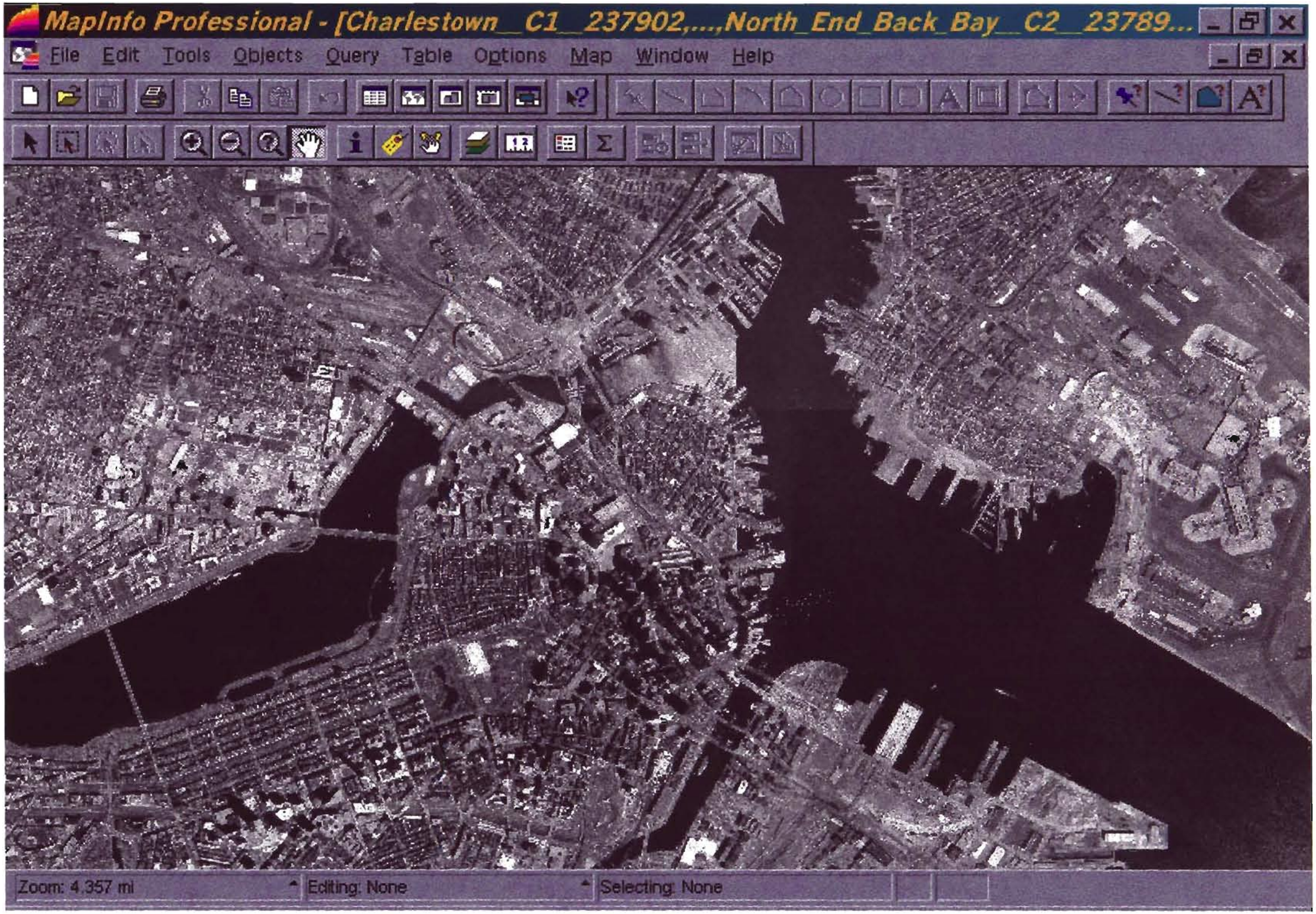

Figure-I4: City of Boston (1999)

BOUNDARY LIMITS

With The increasing population of Boston and filled area, some surrounding towns began to develop. These towns began to be annexed by Boston and boundary limits were set for each town. The map in Figure-L5 shows the boundary limits of the surrounding towns and what land has changed hands over the years.

The first territory to be obtained beyond the original limits of the city was South Boston (1804), or as it was called at that time, Dorchester Neck. A bridge was built from the Shawmut peninsula to South Boston in 1804. The land was owned by wealthy proprietors who began to build roads, between their estates, leading to Boston. The marsh between these roads was then filled in with gravel and ash.

The annexation of Roxbury, which would turn out to be of great importance to the city, was finalized in 1868. The Roxbury Neck was of special importance to the residents of Roxbury, because it was the only road, now Washington Street, that ran into and out of Boston. This road was the Bostonians' only source to get goods in and out of the city, except for shipping. By the beginning of 1868, Roxbury officially became part of Boston.

Right after the Legislature had allowed the annexation of Roxbury, the annexation of other towns followed. Dorchester was given a vote on the decision to join Boston. After an election, Dorchester became part of Boston in 1869. In 1873, Charlestown, Brighton, West Roxbury, and Brookline all were given a vote on the annexation to Boston (Winsor, 1881). Brookline having opposed a vote in 1705, so as to have their own government and not be part of the city, again declined the annexation to Boston. As for Charlestown, Brighton and West Roxbury, they became part of Boston.

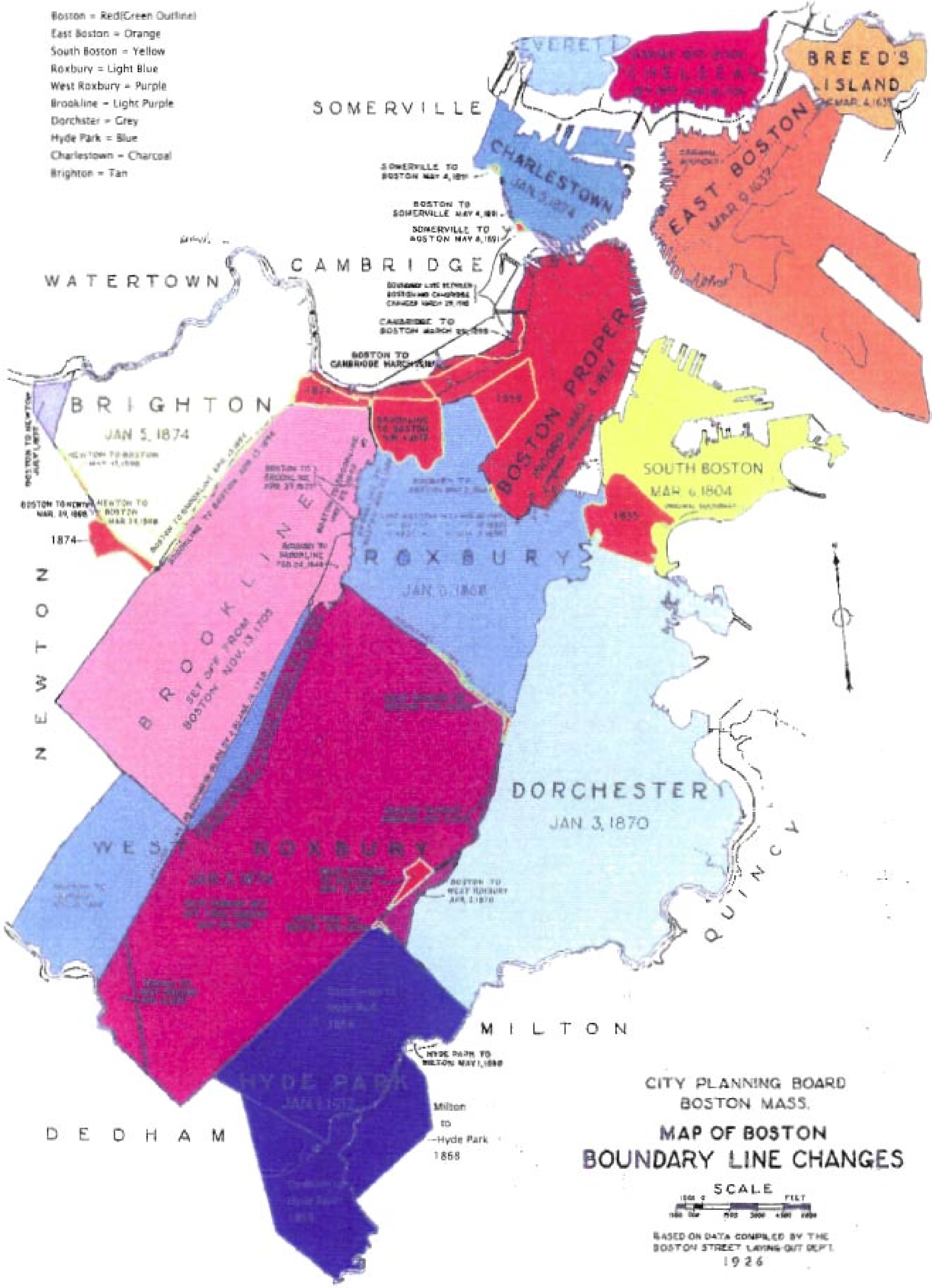

Figure 5: Boundary Limits

In Figure-L5, areas of land were exchanged during the next years between Boston and the surrounding towns. For example, Brookline gave Boston a piece of land in 1670, and then in 1844 Roxbury gave Brookline some land to increase their boundary limits. The last town to be added to Boston was Hyde Park in 1912. The majority of Hyde Parks' land was obtained from Dorchester in 1868, with some from Milton and Dedham in the same year.

GREAT BOSTON FIRE

As Boston grew, the result of various filling projects, a variety of destructive fires swept the area. Knowledge of the affected areas is of importance to archaeologists. Potential findings in these areas can lead to a better understanding of what the city was like in a particular time period. Archaeologists can interpret items that were burnt in the fire (i.e. clothes, household items, building material, etc.), and from that try to interpret what life was like.

In 1787, a fire broke out in Hollis Street Church, which consumed one hundred structures, including sixty dwelling houses. In 1793, a fire burnt down the square from Pearl Street to the water shore. It destroyed six ropewalks, one hundred stores, and many residences. In 1824, a fire broke out at the corner of Charles and Chestnut Streets, spreading to Beacon Street, destroying sixteen valuable buildings. In 1825, two fires broke out, one in Central and Kilby Streets, burning fifty stores. The other fire was on Court Street, destroying ten office buildings. In 1835, a fire destroyed about forty buildings in Blackstone, Pond, and Salem Streets, turning more than one hundred families out into the cold (Winsor, 1881).

One of the most destructive fires was the Great Fire of 1872. Shortly after seven o'clock in the evening of Saturday, November 9, 1872, a fire broke out in the basement of a four story granite block numbered 83, 85, and 87 Summer Street, at the corner of Kingston Street (Winsor, 1881). Some dry goods that had been placed next to a boiler had sparked and caused the fire. At the time the fire department, not being fully capable of handling large fires, had horses that were ill from a strange disease called " epizootic", which practically immobilized them (Winsor, 1881). Pipes that carried water to the area were too small to carry the amount of water needed to douse the flames. The fire's glow could be seen from ninety miles away at sea and as far north as Portland, Maine (Wilson, 1993). The fire raged on until Sunday afternoon. After the fire had been contained, about sixty acres were destroyed, 766 buildings collapsed, and fourteen lives were taken, seven of whom were firemen (Wilson, 1993). The map in Figure-L6 is of Boston in 1872. The area that is outlined in red represents the burnt district. The results of this fire prompted the organization of the Boston Fire Department.

GEOGRAPHIC INFORMATION SYSTEMS

Offering an account of what has happened in the life or development of a people, a country, and its institutions, historical information can be vast and complex. It has been found that people prefer to receive information in a more visual fashion, especially in cases where the information is keyed to different areas or geographic locations (Hearnshaw and Unwin, 1994). Producing maps using a Geographic Informational System will help to visually conceptualize aspects of the history of Boston.

Figure-L6: The Great Boston Fire

A Geographical Information System (GIS) is an organized collection of computer hardware and software designed to efficiently create, manipulate, analyze, and display all types of geographically or spatially referenced data and information. GIS allows complex spatial operations that are difficult to do otherwise. GIS is a computer tool for storing, analyzing, retrieving, and displaying cartographic information (Itami and Raulings, 1993). Data in GIS is stored in a structured format referred to as a spatial database. GIS relies heavily on database management, user interface, and computer graphics. GIS makes use of almost all of a computing system's resources.

The first introduction of Geographical Informational System was in the 1950's and 1960's. The technology developed through numerous parallel but independent efforts spanning multiple disciplines (Antenucci, Brown, Corswell, Kevany, and Archer, 1991). The major types of geographical systems, drafting systems, analysis-oriented systems, and statistical systems all evolved separately.

In the 1970's GIS was initiated in many government and private organizations. As this tool came into widespread use, systems began to be adopted by a broader range of users, typically in a pilot or demonstration mode (Antenucci et al., 1991). By the 1980's the technology of GIS had improved tremendously. Most systems offered powerful capabilities for graphic production, processing of attributes, and analysis.

Today, GIS is widely used by many organizations. States are using GIS to support public policy decisions regarding land and water, natural resources, and environmental assessment and monitoring. At least thirty eight states have developed some ability to use geographic information technology for natural resources, land use, and management (Antenucci et al., 1991). GIS is used to identify and analyze development of minerals, to support environmental regulations, and to manage historical and cultural resources (Obermeyer and Pinto, 1994). GIS has the potential to help conserve the earth's resources in that it makes researching large volumes of material more productive.

Archaeologists prefer GIS to any other system for the various advantages, options, and features it offers. If one considers how the archaeologist gathers data, the precise location of every artifact, architectural unit, site, etc. is carefully calculated and recorded. GIS can handle this data easily and enable the archaeologist to combine various types of geographical data (elevation, soil type, etc.) to produce large scale, in depth analyses of the data (Foote & Lynch, 1993).

In GIS there are other related advantages, options, and features that can help the archaeologist in his or her efforts, such as, computer cartography, 3D rendering, and computer animation. These techniques are useful for creating accurate maps and models, allowing the archaeologist to view sites and data in two and three dimensions (Foote & Lynch, 1993). The map in Figure-L7 shows how GIS can be used to make maps more appealing to the viewer. The capability of GIS makes the applications quite easy to manipulate.

GIS is also designed with a "geo-referencing " system, which ensures that all maps are overlaid accurately. The geo-referencing system sets all data to a common coordinate system. In most countries the Universal Transverse Mercator (UTM) projection is used. The UTM is the best-known plane coordinate system (Star & Estes, 1990). The UTM is a common system for locations on the earth's surface, based upon ground distances. A series of north south zones are established, and locations are

Figure-L7: Example of MapInfo Showing Original 1630 Shoreline designated in terms of distance in meters east of the western edge of the zone, and north (or south) of the equator (Star & Estes, 1990).

The software package that will be used for our Geographic Information System is MapInfo Professional. The use of MapInfo will allow for the various historical maps to be seen on a computer screen with characteristics associated to a specific map tagged right to the map. Information can be edited and new information can be documented right from the MapInfo screen. Having a variety of tools built into MapInfo that allow the user to be linked directly to a Microsoft Access database will help in the recording of information. Also new overlays can be created in MapInfo as soon as new information is found.

METHODOLOGY

Designing and implementing a map of the archaeological sites in Boston and surrounding areas was only possible through extensive historical research. It was important to understand the history of Boston in order to represent accurately archaeological information in a visual fashion. The many culturally rich sites in Boston had to be discerned and understood. Each site has a specific characteristic that distinguishes it. A site can be either significant or have integrity and sometimes both. A significant site is one that can answer the questions how and why: "why is the site important?" and "how is the information useful?". The integrity of a site is what is actually left at the site, as in artifacts.

The goal and purpose of creating the map was a process that took a lot of brainstorming. Various landmarks, buildings, and locations have different degrees of importance to numerous people. A clear objective and direction had to be kept in mind in order to provide for efficient research. The purpose of the project was clarified by speaking with people who are more knowledgeable about the project. Professors, the head of an agency, or project sponsors were instrumental in defining the scope of the project.

The historical information needed was in a multitude of locations. The resources that have been extremely helpful are: the World Wide Web (WWW), Mugar Library at Boston University, Gordon Library at Worcester Polytechnic Institute, Worcester Public Library, the Boston Public Library (BPL), project advisors, and previous similar projects.

On the WWW there were many sites that have information on national, state, and local landmarks. The Internet provided a profile on landmarks that shows ownership, priority, as well as if the landmarks were registered on the national, state, or local level. There are numerous types of search engines on the Internet to query for pertinent information. After querying a search engine, various results were produced. Useful sites were found by sifting through and discarding less significant sites or those with inaccurate information. Government departments, city agencies, and specialized research organizations all have websites that were helpful and they usually had factual information. There were also many articles, publications, and writings on the Web that were informative. These sites most often provided a name, contact information, or other ways to find out additional information. It was useful to investigate the information that was offered.

Mugar Library proved to be a useful site for the historical research. Mugar Library was a strong source for material, first, because it is located right in Boston, and second because it has an extensive archaeological department. Located in the Mugar Library was a Ph.D. dissertation by Nancy Seasholes. This document has a wealth of information all in one place. Reading of the dissertation was immensely helpful in understanding the history of Boston chronologically. In addition to the wealth of material provided by the dissertation, the bibliography was most useful. The bibliography provided a stream of other resources that provided additional documents on the history of Boston.

Once the research was completed, a historical profile, or timeline, of Boston was established. To help with the time periods, the state has developed a chronological framework for historical periods; Appendix D shows the timeline. The timeline gives a better understanding of why and where certain archaeological sites are located, and their degree of integrity.

The other distinguishing process that was undertaken to create an effective map was choosing an appropriate approach to the actual mapping. The process had to be effective and powerful. It had to be easy to use, and capable of manipulating and displaying all cartographic material. The computer tool chosen was Geographic Informational Systems (GIS), and the program of choice was a software package called MapInfo Professional™.

Familiarization with the MapInfo software was the next step that was undertaken. MapInfo is a powerful tool and can only be powerful if one knows how to use it. The software was installed and experimented with to learn how to use the software more efficiently. MapInfo has a tutorial, and reading through this tutorial was beneficial. Other projects that have used MapInfo were also consulted to get a better idea of how to manipulate MapInfo's capabilities.

GIS is a technology that allows stored data to be manipulated so it can be presented graphically on a computer screen as a map. The MapInfo software is GIS compatible, so an understanding of GIS is also necessary to operate MapInfo correctly. There are two major methods of storing information within MapInfo, the vector and raster images. Both vector and raster methods were used in the project. The vector format stores points, lines and polygons with great accuracy. This is an important feature when dealing with urban applications because the data can be tagged and given desired attributes. With these certain attributes, one can search for a specific attribute and the software will filter through the stored data and display all information that contains that attribute. Raster images are just images that have been scanned into the computer. Graphic Interchange Format (GIF), Tagged Image File Format (TIFF), and Joint Photographic Experts Group (JPEG) are all examples of raster images. Raster images can not be manipulated within MapInfo, but can be used as a background image and an image to trace. Figures M1 and M2 are examples of vector and raster images.

MapInfo is a program that can store information in "layers", including street names, demographic information, building type, and other features. Each layer combines to provide a composite view of the information. MapInfo's strengths lie in its data access services. A person can perform query to search and connect to external databases without the need for importing into a MapInfo exclusive format. For example, one can have all the data logged into a database that has been created by a different database manipulation software package. Then, by "linking" the data in the database files to the MapInfo file, searching can be done by using MapInfo's tools and features. The database manipulation software that was employed was Microsoft's Access™.

The database created with Access stores information that is attached to the maps created using MapInfo and provided a clear and organized method for arranging the many historical maps and landmaking sites. The use of layers in MapInfo is significant in separating each individual topic that is mapped. The importance of Access is that, for

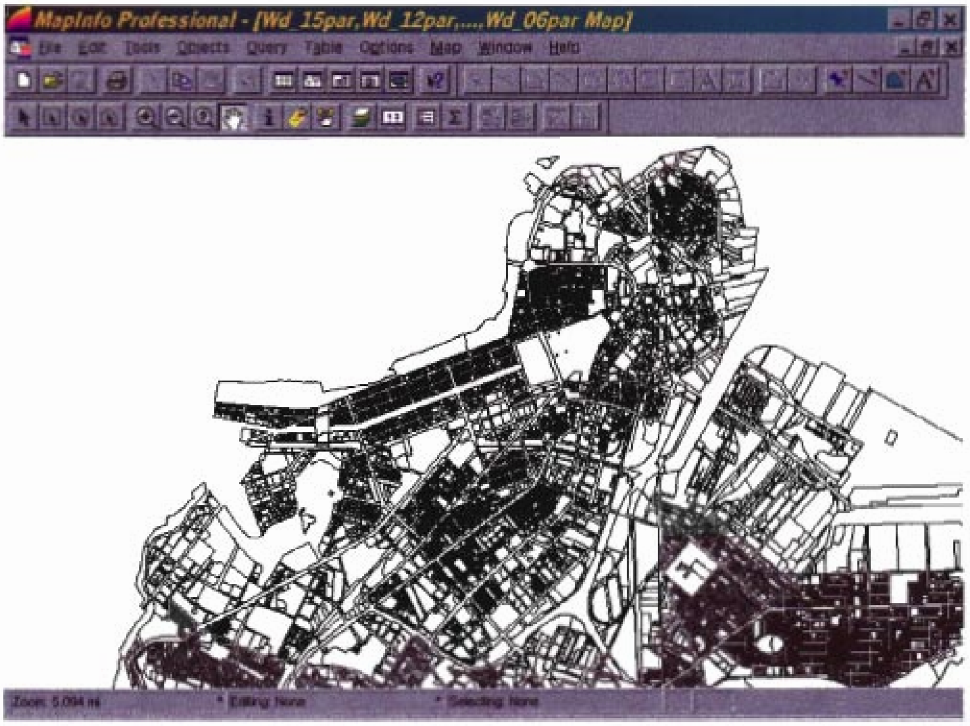

Figure-M1: Example of a Vector Image

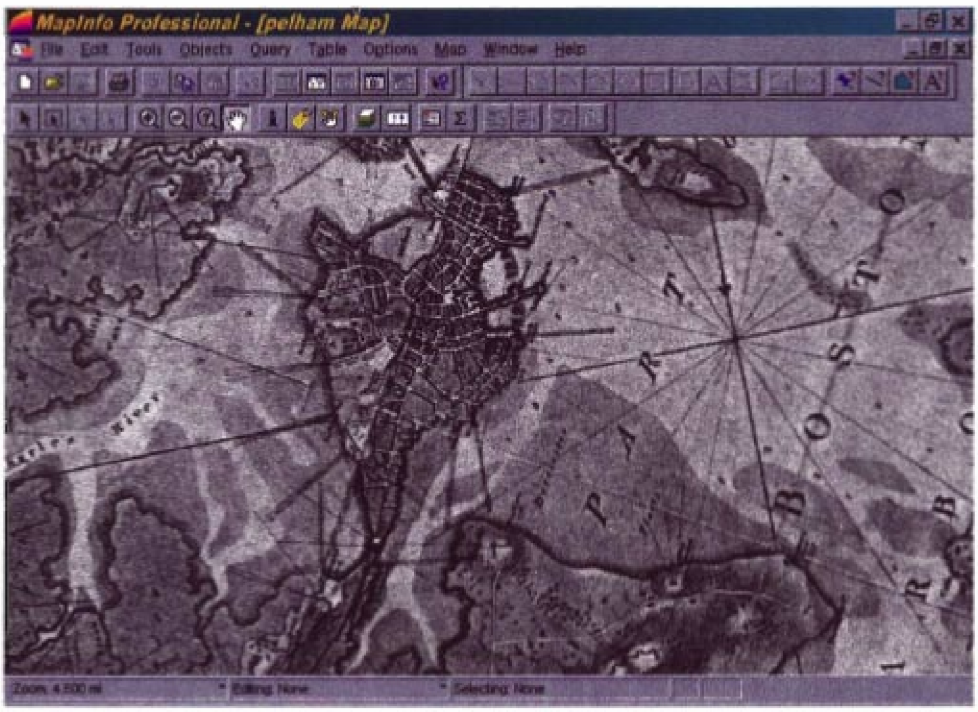

Figure-M2: Example of a Raster Image

the individual layers, the database would include detailed descriptions and precise locations of every artifact, archaeological unit, or site. Not only can MapInfo handle the Access database easily; it enables whoever is researching the topic to combine various types of geographical data to produce large scale, in-depth analyses to each specific purpose. This relationship between MapInfo and Access is critical in manipulating data to enhance the ability to visualize various combinations of factors.

The purpose was simply that, in archaeology, the data is everything or at least all that is left because of the conditions of the discoveries, such as artifacts being old and very delicate to handle. So, having MapInfo linked to an Access database will allow for items, such as the land filled area, to be chosen for queries and have a database pop-up with information describing the area, such as fill type. The database can be large which will allow for the user to keep adding information when new discoveries are made. The amount of knowledge that is derived from the data and the validity of the interpretations of the data are largely dependent on how it is manipulated and organized. Therefore, by utilizing the capabilities of MapInfo and Access, the data and map display can be optimized.

PROCEDURE:

Prior to arrival at the Boston Project Center, there was an envisioned list of tasks to accomplish in order to progress toward the goal. The realization that there would be changes to these tasks requires the necessity for schedule flexibility. Upon arrival in Boston, a much more defined project goal was expected. To clearly define a set of goals and products from the project, a meeting with the project liaisons was scheduled. Successful communication between liaison and project group has resulted in quicker and more efficient task completion.

The initial meeting with Boston Project liaison, Ellen Berkland, City Archaeologist, proved to be a great enlightenment. A good portion of the project was not at all correctly portrayed until this point. A better definition of the project goal was first brought up for discussion. Since the Archaeological Mapping group works closely with the Historical Mapping group, the discussion of both groups' goals produced a clearer understanding and a definitive line of separation of purposes. The mapping goals include mapping all requested historical maps that showed the specific shoreline changes, the Shawmut Peninsula, as well as various filling episodes. Many resources that would prove to be helpful to the project group were noted during this and subsequent meetings. The group could obtain various specific maps and information at these cartographically saturated locations. Discussion of the project's proposal suggested improvements in areas of weakness. By exchanging initial concerns, it was then possible to formulate an effective procedure. The greatest outcome of the first meeting was establishing a strong communication base with the liaison. A strong professional relationship with Ellen allowed for assistance whenever difficulties were encountered. Likewise, she continually defined what was expected of the finished product.

When undertaking a project of this nature, it is important to develop the ability to obtain good contacts and sources for material. The group acquired a list of local and government offices where most of the necessary material is located. Prior to visiting or contacting any of these places, a list was compiled, of phone numbers and names followed by a short summary of the departments/office description including any difficulties we might encounter. Then, within the first week, a familiarity with the locations and contacts of all the sources was established. The Harvard Map Museum, MIT Map Repository, City Hall Map Room, the City Assessing Department, Department of Environmental Protection (DEP), and the Bostonian Society became familiar places where important materials were obtained. As expected, there were some small difficulties with some of the locations. In trying to obtain a digitized map of parcel districts from the Assessing Department, written permission was required before any information would be released. Once Ellen submitted the request, the digitized map was received at the week's end. The Harvard Map Museum was a destination for research, but there was some disappointment in not finding maps with specific criteria. After these minor setbacks, the DEP, the Bostonian Society, and the City Map Room became useful locations of information and maps. Many of the maps located at the DEP had to be signed out and scanned and returned within a couple of days; the other locations allowed for photocopies to be made. The maps obtained were scanned as JPEG files in a software program called Adobe PhotoShop™. Adobe was then used to arrange the scanned images, or raster images, for future use when overlays were to be made.

In order to begin to map the archaeological resources, a basemap was to be obtained. The basemap, which was used by both the Historical and Archaeological groups, allows for different overlays to be employed. Working in correspondence, both groups agreed upon an aerial image of Boston provided by the MIT Map Repository. The map and MapInfo header files were available on the Internet and downloadable in 4000m X 4000m square sections. It took a collective effort in downloading such a large image file. Once all the pieces were obtained, it was pieced together in Adobe. Figure P1 shows the pieces together with a red border showing the boundaries of each picture. Then each section of map was put on separate layers in MapInfo. Having each photo on a separate layer allows for the user to have the ability to open and close each section, which will make for quicker and more efficient navigation through various maps.

With the working basemap, experimentation with MapInfo and the use of overlays began. MapInfo is not necessarily difficult, but requires a few days to become familiar with its functions and workings. At first it was thought that the overlays could be created and that the database of information created in Access could be easily tagged to it. But, with more experimenting, it was realized that the database was to be created first and then, as overlays were drawn, the information could be tagged to it. With more brainstorming, it was realized, that in order to make the program more user friendly, the overlays were to be created on one overlay. This process would allow for the use of MapInfo's queries. Queries in MapInfo allow for the program to sort through the information in the database and to automatically create a map layer with the specific information that was queried. This tool allows for quick and easy usage. Appendix F has been created as a reference manual. This will allow for an understanding of how overlays

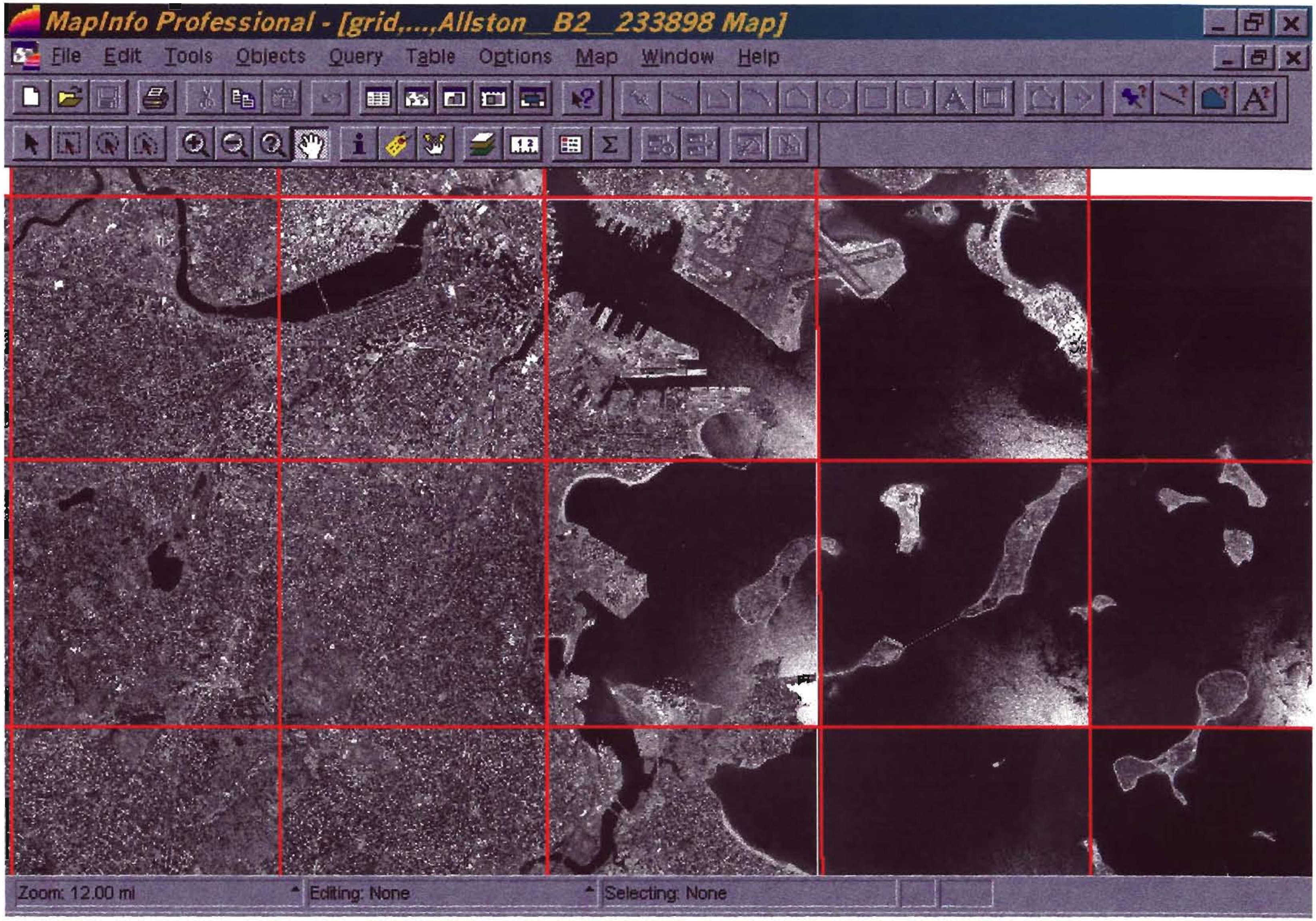

Figure-P1: Base Map With Grid

are created and how the query function can be used. Figure P2 represents a browser, which is the Access database, and the overlay map, which is used to create tagged objects upon.

After all the maps, or raster images, had been scanned into Adobe, a .tab file had to be created for each (See Appendix F for definition and Figure F-18 for example). Then each map had to be registered to fit the basemap. Maps must be registered to the basemap manually because MapInfo can not relate to the aerial view. The basemap is an actual photo of the earth, which is curved. The maps that are to be placed on top are old hand drawn maps that are not really accurate, and MapInfo can not depict this feature. So, registering maps is actually stretching the vector image over the raster image until it fits the way the user wants it to. The general idea is, if it can be imagined, that the vector image is a sheet of rubber and the raster image is a piece of paper. Then, registering the raster image is like taking the rubber map and stretching and pulling it in different directions, deforming the map until the rubber map fits over the paper map. Pins then could be placed on the boundary of the map so as to attach the rubber map to the paper map. MapInfo remembers where those points are and uses them every time that particular raster image is opened. Points in the middle of the map could possibly make the image deform irregularly, which would make the overlay incorrect. The registering of each map took some time because selecting points was a difficult task. Since the maps are old, there was also some difficulties and making them to overlay perfectly. Figure P3 shows an example of a raster image with a vector image overlaid on top of it. In Appendix F, figure F4 represents how each point is chosen and created.

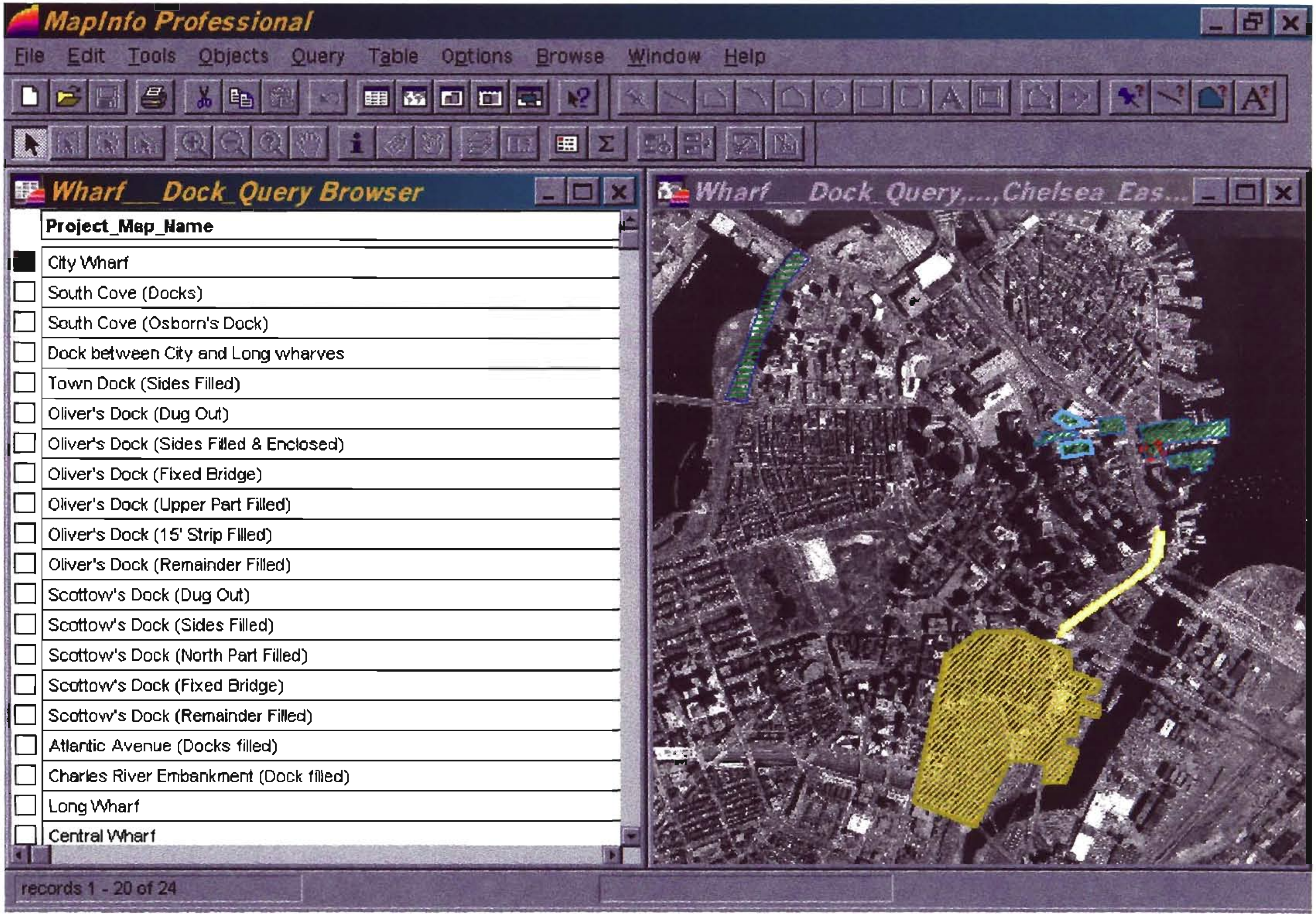

Figure-P2: Browser and Mapper in MapInfo

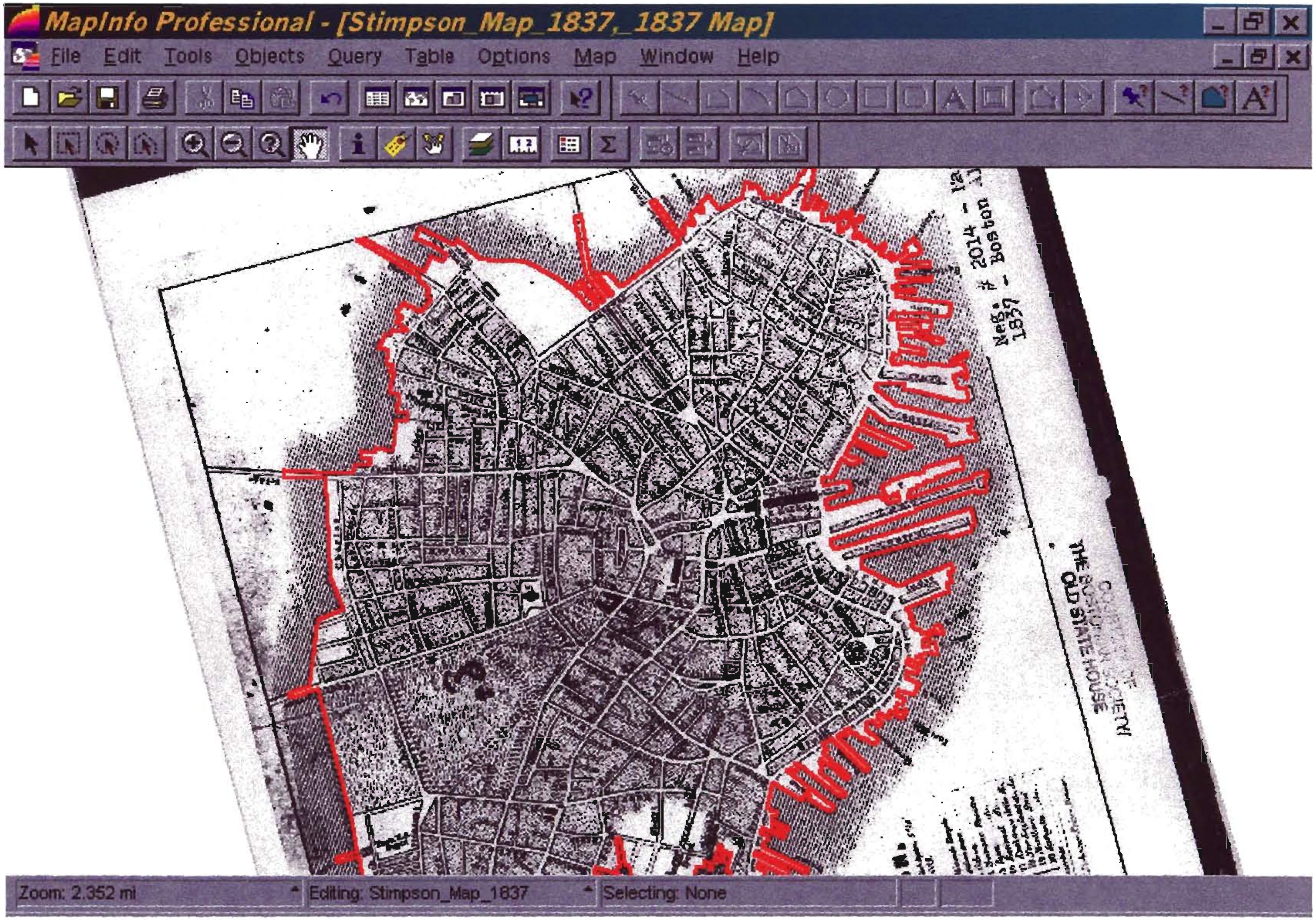

Figure-P3: Raster and Vector Layering

The database that was created in Access came from research done by Nancy Seasholes. Her 555-page 1994 Ph.D. dissertation at Boston University outlines the development of land use in Boston from the 1600s to the present day. The dissertation was outlined and the information gathered was organized and put into the database. Each filling project was outlined, with main concerns on the name of the project, the year of the project, the types of fill used, the methods employed, the purpose for the project, and if the project was large, small, or medium sized. Figure P4 shows an example of how the information in the database can be viewed in Access. The database in Access was designed to be as user friendly as possible. With a couple of day's work of data entry, the database was completed. A friendly front end was created, with some collaboration with the historical group, which shows all the historical data along with the archaeological data. Figure P5 represents the front end that was created.

Proceeding in parallel to the mapping and development of the product on MapInfo, the project report was constantly revised. As more information of the historical background was gathered, the Literature Review was updated. As the advisors and Ellen referenced corrections and modifications, the Introduction, Appendix A, B, C, and D were gone over and refined. Appendix C represents the bibliography that an archaeologist uses when seeking specific information about site evaluation techniques and Appendix D represents the chronological order of each different decade from when Boston started in 1620 to the present day. Ellen uses both frequently when referencing found material.

In order to analyze the final product, an interview with Ellen was incorporated into with the project report. Appendix E is a detailed transcription of the interview. With the information that was obtained from the interview, the Results and Conclusions sections were gone over and redone. As the project came to an end, the Methodology and the Procedure sections were refined and additional information was incorporated.

As the project progressed through the seven weeks of preparation work back at Worcester Polytechnic Institute and the seven weeks at the Boston Project Center many group/advisor and group/advisor/liaison meetings took place. These meetings were most beneficial to the group. Many important questions could be answered, as in specific MapInfo functions and certain criteria that was to be in the final mapped product. Other questions were answered as to what areas of the report needed to be improved and/or left out.

Microsoft Access - [Landmaking/Maps : Table]

Project/Map Name	Date	Purpose	Agency	Terrain	Size
Public Garden (Grading west of Charles Street)	1825	Recreational	City	Flats	Small
West side of Neck (Initial filling)	1826	Residential	City	Flats	N/A
West side of Neck (Church Street District)	1820-1840	Residential	Private Individ	Flats	Large
West side of Neck (Raised)	1868-1869	Residential	City	Existing Land	Large
West side of Neck (Tremont Street)	1830-1840	Residential	City	Flats	Large
West side of Neck (Suffolk Street District)	1830-1840	Residential	N/A	Flats	Large
West side of Neck (Raised)	1870-1872	Residential	City	Existing Land	31A
Faneuil Hall Market	1824-1826	Commercial	City	Flats	Medium
Commercial/Fulton Streets	1828-1830	Street, Resid	Private Individ	Flats	Medium
City Wharf	1829	Commercial	City	Flats	Small
Mill Creek (South section)	1828	Street	City	Creek	Small
Mill Creek (North section)	1831-1833	Street	City	Creek	Small
South Cove (North of Herald Street)	1833-1839	Railroad, resi	Private Corp.	Flats, wharve:	56A
South Cove (Docks)	1840	Railroad, resi	Private Corp.	Flats, wharve:	N/A
South Cove (Osborn's Dock)	1842-1843	Railroad, resi	Private Corp.,	Flats, wharve:	N/A
South Cove (Between Sea and South Streets)	1846-1852	Railroad, resi	Private Corp.	Flats, wharve:	N/A
South Cove (New York Streets)	1843-1844	Railroad, resi	Private Corp.	Flats, wharve:	N/A
South Cove (Between Furnace and Harvard Streets	1843	Railroad, resi	Private Corp.	Flats, wharve:	N/A
Front Street (South of Malden Street)	1831-1833	Street	City	Marsh	N/A
Front Street (North of Malden Street)	1835-1836	Street	City	Flats	5A
West End (Copper Street)	1803	Street	Private Individ	Flats	Small
West End (North of Camb Street)	1803	Commercial	Private Individ	Flats	Small

Record: 1 of 137

Name of Project/Map

Figure-P4: Table View In Access

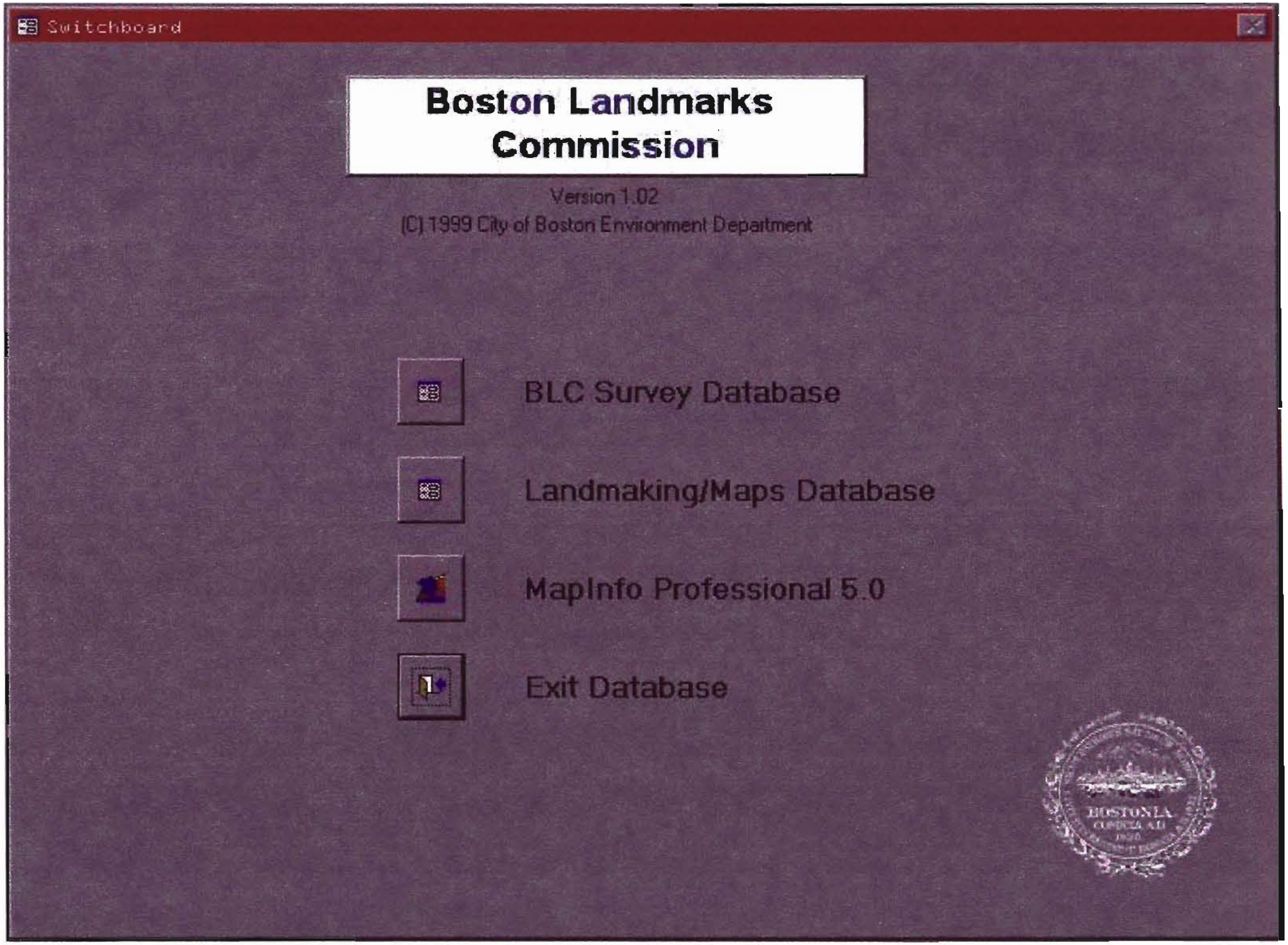

Figure-P5: Example of Front End

ANALYSIS:

The personnel situated in City of Boston Environment Department will be the ones directly effected by the addition of a Geographical Information System that will provide minimal effort and increase productivity. The implementation of the results is most effectively shown through a situation in comparison to actual process to date. By comparing both old and new processes, one understands the great significance that the Boston Archaeology Mapping group provides with this improved system. The following is an example of the effectiveness that will modernize the way archaeologist search for their resources.

The Archaeologist of the City of Boston, Ellen Berkland, processes many requests concerning the background on a particular site. Upon receiving an Environmental Notification Form (ENF) or Proposal Notification Form (PNF), which is basically a site specific summary of planned impacts or construction for a particular parcel. For example, if it is a parcel on the shoreline area, Ellen must go to the Harbor Commissioner's records to look up that particular parcel. Only after she finds documents' proving that there is nothing culturally significant in that parcel, then can it be written off and construction can begin in the area. However, when dealing with parcels of higher sensitivity, the process becomes much more involved.

For instance, if the city was planning some development on the original Shawmut Peninsula and the area has been a park for the past couple hundred years, free of development or landscaping. Automatically that suggests the area is a "hot spot" with much potential significance. Ellen would instinctively send out her recommendation to the construction company for them to consult further with the state and then bid for an archaeological management company that will do an archaeological reconnaissance. Most of the time, she will try to determine if there is archaeological sensitivity to the area by using cartographic maps. This data is how Ellen will determine the geographical makeup of the particular parcel. Unfortunately in most cases, many of the overlays are made by hand. Therefore the difficulties of maintaining scale, color, and contrast, affect the overall accuracy. This is not considering the process of obtaining these maps from the Department of Environmental Protection, Bostonian Society, Boston Redevelopment Authority, Massachusetts Historic Commission, and Engineering Department. Four of these organizations are within walking distance from City Hall, and the last one can be reached by T trains. All together it is more than one day's worth of travel already.

Once the map and overlays are created, that does not complete the assessment of the parcel. Ellen will go to specific books and historical documents of Boston Proper, looking at what was in that particular area. She has to consider the temporal changes over the time, like the land filling. Also by referring to Nancy Seasholes' Ph.D. dissertation on Land Filling of Boston, she can check with what she may have for a particular parcel.

Often, Ellen will visit the Massachusetts Historic Commission and look at what they may have in their files. She will automatically look to see if there are any known prehistoric sites in the area. Proximity to a site is a high indicator especially for prehistoric sites. Chances are, if you have one prehistoric site in one location, you going to have another one very close by. Known sites are also a critical factor. This is different for prehistoric. Various factors must be considered in prehistoric sites. Ellen must analyze water sources, known prehistoric sites, and also soil types. Other variables are the drainage of the soil, location to resources, including rock, topography, and slope.

All of the aforementioned variables are Environmental Indicators. This information is looked over, which would take some time. Then a preliminary report can be made that will evaluate the area. Certain information is taken into consideration, for instance, if the land was filled in, what kind of fill was used, and after it was filled, how did the land get used.

Now consider the consolidation of most of the resources into an extensive database with a software program that displays combinations of this information upon request. Once Ellen receives an Environmental Notification Form, she can call up all the maps that pertain to the specified area. She will be able to visibly see the maps on a colored screen right in front of her. She no longer needs to consider where the numerous maps and reports are located. Overlays of any kind can be displayed over the base map. She no longer has to struggle with color-loss or contrast difficulties.

At this point, the archaeologist can examine the past events of the site and issue a preliminary report to the construction company with great efficiency. The introduction of such a system will change the speed of the reply time, from days to hours. Therefore, creating a smoother and friendlier relationship between all parties.

RESULTS:

The main concern faced by the City of Boston's Archaeologist, Ellen Berkland, is to obtain a single source for all information. Currently, the maps, reports, and utility resources are located in various locations across the state. The MapInfo and Access product for the City of Boston Environment Department is a concise system that can store, retrieve, analyze, manipulate and display site information. The system will contain a database that can facilitate a specified type of research procedure. Finally, a computerized base map compounded with overlays of historical maps all linked to display numerous and different combinations of information. This system will require minimal effort and produce work more efficiently for the archaeologist.

Prior to this system, many of the maps were scattered in the field at different organizations. These maps are now digitized and can easily be viewed, all in one location to minimize any time that would be wasted from going to various organizations within Boston. Figure-R1 represents the digitized Stimpson map of Boston in 1835. Some of the other digitized maps are of the earliest known shoreline of Boston, Stimpson Maps of 1837, 1838, 1839, and 1841, Harbor Lines of 1889, Carleton Map of 1775, and the Hale Map of 1814. With the use of computers and mapping programs, these maps can be overlaid upon each other to view them in ways that were very difficult to create before this technology. Figure-R2 shows how a section of the basemap from our final product can be overlaid on top a digitized map (specifically in figure is the Earliest

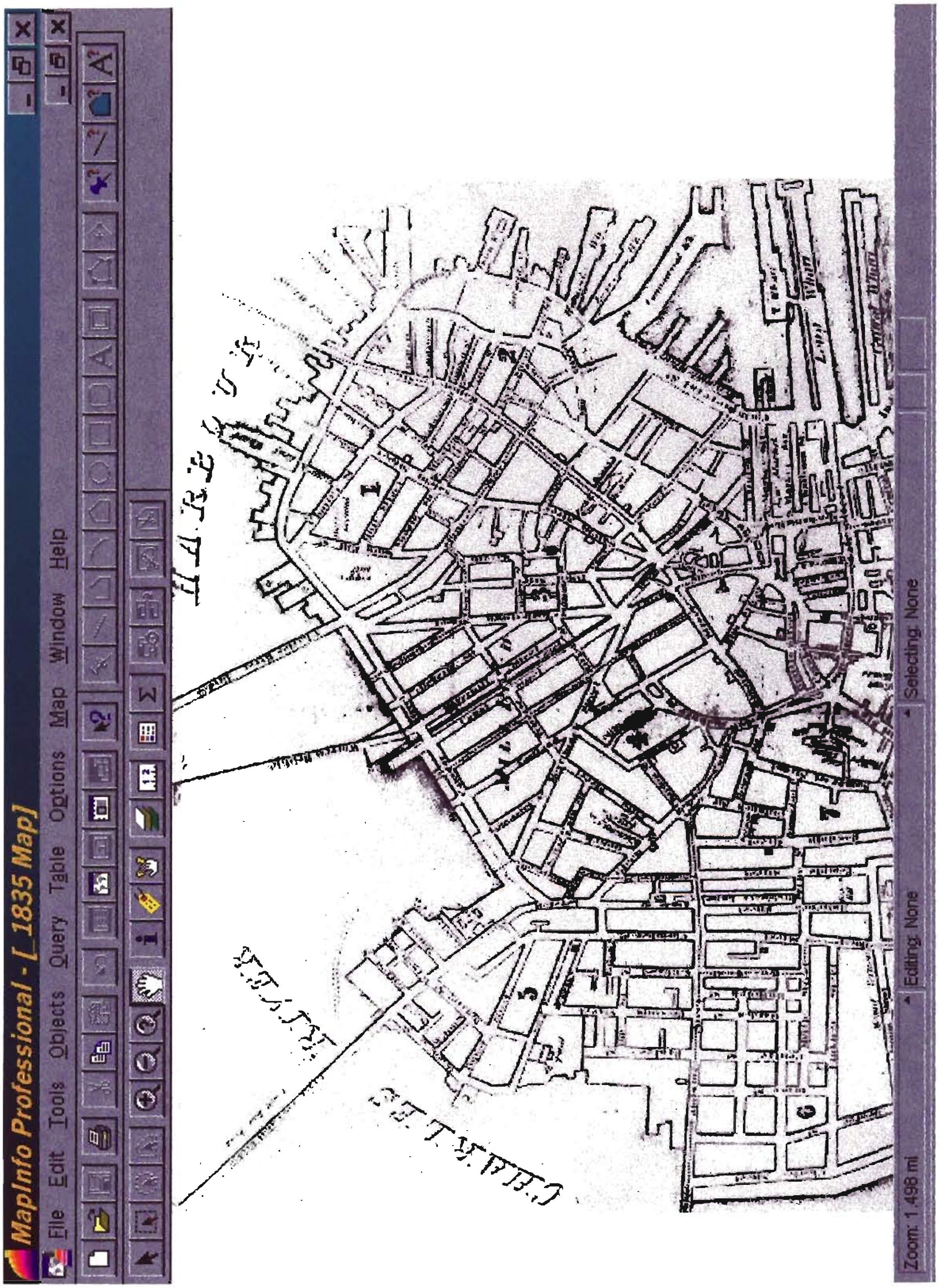

Figure-R1: Stimpson Map of 1835

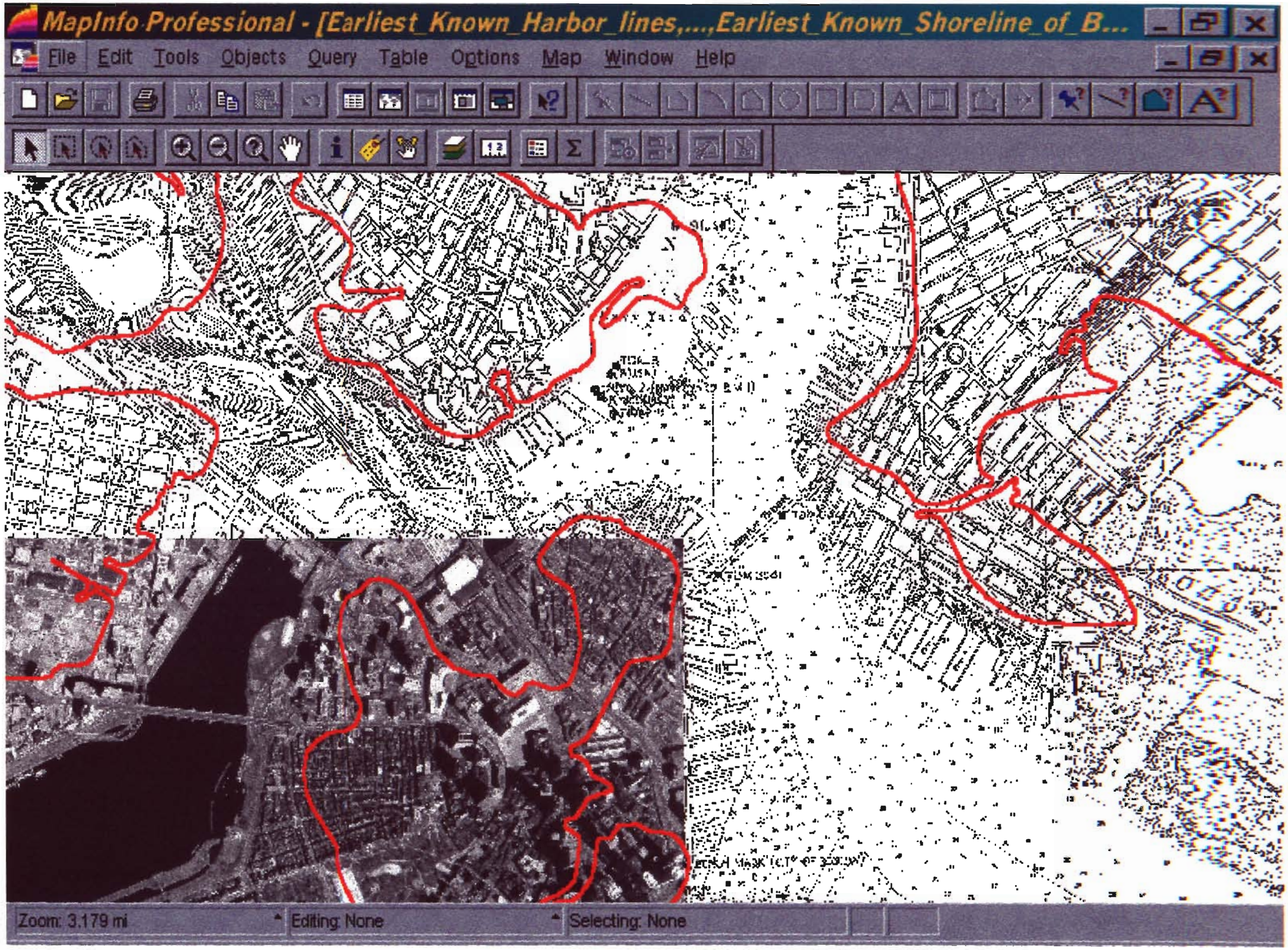

Figure-R2: Example of Layering

Known Shoreline Map and the North End section of the basemap). The digitized maps can be edited, and enlarged to investigate and concentrate on specific areas of the map. Information such as wards, harbor lines, shoreline changes can all be displayed by using this GIS system. Figure-R3 represents the basemap with ward 3 and the Carleton map overlaid on top. Different combinations as to how the maps are overlaid can prove to be a great research tool for archaeologists. As mentioned these maps can be drawn upon and once this is done, information can be attached to the objects drawn (See Appendix F for examples of how to attach information to objects).

One hundred and nineteen total land-making projects were drawn over the basemap. Figure-R4 shows all the Back Bay filling projects that was overlaid. A database has also been created to house the information on all the projects. Maps of land-making projects are connected to the database in the fashion as the historical maps. Users can click on any land-making project and have all its information from the database extracted and displayed. Figure-R5 represents a wharf and dock query, with the information window opened to see how information is called upon. Information for the land-making projects is within the same database of the maps. Organizing the data in this format allows for users in the Environmental Department to display both historical maps and land-making maps in any combination they wish by overlaying one upon another.

The final product also incorporates queries and workspaces defined and created by the students (See Appendix F for references on how queries are created and Figure-F6 for an idea of how they look). Workspaces are specific arrangements of the historical maps and land-making projects overlaid. They are defined by collaborating with members of the Environmental Department to decipher which combinations of maps would be used most often. Queries are explained in the same way and show information by time periods and locations. This will further improve the efficiency of researching these maps and land making projects.

The completed single source system breaks down the tasks of the archaeologist. Minimized travel and collection time equates to more accurate analysis and precise reports. Simply, this complete system changes the process and guidelines for the archaeologist's work.

Figure-R3: Example of Layering

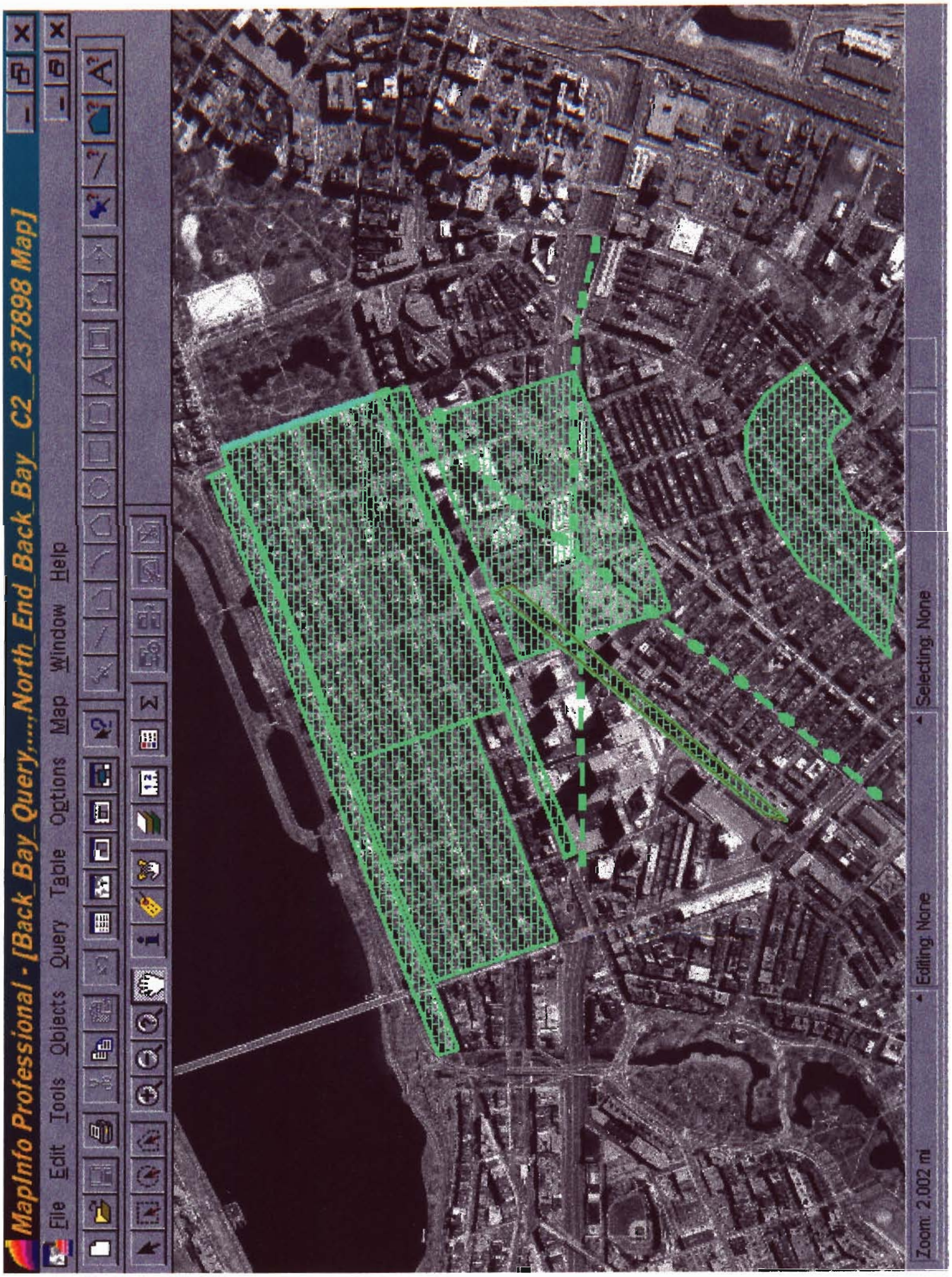

Figure-R4: Back Bay Filling Episodes

Figure-R5: Wharves & Docks

RECOMMENDATIONS:

The recommendations that our group propose have to deal with the potential usage of the mapping product that was produced. Throughout the project there were specific areas that were thought as potential gray areas and areas for improvements, but because of time constraints, some of these issues could not be resolved. The ideas that more groups from Worcester Polytechnic Institute would have the chance to update the product in future IQP's with the City of Boston, were considered.

Over the course of D-term '99 the project team members had to collect many maps from various locations in Boston. Much of the term was spent gathering these maps and because time was spent on gathering all resources into one location, not as much time was able to be spent on tracing and analyzing data from these maps. Future groups could further trace these maps and create more overlays using the MapInfo software to further analyze data from maps; either by date, filling episode, fill type or fill method.

Also much time was spent on learning the software for these programs. Hopefully with the help of the reference and user manuals provided by the Archaeological and Historical Mapping IQP groups located in Appendix C and F of the reports respectively, will minimize the learning curve for some of the mapping procedure. This will provide future groups more time to become more proficient in the mapping software and associated applications. This will give them more time to investigate the powerful capabilities of the programs. Areas of investigation could include database and mapping integration. More efficient ways to associate the information can be looked into.

When it came to the registering of these maps, difficulties in having the maps register exactly with the base map was another area which took time to figure out. Since each map that was registered was a hand drawn map dating back as far as the 1600s, this led to inaccuracies. Points that are on the base map are in real world coordinates and the drawn maps were produced with older techniques and technologies. Some maps were corrected and the end product was of high-quality. The user and future groups should keep this in mind when analyzing these maps and when registering maps for future projects.

The use of UTM coordinates should be investigated more in future projects. Due to time constraints the usage of UTM coordinates was not heavily researched. With the use of these coordinates, searches on geographic locations by latitude/longitude coordinates could be made possible. Also, UTM coordinates could make geocoding possible. These coordinates possibly provide more efficient data management within the databases.

This project's focus for mapping was Boston Proper. Most of the filling episodes that were mapped were in this area. All data for these filling episodes was extracted from Ms. Nancy Seasholes' dissertation. The dissertation concentrated on the filling episodes that were mapped in this project. Areas such as South Boston, East Boston, and Charlestown were not mapped as extensively. Research on what types of fill, where such fill was taken from, and when it took place could be done so layers of these locations could be created and used with the layers produced in this IQP.

Charlestown is the only archaeological site that is known to the public. As mentioned before, concentration in this project was in Boston Proper, not Charlestown. Maps of Charlestown could be created and could have layers that would include information on archaeological finds in that area. These layers could include information on artifacts such as the name of the artifact found, date found, where it was found, and time period artifact is from. Once this is done, archaeologist could use thematic mapping, a feature within MapInfo, to analyze this data. Results of these data could show trends in where artifacts were found and could then predict areas where more artifacts might lie.

During the actual digitizing of various filling episodes and historical maps, time was wasted in locating some of these locations that are only described by street name. A map with street names on it would have proved to be very useful to use as a background to find some of these locations. This type of map would also be useful to future users of this product. This would also provide a way for users to describe locations of the map by street name without having to reference a combination of many maps and documentation. Along with this street map, maps of utilities, T-lines, wetlands, and sewer lines could be mapped and aligned with existing maps to do further analysis possibly by using thematic maps.

If further research on capabilities software is done, it is recommended that future people working on this project log what was found in a similar manner as in "Appendix F". This would provide a foundation for future people researching this project and would minimize redundancy in research. Future users could reference these logs to keep "moving forward" with this project and would not have to backtrack as much.

When creating the maps and database the computer resources that are available to the Environment Department were taken into consideration. The Environment Department computers are insufficient to operate the product that was produced in an effective manner. The computers are outdated and having this product run on their computers would take up most of the computer's resources. This would result in slow manipulating, which would make for inefficient working conditions. An upgrade in computing equipment is recommended if the department is to continue with digitizing historical resources.

REFERENCES

Antenucci, J., Brown, K., Corswell, P., Kevany, M., & archer, H. (1991). Geographic Informational Systems. New York: Van Nostrand Reinhold.

Blake, John (1959). Public Health in the Town of Boston, 1630-1822. Cambridge, MA: Harvard University Press.

Foote, Kenneth E. & Lynch, Margaret (1993). The Geographer's Craft Project. Department of Geography, University of Texas: University of Texas Press.

Freeman, Donald (1970). Boston Architecture. Boston, MA: The Nimrod Press.

Itami, Robert & Raulings, Robert (1993). Geographical Informational Systems. SAGE Introductory Guidebook, Australia: DLSR.

Hearnshaw , H. & Unwin, D. (1994). Visualization In Geographical Informational Systems. New York: John Wiley & Sons.

Kay, Jane Holtz (1980). Lost Boston. Boston, MA: Houghton Mifflin Company.

Miller, Naomi & Morgan, Keith (1990). Boston Architecture. Germany: Prestel-Verlag.

Morison, Samuel Eliot (1923). The Maritime History of Massachusetts, 1783-1860. Boston : Northeastern University Press.

Obermeyer, N. & Pinto, J. (1994). Managing Geographic Information Systems. New York: The Guilford Press.

Seasholes, Nancy (1994). Dissertation: Landmaking and the Process of Urbanization: The Boston Landmaking Projects. 1630-188. Boston: Boston University.

Shand-Tucci, Douglass (1978). Built in Boston: City and Suburb, 1800-1950. Amherst MA: University of Massachusetts Press.

Star, J., & Estes, J. (1990). Geographical Information Systems. New Jersey: Prentice Hall.

Wilson, Susan (1993). The Great Fire of 1872. City Weekly, Boston: Boston Globe.

Winsor, Justin (1881). Memorial History of Boston. 4 vols. Boston: Ticknor and Company.

National Register Information System, 1999. http://www.nr.nps.gov/nrishome.htm

National Historic Landmarks, Park Net, 1998. http://www.cr.nps.gov/nhl

Heritage Preservation Services, Park Net, 1999. http://www2.cr.nps.gov

City of Boston, Environmental Department. http://www.ci.boston.ma.us/environment

Harvard Map Collection, Harvard College Library Page. http://icg.fas.havard.edu/~maps

Appendix A

City of Boston Environment Department

APPENDIX A

The Boston Landmarks Commission is a branch of the Environment Department. Located in Boston City Hall Room 805, the Boston Landmarks Commission has been the City of Boston's historic preservation agency since 1975. Some of the numerous obligations and activities of the Landmarks Commission include identification of historic buildings and places, protection and recognition of historic properties, preservation planning, and public education with technical assistance.

Over the years, the Boston Landmarks Commission (BLC) has put together over 12,000 survey forms on individual historic buildings and places for Boston's neighborhoods and downtown. These survey forms are accessible in the office of the BLC. In addition, the BLC also compiled information on properties and districts that are local Landmarks and those that are listed on the National Register of Historic Places. They even list the properties and districts that are under recommendation for designation or listing. Development histories of most of the neighborhoods are also available.

The Boston Landmarks Commission has the ability to designate individual properties and districts as Boston Landmarks, based on certain criteria, a vote by the Commission, and approval by the Mayor and City Council. Once a site has the distinction of being designated a local landmark, it must go through a series of reviews and approvals if changes are to be made to the exterior. This also applies to property located within a designated landmark district.

The Boston Landmarks Commission administers the National Register of Historic Places for Boston. Initiation of review begins when projects for National Register properties involve federal or state funding, permitting or licensing. Currently there are more than 7,000 properties, which have Landmark status, and close to 10,000 properties in Boston that are listed on the National Register of Historic Places.

The city, state, and federal legislation along with the BLC do require comments on proposed projects to determine if there will be any adverse effects on the historic resources. The purpose of the review is to avoid, minimize, or mitigate potential adverse effects. The BLC in connection with other agencies, routinely conducts these reviews. Examples of other agency reviews are Boston Redevelopment Authority project reviews, Massachusetts Environmental Protection Act reviews, National Register reviews and State Register reviews.

The Boston Landmarks Commission also reviews proposed demolition of historic buildings, under Article 85 of the Boston Zoning Code. Article 85 also allows the BLC to delay demolition for a period of 90 days, during which the communities have the opportunity to participate in a public discussion about the demolition. This is a chance to encourage the applicant to examine alternatives to demolition.

Within the BLC, there is also the part-time City Archaeologist, Ellen Berkland, who tries to preserve the archaeological legacy of Boston by protecting the city's collections of artifacts and making them known to the public and researchers. Ellen Berkland manages the archaeological remains located on public and private land in Boston, and over 26 collections of the Commonwealth of Massachusetts held by the city. She is also dedicated to educating the general public and young city school children about archaeology. There is a 4,000 square foot lab at 152 North Street in which Ellen Berkland brings in volunteers to help teach and present collections to the visitors.

Finally, the BLC provides professional assistance and public information programs that are available to neighborhood groups, property owners and developers. Appointments for meetings and site visits can be arranged through the BLC. During the meetings and site visits, comments can be considered concerning the preservation of specific properties or areas. The BLC office also has available many neighborhood brochures, information on designation and design review, application and other public information material.

Appendix B

List of Acronyms

APPENDIX B
List of Acronyms

GIS: Geographical Information Systems

UTM: Universal Transverse Mercator

BLC: Boston Landmarks Commission

MHC: Massachusetts Historical Commission

MACRIS: Massachusetts Cultural Resource Information System

LHC: Local Historical Commission

CLG: Certified Local Government

NHP: National Historical District

LHD: Local Historical District

LHDC: Local Historic District Commission

NRHP: National Register of Historic Places

SRHP: State Register of Historic Places

NHPA: National Historical Preservation Act of 1966

MPPF: Massachusetts Preservation Projects Fund

MEPA: Massachusetts Environmental Policy Act of 7/1/98

PNF: Project Notification Form

Appendix C

A Bibliography on Archaeology and Historical Preservation For Local Historical Commissions

APPENDIX C

A Bibliography on Archaeology and Historical Preservation
For Local Historical Commissions

Compiled by Edward L. Bell, Massachusetts Historical Commission, 1997
220 Morrissey Blvd., Boston, MA 02125, Tel. 617-727-8470

Documents to live by:

Mass. Gen. Laws c. 40C. Local historical commission powers and duties, including provisions that archaeological records are "not a public record" and not subject to Freedom of Information Act disclosure on demand to prevent looting.

Mass. Gen. Laws c. 9, ss. 26-27C. Massachusetts Historical Commission (MHC) and State Archaeologist powers and duties.

950 Code Mass. Regs. 70. State Archaeologist's permit regulations, including professional qualifications and standards for investigation and reporting. A permit is required for archaeological investigations on any public lands and lands which the Commonwealth has "an interest," such as those with Conservation or Preservation Restrictions, or private land being evaluated by local, state, or federal government for proposed land modification projects (e.g., new subdivisions).

MHC's Know How #4. What to do when human burials are found.

National Park Service 1983 Secretary of Interior's Standards and Guidelines for Archaeology & Historic Preservation, Federal Register 48(190): 44716-44742. *These are the professional qualifications and standards that historical preservation programs need to follow.*

Advisory Council on Historic Preservation 1980 Treatment of Archaeological Properties: A Handbook. ACHP, Washington, DC. *Geared to projects under review in compliance with federal law, this 39 page guidance document outlines professionally accepted principles to assist in making correct decisions on the preservation or mitigation of important archaeological resources.*

Advisory Council on Historical Preservation 1990 Consulting About Archaeology Under Section 106 of the National Historic Preservation Act. ACHP, Washington, DC. *A more distilled version of* Treatment, *this 14 page document outlines principles and accepted preservation treatments.*

General Guidance:

NHC 1992 Preservation Planning Manual. Local Historical Commissions: Their Role in Local Government. *Read this manual and live by it. Pages 20-22 describe how the LHC's can integrate archaeology onto broader preservation efforts.*

Southeastern Regional Planning and Economic Development District 1984 Protecting Historic Resources: A Guide for Local Government Action. SRPEDD, Taunton, Massachusetts. *Very helpful in establishing local preservation review, with examples of model by-laws and regulations.*

MHC 1996 Massachusetts State Historic Preservation Plan, pp. 7-13.
MHC 1994 Special Commission on Historic Preservation Final Report, pg. 11.
Both publications contain helpful guidance on why archaeological resources are worthy of preservation.

MHC 1985 Public Planning & Environmental Review: Archaeology and Historic Preservation, pp. 6-12. *Although now out of print, these pages of the manual contain a summary of how archaeology is integrated within the environmental planning and review under state and federal law, and how it should be under local bylaw reviews.*

MHC 1992 Historic Properties Survey Manual: Guidelines for the Identification of Historic and Archaeological Resources in Massachusetts. MHC, Boston. *Guidance on historic resources survey, as well as line by line instructions for completing MHC archaeological inventory forms.*

National Park Services 1987 Is There Archaeology in Your Community? 3 pages. National Park Services, Interagency Resources Division, Washington, DC.
National Park Services 1987 Choosing an Archaeological Consultant, 4 pages. National Park Services, Interagency Resources Division, Washington, DC.

MHC (various dates) Historical and Archaeological Resources Series (separate volumes for Boston, Cape Cod, Southern Massachusetts, Central Massachusetts, and the Connecticut Valley). *Book length regional treatments of ancient and historical cultural history, significant properties, threats, and recommendations.*

Public Education:

American Association for State and Local History 1990 Historical Archaeology: New Perspectives. Special issue of History News 45(4), July/August 1990. Includes the AASLH Technical Leaflet by Lu Anne De Cunzo, "Historical Archaeology as a Tool for Researching and Interpreting Historic Sites." *A terrific introduction to the subdiscipline.*

Tonetti, Alan C. 1993 History in the Ground: Archaeology and Local Historical Organizations. Local History Notebook (a publication of the Ohio Historical Society) 9(1):i-iv.

Crosby, Constance A. 1994 How to Care for Your Underground Heritage. Preservation Advocate (Newsletter of the MHC) 21(1):4-5.
Cressey, Pamela J., and Keith L. Barr 1989 The Right Way to Dig at Home: How to find and save your underground heritage. Preservation News (a publication of the National Trust for Historic Preservation) June 1989, pg. 8.
Both short articles written for the general public, geared to interested landowners whose small weekend projects may impact their property's archaeological deposits.

Stuart, George E, and Francis P. McManamon, Archaeology & You. Order from the Society for American Archaeology.
Archaeology and the Public. (Special issue of CRM, edited by David A. Poirier and Kenneth L. Feder) CRM 18(3), 1995. National Park Services, Cultural Resources, Washington, DC.
Both short publications are geared to garnering public support and volunteer efforts.

National Park Service, n.d. Participate in Archaeology. Brochure. National Park Services, Cultural Resources Division, Washington, DC.
General sources of information on how the public can participate

Society for American Archaeology, n.d. Reaching Kids through Archaeology. Brochure. SAA, Washington, DC. *A listing of resources for educators*

Saving Important Sites on Private Land:

Simon, Brona G. 1995 Archaeological Site Conservation on Private Property. In Archaeology and the Public, (Special Issue of CRM) CRM 18(3): 25-28. National Park Service, Cultural Resources, Washington, DC.

The Trustees of Reservation, n.d., Saving the Past for the Future: An Introduction to Saving Archaeological Lands. Brochure. TTOR Land Conservation Center, Beverly, Massachusetts. *For private landowners with important sites*

Background on General Cultural History and Archaeological Approaches to the Past:

Braun, Esther K. and David P. Braun, 1994 The First People of the Northeast. Lincoln Historical Society, Lincoln, Massachusetts.
James Deetz, 1997 In Small Things Forgotten: The Archaeology of Early American Life. Anchor Press/Doubleday, Garden City, NY.
Both readable books that a good introduction to ancient and historical archaeology principles and culture history.

Bogus and Fantastic Claims(Vikings, Druids, "Megalithic" Stone Structures, etc.):

Feder, Kenneth L. 1990 Frauds, Myths, and Mysteries: Science and Pseudoscience in Archaeology. Mayfield Publishing Company, Mountain View, California.

Williams, Stephen 1991 Fantastic Archaeology: Walk on the wild Side of North American Prehistory. University of Pennsylvania Press, Philadelphia.

Neudorfer, Giovanna 1980 Vermont's Stone Chambers: As Inquiry into Their Past. Vermont Historical Society, Montpelier.

These books describe the historical and scientific methods necessary to assess improbable and distracting claims about the past. A more advanced paper is:

Cole, John R. 1980 Cult Archaeology and Unscientific Method and Theory. In Advances in Archaeology Method and Theory 3, edited by M.B. Schiffer, pp. 1-33. Academic Press, New York.

Internet Resources:

http://www.magnet.state.ma.us/sec/mhc/mhcidx.htm Mass. Archaeology Week Calendar and Poster are included each year.

http://spirit.lib.uconn.edu/ArchNet/ArchNet.html General Information and links.

http://www.nps.gov/crwebl Links to the past has interesting information, publications, etc.

http://www.saa.org Society for American Archaeology.

http://www.azstarnet.com/~sha Society for Historical Archaeology, FAQ's.

http://www.he.net/~archaeol/wwwarky/wwwarky.html Archaeology Magazine links to internet resources.

http://cr.nps.gov.ncptt/irg-servers.html#arch Internet servers about archaeology and historic preservation, FAQ's.

http://www.achp.gov The Advisory Council on Historic Preservation. Includes publications.

Appendix D

Chronological Framework Based on 1982 Massachusetts Historical Commission

APPENDIX D

Chronological Framework Based on 1982
Massachusetts Historical Commission

- Plantation Period 1620- 1675
- Colonial Period 1675-1775
- Early Republic Period 1775-1830
- Early Industrial Period 1830-1870
- Late Industrial Period 1870-1915
- Early Modern Period 1915-1940
- Modern Period 1940-Present

APPENDIX E

Interview with

Ellen Berkland

The following interview was done so as to have a better idea of how Ellen Berkland exactly goes through the processes of evaluating a specific construction plan that may come to her as the City Archaeologist.

P: What I have to ask you about is the sections of Analysis and Results of our proposal and what it basically contains is how you go about your everyday. Because I know we have already discussed it early in the beginning, but we need more detail in what you do. For example, when you get a proposal for construction and how you would look it up. Also, when you mentioned you are digging at a site, what kind of background you have to do for that.

E: O.K. it is pretty extensive, it depends on the level of the type of project it is. Generally I get an Environmental Notification Form (ENF) or Project Notification Form (PNF) which is basically a site specific summary of planned impacts or construction for a particular parcel. So it is very site specific. Sometimes it is a building, a small property parcel. So I am only concerned with that one parcel. If I know that it is on a shoreline area, I can go down to the Harbor Commissioner's records and just look up that parcel and sure enough in 1859 there was a dock there that had been deconstructed when construction went in 1925. So chances are there would be nothing culturally significant on that parcel so I can write it off. The area was destroyed. I have the documents to prove it. And it was filled in with some type of aggregate. So I don't have to worry about that particular parcel. That's along a shoreline area. But one on original land, say the Shawmut Peninsula, the city was planning some development on a park area that I know had been a park for the last 300 yrs. And had never been developed, never been landscaped, that's going to been a hot spot. And I am going to recommend an archaeological recon., a full investigation of that particular parcel. That would go out. I would sent my recommendations to the company and say, "Hey look, you can't do anything, you can't go any further until you consult with the state and you put out a bid for....you find an archaeological management company that will do an archaeological recon., a study of that. Often I will try to determine if the area has any archaeological sensitivity to it. By cartographic evidence. I look, and in the past, I've picked out a general....I have engineering, called Boring Data Maps. So all the boring data that would tell me what the geological makeup of the particular parcel is. And that can lend insight to the matrix of the property. But historically, I use the maps and I will by hand, basically create my own overlay. Which is ridiculous, if you consider I have to deal with scale. I have to deal with reproducing on a machine which breaks down any type of contrast or color, and I have to do overlays which is very difficult. I've been doing that by hand. So this is cutting out a number of steps, I ordinarily would do. But that would be one of my primary resources, would be the cartographic evidence. They are not extremely accurate. They can be off, by inches, feet.

P: We've have maps that would....we've used the program, and the program itself would, when registering the map overlays, it stretches the map to fit the other map, the base map. But it is off by a little.

E: Could you guys include that in your,...what section would you put it under,....accuracy or the process of how you went about doing this. And that that could contribute to misalignment or whatever. But maybe include that in the bulk of the paper saying that these are some of the problems that we've encountered that could effect the ultimate accuracy of the final project. That would be a good thing to include.

P: Also you mentioned how once you receive that ENFs, do you made a decision....when you know that area was a park,...do you make the decision by yourself, right away, and send it out?

E: Sometimes I consult with people over at the State, but if I know it has never been developed on, there had been no buildings, that there is no foundations, no impact to the property, chances are there might be some historically, culturally significant deposits. Especially if it has been a park area for the past last 300 years. Prior to that the Shawmut Peninsula was used by Native Americans. If we found any prehistoric Indian sites, here Boston Proper would be very significant. I would consider that a highly sensitive area automatically.

P: What if you had some are that was more questionable. What we want to know is how long would the usual task be for you.

E: Alright, for a site specific,...I mentioned the cartographic evidence, historic maps, going back through all of the....

P: Just like going to the different departments and gathering.

E: Well I do have a lot of maps. Unfortunately, I don't have them in any particular order. But a lot of times I go back and get doubles of them or I know that certain Sandborns exist. I have the State House special collections where I know that certain maps exist over the Bostonian Society. I know that I can go to engineering. I know I can go up to the Boston Redevelopment Authority. I know I can go over to the Historic Commission over at the State, and that's usually what I end up doing. Five places right there, I have to go to. Four within walking distance, one by T. That's a day, right there, of my time. Then to do site-specific, I want to go to specific books, historical documents of Boston Proper, looking at many times streets, what was in particular areas. I have to consider the temporal changes over the time. So I have to look at the land filling. I go to Nancy Seasholes dissertation, and look at what she may have for a particular parcel. I go to the MHC and look at what they may have in their files. I automatically look to see if there are any known prehistoric sites in the area. If there are any known historical, archaeological sites in the area. So proximity to site is also an indicator especially for prehistoric sites. Chances are if you have one prehistoric site in one location, you going to have one very close by in another. Known sites is a critical factor. It's different for prehistoric. We look at a number of different indicators with prehistoric. We look at proximity to water sources. We look at known prehistoric sites. We look at soil types. We look at the drainage of the soil. We look at location to resources, including rock, topography. We look at slope. We consider a number of different factors. Environmental indicators. Historical, it's a little different. Although, if I could look at these maps and say, okay this map from 1780 says that there's a structure there. Chances are if you have a structure, you'll definitely have remains. Even if you don't have the structure, you're probably going to have a truncated feature. Which would be a basement or a foundation. You'd have landscaping, deposits, walkways, garden areas, fence area. All of these can lend great insight to into how the house was used, who used it. And very intimate detail information about the lives of these common people. To further study the property, we do deed research. And we go up to the archives, to the deeds, and land court documents, and we go back and do a site specific trace. We can find the owner of the property now. And you can go all the way back to the founding fathers. The documents go back to the 1600s. So you can actually,....and this is scary, and I guess this would've been on the wish list,.....in colonial times they would often mark areas or property by trees or rocks or roads that are no longer exist. So you also work in rods. So doing that site specific analysis for that one particular property you have to convert rods and it's a mess. A plus you deal with roadways that are no longer there, roadways that have been widened. And it's very tricky, but to do that deed research, you basically get right down to who's backyard you are in. And who's privy you are digging in, and who's trash pit you are digging in. And you find the trash. You find personal items. You find fingernails of these people. It is very site specific, but I never get to that particular level unless I am working on a project myself. I just don't have the time. That's why I have to put it off on all the archaeological management firms. It gets very site specific. And then you find, biographies and day journals, day planners, court records....this privy we excavated with the central artery, we found out the woman had her first husband was a drunk....Katherine Naylor and we knew that it was her house. Found the court records, the documents, the probate records, and we knew the demonstrations of the house. We knew from the probate records what things of value were in the house. Including furniture, ceramics, pewter, things of that nature. They sometimes mention gardens, fencing, privies, outer houses, and we also find other evidence that they went to court. And we had found out from the court records, that this was one of the earlier divorce settlements in Boston. It was 1680, so it was very early. She took her husband to court and she won. He had impregnated their servant and fled to New Hampshire with the pregnant servant. He was a wife-batterer. This is just from the documents. He beat his kids. We found this out in the documents. He use to beat his kids with furniture and or threw them down the steps. You can get real intimate details from these court records. So they are very fascinating if you ever get the chance to....

P: So you would almost have a list of things you would find.

E: They can help in locating the smoking gun. What's really is that in some of these day journals they describe in detail ceramics or personal items, things that they'd owned. When you find these things, it's something else. We found men's leather shoes, men's clothing. We knew that she was a seamstress, and she supported herself by taking up piece work. We found needles. We found all these sewing accoutrements, associated with seamstress work. Scissors, thimbles, spools, old wooden spools. How we found real pieces of silk, ribbons. Things that would be great indicators of her profession. Also found things related to food, which they'd mentioned as well. But, you get real specific information. So when before you even go in there, you have a real good idea of what you'll find. And despite all the research you are going to do, you just never absolutely know what you are going to find. So it's fascinating. But, how did I get there?

P: You were looking at the records.

E: Right, the records. That's why historical archaeology, the documentary evidence can be extremely helpful and lend so much insight into what was going on. So, probate, court records, doing title of deed searches on the property, personal journals, histories of the area, the cartographic evidence. There were many documents and resources to go to, but those are the primary ones I deal with. So it is a lot of time.

P: Basically, when we are starting this section, we remembered what you mentioned. The bare bones about how you go about this process. I guess it is like, now I realize how much it really was and how much this would help.

E: Just visually having this aid and to have the overlays, the historical map that's going to facilitate.

Appendix F

Technical Reference Manual

APPENDIX F: "Technical Reference Manual"

The intent of this appendix is to be used as a reference/users guide to certain technical aspects of this project. When undertaking this project the group had to do much detective work to figure out what has been done with existing digitized maps. Also, much time was dedicated to learning the programs and figuring out how to do specific tasks in these programs. The purpose of this document is also to try to minimize this learning curve for future groups that would continue this work. This appendix can be used as a reference for the BLC and other users to learn more about the programs as well. The reader is encouraged to use this document while having the "Glossary of Terms" in hand to refer to for any terminology with which the reader is not familiar.

For a user manual that is geared more toward the user that explains how to use the final product, please see Appendix C "BLC Survey Database and MapInfo User's Guide". This appendix is located in the Historical mapping group's IQP report which is also included within the CD provided to the BLC by both groups. This manual will use less technical terms and can be used to help the user learn how to use the material provided on the CD.

Attaching Information to an Object in MapInfo from the Access Database:

After creating the database within Access the group had to open the database in MapInfo, this can be done by selecting "File, open table". Then the group had to make sure to select the correct file type to open, .mdb. See Figure-F1. After selecting OK a window would pop up asking which tables wished to be opened with this database and the desired tables would be selected. See Figure-F2. After the table is opened, it is displayed in a "browser" within MapInfo. Now the table had to be made mappable so that the team could draw objects which to attach the information; choosing "table, maintenance, table structure" in the menu bar can do this. After this MapInfo asks which table you wish to view or modify. After choosing the desired table, the window in Figure-F3 appeared. "Table is Mappable" was then checked and a projection was chosen, then OK was selected. Now the group could hit F3 on the keyboard to open a new mapper. Every table has a mapper as long as it is made mappable, and a browser for information that is attached to objects in the mapper.

When attaching information to an object, the record first must be entered in the database using Microsoft Access. Any editing to the database should be done in Microsoft Access **not** in MapInfo. Once both the mapper and the browser are open and displayed the group tiled the windows to see both windows at once. This is represented in Figure-F4. The window on the left is the browser and the mapper is on the right. To attach information to an object, the group would first have to click on the box next to the record in the browser to select that record. The box would then blacken to tell the user that it is currently selected, this is illustrated in Figure-F4 as well. Now the group would select the mapper window by clicking on the title bar of the window. If the group clicks on the map of the mapper window it would deselect the record in the browser window. Now the object could be drawn using MapInfo's drawing and editing tools.

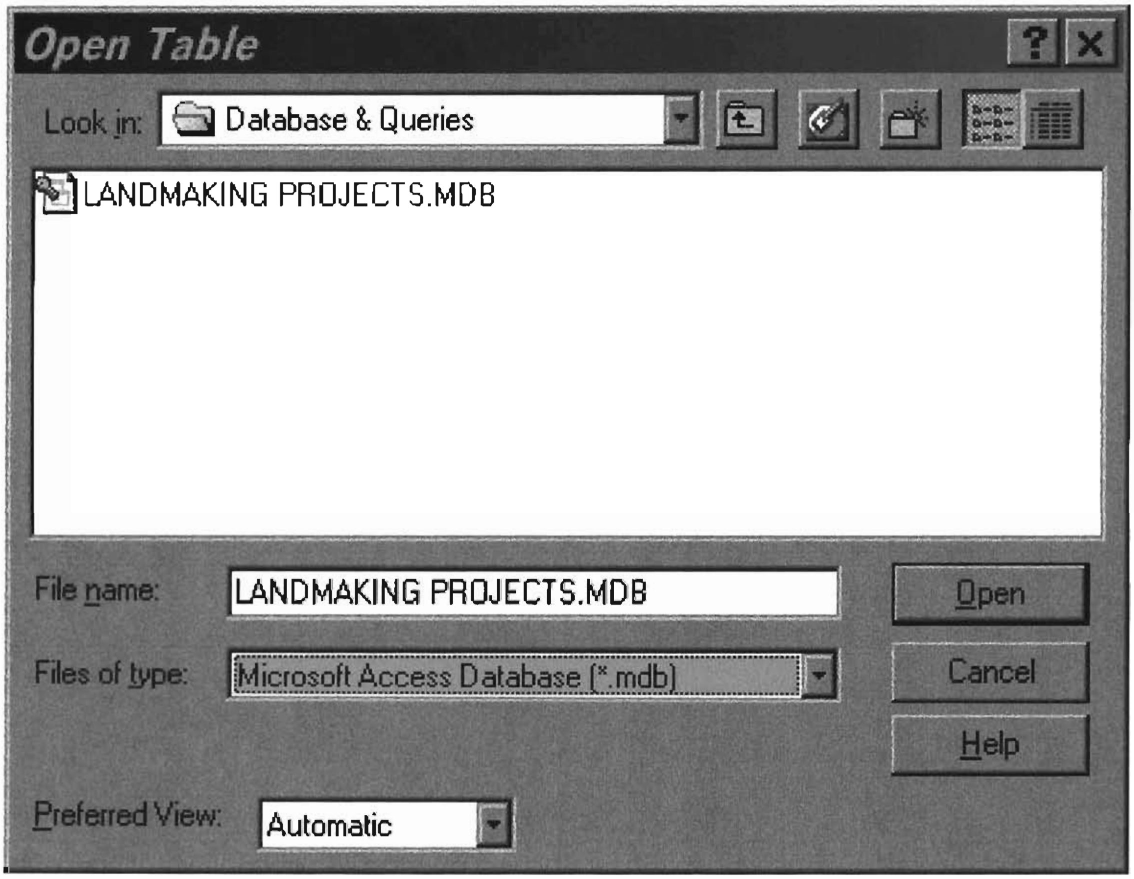

Figure-F1 (Opening .mdb Database in MapInfo)

Figure-F2 (Opening Access Table)

After the table is opened, it is displayed in a "browser" within MapInfo. Now the table had to be made mappable so that the team could draw objects which to attach the information; choosing "table, maintenance, table structure" in the menu bar can do this. After this MapInfo asks which table you wish to view or modify. After choosing the desired table, the window in Figure-F3 appeared. "Table is Mappable" was then checked and a projection was chosen, then OK was selected. Now the group could hit F3 on the keyboard to open a new mapper. Every table has a mapper as long as it is made mappable, and a browser for information that is attached to objects in the mapper.

When attaching information to an object, the record first must be entered in the database using Microsoft Access. Any editing to the database should be done in Microsoft Access **not** in MapInfo. Once both the mapper and the browser are open and displayed the group tiled the windows to see both windows at once. This is represented in Figure-F4. The window on the left is the browser and the mapper is on the right. To attach information to an object, the group would first have to click on the box next to the record in the browser to select that record. The box would then blacken to tell the user that it is currently selected, this is illustrated in Figure-F4 as well. Now the group would select the mapper window by clicking on the title bar of the window. If the group clicks on the map of the mapper window it would deselect the record in the browser window. Now the object could be drawn using MapInfo's drawing and editing tools.

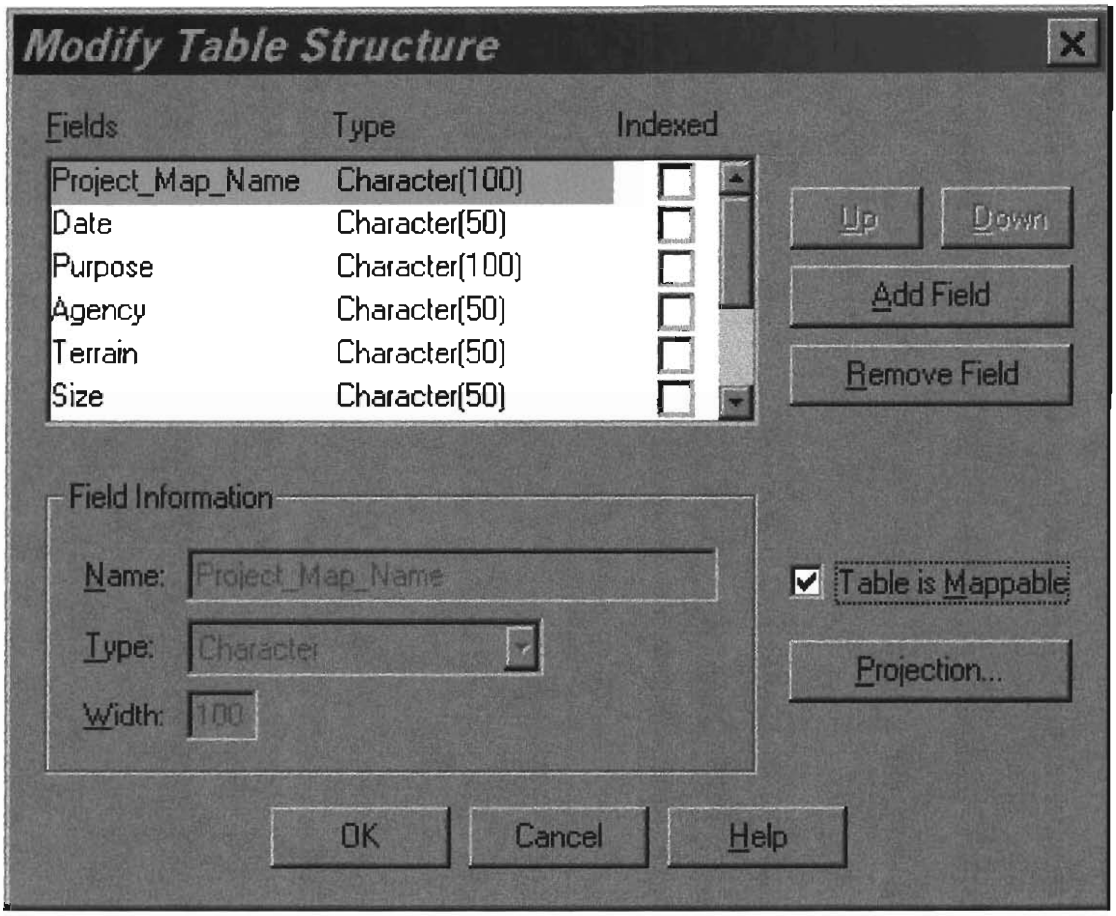

Figure F3 (Modify Table Structure)

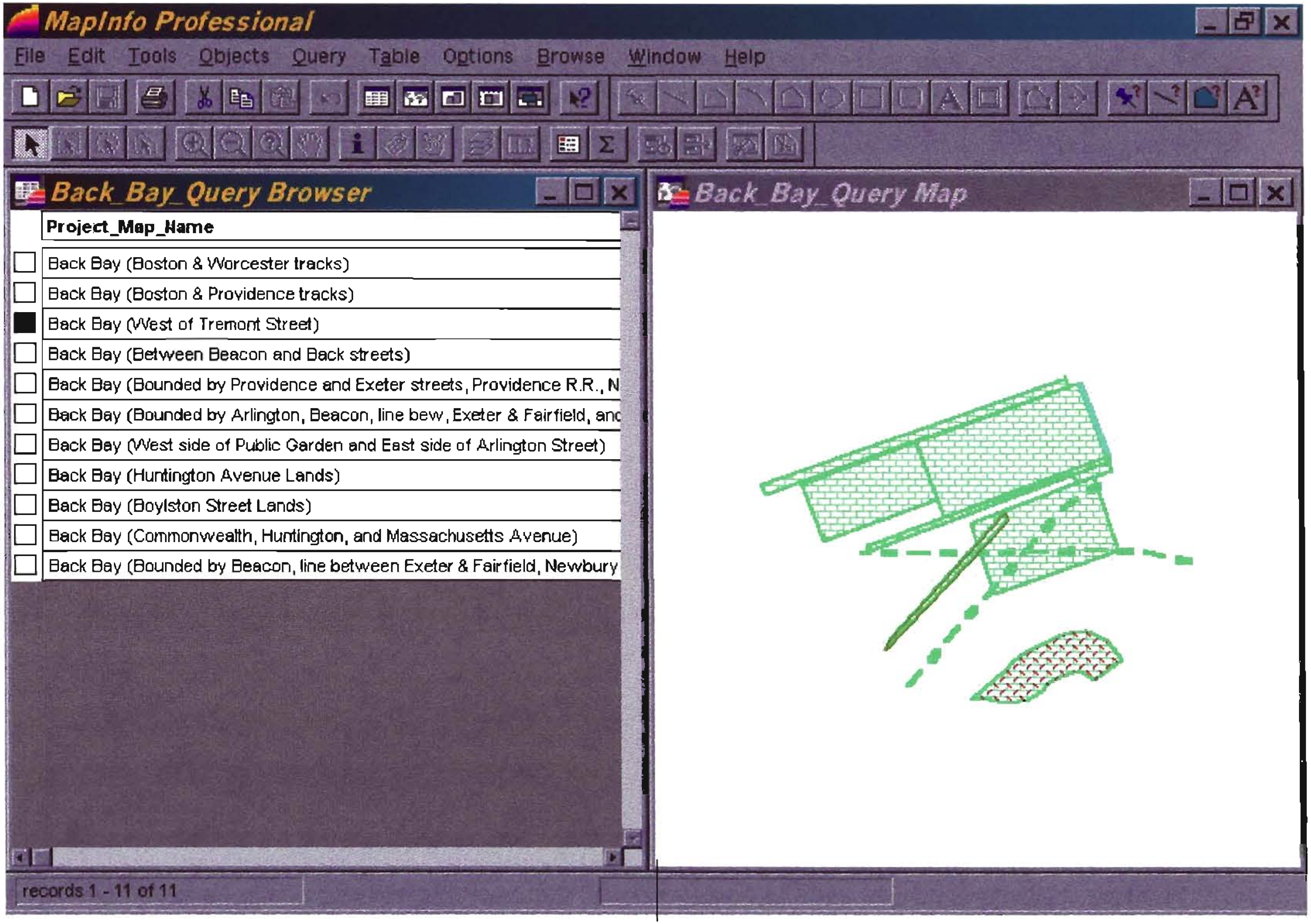

Figure-F4 (Browser and Mapper Tiled)

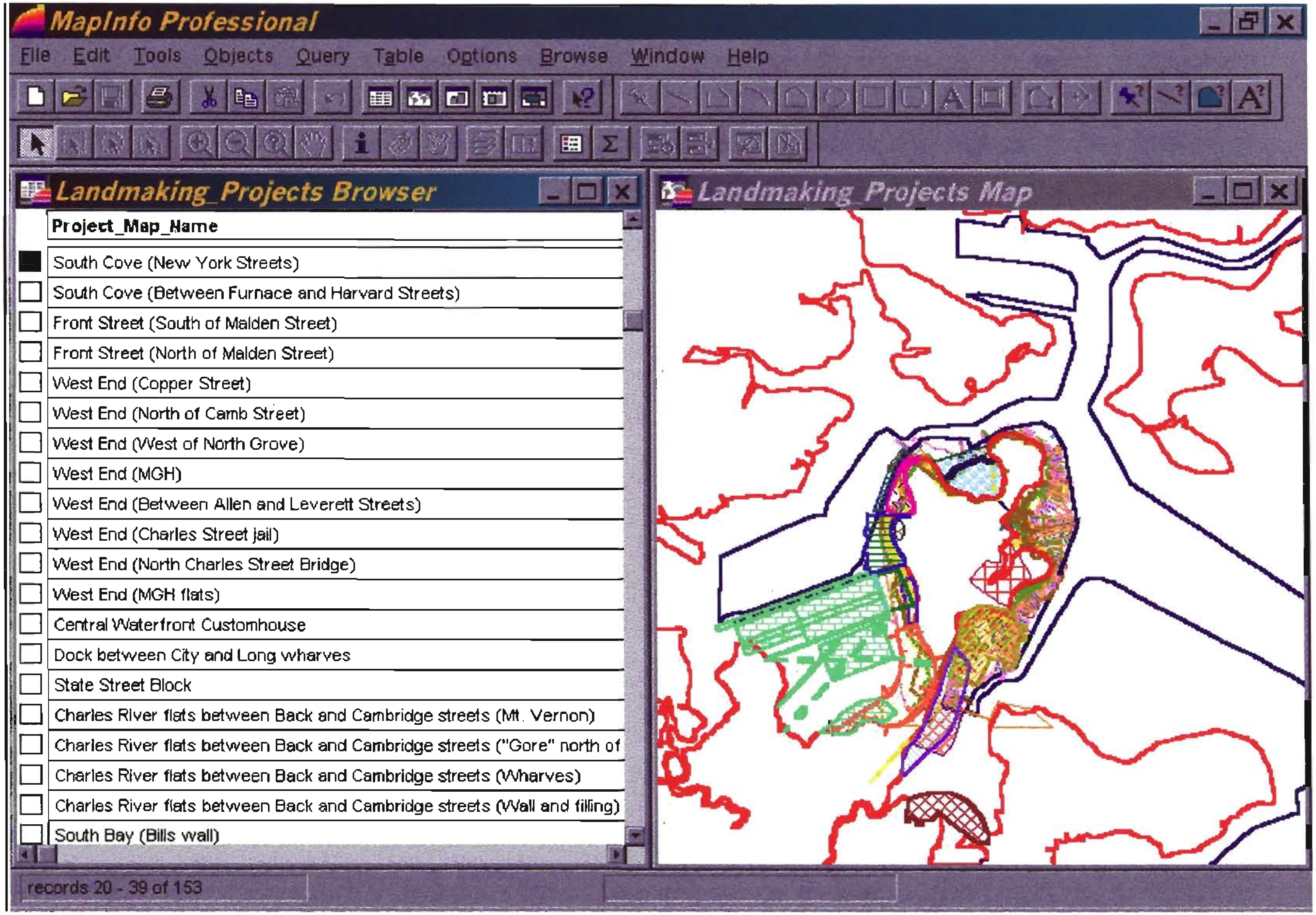

Figure-F5 (Example of Congested Screen)

Creating A Query In MapInfo:

A query can be used to search through a database and display them on their own layer. The project group has made a database with all information about landmaking and historical maps that was in the possession of the students. This database is all on one layer and can be viewed all at once. There is a lot of data and objects that are drawn on this layer and when viewed all at once can seem congested and hard to find what the user is looking for as in Figure-F5. This is where queries can help organize the maps so that they can be viewed more easily. There are many queries that have been created by the team members. But, the students could not cover every possible combination of layering. In this case the user would have to create his/her own query to display what he/she wishes.

When creating queries the group first had to open the database with the information to be queried within MapInfo. Once this is done the group chose "Query. SQL Select..." from the MapInfo menu bar. This prompts the window in Figure-X2 to appear. This is the window where the query is created. Under the "from Tables:" window is where the group selected the table (database) that is to be queried. This was entered by selecting "Landmaking_Projects" from the "Tables" pull-down menu in the window.

The "where Condition:" is where the students defined what columns of the database to search and what to search for within that column. Selecting which column to search was defined by selecting the desired column from the "Columns" pull-down menu. In the case in Figure-F6 the "date" column is being searched. After this the operator is defined. The operator is defined by the pull-down menu titled "Operators". The operator defines how the query is going to search that column. "Like" is the operator depicted in Figure-F6. Then the group typed in quotes what the search is going to look for. In this case it's looking for "16". The "%" is a wildcard character. For example the query will find 16__ where __ can be anything. It's basically returning anything that begins with a 16. The % can be placed before or after what you have in quotes. %16% will return 1816, 1618, and 1168. %16 will find anything ending with 16, for example, 1816, 1916, and 1616. The query in Figure-F6 will result in all records in the 1600's.

The Orthophoto Basemap:

An orthophoto image is a aerial image of the earth. This is the type of image that the group decided to use for its base map. The base map is approximately 17.5 miles in length by 12.5 miles in width, for a total area of approximately 218.75 square miles. The center of the image is Thompson Island (D3).

The images for the base map were all downloaded from the following URL: http://ortho.mit.edu. The base map is not one large file. Rather, it is composed of many smaller square images put together to form the entire image. All the images are in a .jpg file format. A rough interpretation of the entire map is represented in Figure-F7.

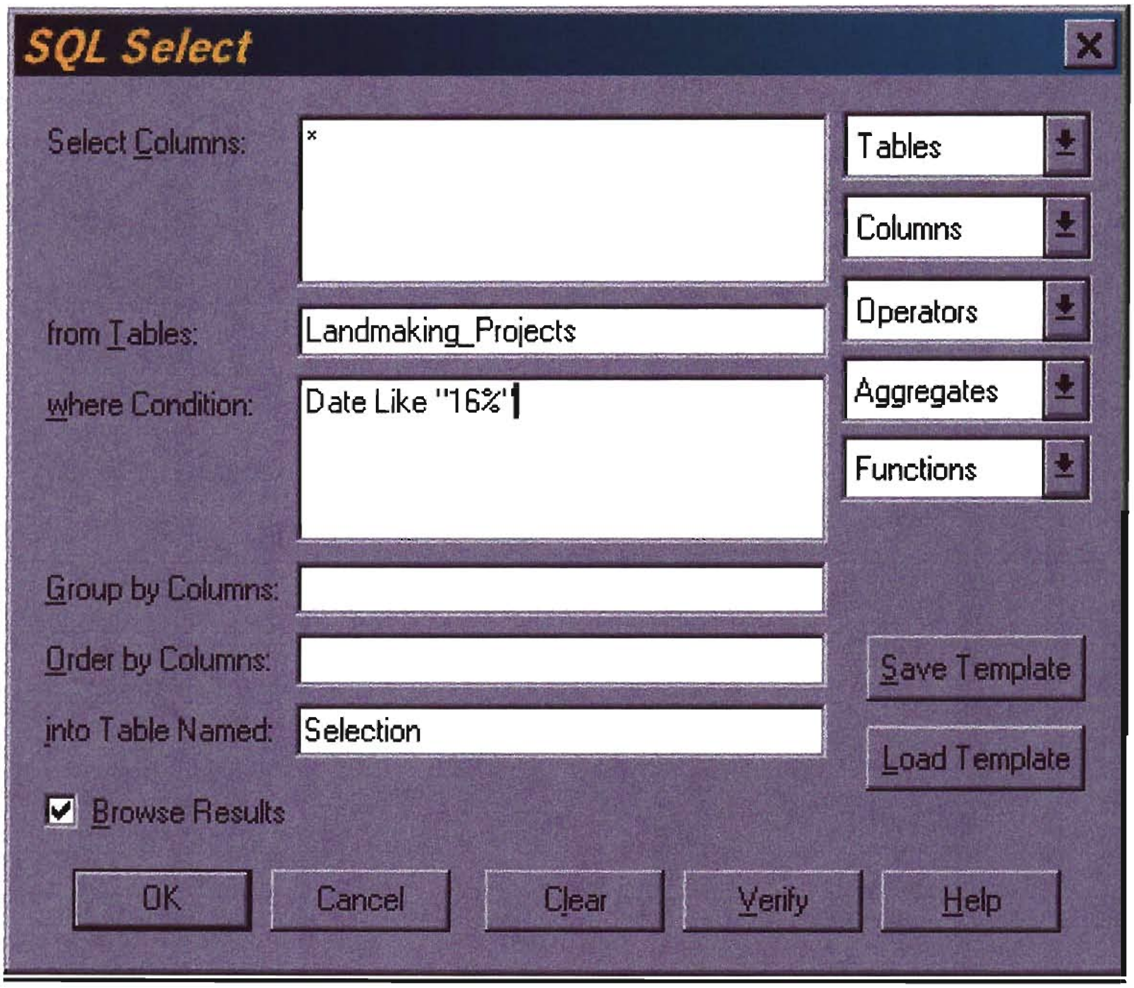

Figure-F6 (SQL Window)

	A	B	C	D	E	F	G
1	Blank	Cambridge (B1)233902	Charlestown (C1)237902	Chelsea/East Boston (D1)241902	Winthrop (E1)245902	Blank	Blank
2	Brighton (A2)229898	Allston (B2)233898	North End/Back Bay (C2)237898	East/South Boston (D2)241898	Deer Island (E2)245898	North Channel (F2)249898	Brewster Islands (G2)253898
3	Brookline (A3)229894	Jamaica Plain (B3)233894	Roxbury (C3)237894	Thompson Island (D3)241894	Long Island (E3)245894	Georges Island (F3)249894	Hull (G3)253894
4	West Roxbury (A4)229890	Rosindale/ Mattapan (B4)233890	Dorchester (C4)237890	Quincy (D4)241890	Quincy Bay (E4)245890	Peddocks Island (F4)249890	Blank
5	Dedham (A5)229886	Hyde Park (B5)233886	Blank	Blank	Blank	Blank	Blank

Figure-F7 (Base Map Naming Scheme)

The resolution of all the images are at 2 meters per pixel. Each square image is 2,000 X 2,000 pixels or 4,000 X 4,000 meters. There were higher resolutions available from the MIT web site. A higher resolution was not chosen because it would require a computer with higher resources to manipulate and work with the images. Neither the group nor the BLC have a computer with these resources. For the purposes of the BLC the image quality chosen is sufficient because they will not need to zoom in too closely. As one zooms in the image gets fuzzier and pixels appear bigger.

All base map images have the projection of "Massachusetts 2001, Mainland Zone (1983, meters). This is the projection that was chosen by the MIT web site and was left as is. All images were left registered as is from the aforementioned URL. (See "Registering A Raster Image") When opening the entire base map, the user will notice white lines outlining each individual square. This is the way the images came when downloaded from the MIT web site. The images are all registered correctly and are located in "the correct location on the Earth". The group attempted to eliminate these lines but was unsuccessful and decided it was better to leave the images as is. (See "white lines outlining base map")

The naming of the map is as follows. Within each box in Figure-F7 is a number. Those numbers are the name of the .tab files for that square section of the map. Each .tab file being prefixed with its appropriate "column letter" by "row number". The column letter and row numbers were added to the existing names of the .tab files for easier access and a more user-friendly interface. Before the column letter and row number is the name of the area that is represented the most within that square piece of the map. If one were to go to the MIT web site, the names of all the .tab files and corresponding .jpg images would be the number immediately following the column letter and row number in parentheses. The number following the column and row number is the name of the file given by the aforementioned URL and is the name of the .jpg file corresponding to the .tab file.

White lines outlining base map:

After downloading the base map in pieces and opening the images in MapInfo, the group noticed white lines outlining each square image on the map. The group tried eliminating these lines in a few ways.

The first idea was to take the images and put them together using Adobe PhotoShop. This was successful in eliminating the lines but, the image came out to be roughly 22 megabytes in size. Because of this, the computer took longer to refresh the image each time a user decides to zoom in and out when using MapInfo. Also with the base map as one .jpg file in its own layer, the user can either turn the entire image on or off.

With the base map kept in pieces and having each piece on its own layer, the user can turn on only the area of Boston that he/she is working with, thus reducing the time it takes to refresh the images and resulting in a more efficient working environment. Having the image as one large image would work fine for a computer with enough resources to handle it. But, again, neither the group nor the BLC have computers powerful enough to handle images that are this large effectively. This is the way the group decided to arrange the base map image.

The group concluded that having the base map in pieces is the superior method to manipulate the base map. The group tried re-registering each square of the map to get rid of the white lines. Originally the group suspected that the white lines were caused because the images were not properly registered in respect to each other. Thus meaning that they weren't lined up flush against each other, pixel to pixel. The group went through and tried re-registering a couple and, when doing so, discovered that, according to the numbers in MapInfo (See Figure-F10), the images were registered correctly, flush against each other. (See "Registering A Raster Image") The points that were picked for these images were all in the upper right hand corner of the image. If the grid in Figure-F6 represented the pixels in the upper left corner of the image, the labels pt1, pt2 and pt3 are where the image's control points are.

As you can see points 2 and 3 are off the image. MapInfo takes positive X values to the right and positive Y values down. So, for example pt2 is registered as –1 in the X direction and 0 in the Y direction. Within Figure-F10 in the window entitled "Edit Control Point", under "Image X:" and "Image Y:" these values can be seen for pt2. The group tried changing these control points so their values would be (0,0) for pt1, (0,1) for pt2, and (1,0) for pt3. So the control points would be in the locations in Figure-F9. Hoping that this might eliminate the white lines. This however did not.

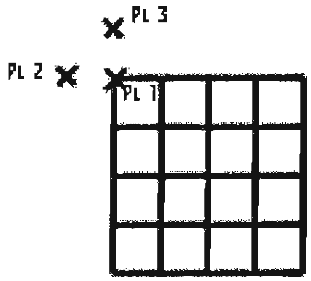

Figure-F8 (Base Map Control Points)

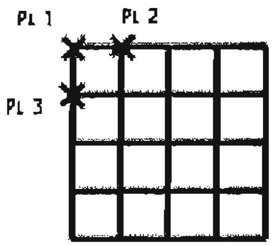

Figure-F9 (Modified BaseMap Control Points)

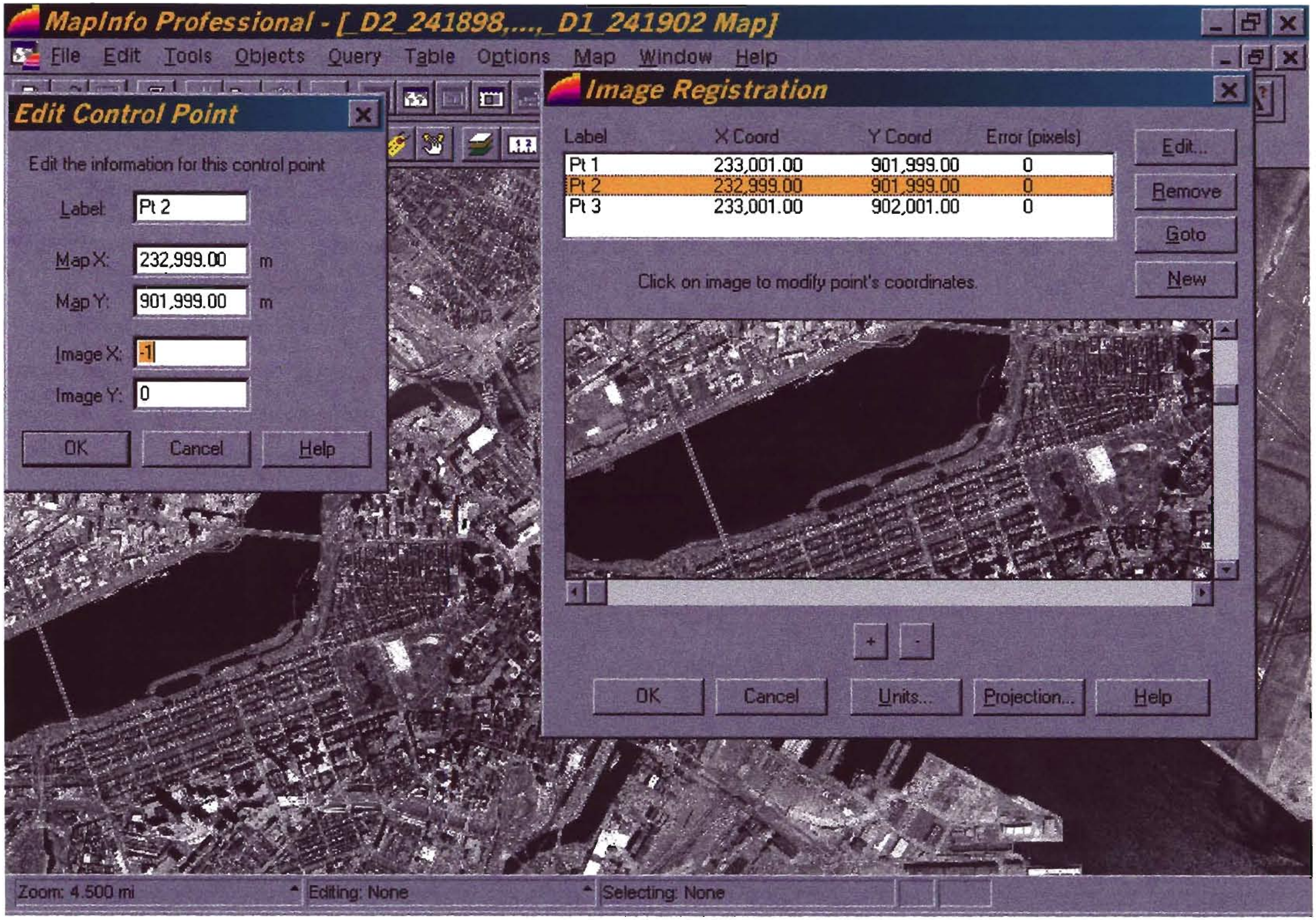

Figure-F10 (Raster Image Registration)

The group then tried to register the control points so that each image overlaps each other by a pixel. Then the group tried overlapping the images by two pixels. The white lines were still there. But, when zoomed in on an area where an image overlaps another image, one can see that they do indeed overlap and there is no gap between the images. The line only appears when the user zooms out. The team concluded that it was better to leave the images registered as is from the MIT web site. Leaving them registered as is would at least ensure that the numbers were correct, thus making any measurements of distance more accurate. Also, it would at least provide a complete image and none of the image would be cut out. The group has a few hypotheses on why the lines appeared. One, it might be that the computer we are using doesn't have enough resources to display that much data. Particularly when zoomed out and the user is looking at the entire image. Two, it might have something to do with the way layers are displayed, one on top of the other. There might not be a way to ever get rid of the lines. That just might be the way MapInfo works.

Registering A Raster Image:

In the cases of this project, there were many older maps that were drawn by hand. These maps were on paper and were taken to a documenting company to have them scanned into raster images. The chosen file format was .TIF files due to the smaller size of the files. Due to the fact that these maps were drawn by hand, they are not entirely accurate. Therefore some of them don't quite match up with the orthophoto images.

When registering raster images, what you are essentially doing is stretching the vector image over the raster image until it fits the way you want it to. If the user could imagine the vector map as a sheet of rubber and the raster map as paper, then registering a raster image is like taking the rubber map and stretching and pulling it in different directions, deforming the map until the rubber map fits over the paper map. We would then place pins to attach the rubber map to the paper one. MapInfo would then remember where those points are and use those to deform vector images every time that particular raster image is opened.

When registering raster images, the group first opened both the raster image and the vector map that was to be registered to in the same window within MapInfo. The commands for registering raster images can be found under "Table, raster, modify image Registration" within the menu bar of MapInfo. This would prompt the "Image registration" window to pop up. See Figure-F10. This window displays the points' locations, or pins using the rubber map analogy, of the raster image (paper map). The window in Figure-F10 entitled "Edit Control points" shows the coordinates of the control point that is highlighted in the "Image Registration" window. This window is opened by clicking on the "Edit" button in the Image Registration window. The "Map X" and "Map Y" coordinates are the coordinates of the control points (pins) on the vector map (rubber map). The "Image X" and "Image Y" coordinates are the coordinates of the points on the raster image (paper map).

To create these points, the team members first would click on "New" in the "Image Registration" window to create a new control point (pin). The group would first find a spot on each map, the vector and raster, then manipulate the "Image Registration" window and the main window so that the spot to be the new control point was in both windows. A control point could be a building, intersection, street corner, etc. Team members first would click on the location of the new control point on the map in the "Image Registration" window. Then, without closing that window, the group would move the window off to the side so a point on the vector map in the main window could be selected. In order to do this, the group had to make sure that the control point was highlighted first. Then the team had to choose "table, raster, select control points from map", then a corresponding point to the point already selected in "Image Registration" could be picked from the vector map.

The farther apart the points are, the more accurate the registration is. At least three control points must be chosen to register a raster image. But, the more control points that are chosen, the more accurate the registration. In the "Image Registration" window under the part that says "Error (pixels)" is an estimated error in pixels. When this number was off, the group would highlight that control point and it could then be edited either by typing in new coordinates using the edit button, or choosing the points again by re-clicking on the map. This was repeated until the "error in pixels" was zero or 1 for all control points.

Registering A Vector Image:

See "The Transparent Wards"

The Transparent Wards:

After the group had a working base map that was correctly oriented. The team proceeded to register the wards with the orthophoto base map. The CD of wards was provided by The City of Boston Assessing Department. They were all in .dxf format, which is a file format for vector images that can be imported by various CAD packages as well as MapInfo. The group had to convert all these files from .dxf to files that could be recognized and manipulated by MapInfo. This method for converting these files was shown to the group by Prof. Fabio Carrera, one of the co-advisors to this project.

When trying to align these vector images of the wards with the orthophoto base map, the group tried to align the two as closely as possible to each other. In order to do this a few wards had to be converted twice. To convert a .dxf file to a file that can be manipulated in MapInfo, one has to do something called "import" the .dxf files by using MapInfo.

The option of importing a file can be found under "table" in the menu bar, then under "import...". The window titled "import file" in Figure-F11 will then appear. The group had to make sure to go to the directory where the .dxf files are located and then had to choose the correct file types, highlighted in yellow in Figure-F11. The desired file to import was chosen and this prompted the window in Figure-F12 to appear. "Preserve Attribute Data" was chosen to keep any information that might be tagged to objects in the files. The team tried importing files with "Suppress Warning Messages" unchecked and the only messages that appeared were ones saying that there are no attributes attached to a certain object this prompted the user if he/she wanted to import this specific object

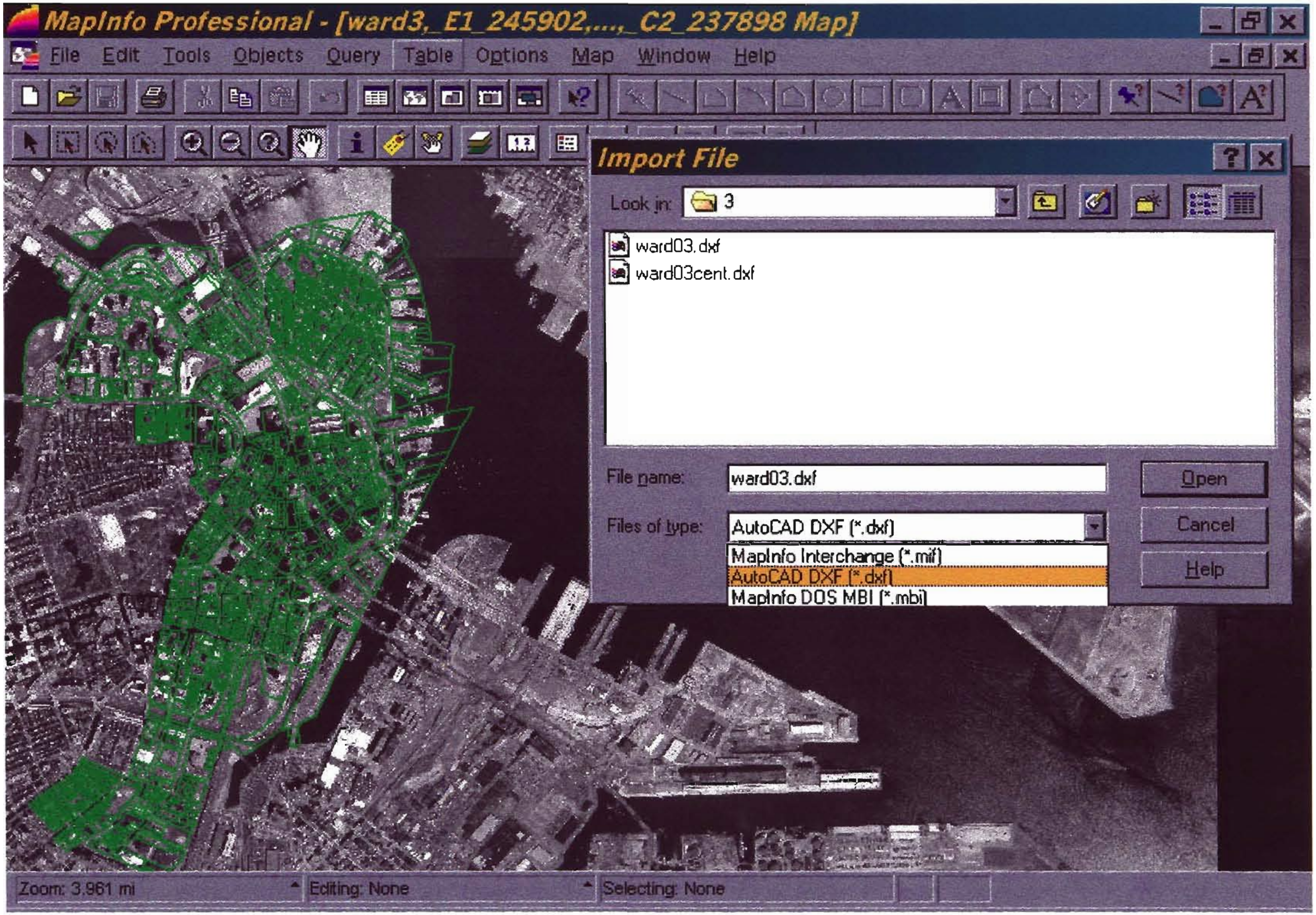

Figure-F11 (Importing A File)

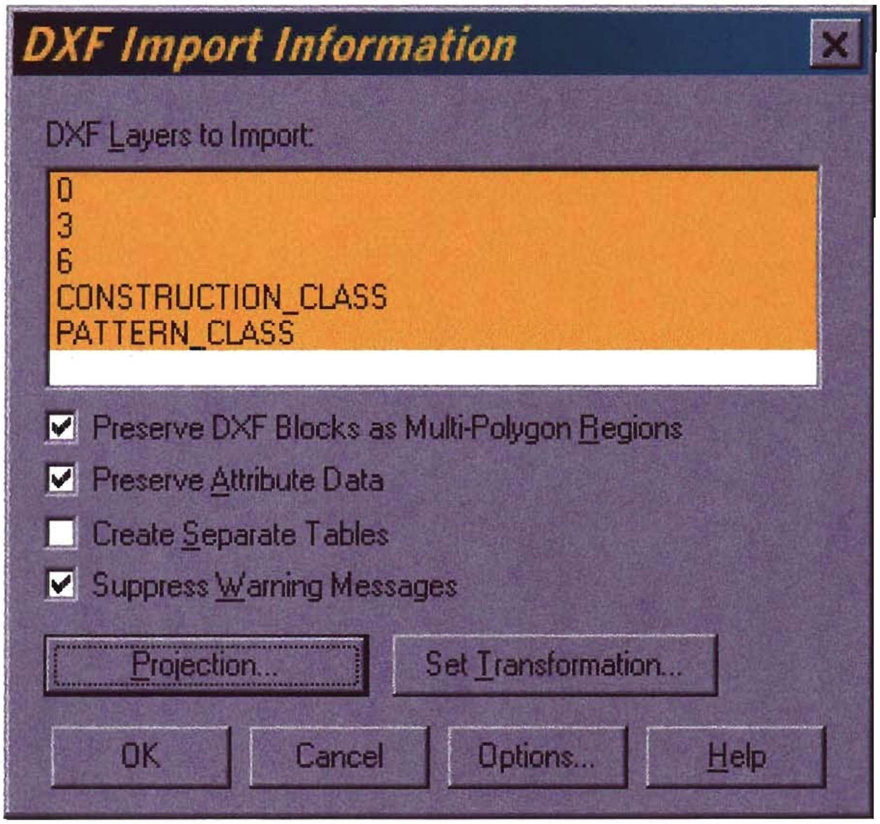

Figure-F12 (DXF File Import)

anyway. The answer was yes in every case, so the group left this option checked as in Figure-F12. The group then chose the correct projection with which to import all these files.

The document that was received from the City Assessing Department along with the CD stated that US State Plane Coordinate Systems (1927), Massachusetts 2001, Mainland Zone (1927) was to be the projection used. This is illustrated in Figure-F13 and was the projection used for importing all the ward images. For the "Set Transformation" option, it was left as is. The user needs to see how the map is currently registered. Where does the map think it is in reference to the rest of the world? A series of points needs to be selected from the map when it is registered *in*correctly so that corresponding points can be selected from a map that is registered correctly. This will give MapInfo the information it needs to correctly import these files. Figure-F16 shows the transformation points that were used when converting these images for the first time, these numbers were not chosen by the team members. Rather, these are the coordinates of the current transformation points. Notice how the numbers for point 1 and 2 of "DXF Coordinates" matches with the numbers of point 1 and 2 of "MapInfo Coordinates". This was desired because MapInfo will import the file as is and will not reorient the image at all. This way the team members were able to pick the series of points on the incorrectly registered map mentioned a few sentences back.

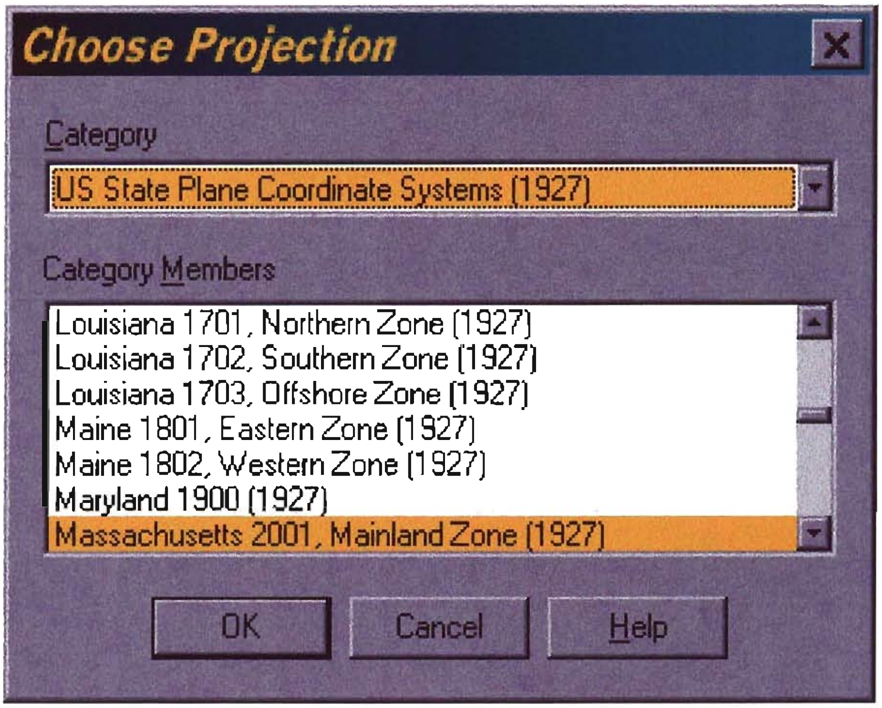

Figure-F13 (Choose Projection)

A CD provided by Prof. Fabio Carrera was obtained which contained some vector maps of Boston. One of the maps on the CD was of wards 1,2,3, and 6. These maps are included in the final CD produced by the IQP group. It is located in the following directory "From Fabio's CD\Boston Parcels Map Future\". These maps, according to Prof. Carrera were correctly registered and it was suggested that points should be used from these maps when importing the ward maps. The process goes as follows.

Import the file as is, with no transformation, open it in MapInfo and have Prof. Carrera's map of the same area in another MapInfo window. Pick a point in one window, note it's coordinates. Then pick the same point in the other window and note its coordinates as well. For example the group would click on a building, intersection, etc, in Prof. Carrera's map. Then choose the same building, intersection, etc, in the wards maps provided by the City Assessing Department. Two points must be chosen for MapInfo to "transform" the image properly. So, a total of four numbers were to be

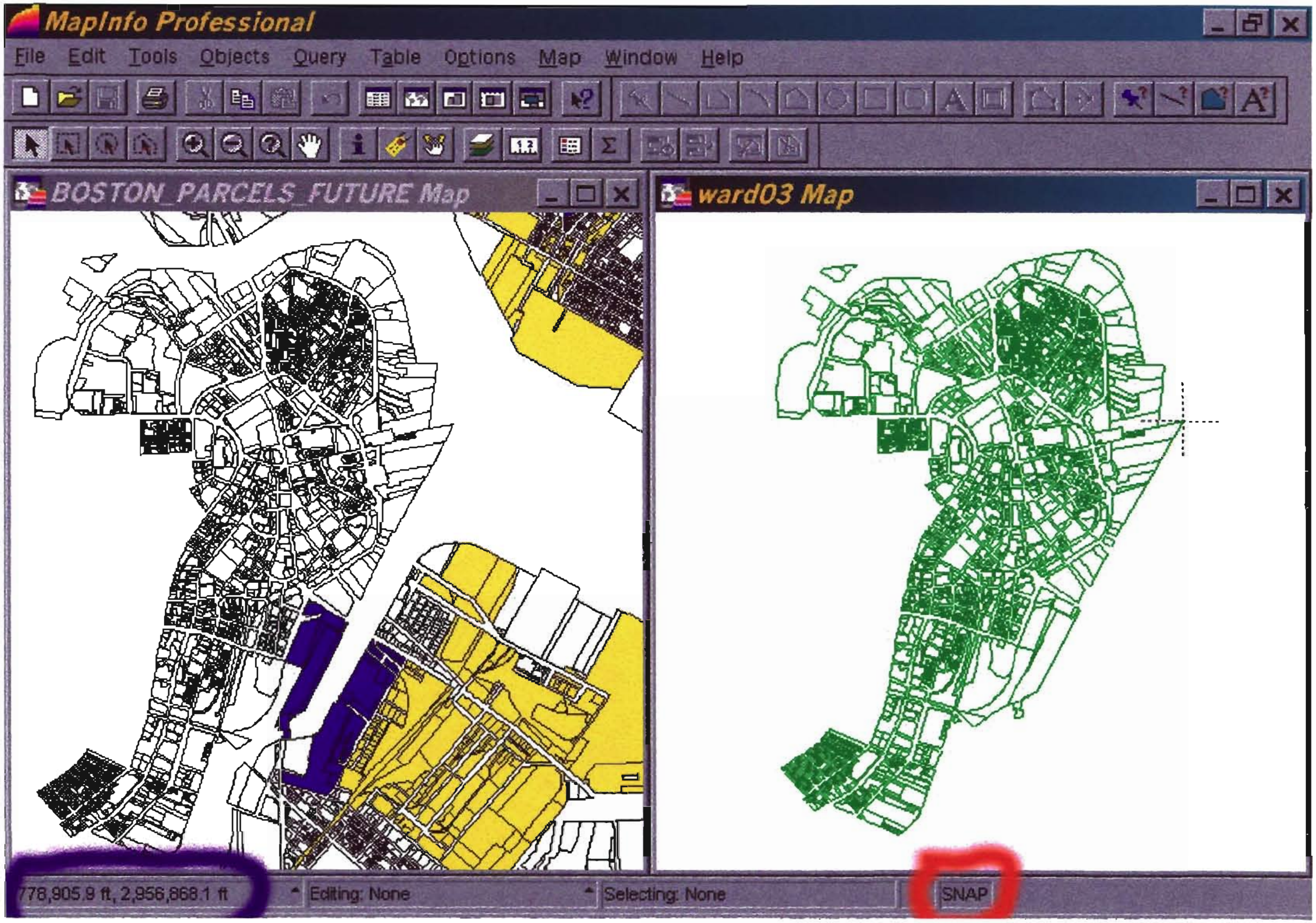

Figure-F14 (Example of Window Tiling)

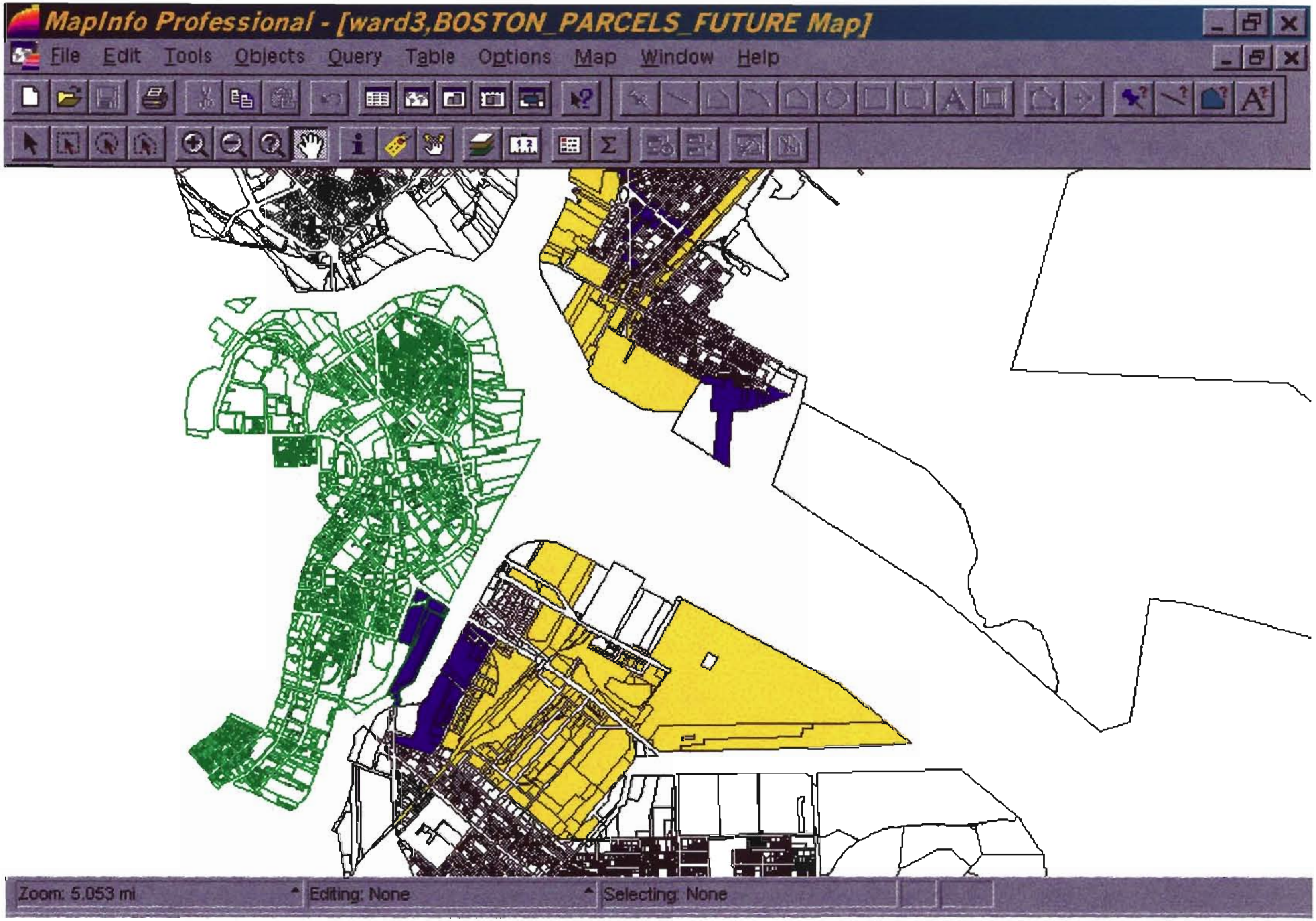

Figure-F15 (Wards Aligned)

recorded and used for the second conversion of the ward maps: An X and Y coordinate from each map.

When picking the points, the group was sure to have both windows using the same projection as in Figure-F13. Figure-F14 shows an example where the two windows, with the two different maps located in the same MapInfo session. To maximize accuracy, points are to be picked as far apart as possible. Also, when picking these points, the group used the snap feature of MapInfo. This is activated/inactivated by pressing the "S" key on the keyboard. This will snap to an intersection of two lines. Using the snap feature made it possible to pick the exact same points. Again, resulting in more accurate results when the actual transformation takes place.

After the points were recorded, the group then would import the .dxf file for a second time. Once again this is found under the "table" option in the menu bar. See Figure-F11. After selecting the file again, the window in Figure-F12 appears. Everything was to stay the same when importing for the second time. The only option that changed was under the "Set Transformation" button in Figure-F12. After clicking on the "Set Transformation" button, the team then entered the four numbers in the proper boxes in Figure-F16. The X and Y coordinates that were chosen from the map that is being used as reference were entered under "MapInfo Coordinates" in Figure-F16. The X and Y coordinates that were chosen from the map that is being transformed, the .dxf file, were entered under ".DXF Coordinates". After that, the team selected "OK", then selected "OK" again, then MapInfo begins the transformation. After the transformation is complete, both maps lined up as in Figure-F15.

This was the method that was used to transform wards 1,2,3, and 6, which were the four wards that were available on the CD provided by Prof. Carrera. This was done because, for these wards, exact points could be picked, resulting in greater accuracy. After these four wards were completely oriented correctly, the group opened all four wards in the same mapper within MapInfo and then chose one more set of points for converting the .dxf files. Points were picked from the furthest points possible from the four wards. Then these numbers were noted and were used for transforming the remaining wards. This was done because there were no wards to reference points from because only wards 1,2,3,and 6 were provided.

The final product from transforming all the ward maps is depicted in Figure-F17. The green outline is the .dxf files that were transformed. The black and white picture is one of the orthophoto images that were used in this project. The white and yellow drawings are the ward maps that were provided by Prof. Carrera and were used to reference points.

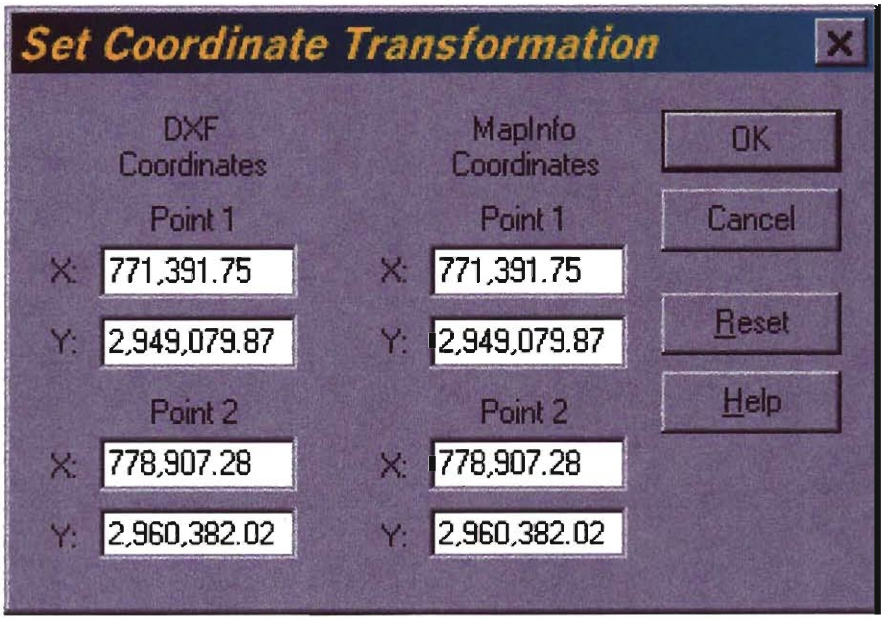

Figure-F16 (Setting Coordinate Transformation)

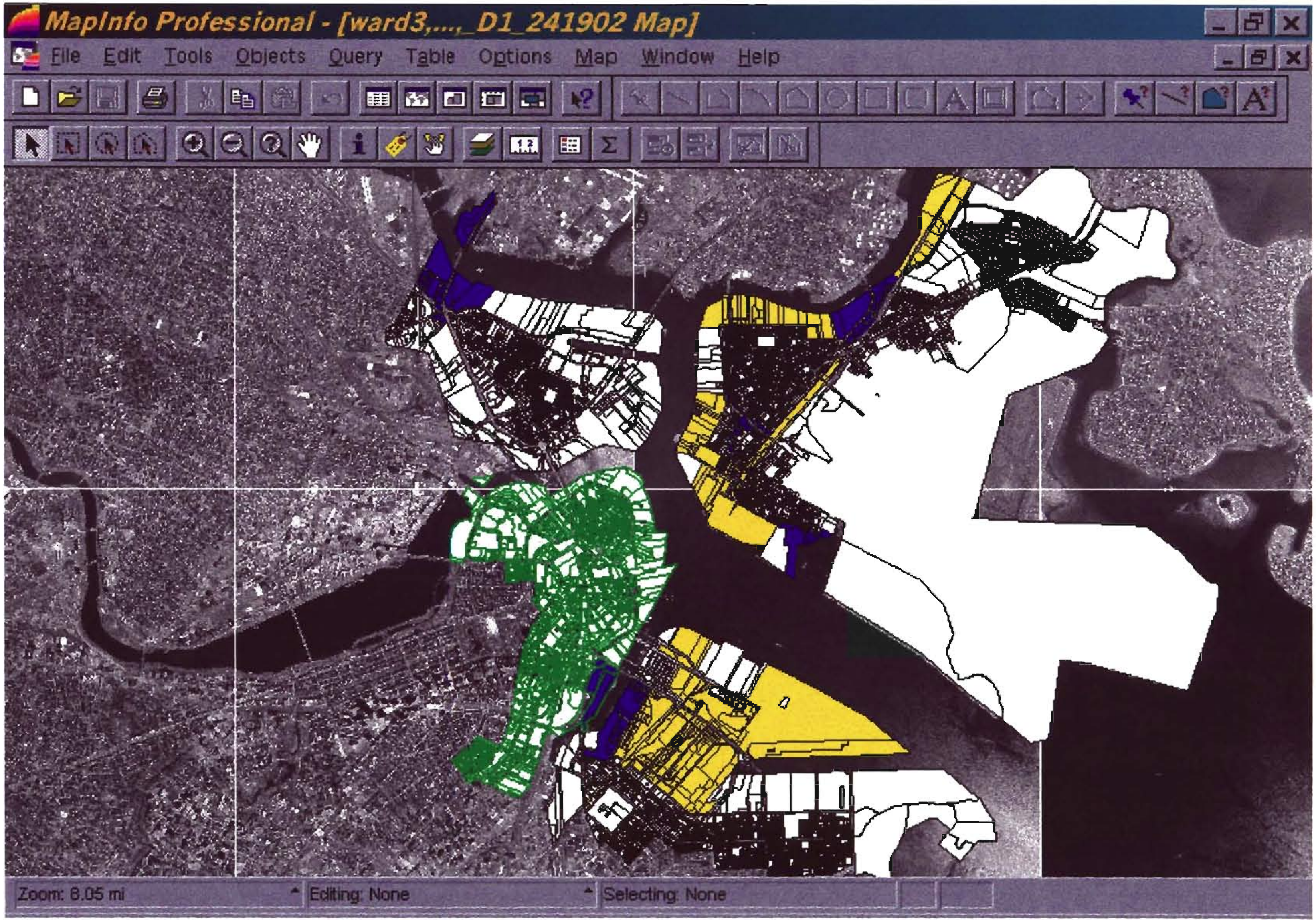

Figure-F17 (Final Ward Registration)

Glossary of Terms

AutoCad: A software application that uses vector images primarily used to draft technical drawings and layouts.

Browser: A browser in MapInfo terms, is a window that will display all records/information that is attached to that map.

BLC: Boston Landmarks Commission

CLG: Certified Local Government

DXF Files: A .dxf file is a type of file made in AutoCad so that files can be imported and exported in other programs using vector images such as MapInfo, Pro Engineer, and various CAD programs.

Field: A category within a record within a database. For example, the field date in the 5th record in a database of landmaking projects.

GIF: Graphics Interchange Format

GIS: Geographical Information Systems

JPEG: Joint Photographic Experts Group

LHC: Local Historical Commission

LHD: Local Historical District

LHDC: Local Historic District Commission

MACRIS: Massachusetts Cultural Resource Information System

Mapper: A mapper in map info terms is a window that will display all graphical information that is drawn. Information can be attached to objects drawn in the mapper.

MEPA: Massachusetts Environmental Policy Act of 7/1/98

MHC: Massachusetts Historical Commission

MPPF: Massachusetts Preservation Projects Fund

NHD: National Historical District

NHPA: National Historical Preservation Act of 1966

Node: MapInfo's definition of vector images is as follows, * "An end-point of a line object, or an end-point of a line segment which is part of a polyline or region object. If two streets intersect, there is a node at the point of the intersection."

The project group's understanding of raster images is as follows. A node can also be thought of as a control point. For example a user can select a node of a polyline to manipulate and stretch the line to the desired length and shape. A node is also what is snapped to when the snap function is active.

NRHP: National Register of Historic Places

Orthophoto Images: An orthophoto image is a satellite image of the earth.

PNF: Project Notification Form

***Projection:** "A mathematical model that transforms the locations of features on the earth's surface to locations on a two-dimensional surface, such as a paper map. All projections have some degree of distortion, because a map is an attempt to represent a spherical object (the earth) on a flat surface. A map projection can preserve area, distance, shape or direction but only a globe can preserve all. Some projections (e.g., Mercator) produce maps well suited for navigation. Other projections (e.g., equal-area projections, such as Lambert) produce maps well suited for visual analysis."

Query: A query is essentially a question. Within MapInfo the user can do a search through the information that can be tagged to objects and have them displayed on its own layer.

Raster Images: MapInfo's definition of vector images is as follows, *"A type of computerized picture consisting of row after row of tiny dots (pixels). Raster images are sometimes known as bitmaps. Aerial photographs and satellite images are common types of raster data found in GIS. A computer image can be represented in raster format or in vector format."

The project group's understanding of raster images is as follows. A raster image is a picture that can only be manipulated in a paint program such as Adobe Photoshop, Paintshop Pro, Microsoft Paint, Microsoft Imaging, etc. Some examples of raster images are .GIF, .JPG, .TIF, .BMP, .PCX, and .BIL files. The term raster images is not specific to MapInfo. Most images one would see on the internet are raster images. Any pictures taken with a digital camera are raster images, including the satellite image that was used for the base map in this project. Figure-F18 is a raster image as well. (See definition for Raster Images)

Record: An entry within a database.

Snap function: Within MapInfo the user can "snap" to a node. This can be useful to obtain an exact point if need be. The snap function can be turned on and of by pressing the "S" key on the keyboard. In Figure-F14 the snap function is on and is snapped to a corner of two lines on the map. The area of the screen circled in blue in Figure-F14 shows how coordinates of the node that was snapped to can be read. The area of the screen circled in red in Figure-F14 tells the user if the snap function is currently on or off.

***SQL(Structured Query Language:** A standard language used for analyzing information stored in relational databases. MapInfo's database engine is based on the SQL standard.

SRHP: State Register of Historic Places

***Table (Database):** "MapInfo databases are organized as tables. Tables are made up of rows and columns. Each row contains information about a particular geographic feature, event, etc. Each column contains a particular kind of information about the items in the table. MapInfo can contain graphical objects representing geographical objects. Such tables can be displayed as maps."

Table(.tab files): Every image, whether it be a raster or vector image, has a .tab file. Or a table file. (.tab file = table) This file is a header file that tells MapInfo how to display the images and maps that correspond to the .tab file. As can be seen in Figure-F18, there are three other files associated with the file ward3.TAB. These are ward3.DAT, ward3.ID, and ward3.MAP. When a .tab file is opened in MapInfo, The .tab file "talks" to the other three files, reads what's in them, then displays what it read from the other three files in MapInfo. The .tab file is what decides how to display the images. Modifying the .tab file can be done in MapInfo. Different methods are required depending if the images that are associated to the table are raster or vector. The table is just a header file and is all text. It can be viewed in Microsoft Wordpad and even edited there. But, it is better to edit them in MapInfo. Figure-F19 shows the .tab file ward3.tab opened with Microsoft Wordpad.

TIFF: Tagged Image File Format

UTM: Universal Transverse Mercator

Vector Images: MapInfo's definition of vector images is as follows, *"A coordinate-based data structure commonly used to represent map features. Each object is represented as a list of sequential x,y coordinates. Attributes may be associated with the objects. A computer image can be represented in vector format or in raster format.".

The groups understanding of a vector image is as follows. Anything that a user draws in MapInfo is a vector image. The advantages of having a vector image is that when a user zooms in he/she doesn't see the pixels get bigger. This is due to the above definition by MapInfo, the section that says "Each object is represented as a list of sequential x,y coordinates". A vector image is composed of a bunch of objects that can be selected, edited, and modified, using MapInfo's editing commands. The user can link info and give each object attributes which is another advantage to vector images. The term vector images is not specific to MapInfo. CAD(Computer Aided Design) drawings are vector images as well. (See definition for Raster Images)

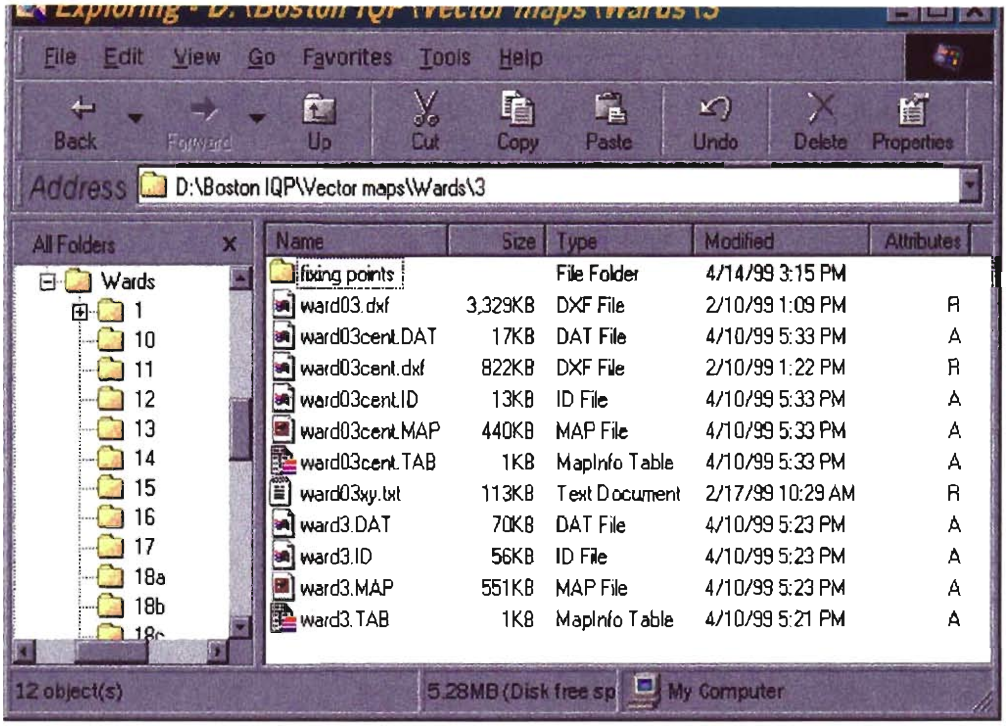

Figure-F18 (Examples of .tab files)

Figure-F19 (.tab file opened in Wordpad)

*[This definition came from the MapInfo's help files]