A GIS Analysis on the Effects of the Hiawatha Light Rail on Single-Family Residential Property Market Values.

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Abstract

Mass transit systems are becoming ever more popular in metropolitan cities. The light rail system is one of the more popular transit systems. The Twin Cities recently introduced their first light rail corridor, the Hiawatha Line, with continued expansion anticipated in the new future. Studies performed in other states with light rail systems show property value increase in the surrounding areas of the light rail and its' stations. This research focuses on the Hiawatha Line and the communities it serves to analyze changes in property values.

Introduction

Light Rail Transit Systems

Light Rail Transit (LRT) systems are the modern version of streetcars. LRT is an important part of a transit system because of its ability to transport high numbers of commuters comfortably, efficiently, and quietly. LRT trains are clean and quiet because they are electrically powered by overhead lines. This transit system can make use of track laid on ordinary roads along a right-of-way which may be segregated from other road users by a fence, or even just road markings. LRT is a true mass transit system in the sense of being capable of conveying large volumes of passengers quickly and efficiently. Gatzlaff & Smith (1993) point out that by their very nature; fixed rail transit systems have a linear, downtown-oriented character.

Hiawatha Corridor Line

The Hiawatha Line currently serves the Twin Cities metropolitan area by offering 12 miles of service tracks and 17 stations connecting Downtown Minneapolis, Minneapolis/St. Paul International Airport and the Mall of America (Figures 1 & 2).

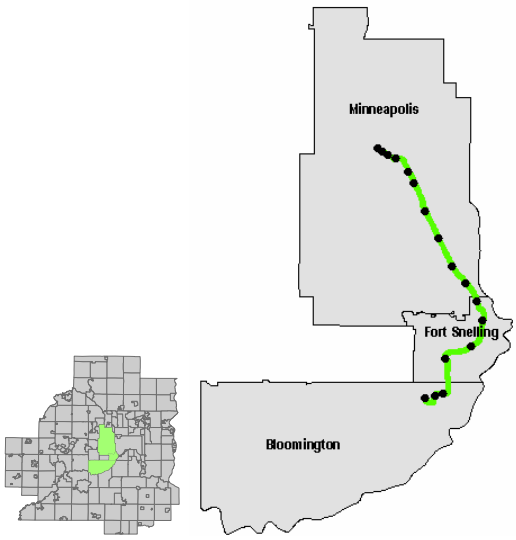

Figure 1. The Hiawatha Corridor runs from Minneapolis to Bloomington.

Construction began on the corridor in June of 2001. Three years later, on June 26, 2004, partial service was offered from the Downtown Warehouse District to the Fort Snelling Street Station, with full service to the Airport and the Mall of America added in December 2004. Metro-Transit boasts 24 cars, each 94 feet long. Each train may contain 2 cars and a car can hold 66 seated passengers and 120 standing passengers. The estimated ridership in 2005 is expected to be 19,300 per day (Metropolitan Council, 2005).

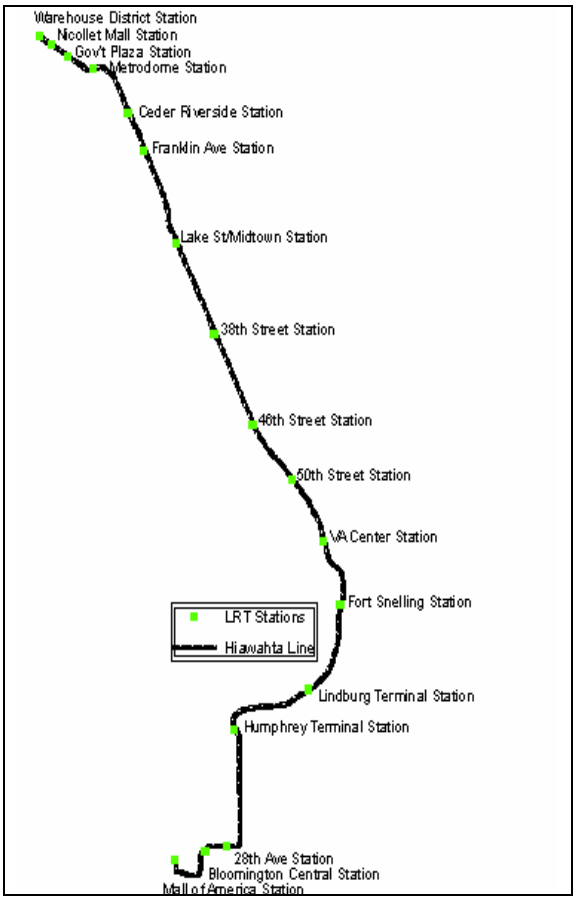

Figure 2. Metro Transit Hiawatha Line stations.

Significance of Research

Light rail transit systems are becoming increasingly popular in metropolitan cities. It is important to know the impact that transit systems bring within communities. Diaz (1999) states that one of the most significant impacts of a rail transit system is its impact on property values.

Transit service may either enhance the value of residential property values by providing greater accessibility or it may negatively affect the value by causing noise, pollution, and temporary disruption due to construction, or other incidental effects (Gatzlaff & Smith, 1993). The monetary value of the effects of transit services will be reflected in the value of a home or business, in addition to the value of other features such as the specific physical attributes of the building and neighborhood characteristics (Brinckerhoff, 2001).

Property value impacts tend to be highly localized around rail stations, which suggest that attention must be given to the location of stations (Brinckerhoff, 2001). The effects of rail transit were most predominantly felt within a very limited distance from the transit stations. The distance is determined by the distance of a reasonable walk from a station, generally one quarter mile to one half mile (Diaz, 1999).

Evidence for the light rail's influence on residential property values has been demonstrated more clearly than that for commercial property values. Landis et al. (1995) notes three reasons that residential property values are analyzed more than commercial properties: (1) they have more comprehensive and reliable data; (2) number of observations to be made in the zone around LRT stations; and, (3) housing values are determined in the market place.

The Twin Cities currently has one LRT corridor, the Hiawatha Line,

with expansion of the Central Corridor planned for construction. It is important to understand the impact the LRT has in Minneapolis for future planning and economic purposes.

This research focuses on the effects of light rail transit systems on property values and how Geographic Information Systems (GIS) can be used to answer two questions. First, what is the difference in single-family property values from 2000 to 2004? And second, does the introduction of the Twin Cities first light rail line positively or negatively affect these property values?

Methods

The Role of GIS

Geographic Information Systems (GIS) plays an important role in evaluating the effects of the LRT on property values. Non-GIS methods require a substantial amount of resources, are data intensive, and spatial relationships are difficult to model dynamically using conventional programming methods (Bell et al, 2000).

GIS can be employed to calculate spatially related variables such as distance to the LRT stations and use queries to extract unwanted data (Chen et al., 1997). The use of GIS technology is becoming more prevalent among planners. GIS is used to link map data with parcel data allowing a large scale analysis.

Description of Study Area

This study examines single-family residential homes in order to make initial evaluations on the changes in property value along the Hiawatha Line. Multi-family residences were not evaluated due to the discrepancy of having many owners to one land parcel. This would skew the data because of the large value associated with multi-family property.

Environmental Systems Research Institute's (ESRI) ArcMap 9.1 was used to determine the two LRT stations that serve the majority of single-family residences. Based on the visual identity of a spatial pattern, it was determined that single-family residences were most concentrated around the 39th Street and 46th Street stations (Figure 3).

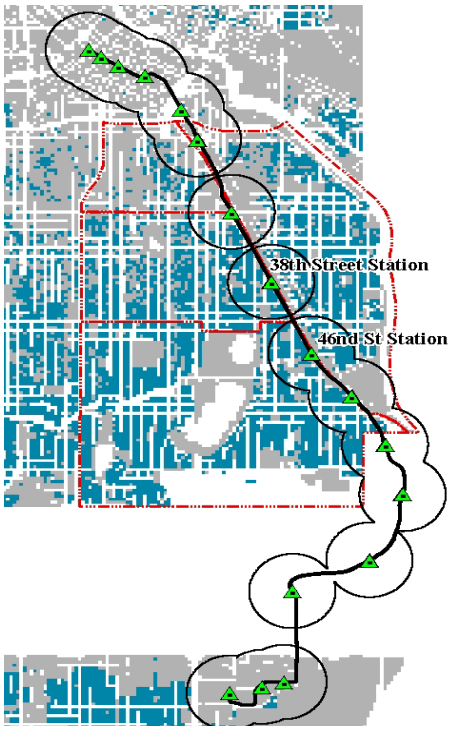

Figure 3. Single-Family Residential Distribution. Blue areas represent "Residential" while gray areas represent "Non-Residential" (note: the gap in parcels represents Fort Snelling Military base and the white areas represent road networks and water bodies).

This study includes single-family residential properties located inside a half-mile buffer of the 38th Street and 46th Street stations and the surrounding neighborhoods. The 38th and 46th Street stations serve 4 communities comprised

of 23 neighborhoods (Figure 4 and Table 1)

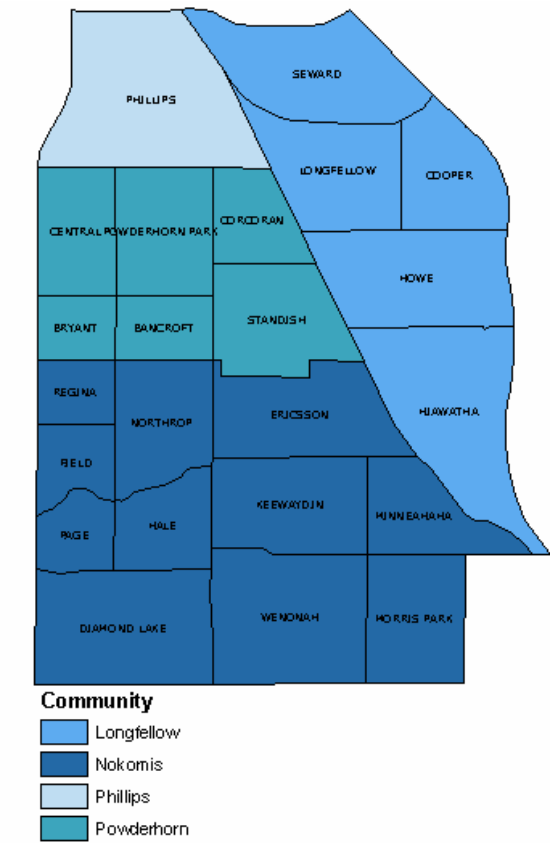

Figure 4. Study Area.

It is the purpose of this research to analyze the effects of the LRT on single-family residential property values within the defined effected area (two stations) to that of the communities outside of the half-mile buffer. This study examines over 28,000 parcels of residential property and 3,783 acres or 79% of the total number of parcels located in the study area.

Data Collection

Property market values for 2000 and 2004 for single-family residential homes are used for this study. The data from 2000 was chosen to evaluate the market value of single-family homes prior to construction of the Hiawatha line. 2004 data is used to review changes in market value that occurred after construction and opening of the corridor.

Table 1. Communities affected by 32nd & 46th Street Stations.

Communities	Neighborhoods
Phillips	Phillips
Longfellow	Seward Longfellow Cooper Howe Hiawatha
Powderhorn	Central Powderhorn Park Corcoran Bryant Bancroft Standish
Nokomis	Regina Field Page Northrup Hale Diamond Lake Ericsson Keewaydin Wenohah Minnehaha Morris Park

All the data for this study was obtained from the Metropolitan Council in St. Paul, Minnesota. Data used include:

- Hennepin County parcel data for 2000 and 2004
- Department of Revenue market value DbaseIV files for 2000 and 2004
- Hiawatha Line shapefile
- Hiawatha Line Station points
- Minneapolis neighborhoods shapefile

Department of Revenue data was selected because it contains a more accurate assessment of property values. This project used data projected in

Universal Transverse Mercator (UTM) NAD1983 Zone 15N.

Creation of Datasets

A crucial component for this analysis was the creation of datasets. ESRI's ArcMap 9.1 was utilized to create shapefiles from the existing data obtained from the Metropolitan Council and Department of Revenue.

Before the changes in property values could be observed, it was necessary to perform a spatial join between the market value tables and the parcel datasets. The Department of Revenue data contained fields for the Property Identification Number (PIN), county, use, building value, land value and total market value. This database did not contain any location data, so it had to be joined to the Hennepin County parcels so that it could be mapped. The common unique identifier in both tables was the PIN. A PIN is a unique number assigned to each parcel along with all associated information pertaining to the parcel.

The joining process was a burdensome task due to the different formats of the PIN for each dataset. The Department of Revenue market value data had PIN numbers that contained extra zeros at the beginning and no county code attached to them. The Revenue data had to be modified so that the PIN number matched the PIN in the Hennepin County parcel dataset.

This was prepared in Excel by first parsing out the leading two zeros and adding the three digit county code (053 for Hennepin) and a dash ("-") to the Department of Revenue PIN creating new field with the corrected PIN.

The Hennepin county parcel shapefiles were dissolved on the PIN field. A dissolve is performed to ensure one record per field attribute to avoid duplicate data. The area and acreage fields needed to be re-calculated after performing the dissolve function. Fields were added and the following Visual Basic for Application (VBA) statement (from ESRI) was used to calculate the area:

```
Dim dblArea as double
Dim pArea as IArea
Set pArea = [shape]
dblArea = pArea.area
```

After the area field was calculated it was multiplied by 0.000247105 to obtain the acres for each parcel.

After the aforementioned steps were performed, a spatial join between the parcel data and the market value data was created. Using the structured query language (SQL) expression, "USE1_DESC" = 'Residential', allowed all of the residential parcels to be selected from the new shapefile. The selected records were then exported to create a new shapefile. This process was completed for both years of the study.

New fields were then created in the attribute data. One field, total market value per acre, was created and calculated for the 2000 shapefile. New fields created for the total market value between 2000 and 2004 were created in the 2004 shapefile. These fields included actual change per property, percent change per property, total value per acre, per acre change and per acre percent change (Table 2).

Subsequently, the 2000 and 2004 shapefiles were joined together based on the PIN and the new fields were calculated. After the calculations, the spatial join was removed leaving one complete dataset containing all the attribute information needed for analysis of property values.

While merging the tables for the two years, a perfect match did not occur. If there was a match between 2000 and 2004 PINs, and the total market value data in 2000 was zero and also zero in 2004, the change was noted as zero (0).

Table 2. New Field Calculations.

Field Name	Definition	Calculation
TMV0004CH	total market value actual change	TMV04 – TMV00
TMV0004PCH	total market value percent change	TMV0004CH / TMV00
TMV0004AC	total market value per acre change	TMVAC04– TMVAC00
TMV0004APC	total market value per acre percent change	TMV0004AC / TMVAC00
TMVAC00	total market value per acre 2000	TMV00 / ACRE
TMVAC04	total market value per acre 2004	TMV04 / ACRE

If the total market value data in 2000 was zero and greater than zero in 2004, the field was calculated to 99. However, if there was no match between the 2000 and 2004 PIN, the field was calculated to -99.

The original file contained 29,409 parcels for the entire study area and 5,449 parcels for the two stations. The records with a total market value change containing these calculations were removed from the final dataset using the SQL expression (Figure 5):

"TMV0004PCH" <= 0 OR
"TMV0004PCH" >= 99.

This resulted in a total of 442 parcel PIN numbers that did not match.

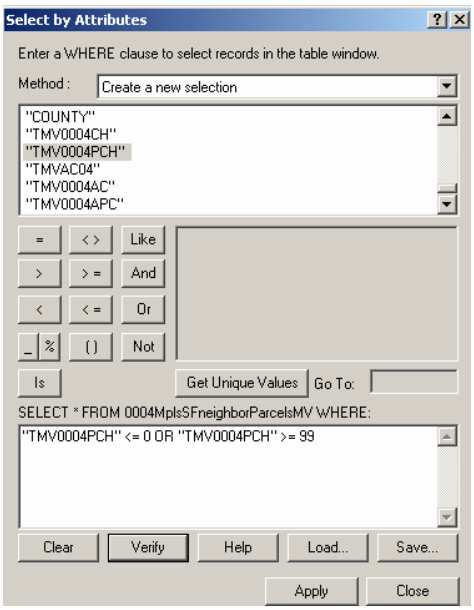

Figure 5. Select by attributes.

Creating the community layer from the Minneapolis neighborhood shapefile had to be dissolved on the selected four communities. Slivers occurred during the dissolve. Slivers are polygons that can be created between features within the same map. They are a gap between two lines that should be contiguous. As a result, any slivers had to be selected and assigned to their respective community. Then the layer was dissolved again to create a layer that separated the 23 neighborhoods into the four categories or communities.
The 2000-2004 residential shapefile was then clipped to the communities' shapefile to allow for further analysis.

Analysis

The first stage of analysis for this project began with the creation of datasets. The result of the aforementioned data manipulation ended with a single shapefile containing all the information that was needed for the examination of market values. The attributes included

the PIN, acres, total market value 2000, total market value 2004, total market value change, total market value percent change, total market value per acre change, and total market value per acre percent change.

Thematic maps were created to visually observe any distributions of a single attribute within the study area. Therefore, trends and patterns can be detected on a visual basis. Appendix A and B show thematic maps for the total market value and the total market value per acre change for the two years used in this study. Visual observations seem to indicate that patterns exist. Appendix A shows two maps representing total property market value for 2000 and 2004. A concentration of high value properties are in one area. This raises the question "what is happening here?" It is noted that the concentration consists of parcels that are near water bodies (Lake Diamond, Lake Hiawatha, Lake Nokomis and the Mississippi River). Properties adjacent to water tend to have a higher appeal; consequently, this is reflected in higher property values.

The thematic maps showing the acreage change and the percent acre change (Appendix B) suggest a different cause for increasing property values. The average single-family residential parcel is 0.13 acres. The first map, Total Market Value per Acre, indicates the change in value per acre and does not suggest a dramatic pattern. Significant property value changes seem to be scattered consistently across the study area. When the percent change map from Appendix B is viewed, patterns are more clearly represented and a higher percent change does seem to occur around the light rail.

The thematic maps indicated some patterns and trends. Residential parcels within a half-mile radius of the two stations were compared to all other parcels. A total number of 28,967 parcels (3,724 in the 38th Street station buffer and 1,664 in the 46th Street station buffer) were reviewed.

Using ArcToolbox statistics, a frequency table was performed on the datasets. A frequency creates a list of unique code occurrences and their frequency for a specified set of items in a table. A table with the output frequency statistics was generated. For this project, the neighborhood and station fields were used to calculate frequency statistics. The previously described calculation fields were used to summarize the frequency results. Microsoft Excel was then used to calculate the totals and percentages for each community and station.

Parcels within the buffer were calculated by adding all total market values of all parcels divided by the number of parcels, to find the average of all market values. The same procedure was computed for the community as a whole. These two values were then compared.

Results

The average total market percent change for the entire study area show property's having an increase of 93% from 2000 to 2004. Within the half-mile buffer of the two stations, the change in total market value is consistent with the entire study area showing an overall increase of 92%. However, the 38th street station, showed a higher overall increase in market value of approximately 100% and the 46th street station showed a lower increase than the study area of 78% (Figure 6).

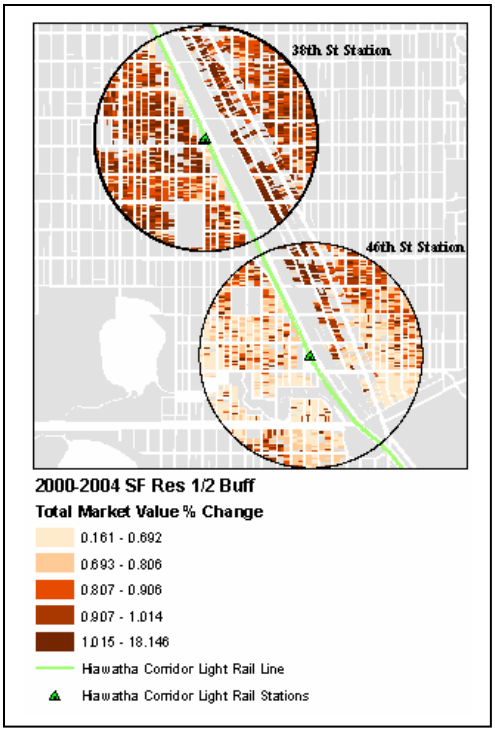

Figure 6. 2000-2004 Total Market Value % Change for the 1/2mile buffer of the 38th St. 46th St. station.

Also noted was the concentration of increased market values in the Powderhorn community (Figure 7). Findings show that 5,623 parcels (80%) of the single-family properties in Powderhorn, show a total market percent change from 2000 to 2004 to be that of over 80%. However, the parcels in the highly priced Nokomis neighborhood showed only 4,111 (30%) of the parcels having an 80% increase in total market value. This could be due to the assessed values being recalculated to align within the current market by adjusting the under assessed Powderhorn properties to balance the over assessed Nokomis properties. This might explain such an increase in the assessed values from 2000-2004.

Literary research revealed a positive relationship between LRT and property values. This study was a broad review of assessed market values. The initial hypothesis was that the Hiawatha Corridor Light Rail would have shown a greater impact on residential property values concentrated in a half-mile radius of the 38th and 46th Street stations than that of the four communities those stations serve.

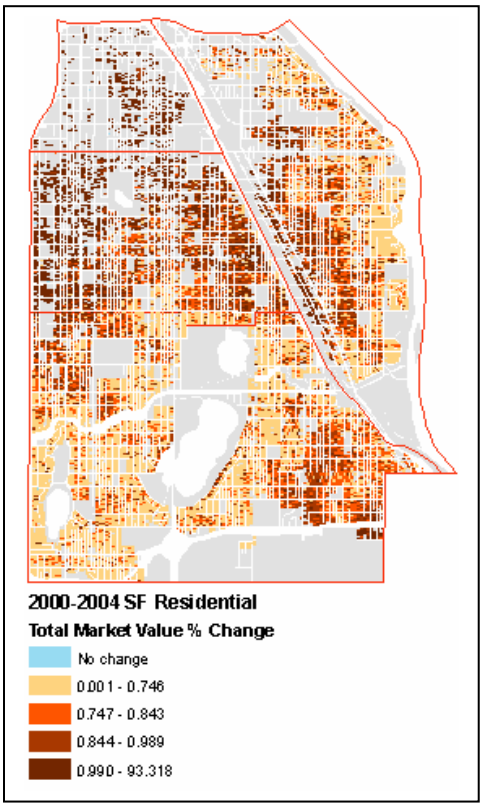

Figure 7. 2000-2004 Total Market Value percent change.

While no significant increase was found along the LRT, there is one very important finding; the Hiawatha Light Rail had no negative impacts on property values. Neither the half-mile buffers nor the effected communities show a loss of value. Therefore it can be implied that the accessibility that the light rail offers, is considered a positive attribute in accessing property values.

Discussion

A limitation was placed on this study due to the LRT being only one year old. Impacts will usually occur over time. A true assessment cannot be made on the actual impact that the light rail has on properties for 3 to 5 years after its introduction (Gatzlaff & Smith, 1993). This is a pilot approach to evaluate the feasibility of using GIS to evaluate the short-term impacts of property values via the light rail.

The techniques developed in this study can be used to identify the impact of the proposed Central Line that is currently in the planning process. The Central Line will run the 11 miles along University Avenue connecting the two downtowns of Saint Paul and Minneapolis. The findings of this study can be used to study, analyze property values, and make assumptions on comparable communities and neighborhoods that will be affected by the new Central Line.

This research has proven that the effects and magnitude differ between neighborhoods and even light rail stations themselves. It is important to continue research on these impacts to help in city and transit planning.

Acknowledgements

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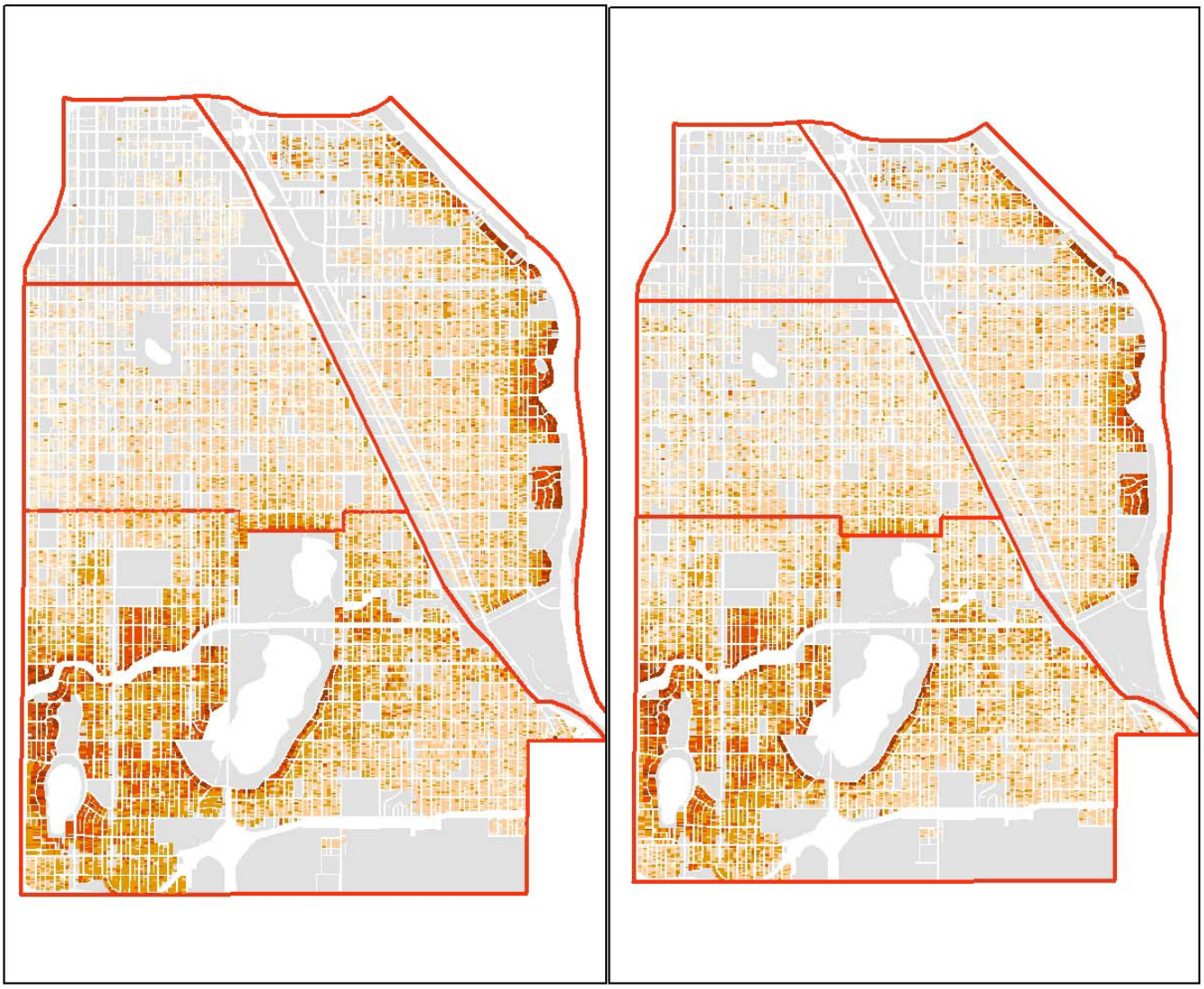
Appendix A. Thematic Maps showing the distribution of Total Market Values of single-family residential homes for 2000 and 2004. Thematic maps allow for trends and patterns to be detected.



Total Market Value 2000

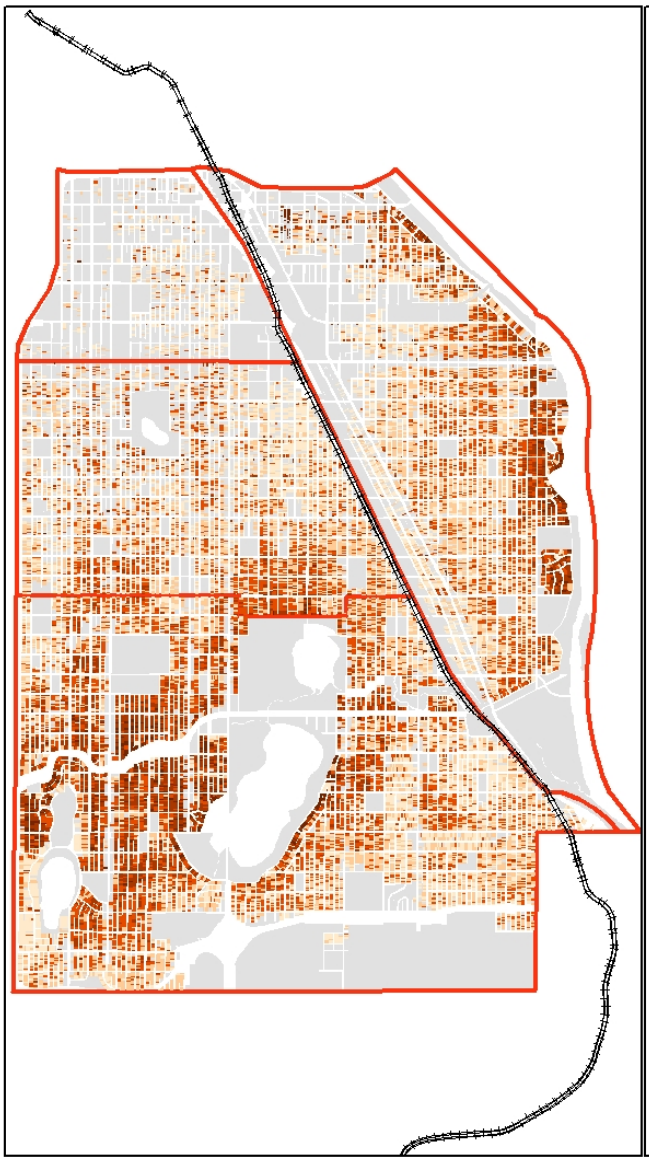
- 0.00 - 78700.00
- 78700.01 - 111200.00
- 111200.01 - 152500.00
- 152500.01 - 228500.00
- 228500.01 - 697000.00

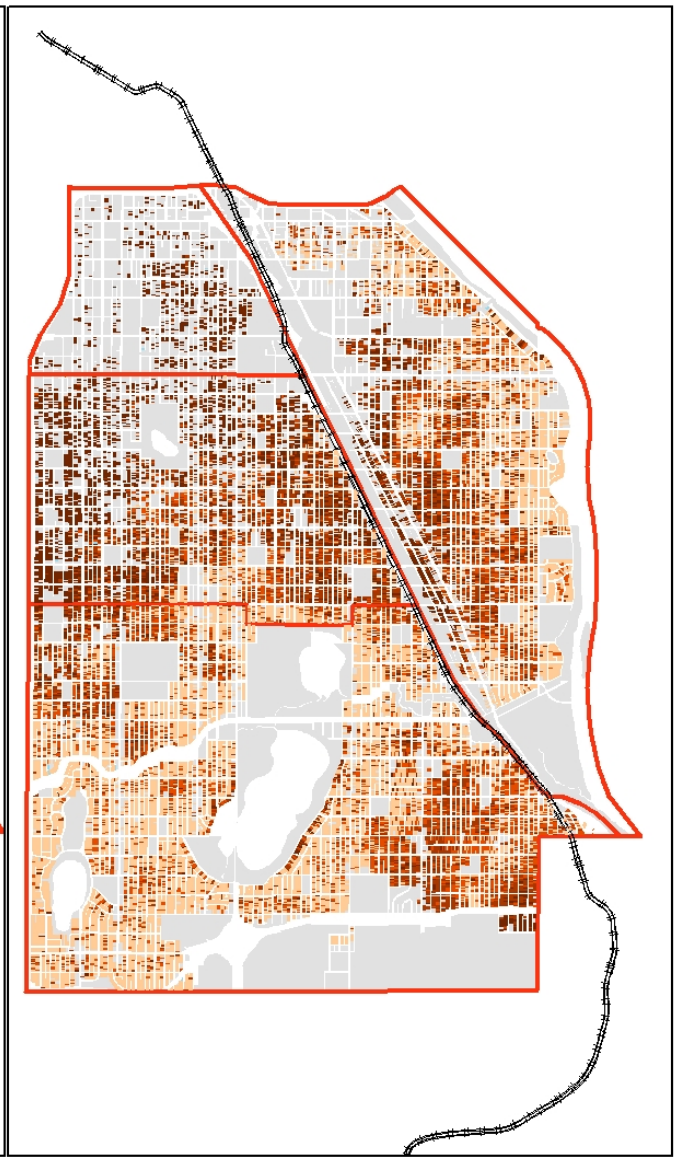
Total Market Value 2004

- 0.00 - 157500.00
- 157500.01 - 205000.00
- 205000.01 - 270000.00
- 270000.01 - 390000.00
- 390000.01 - 1044000.00

** Values represented in Thousands of dollars*

Appendix B. Thematic Maps for Total Market Value Change per Acre and Total Market Value Percent Change per Acre of single-family residential homes. Thematic maps allow for trends and patterns to be detected.





2000-2004 SF Residential

Total Market Value Per Acre

- 0.00 - 1146739.85
- 1146739.86 - 1480593.31
- 1480593.32 - 1857614.43
- 1857614.44 - 2449187.34
- 2449187.35 - 6020830.16

2000-2004 SF Residential

Total Market Value % Chg per Acre

- No change
- 0.001 - 0.748
- 0.749 - 0.845
- 0.846 - 0.994
- 0.995 - 96.265

Hiawatha Corridor Light Rail Line Alignment

**values represented in Thousands of dollars*