2008

Intra-Urban Analysis of Commercial Locations: A GIS-Based Approach

Christopher D. Storie
Wilfrid Laurier University

NOTE TO USERS

Your file Votre référence
ISBN: 978-0-494-46154-9
Our file Notre référence
ISBN: 978-0-494-46154-9

Intra-Urban Analysis of Commercial Locations: A GIS-Based Approach

By:

Christopher D. Storie. MA.
Bachelor of Arts, Laurentian University, 1997
Master of Arts, Wilfrid Laurier University, 2000

Doctoral Dissertation

Submitted to the Department of Geography and Environmental Studies in partial fulfillment of the requirements of the Doctor of Philosophy (Geography) Degree

Wilfrid Laurier University

ABSTRACT

The urban landscape is an interspersed mixing of residences, shops, theaters, parks, natural areas, and a multitude of other uses. From the early days of the central markets, to the planned downtown, to the heavily planned super-regional shopping complexes, commercial landscapes evolve. There has been considerable research conducted on analyzing the commercial structure of urban environments in an attempt to better understanding the nature of retailing and its resultant impacts on the geography of the city.

This research has three broad goals: a) to develop a technique that makes operational, in a systematized and objective manner, an approach to analyzing the structure of the commercial environment; b) to apply the approach within a GIS environment, and; c) to develop a generalized typology of urban commercial structure. The systematized analysis is a series of guidelines and statistics which can be applied in an objective manner. The development of the nearest commercial neighbor as a statistical measure of proximity to other commercial operations was the foundation of the approach to clustering commercial operations in to retail areas.

To achieve the overall goals, three census metropolitan environments (Sudbury, Kitchener and Ottawa) were used as study areas. These cities represent small, medium and large census metropolitan environments, respectively, within Canada. Commercial locations for each city were extracted from a national database of locations and mapped in a GIS environment. For each study area, the nearest commercial neighbor values were generated and the appropriate statistics extracted.

Commercial clusters were generated by using the average nearest commercial neighbor value and multiples of the median commercial neighbor value. These nearest neighbor and median values were inputted into a buffering routine as the buffer size. The resulting clusters were then compared to ortho-imagery and in the case of Kitchener, land use planning documents. Two approaches for cluster generation were employed; 1) Point-only where all individual addresses were used on the clustering, and; 2) Point plus Polygon where those commercial operations that existed within polygons (malls and central business districts) were removed from the dataset, the remaining points were then clusters and the polygons added back to the results. Finally the results from both clustering approaches were compared to land use parcels to assess accuracies of the technique.

The results indicated that the overall method proposed was effective in determining commercial zones, and that the 2x iteration of the median nearest commercial neighbor technique yielded the most accurate results. Moreover, three main conclusions were drawn. The first was that there was a difference, and in some cases significant

differences, between the land use planned commercial areas and areas that have grown larger through agglomeration. Secondly, there are density variations between core and suburban areas that, at times, resulted in a larger definition of a commercial area within the core because the lesser dense suburban areas having an impact on the nearest commercial neighbor values. Thirdly, there was considerable over-capturing of commercial areas when the buffer multiples were greater than 3x. In addition, the point plus polygon clustering technique indicated that while the defined areas were more accurate when the polygons were used, it was only in areas where those polygons were the main commercial cluster. In mixed areas, there was no discernable advantage to using the polygons. Furthermore, the removal of points had a strong impact of the nearest commercial neighbor values generated. Lastly, when dealing with polygons, the geographic arrangement of the commercial type became important.

Based on the findings of the commercial zone analysis, a typology of commercial development was detailed. This typology contained three main geographic components, namely the core, suburb and gateway areas of the urban environment. Within each geographic location, a series of commercial forms were identified. This new typology allowed for the inclusion of historical remnants of landscapes and consequently allows for a comparison against older typologies. The typology employed a three part urban classification system which is applicable to any type of urban environment and, finally, the focus on geographic form removes the impact of store changes and the changes in the nature of commercial zones over time.

This research has operationalized a systematic and replicable method of examining urban commercial location data for the purpose of determining commercial structure. This technique can be applied to future datasets easily and objectively allowing for a readily updatable typology; thus rendering it less static than previous typologies. It is the use of the technology, namely GIS, that adds this dynamism to the analyses. Furthermore, it has been demonstrated that the potential exists for using GIS to analyze commercial location data.

This research has contributed to this evolution by analyzing the geography of commercial development during a snapshot in time. However, by developing a series of operational and repeatable techniques that focus on the geographical organization of commercial locations, it is hoped that the results will function as the conceptual and practical framework for commercial structural analysis of urban environments for future studies.

ACKNOWLEDGMENTS

Writing a dissertation is a process that involves numerous people all of whom I wish to thank, however, there are several people that require special mention.

To my Parents: Beyond giving birth to me, you have always encouraged a love of learning in me and have remain solid in your support of me throughout my entire education. For this and everything else you have given me I am eternally grateful and hopefully, without you I would not be where I am today. Thank You and I love you both very much.

To My Friends: Your support over the years has meant a lot to me. We have shared many life experiences and many of those experiences have separated us with great distance from time to time but the friendship remains and for this I am thankful. I am doubly thankful that you knew better than to ask "How is that thesis coming?"

To My Committee: It has been a long journey and one which many of you thought may never end with a completed dissertation. Here it is! Thank you for your support and assistance when I needed it, for you careful editing and commenting, and for executing your roles as mentor, advisor, friend, teacher, and colleague with the utmost professionalism and compassion.

To My Wife: Joni, you have been there beside me for the entire gestation period of the dissertation. You were there from the beginning and have been supportive ever since. You understood what I was going through, you knew what to say and when, and most importantly you kicked my butt when it was needed! You are my rock, my life, my past, my present, and most importantly my future. I do not think I would have made it through this entire experience if you were not by my side. I love you.

TABLE OF CONTENTS

Chapter 3: Study Areas and Data

Chapter 4: Methods

Chapter 5: Results

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

CHAPTER 1

INTRODUCTION

"Virtually since the dawn of civilization, we have organized our world in part around the function of shopping. Even the simplest agrarian societies needed places to assemble to trade in goods, and from that basic impulse came everything else – marketplaces, villages, towns, cities.

Underhill (2004)

1.0 Introduction

During the last decade there has been a resurgence of interest among social scientists in the cultures of consumption and their associated spaces of retail capital (Lowe and Wrigley 2000). This period also coincided with the re-emergence of the study of commercial geography, and the discipline expanded its focus to include not only basic commercial location theory but the cultural and economic geographies associated with it.

The biggest reason for this resurgence is that shopping is one of the most common place human activities and that these locations in which this consumption takes place have dramatically shaped the urban environment. Shops and shopping areas are common characteristics of virtually all settlements in the developed world. Therefore, it is not surprising that the commercial system is a prime area of study for many geographers. Following the development of central place theory as a means of studying service provision in rural areas, Proudfoot (1937) examined a series of urban

environments and developed the first classification of urban commercial location. Subsequent commercial models examined the spatial patterns formed by the development of commercial activities within the urban area.

This system, in essence, has three facets to the act of consumption: the demand-side, the supply-side and the transportation and communication linkage between the two. The demand-side is comprised of the consumer but can be extended to include anyone or anything (in the case of a business) that acquires goods or services. The other side of the "consumptive coin" is the supply-side. This side is comprised of the retailers, wholesalers, and developers. It is the supply-side that this research focuses on as it is their location decisions and subsequent developments that have a lasting impact on the urban system and more specifically the commercial structure of that urban area.

The third component comprises the transportation and communication aspects of the commercial system – the physical ability to access goods and services, shipping and transportation, communication, advertising, internet sales, electronic transactions, etc. The third facet permits the system to work.

The urban commercial system becomes of primary focus because most of the population of the industrial (or westernized) world resides within the built environment. In Canada, approximately 78% of the country's population lives in areas defined as urban. Moreover, 83% of those who live in an urban area reside within the twenty-five largest urban centers (Canada 2003). In Canada, this indicates an urban system dominated by the largest cities. Consequently, it is the activities within these centers

that are the focus of much public and academic concern. One of the largest and most important aspects of the urban system is the commercial environment.

The commercial system is one of the major forces shaping the geography of our cities. The vitality, either actual or perceived, of a city is largely connected to the health of the central business district (CBD), otherwise known as the downtown core. Since this core tends to command a high concentration of commercial activity, it has become a surrogate for a city's economic health (Bunting and Millward 1998). The introduction of the regional mall into the urban fabric has created highly visible and highly accessible nodes outside of the CBD thereby changing the overall form of the commercial system. The continuing result has been the suburbanization of commercial development. These nodes shape our daily behavior and our perceptions of the city, but more importantly, they affect location decisions, other land uses and shape planning choices (Simmons 1991). The end result is an urban form that is dominated by the commercial system.

Over time, cities change and so does the commercial system. This changing system is a result of complex and often disruptive forces, both internal and external, such as geographical (physical) constraints and economic influences including a slumping or booming economy (Bourne 1997; Adolphe 2001). In addition, as the economy of many Canadian cities continues to move towards the service sector and beyond, the nature of our cities will continue to change and reflect the nature of the economy at that time. Furthermore change can also be caused, or accelerated, by competition between retailers.

This competition coupled with population growth within our cities has forced retailers to find new and innovative ways to provide goods and services to consumers. A contemporary example is the new-format retailer. These retailers use large, warehouse style stores (volume sales) which result in cheaper overall prices for the consumer. This shift towards substantially larger stores caused a dramatic change in the commercial system because of the location within the urban environment where these stores were built. New locations needed to be sought when compared against the traditional "main street" style of retailing and even the enclosed shopping malls. These big-box clusters required large tracts of land, and good to exceptional access to major arteries and highways. This geographic requirement dictated suburban, and in many cases, urban fringe development, thus drastically changing the way the system worked.

According to Jones and Simmons (1993) "the [commercial] environment, including our patterns of consumption, and the facilities that we use in the process of consumption, has always played a central role in social, economic, and geographic processes." The commercial system is one of the major forces shaping the overall spatial organization of our cities.

Over the last twenty years, commercial services have moved from being an industry dominated by the general merchandise department store located within the core, to a dynamic environment comprised of numerous generic and specialty stores in a variety of sizes and styles. This has resulted in temporal changes to the form and function of these commercial zones. This change, initiated post World War II, exploded during the shopping mall boom of the 1970s and the subsequent big-box store growth

of the early 1990s. This unparalleled growth has had an irreversible impact on our towns and cities.

Throughout this period of change, consumers have been faced with an ever increasing selection, both in terms of stores as well as products. The result, as Wrigley and Lowe (2002) have identified, is a "retail culture". This culture has grown from being a downtown, traditional main street phenomenon – an area once exclusively reserved for the act of consumption – to a phenomenon that has integrated itself into almost every aspect of Canadian life. Our suburbs, airports, sporting complexes, arts centers, and almost any other possible area have become potential commercial destinations. So great has been the growth of retailing in these new forms that Lowe (2000) has suggested that the idea of the mall as a catalyst for housing development has been advanced to a stage where the introduction of a regional mall has become the catalyst for *new* city development.

However, all these changes have not occurred evenly across the urban hierarchy. Change has been irregular and sporadic in some cities, and vigorous and consistent in others. What is known is that these changing commercial structures are having a profound impact on the spatial organization of Canadian cities. Within Canada, the commercial economy plays a vital role in the overall economic health of the country and the urban areas within it. An examination of the employment figures in Canada quickly illustrates that commercial services have become one of the most vital aspects of the economy (Canada 2003). Yet, commercial growth also contributes negatively in terms of urban sprawl through the continued development of low density commercial clusters

instead of a mixed use development style whereby both commercial and residential are integrated together (Bunting and Filion 1999), and the inequitable distribution of goods and services across the entire urban environment, sometimes referred to as 'deserts' (Wrigley 2002; Wrigley, Guy et al. 2002).

This growth in employment also coincides with a change in attitude towards consumption. In addition to the necessities that shopping provides, it is now also regarded as a major leisure activity. The increasing mobility of consumers coupled with the idea of shopping as leisure has led to the reality that *all* commercial locations can become *potential* destinations. Therefore, the consumer has a wide variety of shopping environments or forms (malls, plazas, markets, downtowns) from which to choose from within their respective urban environments. This does not even include bordering or neighboring areas beyond their respective realm. The result is that any commercial area within the urban environment has the potential to attract anyone from anywhere within the same environment. The deciding factors are what the area has to offer – or more simply its functionality – and whether or not the costs (times and money) associated with traveling to that location are deemed acceptable.

There has been a strong tradition of applied research in commercial geography, from the development of methods of analysis and forecasting that can be used to increase the profitability of new commercial locations, to the development of techniques that have been widely used in town planning practice to assess the impacts of existing and proposed commercial developments within the urban area (Guy, 1999).

Research on the development of techniques for analyzing the geographic structure of the commercial system has been virtually non-existent.

Wang and Jones (2002) wrote that "retailing has always been a prominent element of urban morphology. As a city evolves and expands, so does its retail sector." This statement echoes the sentiment of Underhill (2004) who stated that "virtually since the dawn of civilization, we have organized our world in part around the function of shopping." These two statements reflect a past, present, and future trend in urban society: namely, the act of consumption plays an integral role in the evolution and formation of our urban system. The spatial pattern of commercial locations within the urban area consequently has a strong influence on the overall form of that urban system.

This dissertation addresses the need to examine this element of the urban system. This research uses the geographic information system as a vehicle to identify commercial zones in a systematized and objective way. These zones can then be categorized according to their respective form and function. This identification and categorization is then used in the construction of a generalized typology of urban commercial structure.

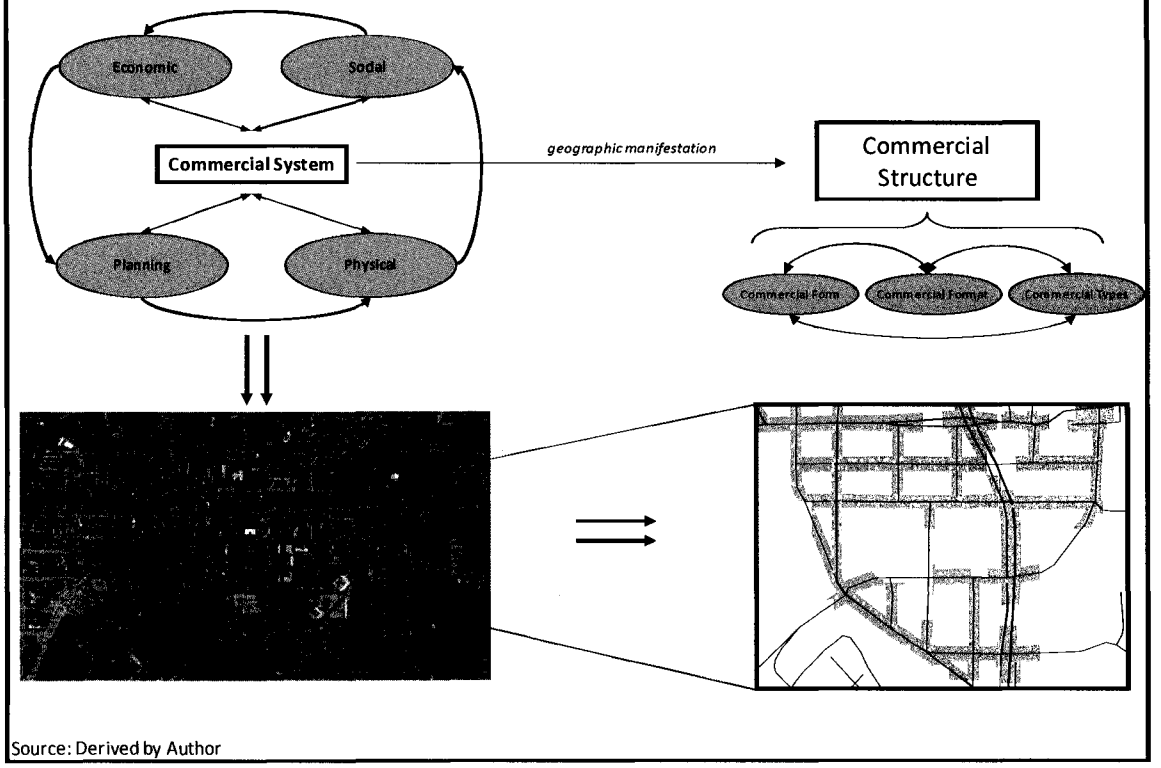
1.1 Definitions and Terminology

Before beginning an in-depth discussion of the commercial environment it is first necessary to understand what it is. The commercial environment is an overarching, somewhat ambiguous term used to describe the result of the interplay between the economic, social, political (planning) and physical (natural) environments of the urban

system resulting in the provision and consumption of goods and services (Figure 1.1: Commercial System versus Commercial Structure). These components are organized into a system – the commercial system.

The commercial system includes all retail activities, business and personal services, restaurants and entertainment services. It accounts for approximately seventy-eight percent of all jobs in Canada and therefore forms an important role within the Canadian economy (Canada 2003). More recently, this sector of the economy has undergone a period of globalization and rapid restructuring as a result of technological change and deregulation (Yeates 1998). In terms of scale, the commercial system functions at several interrelated levels ranging from the city, town or village to larger economic regions (i.e. Greater Toronto Area) to the entire country as a whole, known as

Figure 1.1: Commercial System versus Commercial Structure



Source: Derived by Author

the national commercial structure (Simmons, Barbiero et al. 2000).

In addition, the globalization of retailing has resulted in the evolution of a logistics system that has at its foundation with an ever increasing global focus. Products are being shipped from manufacturers located across to globe to consumers who are equally geographically dispersed. Furthermore this globalization has also meant increased selection of products, increased demand for "exotic" products and the ability to "consume" at a global level, the latter which has also increased competition.

When dealing with a geographically orientated discussion on the commercial system, the concept of commercial structure dominates. At a basic level, the commercial structure of a city is simply the geographic realization or manifestation of the commercial system. However, it refers more specifically to the actual location of commercial activity (geography) and the organization of that activity within a particular location (form, format, type, and function). This concept has been referred to as commercial structure, or commercial spatial structure, and is frequently accompanied by the term intra-urban to refer to the internal commercial structure of an urban area. Since the commercial structure is the geographic manifestation of the commercial system, these structures can also exist at the different levels of scale (city, region, country). For the purposes of this dissertation, the term commercial structure will be used exclusively to represent the intra-urban spatial commercial structure of an urban area.

Cohen and Lewis (1967) wrote that all too often geographic studies separate form and function. They suggest that this is not a methodological bias, but more that is

done for convenience in analysis. However, they remark that form and function are so thoroughly interrelated that each has to be judged as a contributor to and a direct result of the other.

Within the definition of the commercial structure several other important concepts arise. Firstly, the commercial structure contains a variety of commercial zones that are defined by their commercial form. The commercial form is the geographic arrangement or spatial imprint of a grouping of commercial formats within a defined area. For example, a series of commercial operations along a highway is known as an arterial ribbon. Located within each of these commercial forms are the businesses themselves. Secondly, a commercial format is the store size and mix of merchandise of a specific commercial operation (Simmons and Kamikihara 1999). For example, Home Depot is known as a new-format retailer that uses large warehouse style stores (size) to reduce prices and offer a greater selection of goods (mix of merchandise)[1]. Thirdly, a commercial type refers to the category in which the retailer would fall (shoe store, grocery store). Finally, commercial function refers to the collective grouping of stores and the general or specific purpose they serve.

1.2 Research Objectives and Methodologies

Changing commercial systems are having a profound impact on the overall spatial structures of Canadian cities. The changes have been sporadic, lacking in homogeneity, and increasingly dispersed. This development presents a major problem when using

[1] Home Depot is also known as a category killer as a result of the large store of product variety, other similarly related operations have a hard time competing against Home Depot, consequently they tend to go out of business or are "killed" by the larger-format store.

many older commercial categories to classify commercial operations, because they do not adequately describe new commercial types that have emerged nor do they reflect a more contemporary geography. Consequently the goals of this dissertation are as follows;

1. The creation of a generalized system for detecting and classifying the spatial organization and morphology of commercial zones within the census metropolitan areas (CMAs) of Canada,
2. The application of the system within a GIS environment,
3. The development of a generalized typology of urban commercial structure.

The result is a technique that operationalizes in a systematized and objective manner an approach to analyzing the structure of the commercial environment. Furthermore, the technique is based on a series of guidelines and statistics (primarily nearest commercial neighbor values) which can then be applied to other study areas.

1.2.1 Nearest Commercial Neighbor

Nearest neighbor analysis is a mathematical technique for analyzing point patterns. The general application of the technique is to compare the overall point pattern to a random point pattern to determine the level of dispersion or clustering of the points (Bailey & Gatrell, 1995). Nearest neighbor analysis has been used in wildlife studies, crime analysis and a variety of other analyses involving point patterns.

The Nearest Commercial Neighbor (NCN) is the primary technique this research uses to identify clusters of commercial activities. This value is derived by calculating the nearest neighbor distance for all the commercial locations using the standard Clark and

Evans nearest neighbor technique and its associated corrections for edge effects (Sawada, 2002). Essentially the NCN is a measure of commercial proximity based on a generalized XY point location. Once the nearest neighbor for each location is calculated, two main pieces of information can be generated. The first and most important piece of information is the average nearest commercial neighbor (ANCN). The ANCN represents the average proximity on the commercial locations to one another within the study area. The value can be interpreted as meaning the larger the value, the farther apart - on average - the commercial locations are from one another.

The second value that can be extracted is the Median Nearest Commercial Neighbor (MNCN). This value represents the most common distance between commercial locations. A basic assumption being made (and tested) is that based on this value, commercial zones can be delineated through a series of MNCN multiples.

1.2.2 Objectives and Questions

Based on the primary goals of the dissertation, three major central research objectives with their associated research questions can be stated:

1. The development and refinement of the Nearest Commercial Neighbor (NCN) Measure
    a. What is more effective at detecting commercial structure the ANCN or MNCN values?
2. The development of a generalized empirical analytical technique using the NCN.

a. Is it possible to analyze the commercial environment that is unknown to the analyst while still being able to produce accurate results?
b. Is this technique rigorous enough to facilitate the comparisons of multiple urban areas to one another?

3. The development of a generalized model of urban commercial space.
    a. Do all cities exhibit similar spatial forms of commercial development or are there systematic differences?
    b. What is the morphology of these commercial zones?
    c. Is the morphology of these commercial zones similar between cities?
    d. What are the present forms of commercial development?
    e. Can a typology be developed that does not focus on any type of organizational hierarchy, such as central place which tends to dominate the classification of shopping centers and commercial areas?

Given these objectives and questions the thesis of this dissertation can be stated as follows: "The creation of a generalized analytical framework for detecting and categorizing the spatial organization and morphology of commercial zones within Canadian CMAs leading to the development of a generalized typology of urban commercial structure."

1.3 Thesis Organization and Layout

This dissertation will be broken down into a series of discrete chapters, each of which will be connected together by 3 underlying threads:

1. The changing nature of the commercial system and resultant changes in commercial structure;
2. The evolution of the commercial typology as a way of describing the "present" commercial system, and;
3. The identification of techniques used to analyze the commercial structure of an urban area to facilitate the identification and detection of these changes in form and function.

Chapter Two traces the study of the commercial system starting with the original typology proposed by Proudfoot (1937). This chapter examines not only how these typologies were developed but also focuses on the changes to the commercial system that fuelled the development of subsequent typologies. This chapter concludes by defining a set of characteristics any analysis of commercial structure should include.

Chapter Three details the three study areas specifically the census metropolitan areas of Sudbury, Kitchener, and Ottawa as well as the data requirements necessary to perform the analytical steps as defined in chapter four.

The generalized methods developed to analyze the commercial structure form the heart of Chapter Four. This chapter details the procedures that have been developed. Furthermore this chapter presents recommendations and courses of action based on data availability and time constraints.

The results of the analytical procedures are presented in Chapter Five. This chapter details the results of the analysis on each of the study areas. The first half of the chapter

summarizes the results while the second half discusses the results in relation to the efficacy of the analytical technique(s).

Chapter Six examines the results from Chapter Five to develop a generalized typology of urban commercial structure based on the characteristics exhibited within the three study areas.

Finally, Chapter Seven ties together the research conducted and makes suggestions as to future research directions of both this research as well as the greater body of commercial geography.

1.4 Conclusions

The commercial system has been the subject of academic study for over fifty years. This work has been primarily focused on describing and categorizing the commercial environment through the creation of commercial development typologies. However, the commercial environment never remains the same for a long period of time, resulting in typologies that have become dated and of limited use. Consequently there is a clear need for a method that allows for the analysis of urban commercial structure which is flexible in its approach so as to accommodate these constant changes. Furthermore it will be shown that within the literature there is a gap in knowledge with regards to techniques for analyzing the commercial environment when using GIS. These two factors combine to provide for a strong justification for this research.

CHAPTER 2

CONTEMPORARY LITERATURE ON COMMERCIAL GEOGRAPHY

"Our enormously productive economy ... demands that we make consumption our way of life – that we convert the buying and use of goods into rituals, that we seek our spiritual satisfaction, our ego satisfaction, in consumption ... We need things consumed, burned up, worn out, replaced, and discarded at an ever increasing rate."

Victor Lebow (Date Unknown)

2.0 Introduction

When studying any urban environment it is important to understand the historical evolution of that environment as not every system develops at the same rate and in the same way. The Canadian urban system is no different. Changes within the system are uneven, growth is highly variable between different cities, and within the commercial environment the introduction of new stores or commercial forms does not follow any particular timeline. The result is that each city is truly unique both in terms of its commercial environment and its overall urban evolution.

This chapter is designed to provide a historical overview of two major themes: the commercial environment in Canada, and the development of models or typologies of commercial structure. Each section is organized around a series of questions for discussion. A third and final section ties the previous two together and forms the justification for this research.

The first section deals with understanding the variety of changes to the Canadian commercial environment with a specific focus on the largest metropolitan areas; what changes have occurred? What is the present situation? What are the general characteristics of most Canadian cities?

The second section looks at a parallel development in the models and typologies that are used to analyze, quantify and categorically classify urban commercial environments. Within this section the major typologies of commercial structure are identified with particular emphasis on their creation, furthermore the unique differences in terms of geographical organization are presented.

Though these two sections will be presented separately, linkages and commonalities will be extracted in the third and final section; what commonalities exist between the changes in the Canadian urban systems and the associated changes in the commercial typologies? What modifications or alteration needed to be done to the typologies to accommodate these changes? What are the identifiable limitations of the typologies to adapt to these changes?

2.1 Brief History of the Canadian Commercial System

This section deals with the geographical aspects of the commercial environment within Canada, and more specifically the CMAs that define the largest twenty-five cities. Although commercial activities only comprise a small portion of the land use within a city they are a vital component of the city makeup.

With approximately 74% of the Canadian population (Canada 2003) currently working in the services-producing sector, this environment is a large generator of income and represents the sector where the majority of disposable income is spent. The commercial system is also a large generator of traffic flow, and during the late 1960s and early 1970s commercial areas became catalysts for housing growth that continues to this day (Simmons 1991; Lowe 2000). Davies and Baxter (1997) add that with the continued growth of low-density suburbs, the residents of these areas almost exclusively rely on the automobile as the primary mode of transportation. This dependence on the automobile alone has almost single-handedly shaped the commercial structure into the form it is today.

Several major changes have occurred over the last fifty years. These changes include the continued decentralization of commercial services, increasing Greenfield development[1], the globalization of retailing, the shifting demands of the consumer, and finally as Kumar (1997) puts it, "from market driving to market driven" commercial change.

This section addresses these issues and others through an overview of the geographical aspects of the commercial environment of Canada over the last fifty years to provide context for the changes that have occurred more recently.

[1] Greenfield developments are those projects where development occurs on natural or otherwise undeveloped areas.

2.1.1 What Changes Have Occurred?

Until about World War II, the commercial environment of Canada was dominated by the central business district with a few neighbourhood level stores servicing a limited market area. The conclusion of WWII saw the growth of suburban living. Over the next thirty years, until about the mid-1980s, several major commercial changes occurred throughout Canada. These changes are detailed chronologically in Table 2.1 and include the growth of suburban development, downtown revitalization, infilling, and the development of theme malls.

Table 2.1: Chronology of Commercial Change in Canada

Date	Description
1950s	The growth of suburban developments at the urban fringe was followed by commercial development to service these new areas. The commercial developments were normally in the form of unplanned ribbons and were focussed along major roadways. Major department stores were still reluctant to leave the downtown core.
1960s	Simultaneous development of both commercial services and residential stock within the suburban area. Encourage further decentralization of commercial services. Many of the department stores that once resided in the downtown cores moved to the suburban malls during this period. Residents no longer needed to travel into the downtown core for their basic needs. A synergy between mall developers and retailers developed which still exists today.
1970s	Emergence of catalytic development. Suburban shopping centres were developed first to act as a growth node for future residential growth. This development further encouraged the continued decentralization of commercial services.
1960s &1970s	Characterized by a period of downtown revitalization to combat the loss of commercial services to the suburban areas. During this period the bulk of the major urban centres in Canada had an enclosed shopping facility within the downtown core.
Late 1970s	The saturation of the shopping centre market saw the revitalization of existing shopping centres. This was accomplished by enclosing those that were not and by re-mixing the retail selection in others.
Late 1970s	Saw the introduction of malls into smaller communities that did not have any mall development. This strategy known as 'infilling' caused the decimation of many downtown cores in these smaller areas.
1980s	The era saw the emergence of the shopping centre as a form of entertainment or leisure. The mall became a tourist attraction and represents a major shift in consumer behaviour.
1990s	The rapid expansion of the big-box store or new format retailer. The continued suburbanization of retail space and the development of large-scale retail clusters anchored along major highways (big-box parks).

Source: Jones and Simmons (1993); Jones (2000); Storie et al (2001).

The result of these changes led to a highly dichotomous and polarized commercial system; a system characterized by inner city *and* suburban developments. The new suburban developments were planned[2], homogeneous, and under the control of the corporation. In contrast, the older inner city developments, and primarily the CBD, were left unplanned[3] and were dominated by the independent merchant (also known as 'mom-and-pop' operations). In many instances, the CBD survived naturally during this time. All the while, the suburban malls, fuelled by the corporation (both retailers and developers), were continually finding ways to attract and retain customers. The geographic impacts of these changes were focussed on the continued decentralization of commercial services away from the central core with an orientation towards automobile accessibility.

2.1.1.1 The Commercial Environment: The Last 20 Years

The changes in the geographical aspect of the commercial environment over the last twenty years will be presented in four separate sections: (1) commercial structure, (2) corporate strategies, (3) consumer behaviour, and (4) major forces of influence.

2.1.1.1.1 Commercial Structure

The single greatest noticeable difference to the Canadian commercial environment has been its rapidly changing commercial structure. Commercial services exert considerable influence on the morphology and function of the Canadian city. The

[2] The term "planned" is used to refer to a development that is done by a single developer, consequently the entire development presents a uniform image. This is in contrast to an "unplanned" development whereby multiple developers have a stake in the project resulting in multiple "images" emerging. These terms do not refer to the degree of land use planning involved from the municipal perspective.
[3] The term "unplanned" refers to the existence of multiple developers within a particular area.

present-day city has to a large degree developed in relation to its commercial facilities. This relationship is the direct result of the increasing dependence on the automobile. As Jones (2000) states, "when mobility is low, retail activities concentrate, when mobility is high retail activity disperses." Current studies have shown that cities are dispersing and, in many instances are becoming multi-nuclei as the size of the city continues to grow (Bunting and Filion 1999; Millward and Bunting 1999; Batty 2001). This signifies an era where mobility is very high and therefore dispersion is equally high.

The commercial structure of urban Canada in the 1980s differs significantly from how it appears today. The commercial environment in the late 1980s was mired by the economic recession that hit the entire Canadian economy. In addition to the recession, Jones (2000) identified three other major issues restricting commercial development in Canada: (1) increased cross-border shopping, (2) decline in real income of consumers as a result of the recession, and (3) changing demographics and the associated changes in consumer consumption patterns. The results were little to no significant changes to the system.

Enclosed mall development reached a pinnacle in the late 1980s as a result of long term planning and increased capital investment prior to the recession. Since then, little to no shopping centre growth has occurred. Only the most profitable and growing urban centres experienced any new mall development specifically Toronto and Vancouver (Jones and Simmons 1993).

Suburban malls dominated the commercial structure at this time. Approximately 84 regional malls (those malls with more than 500 000 ft^2 of retail space) existed in

Canada accounting for more than 10% of all retail sales by 1990 (Simmons 1991). In addition to reaching market saturation, the shopping centre began to be reinvented as a tourist attraction. The most ambitious example of this was the West Edmonton Mall in Edmonton, Alberta. It had approximately 3.5 million ft^2 of retail and entertainment space, including an indoor amusement park and ice rink.

Even though the suburban malls dominated the commercial landscape, both the CBD and the arterial ribbons still played a major role in the provision of commercial services within the overall commercial environment. Unfortunately, as the forces of decentralization continued, the importance of the CBD began to diminish in virtually all major Canadian cities except those within the high-growth centres. Two large contributions to this decline were the increased distance and time one would have to travel to reach the core and the cost of parking once there[4]. This distance fuelled the development and encouraged the expansion of arterial ribbons connecting the main areas of the city to one another. The organization of the commercial structure of the late 1980s was well represented in the typologies used during that time period. The commercial structure was primarily comprised of strips (arterial), centres (planned or unplanned), and specialty areas[5].

As the process of decentralization continued, the eroding of the normative structure of the commercial environment began, or at least the eroding of the

[4] Typically there was a cost to park downtown because of a limited number of spaces as a result of the higher costs of land. The suburban developments generally did not charge for parking as the automobile was the main form of transportation to and from these developments and by not charging give them a market edge.

[5] Refer to the Jones typology in the following section for more detail on this sub-area of the commercial structure and its associated changes.

environment that consumers had become accustomed to over the previous decade. This dramatically changed not only the way people shopped, but the very nature of the way people interacted within Canadian cities. As a result of the recession, shopping centre growth stagnated but more importantly the consumption patterns of the consumer changed. Consumers who experienced declining disposable income as a result of the recession, wanted to save money. This, coupled with decreasing land values, left the Canadian commercial environment primed for major change. This change would wind up being an indelible mark on the commercial environment.

This major force of change came in the form of the new-format retailer, more commonly known as the big-box store. The arrival of these behemoth retail ventures, and their associated power centres or clusters[6] precipitated a shift in consumer behaviour away from the traditional department store and regional mall to these new free-standing discount superstores. These large destination retailers, led by Wal-Mart Home Depot, Price Costco (formerly PriceClub and Costco Wholesale), Business Depot and others stressed aggressive pricing and merchandising practices. According to Jones (2000) between 1990 and 1997, one hundred and seventy-five big-box retailers entered the Greater Toronto Area market alone adding over 6.5 million ft^2 of retail space compared to the 1.0 million ft^2 of retail space added through new shopping centre development or re-development of existing centres.

These new power centres were typically Brownfield (and later Greenfield) developments on the periphery of the city and in close proximity to major highways or

[6] A power centre is the planned grouping of big-box stores. A power cluster is an unplanned grouping of big-box stores.

roads. In many instances, they were strategically located to serve a super-regional market. Brownfield developments were required because of the amount of land needed for these store-types which were typically big, single-storied, free-standing superstructures with a spacious asphalt parking lot (Arnold 2000) and as a result of abandoned industrial locations were readily available in many urban environments. This resulted in a continued and advancing level of commercial decentralization.

These new power centres or clusters were an addition to the commercial structure of the city. The historical remnants of the older structure still existed, but in many cases these new developments created new commercial areas. In other situations, they were additions to existing commercial areas, therefore, changing the function and composition of these areas.

2.1.1.1.2 Corporate Strategies

Many of the changes to the commercial structure have been a direct result of the changes in corporate strategies. Corporate strategies have changed dramatically over the last fifteen years. In many cases, the changes experienced in the commercial structure were a direct result of the changes in corporate strategy. Commercial chains needed to make decisions about store size, location, merchandise mix, outlet standardization, and advertising themes as well as the performance expectations on these stores. Often these decisions were a direct result of changing consumer preferences, adaptations to land use planning controls and by-laws, or the result of the exploration into new markets (via new locations or through changes to the morphology

of the store). As in the past, corporate strategies leave a spatial imprint such as a new store, a redeveloped one, or an abandoned one.

Kumar (1997) writes that the initial image to appear in one's mind when the term retailing is mentioned is the small corner store. Independently owned and operated, these stores represented the small, local, traditional businesses usually associated with the neighbourhood convenience store, deli, barber shop, or bakery. These commercial operations have been fundamentally transformed over the last fifty years. These small, owner-operated stores still exist, and will continue to exist because they serve a specific purpose within the greater commercial system. However, these stores have had little impact on the overall system unlike the corporate retailer.

These large corporations have developed the commercial environment to suit their needs. Today, several retailers like Wal-Mart and Ikea have dramatically changed the commercial environment. In turn these changes are directly reflected in changes in consumer behaviour. Kumar (1997) writes, "Wal-Mart for example has taught consumers not to shop around for sales and instead to buy at everyday low prices."

For commercial operations to provide 'everyday low prices', they had to conduct their businesses in a different way. The past twenty-five years, especially the last fifteen years in Canada, has seen the emergence and growth of several new retail formats and concepts. These new-formats are dominated by the big-box store style of retailing. The

traditional formats, especially the department store began to see customers flee to these new formats in search of better value[7].

The commercial landscape has not simply been driven by supply and demand as it once was. Nor is it a situation of optimizing facilities to ensure that all citizens have reasonable access (a goal of the urban planner). It has quickly become obvious that commercial operations have choice; choice as to the format of the store, the merchandise mix, and ultimately the location to build that store. In addition, the participation of foreign retail firms in Canada has grown rapidly, with the number of formats tripling and the floor area and sales doubling (Simmons and Kamikihara 1999). The majority of these additions occurred in the peripheral areas. Moreover, as the mobility of the consumer continued to increase, these stores would continue to locate further away from the urban core, on the low cost land surrounding the massive networks of roads linking everything together. Corporate strategy has truly defined the new commercial markets of the future and consumers followed.

2.1.1.1.3 Consumer Behavior

Spatial consumer behaviour may be defined as "the aggregate manner in which individual consumers act in the process of acquiring the goods and services that they need and want" (Potter 1982). Basic aspects of consumer behaviour include the frequency of shopping trips, the distance travelled and lastly the nature of the trip itself. Just as corporate strategy and the commercial structure are highly interrelated, consumer behaviour can also be added to the mix.

[7] See the following discussion on consumer habits for more a detailed discussion on changing consumer behaviour.

As commercial decentralization continued and was further fuelled by the introduction of the power centres, the consumer's dependence on the automobile also increased. Consumers were *willing and able* to travel greater distances for their needs which resulted in an increase in their activity space. This represented a major change from the early 1950s where consumers would (and could) only shop downtown. As the growth of suburban malls progressed, consumers were more and more willing to travel further distances to gain access to these malls.

During the late 1980s and early 1990s, prior to the entry of big-box stores, consumers tended to patronize shopping malls for their needs, a trend that still continues today but has been threatened by the big-box store. However, as Gerhard (2001) found, shopping was no longer the main reason for going to the mall. Consumers were visiting the mall for pleasure and the introduction of the theme mall capitalized on this consumer behaviour.

This dependence on the automobile has prompted some researchers to refer to the car as a shopping cart on wheels (Bromley and Thomas 1993) reflecting the 'store hopping' behaviour of many consumers. This can be further evidenced by the nature of the power centre; large complexes, comprised of single free-standing structures, interconnected by roadways, all prompting consumers to drive from store to store.

Since the late 1980s the trend in consumer behaviour has also been towards value-orientated shopping, possibly a result of the recession and/or the introduction of major discount retailers such as Wal-Mart, consumers are even more willing to travel greater distances further increasing their dependence on the automobile. Foot (1998)

wrote that retailing that based on low prices was (is) a major trend in Canada. To support this claim, Griffith and Krampf (1997) also noted that consumers have become more focussed, more value-orientated, and more diverse than they once were.

The consumer still has considerable influence in determining the variety and form of commercial activity even with all this choice. Guy (1975) suggests that the underlying factor affecting commercial location is consumer perception: the manner in which consumers organize their perception of the external environment and consequently how they determine the commercial locations they prefer to patronize. Couple consumer perception with the use of the automobile and virtually all shopping within an urban centre (and in many cases beyond) becomes a potential destination.

2.1.1.1.4 Forces of Influence

There are other factors that exert a strong influence on the commercial system. Two major forces will be discussed in this final section: governance and planning, and the internationalization of retailing.

Guy (1994) suggested that the planning process was essentially negative. Developments may not occur without first obtaining planning permission. Given the amount of traffic that commercial operations generate (especially those within major centres), commercial developments tended to receive considerable attention by the planners. It should be stressed that the planning process is dynamic and open to conflicting input from the retailers and developers, the consumers, and a myriad of interest groups (Potter 1982). Given the parties involved, and the inevitable conflict, it has been up to planners and politicians to resolve these differences.

It is clear that the regulatory environment shapes commercial structures both directly and indirectly via capital investments and public policies that have helped to shape the urban form (Simmons, Jones et al. 1998). The official plans of many municipalities were designed to create a commercial structure that provided adequate facilities to all consumers without excessive transportation costs. However, as the downtown core gave way to the suburban mall, this normative structure deteriorated. With the introduction of the power centre, governments and planners had to reconsider policies regarding the commercial structure because these new components do not fit easily into the planned commercial structure (Muncaster 1998). Often the main conflict between planners and retailers/developers is the location of development being proposed. However, current trends indicate that politicians are willing to forego planning constraints in the interest of economic growth.

Prior to 1994, (the year the North American Free Trade Agreement was signed) the majority of commercial operations were Canadian owned. These stores were generally smaller than they are today and usually located in malls or traditional shopping ribbons. In many cases, these retailers as well as the planners were trying to fight the continued decentralization of commercial services. This aversion to suburbia set the stage for the demise of several retailers. As a result of NAFTA, the Canadian commercial environment was opened to the foreign market. Simmons and Kamikihara (1999) identified three distinct differences between foreign and local firms: (1) foreign firms were much larger than domestic firms, both in terms of floor area and stores per format; (2) the spatial strategies of these retailers also differed considerably, very few of

them were restricted to small, local markets (one city) and were more apt to appear in multiple regions, thus promoting brand recognition and loyalty, and; (3) many of the foreign firms initially entered the Canadian market via corporate acquisition[8].

The spatial strategies of the international corporations were two-fold. First, they wanted to minimize the cost of land and second, maximize automobile accessibility. The optimal locations were those that were zoned industrial and located near major expressways, essentially areas on the periphery of the urban area. Surrounding areas to these developments began to experience parasitic type growth. Until the 1990s, these types of developments were regulated by planning controls, but since then regulations have been relaxed (Jones and Doucet 2000). This resulted in a type of commercial sprawl that was also experienced in many American cities.

2.1.1.1.5 Conclusion

The commercial environment has undergone a period of dramatic change over the last twenty-five years. The commercial structure has shifted from being CBD orientated to suburban to industrial-peripheral dominance. The initial organization of this structure was typically comprised of a hierarchy of strips, centres and specialized areas but with the increased decentralization of commercial services this normative structure eroded. Presently the organization is dominated by new shopping malls and power centres located on the periphery of the urban area with the commercial structure still containing many of the historical remnants of the past.

[8] The purchase of the department store retailer Woolco by Wal-Mart in 1994 is classic example of this.

Corporate strategies have equally changed. Many Canadian retailers were reluctant to embrace suburban expansion and eventually faced the demise of their once viable CBD locations. Those who embraced the suburban shift thrived in this new environment. However, the introductions of foreign retailers into Canada began to challenge and redefine the existing markets. These large, global corporations sought out cheap land on the urban fringe for their developments. Parasitic growth around these developments began to erode the market attraction of the shopping centre. Fuelled by changes in planning policy (or disregard), these areas now resemble sprawl that is associated with American cities.

Finally, changes in consumer behaviour have further changed the commercial environment. Consumers, once content to shop downtown, are now willing to travel greater distances for their consumption needs. Shifts towards one-stop shopping and shopping as a form of leisure are two major alterations in consumer behaviour. However, the biggest change has come in the increasing dependence on the automobile.

2.2 Models and Typologies

The commercial pattern in Canada has evolved over the last 50 years with significant changes occurring within the last 15 years. The location of commercial services, especially retailers, has shifted from the downtown core to suburban malls and arterial ribbons. These changes have been reflected in a series of commercial typologies. As major changes to the commercial environment arose, new typologies (or modifications to older ones) were created to address those changes.

Increasing supply and demand are the main factors responsible for this dynamism. On the demand side, consumer preferences and shopping behaviour are changing due to transitions in demographics (income, mobility, age). On the supply side, commercial units have had to respond to change in economic conditions and increased competition by finding new market areas and developing new commercial formats (Borchert 1998). These two changes, in the 'demander' and the 'supplier', have altered the underlying fabric of the commercial system and consequently, the way in which it is observed and described.

This is not to say that the 'old' system has been abandoned. Massive capital investment in shopping mall development, central business district development and redevelopment, has forced many of these evolutionary changes to occur within the existing commercial structure. It has only been within the last ten years that some retailers are again seeking new commercial locations, moving away from their dependence on the traditional shopping mall. These new locations, allow for new commercial forms to emerge, such as the big-box power centre.

These additions have come in a variety of development projects ranging from existing mall expansion and limited new mall development to the more common Brownfield and Greenfield developments. Greenfield development is the aspect of change that has caused the greatest problem when trying to apply 'dated' typologies.

Traditionally, commercial typologies have been directly tied to scale. Many typologies have been developed to address the urban centre (as a closed entity) independent of its relationship to its urban neighbours. Other typologies use a larger

regional approach by examining interrelationships between urban areas and the surrounding hinterland. This discussion is going to focus on those typologies that describe the intra-urban or city-level commercial environments. Moreover, only those typologies that deal with the geographic categorization of commercial development will be addressed.

What follows is a presentation of the original theories or the pre-cursors to the modern commercial typologies. Within this overview, the theories of Christaller (central place) will be examined and Proudfoot's concept of city commercial structure. The second half of this section presents a critical overview of the existing typologies. Typologies are critiqued based on their applicability to present-day urban Canada as well as their (in)ability to adapt to changes in the commercial system. A synthesis of the information presented concludes this section.

2.2.1 The Two Original Theories

The pre-cursors to the modern commercial typologies were formulated on the basis of broad types of commercial activity that was dominant within the urban area at the time. It is within these models that the intra-urban typologies derived their geographical foundations. These are the models that were developed pre-WWII and represent signification insight into the urban organization at the time. The two 'founding' models presented are Christaller's central place, and Proudfoot's concept of city commercial structure.

2.2.1.1 Christaller's Central Place

Central Place Theory (CPT) is an attempt to explain the spatial arrangement, size, and number of settlements in a given area. Walter Christaller, who studied the settlement patterns of southern Germany, originally published this theory in 1933. The central place model has since been used to describe the internal organization of commercial development (normally planned shopping centres), sometimes known as the commercial hierarchy.

Strictly speaking, central places are "neither no more or nor less than a cluster of commercial establishments located in a place that provides a convenient point of focus for consumers who visit them to purchase the goods and services they need" (Berry 1963). It is this simplicity of description that made the central place theory so adaptable.

Central place theory takes into account the differences between lower order functions and higher order functions, or, in terms of retailing, lower and higher order goods. The result is a careful integration of various sized trade areas (or cities when dealing with the initial formulation of the theory) to produce a regional market. The groups or clusters of goods and services provided at a specific level are known as the 'central functions'. The differences in the size of the 'central function' zones will result in differently sized market areas. This produced the organizational commercial hierarchy.

The original Central Place Theory simply looked at the hierarchical ordering of cities, towns and villages. Since this hierarchy was linked to the number and types of goods and services at each central place, it implicitly set up a framework for studying a

commercial hierarchy. Many authors, several of whom proposed typologies for commercial development within a city, developed this analogy between central place and commercial centres. Central Place Theory has limitations for studying internal business structure, and "without considerable mental gymnastics it is difficult to apply it to the study of urban business ribbons" (Chorley and Haggett 1967). However, Morrill (1987) argues that the essential theoretical basis for these commercial typologies remains Christaller and Central Place Theory because it was the first concrete typology of commercial development.

2.2.1.2 Proudfoot's Concept of City Retail Structure

Unlike Central Place Theory, Proudfoot's work on retail structure in the latter 1930s does not use the same type of hierarchical organization. His work was based on the study of a number of the larger cities in the United States, with his primary focus being Philadelphia. Like Christaller, the bulk of the research was based on observation. Proudfoot was able to differentiate five different types of retail structure: (1) The central business district, (2) outlying businesses, (3) principle business thoroughfares, (4) the neighbourhood business street, and (5) the isolated store cluster. Moreover, this classification has broader applicability because it did not have a hierarchical organization structure. The problem, writes Murphy (1966), is that Proudfoot's five categories can be simplified to two: nucleations and ribbon development. But, the definition of nucleation, according the Proudfoot typology would not include the planned centre (or shopping mall) as it was only being introduced into the United States around the time he was developing his theories.

2.2.1.3 Synthesis

These two theories of urban commercial structure are the basis of the traditional typologies commonly associated with commercial development. Although Christaller was concerned with the system of cities and towns, the key concepts of agglomeration and sets of activities are relevant to the structure of centres and other commercial nucleations within cities. In addition, Proudfoot provided commercial geography with a useable classification scheme. Although it was limited in terms of commercial format scope, Proudfoot's work did not contain the use of the hierarchical arrangements inherent in Central Place Theory.

Several modern typologies dealing with intra-urban commercial development have been formulated over the last 50 years. The majority of these typologies find their foundations in the Berry (1963) model. This section presents the chronological progression of these typologies starting with the Berry model. For ease of identification each model will be referred to by the name of the author who created it.

2.2.2 The Modern Typologies

Virtually all of the modern typologies of commercial structures were based on the work of Proudfoot and Christaller, or at least used vital components in their construction. Since these two, a multitude of typologies have been developed since the end of WWII. The following list represents a selection of the more popular or predominant typologies often referenced in the literature and also represent significant milestones in the overall changes experienced within the commercial environment. The

following typologies along with their major variants will be addressed as identified by originating author. Refer to Table 2.2 Selected Commercial Typologies.

Table 2.2: Selected Commercial Typologies

Reference	CP Based	Non-CP Based
Christaller (1933)	X	
Proudfoot (1938)		X
Losch (1954)		
Berry (1959)	X	
Berry (1963)	X	
Simmons (1964)	X	
Garner (1966)	X	
Simmons (1967)	X	
Garner (1967)	X	
Potter (1982)	X	
Jones (1984)	X	
Morill (1987)	X	
Berry (1988)	X	
Brown (1991)		X
Jones & Simmons (1993)	X	
Brown (1994)		X
Guy (1994)		X
Borchert (1998)		X
Guy (1998)		X
Jones (2000)	X	

*CP and Non-CP Based refer to those typologies which have either a hierarchical foundation (Central place) or non-hierarchical geographical foundations.

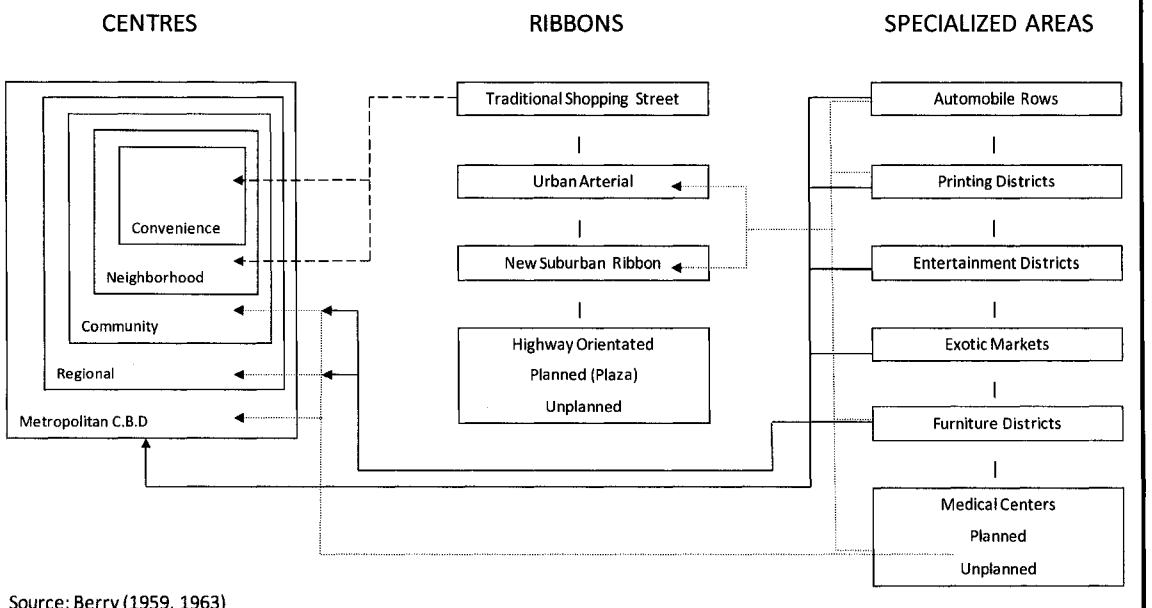
Source: Compiled by the author

2.2.2.1 Berry (1959; 1963)

The first post WWII typology of business areas within an urban centre to be developed, Berry's typology has been extensively applied to describe the patterns of commercial development within an urban area. Originally this was part of a larger study designed to determine the extent, location, nature, and trends of commercial blight and deterioration in the Chicago area (Murphy 1966) .It has gone on to serve as the framework for numerous studies on commercial structure.

Reflective of Proudfoot's work, the main structural geographic elements of the model included three geographic features: ribbons, specialized areas and a hierarchy of business centres. Each of these areas can be further broken down into several sub-categories (see Figure 2.1: The Berry Typology). Within each of these categories, Berry identifies the commercial type and to a lesser degree the format of the stores in determining its overall classification. The result is a hierarchical classification of centers

Figure 2.1: Berry (1959, 1963)



Source: Berry (1959, 1963)

(only) within the urban centre.

This model, like its many hybrids, has its geographic foundation in Central Place Theory. It is based on this Central Place model that Berry developed the hierarchy of centres, shopping arterials (ribbons), and specialized areas into one general framework.

It is also important to note that many commercial functions are represented in several location environments[9] and are therefore not mutually exclusive. However, "this classification remains the most suitable today to describe the retail landscape and is especially appropriate to explain the hierarchy of shopping centres" (Hartshorn 1992). This explains why the typology is still currently in use.

Two follow up studies were conducted using the Berry typology. Simmons (1966) applied the typology to study commercial blight in the city of Toronto. The objective of this research was to provide an assessment of the location, trends, and nature of commercial absence in Metropolitan Toronto. Simmons found that the commercial structure of Toronto was dominated by three main forms, unplanned centres, planned centres, and outlying places (Simmons 1966). In addition, he found that ribbon retailing was exhibiting a stronger role in the overall commercial system, but with one *caveat*. Suburban ribbons were enjoying increasing growth as shops relocated away from the inner-city ribbons. The work of Simmons provided confirmation that the Berry typology was useful outside of Metropolitan Chicago.

The second study, Garner (1966) used the Berry typology as the basis for classifying commercial operations. The author attempted to identify the hierarchy of

[9] An example of this can be seen in the expansion of the Canadian coffee giant Tim Horton's. Its stores are located all across Canada, in virtually all of Berry's classification categories.

nucleated commercial centres outside of the main central core of Chicago and the internal organization of those nucleations. Garner found that more than one hierarchy existed and that these different hierarchies were related to socio-economic conditions in the neighbourhoods being studied. It can be concluded that a sub-hierarchy exists within the overall hierarchy of commercial nucleations (as presented by Berry) facilitating a need to update the Berry typology.

2.2.2.2 Potter (1982)

Potter (1982) applied the Berry typology in an attempt to analyze the British commercial system. The United Kingdom, at this point, was only beginning to experience the mall boom experienced by the United States in the 1950s. His assumption was that the UK was beginning to 'catch up' to the United States in terms of the spatial organization of commercial systems. It should be noted that Potter's use of the Berry typology constitutes only one small part of the entire study he conducted.

Several generalizations can be made about the facets of urban retailing in British cites. Namely that the commercial system was still dominated by the central core, commercial centers exhibited a 'random' spacing, and a relatively large concentration of commercial centers occur close to the urban core reflecting a high level of accessibility (Potter 1982).

Based on these findings it was evident that the Christaller Central Place system did not fully exist in Britain, (being an underlying foundation of the Berry typology) but that it still 'works' in the case of the study area.

Potter also proposed a newer, more sensitive model that was both geographically and behaviorally representative of the commercial system. The newer model being proposed by Potter was conceptually similar to the Berry model in that it contained the threefold-criteria of ribbons, centers and specialized areas. However, its organization was more reflective of a multi-layered hierarchical organization (Potter refers to this as a true numerical hierarchy) as identified by Garner (1966) and of a decentralizing urban environment (Bunting and Millward 1998). On the basis of the relative spatial locations of centers and their associated market size, an updated nomenclature was used to describe the commercial centers (See Table 2.3).

2.2.2.3 Jones (1984)

As Jones (1984) writes, "this [research] was undertaken in response to the fact that the structure of the commercial landscape of the North American city had not been closely examined since the works of Berry and Simmons in the 1960s. Yet over the past 20 years, the urban commercial structure has been modified by a series of significant developments." The goals of the research were to develop a conceptual model of inner city specialty retailing, and to develop a typology for detailing the functional differences between major inner city and suburban commercial environments.

Jones presented a new typology of contemporary commercial structure. This new typology represented a logical evolution of the Berry typology as it retained much of the original organization but clearly addressed the new additions to the commercial structure.

Table 2.3: Potter (1982)
Revised Model of Commercial Classification Nomenclature for:
Retail Centers (a); Ribbons (b); Specialized Areas (c)

a. Hierarchic Retail Centers

Level	Name	Commercial Form	
1	Regional	Centre	
2	District	Centre	Ribbon
3	Community	Centre	Ribbon
4	Neighborhood	Centre	Ribbon

b. Urban Arterial Ribbons

Level	Name	Commercial Type (General)	
2	District	Specialized	
3	Community	Specialized	Non-specialized
4	Neighborhood	Specialized	Non-specialized

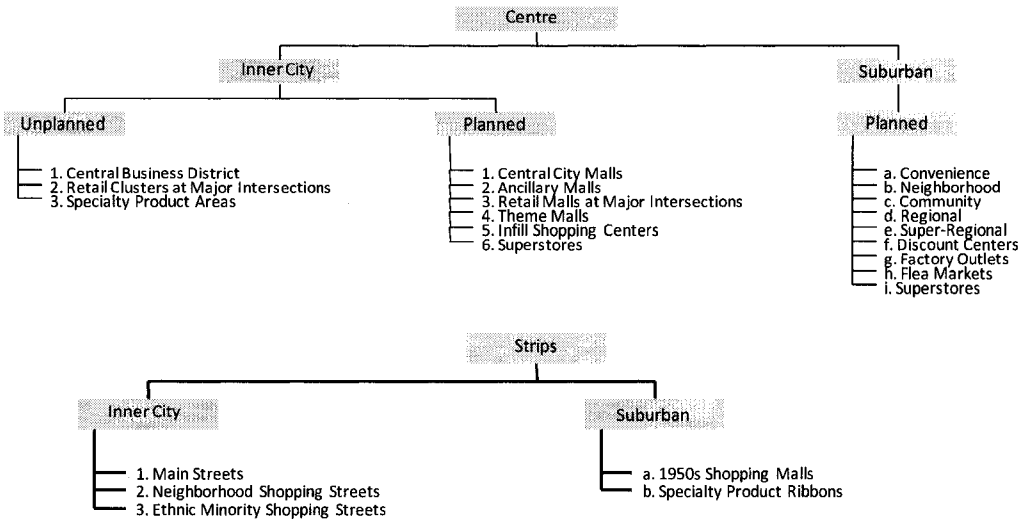
c. Specialized Areas

Level	Name	Commercial Form		Commercial Type (At Each Level)
1	Regional	Centre		
2	District	Centre	Ribbon	Professional Motor Building Furniture
3	Community		Ribbon	
4	Neighborhood		Ribbon	

Source: Derived from Potter (1982)

These additions included the new super-regional mall and the discount mall. The discount mall was designed to cater to those who prefer bargain orientated shopping. This trend was also reflected in three other shopping forms: the factory outlet, the flea market and the superstore. Even with these additions to the "centres" category, there was clearly a hierarchy of shopping centres, which could be defined using a set criterion.

Figure 2.2: Jones (1984)



Source: Jones (1984)

These included: number of stores, number of parking spaces, customer volume, trade area size, rent, and sales per square foot (Jones 1984).

When addressing commercial ribbons, Jones maintained the basic categories of the Berry typology but divided ribbons into either inner city or suburban before classifying them. This revised classification further advanced the classification of varying types of commercial ribbons and modified the hierarchical organization used in previous typologies. This typology was re-presented with minor modifications by Jones and Simmons (Jones and Simmons 1993). Refer to Figure 2.2 for a diagram of the typology.

2.2.2.4 Brown (1991)

Brown (1991) suggests that the "academic conceptualizations of retailing location have changed little in the last thirty years." He suggests that even though retailers have transformed their location decision making, in terms of identifying new potential sites for development the same cannot be said for location theory and analysis. He further goes on to suggest that despite enormous Post WWII changes in socio-economics and

urban form, the hierarchical taxonomy still experiences wide usage. The problem with this model is that it is predicated upon a "series of highly restrictive assumptions concerning the nature of demand . . . and is determined by the frequency with which goods are bought." The contemporary failings of this model are simply that the nature of demand has changed as consumer mobility has increased.

Brown (1991) suggests that urban retailing can be better summarized using a non-hierarchical model. He presents two rationales for this conclusion:

i. A rapid growth in refrigerator and motor car ownership has dramatically altered the way people shop for food and has altered geographic constraints. Based on this a continuum of shopping trips can be postulated that do not fit neatly into a hierarchical model.

ii. Supply is not simply a reflection of prevailing economic threshold but a greater manifestation of interaction institutional forces such as land use planning provisions, shopping center policies, and corporate strategies.

Given the rapidly changing nature of consumer demand and retailer supply and the growth of superstores, retail warehouses and other large scale retailing formats has now served to further undermine the applicability of the traditional hierarchical framework.

What Brown suggests is a framework that classifies location based on its form and function with a focus on consumer demand or need. He suggests that three forms can be identified: cluster, linear and isolated. In addition he suggests three types of functions are possible: general, special and ancillary shopping areas. Table 2.4(a)

Table 2.4: Brown (1991) : A Post-Hierarchical Classification

a. Shopping/Retailing Activities

Consumer Need	Retail Response	Primary Characteristic
Essential Shopping	• Local convenience shops • Corporate mass merchandisers	• Convenience • Price Utility
Fun/Leisure Shopping	• Specialist shopping areas • Large leisure/shopping complexes • Fashion/lifestyle retailing in planned cluster	• Product Range, Style • Leisure Activity, Style • Multi-Purpose Activity
Purposive Shopping	• Large, target shopper units • Wide range or variety stores	• Product Range • Value
Time-Pressured Shopping	• Home shopping • Petrol station shops/convenience stores	• Time • Time
Innovative Shopping	• Home based facilities • Catalogue showrooms	• Access • Range

Source: Adapted from Dawson and Sparks (1987) in Brown (1991)

b. A Non-Hierarchical Classification of Locations

FUNCTION

FORM	General	Special	Ancillary
Cluster (Unplanned)	Town and City Centers	Bright Lights District	Sandwich Bars in Financial District
Cluster (Planned)	Mega-center	Specialty Shopping Center	Shops in Airport Departure Lounge
Linear	Traditional Arterial Route	Ethnic Shopping Street	Hamburger Alley
Isolated	Corner Shop	Carpet Warehouse	Crush Bar in Opera House

Source: Brown (1991)

presents the various consumer demand possibilities while Table 2.4(b) combines form and function into more comprehensive classification of location. Brown argues that this new taxonomy is stronger because unlike the Berry typology it can better separate form and function and can handle freestanding outlets and ancillary forms of retailing which Berry cannot (Brown 1991).

Brown does however suggest several limitations to this new taxonomy:

1. As with all classifications, theory and realty rarely meet perfectly.

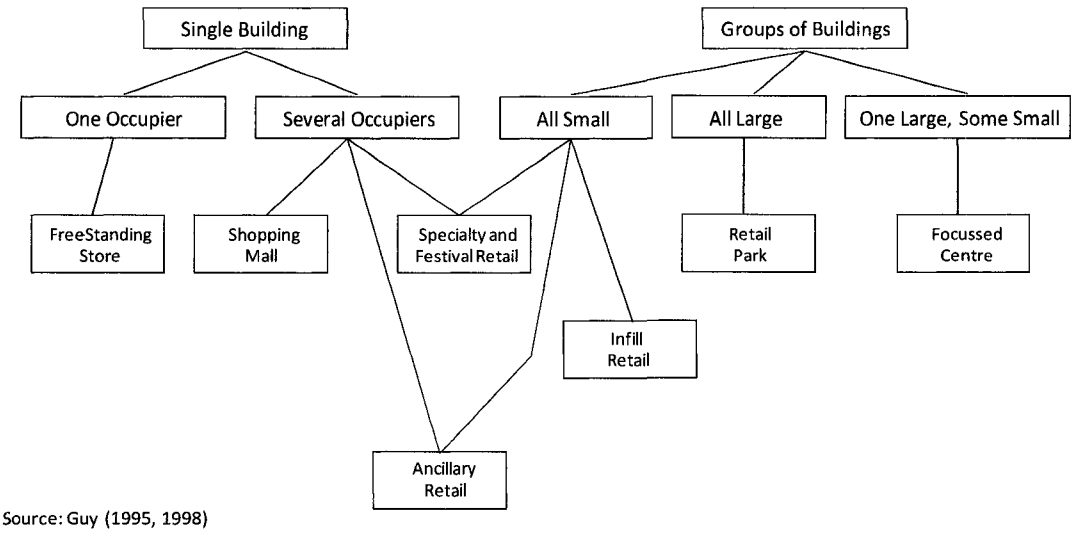
2. If the taxonomy is to be operationalized it must be synthesized with the more traditional models as it eschews the hierarchy completely though in many urban environments this hierarchy still exists (at least to some degree).
3. Although the taxonomy is fairly broad in nature it is essentially static especially in the ancillary category where changes can happen quite rapidly, because in many cases the fate of the operation within this area is highly dependent upon a non-retail entity.
4. In certain unique environments like Toronto or Tokyo, where there is a vast underground network, subway passengers can disgorge directly into department stores thereby blurring the distinction between various location categories.

Though these limitations exist, limitations exist within all other classification schemes as well. The benefit of this proposed system is that it is much more adaptable than older schemes, and more importantly it reflects a more contemporary commercial structure.

2.2.2.5 Guy (1994; 1998)

Unlike the other authors presented in this section, Guy's (1994) typology was based more on physical store characteristics instead of the overall commercial form of an area. The goal of the typology was to classify both the simple (single store) and the complex (multiple stores) commercial areas into a basic framework. The terminology was changed slightly to reflect the advent of the commercial ribbon. In addition, the typology did not employ the planned versus unplanned distinction. As Guy (1994) argued, planned commercial development can exist within unplanned areas, but if this development is minimal compared to the entire area, the area is said to be unplanned.

Figure 2.3: Guy (1995, 1998)



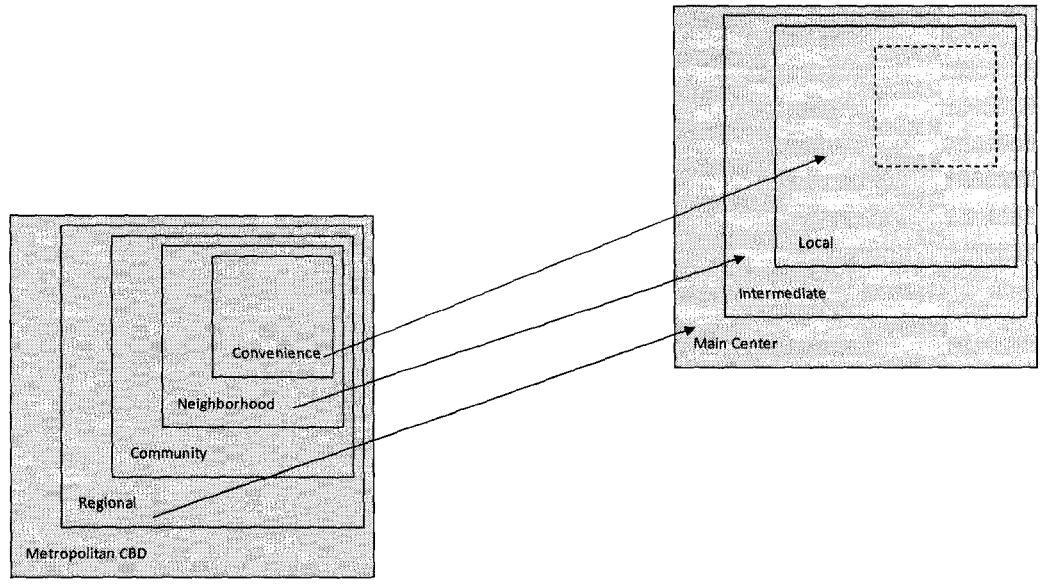
Source: Guy (1995, 1998)

It was concluded that Guy's typology (Figure 2.3) has limited applicability, but may assist in the initial categorization based on commercial area morphology.

2.2.2.6 Borchert (1998)

Borchert (1998) comes to the defence of the commercial hierarchy and the Berry typology. He suggests that it can still adequately describe the spatial patterns of urban retailing. Moreover, he supports the claim that the hierarchy still exists because the hierarchy of shopping centres that has been constructed in many urban areas is very inflexible and cannot easily be changed. The author suggests that instead of abolishing the hierarchy in its entirety that the hierarchy needs to be adjusted. He suggests that many stores will "move up" the hierarchy by physically relocating in a higher level location. The other option, where possible, is that the existing location is redeveloped to better serve a larger market and subsequently moves up the hierarchy that way. The result of the upward movement is that the community level of the hierarchy is lost as it either expands to suit a larger market or "drops" to become a local area provider.

Figure 2.4: The Upward Hierarchical Movement



Source: Borchert (1998)

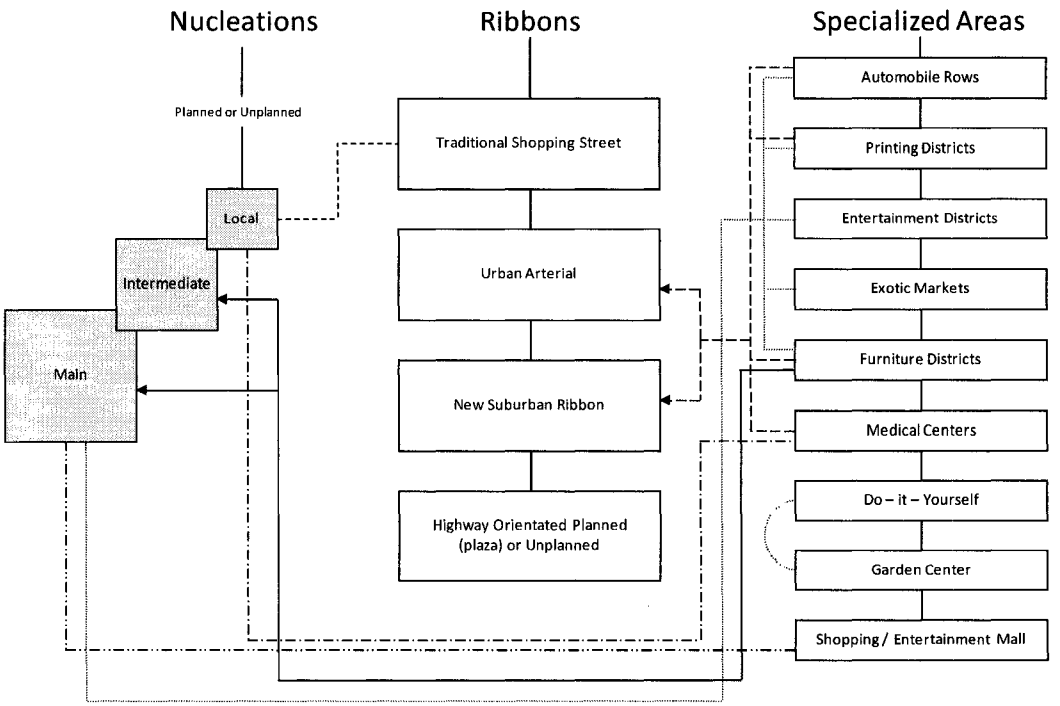
Secondly the Metropolitan CBD is removed and becomes part of the town center category (Figure 2.4).

While Borchert recognizes that the traditional hierarchy needs to be adjusted, he does concede that the classic spatial component of the central place theory needs to be removed. Increased mobility, he argues, "releases the necessity of a regular spatial pattern" (Borchert 1998). The result of this concession and adjustment is that he suggests that the Berry typology simply be amended. The five-fold classification of hierarchical centers has been replaced by a three-fold one (called nucleations). The ribbons component is maintained and the specialized centers category is expanded in order to accommodate emerging types of retailing (Figure 2.5).

2.2.2.7 Jones (2000)

This final typology by Jones represents the third iteration of the typology originally created by Jones (1984) and revised by Jones and Simmons (1993). It also

Figure 2.5: Borchert (1998)

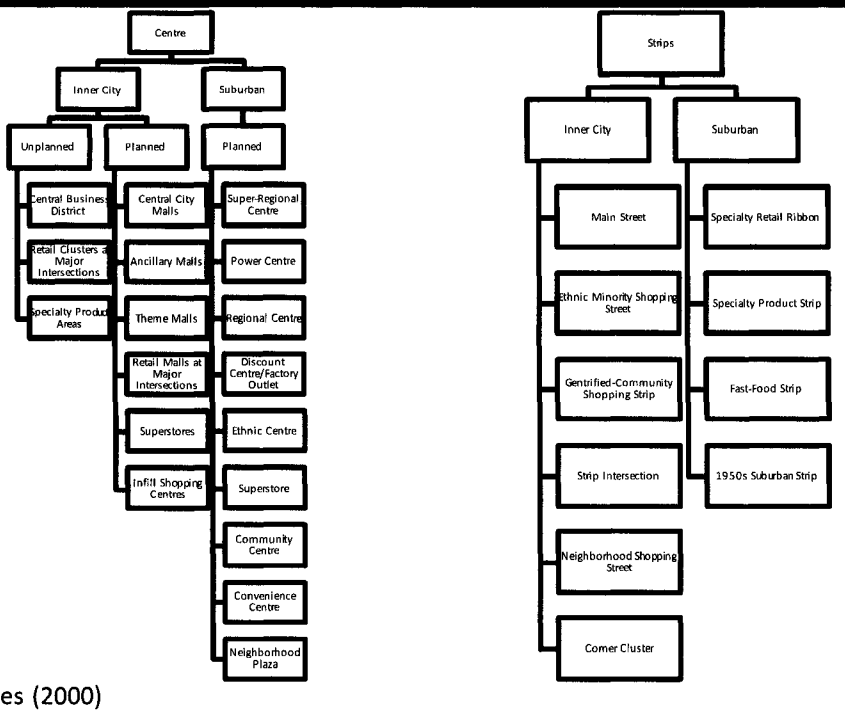


Source: Borchert (1998)

represents the most recent significant commercial typology to be developed. By Jones' own admission, "an attempt to generalize and classify urban retailing should be balanced by the realization that the retail landscape within metropolitan areas is difficult to categorize" (Jones 2000).

This system contained four main criteria used to approximate the location within the typology where a particular commercial area should belong. These include: (1) the morphology or spatial form of the area, (2) the functional composition of commercial types within the commercial area, (3) the composition of the market server, and, (4) the ownership patterns to determine whether it is a planned or unplanned area (Jones 2000).

Figure 2.6: Jones (2000)



Source: Jones (2000)

The typology begins by determining whether the commercial zone is a strip or centre. This is followed by the commercial zone's location within the metropolitan area, inner city or suburban[10]. At this point, strips are classified based on their morphology and market. Centres are divided into either planned or unplanned and then classified according to their morphology and market (see Figure 2.6).

The immediate noticeable difference over its predecessors was that this typology reflected many of the new commercial forms that have entered the commercial environment (i.e. power centres). In addition, it reflected the complexity of the commercial environment, as it had existed. It classified the markets being served, whether they are spatial or specialized.

[10] The definition between inner-city and suburban areas is vague at best. In the case of Toronto, Ontario, the inner-city is defined by the original city of Toronto and consequently the remaining outlying areas are part of the suburban areas. Conversely a city like Sudbury, Ontario, which has not experienced the same population growth, has a less definable inner-city and subsequently a less definable suburban area.

2.2.2.8 Synthesis

The evolution of these commercial typologies has reflected the changes within the commercial structure. The initial theories of Christaller and Proudfoot provided the practical foundation for the development of the Berry typology. In turn this typology has been the foundation of all subsequent typologies. However, as several authors have shown (Potter 1982; Jones 1984), the Berry typology has limitations in the modern urban context. Improved typologies reflected the changes observed in the commercial structure, and these too have become dated. Jones again proposed a new typology of commercial development in 2000 that once again reflected the major changes to the commercial environment.

Early typologies represented simple classifications of the organization of commercial structure within the urban space. As the commercial environment has become more complicated, so have the typologies to describe it. A comparison of the Berry typology to the Jones (2000) typology reveals this increasing complexity. However, regardless of the typology, a continual change in the commercial system as well as differences between cities makes the broad applicability of these typologies difficult.

Borchert (1998) writes that Berry's typology can still be used to adequately describe the functional differentiation of urban retailing provided some minor alterations are carried out. The highest levels of the hierarchy have gained in importance while the lower levels have lost their position. Even with these modifications the Berry typology and its spawn, still require much adaptation when trying to apply them to the Canadian context.

Several major changes have occurred in the commercial environment over the last fifteen years that have facilitated this need for change. With the introduction of power centres or power clusters this work proposes that they should be added as a new commercial classification; a class equal to the centre or ribbon and should not be absorbed into the centre classification. As well, there has been the emergence of a new commercial form as a result of the coalescence of a group of commercial forms into a new one. Davies and Baxter (1997) illustrates that neither Berry nor the other typologies address the issue of the linear commercial complex. The linear commercial complex (LCC) is a situation where a commercial ribbon is anchored, at each terminus, by a regional or super-regional centre. The result of this merging of forms is a commercial node of massive proportions. The appearance of the LCC has been documented by Davies (1997) and by Storie, Oakely *et al.* (2001). It was concluded that, in many cases, these new land use patterns have added to the commercial structure of the city rather than replacing the older patterns previously observed.

Another problem when using the existing typologies is that they tended to be site specific. Berry developed his typology based on observations in Seattle and then Chicago, while Jones' work primarily focuses on Toronto. Any new typology should attempt to be city-neutral and exemplary of a wider variety of urban structures.

Changes in the commercial structure have been reflected by the development of new commercial typologies. Recent changes and observations have made many of these typologies unsuitable without major modifications. This analysis strongly suggests that a new typology be developed which better reflects not only the changes in the

commercial environment of Canada but is sensitive to differences among cities. The following section discusses how such a typology could be developed within a GIS environment.

2.2 Conclusions

Commercial environments in Canada have undergone considerable change over the last fifty years. Traditional downtowns, in many cases, have been supplanted with suburban malls and power centers, while others have returned their dominant role. The emergence of the shopping center, and later the big-box store with its power centers and clusters has reshaped the commercial geography of the urban environment. However these changes, as noted, have not occurred equally across all environments, consequently changes have been rapid in some areas while almost non-existent in others.

The changes to the models and typologies that describe this intra-urban commercial structure have changed as well. However, in most cases the changes came as additions to the existing models as new forms of retailing entered the urban environment. Consequently, in many cases the importance of these new forms are lost to a hierarchical type arrangement, or more appropriately existing forms retain an importance which they no longer have. In any event, it can be argued that a new model or typology needs to be created. The following chapter discusses the study areas for this research and identifies the appropriate data required to conduct a study of this nature.

CHAPTER 3

STUDY AREAS AND DATA

What is the difference between exploring and being lost? The journey is the destination.

Dan Eldon (Date Unknown)

3.0 Introduction

The very nature of conducting research within the discipline of geography requires that a study area and data about that particular area be defined and obtained. This research is no different. Unlike national census data that is readily available for all areas of Canada, commercial location data is far less widespread. Quality databases are generally quite costly, and consequently only exist for the largest urban areas.

This section details the data availability and subsequent preparation of the data for analysis. Furthermore ancillary data requirements are outlined for the in-depth case studies. Lastly the three primary study areas are briefly described and justification is made for the selection of these study areas.

3.1 Data

To accomplish the diverse set of goals set forth in this dissertation an equally diverse dataset needs to be developed. At the heart of the dissertation is the conceptual model of commercial structure which will be the resultant outcome from the data

synthesis and analysis. As a result the data becomes paramount to the execution of the research agenda.

Many authors have discussed the data requirements for analyzing urban areas and have concluded that regardless of the size and extent of the database, a truly accurate representation is not generally possible (Martin, Longley et al. 1994). However, detecting basic or generalized structures is possible. This conclusion fits strongly within this research agenda because it is the basic or generalized commercial structures that are being "detected". Furthermore, as illustrated in Figure 1.1 (Commercial System versus Commercial Structure) the commercial structure is an "outcome" or "result" of a series of complex interactions with many other aspects of the urban environment. Consequently, the analysis focuses on the visible structures and *not* on the underlying processes which are virtually impossible to model accurately.

The data that is required for this research is relatively straightforward – namely the locations of commercial operations. In addition to location information a variety of additional variables are needed. These will be discussed later in this chapter. There is, however, one major problem associated with any data based on a location's address. In the province of Ontario there is a dichotomy between rural and urban addressing[1]:

1. Many rural addresses do not share the same convention as their urban counterparts, for example an urban address may be indicated as <100 Copper St> whereas a rural address may be indicated as <100 R.R. #2> or simply <R.R. #2> or more commonly as <100 Highway 17>. Given this variety

[1] E911 or emergency addressing is designed to remove this problem; however, it has not been fully or accurately reflected across the entire province and more importantly in the spatial street network files.

in the reporting of addresses in the street network files there are difficulties in determining the proper location of rural addresses.

2. Given the relatively small population of these rural areas, many rural addresses posses a rural postal code that directs mail to a central Post Office. Therefore an entire community (i.e. Copper Cliff, Ontario) shares the same postal code (POM 1NO). Therefore, during the geocoding process if a postal code fallback is required the point will fall to the centroid of the postal code (the entire community). This is unlike their urban counterparts where the postal code generally places it at the centre of a block face and therefore much closer to its actual location.
3. Lastly, the percentage of locations contained within the rural area as compared to entire metropolitan area is relatively small[2] and therefore their exclusion does not impact the overall model substantially.

Given these identified restrictions the decision was made to examine *only* those areas that are defined as urban (normally those with a "city" designation) within the CMA. Refer to Figure 3.1 Census Metropolitan Area Definitions.

3.1.1 Commercial Structure

The primary data component is the commercial locations file. This file, provided by the Centre for the Study of Commercial Activity[3], is comprised of 355 431 individual

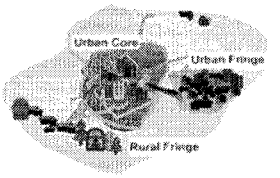
[2] The percentage of rural locations as compared to urban locations that are dropped from the dataset will be noted within the discussion of each study area.

[3] Refer to Simmons, Barbiero et al (2000) "Exploring a National Database of Commercial Activity" for a description of the original dataset extraction and creation.

Figure 3.1: Census Metropolitan Area Definition

A **Census Metropolitan Area (CMA)** is formed by one or more adjacent municipalities centred on a large urban area (known as the urban core). The census population count of the urban core is at least 100,000 to form a census metropolitan area. To be included in the CMA, other adjacent municipalities must have a high degree of integration with the central urban area, as measured by commuting flows derived from census place of work data.

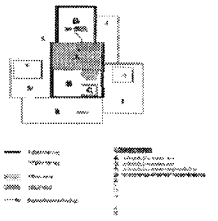
Once an area becomes a CMA, it is retained as a CMA even if the population of its urban core declines below 100,000. The urban areas in the CMA that are not contiguous to the urban core are called the urban fringe. Rural areas in the CMA are called the rural fringe.



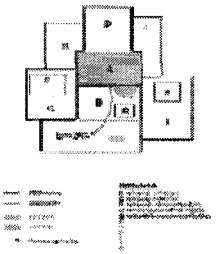
Commuter Rules

The high degree of integration with the central urban area is defined by a series of commuter rules:

Forward Commuting Flow Rule: Given a minimum of 100 commuters, at least 50% of the employed labor force living in the rural or urban fringe works in the urban core as determined from commuting data based on the place of work question in the last decennial census (1991 Census).



Reverse Commuting Flow Rule: Given a minimum of 100 commuters, at least 25% of the employed labor force working in the rural or urban fringe lives in the urban core as determined from commuting data based on the place of work question in the last decennial census (1991 Census).



**Definitions and images have been taken directly from Statistics Canada. For simplicity and presentation some information has been omitted. For a full definition of a CMA refer to:

Source: Statistics Canada, 2004

commercial locations, excluding automotive dealerships for the twenty-five CMAs for the year 2000. From this file, the respective commercial locations for the selected study areas are extracted. In addition, this data contains two vital pieces of information.

The first component is the location information. Commercial locations are recorded according to their street address, city, province, and postal code. Based on these variables latitude and longitude coordinates are generated removing the need for potential inaccuracies when address matching one dataset to another. This also removes the dependence on a street network file allowing for a wider range of spatial analytical functions to be performed such as cluster and nearest neighbour analyses. The addresses will be parsed and cleaned to ensure that they are in a proper format for the geocoding software.

The second component is the attribute information for each commercial location. Each location is categorized according to the type of business operation it reports itself to be. This information is reported as a code based on the 1987 US Standardized Industrialized classification system (SIC). Each location has up to four independent or related SIC codes. This information provides insight into the nature and type of each commercial operation. Only the primary SIC code will be used. In addition, only the first 4-digits will be used as they are usually the most reliable and provide a good generalized description of the commercial operation.

The third component of the data are those variables that are added to the database to enhance the overall analysis, these include:

1. **Nearest Neighbour Distances.**
    - To fulfill the needs of the nearest commercial neighbour analysis the commercial locations must exist as individual points in the dataset. The nearest neighbour operator can then perform the necessary functions on this dataset. The resultant calculations are included as additional fields in the original points file. For each commercial location, its ID number (as defined by the algorithm) the distance to its nearest neighbour, and its nearest neighbour ID are added respectively. This data is then extracted to a Microsoft Excel data file for basic data analysis.
2. **Malls and Downtowns**
    - The final data preparation is to extract from the land use planning database all malls and central business districts as these are fixed,

planned concentrations that require substantial investment to alter and therefore are more static entities within the overall commercial structure. These will be identified as polygons and will reflect the actual land use parcels (malls) or planned zones (downtowns).

3.1.2 Land Use Planning Data

The final component of the analysis requires the use of land use planning data. The data identifies the planning designation of each of the parcels in the urban area. More importantly, it allows for the extraction of areas that have been specifically planned as commercial and consequently can be used as either a part of the analysis or as a means of validating and confirming the analysis. Unfortunately each of the study areas has dramatically different datasets available. Each will be discussed briefly.

For the Ottawa CMA, the land use planning data set contains the land use zones and their associated codes for 1986, 1991, and 1996 (this is the last official year for the regional plan, a new plan entitled Ottawa 2020 will not take effect until that calendar year) for the regional municipality of Ottawa-Carleton. This dataset is provided by the regional municipality and does not include Gatineau (on the Quebec side). As this data originates with the regional municipality planning department it is viewed to be highly accurate.

Land use information for the Kitchener CMA has been acquired through an academic licensing agreement between the University of Waterloo and TERANET, the licensed provider of the Ontario land registry database. The geographic coverage for this database includes the entire region of Waterloo at the parcel level. A survey was

conducted in 1996 (original survey year) to identify the land use for each parcel. The final revision year and release date of the data is 2000. This data is considered very accurate as it has been provided by the region of Waterloo and field verified by TERANET.

The land use data for the city of Greater Sudbury is unfortunately not as readily available. Repeated efforts to acquire land use planning data from the region have been met with disappointing results. At present there are NO digital land use maps and as a result secondary data sources have been used to identify land use. For this study area, DMTI CanMap 5.1 land use files will be used. Considerable effort has been made to ensure the accuracy of the land use files being used through field verification. At present the best confirmation tools are the official 2006 planning maps. Though they do not correlate with the year of the data for this study, they will, at least, provide a basic means of insuring the accuracy of the data.

Given the nature of land use controls and zoning regulations, the databases will be generalized to only show broad classifications such as commercial, residential, industrial, etc. It will be based on these broader classifications that analysis and confirmatory actions will be conducted.

3.1.3 Ancillary Data Requirements

The ancillary data requirements for this research are minimal. An up-to-date street network file is needed for each study area to provide the necessary contextual information. This ancillary data is not used directly in the creation of the typology but is used to gain a better understanding of the 'nature' of each study area.

In addition, the need to fuse various data sources into the development of the model becomes vital. These other data source includes: Satellite/Aerial Photography to aid in the determination of commercial zones and to act as a point of reference when assessing the accuracy of the model. Land use planning data, and more specifically parcel maps to assist in the accurate location of the commercial locations.

3.2 Study Areas

Canadian cities have changed drastically from their original forms. The principle assumption here is that it is possible to identify similarities and differences in the generalized form and function of the commercial systems within major Canadian urban areas. Underlying this assumption is that Canadian cities as larger groups share many characteristics which drive the growth they experience. Bourne (1987) suggests that within this context two other principle determinants of differences in urban spatial structure are city age and size. Urban size is a surrogate variable for many other interrelated factors. In terms of commercial structure, the larger cities tend to have a more a diverse and complex commercial structure. Smaller cities cannot simply be mathematically enlarged to allow for easier comparison with larger cities. The inherent pressures included with an increase in city size, such as an increase in social funding, produce a myriad of results that are generally not present in smaller urban centres.

The second factor that Bourne addresses is city age. He suggests that there is a sharp contrast between cities that were substantially developed prior to World War II and those that experienced the post war boom. In these cases suburban housing stock is the greatest difference where those cities that developed during the post war boom

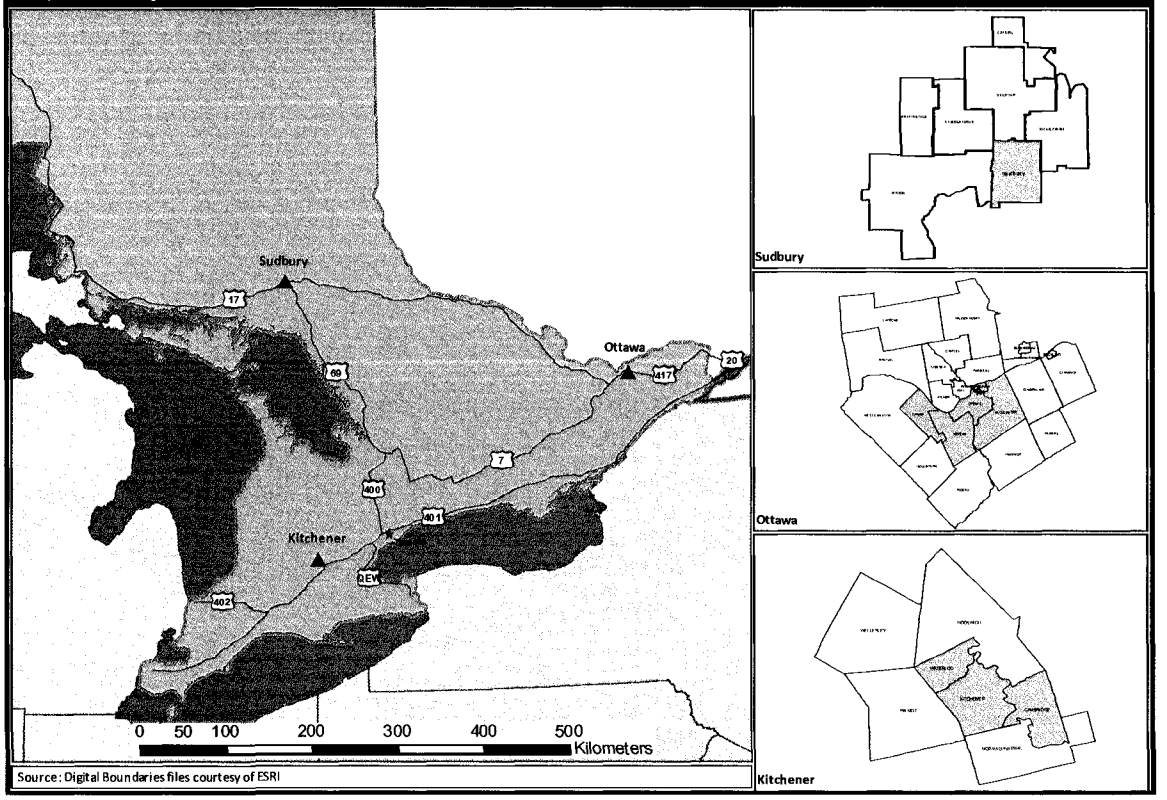
tended to be more suburban-orientated. These differences are best noticed between cities in central and eastern Canada with those in the west given the nature of the historical growth of Canada.

A third and final characteristic of urban form is density. Several authors have examined the issue of density (Bunting and Filion 1999; Filion, Bunting et al. 1999; Bunting and Filion 2000; Fonseca and Wong 2000) but primarily from the greater overall urban form. Their discussions focussed on the continued development of low density suburban housing areas. Associated with these low density developments are generally some type of commercial development as well. Davies and Baxter (1997) suggest that low density commercial development is primarily linked to "sprawling ribbons" which are extremely space extensive. In addition, they deal with density as a function of stores/unit area or stores/unit length. Therefore adding several small strip malls with multiple tenants would represent an increase in density. However, they also add that the addition of big-box stores, and their associated massive increases in physical size underestimates the scale of change, in essence there are several density issues worth examining.

The study areas for this research represent urban areas of three different population sizes. It is hoped that by selecting cities of varying urban scales a typology can be developed that is not constrained by city size. The three main study areas (Map 3.1 Study Areas) are the census metropolitan areas of Sudbury, Kitchener, and Ottawa-Gatineau.

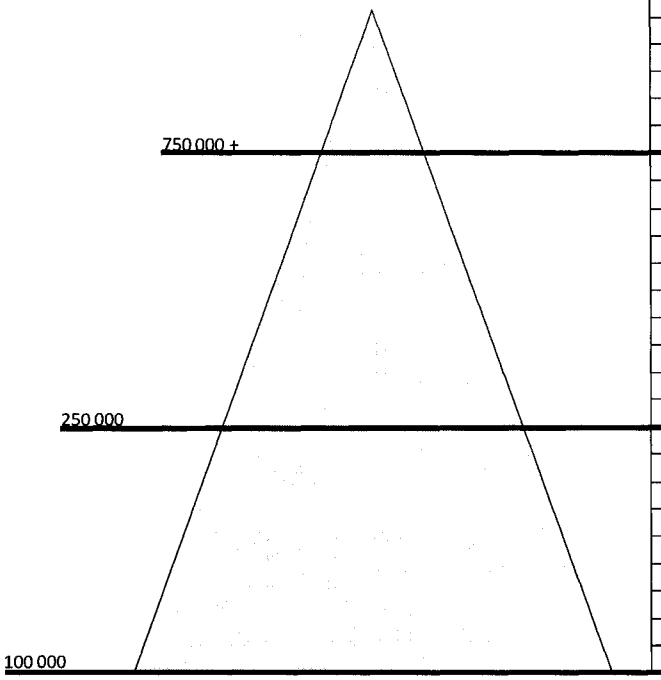
In addition to their location in the urban hierarchy these three cities were selected because of the author's local knowledge of each community. Past research (Storie, Oakley et al. 2002) has shown local knowledge of the study area is critical when conducting research of this nature. Moreover, the city ages are relatively similar (Kitchener, 1857; Ottawa, 1826; Sudbury, 1867), but more specifically they were well established as cities prior to 1950[4]. However, their growth profiles are dramatically different as are the major economic bases for each of the cities which have resulted in significant differences in commercial structure and form.

Map 3.1: Study Areas



[4] As illustrated in the literature review, the majority of changes to the commercial systems of Canadian urban areas occurred post WWII, or approximately 1950 and beyond. These cities were well establish by this time period and therefore would have experienced the same potential for growth arising out of this period [Bourne, L. S. (1987). "Evaluating the Aggregate Spatial Structure of Canadian Metropolitan Areas." The Canadian Geographer **31**(3): 194-208].

Figure 3.2: Canadian Urban Hierarchy (CMA Only / 2001 Census)



Census Metropolitan Area	Population (000s)
Toronto (Ont.)	4,883.8
Montréal (Que.)	3,507.4
Vancouver (B.C.)	2,076.1
Ottawa–Gatineau (Ont.–Que.)	*1,102.9*
Calgary (Alta.)	976.8
Edmonton (Alta.)	961.5
Quebec (Que.)	696.4
Hamilton (Ont.)	689.2
Winnipeg (Man.)	690.1
London (Ont.)	449.6
Kitchener (Ont.)	*431.3*
St. Catharines–Niagara (Ont.)	391.7
Halifax (N.S.)	369.1
Windsor (Ont.)	320.8
Victoria (B.C.)	325.4
Oshawa (Ont.)	308.5
Saskatoon (Sask.)	230.8
Regina (Sask.)	196.8
St. John's (N.L.)	176.2
Sherbrooke (Que.)	157.0
Greater Sudbury (Ont.)	*161.5*
Saguenay (Que.)	157.8
Trois-Rivières (Que.)	140.1
Saint John (N.B.)	126.0
Thunder Bay (Ont.)	126.6

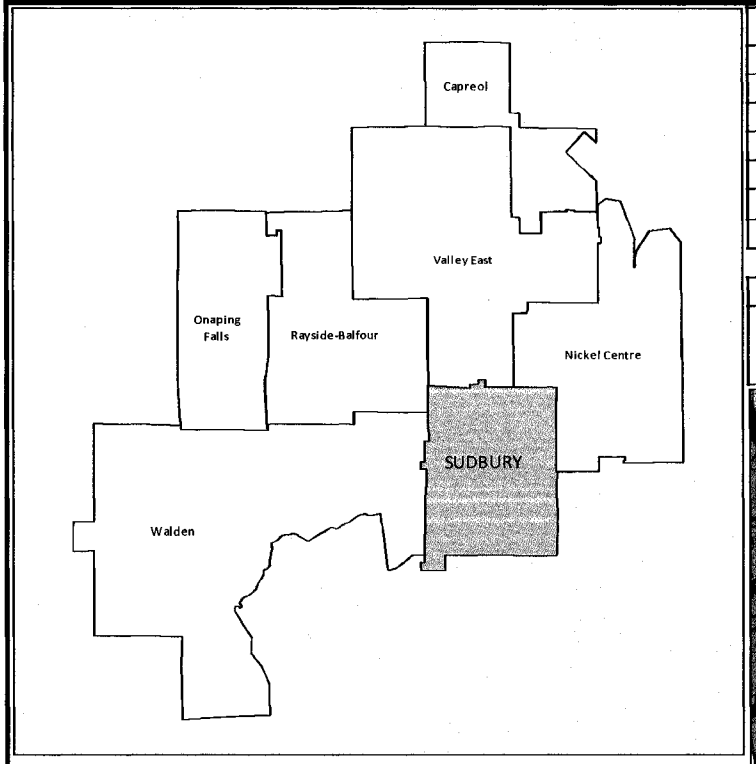
Source: Statistics Canada, 2001

These CMAs fall within different levels of the urban hierarchy, a hierarchy that generally divides cities into small, medium, and large urban centres. Small metropolitan areas have a population of between 100 000 and 250 000 people, medium CMAs between 250 000 and 500 000 and large CMAs of over 500 000 (see Figure 3.2: Canadian Urban Hierarchy). Therefore, the study areas represent each of these levels. Furthermore little research in terms of commercial structure has been done on Sudbury and Ottawa. Kitchener has been studied more extensively, and consequently forms the detailed case study of the research.

3.2.1 City of Greater Sudbury (Sudbury CMA)

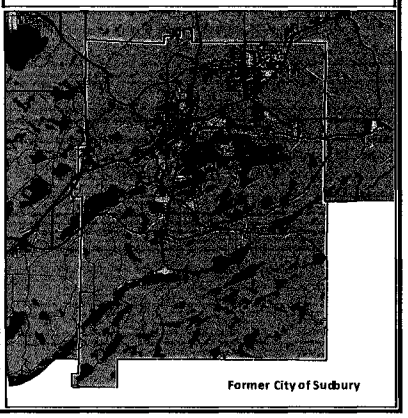
The City of Greater Sudbury is Canada's 20th largest census metropolitan area with a population of 161 500 (Canada 2003). The city is located approximately 380

Map 3.2: The City of Greater Sudbury



Township or City	Population
Capreol	3 486
Nickel Centre	12 672
Onaping Falls	4 887
Rayside-Balfour	15 046
Sudbury	85 354
Valley East	22 374
Walden	10 101
CMA Total*	155 219

*The numeric total of the above values and the CMA total do not add up. This the result of two First Nation Reserves whose population is not counted within their respective township or city but counts within the CMA total.



Source: Data - Statistics Canada, 2001 / Geography – DMTI CanMap

kilometres north of Toronto in Northeastern Ontario, and functions as the regional centre for medicine, education, retail and government (Map 3.2 Sudbury CMA).

The City of Greater Sudbury was formed on January 1, 2001 and represents the amalgamation of the towns and cities which comprised the former Regional Municipality of Sudbury, as well as several surrounding unincorporated townships. Prior to amalgamation two cities existed – Sudbury and Valley East – and the surrounding, predominantly rural townships of Onaping Falls, Rayside-Balfour, Capreol, Nickel Centre and Walden, each of which has their own smaller central town. Consequently this CMA serves a fairly large urban and rural population in addition to its estimated market area of almost 550 000 (City of Greater Sudbury Development Corporation 2000).

3.2.2.1 General Description of Commercial Structure

The general commercial structure of the city of Greater Sudbury reflects the merging of a series of less populated townships and communities around the denser central city. The majority of the smaller surrounding communities have some form of "downtown" which contemporarily functions as a neighbourhood commercial area. Only the original city of Sudbury has a central business district that is highly developed and which continues to function as the dominant core area for the CMA.

The city of Sudbury and the surrounding townships each has a level of commercial development commensurate with their population. Arterial ribbons and strip malls form the main commercial zones in the smaller communities while the larger surrounding also have enclosed malls and some free-standing stores. Unfortunately data reliability issues and addressing problems preclude the inclusion of these areas within the study.

This research will only focus on the former city of Sudbury as the data is more easily verified and problems of rural addressing do not exist. Within the city there are three dominant commercial areas – New Sudbury, Downtown and the Four Corners. Each area has a dominant enclosed mall surrounding by a variety of other commercial functions. In addition, the New Sudbury commercial zone has experienced the addition of free standing stores and new-format retailers into its commercial mix. Furthermore there are a variety of smaller arterial ribbons and commercial parks that exist throughout the city.

3.2.2 Regional Municipality of Waterloo (Kitchener CMA)

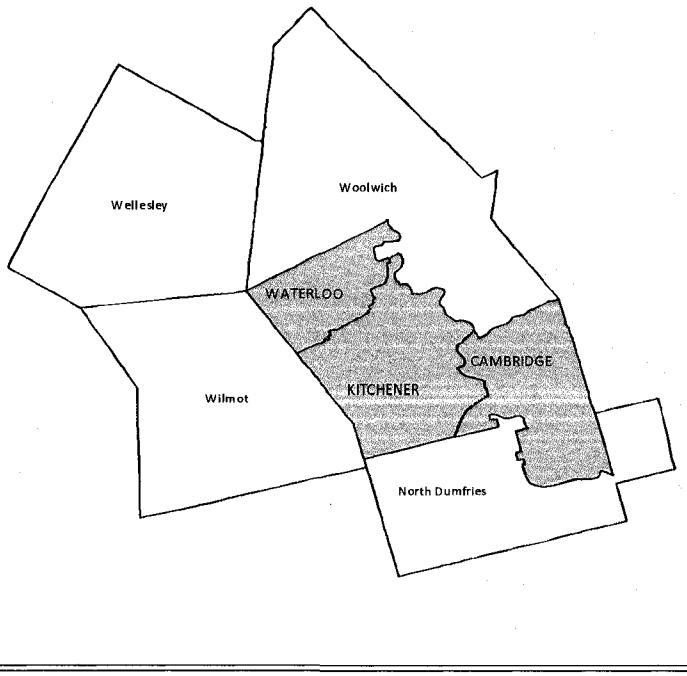
The Region of Waterloo is the eleventh largest urban area in Canada with a population of 431 300(Canada 2003). Located approximately 110 km from the Greater Toronto Area along the highway 401 corridor, it is within the outer edge of the Toronto commuter zone (Muncaster 1998). See Map 3.3: Regional of Municipality of Waterloo.

The Regional Municipality of Waterloo is comprised of three cities (Kitchener, Waterloo and Cambridge and four smaller townships (Wellesley, Woolwich, Wilmot, and North Dumfries. The region was established in 1973 by the province of Ontario to govern the "highly interconnected and rapidly urbanizing area" (Muncaster 1998). The result was a political structure that merged the former cities of Galt, Preston and Hespeler into the one new city, Cambridge and placed this new city under the new regional authority along with Waterloo and Kitchener. Four peripheral townships were added because of their increasing levels of urbanization as well as the linkages to the core cities, however, each township had its own central service community which still exist and thrive to this day. The regional area consequently services both a large urban and rural population.

3.2.2.1 General Description of the Commercial Structure

The general commercial structure of the region of Waterloo reflects the amalgamation of 5 cities into three. Each of the former cities within Cambridge have the remnants of their former central business districts, with the former city of Galt's CBD functioning as the central business district for Cambridge while the other two are now neighbourhood level business districts. Given the proximity of Kitchener and Waterloo

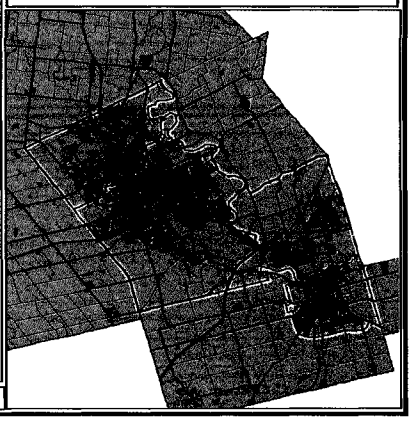
Map 3.3: The Regional Municipality of Waterloo



Township or City	Population
Cambridge	110372
Kitchener	190399
North Dumfries	8769
Waterloo	86543
Wellesley	9365
Wilmot	14866
Woolwich	18201

CMA Total*	414284

*The regional total does not match the CMA total because Wilmot is not part of the CMA but is part of the region.



Source: Data - Statistics Canada, 2001 / Geography – DMTI CanMap

to one another, Kitchener has traditionally had the downtown which served the regional market, while Waterloo had the "uptown". The Kitchener CBD functions are the dominant core area for the entire region, while Waterloo's "uptown" tends to serve a more upscale niche market and directly caters to both the high-tech industry and the university sector of the community. As a side note, each of the outlying communities has their own, albeit dramatically smaller, downtown core areas.

Each of the three cities has a strongly developed shopping centre hierarchy, arterials roads and most recently commercial power centres centred on major highway confluences. There are several major shopping nodes with enclosed and open mall space, strip mall and standalone stores. Overall the three major cities have a strongly developed commercial sector, thought the "downtowns" have shown a level of deterioration from age and competition from the more suburban commercial areas.

As of the 2000, each of the cities had a major commercial cluster comprised of predominantly stand-alone new-format retailers, or a combination of large regional mall with stand-alone retailers acting as satellites to the commercial area.

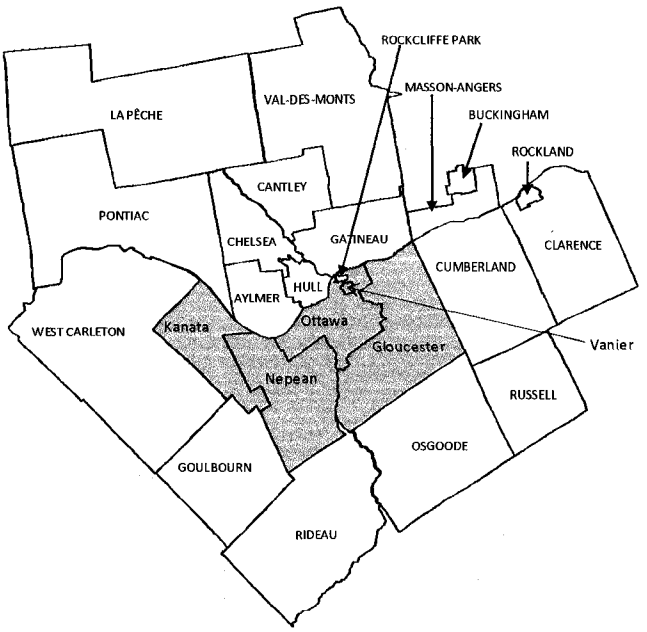
For the purposes of this research, only the three cities (Kitchener, Waterloo and Cambridge) will be considered in the analysis. The surrounding townships have several technical challenges associated with them and for consistency with the other two study areas, only city-designated areas will be considered.

3.2.3 The National Capital Area (Ottawa-Gatineau CMA)

Canada's national capital area, more commonly known simply as Ottawa is officially comprised on the former region of Ottawa-Carleton on the Ontario side and the city of Hull (now known as Gatineau) on the Quebec side. The Ottawa-Gatineau CMA is Canada's fourth largest metropolitan area with a population of 1.1 million (Canada 2003). Located approximately 430 kilometres northeast of Toronto in Eastern Ontario, not only is Ottawa Canada's capital but it is also the major commercial, education, medical and retail area for this part of the province and its commensurate part in Quebec (Map 3.4 The National Capital Region).

The geography of city of Ottawa is quite complex given the historic roots of the city. Ottawa is divided into three main regions: 1) the original cities (Ottawa, Nepean) inside the greenbelt, 2) suburban regions (Kanata, Gloucester, Orleans) outside the greenbelt, and; 3) the outlying rural areas (see map 3.4). This research will focus only on the "former cities" which include; Kanata, Nepean, Gloucester, Orleans, the former city

Map 3.4: The National Capital Region (Ottawa-Gatineau)



Township or City	Population	Township or City	Population
Aylmer	36 085	Masson-Angers	9 759
Buckingham	11 668	Nepean	124 878
Cantley	5 999	Osgoode	17 607
Chelsea	6 036	Ottawa	774 072
Clarence-Rockland	19 612	Pontiac	4 643
Gatineau	102 898	Rideau	12 695
Gloucester	110 264	Rockcliffe Park	2 028
Goulbourn	23 607	Russell	12 412
Hull	66 246	Val-Des-Monts	7 842
Kanata	58 636	Vanier	17 632
La Peche	8 543	West Carleton	17 267
CMA Total* 1 063 664			
CMA Total does not equal region total because of boundary differences.			

Source: Data - Statistics Canada, 2001 / Geography – DMTI CanMap

of Ottawa. There several smaller urban areas located within the outlying rural areas but have been excluded because of the same issues as discussed for the Sudbury study area.

3.2.3.1 General Description of the Commercial Structure

The commercial structure of the Ottawa area is the most complex of the three study regions. There is the primary central business district located within the former city of Ottawa, with each of the other former cities functioning as suburbs of the central city. Each city has a highly developed arterial ribbon and mall structure, as well as smaller pedestrian orientated shopping areas and in some cases suburban downtowns. All areas have substantial free-standing and new-format stores either within planned centres or unplanned clusters.

3.3 Conclusion

These three cities were primarily selected because of the author's local knowledge of each community. Past research (Storie, Oakley et al. 2002) has shown local knowledge of the study area is critical when conducting research of this nature. Furthermore the objectives of the assignment require an intimate knowledge of the study area.

CHAPTER 4

METHODOLOGY: THE SYSTEMIZATION OF SIMPLIFICATION

Retailing is dynamic and measurable changes in form and function occur within spans of time that are easy for the investigator to perceive, to comprehend, and to explain to others.

Cohen & Lewis (1967)

4.0 Introduction

Geographical information systems (GIS) provide a flexible and efficient platform for conducting commercial analysis especially when large spatial databases are involved. At the same time, as technology advances, there is a continued need for understanding and managing changes within the commercial and greater urban systems. However, according to Bond (2002) "the early optimism surrounding GIS has now faded. Few GIS implementations have lived up to expectation." He adds, however, with algorithm development and a decrease in the cost of the software packages and databases, there is the possibility of using GIS for more advanced urban analysis. The use of GIS for analyzing commercial locations definitely falls within this category.

Before the introduction of computer-assisted methods, researchers developed and performed similar functions manually. The initial works of Berry (1963) and Simmons (1964) were done using manual analytical techniques. Maps were made by hand and patterns were identified based on visual observation. The researchers

examined commercial locations and groupings of these locations to determine the form of each cluster. The results were then classified according to geographical form (ribbons or clusters), and market function. The process of collecting, mapping and analyzing these commercial locations and the consequent commercial zones was a tedious and time-consuming process. This resulted in typologies that were restricted to zone identification and classification only.

With the increasing availability of digital databases, coupled with the technical ability to handle such large databases, it is now possible to develop and rigorously test new commercial typologies more efficiently and accurately. A typology can be created based not just on the characteristics and attributes of one urban area but for multiple urban areas more efficiently. The end result is a typology that is more universally applicable and representative of the commercial environment in Canada as a whole. However, before a typology can be developed, a standardized way of analyzing the data needs to be defined. Much like a calculator did for mathematics, the GIS can allow for the analysis of data and the production of meaningless results. The goal here is to produce "meaningful" results. The first step needs to be to define how to analyze the data.

Building on the pioneering works of Berry and Simmons as well as many others, this research presents a unique method for analysing the commercial environment. Given the nature of location data presently available, commercial locations are usually geographically represented as a point. Therefore the techniques presented focus on how to effectively deal with point data while attempting to model a phenomenon that

has dimensions greater than a single point. As presented in the previous chapter, in addition to the point data several other ancillary data sources will be used that will be able to further refine the model, therefore reducing the amount of fieldwork required to verify and validate the derived forms.

The following question can be asked "How is using the GIS in this manner different than in other similar studies?" The answer, though straightforward requires some elaboration.

4.1 Using GIS in the Study of Commercial Location

Brail and Wiggins (2002) illustrated that a common usage of the GIS in urban analysis is descriptive in nature. These types of applications help the researcher quickly visualize and ask questions about spatial patterns at varying levels of scale. Large generalized patterns can quickly be identified and examined to determine if smaller patterns are contained within. This approach is very similar to the visual techniques employed prior to the advent of digital mapping. These simple descriptive GIS applications can be expanded, with multiple datasets, to add a temporal component to the description. However, to properly analyze data over time, a standardized way of analyzing the data needs to be developed to ensure temporal consistency.

The value of using a GIS to analyze large commercial databases is reflected in its speed of data visualization. The GIS has the ability to display large amounts of information relatively quickly. In addition, modifications can be made to the database as needed, therefore, providing a flexible and adaptive environment through which the

analysis of commercial structures can be done. Commercial locations can be added and removed interactively through the entire development and analysis process.

The traditional methods of collecting, storing and retrieving spatially referenced data have several disadvantages. Manual methods are limited in their ability to combine different sources of information rapidly and accurately. Moreover, the possibility of having duplicate data is high, and the ability to ensure consistency and accuracy is degraded with each additional person performing a data collection function. The advent of electronic databases has ensured that the databases are created in a consistent manner. The problem of data accuracy still exists. These databases are still being created manually for the most part, and human error at the data collection and entry levels still exists. Each level of error may then be propagated to the final analysis.

Although speed and ease of methods are useful, the major benefit of the GIS lies in the ability to develop processing routines to analyze the data based on a standardized set of parameters. This standardization ensures that each analysis is performed in an identical manner to the previous analysis. Therefore, the accuracy and consistency of each successive analysis can be guaranteed. Within commercial environment research, it is also known that not all urban systems have the same structure. Therefore, the process of analysis in a GIS can be designed to be interactive to allow for modifications conducive to the environment under study. These modifications can also be standardized. The end result is situation where commercial typologies can be rapidly tested on known areas and then accurately applied to other study areas. See Table 4.1 for a summary of the advantages of using a GIS to analyze commercial data.

Table 4.1: The Value of using a GIS in the Analysis of Commercial Data	
Value	Description
Organization	The GIS acts as the main information system organizing spatial and non-spatial attribute data.
Visualization and Summation	The GIS provides rapid visualization and summation of large complex spatial databases and its associated attributes.
Manipulation Tools	A variety of manipulation tools exist at a variety of scales to conduct basic analysis such as clustering or address-matching
Feeds Model Development	Provides descriptive information that can lead to the development of newer models.
GIS-Based Models	These are models that employ the processing ability of the GIS to a specific spatial database at a variety of scales.
Temporal	The integration of multi-year databases allows for the rapid description and analysis of change over time.
Scale	The GIS is scale-independent. Large area analysis can be conducted with to identify general patterns. Small area analysis can then be performed to determine underlying processes.

Source: Derived from Brail & Wiggins (2002)

4.2 The Big Picture: How to Get It Done

Determining how to proceed once a problem has been identified is possibly the most difficult aspect of conducting research. The way in which the problem is tackled ultimately becomes the very essence of the research and subsequently one which dictates its overall success. The methods are not only the way in which the problem is approached and for which answers are found, but more importantly the methods are the probes used to understand and interpret the information; methods are useless unless they provide the user with a greater insight of the problem under study.

Conceptually and structurally commercial elements within the urban area can be easily represented within a vector-based GIS environment. The concepts of stores, strips, and downtowns can be directly related to points, lines, and polygons. Therefore

the visual representation of commercial location data is immensely aided by using a GIS. Furthermore, the analysis of said data can also be aided.

Before any detailed discussion of methods can begin a major issue must first be addressed; namely the ability to reduce a three-dimensional geographic commercial entity, such as a Home Depot down to a 1-dimensional point for ease of analysis. It is very common to represent 3-D entities as simple points because of data availability – commercial addresses which generate point locations are more readily available than building footprints. One must recognize that by following this style of symbolization that this representative centroid "is an artificial point reference which is located so as to provide a summary measure of the location of an object" (Longey, Goodchild et al. 2001) the problem facing commercial structure research is that the very nature of the entities being studied have dimension greater than that of a simple point. In other words, by representing a Home Depot as a single point, you cannot then extrapolate its approximate spatial extent. When trying to detect the spatial extent of a commercial zone, this becomes an even greater consideration. However, given the technique proposed here is a generalized method of detecting commercial structure, it is expected that this data limitation will not be a major hindrance.

The literature is lacking when dealing with a procedural way of quantifying and defining the various commercial forms. Simmons, Barbiero et al. (2000) have put forth a basic scheme for classifying the variety of pre-defined commercial locations (Table 4.2 Variety of Commercial Locations). However, this appears to be the only such suggested scheme of its kind. The variety of present classification schemes focussed on adding to

Table 4.2: The Variety of Commercial Locations

Commercial Location	Form	Stores	Floor Area (1000s sq. FT)	Activities
Downtowns	Polygon	25 – 10000	<= 50 000	Retail Finance Services
Shopping Centres	Polygon	10 – 300	50 – 4500	60% Retail
Big Box Stores	Point	> 1	> 10	Retail Service
Retail Strips	Line	25 – 300	50 – 500	50%+ Retail
Arterial Strips	Line	25 – 300	50 – 1000	Auto Retail Auto Service
Industrial Zones	Polygon	25 – 300	50 – 1000	Specialty Retail Services
Office Building	Point	25 – 300	<= 300	Business Service

Source: Simmons et. al., 2000; pg. 8

existing schemas those structural features that were not yet classified within the typology. These typologies merely provide a general classification of the commercial structure since they lack the concrete criteria for quantifying and defining each of the commercial categories set out in the typology.

Given the lack of detailed methods on how to determine commercial zones, this research has broken down the analytical approach into two main sections: (1) Nearest Commercial Neighbour Generation, and; (2) Commercial Cluster Detection.

The first major sub-section is the discussion on the nearest commercial neighbour. This section will address two main issues: the calculations and statistics generated, and more importantly the reasoning for using this technique. The second major sub-section looks at commercial cluster detection, generation and validation.

4.2.1 The Nearest Commercial Neighbor

The application of the nearest commercial neighbour is to determine spatial proximity of commercial locations to one another. The underlying premise here is that "shopping areas" or commercial zones function as a coherent unit because they are in close proximity to each other. Therefore by generating each location's nearest neighbour, and through a series of basic descriptive statistics, a generalized measure of proximity can be calculated. The two main measures that are calculated are:

1. Average Nearest Commercial Neighbour (A-NCN): This descriptive measure uses the average of the distances generated by the nearest neighbour algorithm. The benefit to this measure is that each city will have its own A-NCN thereby allowing the analysis to be specifically tailored to the city. The major drawback is that outliers and single stores outside of commercial zones have the potential to skew the average value. However, given the large number of points being addressed this skewing effect should not be significant. If this presents a problem, outliers can be mitigated by removing them from subsequent iterations once the general commercial zones are identified.
2. Median Nearest Commercial Neighbour (M-NCN): This value represents the middle value in the dataset and therefore represents a balance between the very small and very large values without being directly influenced as an average value would be. Unlike the A-NCN, it is not influenced by outliers and other anomalies. Furthermore it can be used as a surrogate density measure as it provides a generalized proximity value that would represent the most common spacing between locations.

These two descriptive values provide information about the proximity of commercial locations across the entire study area. Another problem, which is easily addressed, is that of multiple stores at a single location - a mall for example. Given that each mall location's nearest neighbour would be other mall locations (same address), this produces a zero (0) value. These must be removed to avoid skewing the data to the lower end of the distance measure.

The calculation of the nearest neighbour values is a straightforward process. The algorithm is contained within an ArcGIS extension (Sawada 2002), and requires point class data[1]. To generate a dataset on which this extension can be used involves three basic steps:

1. The current shapefile containing the commercial locations must be dissolved based on a filter. This filter is generated by combining the latitude and longitude values into a single field. The shapefile is then dissolved using this filter, with the result being 1 point for every unique coordinate pair. This function produces a new multipoint-class shapefile with a count of the number of previous points that existed at that address[2]. Unfortunately, the nearest neighbour extension cannot handle multipoint-class shapefiles; therefore two additional steps must be performed. The

[1] ArcGIS and ArcView have two types of point classes: (a) a Point class has a combination of two values (coordinates) that locate the attribute in geographic or mathematical space, and; (b) a Multipoint class is a shape representing a set of points and is usually generated when a Point class file is dissolved. The algorithm only accepts Point class shapefiles.

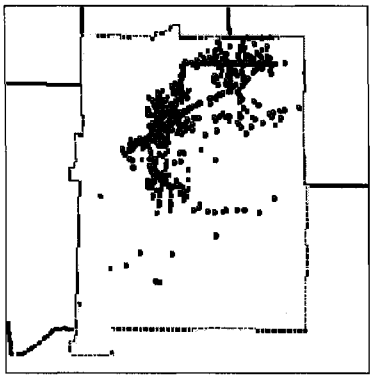
[2] This technique is also very valuable when trying to determining mall locations. As each point contains the number of previous points at that location, malls can be found by looking for multi-points that have a minimum count of a specified value or greater.

value of this filter is that it can be linked back to the original dataset. [ArcGIS: Dissolve]

2. Once the new multipoint-class shapefile is generated, an XY coordinate pair (preferably in latitude-longitude format) needs to be generated for each location, and [ArcGIS: Add XY Extension];
3. Once the XY coordinate pairs have been generated the file is remapped using these pairs [ArcGIS: Add Event Data]. This produces a point-class shapefile. It is based on this shapefile that the nearest neighbour calculations can be performed. (Map 4.1: Map of Commercial Locations by study area).

It should be noted that this dissolving of points is done **only** to facilitate the nearest neighbour calculations. These dissolved shapefiles will not be used in the analysis of the commercial zones as the dissolved shapefiles contain significantly less information about each commercial location than the original shapefile. Therefore, for all analyses and display functions the original datasets are used.

Map 4.1 – Commercial Locations By Study Area

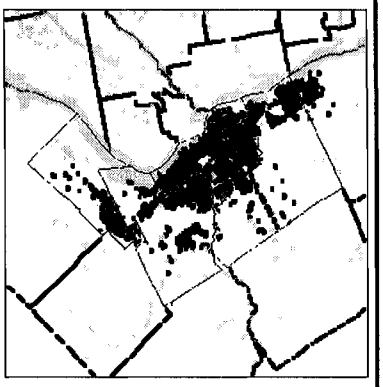


Sudbury

Total Points	2436
Total Unique Addresses	1300

Kitchener-Waterloo-Cambridge

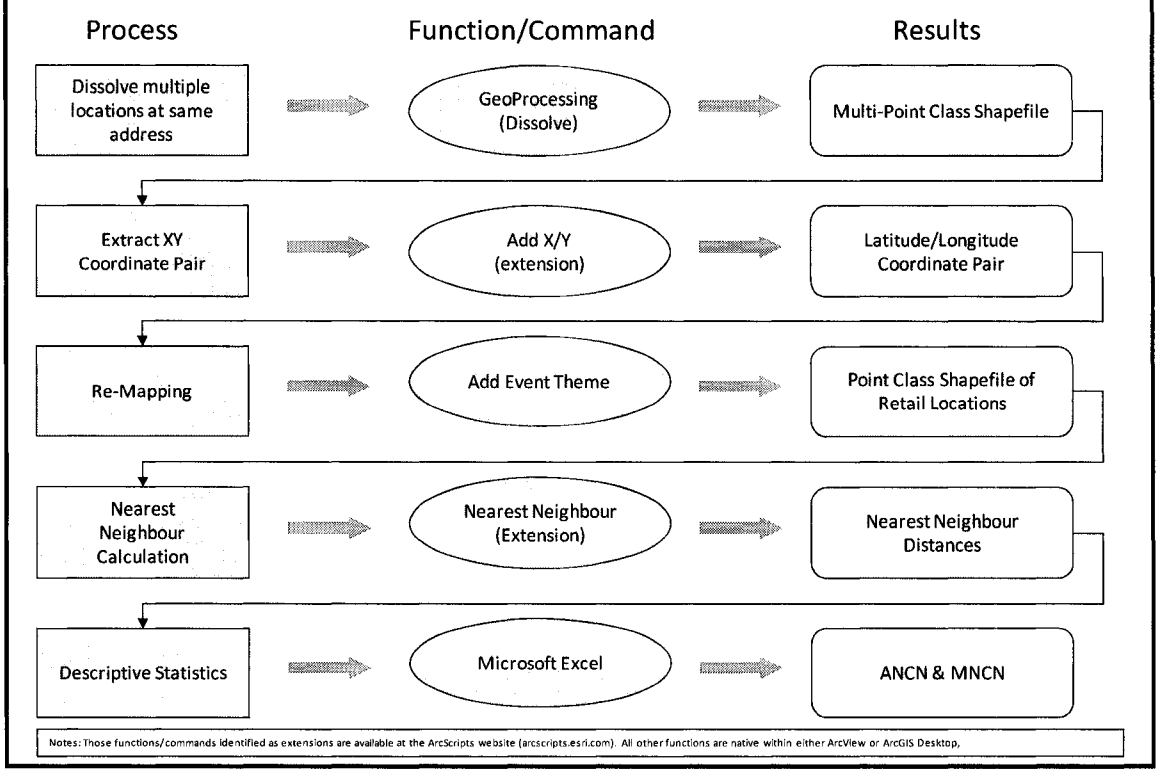
Total Points	6848
Total Unique Addresses	3568



Kanata-Nepean-Ottawa-Vanier-Gloucester

Total Points	13 268
Total Unique Addresses	6522

Figure 4.1: Nearest Neighbour Calculation Procedures



Using these new shapefiles, the nearest neighbour distances are generated. The extension **only** calculates the nearest neighbour and not all inter-point distances[3]. These values are then added to the shapefile tabular data as a new column. At this point the descriptive statistics can be generated (Figure 4.1: Nearest Neighbour Calculation Procedures).

4.3 Cluster Detection Techniques

The following discussion details the two main detection approaches: point only, and point plus fixed entities.

[3] Calculating all inter-point distances is a time-intensive operation. By calculating just the nearest neighbor time efficiencies can be achieved as well as minimizing data overload.

4.3.1 Point Only Cluster Detection

To empirically detect and then quantify the spatial organization and morphology of the commercial areas, the following steps are required:

1. Using the derived NCN values (ANCN and MNCN) cluster the data points using a buffering technique. The technique works by creating a buffer around each point location, with the size of the buffer being defined as the ANCN or MNCN value or multiple thereof. When two or more buffers coalesce they are dissolved into a single unit. This is an iterative process until all overlapping buffer polygons have been dissolved. The result is a series of polygons that cluster the commercial locations according to the buffer size.
2. Once the clusters have been generated, the number of commercial points within each cluster is determined. Those clusters that have less than 5 stores are removed based on the threshold criteria posited by Simmons, Barbierio et al (2000) who suggest that cluster or 4 or fewer stores are not "commercial areas". The remaining clusters then constrained using a buffered road network (20 meter buffer). The produces a representation that corresponds more with what the actual ground-level perspective would produce. This differs from Simmons, Barbierio et al (2000) where they have represented commercial zones using a point symbol located at their centroid along a street network. It is felt that this represents a truer cartographic representation of the actual commercial zone.
3. At this stage, steps 1 thru 2 are repeated. Successive iterations will involve a multiple of the MNCN value as the buffer value. The ANCN is not used in multiples as

it is typically a larger value than the MNCN. Multiples would produce excessively large buffers that would capture more than actually exists.

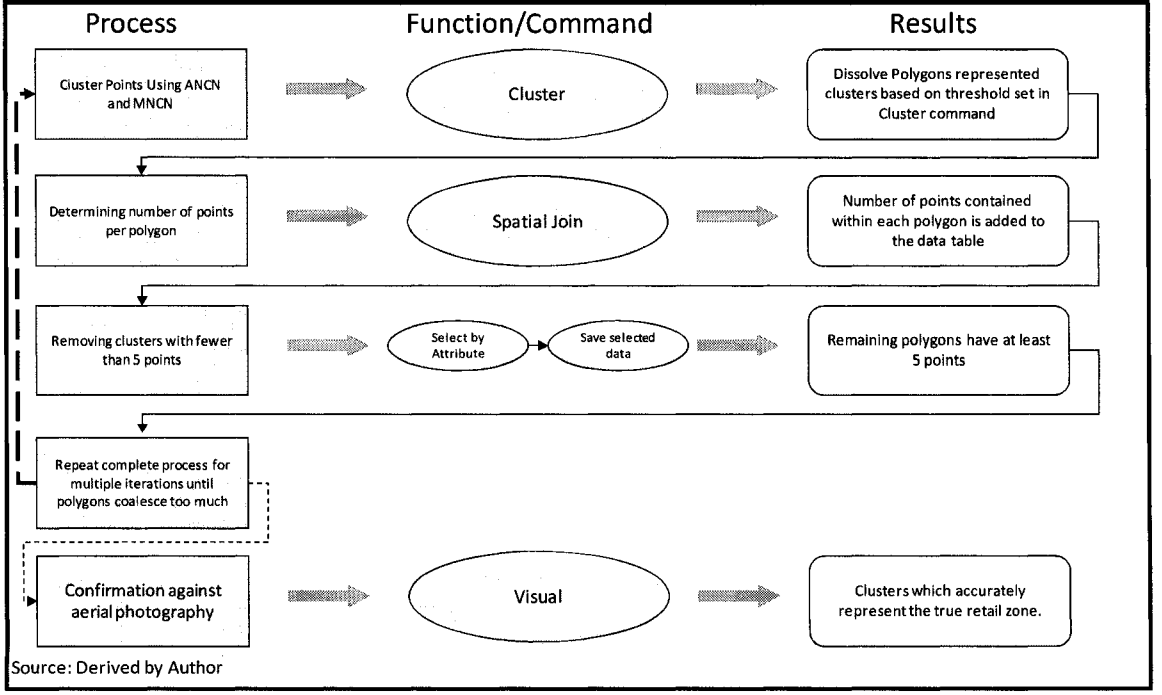
4. The value that is determined to have produced the more accurate result, based on field observations and direct comparisons to the orthoimagery, will be deemed the most effective.

For a detailed overview of the commands and procedures used for the General Cluster Detection, refer to Figure 4.2: Point Only Cluster Detection Flow Diagram.

4.3.2 Point + Fixed Entity Cluster Detection

The next level of detection introduces a second data layer. Using the existing point location dataset, those points which are located within Malls, Power Centres, and the central business district are removed from the analysis. The result is that only freestanding locations outside of clearly defined (fixed) areas are analyzed. The resulting

Figure 4.2: Point Only Cluster Detection



Source: Derived by Author

polygons are then combined with the planned commercial zones to produce a final commercial structure.

The results of this level are compared against the orthoimagery and field observation to identify it levels of accuracy.

4.3.3 Land Use Comparison

The final section involves comparing the results generated in the two detection methods to accurate parcel data for the Kitchener CMA. This is to function as a measure of accuracy of the detection techniques. This will involve:

1. Extracting and grouping land use parcels for the Kitchener CMA that have been defined as commercial. This is will represent the known commercial structure of the CMA.
2. Overlaying the generated clusters from the two detection techniques and visually compare the accuracy of the clusters to the actual land use parcels.

This step will only be performed on the Kitchener CMA due to data limitations.

4.4 Classifying the Components of Commercial Structure

When developing a typology of commercial structure several definitions and methods of classification must be addressed first. These include the classification of: commercial stores, geographic location, geographic form, shopping centers, and commercial areas. Finally a discussion on how to combine these definitions into a usable typology of commercial structure is presented.

Guy (1998) suggests that these classifications and definitions are critical when conducting this type of research. He suggests that classification is essential when trying to simplify the complex structure of the commercial sector in order to be able to more effectively analyze it. He goes on to present two reasons to justify this position:

1. A logical and appropriate classification system assists in the systematic analysis of the commercial environment. Furthermore, he adds that the classification structure should be in some way "the perspective of the researcher and the objectives of the research".
2. A consistent and comprehensive classification system allows research to compare and contrast empirical findings across a variety of spaces, cultures and time periods. Consistency becomes the key underlying factor.

Based on these two broad justifications a series of classification and definitions will be presented that will assist in analysis stage of this research.

4.4.1 Classification of Commercial Stores

The first major task is a definition of what a commercial store or location is. A common, simple definition is any building from which retailing is carried out. However, this basic definition is extended to include those outlets which sell retail goods to members of the public from the premises without prior appointment (Guy 1998). In other words, commercial locations are those stores which offer goods and services in exchange for money in a context normally associated with the term "shopping".

When classifying retail outlets, several systems have been used. However, for the purposes of this research two basic systems will be discussed: classification by type of good and classification by size and type of store.

4.4.2 Classification by Geographic Location

The first level of classification is based on the geographic location within the urban environment. This research will use a three category approach:

1. Inner City – Within the context of the census metropolitan area the inner city is typically the original city - sometimes the entire city - that the CMA designation is based upon. Usually the oldest part of the urban environment this typically contains the central business districts as well as the original arterial developments.
2. Suburbs – The suburbs represent the major residential and commercial developments that surround the inner city. Within the context of the CMA these are usually defined as the city and towns that comprise the catchment area of the core city. These developments are typically less dense than the inner city and are designed around the use of the car.
3. Gateway – The final classification is the gateway, also known as the edge city (Garreau 1992) and defined by Lowe (2000) as having the potential to be the centre for new town development. These developments represent growth on the urban-rural fringe and in many instances signify where suburban development is going to continue. The term ***gateway*** is used here to denote those commercial areas on the extreme urban fringe that lack surrounding residential development and act as a potential focus for continued suburban growth.

4.4.3 Classification by Geographic Form

The second level of classification is by geographic form. Given that the analysis is conducted within a GIS three forms will be used point, line, and polygon:

1. Point – A point is a single, free standing store
2. Line – A linear cluster represents a commercial area existing along the length of a road or roads in the case of an intersection.
3. Polygon – A polygon is representative of commercial areas that exist over several roads (a CBD for example) or over a large geographic (a mall, industrial park, power centre).

The use of these three forms will aid in the final classification of the commercial area itself. However further classification of the shopping centre (the polygon) is required.

4.4.4 Classification of Shopping Centers

Classifying a shopping centre has been the focus of considerable debate in the literature. Some research has suggested defining a shopping centre based on size while others suggest that a group of shops may very well be a center. Some definitions take into consideration whether the shopping center is planned or unplanned, purpose-built or not.

A common classification and one that will be employed for this research is as follows:

a. Shopping Centers: Those planned, purpose-built retail developments that are generally enclosed, but do not have to be, and consist of a variety of stores within close proximity to one another (Dawson 1972)

b. Retail Areas: Those unplanned, clusters of retail stores, where stores are in proximity to one another such are the characteristics of a downtown (Simmons, Barbiero et al. 2000).

A further method used to classify shopping centers is based on function. Predicated on the central place model, the classification of shopping centers is based on the size of the market that they serve. However, as it has been suggested previously (Borchert 1998; Guy 1998) this method of classifying based on central place might no longer applicable or at least it needs to be re-evaluated, especially in multi-nucleated urban areas where traditional hierarchical divisions are blurred.

A more contemporary classification of shopping centers is based on physical form. The advantage of this classification is that is more closely reflects the more recent developments and reflects they ways in which consumers evaluate and identify their shopping destinations (Guy 1998). The main forms of commercial area development are as follows: (1) The Focused Center; (2) The Retail Park; (3) The Shopping Mall; (4) The Regional Shopping Centre; (5) The Factory Outlet Center, and; (6) The Specialty Centre (for greater detail see table 4.3 Main Forms of Development).

One special note must be made, the regional shopping centre, a remnant of the older central place classification retains its title for two reasons: these are physically large shopping centers {> 500 000 sq feet GLA} and serve a substantially larger market than their "shopping mall" cousins.

Table 4.3: Main Forms of Development

Size	Description
The Focused Center (Neighborhood Center)	Built to serve surrounding residential areas with convenience shopping needs.
The Retail Park	Usually built in office centre locations. Variety of household good and do-it-yourself stores. Generally contains at least 50 000 sq feet of gross retail space.
The Shopping Mall	Typically an enclosed, large building that contains a variety of stores, one or more large anchor stores and a food court. Attempt is made to replicate the variety and environment of a traditional CBD. A minimum size of 10 000 sq feet is generally required to mall classification.
The Regional Shopping Center	A large shopping mall generally built in a free standing position rather than part of an existing area. Typically a minimum of 500 000 sq feet is required for "regional" status.
The Factory Outlet Center	Similar physically to a shopping mall but has no anchor store. Stores tend to sell good as discount prices. Purpose is generally to sell surplus goods and overruns.
The Specialty Center	Similar to a shopping mall or can be a combination of existing buildings, there is no anchor store and retail outlet (mainly independent) tend to specialize in either in one type of good or are designed for a specific market (generally tourists). Sometimes referred to as festival markets to generate a strong tourist appeal.

Source: Guy (1998)

4.4.5 Classification of Commercial Areas

The final classification that needs to be addressed is when dealing with commercial areas. As mentioned previously, this section will deal with those unplanned areas that have typically grown within areas that have been planned, at the city or regional level, for commercial development. These areas are characterized by a multiplicity of property owners, and consist of many separate buildings which are varied in physical appearance. These areas have generally developed in two ways:

1. In the inner city or original city as a central business district or downtowns.
2. In the suburban areas as conversions of land from typically Greenfield or brownfield to commercial in order to be able to provide services to the growing suburban communities.

Much effort has been dedicated to classifying these commercial areas (Berry 1963; Guy 1994; Jones 2000). Typically these classifications have followed a central place structure to analyze the catchment population of these commercial areas. There are three general problems when using the central place hierarchy to classify commercial areas:

1. The designation of a hierarchy suggest that there are clear, distinguishing characteristics for each level, when in fact empirical evidence suggests a continuum exists (Davies 1972; Potter 1981).
2. Retail and service ribbons, particularly in European towns have usually grown to serve the needs of adjacent communities which contradicts the definition Berry (1963) uses of highway users commuting to work.
3. The third criticism posed by Dawson and Sparks (1987), and Davies (1989) is that large modern retail structures which are highly specialized in purpose - hypermarkets or big-box stores – and are difficult to fit into conventional hierarchies. However, Jones (2000) continues to use the hierarchical classification and has added a category for these large format retailers. Moreover, he does not make any distinction when these large format businesses are contained within more traditional areas.

It is clear that in the modern urban area, using a classification system based on a hierarchical organization that assumes consumer will select the closest store to satisfies their needs may no longer viable. Therefore the classification system presented here does not employ any type of hierarchical schema and relies more on the physical

location of the commercial area within the greater urban environment. Three types exist:

1. Unplanned Cluster: Typically a downtown or suburban commercial area.
2. Linear: A traditional road/highway orientated shopping ribbon or shopping street.
3. Isolated: A standalone commercial outlet.

(Source: adapted from Brown (1991))

The two dimensions of this classification are physical form and function. This classification has wide appeal because the physical and functional characteristics are easily identifiable within a GIS environment (Guy 1998) . Simmons, Barbiero et al. (2000) presents a basic classification scheme for commercial locations which include generalized classification characteristics (See Table 4.4 Classification of Commercial Areas).

Table 4.4: Classification of Commercial Areas

Commercial Location	Form	Stores	Floor Area (square feet)	Activities	Comments
Downtowns	Polygon	25 – 10 000	Up to 50 000 000	Retail Finance Service	Non-residential, Includes strips, mall and office
Shopping Centers	Point	10 – 300	50 000 – 4 500 000	60% Retail	
Big Box Stores	Point	1	10 000 +	Retail Service	
Retail Strips	Line	25 – 300	50 000 – 500 000	50%+ Service	Shared pedestrian flows
Arterial Strips	Line	25 – 300	50 000 – 1 000 000	Auto Retail Auto Service	Shared accessibility and traffic flow
Industrial Zones	Polygon	25 – 300	50 000 – 1 000 000	Specialty Retail Service	Mixed land use, industrial zoning
Office Buildings	Point	25 – 300	Up to 300 000	Business Service	Share location.

Source: Simmons (2000)

4.5 Constructing a Commercial Typology

Once the empirical analysis and refinement process has been completed and the commercial zones derived, a generalized model of urban commercial space can be created which contains three components:

1. Geographic Location
2. Geographic Form
3. Commercial Area

This model will be constructed by analyzing the derived commercial forms from the study areas as the main building blocks. At the top level is the overall urban system, the first division is between urban, suburban and gateway developments. The second level looks at the geographic form of the various zones within each sub-section. The third and final level of classification is that of the commercial area itself.

Though this classification scheme is presented in a hierarchical layout, it is not based on any type of planned commercial hierarchy but upon a location hierarchy characteristic of the average Canadian city. Therefore no one single commercial form is regarded as geographically more significant than another.

4.6 Conclusion

The ability to develop a series of standardized techniques that assist in the analysis of the commercial areas of urban environments is invaluable. By being able to apply these techniques to different urban areas in a consistent manner, meaningful and comparable results can be generated that provide greater insight into the overall

commercial development of an urban area. Furthermore, these procedures can then be used to develop a more theoretical model of intra-urban commercial structure.

CHAPTER 5

RESULTS AND DISCUSSION

Retailing is dynamic and measurable changes in form and function occur within spans of time that are easy for the investigator to perceive, to comprehend, and to explain to others.

Cohen & Lewis (1967)

5.0 Introduction

The spatial pattern of commercial development within an urban environment is generally dictated by its physical layout and socio-demographic structure (Sun 2000). The average urban centre has evolved from a multi-function mono-centre (downtown) to a multi-nodal environment in which commercial function has been dispersed into highly specialized areas.

Consequently analyzing commercial structure within urban environments is a challenging process. Zoning and land use planning, building size, market composition, and changing consumer preferences all factor into how the commercial structure will "look". This is referred to as commercial form and can be readily observed by examining commercial areas originally designed for pedestrians compared to the modern automobile-orientated zones. The result is that the commercial structure within an urban environment is going to exhibit a variety of potential forms. Therefore the

contemporary commercial structure represents a mixture of commercial forms and functions of varying age and development style.

Commercial function is the second highly variable feature of commercial structure. Not only has the form of the zone changed but in many cases so has the function. Urban environments have migrated away from the one-stop shopping of the downtown, to the enclosed one-stop shopping of the mall, and more recently to the discount department store and warehouse club. As a result the function of these commercial zones will also have the potential to be heavily varied, and can range from entertainment districts, to jewelry districts, to automotive districts and potentially anything in between.

Commercial zone form and function become the two primary characteristics when describing commercial structure. In many cases the form of the commercial zone will dictate its function – linear developments along major arteries generally reflect a vehicle oriented function. However, the opposite is true as well. Function can sometimes dictate form. Entertainment districts, as a result of the nature of the businesses present are generally compact in size and pedestrian friendly. Consequently they tend to be observed within older core-area environments. Even newer power clusters, where the orientation is on the vehicle, have operations such as movie theatres and restaurants *relatively* close together.

This chapter details the results of the GIS analysis. The point only, point + fixed entity cluster detections are discussed for each of the three study areas, while the land use comparison because of data limitations is detailed only for the Kitchener CMA.

5.1 Point Only Cluster Detection

As discussed in the previous chapter the point only cluster detection involved three general steps:

1) Creating a subset of data points that has one entry per address location;

2) Generating nearest neighbor values for the sub- dataset;

3) Generating clusters on the full commercial dataset for each study area based on the derived NCN values.

5.1.1 Data Sub-setting and NCN Generation

The first stage was to reduce each of the commercial datasets into a subset that contained a single point location for each unique address. Each of the study areas experienced a substantive reduction of data points indicating that the majority of commercial locations contain more than one unique business. The CMA of Sudbury and Kitchener were reduced by approximately 52%, while the CMA of Ottawa was reduced by 49%. It is speculated that this increased reduction in Ottawa can be attributed to the number and size of enclosed shopping malls when compared to the other areas. See Table 5.1 (Nearest Commercial Neighbor Analysis Results) for a summary of values.

Once the subsets were generated the nearest neighbor point distances were calculated. Based on the inter-point distances (measured in metres) the mean and median values were extracted. The average values ranged from a low of 67.48 (Ottawa) to a high of 79.58 (Kitchener) with Sudbury sitting in the middle at 71.03 metres. This variation in values can be explained based on the general geographic arrangement of each study area.

In the case of Ottawa, though geographically large, the density of points within each of the cities was still quite high thereby generating comparatively low values for each nearest neighbor, whereas the Kitchener CMA has outlying areas with only small number of commercial locations that are not densely clustered. In Sudbury a data bias arises because it is the only study area that has one primary urban area as a result of rural addressing issues and does not exhibit the geographic variety of the other two areas (core area surrounded by suburban development).

When examining the median NN value each of the study areas produced similar results. For Ottawa and Kitchener the value derived was 31.5 meters while for Sudbury it was 30.75 meters. These values are similar because in all three cases a traditional grid network planning structure exists within the core areas producing a regular spacing of commercial locations influencing this particular value (refer to Table 5.1 for a summary values for both the median and average measures).

Lastly, threshold values for each of the study areas need to be calculated for each of the clustering iterations (Table 5.2 Clustering Threshold). Five threshold values

Table 5.1: Data Sub-setting and NCN Generation – Point Only Cluster Detection

CMA	Points		Distance Measures (meters)*	
	Multi**	Single***	Average	Median
Sudbury	2436	1300 (53%)	71.03	30.75
Kitchener	6848	3568 (52%)	79.58	31.50
Ottawa	13 268	6522 (49%)	67.48	31.50

*Based on a 20m offset during geocoding

** The multi-point number represents the original clean dataset without address duplicates removed.

*** The single-point number reflects the reduction of the dataset down to single entries per address.

Source: Generated by Author

Table 5.2: Threshold Values for Cluster Iterations

Sudbury

Iteration	Distance (metres)	Number of Clusters Produced	Remaining Clusters (> 5 stores)
ANCN	71.03	277	54
MNCN (1x)	30.75	508	100
MNCN (2x)	61.50	312	62
MNCN (3x)	92.25	203	45
MNCN (4x)	123.00	138	32
MNCN (5x)	153.75	84	22

Kitchener

Iteration	Distance (metres)	Number of Clusters Produced	Remaining Clusters (> 5 stores)
ANCN	79.58	849	176
MNCN (1x)	31.90	1691	300
MNCN (2x)	63.80	1052	213
MNCN (3x)	95.70	688	159
MNCN (4x)	127.60	400	113
MNCN (5x)	159.00	234	74

Ottawa

Iteration	Distance (metres)	Number of Clusters Produced	Remaining Clusters (> 5 stores)
ANCN	67.50	1415	262
MNCN (1x)	31.50	2539	439
MNCN (2x)	63.00	1516	278
MNCN (3x)	94.50	1004	215
MNCN (4x)	126.00	619	176
MNCN (5x)	157.50	340	110

Source: Generated by Author

representing multiples of the median value were calculated. Five multiples were determined based on the visual inspection of test clusters that were generated where by the fifth multiple the amount of cluster coalescence was so high that in many cases independent commercial clusters were joined together and identified as being of the

same cluster which they should NOT be. However, it was prudent to ensure that the model "went past" the accurate values to ensure strong comparison between each of the thresholds.

5.1.2 Cluster Generation

Based on the threshold values calculated six cluster maps for each of the study regions were generated. Each of the commercial clusters was generated by using a buffer routine with the buffer size set to the threshold value. Overlapping polygons were dissolved creating a larger commercial cluster. Once the clusters were generated the number of commercial points was added, and those clusters that contained four or less points were removed resulting in commercial polygons that had five commercial locations or more contained within them. These remaining polygons were then clipped using a road network with a forty meter wide buffer. This was done in order to constrain the polygons to the existing road network and to make them more visually accurate in relation to the roads[1]. Each study area is discussed individually. See Appendix A for a complete set of maps for each study area and iteration.

5.1.2.1 Sudbury CMA

The Sudbury CMA is the smallest of the study areas and consequently generated the fewest number of commercial clusters. Of the six iterations conducted a maximum number of one hundred clusters were achieved for the 1x iteration while the 5x iteration, as expected, produced the lowest number of clusters (22). Once the polygons

[1] Unfortunately, this particular step removes any possibility of calculated area values for the commercial zones and in some cases length values as well. Conversely the cartographic representation is enhanced as it better reflects what the consumer sees at street level.

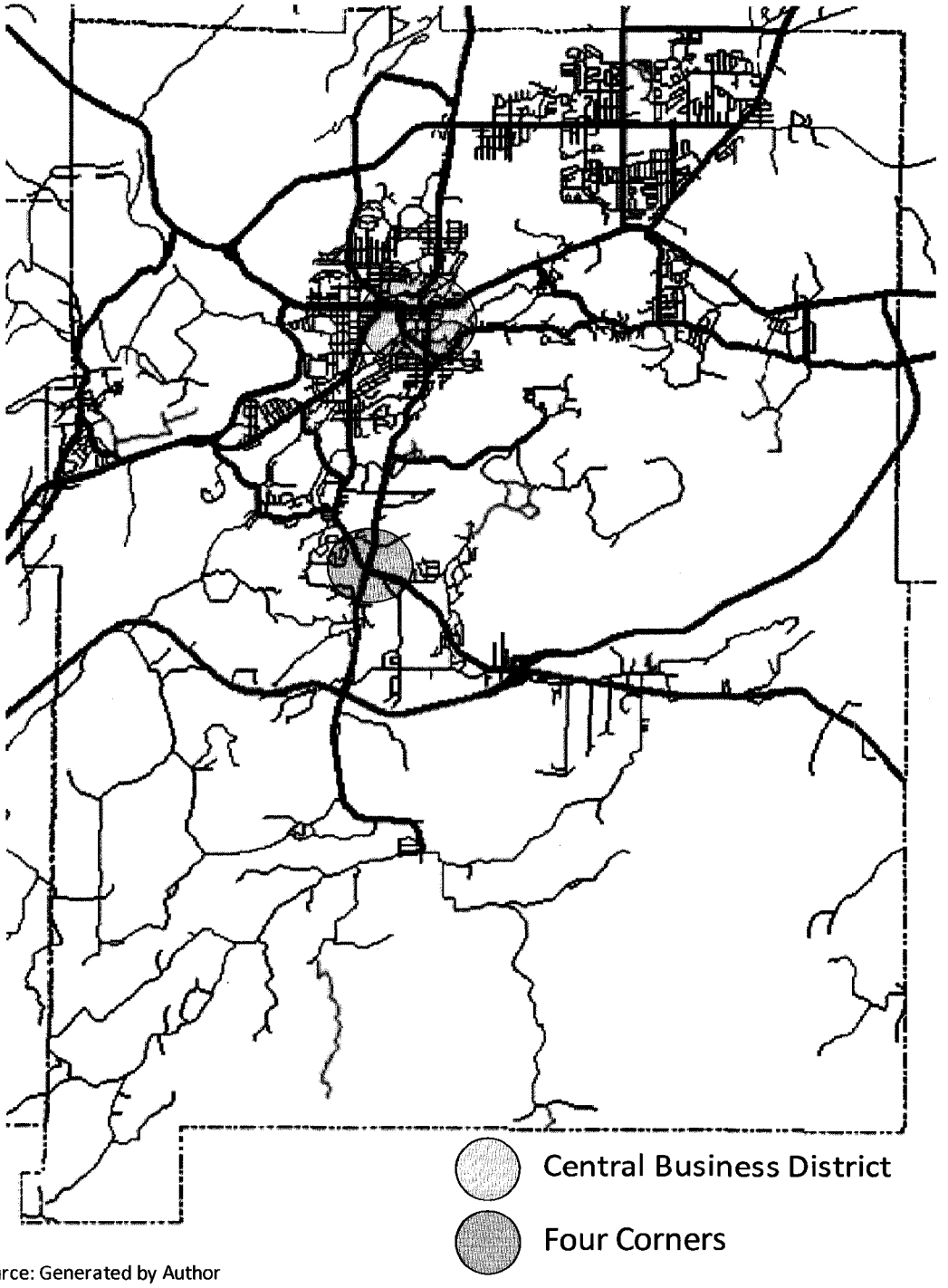
for the iterations were generated they were compared against the orthoimagery and land use planning information to visually assess their level of accuracy.

For the Sudbury CMA the central business district and the "Four Corners" commercial zones were used for comparison (see Map 5.1 Sudbury Overview Map). Each area is clearly distinguishable from surrounding land uses and both are clearly identified within land use plans. Map 5.2 (Sudbury CMA Point Only Cluster Detection Polygon Accuracy) illustrates the actual commercial areas as identified on the imagery and land use plan as well as the polygons generated for each iteration.

For the central business district, the results indicate that the iteration multiples quickly create polygons which are artificially larger than the area for which they are attempting to define. The 1x iteration "under-defined" the commercial areas by missing several areas where there was a large relative distance between commercial operations. The 2x iteration was visually deemed to be the most accurate as it produced a polygon structure that strongly matched the existing CBD with little interior area missing and minimal "spillover" outside of the actual region. The 3x, 4x, 5x, and median value iteration produces polygons that were larger than the CBD and resulting in the capturing of bordering areas that are not part of the central business district.

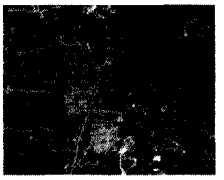
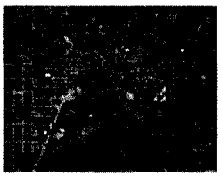
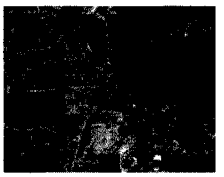
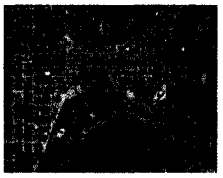
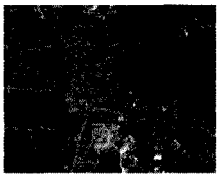
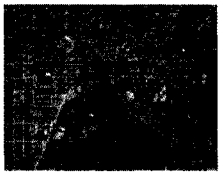
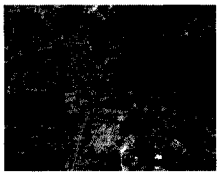
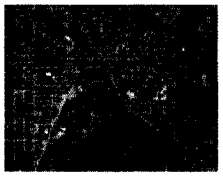
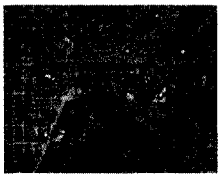
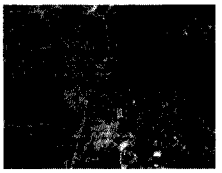
The Four Corners commercial area results are very similar to that of the CBD but with one exception. Whereas the CBD had broad areal extent, the Four Corners commercial area is much more linear as it represents the intersection of two major arterial roads. The visual analysis of the results for this region suggests that the 2x iteration was again the most accurate in defining this commercial area. In all cases the

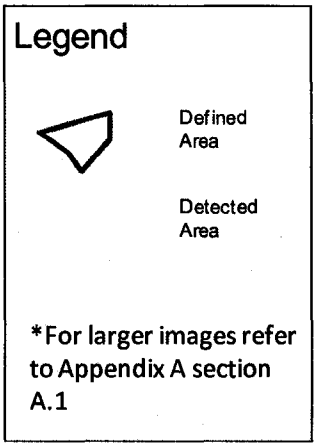
Map 5.1: Overview Map of the Sudbury CMA



Source: Generated by Author

Map 5.2: Sudbury CMA Point Only Cluster Detection

Central Business District	Iteration	"Four Corners"
	Original	
	1x	
	2x	
	3x	
	4x	
	5x	
	Average	



Source: Generated by Author

polygon "over-defined" the southern extent of the north-south trending artery. This can be attributed to two related factors;

1. A mixed use designation that permits for both commercial and light industry bordering on the planned commercial area, and;
2. The externality effects generated by the planned commercial area and its subsequent spillover into neighboring areas.

Though this over-estimation exists it is deemed to be less than critical as it reflects the commercial operations of the area and does not capture non commercial activities (such as residential neighborhoods).

Based on the results of the point only cluster detection for the Sudbury CMA it is apparent that the 2x iteration is sufficient to define the commercial zones within this metropolitan area. This iteration produces polygons that closely approximate the actual areas as visually defined by changes in land use. Furthermore, and more importantly, this iteration generally does not overestimate the actual area. This becomes beneficial in those areas where various land uses are tightly mixed and accordingly will result in those areas not being included.

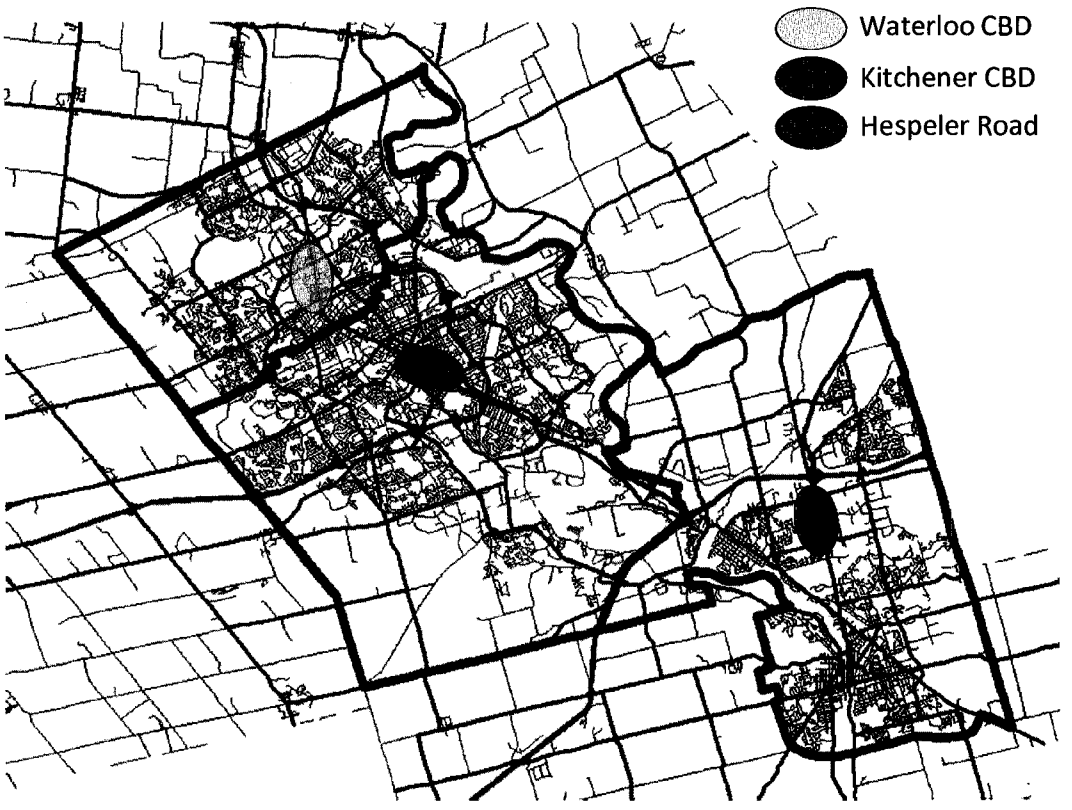
5.1.2.2 Kitchener CMA

The Kitchener CMA is much larger than the Sudbury CMA and therefore has a much more developed and geographically varied commercial structure. Of the six iterations conducted, a maximum number of clusters (298) was generated using the 1x iteration and a minimum of seventy-three was generated using the 5x iteration. Like the Sudbury CMA these polygons were compared against the orthoimagery and the land use

planning polygons to determine which iteration was the most accurate. The comparison was done using three readily identifiable commercial areas; the Kitchener CBD, the Waterloo CBD and the Highway 24 linear commercial complex in Cambridge (see Map 5.3 Kitchener Overview Map and Map 5.4 Kitchener CMA Point Only Cluster Detection Polygon Accuracy).

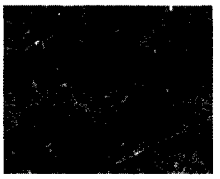
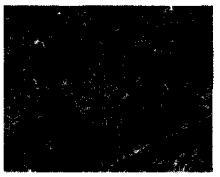
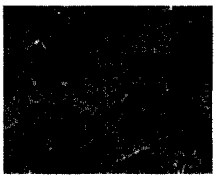
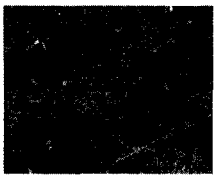
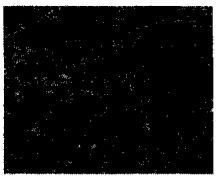
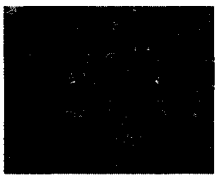
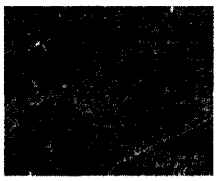
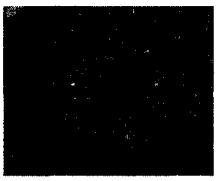
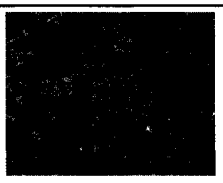
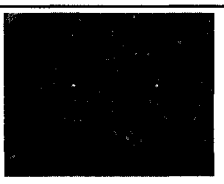
In the case of the Waterloo CBD, the 1X iteration was the only result that generally fell within the official CBD boundaries with little spill over. However, it can be argued that though visually this would be the most accurate there is a discrepancy between the land use definition of the CBD (boundary in red) and the location of commercial and commercial operations within this inner city area.

Map 5.3: Overview Map of Kitchener CMA



Source: Generated by Author

Map 5.4: Kitchener CMA Point Only Cluster Detection Polygon Accuracy

Iteration	Waterloo CBD	Kitchener CBD	Highway 24 LCC
Original			
1x			
2x			
3x			
4x			
5x			
Average			

Source: Generated by Author

*For larger images refer to Appendix A section A.2 **See Table 5.2 for Legend

Like many larger urban environments, arterial roads connect the suburban and outlying areas with the core. Waterloo is no different. To the north-east edge of the CBD is Bridgeport Road which connects the Conestoga Parkway to the east with the downtown area to the west. This arterial strip is mostly comprised of commercial operations starting at the Bridgeport Mall and continuing into the core. In addition, this is a one-way road, west-bound into the core. As a result of road connectivity and continuous commercial development those two areas may function as a single commercial area. Therefore, this research suggests that the 2X iteration more accurately captures this commercial area. Furthermore, the 2X also most accurately captures the CBD and captures the commercial development that borders the CBD as a result of externality effects.

The Kitchener CBD produced results that were similar to the Waterloo CBD. The 1X iteration accurately captures the CBD as well as the arterial development radiating outside of the core area. The 2X iteration produces a similar, albeit a more area encompassing result. Once again the differences between formally planned and identified areas (the CBD) and the more functional commercial zone that developments within and around the CBD emerges.

Like the Waterloo CBD, the Kitchener CBD has several major arterial roads the permit access to and from the core. These arterials are almost fully developed for commercial service provision and in most cases are directly "connected" to the core – in terms of continuous stores, with little to no discernable gaps (houses, green space, etc). Therefore, if one considers only the CBD then the 1X is more accurate, whereas if one

considers the commercial area as a functional zone then the 2X iteration is most accurate[2].

The final area studied within the Kitchener CMA is the Highway 24 (Cambridge) linear commercial complex (LCC). This is unique area consisting of a primary arterial strip (Highway 24) with a super-regional new-format center anchoring the north and a super-regional mall anchoring the southern extent. Radiating off this main core are a series of smaller arteries that have developed because of the externality effects resulting from the proximity to this large commercial area.

When looking at the results it becomes clear that the 2X and 3X iterations most accurately capture this area. However, the 3X iteration also over-captures surrounding areas and includes them within the LCC, where as the 2X is similar but to a lesser extent. The challenge being faced in this context is the difference between the dense CBD and "sprawling", suburban orientated arterial developments. Businesses along the linear commercial complex tend to be located in free-standing buildings, strip malls, and even larger regional and super-regional malls. These differences will be further expanded upon in the discussion section.

5.1.2.3 Ottawa CMA

The Ottawa CMA is the largest of the study areas and represents a highly diverse urban environment. This diversity was reflected in the number of clusters generated. For the point only cluster detection a maximum total of 429 clusters were generated during the 1x iteration while the 5x iteration produced 101 clusters. Like the two

[2] Refer to the discussion section 5.4 for further expansion on this issue

previous study sites, readily identifiable commercial areas were selected for analysis. These areas include:

(1) the Ottawa central business district and inner city bounded by the King Edward Avenue to the west (indicated by the western extent of the CBD), the Ottawa River to the North, Highway 416 to the South and Bronson Avenue to the East;

(2) Bank Street within the Glebe neighborhood bounded by Powell Avenue to the North and Holmwood Avenue to the South;

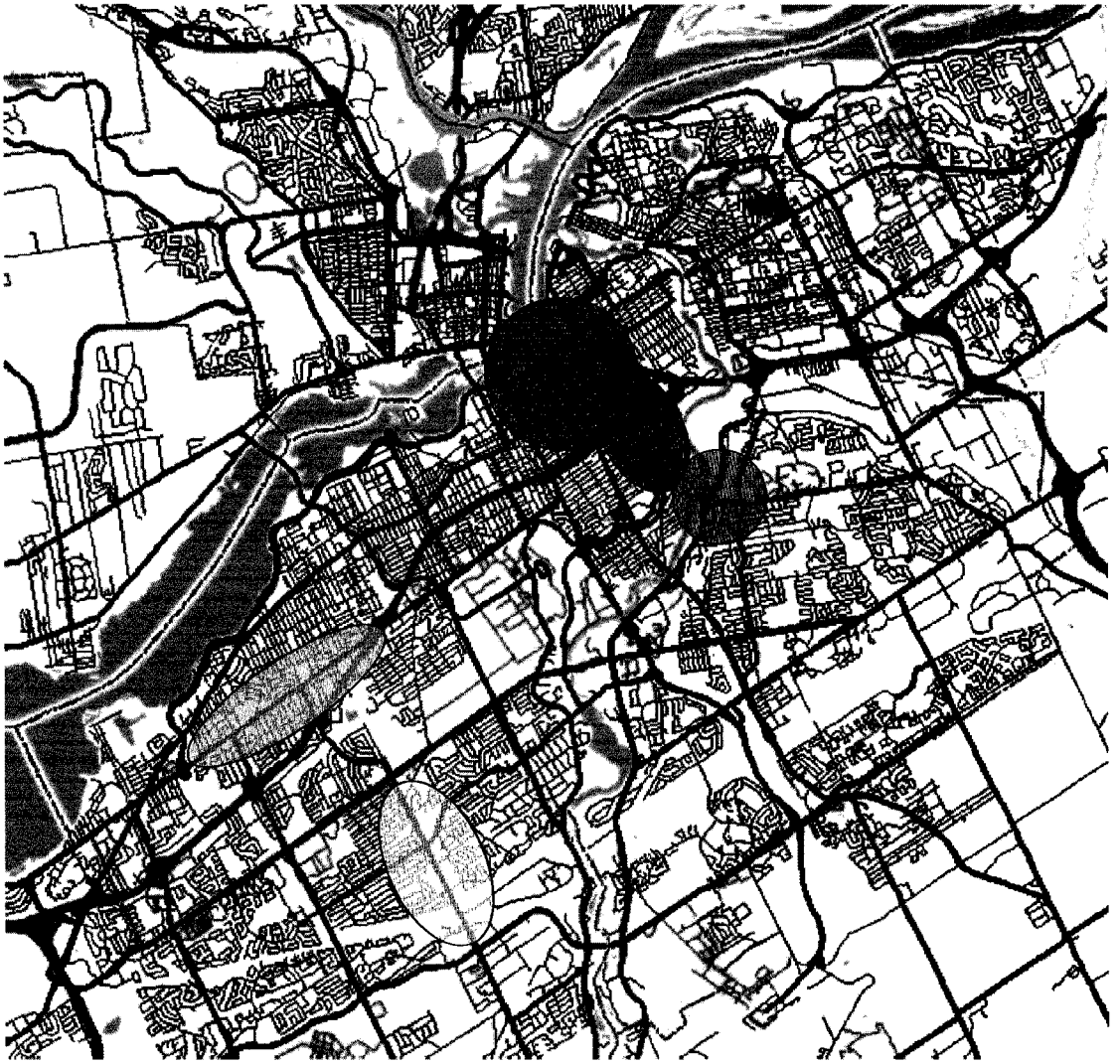
(3) Bank Street at the Billings Bridge commercial area bounded by the Rideau Canal to the north extended past the Rideau River to the southern terminus at Heron Road;

(4) Merivale Road from Baseline Rd to Hunt Club Road, and;

(5) Carling Road from the Carlingwood Mall in the East to Edgeworth Avenue in the West (Map 5.5 Ottawa Overview Map and Map 5.6 Ottawa General Results Maps).

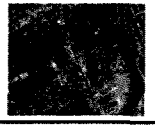
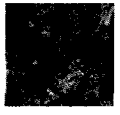
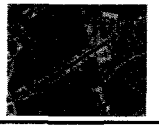
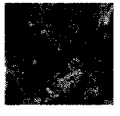
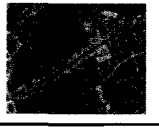
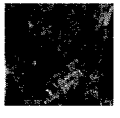
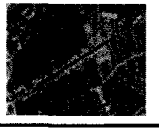
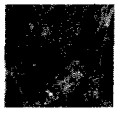
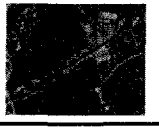
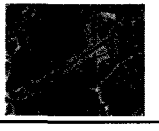
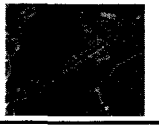
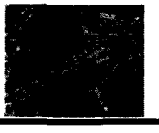
These five areas were chosen because the commercial structure of Ottawa is dominated by the historical core and inner city with a series of arterial commercial zones within the suburban areas. These areas selected represent the larger and more dominant of those arteries.

Map 5.5: Overview Map of Ottawa CMA



Source: Generated by Author

Map 5.6: Ottawa CMA Point Only Cluster Detection Polygon Accuracy

Iteration	Ottawa CBD and Inner City	Bank Street (Glebe)	Bank Street (Billings Bridge)	Merivale Road	Carling Avenue
Original					
1x					
2x					
3x					
4x					
5x					
Average					

Source: Generated by Author

*For larger images refer to Appendix A section A.3 **See Table 5.2 for Legend

The first area to be examined was the Ottawa CBD and original inner city. This is part of the original settlement area and contains not only the downtown core but Parliament Hill and the Byward Market. In addition, this is an area of dense mixed use (commercial, residential and institutional), consequently the model for this area generated results that were not in line with previous results for other cities. Firstly, if the central business district (as identified by the red outline) is the only area of concern then the 1x iteration produces the closest result, and though it extends past the boundaries it does so in a predictable manner (along arterial connectors). All other iterations extended far beyond the boundaries and are therefore useless.

This predictable manner is the challenge that is presented by the large urban environment. The CBD is traditionally accessed by several major roadways, and inevitably some of those roads will also develop commercial services. This is the case for the Ottawa inner city. By examining the 1x iteration two major arteries become apparent, Elgin St (center-east) and Bank Street (center west) extend beyond the defined core. In this situation there is no true distinction between where the CBD ends and these arterial zones begin. Therefore in this type of situation it is suggested that examining the Inner City as a whole is more effective and more representative of how a consumer would view the area – namely one that functions as a whole and not as separated entities.

When examining the Inner City as a whole, the 2x iteration performs almost flawlessly. The CBD is clearly captured from east to west, with the exception of the

extreme area to the west where the Canadian War Museum now exists. This land was vacant during the time period of the study area data. The cluster extends to the natural boundaries presented by the Rideau Canal and the OC Transpo Railway tracks to the east. The only problem with the definition is that Highway 417 (Queensway) which bisects this area and acts as a mental dividing line between the inner city and the more suburban areas to the south is elevated and does not hinder traffic flow on the major arteries beneath it. Consequently, the cluster follows Bank Street, Bronson and Preston Avenues beyond the Queensway, all three of which are heavily developed commercially and are directly linked to the core. The problem with these extensions is that these areas, especially Bank Street tend to be viewed as independent of the core.

One final note is that since the average NCN for this area was so close to the 2x value that the results were virtually identical. It is suggested that since this is not always the case using the results of the multiple iterations is more accurate as it is more consistent with the previous study area results. Finally, it can be concluded that density becomes a strong influencing factor on the accuracy of the results. This will be addressed further in the discussion section.

The second area to be examined is known in the vernacular as the "Glebe", a mixed commercial and residential neighborhood that was one of the original suburbs but can more commonly be considered "inner city" when compared to the modern suburbs. The Glebe has deep historic roots and when one goes to the area they commonly refer to it by its name, therefore clearly distinguishing it from the inner city of the CBD. This area extends along Bank Street south of the Rideau Canal and like the

core is also very dense in relation to other areas of development. Consequently when examining the results, the 1x iteration perfectly captures this area, all other iterations generate clusters that extend well beyond the boundaries of this area. Backtracking, this area was captured by the 2x iteration analysis of the Inner City. It is being addressed uniquely here because it represents an area that is unique from the core yet because of density issues addressed above gets clustered into the inner city; a problem that will be addressed within the discussion section.

The third area to be examined is another area along Bank Street known as South Bank or Billings Bridge (the main mall located within the center of the commercial area). This area has several types of development including traditional street front retailing (northern areas), large community sized malls (center – Billings Bridge) and strip malls and some freestanding stores to the south. It was expected that this variety of commercial operations would present a challenge when generating clusters given that each development style has a drastically different density of stores.

The 1x iteration captured the upper portion of the commercial area exactly. This is not surprising because this area is comprised of denser, street front retailing. The other two sections of the area, the Billing Bridge mall and the southern extent are represented but not accurately. The 2x (and the ANCN) iteration captures the upper portion of the area effectively and identifies a small externality effect being generated near the upper portion of the street. The mall in the middle is better represented as the neighboring, but separate, businesses are captured. Lastly, the southern extent is better defined, again capturing the surrounding businesses and not just those on the main

artery. This iteration did not join the three sections into a single polygon as the gaps between them were too great. All other iterations captured far more area than was accurate.

The fourth area to be examined was the Merivale Road arterial strip. Unlike other areas studied, this one is primarily comprised of strip malls (northern extent), a community mall (north of the gap in the centre), and free standing/new format stores (from the mall south). It was anticipated that this configuration would present a challenge for the model, and it did.

When looking at the results is quickly becomes apparent that density of buildings (addresses) has a dramatic impact on the resultant clusters. No single iteration captured the area accurately. However, several iterations were better than others. The 1x, 2x and 3x iterations captured the commercial strip, albeit in several sections. The 3x iteration, captured the commercial area, arguably the most accurately of the iterations but a gap within the upper-middle still exists. This gap is actually the north end of the Merivale shopping centre, a long, enclosed mall, which happens to have government office across the street. Given that institutional sites were removed from the dataset, this gap is accurate. The gap towards the middle, where the green space exists contains a natural corridor but also a large high school, thereby fracturing the strip. The southern portion (below the greenway) is captured very accurately with the 3x iteration as this area is a combination of free-standing, big box stores (Costco, Canadian Tire, Pet Smart). Once again, however, the issue of density arises.

The final area to be examined is the Carling Avenue arterial strip. This is an older area than the Merivale development and therefore the density of stores is greater. This strip is comprised of a large regional mall (Carlingview Mall) a few smaller enclosed malls and a series of small strip malls and individual freestanding stores. To the western extent there is a strong automotive focus with gas stations, repair shops, and related businesses. Given the higher densities associated with this area, it was expected that a lower iteration would accurately capture the area.

The 2x iteration captured this area accurately with little overflow on the ends of the commercial area[3]. Since this area is bordered by residential (high and medium density) there is little externality effects of intersecting roads. In fact with the exception of the two malls in the upper right quadrant of the map, there is virtually no commercial development outside of that which is facing Carling Avenue. It is a very contained area.

5.1.3 Point Only Cluster Detection Summary

Based on the results of the three study areas for the Point only cluster detection it is apparent that the multiple iterations were effective in capturing existing commercial agglomerations. The 1*x* and 3*x* iterations were effectively in capturing commercial agglomerations that had density variations that were unique to that particular area. Furthermore, the 2x proved to be the most effective overall at defining existing commercial agglomerations.

[3] It should be noted that the 2x iteration produces 2 clusters that captured the Carling Avenue commercial area, the ANCN because the value is slightly larger captured the area with 1 cluster. However, the 2x iteration is discussed for two reasons: (1) The *N*x iterations are more sensitive to density changes, and; (2) It cannot be assumed that the ANCN and the iteration multiples will always produce a close result. Therefore, the multiple iterations are discussed.

Secondly, this technique for determining commercial clusters, especially those associated with heavily developed arterial strips also provided the ability to detect externality effects as a result of commercial spill over onto roads which are perpendicular to the main artery. In the Kitchener CMA Highway 24 example, the perpendicular development is very apparent.

Lastly, the issue of defined commercial areas (CBD) versus a broader area (inner city) arises. This is especially true of the Ottawa CMA. While there is a planned central business district, the density of development within the inner city precipitates a situation where smaller community orientated commercial clusters have become linked with larger arterial clusters and to the CBD. This is reflective of inner city areas that have high degrees of residential and commercial development next door to one another. What this also reflects, again, is the issue of density.

5.2 Point + Fixed Entity Cluster Detection

As discussed in the methods section this next level of cluster detection involves the same steps as were performed for the point only cluster detection but with the major difference being the data that is analyzed. For this level of analysis, all points that existed within malls (as identified by planning documents) and central business district(s) were removed from the nearest neighbor generation. Therefore three general stages were used:

1) Creating a subset of data points that has one entry per address location after the malls and CBD data points were removed;

2) Generating nearest neighbor values for the subset, and;

3) Generating clusters on the full commercial dataset for each study area based on the derived NCN values.

5.2.1 Data Sub-setting and NCN Generation

The first step was to remove all those records that are contained within malls (both enclosed and open according to planning documents) and the CBD. The result was a decrease in the overall database size by almost 50% for Sudbury, 37% for Kitchener, and 30% for Ottawa respectively. In addition, the resulting reduced datasets were then reduced again so that there was one point per address. This resultant subset was 67% of the original for Sudbury, 58% for Kitchener and 57% for Ottawa (see table 5.3 Intermediate Nearest Commercial Neighbor Results for a complete list of values).

Once the subset was generated, the nearest neighbor point distances were calculated as were the average and median values for each study area. The variation of values for the ANCN and MNCN followed a similar pattern to the point only cluster

Table 5.3: Data Sub-setting and NCN Generation – Point + Fixed Entity Cluster Detection

CMA	Points		Distance Measures (meters)*	
	Multi** (% of full dataset)	Single*** (% of multi)	Average	Median
Sudbury	1238 (50%)	831 (67%)	100	41
Kitchener	4312 (63%)	2500 (58%)	107	58
Ottawa	9339 (70%)	5352 (57%)	76	39

*Based on a 20m offset during geocoding

** The multi-point number represents the original clean dataset with malls and CBDs locations removed but without address duplicates removed.

*** The single-point number reflects the reduction of the dataset down to single entries per address.

Source: Generated by Author

detection. Kitchener once again had the highest value (107 ANCN and 58 MNCN) while Ottawa had the lowest (76, 39) with Sudbury at 100 (41 MNCN) meters respectively. Again this variation can be attributed to the general geographic configuration of the study areas as discussed in the study area descriptions and the previous section.

Lastly, a table of threshold values (Table 5.4 Intermediate Clustering Threshold Values) was generated. However, for this stage of the analysis the maximum number of iterations was capped at three. In the previous stage, it became clear that iterations above 3 were "capturing" more area than was accurate. Therefore the goal of this stage was to integrate the findings of the previous level of analysis with the pre-defined polygons representing the CBDs and malls.

5.2.2 Cluster Generation

Using the threshold values generated, four cluster maps were generated for each study area. The clusters were generated in the same manner as those in the point only cluster detection to ensure consistency across the various levels of analysis. The number of points contained by each cluster was determined and those which had 4 or fewer points were removed. The remaining polygons were then clipped using a buffered road network with a forty meter wide buffer. As with the previous level of analysis this was done to constrain the polygons to the existing road network and to make them more visually appealing. At this point a new step is added whereby the existing CBD and

Table 5.4: Threshold Values for Cluster Iterations – Point + Fixed Entity Cluster Detection

Sudbury

Iteration	Distance (metres)	Number of Clusters Produced	Remaining Clusters (> 5 stores)	Number of Clusters with CBD and Malls Added
ANCN	100	200	42	44
MNCN (1x)	41	389	56	72
MNCN (2x)	83	246	47	51
MNCN (3x)	125	151	39	39

Kitchener

Iteration	Distance (metres)	Number of Clusters Produced	Remaining Clusters (> 5 stores)	Number of Clusters with CBD and Malls Added
ANCN	107	593	142	148
MNCN (1x)	58	1109	199	226
MNCN (2x)	116	508	133	134
MNCN (3x)	174	199	61	132

Ottawa

Iteration	Distance (metres)	Number of Clusters Produced	Remaining Clusters (> 5 stores)	Number of Clusters with CBD and Malls Added
ANCN	76	1250	225	236
MNCN (1x)	39	2094	333	378
MNCN (2x)	78	1224	223	230
MNCN (3x)	117	722	192	184

Source: Generated by Author

mall polygons are merged with the generated commercial clusters producing a final series of commercial polygons[4].

5.2.2.1 Sudbury CMA

Following a similar pattern to the point only cluster detection, the Sudbury CMA produced the fewest number of clusters for this level of analysis. A series of

[4] After the malls and CBD polygons were merged with the generated commercial polygons, the entire file was re-buffered so that any overlap was removed.

representative clusters (the CBD and the "Four Corners" commercial zones) were selected and compared against the orthoimagery as well as clusters from the previous level of analysis. The goal of the final comparison is to determine whether or not this level of value added analysis produces a more accurate result.

Of the four iterations performed a maximum of 56 clusters and a minimum of 39 produced. At this point the CBD and mall polygons were merged with the generated clusters; this combination resulted in a low of 39 and a high of 72 clusters. The dramatic change in the high value can be attributed to two related factors:

1. A large number of malls
2. The relative impact the removal of the malls has on the NCN generation process, specifically in relation to the 1x iteration. In most cases the malls were added as additional polygons instead of being merged into existing polygons until the higher iteration values.

Consequently, the accuracy of this level of analysis is very high in the lower iterations and extremely inaccurate in the higher ones.

For the CBD, the 1x iteration was the most accurate as it was solely represented by the merged polygons that define the CBD. The 2x iteration captured all of the externality based development along the main western arteries leading into the CBD[5]. The 3x and average iterations captured more area than is correct. These observations are almost identical for the "Four Corners".

[5] The 1x iteration also captured these, however, the distance threshold was not large enough for them to be "connected" with the CBD and consequently they are identified as separate clusters.

The "Four Corners" area was defined correctly by the 1x, 2x, and average iterations. In fact the average iteration accurately captured growth along the southern artery which the other iterations did not. The 3x iteration over-captured the area.

What can be concluded from this analysis is no single iteration performs correctly. While the inclusion of the mall and CBD polygons did increase the overall accuracy in select areas and for select iterations, the overall changes in NCN values resulted in areas not being captured, or at the very least, merged into the existing mall/CBD structure thereby producing multiple polygons when only one should have been generated. Furthermore, the lack of a single iteration which works best with this study area also provides further complication when attempting to define a technique that would be effective on areas where local knowledge is weak or lacking.

5.2.2.2 Kitchener CMA

The Kitchener CMA did not follow a similar pattern to the Sudbury study area. Of the four iterations conducted the smallest number of clusters generated was 61 with a high of 199. When the malls and CBD polygons were added a minimum of 132 and maximum of 226 resulted. These differences can be attributed to the reasons previously identified. In addition, the geographic organization of this CMA has several isolated areas whereby a small community mall services the surrounding area, an area which does not have any discernable means of development beyond the mall. The same three areas of interest were examined: The Waterloo CBD, the Kitchener CBD and the Cambridge LCC.

When looking at the results of the Waterloo CBD it becomes clear that the 1x was the most accurate but with certain caveats. Firstly, the merging of the CBD polygon with the generated polygons produced an overall polygon that not only represented the actual CBD but captured the corresponding growth that is connected, but outside of its formal boundaries. This external growth along Bridgeport Street and Caroline Street (the backside of the former Waterloo Town Square Mall) is directly linked to the official CBD and are accurately represented as such.

The results for the Kitchener CBD followed a similar pattern to those of the Waterloo CBD. The 1x iteration was the most accurate and captured development occurring along three major arteries leading into and out of the core area: Victoria Street, King St South, and Frederick Street[6]. All other iterations over captured the core area.

The results for the linear commercial complex in Cambridge again follow a similar pattern. However because of its geographic location and particularly its relative isolation in relation to other commercial areas, one major difference becomes evident. Unlike the previous two CBDs, this area is comprised of freestanding stores, enclosed and open malls, and a power centre. Whereas the CBD can be defined by a single polygon, this area is comprised of at least 7 separate polygons representing the largest of the malls (including the power centre as a single polygon). The connective retailing between these larger entities is apparent especially in the northern half of the LCC

[6] The Frederick Street corridor leading out of the core (or into) the CBD is comprised primarily of law offices and other professional services and are not necessarily linked with the downtown retail area but because of their proximal location they are included.

where the polygon connects with its neighbor, but in the lower half – the location of a super-regional mall – this connectivity is less apparent. The 1x iteration is accurate but does not connect all the individual polygons together into a single uniform area, whereas the 2x iteration (and the average iteration) does and also captures development perpendicular to the main complex along a secondary artery. The 3x iteration over captures along the horizontal axis but is accurate along the main artery.

5.2.2.3 Ottawa CMA

The results of the Ottawa study area followed a logical pattern. The greater the iteration value the fewer the number of clusters produced. When the malls and CBD were added, in all cases but the 3x iteration, the remaining clusters increased. The 3x iteration had a reduction in clusters that can be attributed to the merging of separate clusters as a result of a mall or CBD overlapping and joining neighboring polygons. The low values for the median and average NCN give indication that the commercial structure is still quite dense even with the removal of the CBD locations.

When examining the CBD and inner city, the 1x iteration as a result of the inclusion of the CBD captures the downtown the best but does not join with the inner city areas to produce the larger commercial area. The 2x iteration performs more accurately by joining the inner city retailing (along major east-west and north-south arteries) with the CBD. However, the inner city is over captured as it joins the Glebe Commercial area as well as extending beyond the Queensway to the south and the OC Transpo light rail to the east (both act as breaks in the structure).

In the case of the Bank Street areas – the Glebe and South Keys – the 1x iteration defined the area most accurately. All other iterations over captured the area. This differs dramatically from the Merivale Road commercial area even though structurally South Keys is similar to Merivale. Both are linear commercial areas comprised of mixed retailing with dominant enclosed malls. Both have new-format retailers, however, Merivale has these retailers in both individual freestanding and power centre configurations. South Keys has a single Power Centre with minimal freestanding stores.

The Merivale linear commercial area is not captured effectively by any iteration. This can be attributed to the fact that almost the entire strip is comprised of medium to large sized enclosed and open malls, with very few commercial operations between them. Consequently the removal of those commercial locations from the NCN calculation and cluster generation means that cluster generation is not actually occurring within this area. Merge the mall polygons to the output and the result is simply the mall polygons without any coalescence between neighboring polygons. Furthermore as the iteration value increase the accuracy increases whereby those remaining stores do merge with the addition of the mall polygons, but at the southern extent too much east-west area is captured. This geographical arrangement will be addressed in further detail in the discussion section.

The Carling Avenue commercial area has a different geographic arrangement to both South Keys and Merivale road. This area is defined by a large regional mall and a smaller community mall across the street from it at the western extent of the arterial ribbon. The remainder of the area is comprised of small open strip malls and free

standing stores, consequently this area performed better that the other two arterial strips. The ANCN iteration captured this area most accurately though there was slight over capture on the eastern extent. All other iterations over captured too much area.

5.3 Land Use Comparison

The final "analysis" conducted was to compare the results of the Kitchener CMA cluster detections against the land use parcels for the area for the same time period (Map 5.7 Commercial Land Use Parcels). All those parcels that were defined as commercial were extracted and then compared against the derived commercial clusters for the point and point + fixed entity detections.

When a regional comparison is conducted between the land use parcels and the six iterations for the point only cluster detection three patterns emerge (Map 5.8 Commercial Land Use Comparison – Point Only):

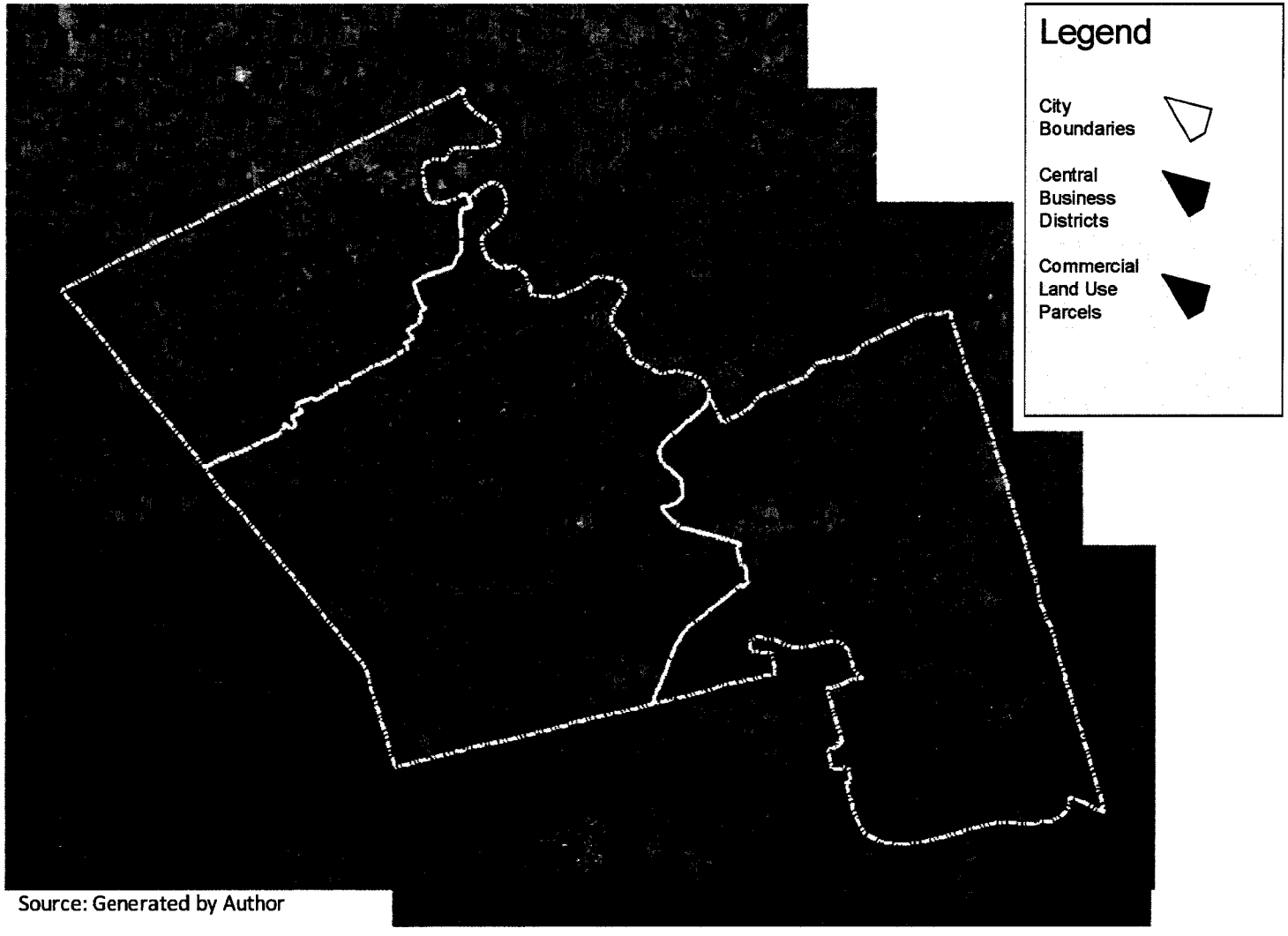
1. All iterations to some extent duplicate the general pattern exhibited by the land use parcels. The general geography and spatial orientation is similar as well as the general orientation of the different commercial areas.
2. When examining each of the iterations in greater detail it becomes clear that the 2x and 3x and average iterations most closely match the "original" in both extent and orientation. This parallels the results for the point only analysis when compared against the orthoimagery.
3. The 4x and 5x iterations over-capture the commercial structure and begin to blend together as a result of the larger cluster sizes.

Furthermore when a comparison is done between the "original" and the point + fixed entity cluster detection similar patterns are revealed (Map 5.9 Commercial Land Use Comparison – Point + Fixed Entity).

When a closer analysis of each of the three points of interest is conducted the following patterns are identifiable (see Maps 5.10, 5.11 and 5.12 for images):

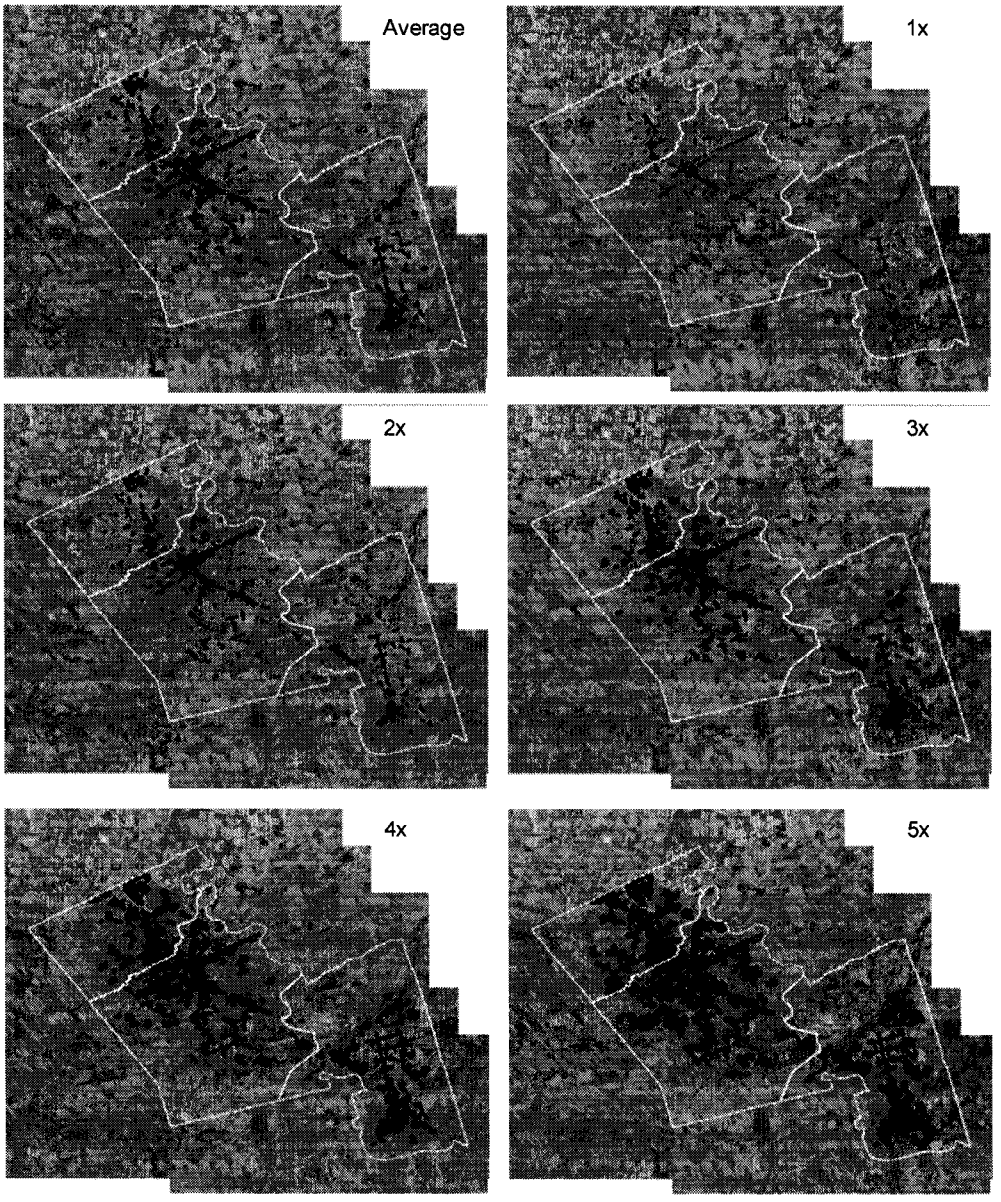
1. When examining the point only cluster detection the 2x iteration best matches the general pattern exhibited by the commercial parcels. Though the spatial extent is not exact as a result of the buffering and clipping technique employed it does however produce a reliable fit when compared to the original.
2. When examining the point + fixed entity cluster detection as compared against the original two distinct conclusions can be made
    a. The addition of the malls does add precision in terms of spatial extent as the malls match the parcels precisely. However, the removal of a clustering point results in several individual clusters needed to define the commercial area. The addition of the CBD polygon, like the malls polygons, does add precision but impacts the overall cluster detection in the same method.
    b. The 1x iteration represented the commercial area most accurately as it was the only iteration that did not over capture the area.

Map 5.7: Kitchener CMA Commercial Land Use Parcels



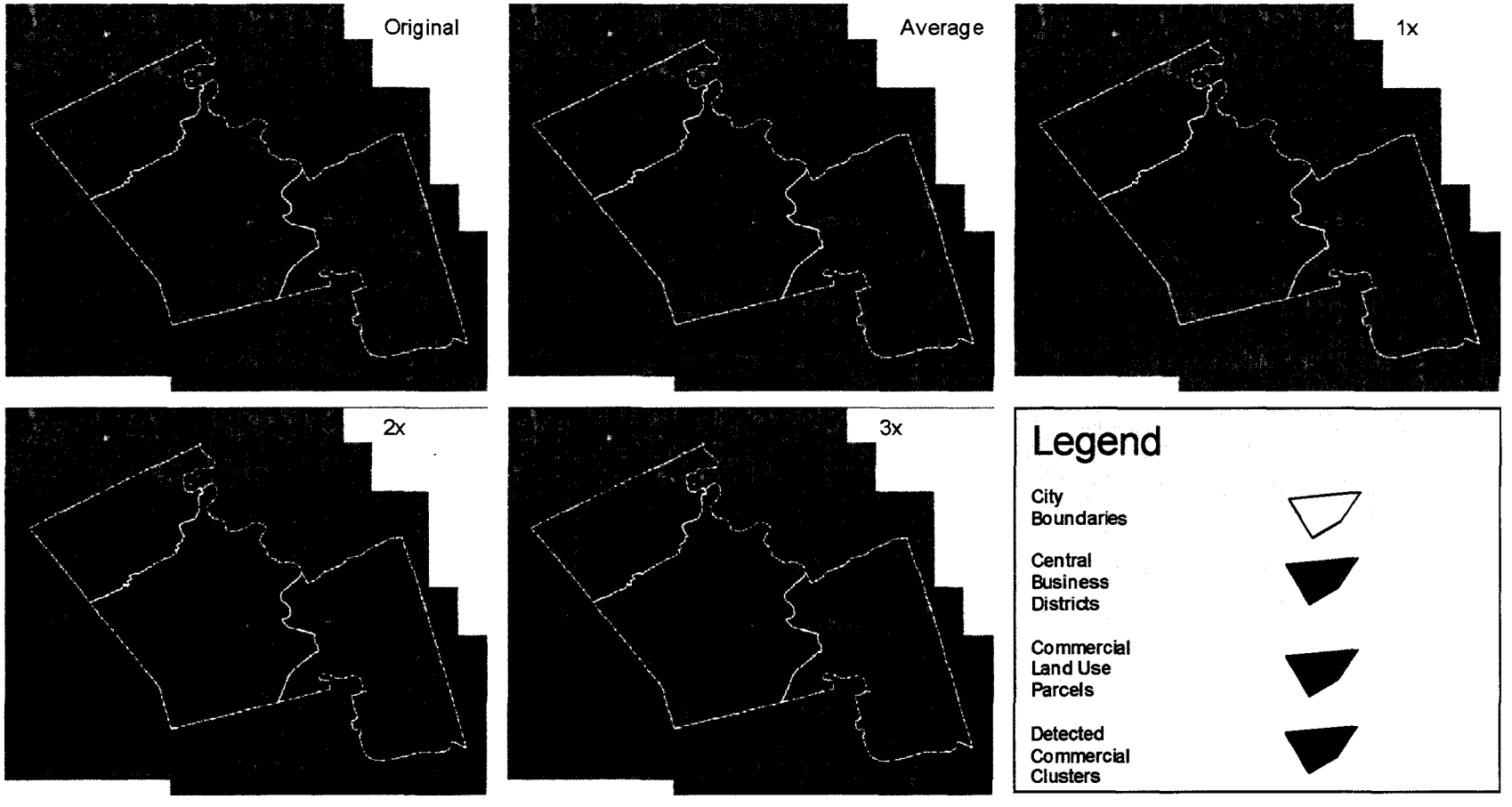
Source: Generated by Author

Map 5.8: Commercial Land Use Comparison – Point Only



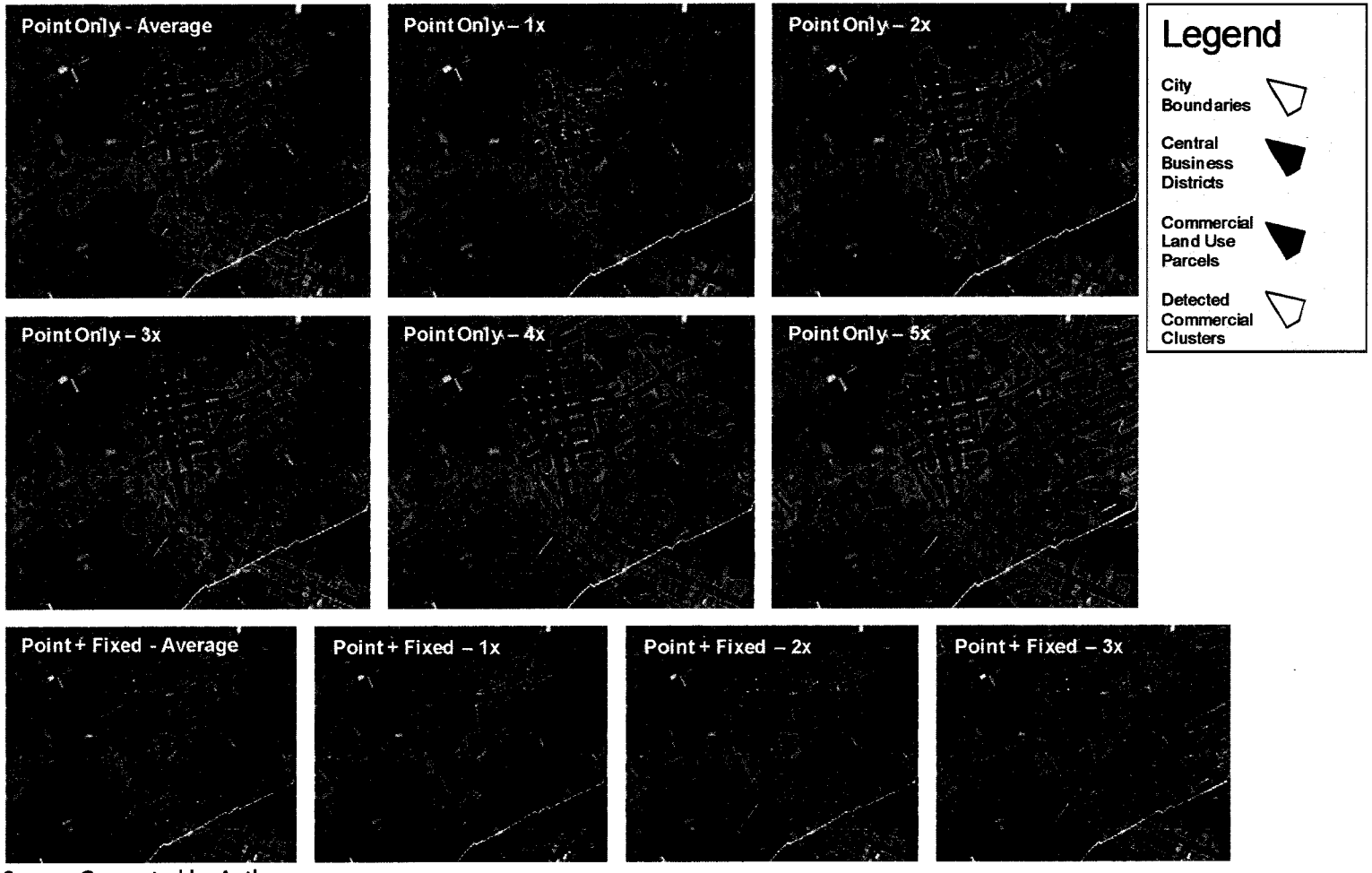
Source: Generated by Author

Figure 5.9: Commercial Land Use Comparison – Point + Fixed Entity



Source: Generated by Author

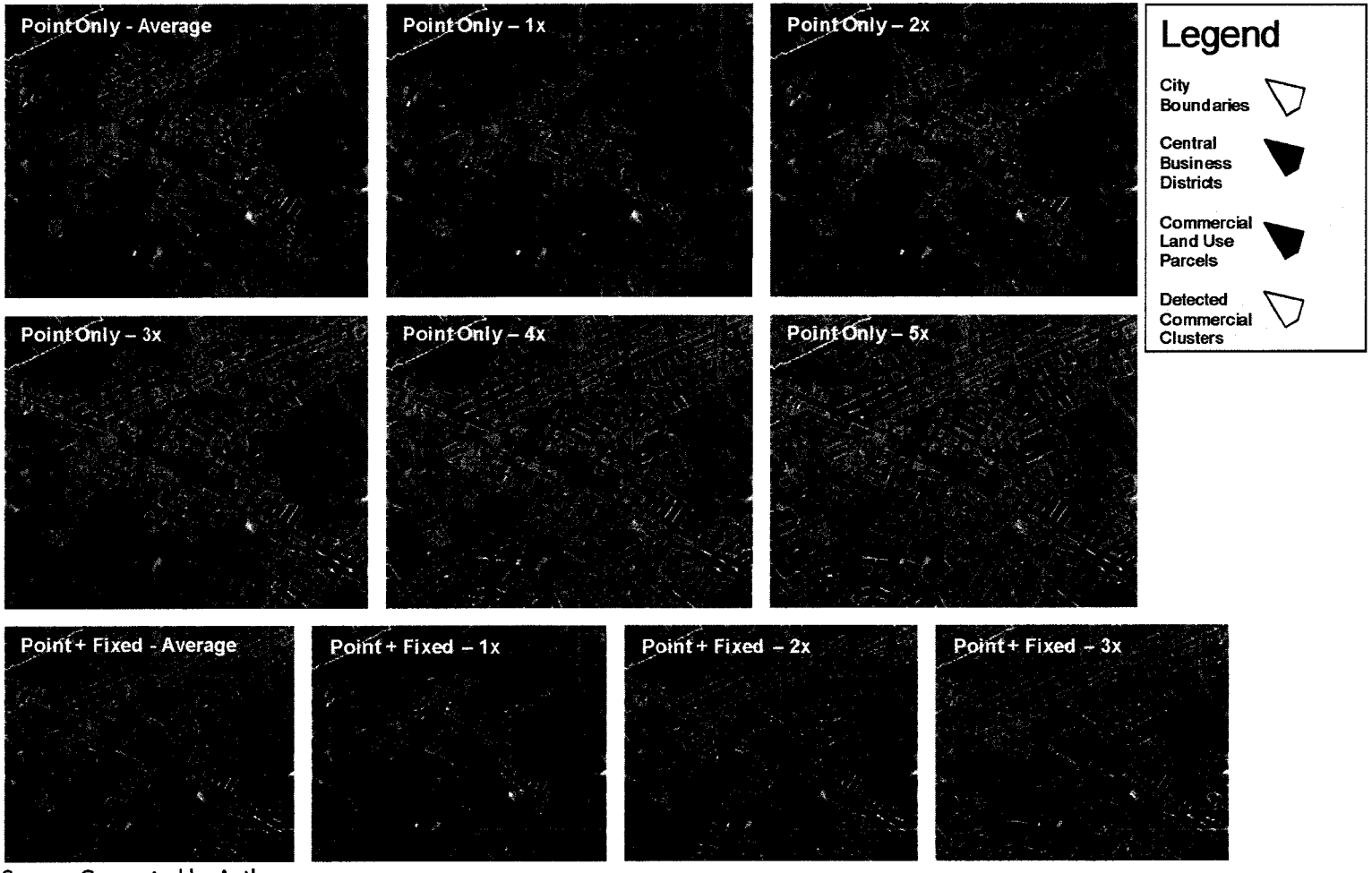
Figure 5.10: Commercial Land Use Comparison – Waterloo CBD



Source: Generated by Author

**For larger sizes images refer to appendix C

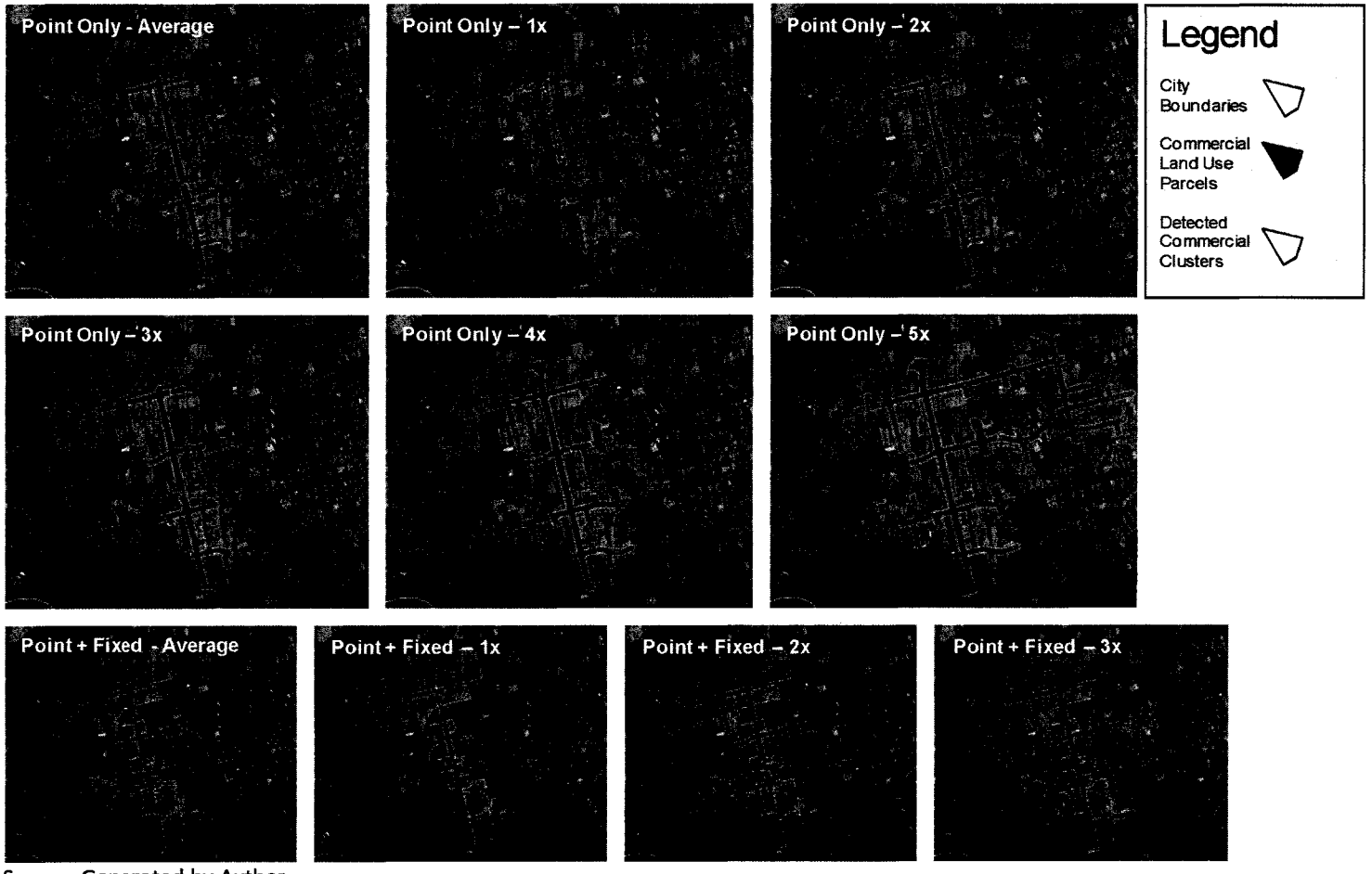
Figure 5.11: Commercial Land Use Comparison – Kitchener CBD



Source: Generated by Author

**For larger sizes images refer to appendix C

Figure 5.12: Commercial Land Use Comparison – Cambridge LCC



Source: Generated by Author

**For larger sizes images refer to appendix C

this from a commercial perspective the consumer becomes the critical determinant and how they perceive the area that is most vital. When someone refers to "going shopping downtown" they are probably referring to all the stores in the general area and not just those that are in the officially defined area. In addition, many consumers do not know what the true planning defined boundaries actually are. Therefore, when defining a commercial area it is important to examine the greater surrounding area as well.

The final comment surrounds the possibility of two or more distinct commercial areas growing together. This could be said of the Ottawa CBD and the inner city. The density of development and continual demand for space which is proximal to the core has, in essence, enlarged the core area beyond its official limits. This problem is sometimes addressed at the planning level whereby the planned area is re-defined or, as in the case of Sudbury, a secondary boundary is established. In either situation, the core is more than simply the original planned definition of it and in other cases no amendments are made and the original definition remains.

5.4.1.2 Density Variations between Core and Suburban Areas

The second observation deals with the variations in development between older core and newer suburban areas. This was most obvious in the Ottawa CMA study area. The variation in density was apparent between the older core style development and the newer mall, and arterial styles of development. The effects could most readily be noticed in over capturing in the inner city and under capturing in the suburban areas. However, the areas of the focus within each study area this did not present a large problem.

5.4.1.3 Over Capturing

The final issue identified is over capturing of commercial areas. Due to the nature of the technique being used, whereby a threshold value is used to define a buffer equally around a commercial point location, inevitably some over capturing will occur. The amount directly varied with the size of the threshold value. In almost all cases, threshold above and including 3x were too great and resulted in too much over capturing. Only in more suburban areas did the 3x perform reasonably well.

5.4.2 Point + Fixed Entity Cluster Detection

When examining the point +fixed entity cluster detection three major conclusions can be drawn:

1. The inclusion of the CBD and mall polygons does increase the accuracy, but only in those areas where these are the main features of the commercial landscape such as the "Four Corners" in the Sudbury CMA. In other cases this polygon prevents a potential overlap with a neighboring location and consequently does not join with that location creating two separate commercial polygons. This affects the ability to "completely" define a single commercial area;
2. The removal of those points which are contained in within the added polygons has an immediate and direct effect on the generation of the NCN values. In all cases the values increased thereby making the iterations above 1x too large, and;
3. Lastly, the geographic arrangement of commercial types becomes an issue. When a commercial area is made up on malls exclusively, with little variety

between them, the intermediate technique fails to properly combine the neighboring polygons into a greater single commercial area. Visual interpretation and local knowledge become critical in understanding the nature of the geographic arrangement of the area under questions.

5.4.3 Land Use Comparison

The inclusion of the land use comparison proved to be a useful step in confirming the results of the cluster detection techniques. Several broad conclusions can be made:

1. The point only and point + fixed entity approaches accurately generalized the commercial structure at the regional scale. Moreover, the 2x and 3x iterations for the point only and the 1x iteration for the point + fixed entity were the most accurate.
2. The point only cluster detection was the most accurate is defining the general geography of the commercial area. Though spatial extent may not be entirely accurate, the commercial area was clearly delineated and easily detected. The 2x iteration proved to be the most successful in all areas of interest for all study areas.
3. The point + fixed entity, while adding accuracy as a result of the inclusion of malls and CBD polygons did not detect the commercial areas as effectively because these included polygons were not incorporated into the nearest commercial neighbor analysis and consequently represented

physical gaps in the clustering. In almost all instance the 1x iteration proved to be the most effective, though its limitations were still visible. Overall, the comparison against the "original" was effective litmus test for the automated detection of commercial areas.

5.5 Discussion of Research Objectives

The exercise of analyzing commercial data within a GIS is a complex one. Couple this with the inherent variety contained within any urban environment and the challenge of trying to achieve an automated analysis of urban commercial structure can become quite daunting. The first two goals of this research were to define a rules-based system for detecting and classifying the spatial organization and morphology of commercial zones with the Canadian urban environment and secondly to apply that rules-based system within a GIS. These goals are detailed in research objectives 1 and 2 (Chapter 1, page 12). This chapter reflects the outcome of that undertaking with mixed results.

The development of the NCN proved to be an effective way of analyzing commercial locations. By generating NCN values it became apparent that the use of them as clustering thresholds was an excellent way to group locations together. What also became readily apparent is that the median value was far more effective when used in multiples when compared against the average value for the dataset. Only in those cases whereby MNCN multiple was almost identical did the ANCN produce results which were comparable. Consequently, the use of the MNCN individually and in

multiples generally produced the more accurate results and is therefore more effective at detecting commercial structure.

In addition, it became apparent that the NCN values also function effectively as a surrogate density measure. When malls and CBDs were removed from the calculations, the commensurate values were larger and more reflective of development outside of heavily planned areas. It is suggested that this value could be used to monitor density within urban environments whereby increases in the value over time represent an ongoing dispersion of commercial locations.

Secondly, the application of the NCN value within a rules based system was successful. The values, generated within the GIS, were readily usable when applied within the buffering algorithm. The values have meaning as do the results allowing for interpretation and discussion of the results. There were specific data requirements of the nearest neighbor algorithm which were not insurmountable but needed to be addressed prior to NCN generation (see Chapter 4 for data format requirements).

5.6 Conclusion

The analysis of commercial data is still a challenging undertaking. Analyses of this nature are constrained by not only the availability of data but the techniques that can be applied. A fully automated analytical technique is still not possible. However, an automated generation of polygons is more realistic. These two main cluster detection techniques explore a combination of data types and techniques to generate commercial cluster. The point only cluster detection uses simply point data, a more automated process and can generate relatively accurate commercial areas. The point + fixed entity

cluster detection combines both point and polygon data and as a result achieves some higher levels of accuracy but overall the analysis is cumbersome and does not dramatically improve over the general level.

The results of this chapter, namely the identified commercial forms and their associated location within the urban system became the basis for the following chapter. The proceeding chapter examines the analysis conducted within this chapter, in conjunction with the existing knowledge of urban commercial structure to define a new typology of urban commercial structure.

CHAPTER 6

TOWARDS A NEW COMMERCIAL TYPOLOGY

"Thinking is more interesting than knowing, but less interesting than looking."

Goethe (Date Unknown)

6.0 Introduction

One of the major goals within the area of commercial research has been the development of typologies which describe, albeit in a fairly generalized manner, the structure of this sector of the urban economy. These models, as described in Chapter Two, examine the geographic arrangement of commercial clusters or zones across the urban area, and then address the internal configuration of these zones. Once done, a broader more generalized model is produced. This research will follow a similar pattern.

Using the results generated in the previous chapter as a baseline for the existence of various commercial forms it is possible to construct a typology of urban commercial structure. This typology is more reflective of the modern urban environment, is free from the constraints of previous models, and one that is potentially more adaptable to a variety of urban settings. Though as Jones (2000) eloquently states, "an attempt to classify urban retailing should be balanced by the realization that the

retail landscape within the metropolitan areas is difficult to categorize." Therefore, this model, like any others, is a generalization of a complex system and should be understood as so.

This chapter details the development of a new commercial typology. It first establishes the typological components based upon the combination of research findings and previous research for the creation of the new taxonomic structure. Secondly, appropriate commercial concentrations within the three study areas will be used as exemplars for each of the typological classifications.

Of final note, one of the underlying goals is to develop a typology that is free from any type of geographic organizational hierarchy, such as central place, which tends to dominate the classification of shopping centers. Central place classification within an urban environment was typical of typologies when mobility was low and options were limited. However, with the dominance of the automobile, the improvements in road infrastructure, and the massive increase in the number of options available to the consumer, it is now possible that any commercial location within an urban environment could be a *potential* destination for the consumer. Furthermore, if that commercial location offers the right mix of products or is specialized enough it is possible to draw consumers in from a greater market area than just the immediate urban environment. Therefore, this model will treat all commercial zones as equal for the purposes of organization.

6.1 Typological Components

As with previous urban commercial typologies, the schema levels are designed to define and refine the classification of a selected commercial area. These levels are based on factors such as; (a) location within the urban environment, (b) zone morphology, and (c) ownership or planning.

This research organizes the commercial typology based upon the commercial area's location within urban structure and then by its geographic form. Consequently the criteria that will be detailed are; geographical location, geographic form, and commercial form. These categories are broad enough that the addition of new locations, and/or forms can be undertaken as required, but more importantly are general enough so the they can be applied to a variety of urban settings and not just upon those from which they were developed as they are based upon the general geography of urban areas and development styles that are consistent with virtually all urban areas.

6.1.1 Geographic Location

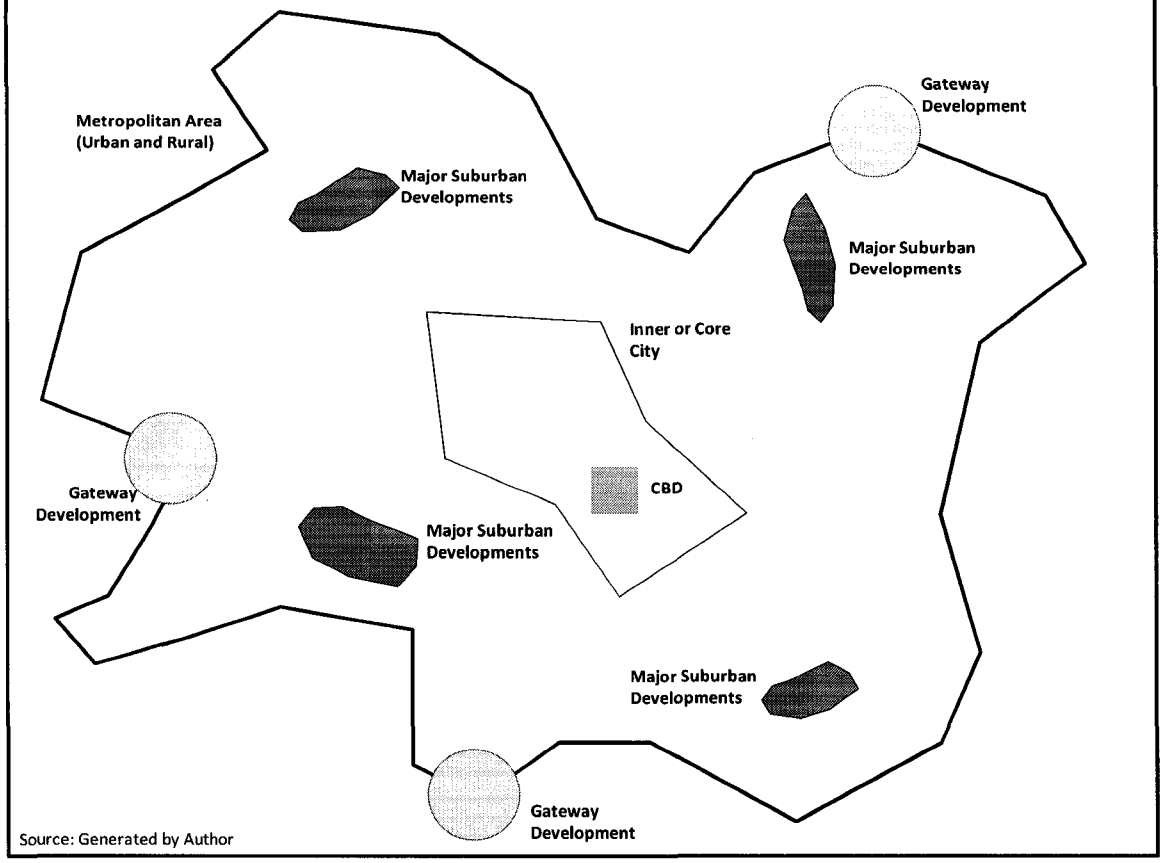
The first level of classification is based upon where within the urban environment the commercial entity or area is located. There are three possible locations:

1. **Inner City** – The inner city is either the original core city within a highly developed metropolitan area or the original downtown core of a smaller, less developed urban environment. In the case of Canadian CMAs the inner city will be defined as the core city upon which the CMA designation is granted.

2. **Suburban** – The suburban area represents the opposite of the Inner City. Therefore the suburbs are either the newer, surrounding areas to the original core city, or the more recent developments around the original core of the smaller, less developed urban environment. For the Canadian CMA context these will be the surrounding rural and urban areas which create the metropolitan area around the inner city.
3. **Gateway** – The final classification is the gateway location. This is a location that exists at the extreme outer boundaries of the urban area. Though it technically could be defined as being within the suburbs, the gateway represents the newest developments on the urban fringe. Overtime, it is expected that the gateway areas transition into suburbs as urban development and growth progresses and these areas act as a catalyst to that growth. A final note is that the gateway designation is generally applied to rapidly growing urban areas where outwards expansion is continuing at a rate greater than infilling. This classification builds upon Lowe's (2000) suggestion that new mall development can become the catalyst for new city development by recognizing the importance of developments on the urban fringe and their potential for external growth around them. This category was added after examining the commercial systems of the three study areas and recognizing the presence of urban fringe developments.

These three areas are schematically illustrated in Figure 6.1 Geographic Location Classification.

Figure 6.1: Geographic Location Classification (Theoretical Representation)



Source: Generated by Author

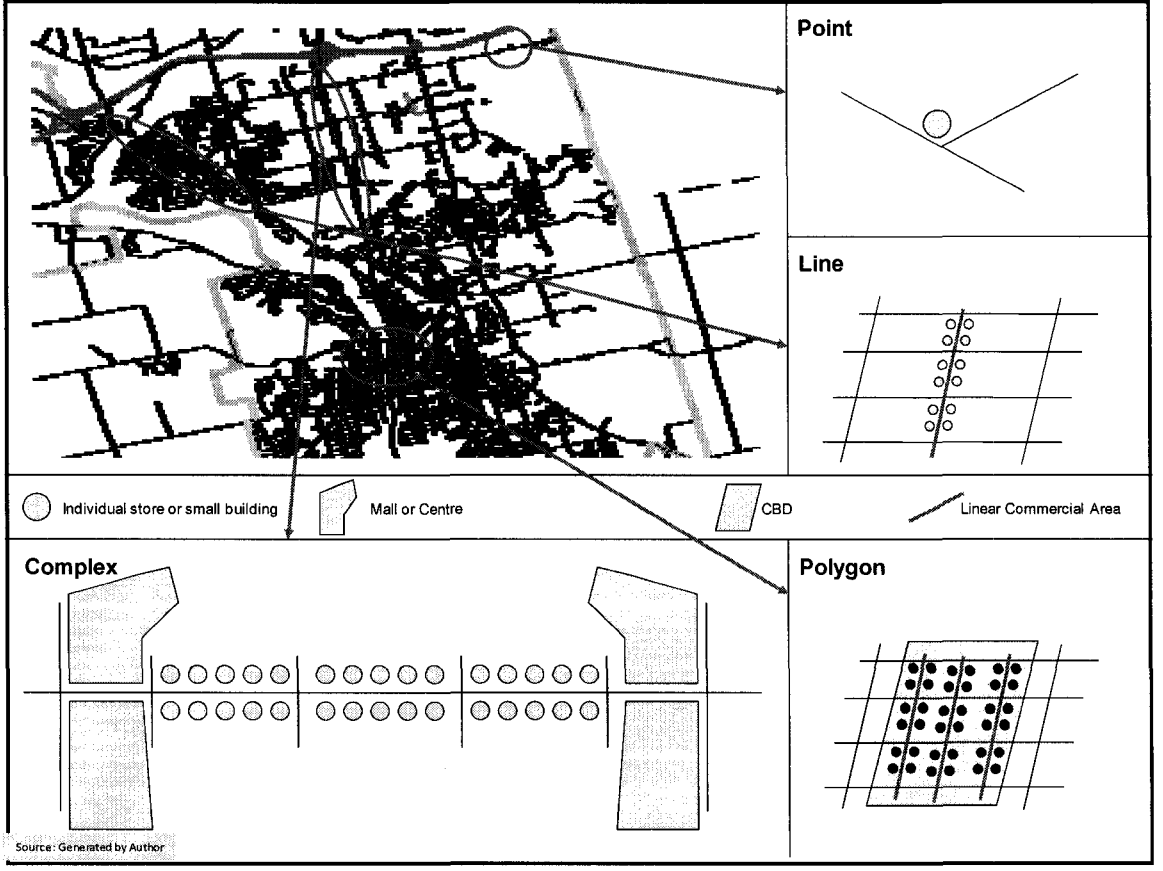
6.1.2 Geographic Form

Once the geographic location of the commercial area has been determined then the form (or shape) of that area is classified. Four possible forms are identified:

1. **Point** – A point is a single commercial location that can be represented by a free standing store or other individual commercial operation. Though the commercial cluster analysis eliminated those areas with fewer than five stores, freestanding stores still play a vital role in the overall commercial structure (i.e. gas stations) of the urban and are therefore included within the typology.

2. **Line** – A linear commercial entity exists along a roadway and visually forms a simple line.
3. **Polygon** – A cluster of commercial operations that exists within a larger geographic space. Multiple streets or large tracts of land are consumed to create the commercial area. A polygon may also include a large enclosed shopping centre or grouping of smaller open or strip malls.
4. **Complex** – A specific combination of line and polygon forms. A complex is a linear commercial development that is anchored at both ends by large commercial polygons thereby forming a larger commercial complex. (Figure 6.2 Commercial Form Classification)

Figure 6.2: Commercial Form Classification



The geographic form of a commercial area is highly reflective of past, current, and future planning styles and is directly related to how our cities look. These classifications also fit directly with how a GIS system handles vector data and coincide with how the data is visualized.

6.1.3 Classification of Commercial Area

The classification of the commercial area is based upon the geographic location and the geographic form of the area. There are nine possible classes:

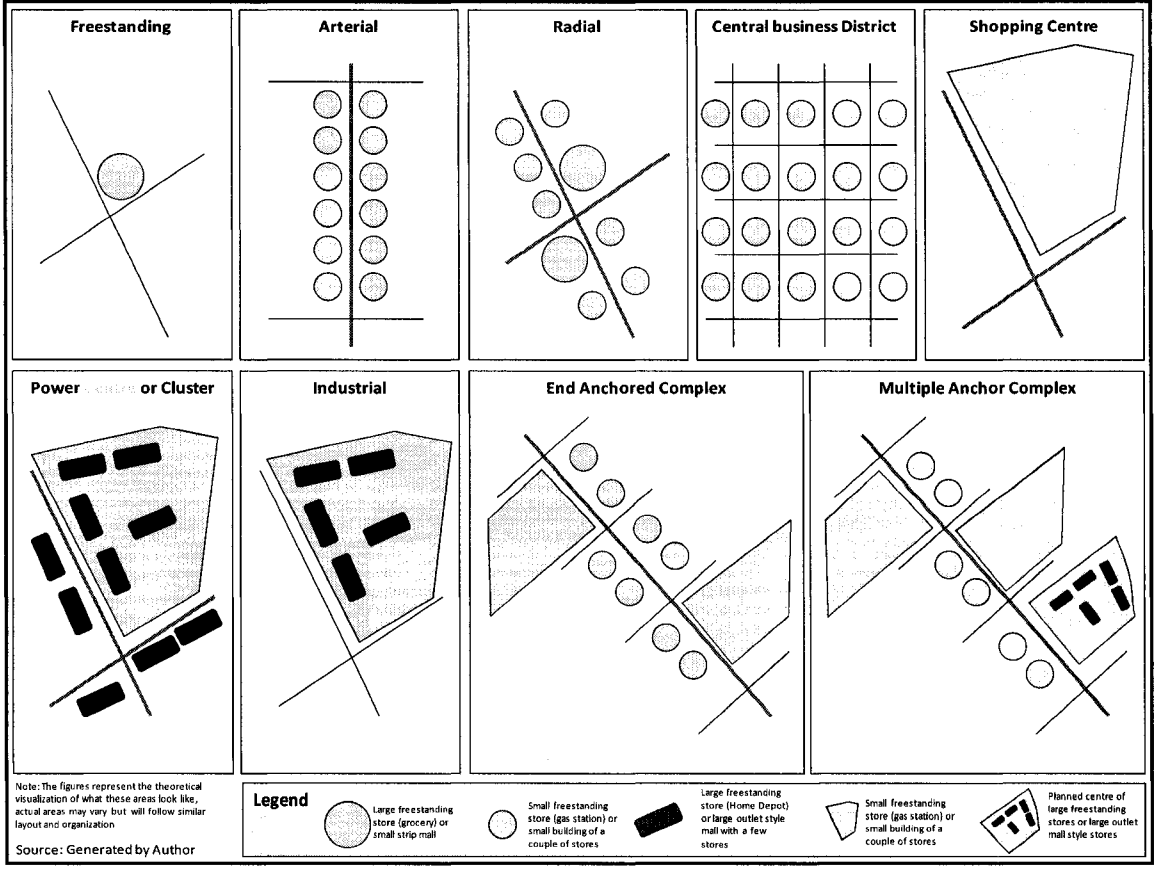
1. **Freestanding** – A single commercial operation.
2. **Arterial** – A simple linear form that caters to a predominantly commuter, car orientated consumer.
3. **Radial or Intersecting** – A situation where two roads cross forming an "X" or "T" pattern. In this situation two arterial areas have merged or grown together. The intersection may or may not be anchored by a convenience orientated operation (grocery store).
4. **Central Business District (CBD)** – A downtown; typically planned and identified on land use documents. The internal configurations of downtowns have changed dramatically over the past 50 years. May contain large malls and other vehicle orientated structures or may be a more traditional street front retailing setup.
5. **Shopping Centre** – A large enclosed or partially-enclosed shopping mall. Open air strip malls are normally associated with linear developments.

6. **Power Centre or Cluster** – A grouping of large, usually free-standing big-box and factory outlet stores. A cluster is a natural grouping of these stores while a center is planned (single developer) development. The distinction can generally be determined by the naming of the commercial area. Named zones tend to be single developers where the investment is in branding and developer identification is essential and are usually associated with a particular mix of stores.
7. **Industrial** – A commercial area which has at its focus a business to business orientation. There may be some business to person retailing such as public wholesalers.
8. **End Anchored[1] Complex** – The first of the two complex styles. This complex is only anchored at the termini of the linear area.
9. **Multiple Anchors Complex** – The second of the complex styles. This complex is not only anchored at the ends of the linear area but has major anchors within it.

These nine sub-classes are schematically illustrated in Figure 6.3 (Commercial Area Classification).

[1] An anchor in this context refers to a large commercial operation, typically a department store or large grocery store that attracts customers to the commercial zone and is typically located at strategic locations within the commercial area to provide maximum exposure and accessibility.

Figure 6.3 Commercial Area Classification



6.2 Modern Typology of Commercial Structure

Based on the previous discussion of the major typological components a new typology can be constructed. This typology shifts the focus away from the organizational structure of the commercial system based on a hierarchical system to a structure based upon a geographical one. Consequently this typology serves two valuable functions:

1. The main benefit to this modernized way of examining commercial structure is the emphasis placed upon ***where*** in the urban system the commercial entity is located – its **geographic location**. Though not new in itself, the addition of the gateway area provides a distinct separation from the suburban category. The

gateway area gives insight into the growth dynamics of the urban area and provides information on the dominant "new" commercial growth areas.

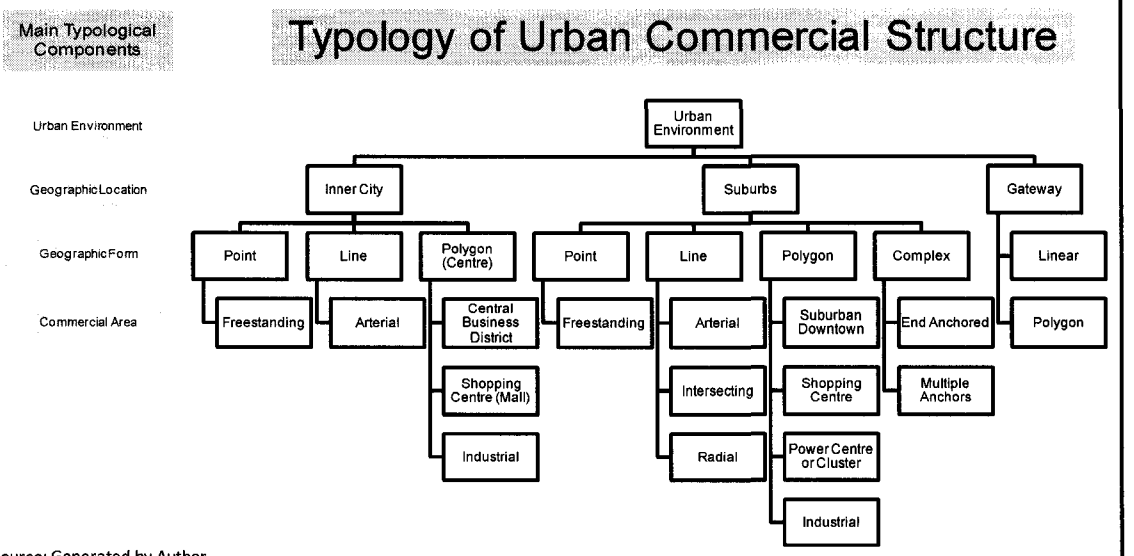
2. In addition to emphasis on geographic location, there is a secondary emphasis placed on **geographic form**. The evolution of commercial development has shifted from a downtown orientated environment to the arterial strip to the regional mall. By focusing on the form of the area we can once again shift the focus away from the market orientation. Subsequently the classification focuses on the how the areas look within the urban environment, therefore providing valuable knowledge as to how it functions. Finally, by using this classification schema, new forms are easily added making the typology more adaptable by allowing new classes to be added to the commercial area classifications.

The final typology is illustrated in Figure 6.4 (Typology of Urban Commercial Structure). The following section illustrates though examples derived from the study areas the applicability of the typology to an urban environment.

6.2.1 Application to Study Areas

It should be noted at the outset that the creation of a typology is a circuitous process. By analyzing the study areas, insight is gathered as to the specific organization of the commercial structure. From this a generalization of commercial structure can then be made. Subsequently the generalization is then re-applied to the study areas to ensure a "best fit". The following sub-sections dissect the typology through its various levels by providing a visual example for the study areas, where applicable, as well as providing detailed discussion when a particular classification does not fit within a study

Figure 6.4 Typology of Urban Commercial Structure



Source: Generated by Author

area but does in others. The goal of this section is to be able to provide not only a visual classification (based on the typology) but a written one as well.

6.2.1.1 Inner City

As described previously the inner city or older core city reflects the denser urban development. It is within this section that the central business district and the major arteries accessing the core areas are located. This component of the typology can be broken down into three geographic forms – point, lines and polygon.

6.2.1.1.1 Points

In terms of a commercial classification a point is reflected by a freestanding store such as a gas station, convenience store or other highly localized neighborhood operation. However, examination of many of the stand-alone points within each of the study areas also reveals that many "freestanding points" are also more professional services such as a medical or legal office, home-based consulting firms, and construction

companies (based out of a home). In all instances the point is located away from other commercial entities and consequently does not create a commercial area.

6.2.1.1.2 Line

The line classification is reflected by the artery development. The arterial strip is generally exemplified by a single, highly developed road linking the outer regions into the core area. Development along these arteries is generally reflected by mixed array of goods with emphasis on vehicle access. The arterial strip can have an anchor of some form, normally a grocery store or other type of convenience location but typically because of location the room to accommodate stores of this size is not readily available and therefore their existence is not entirely common or uncommon. Within the three study areas arterial strips are exemplified by the Notre Dame commercial area in Sudbury, the Victoria Street commercial area in Kitchener, and the Somerset strip (Chinatown) in Ottawa. Figure 6.5 (Inner City – Line Classification) provides examples for each of the study areas.

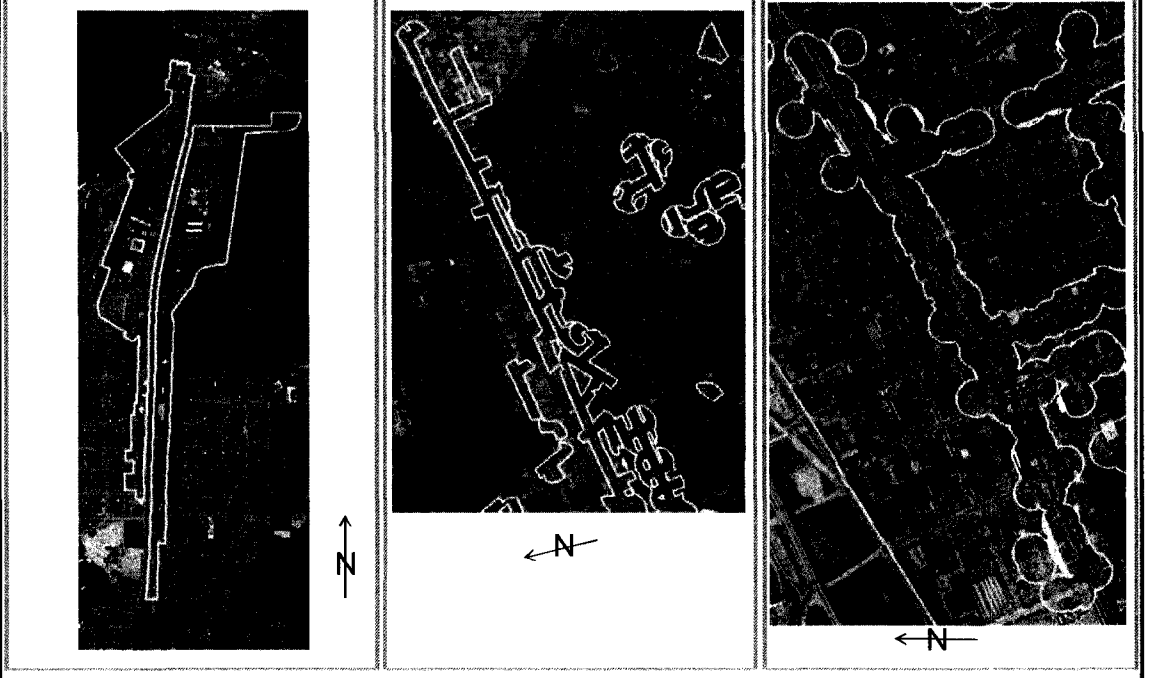
6.2.1.1.3 Polygon

The polygon classification represents one of three components, either a large agglomeration of free standing stores, building and shopping malls which are generally referred to as a central business district when dealing with inner cities, as a stand-alone shopping mall (either open or enclosed) or as an industrial park. In many cases the first two classifications overlap where the shopping centre is contained within the central business district.

Figure 6.5 Inner City – Line Classification

Sudbury	Kitchener	Ottawa

Arterial

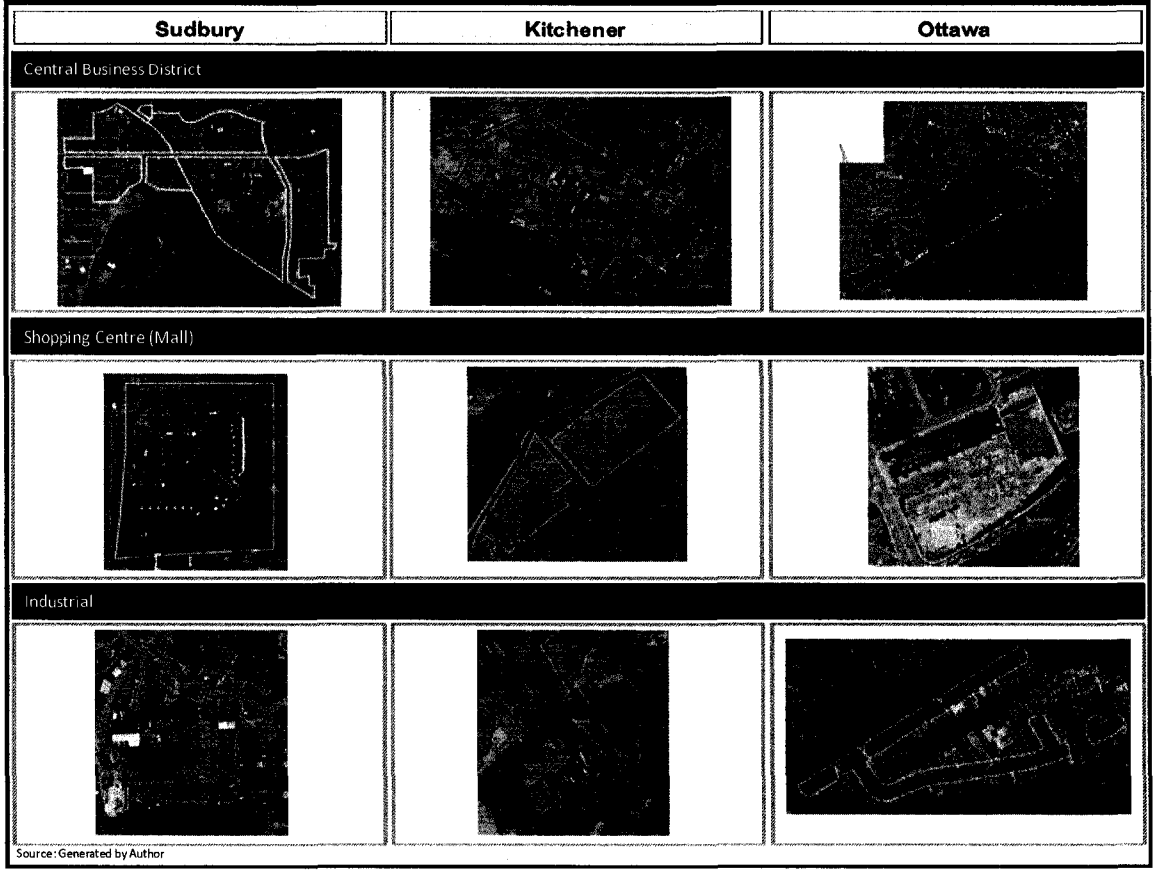


Source: Generated by Author

The central business district exists in virtually all urban environments and typically the larger the CBD development the larger the overall urban area. These three study areas follow this with the Ottawa CBD being significantly larger than either Kitchener or Sudbury. Furthermore in all three cases there are large enclosed malls within the core area. The other final characteristic is that since these are planned entities the spatial extent of the CBD may not match precisely with the land use planned extent as a result of externality effects. Therefore when dealing with the CBD the full spatial extent (planned area plus externality development) will be used.

The shopping center is the next commercial area. In many cases these malls become the center of a larger development but there are instances where there is just a mall. Typically larger enclosed malls will have external development surrounding them

Figure 6.6 Inner City – Polygon Classification



Source: Generated by Author

while the smaller open mall can exist as a standalone area. All three study areas have examples of shopping malls existing independent of other developments.

Lastly is the industrial classification. These tend to be large geographic areas when compared against other types of commercial areas. These businesses require larger buildings, and there are fewer businesses within these industrial parks, but because of their increased relative sizes, they consume more land. In many cases there are smaller strip style open malls within them for businesses requiring a smaller footprint mixed in with larger free-standing operations. Each study area has examples of this style of development. Figure 6.6 (Inner City – Polygon Classification) provides examples for each of the study areas.

6.2.1.2 Suburbs

In many cases the suburbs follow similar styles of development when compared against the inner city, with the biggest difference being the density of development. The suburbs tend to have a less dense style of development reflected in more open and enclosed malls and greater spacing between businesses. Within the suburban geographic location classification there are four main types of geographic forms: point, line, polygon, and complex.

The point classification is identical to the inner city classification and will not be detailed further. The remaining classifications will be detailed.

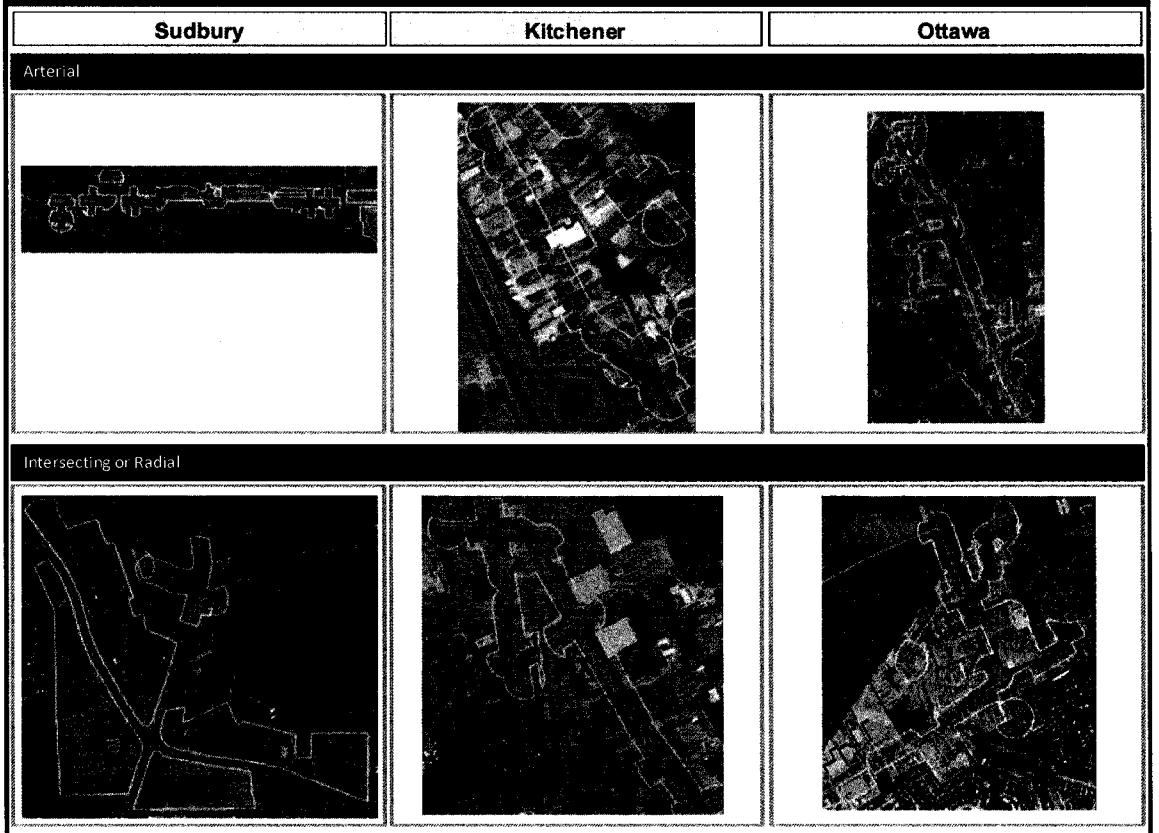
6.2.1.2.1 Linear Development

The suburban linear classification is the same as the suburban classification. The new additions are the intersecting and radial classifications.

The intersecting or radial strip development is where either two arteries grew together, centered along a major intersection or where a major artery expanded along a perpendicular artery in essence created a "T" or "X" look. Given the nature of this form, there is normally an anchor at the intersection, typically a shopping centre or other large mall. In Sudbury this is exemplified by the Four Corners commercial area anchored by two major grocery stores and one major mall with a grocery store within it, at the intersection of Regent and Paris streets.

In Kitchener, there is the smaller example in the north section of the city of Waterloo where Weber Avenue intersects with Northfield Drive. At the intersection there is a small open mall with a grocery store contained within it. Further commercial

Figure 6.7 Suburbs – Line Classification



Source: Generated by Author

development radiates along Northfield eastward and along Weber to the north and south[2].

In Ottawa there is an intersection type development in Kanata at the corner of Moodie and Robertson. There are several strip malls, a national chain grocery store as well as a variety of other smaller parasitic type stores. Refer to Figure 6.7 (Suburbs – Line Classification) for illustrations of each of these.

6.2.1.2.2 Polygon Development

Polygon development in all three study areas is substantial and represents one of the more dominant forms of commercial forms. Within this classification there are

[2] These are actual cardinal directions and are NOT the named street directions. As a result of coalescence of Kitchener and Waterloo, shared roads are designated North/South in Waterloo and East/West in Kitchener regardless of the direction they actually trend.

four sub-types; suburban downtown, shopping centre, power cluster or centre, and industrial. Each form will be illustrated.

The suburban downtown is typically the result of one of two factors and is generally reflective of the size of the urban area:

1. **Coalescence:** The first situation is where several smaller towns or cities have grown together into a single larger metropolitan area. In this situation each former city/town retains their original central business district. Depending on the "core" city, and the subsequent defining of that city's CBD as the downtown, all other downtowns are subsequently considered to be "suburban", but in location only.
2. **Sprawl:** The idea of sprawl in this context is reflecting in substantial outward expansion and commercial development. In this situation an original core exists but as development progresses at a rapid rate, smaller suburban downtowns emerge to replicate, albeit on a smaller (less dense) scale, the role the larger CBD plays. These tend to occur in extremely large metropolitan areas where distances are skewed due to commute times and also because of high costs (either rent or development) in the core area thereby making these suburban areas desirable due to cost.

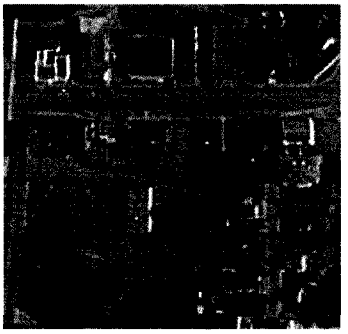
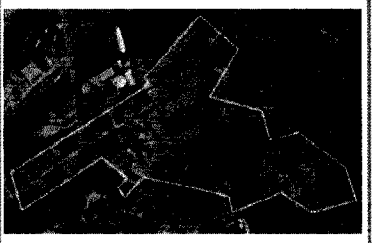
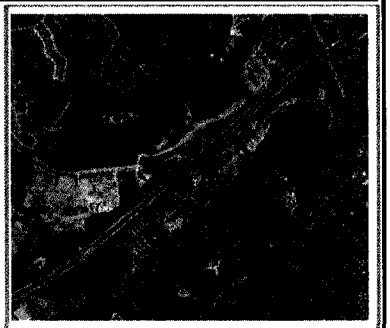
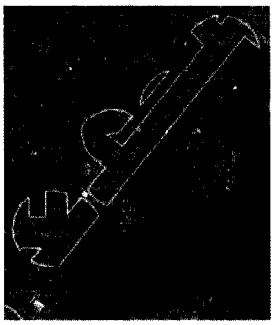
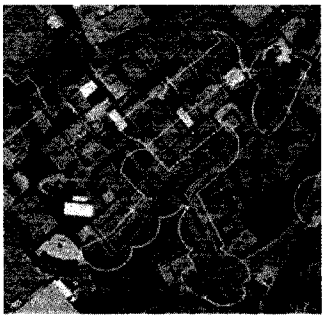
Each of the study areas has what could or would be considered suburban downtowns. In the case of Sudbury and Kitchener, the suburban downtowns are the result of merging of many smaller towns and cities into the larger metropolitan area. In the case of Sudbury several of the smaller communities have a "downtown" but because of data

issues outlined in Chapter 3, they cannot be illustrated. However, the most dominant example would be Copper Cliff which is a former mining town that was absorbed into the city when the city was formed. Kitchener has at least 4 suburban downtowns – Uptown Waterloo (the CBD for the city of Waterloo), downtown Galt (the current CBD of Cambridge and the former CBD of the town of Galt) and the smaller cores of Hespeler and Preston (each of which were absorbed into the city of Cambridge).

The Ottawa CMA is dominated by coalescence cores but is also beginning to see sprawl cores develop as well. The Ottawa CMA is the amalgamation of over six different former cities and a variety of smaller towns and villages, though in many cases due to the proximity of the former cities to the larger core of Ottawa they did not develop as distinct downtowns. Coalescence cores can be found in Vanier, Orleans, and Gloucester respectively, while sprawl cores can be found in Kanata, and Barhaven. (Figure 6.8 Suburbs – Polygon Classification – Suburban Downtown and Industrial)

The shopping centre and power cluster/centre are the next classifications. Both look visually similar on a commercial structure map as they appear as large polygons. However, in the case of the mall there is a single free-standing building with minimal out-building development while the power cluster/centre has a considerable number of large free-standing buildings contained either within the same development (centre) or grouped together independently within the same area (cluster). All three study areas have these; however, the number increases with the size of the city. Sudbury has only a single power centre, while Kitchener has three substantially developed and several smaller ones being developed. Ottawa has at least six major developments (at least one

Figure 6.8 Suburbs – Polygon Classification – Suburban Downtown and Industrial

Sudbury	Kitchener	Ottawa
Suburban Downtown		
		
Industrial Parks or Clusters		
		

Source: Generated by Author

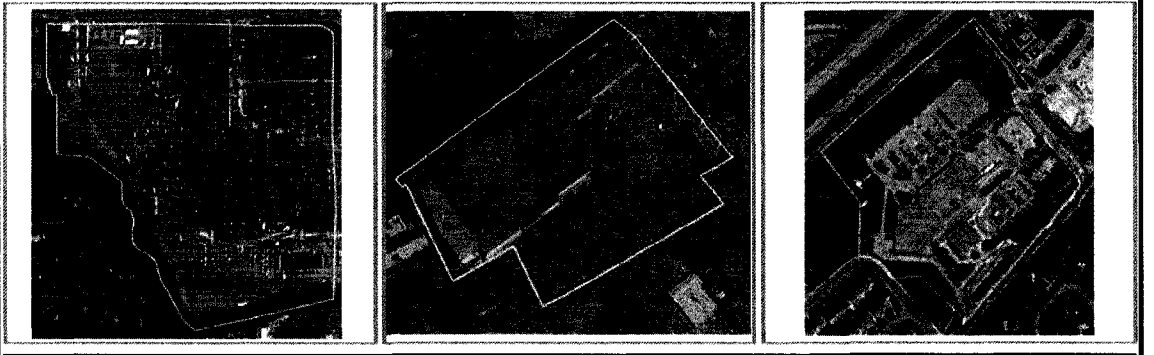
in each of the former cities) and several others in the process of being developed or expanded. Figure 6.9 (Suburbs – Polygon Classification – Shopping Centre / Power Centre or Cluster) provides illustrations for both the shopping centre and the power centre/cluster.

The final classification is the industrial park. While part of the commercial services classification, industrial parks typically service other businesses. However, with the growth of wholesaling and warehouse direct sales, industrial parks have entered the mainstream commercial fabric. All three study areas have industrial parks, especially Sudbury and Kitchener which are former industrial towns. Figure 6.8 provides examples of these.

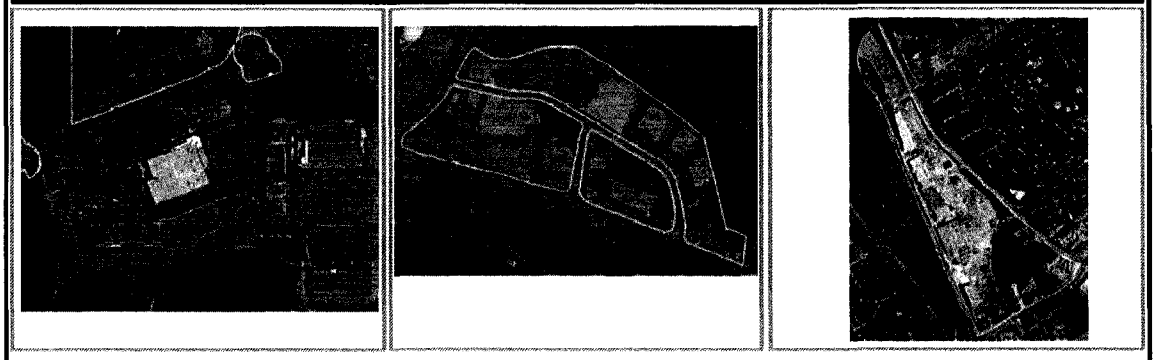
Figure 6.9 Suburbs – Polygon Classification – Shopping Centre / Power Centre or Cluster

Sudbury	Kitchener	Ottawa

Shopping Centre



Power Centre or Cluster



Source: Generated by Author

6.2.1.2.3 Complex Development

The final suburban development is the complex. In this situation an arterial ribbon has grown considerably through the addition of anchors creating a large commercial area which substantive drawing power. Normally located near or along major transportation corridors, these complexes grow initially because of traffic than because of their size. Parasitic development is characteristic along these corridors because of the anchors.

In the case of the Sudbury CMA, there is what could be considered an emerging commercial complex. The Barrydowne corridor is anchored at one terminus by a large power centre and at the other by a large shopping center. The problem is that

development between these two sites has not yet connected. There is considerable externality driven development originating along the corridor away from the anchors but the centre area is still underdeveloped commercially. Within this area medium density residential development exists with sporadic commercial operations intermixed.

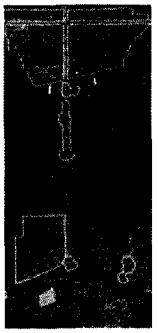
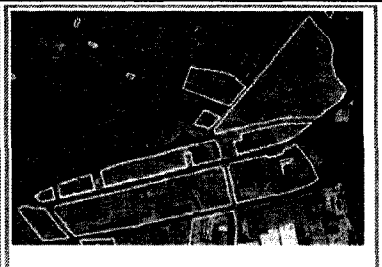
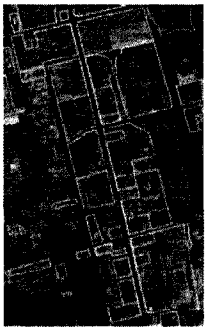
In both the Kitchener and Ottawa CMAs there are very strong examples of commercial complexes. In the case of Kitchener there are two end-anchored complexes, one in Cambridge along the Highway 24 corridor and one in Kitchener along Fairway road. In each case a large "super-regional" malls anchors terminus while new-format development anchor the other end. In the case of Ottawa, one complex emerges as dominant, namely Merivale Road. This is a multiple-anchor complex with both shopping center and power centre development occurring along the entire corridor. Figure 6.10 (Suburbs – Complex Classification) illustrates these.

6.2.1.3 Gateways

The final classification is the gateway development. Typically occurring at the rural-urban fringe this style of development usually precedes any type of residential development. These developments signify the creation of new suburban areas, and in many cases new suburban towns[3]. They are generally characteristic of fast growing urban environments where infilling is generally impossible due to a lack of adequate land or where sprawl style development is characteristic. There are two types of gateway developments, a linear and a polygon development:

[3] Refer to Lowe, M. S. (2000). "Britain's New Shopping Centres: New Urban Forms?" Urban Studies **2000**(37): 2, for a more detailed discussion on retail developments as focal points for new urban developments.

Figure 6.10 Suburbs – Complex Classification

Sudbury	Kitchener	Ottawa
End Anchored		
		
Multiple Anchors		
		

Source: Generated by Author

1. **Linear:** The linear development typically follows a major artery that is leading out of the urban area towards the rural surroundings, or follows a newly developed artery leading to future residential development and in many instances exists at an intersection with another secondary road.
2. **Polygon:** Similar to the linear development the key difference is instead of development following the artery this development is typically focused around a shopping centre or power centre/cluster.

In relation to the study areas, Kitchener and Ottawa have gateway style developments on the exterior boundaries of the core metropolitan area. Sudbury, on the other hand lacks any true gateway developments. Both Kitchener and Ottawa have fast growing

populations in comparison to Sudbury and subsequently have considerably more new developments of both residential and commercial happening.

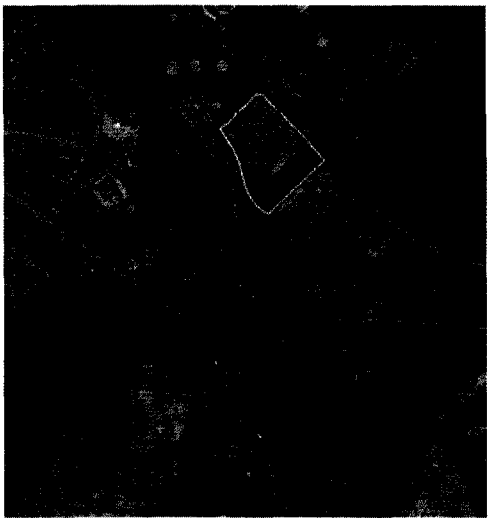
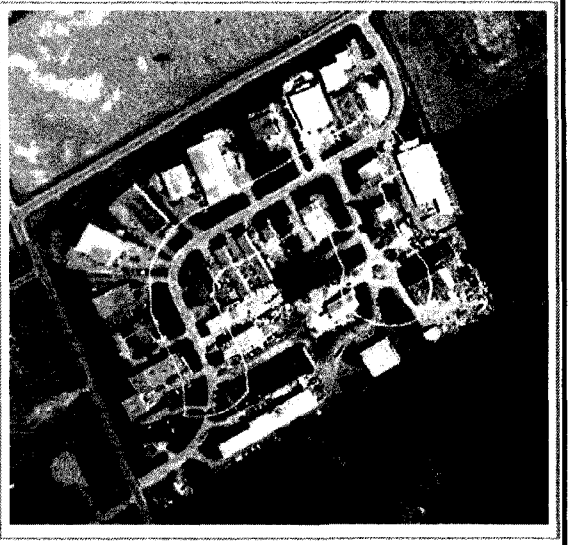
In the case of Kitchener, the developments continuing along Fisher-Hallman Road in the Southwest would be an example of a linear gateway development. In many instances, the commercial development occurred first before any residential development happened.

In the Ottawa study area, there are several gateway developments at the outer borders of the city; developments along Bank Street south towards Greely, and Innes Road east of Orleans towards Cumberland. Due to the nature of Ottawa's geography there is considerable infilling occurring when compared to Kitchener where in many cases the cities are "full". Figure 6.11 (Gateway Development) illustrates these developments.

6.3 Discussion and Conclusion

The development of a commercial typology represents a generalization of the urban commercial environment as it is observed during a snapshot in time. The data used to develop the typology represents a single point of reference and therefore has to be viewed as being less than accurate when compared against a more current dataset. However, this does not mean the data is wrong. It is easy to change from a clothing store to a shoe store, but the creation, and to a lesser extent the destruction of commercial space (buildings) is much more difficult. Therefore the data more accurately represents where commercial operations are occurring and in what geographic form, than the nature of the stores themselves. Consequently this typology places emphasis

Figure 6.11 - Gateway Development

Kitchener	Ottawa
	
Pioneer Rd & Homer Watson Traditionally an Industrial area, development has occurred in this area centered around the Pioneer Park Mall as a result of its proximity to Highway 401 and Conestoga College.	Albion Rd & Chemin Latrim A small mixed development on the main road leading to the town of Greely

Source: Generated by Author

on the geography of urban commercial development and its related commercial forms that it takes on.

In addition, the typology also reflects a characteristic not normally found in older typologies namely that of the gateway zone. The inclusion of this represents a dominant trend in urban development, namely the continued outward growth of a metropolitan area. Though two of the study areas under examination have gateway style developments, the fact is that given the rapid rate of development these gateways will inevitably become part of the suburban classification and potentially replaced by a new set of gateways. The inclusion of this classification also reflects a trend in the literature towards understanding how commercial development has the ability to drive urban

growth, in essence, the creation of gateway cities around large commercial developments.

Therefore it can be argued that this typology contains three characteristics that make it not only unique, but a valuable tool in analyzing urban commercial systems:

1. The typology allows for the continued classification of older traditional forms of development (**Historical Remnants**) which still exist and are still a major component of the urban commercial system. Furthermore, the continued inclusion of these areas allows for comparison to be done with older classification schema.
2. The use of a **three-part urban classification system** allows the typology to be applied to any type of urban environment and not just the fastest growing. Each of the three study areas had examples in almost all categories but only the fastest growing areas had examples of gateway development. This becomes a valuable insight in understanding the growth of a city.
3. An orientation towards the **geographic form** of the development and less on the types of stores within that development permits a better historical analysis with older typologies, where the focus is on the continual existence of commercial area and not on the fact that stores change, therefore changing the morphology of that area.

Finally, the use of any typology must be done with a "grain of salt". As it is a generalization, there will inevitably be areas within the urban environment that may not fit nicely into a single classification but may fit into several depending on the

configuration of the commercial area. Hopefully, by focusing on the dominant geographic form, this potential problem can be mitigated unless a NEW form has been created, in which case the typology would need to be updated. Since this is a systematic and operationalized approach to commercial analysis, the ability to update the typology exists whenever needed.

CHAPTER 7

CONCLUSIONS

There will come a time when you believe everything is finished. That will be the beginning.

Louis L'Amour (Date Unknown)

7.0 Introduction

Due to the inherent spatial nature of shopping activity, where the consumer is likely to shop will affect the location and organization of the commercial system. The reverse is also true, the location and organization of the commercial system will effect where consumers shop. The emergence of a new commercial area, on one hand can be viewed as a result of changes in consumer behavior. On the other hand, it will cause changes in many factors related to consumer behavior (Marjanen 1995).

Holdsworth (1995) writes that the "Canadian urban landscapes defy easy categorization. Most places have distinctive 'signatures' – their own mixing of site attributes and settings – but at the same time there also are many similarities. These unique elements shape the spatial arrangement of our present day cities." Considerable progress has been made during the past twenty years in understanding the character of modern day urban system and the processes that have created and changed these systems (Davies 1989). There has been much work done on describing and characterizing urban systems. From the first use of central place theory to the modern

day concepts of multi-nucleic and dispersed communities, urban scientists have tried to understand the form and nature of these areas.

Historically the commercial component of the city has changed dramatically since World War II. Fuelled by suburban growth, the spatial arrangement of commercial operations has undergone dramatic change. Since the inception of the first shopping mall, commercial growth and change has followed many different development paths. In over 50 years urban environments have experienced a change from a system where residents dictated commercial growth to where commercial growth can act as a catalyst for residential growth. It is this twist that leaves these two facets of the urban system inexplicably tied to one another.

All these changes have facilitated the need for a greater understanding of not only the underlying processes at work, but the geographic changes to the urban area as well. This dissertation set out to develop an empirical technique for detecting and analyzing commercial zones within the Canadian urban system therefore producing a technique whereby change can be detected and monitored. Based on this analysis a generalized model of urban commercial space was derived allowing for the present configuration to be generalized and described.

7.1 Key Findings

This research has operationalized a systematic and replicable method of examining urban commercial location data for the purpose of determining commercial structure. As a result this technique allows for ease of repetition over time resulting in a readily

updatable typology rendering it less static than previous ones. It is the use of technology, namely GIS, that adds this dynamism to the analyses.

The overarching goal of this research was the analysis of urban commercial structure. This research has found:

1. Literature Analysis – The literature review illustrated that while the field of commercial geography is vibrant, there are significant gaps within it. Most notably is in the analysis of urban commercial structure. Though there has been considerable work done during the last 75 years starting with Proudfoot, there has been virtually no NEW research on urban spatial structure and more specifically on typologies to describe that structure within the last 10 years. The only major typology produced within that time period was from Jones (2000) and that was an update to an existing typology that he had created previously. Furthermore, the literature has demonstrated that there has been considerable change to the urban commercial system. These two factors have resulting and demonstrated the need for an updated typology of urban commercial structure.
2. The literature has shown that there is a void when dealing with HOW to analyze the commercial environment. There has been virtually no research on using GIS for commercial structural analysis. Previous analyses were typically done using a visual interpretation of commercial data. Geographic data sets containing commercial locations were limited as were the means to process and analyze them. Only within the last 15 years has the ability to handle large geographic datasets become realistic. Through the use of the geographic information system these datasets can be

manipulated and analyzed. In addition, the availability of said datasets has increased to a point that coupled with the GIS, rapid and accurate analyses can be conducted. This research has capitalized on the availability of these new datasets and has developed and detailed one possible way of analyzing this system.

3. One of the major benefits of the GIS is that the analysis of data can be systematized and operationalized so that it can be replicated in a variety of contexts, or in this case different study areas. This research has demonstrated that the analysis of urban commercial locations can be conducted in an efficient and fairly accurate manner.
4. The main way the analysis was operationalized was through the creation of the Nearest Commercial Neighbor. This density measure becomes critical when trying to cluster or group commercial operations that form a "commercial area". This research has shown that use of either the 1x or 2x multiple of the median NCN is the most effective in delineating commercial areas.
5. The identifying of the commercial areas as a result of the clustering techniques developed was critical in the creation of a new typology of urban commercial structure. By examining the defined areas in conjunction with the literature analysis it was possible to create a generalized model. This model identified that there are a variety of commercial forms within three main geographic areas of the city. Furthermore it is clear that as cities grow in size their commercial structure becomes more complex. However, it is also apparent that the model is useful for a variety of metropolitan areas.

6. Lastly, this research has demonstrated a way of analyzing the ***geography*** of urban commercial development. By focusing on location and geographic form, and less on the actually types of stores within the various commercial zones, the model becomes more adaptable. It is easy to change the store type within a commercial area but it is much harder to change the location of the commercial area.

These key findings, albeit generalized, reflect the broad conclusions that can be garnered from this research. However, with any research, there are areas that need further consideration.

7.2 Future Considerations

This research has demonstrated the potential which exists for using GIS to analyze commercial location data. However, as a result it has also become apparent that there are major considerations that need to be addressed for future research.

7.2.1 Point Data

The use of point data, which is convenient and useful, is limited as a result of the need to generalize the three dimensional down to a two dimensional object. The comparative analysis performed on the Kitchener CMA using parcel data illustrated how much more accurately the commercial zone can be delineated. It is recommended that the use of point data be for rapid identification of commercial areas based on number and density, and that parcel data be used for the final delineation and identification of the individual commercial areas. This recommendation takes into consideration the

availability of accurate data. Commercial location data is readily available as is land use planning parcels in many urban areas. Building footprints, which would be the alternative to commercial point data, are less readily available. Consequently the availability of data becomes paramount. Furthermore the techniques developed here required point data and at the moment techniques do not exist to be able to duplicate this analysis using polygon data beyond what has been recommended.

7.2.2 NAICS/SIC Codes

One of the advancements that can be made to the typology and the analytical framework is the integration of the North American Industrial Classification Systems (NAICS) or the Standardized Industrial Classification (SIC) codes that allow for the identification of store type.

This integration will allow for a greater understanding of the commercial cluster in terms of its store composition. The commercial area can now be identified according to the "nature" of the area. For example, when two similar commercial areas are identified, through the use of NAICS/SIC codes, it can be determined that one area is a clothing/jewelry district while the other is a restaurant district. By identifying the store type and composition, a greater insight into the role the commercial area plays within the greater urban system can be identified.

Lastly, by identifying the composition of the commercial area, comparisons against older typologies are easily facilitated as many of them focused on commercial area composition as a mean of further differentiating commercial areas.

7.2.3 Central Place Theory

One of the main critiques presented by this research was the applicability of central place theory as a means of organizing commercial areas. It has been argued that it may no longer be applicable, or at the very least needs to be re-evaluated for its applicability. This research can aid in understanding the role, if any, central place plays in current urban commercial organization.

By examining two characteristics of the commercial area, namely the number of stores in the area (rank order) and the distance between areas of similar size AND their relationship with areas of differing sizes it becomes possible to determine if a true or modified central place structure actually exists. Furthermore, if this analysis is conducted using the integrated NAICS/SIC codes a true central place hierarchy based upon distance AND types of services provided can be determined.

Finally, analyzing central place can be undertaken in two ways. Firstly, as identified above, by looking at the entire commercial system it is possible to determine the presence of absence of central place. Secondly, by examining specific components, such as the centers, it is possible to determine whether or not there is a hierarchy of centers as identified in previous typologies.

7.2.4 Typology Applications

As an academic pursuit the development of a typology of commercial structure is a valuable exercise as it permits a greater understanding of the spatial configuration of the commercial landscape. However, the true value of the typology becomes its applicability outside of the academic realm.

When dealing with urban planners, the typology can be used to identify the results of their planning decisions. For example, while planners control *where* and to a certain extent *what* is development, they do not individually control each commercial area. The typology provides insight into the nature of each commercial area and how it has developed. Planners can gain insight into differences between specialty areas (entertainment versus fashion) and set forth planning provisions that encourage or discourage future development. Furthermore they can also identify areas that may be lacking in commercial development

In addition, the typology can be used to test the presence of central place from a planning perspective. Does the current spatial configuration and service provision match with the planner's intent or has it naturally deviated in some identifiable way? Does the shopping centre hierarchy still exists or have they coalesced into larger commercial areas such as the linear commercial complex further obscuring a specific type of hierarchy, while creating another. Planners can use the typology as a means of visualizing and understanding the system they are trying to plan.

Another potential user is the small-scale retailer. When trying to identify market areas in which they can develop, the typology (with NAICS/SIC codes integrated) can identify those area of similar store configurations or provide information as to commercial area configurations which may have development potential. Furthermore when using the typology with central place in mind, retailers can identify the "levels" within which they want to develop, based upon their market needs.

7.2.5 Final Thoughts

The final consideration surrounds the generalized model of urban commercial structure. Since it is a ***generalized*** model based on three Canadian census metropolitan areas and developed as a result of the analysis of these areas, the application of the model to other urban regions within Canada and beyond will either prove its usefulness or identify potential gaps in the model leading to future revisions. As Jones' (2000) typology was an update of a previous typology, likewise it is expected that this typology will also evolve over time. However, each evolution can be done in it's entirety, namely a full analysis of the entire urban system, and not simply the addition of new area, forms, or commercial types.

7.3 Conclusions

Changes in the geographical aspects of the commercial environment are numerous. The commercial structure has evolved from a period where the CBD was the 'commercial core' of city to a situation where this 'core' has shifted to the suburban, super-regional shopping centre. Unlike the previous decade, the 1990s experienced little growth in shopping centers. Growth during this time period came in the form of the new-format retailers. With the addition of these power centers came major arterial ribbons that prompted the emergence of another commercial form, the linear commercial complex. Society has arrived at a point where the once clearly defined boundaries between land uses are beginning to blur. Associated with these changes in geography, are changes in corporate strategy, consumer behavior, land use planning

and many of other influences. These in turn have dramatically shaped the geographic manifestation of the commercial system.

Commercial environments will continue to evolve. Consumer behavior, corporate strategies and the influences of a multitude of other factors will constantly change the commercial system. Typologies will be developed which reflect changes over a short period of time, and eventually will become dated. This research has contributed to this evolution by analyzing the geography of commercial development during a snapshot in time. However, by developing a series of operational and repeatable techniques that focus on the geographical organization of commercial locations it is hoped that the results will function as the conceptual and practical framework for commercial structural analysis of urban environments for the 21st century in Canada and beyond.

Appendix A

Point Only Detection Maps

The following maps represent the generated polygons for the point only cluster detection for the three study areas with their specific areas of interest:

A1. Sudbury CMA
   a. CBD
   b. Four Corners

A2. Kitchener CMA
   a. Waterloo CBD
   b. Kitchener CBD
   c. Cambridge Hwy 24

A3. Ottawa CMA
   a. CBD and Inner City
   b. Bank Street (Glebe)
   c. Carling Avenue
   d. Bank Street (Billings Bridge)
   e. Merivale Road

Each area of interest contains seven maps: The "Original", The Average Iteration, and the 1-5x Iterations. All maps are orientated with North on the left side of the page unless otherwise stated.

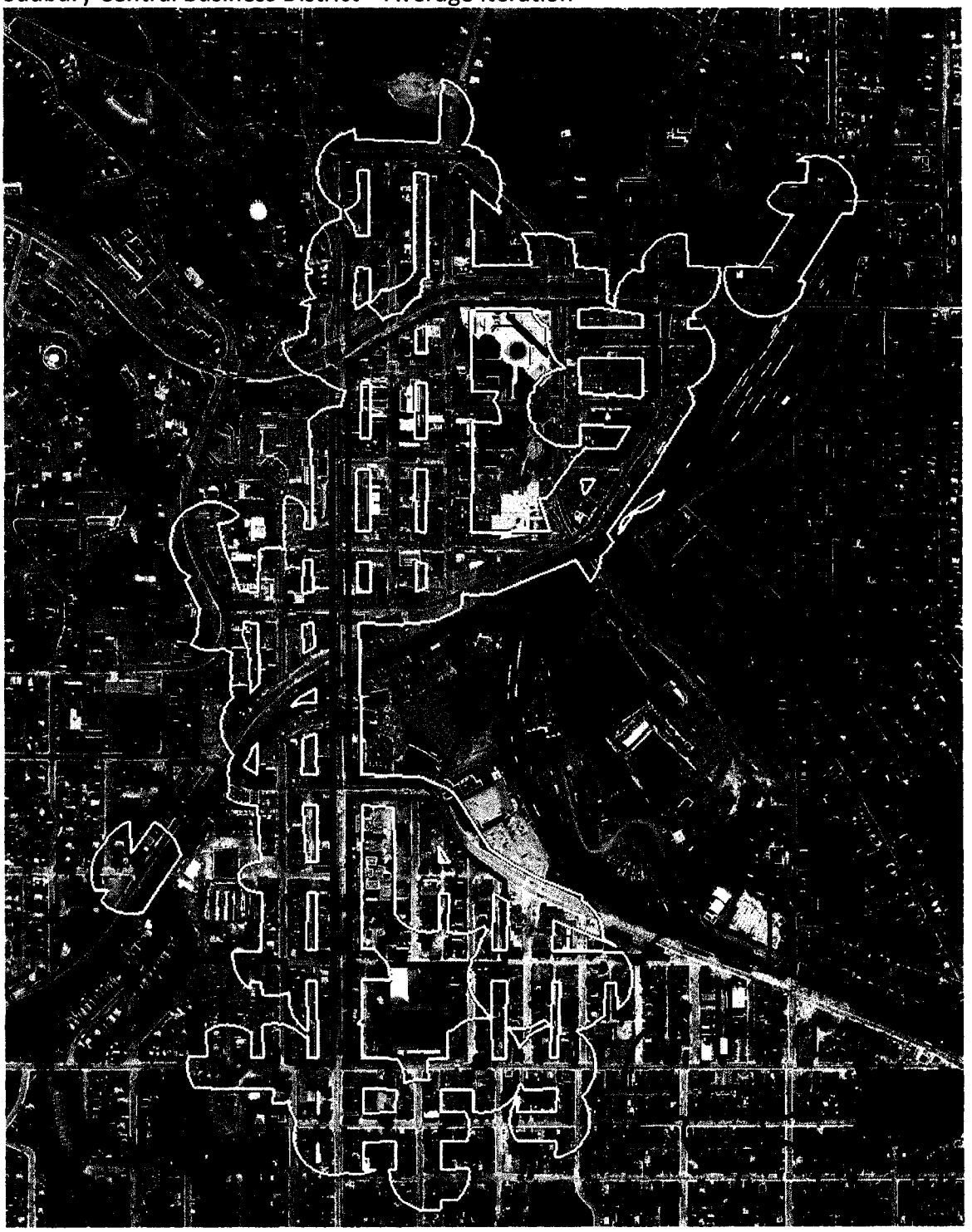
The legend for all maps is as follows:

RED (dots)	"Original" Area
	Detected Area
BLACK	Detected Areas Outside of Area of Interest

A.1 Sudbury CMA

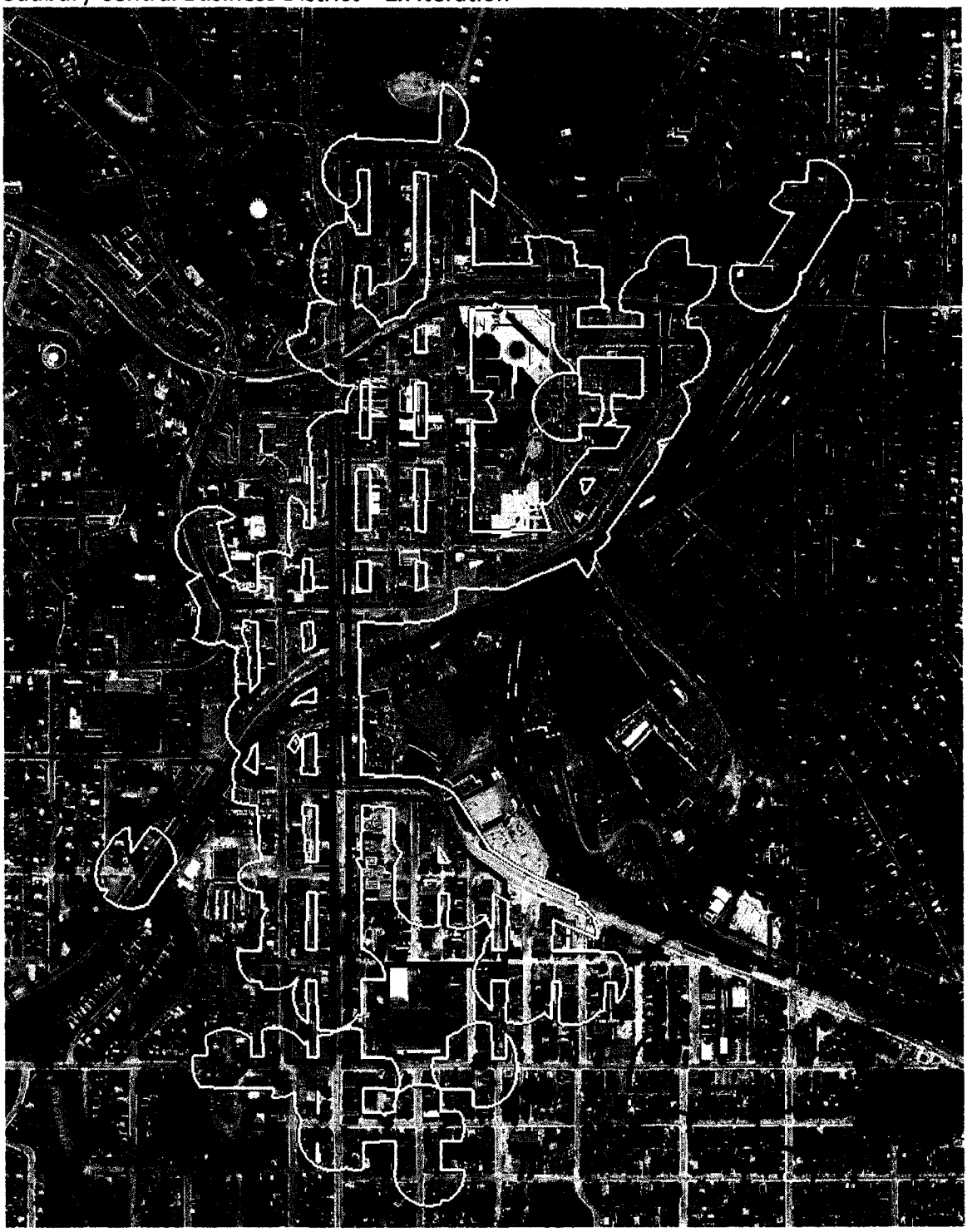
Sudbury Central Business District – Land Use Defined Boundaries

Sudbury Central Business District – Average Iteration



Sudbury Central Business District – 1x Iteration

Sudbury Central Business District – 2x Iteration



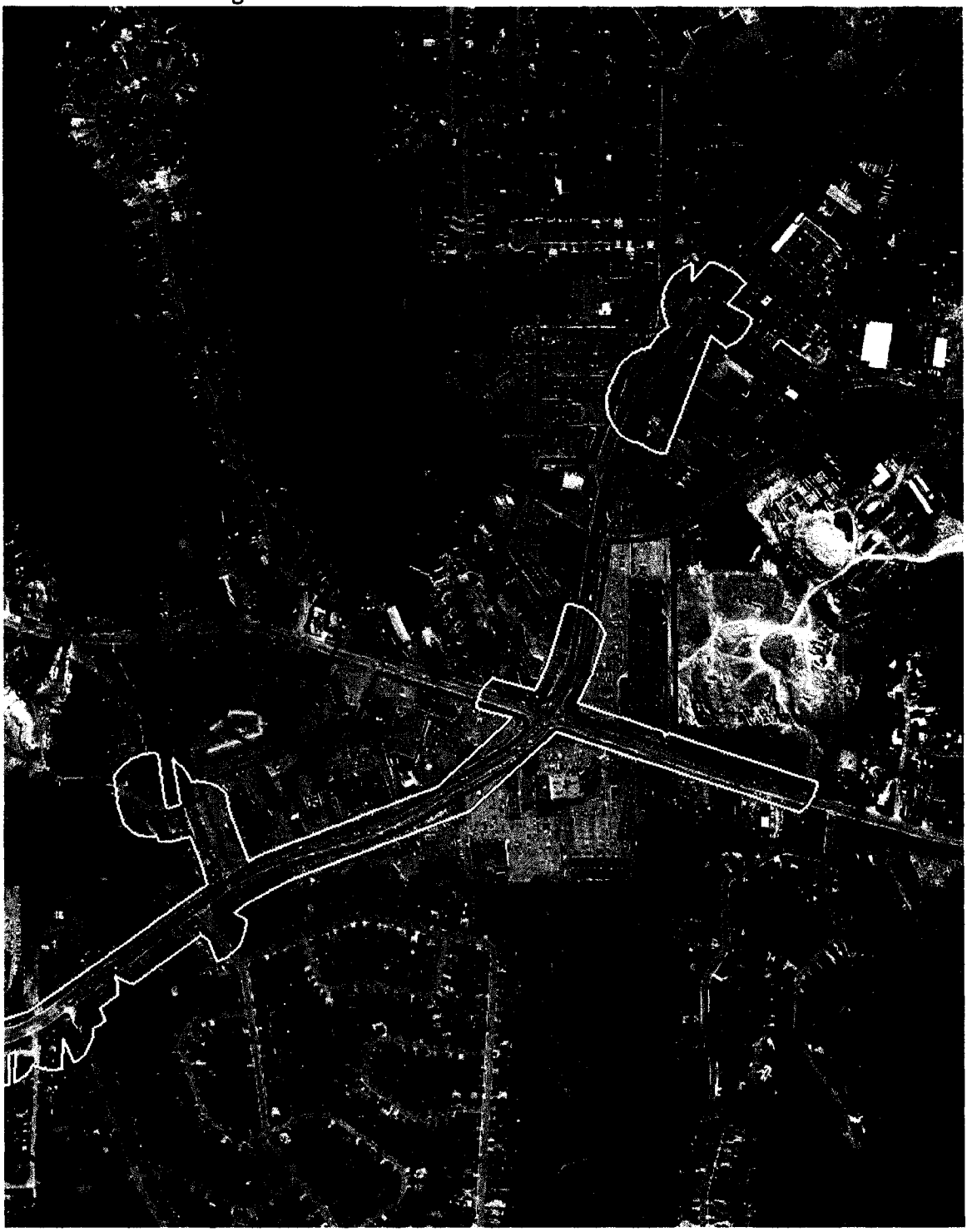
Sudbury Central Business District – 3x Iteration

Sudbury Central Business District – 4x Iteration

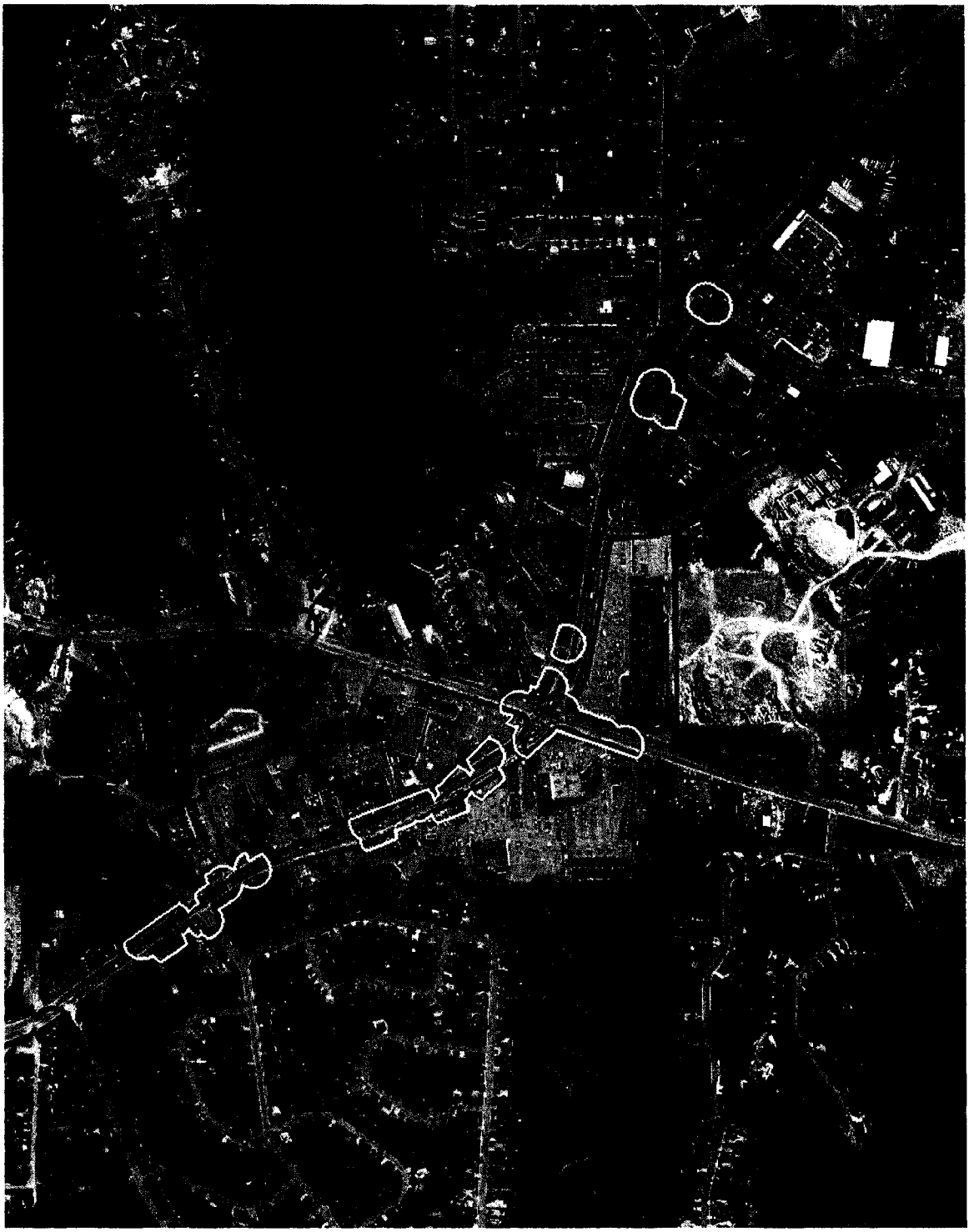
Sudbury Central Business District – 5x Iteration

Four Corners – Land Use Defined Boundaries

Four Corners – Average Iteration



Four Corners – 1x Iteration

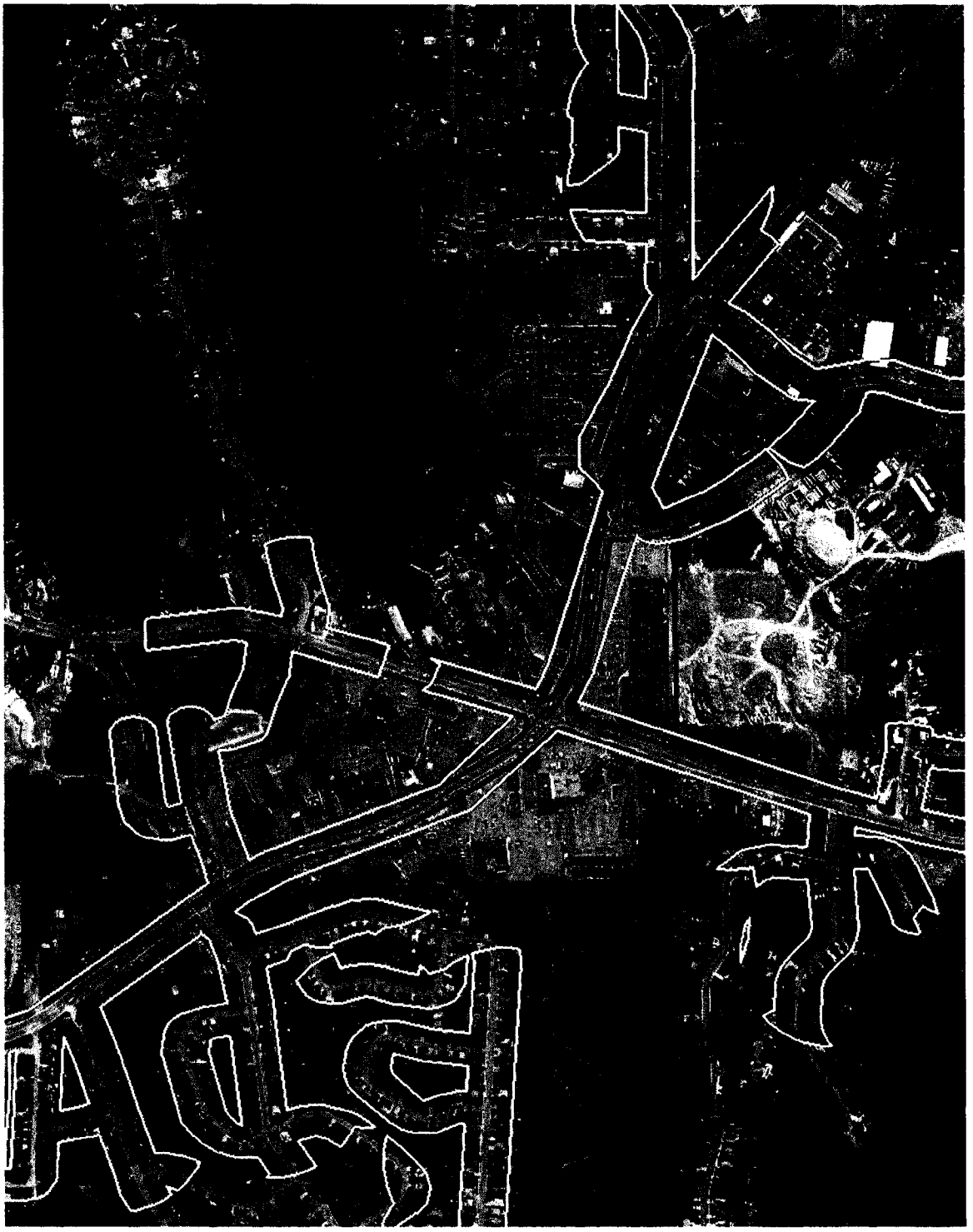


Four Corners – 2x Iteration

Four Corners – 3x Iteration

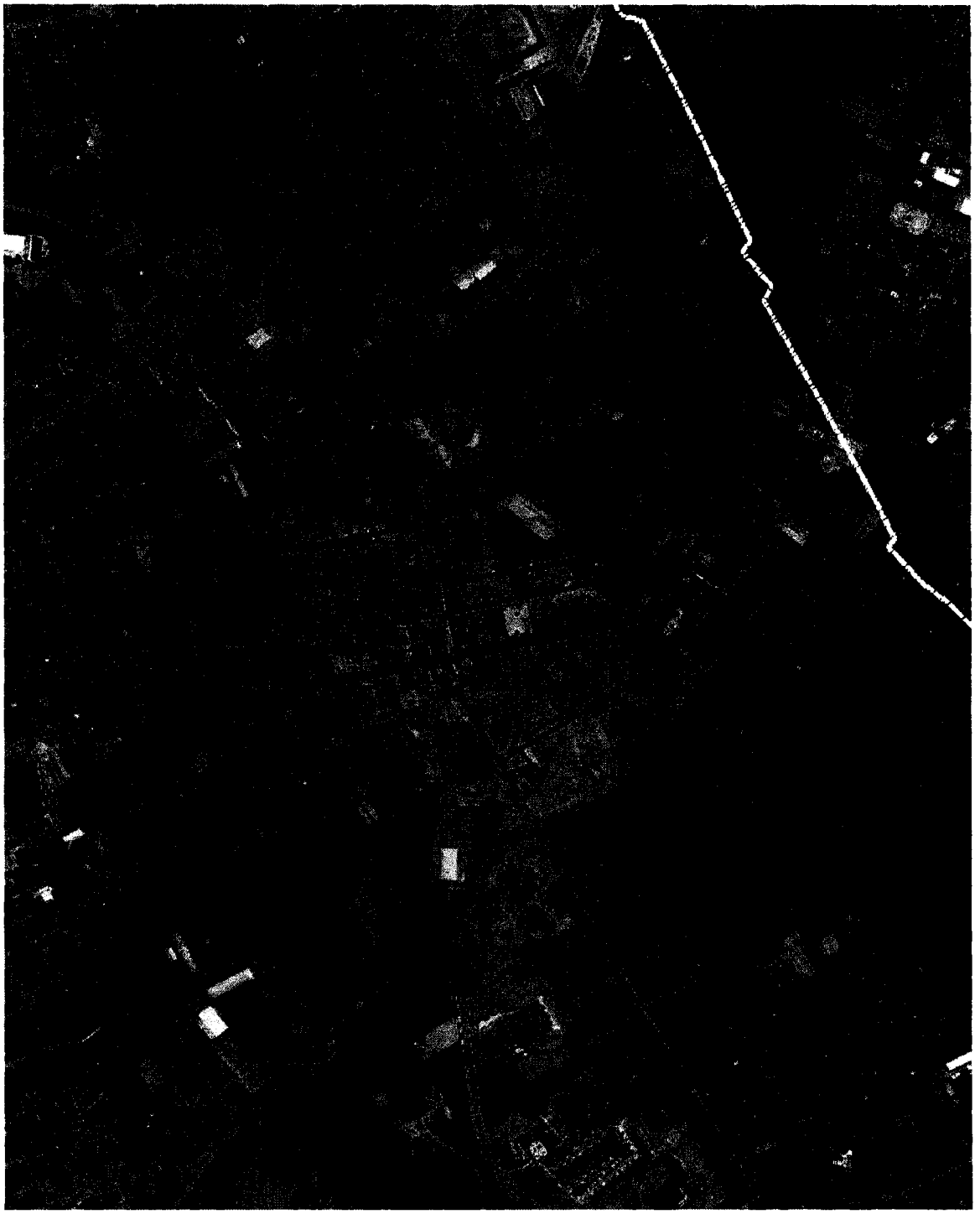
Four Corners – 4x Iteration

Four Corners – 5x Iteration

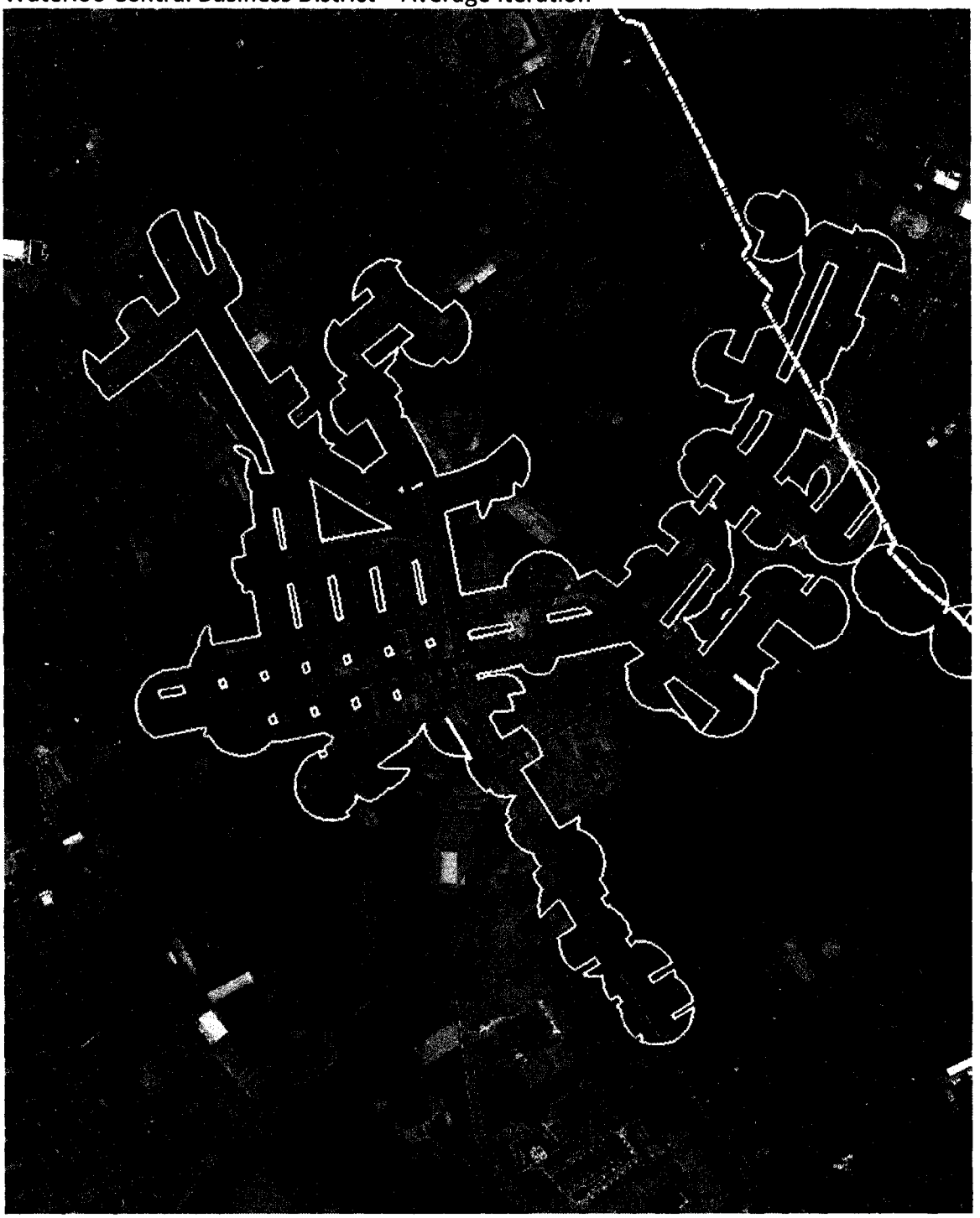


A.2 Kitchener CMA

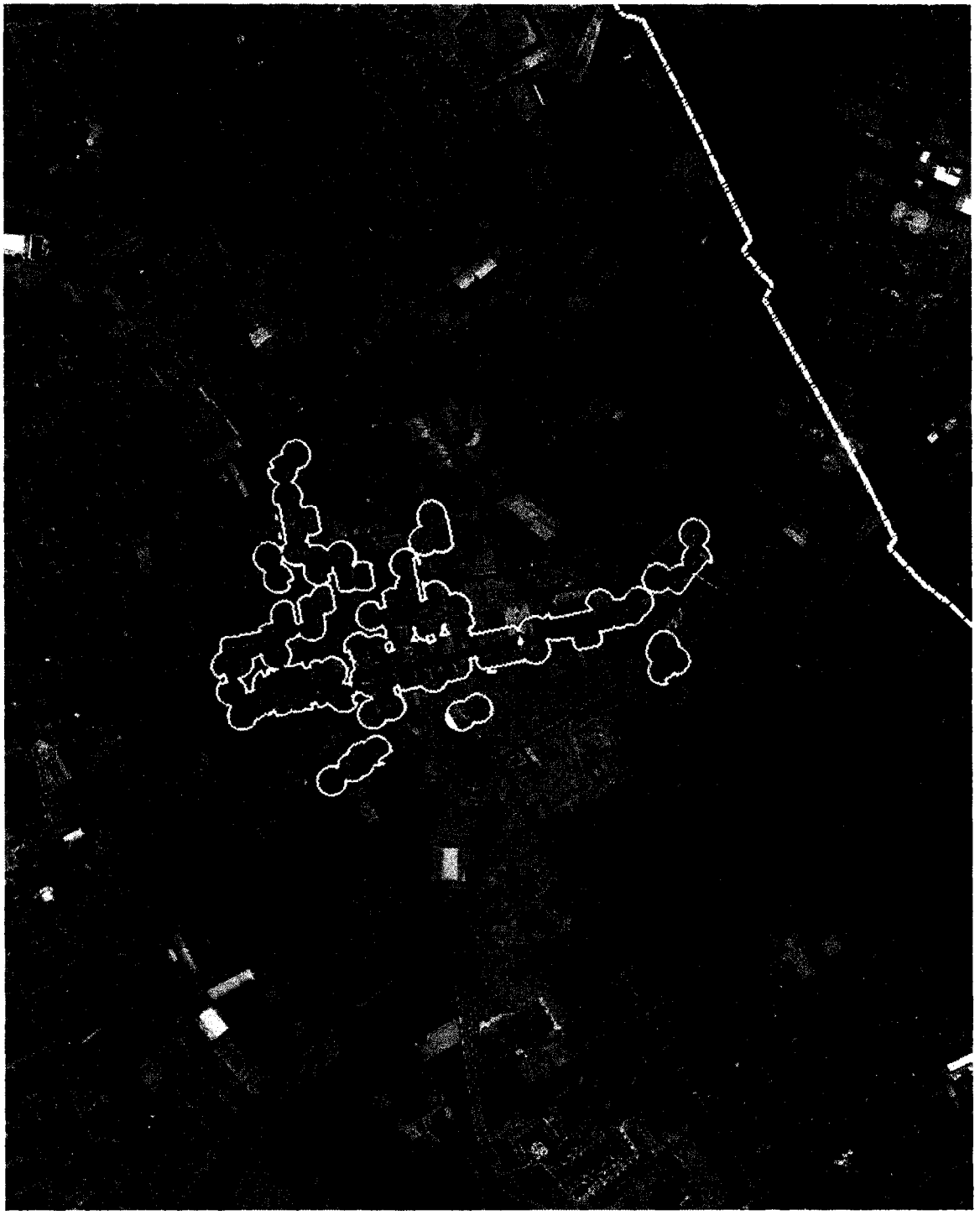
Waterloo Central Business District – Land Use Defined Boundaries



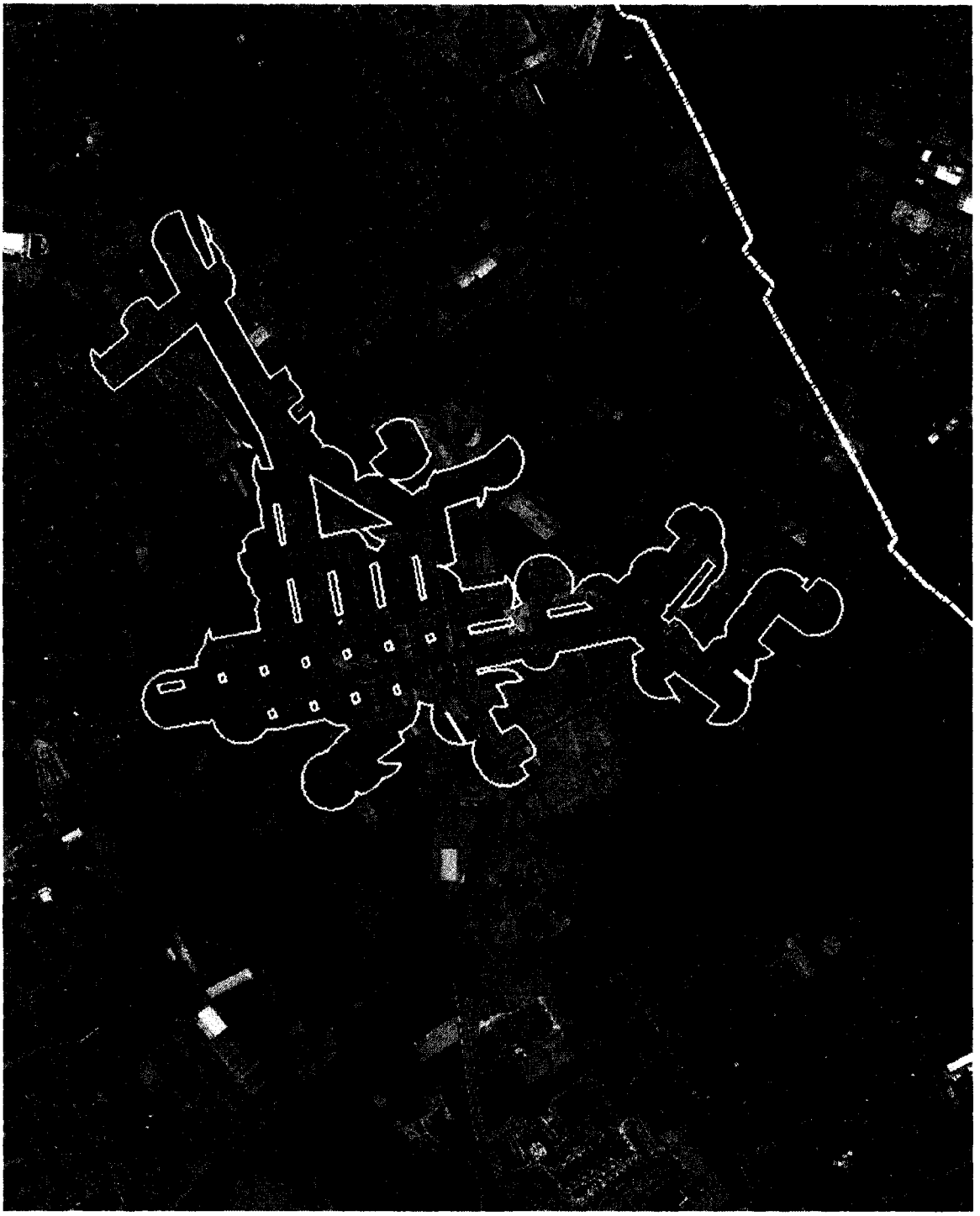
Waterloo Central Business District – Average Iteration



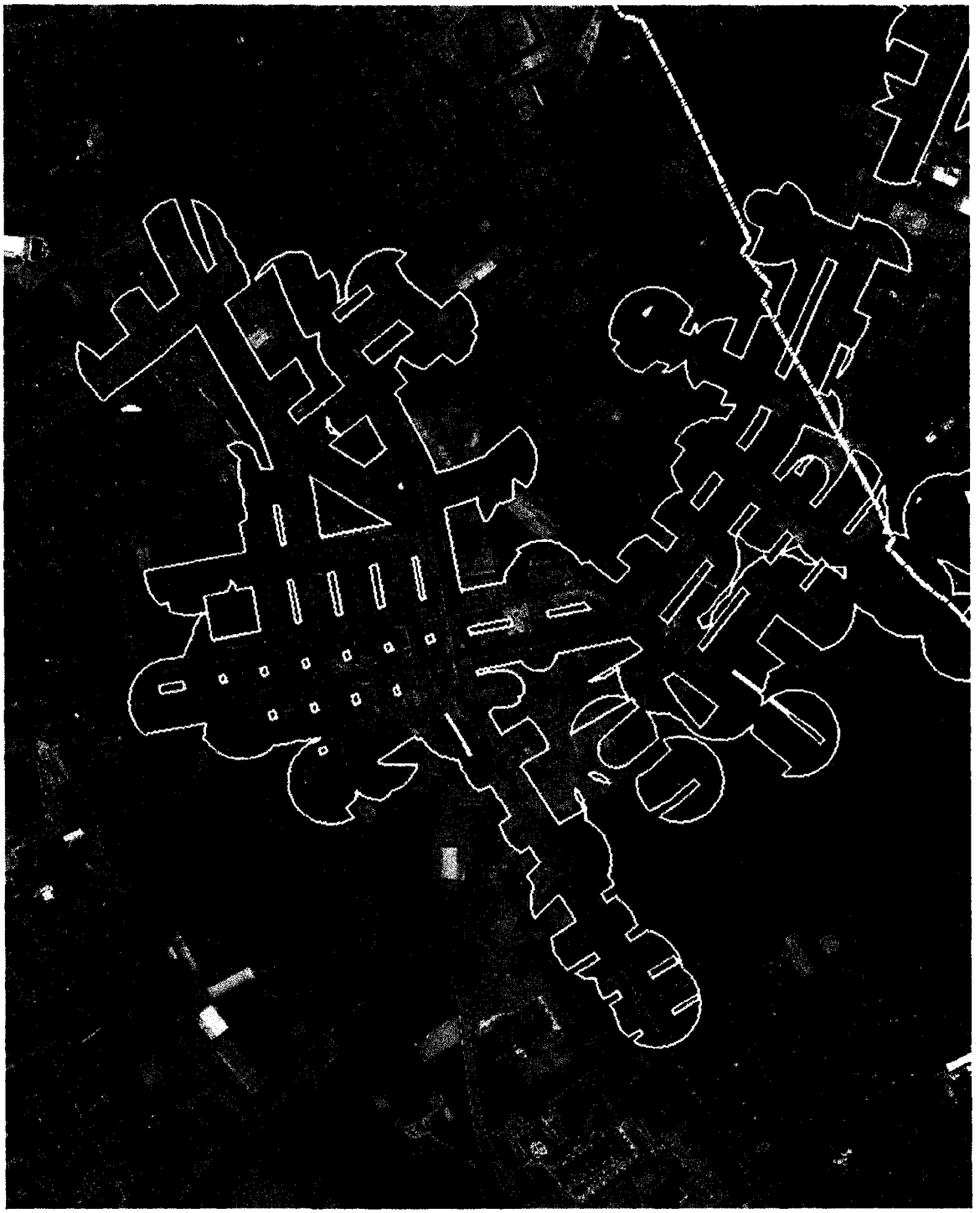
Waterloo Central Business District – 1x Iteration



Waterloo Central Business District – 2x Iteration



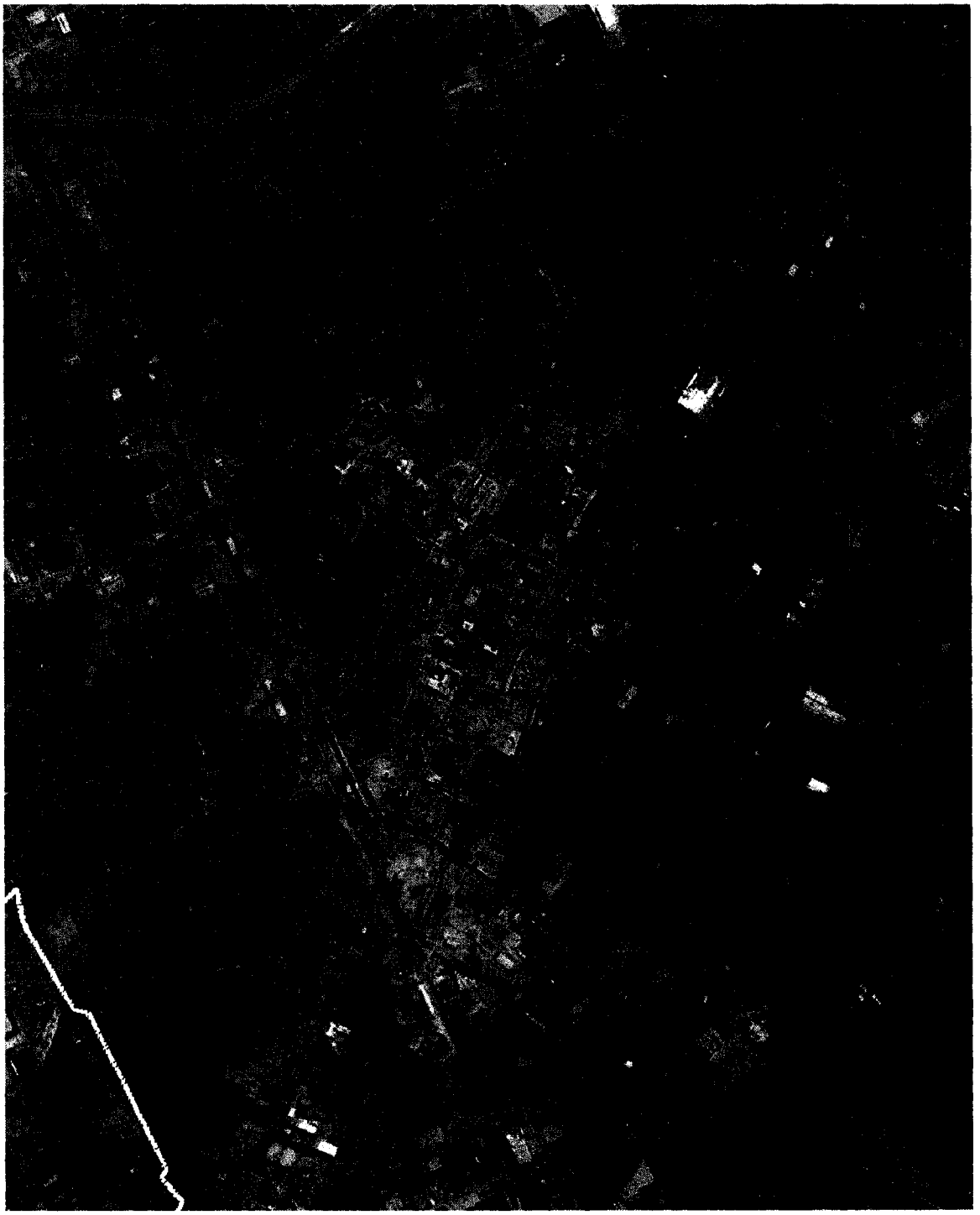
Waterloo Central Business District – 3x Iteration



Waterloo Central Business District – 4x Iteration

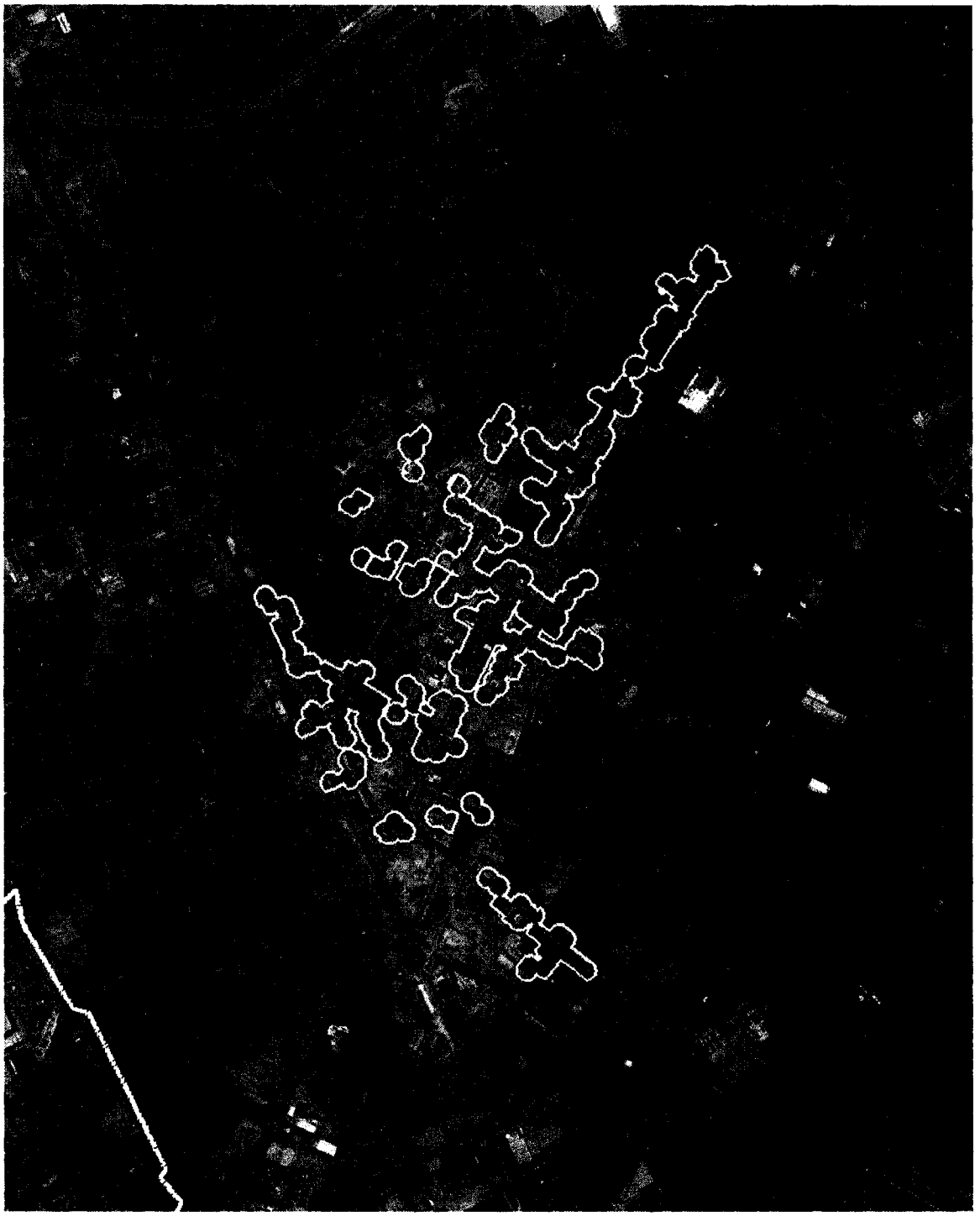
Waterloo Central Business District – 5x Iteration

Kitchener Central Business District – Land Use Defined Boundaries

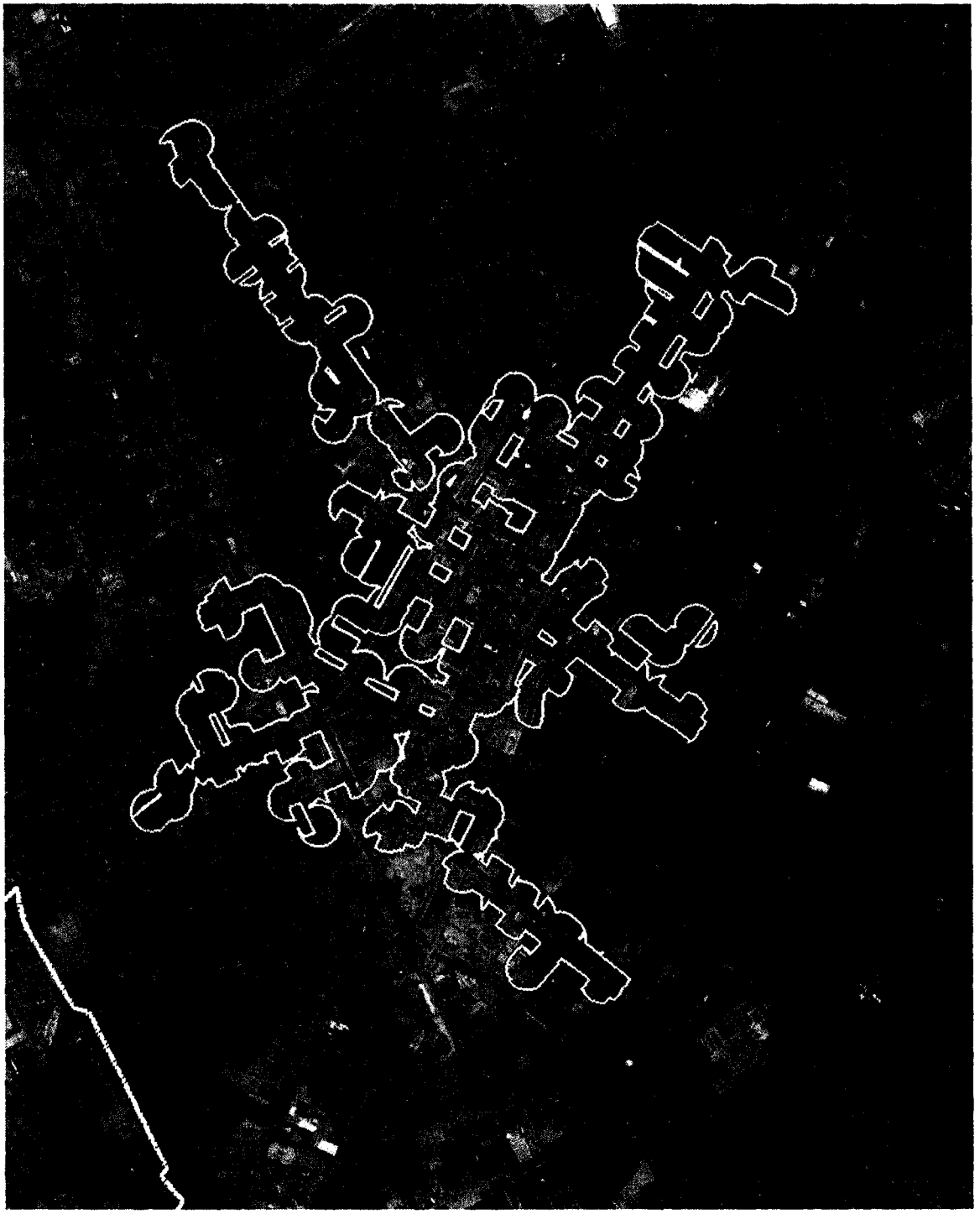


Kitchener Central Business District – Average Iteration

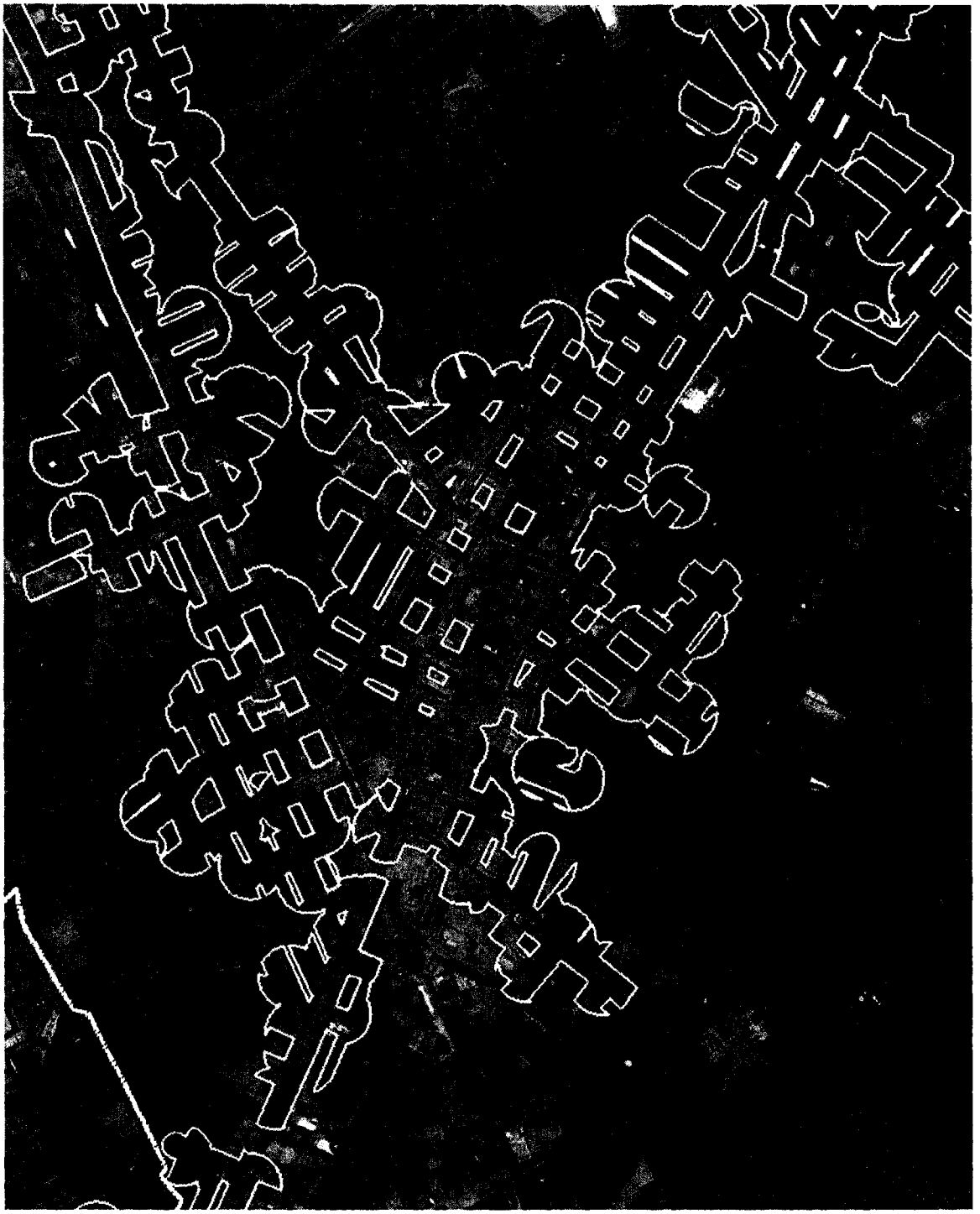
Kitchener Central Business District – 1x Iteration



Kitchener Central Business District – 2x Iteration

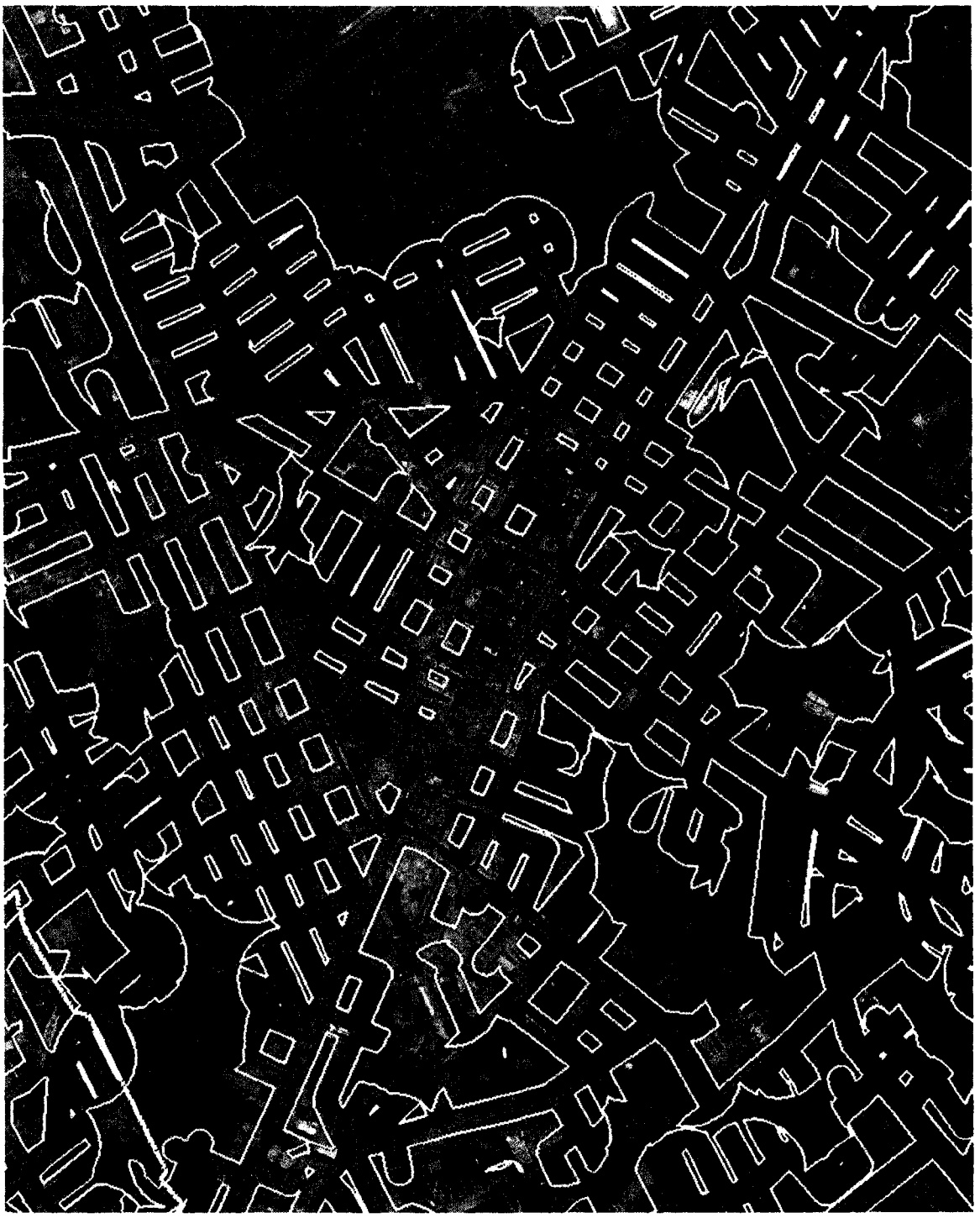


Kitchener Central Business District – 3x Iteration

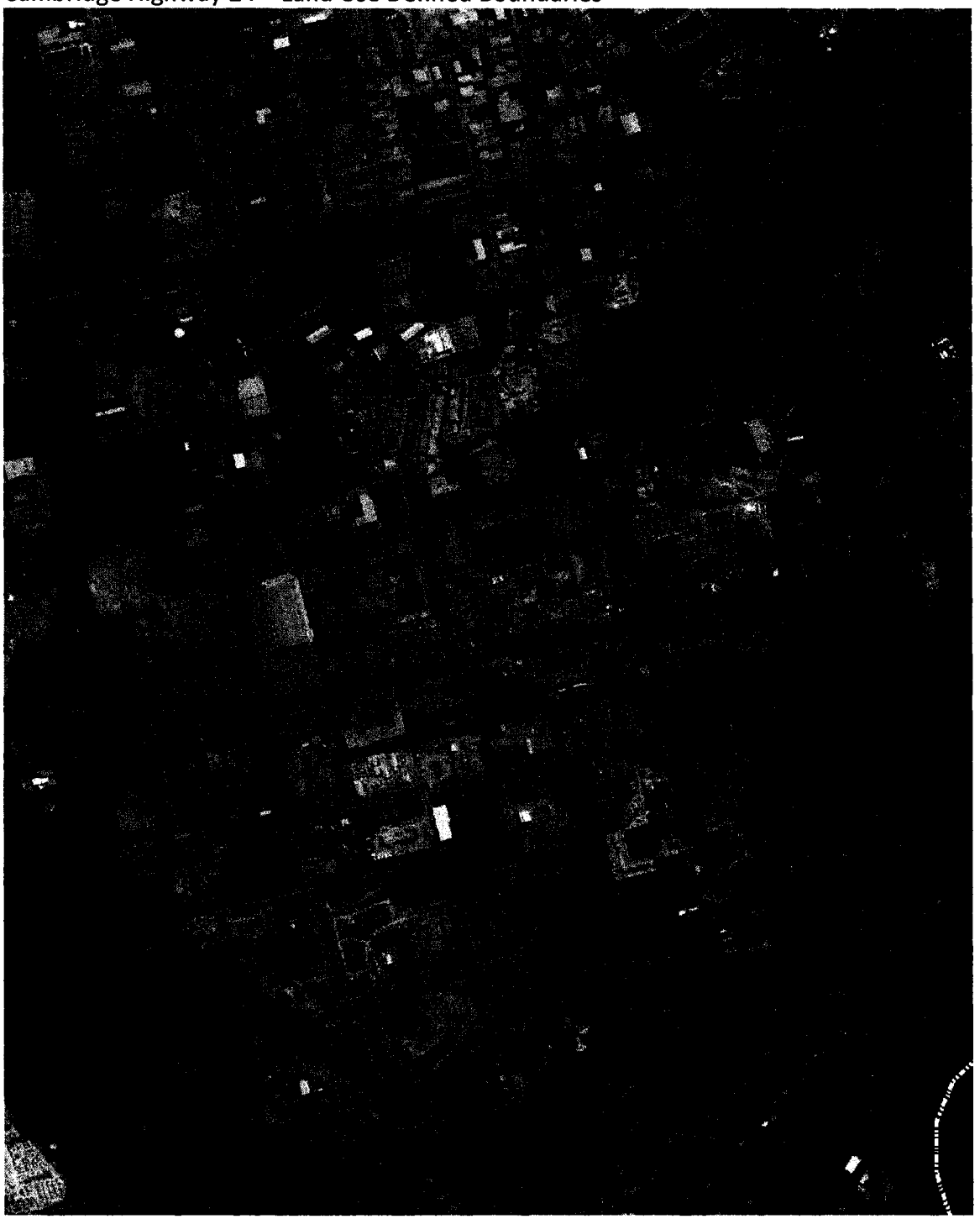


Kitchener Central Business District – 4x Iteration

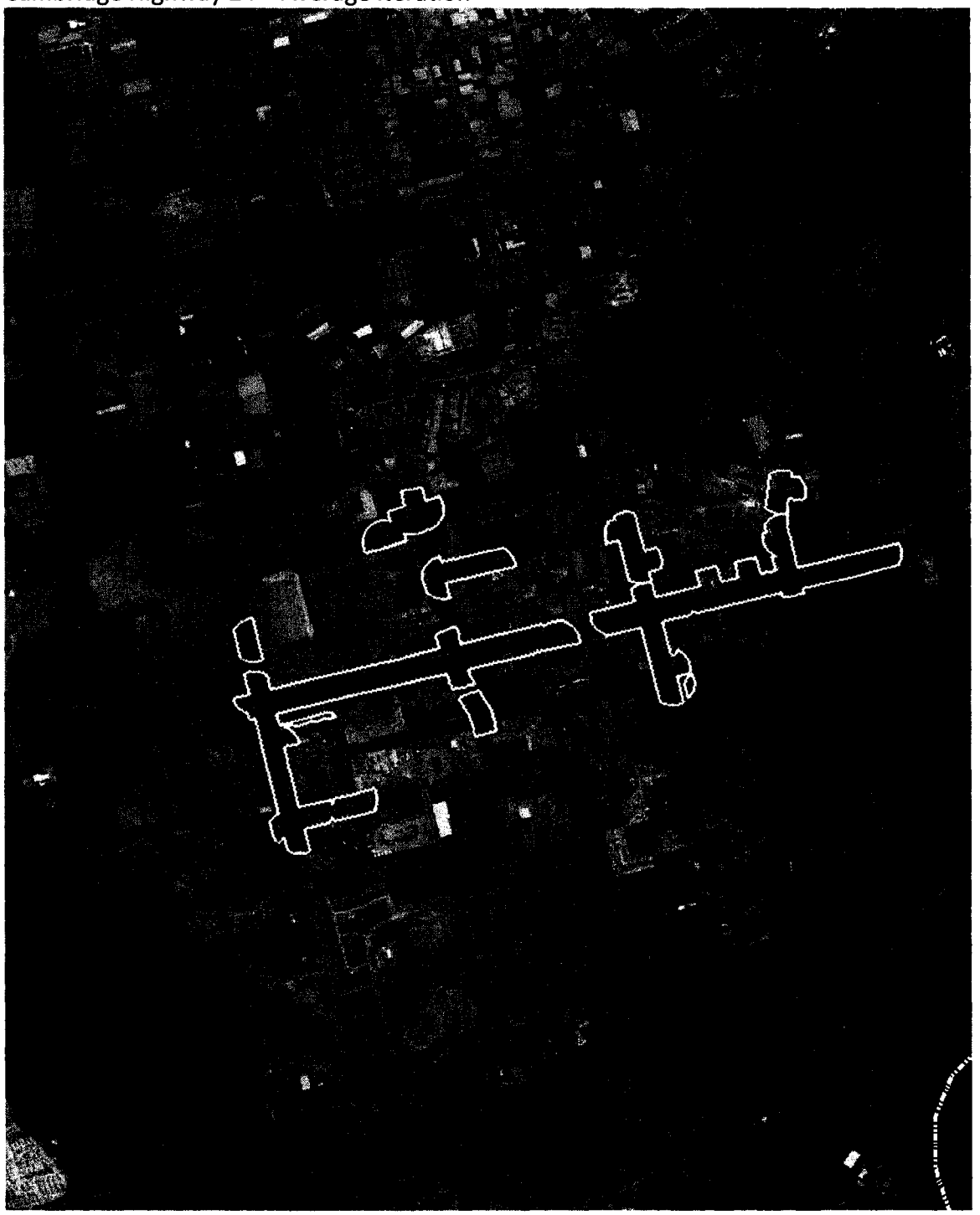
Kitchener Central Business District – 5x Iteration



Cambridge Highway 24 – Land Use Defined Boundaries

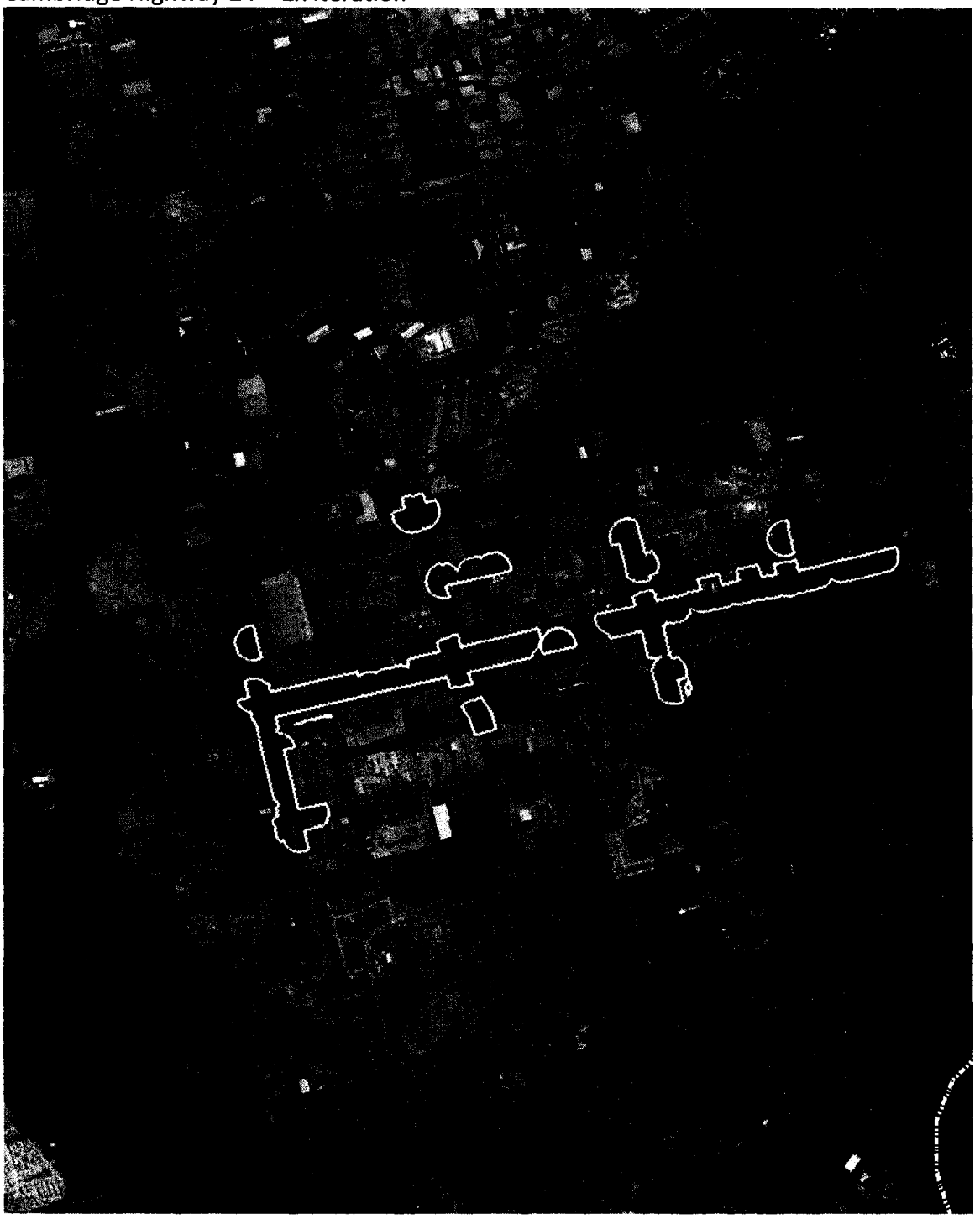


Cambridge Highway 24 – Average Iteration

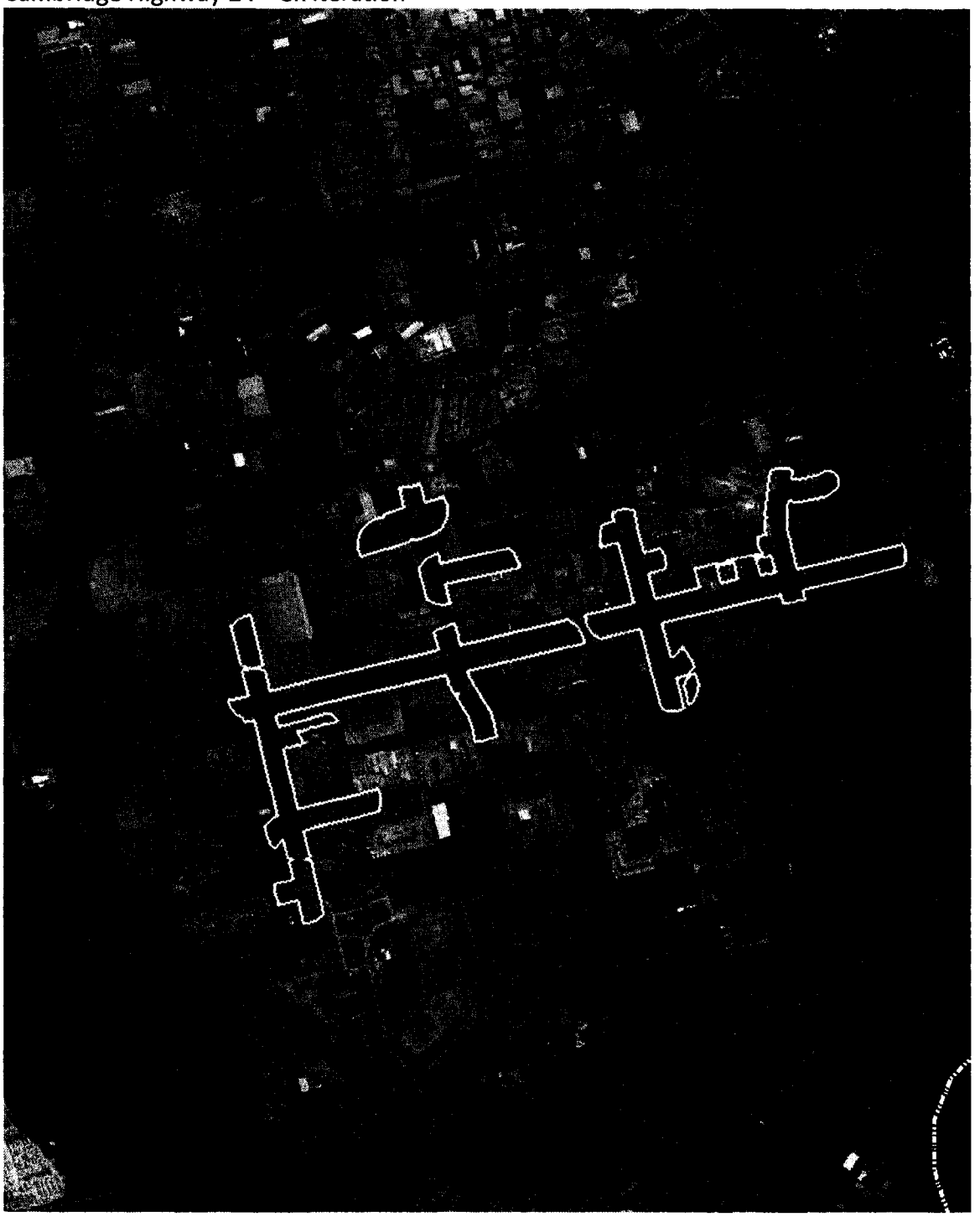


Cambridge Highway 24 – 1x Iteration

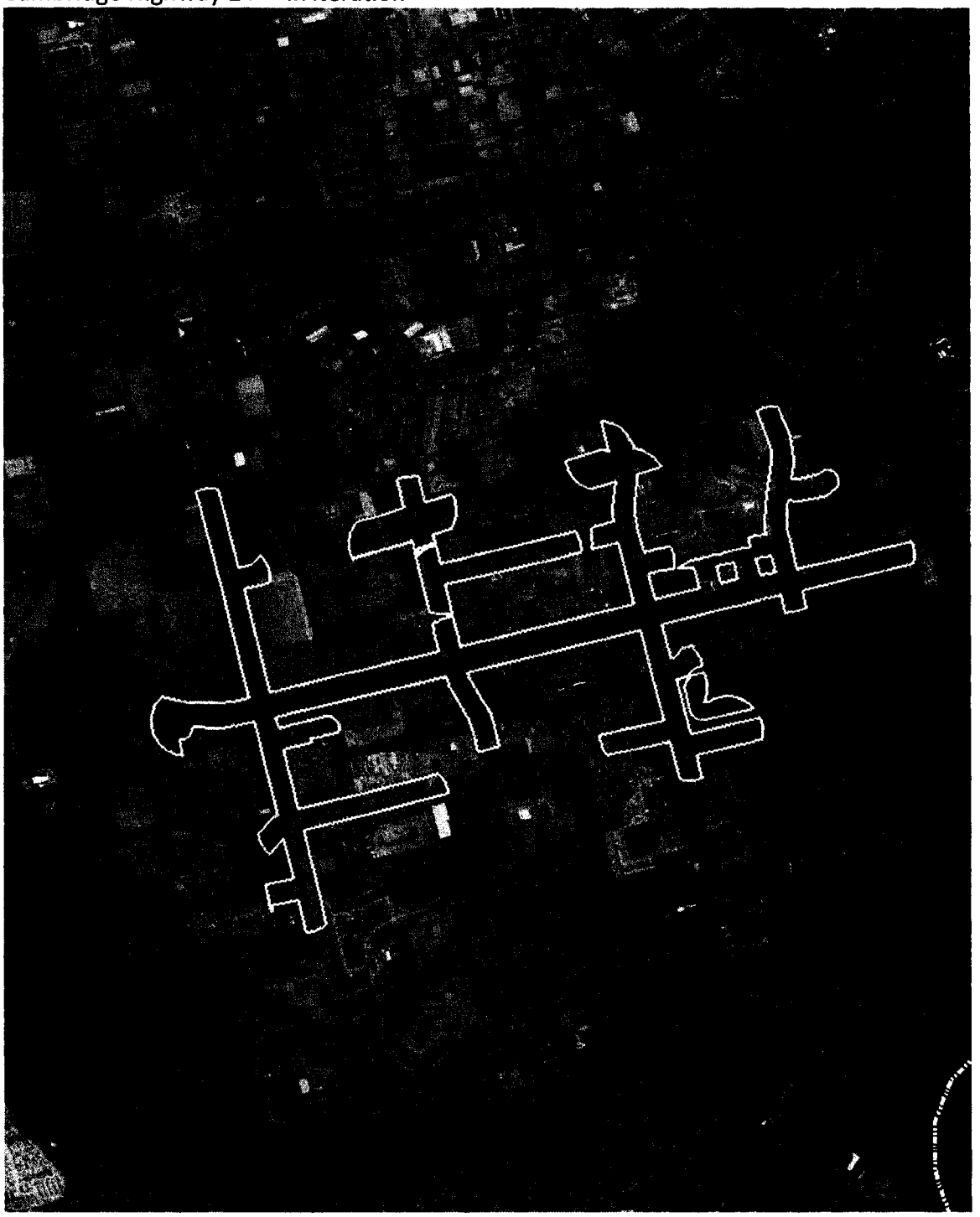
Cambridge Highway 24 – 2x Iteration



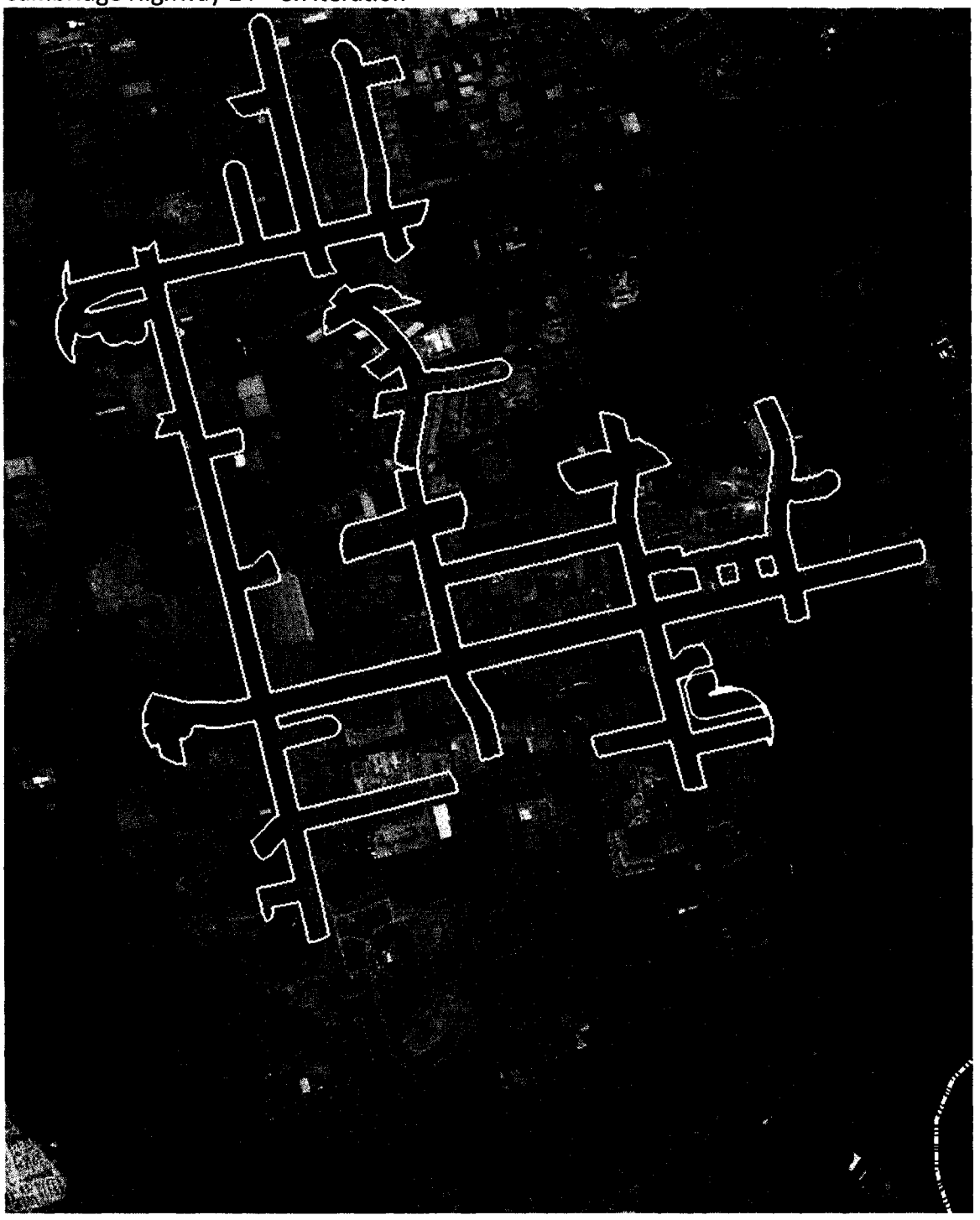
Cambridge Highway 24 – 3x Iteration



Cambridge Highway 24 – 4x Iteration



Cambridge Highway 24 – 5x Iteration



A.3 Ottawa CMA

Ottawa Central Business District – Land Use Defined Boundaries

Ottawa Central Business District – Average Iteration

Ottawa Central Business District – 1x Iteration

Ottawa Central Business District – 2x Iteration

Ottawa Central Business District – 3x Iteration

Ottawa Central Business District – 4x Iteration

Ottawa Central Business District – 5x Iteration

Bank Street (Glebe) – Land Use Defined Boundaries

Bank Street (Glebe) – Average Iteration

Bank Street (Glebe) – 1x Iteration

Bank Street (Glebe) – 2x Iteration

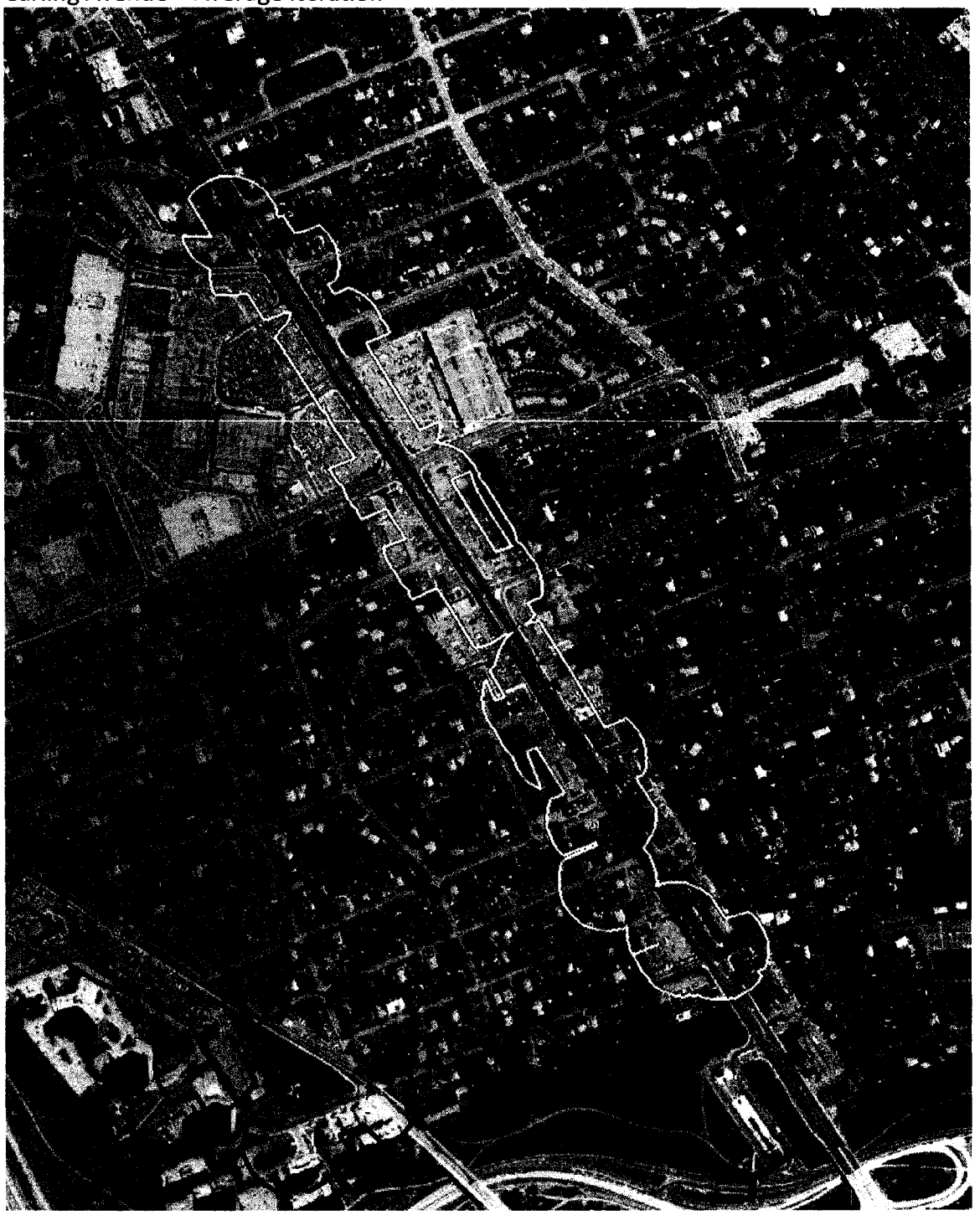
Bank Street (Glebe) – 3x Iteration

Bank Street (Glebe) – 4x Iteration

Bank Street (Glebe) – 5x Iteration

Carling Avenue – Land Use Defined Boundaries

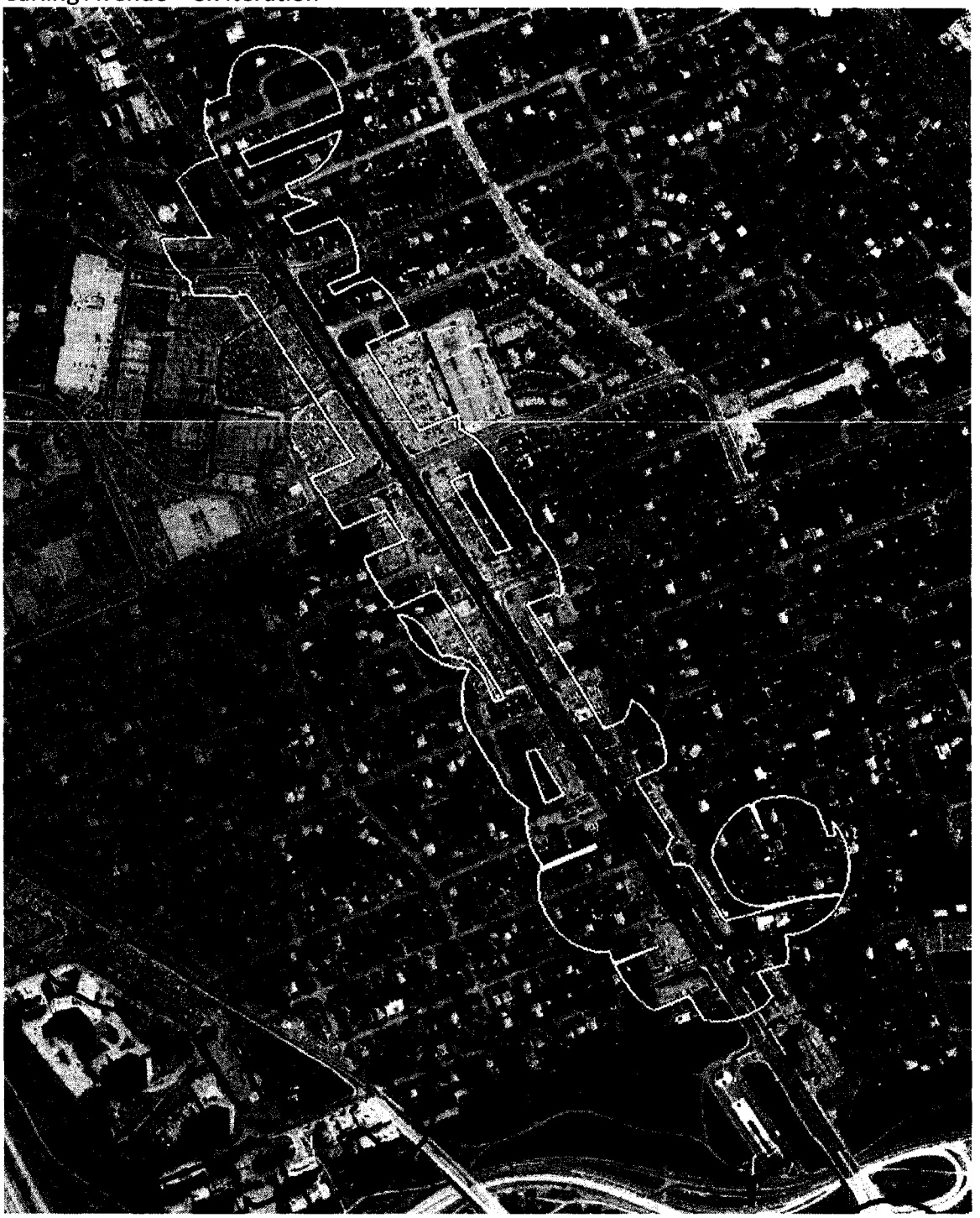
Carling Avenue – Average Iteration



Carling Avenue – 1x Iteration

Carling Avenue – 2x Iteration

Carling Avenue – 3x Iteration

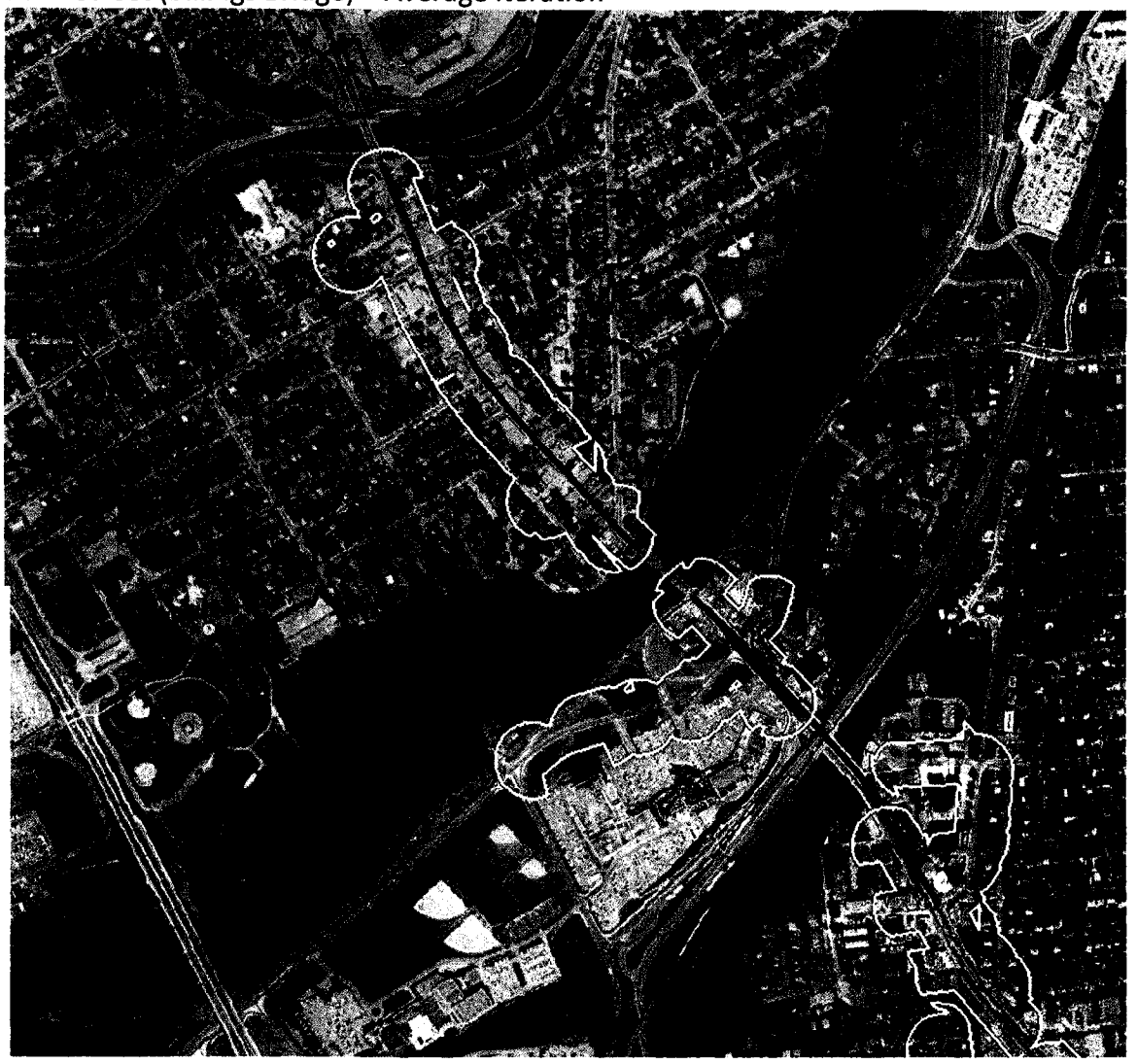


Carling Avenue – 4x Iteration

Carling Avenue – 5x Iteration

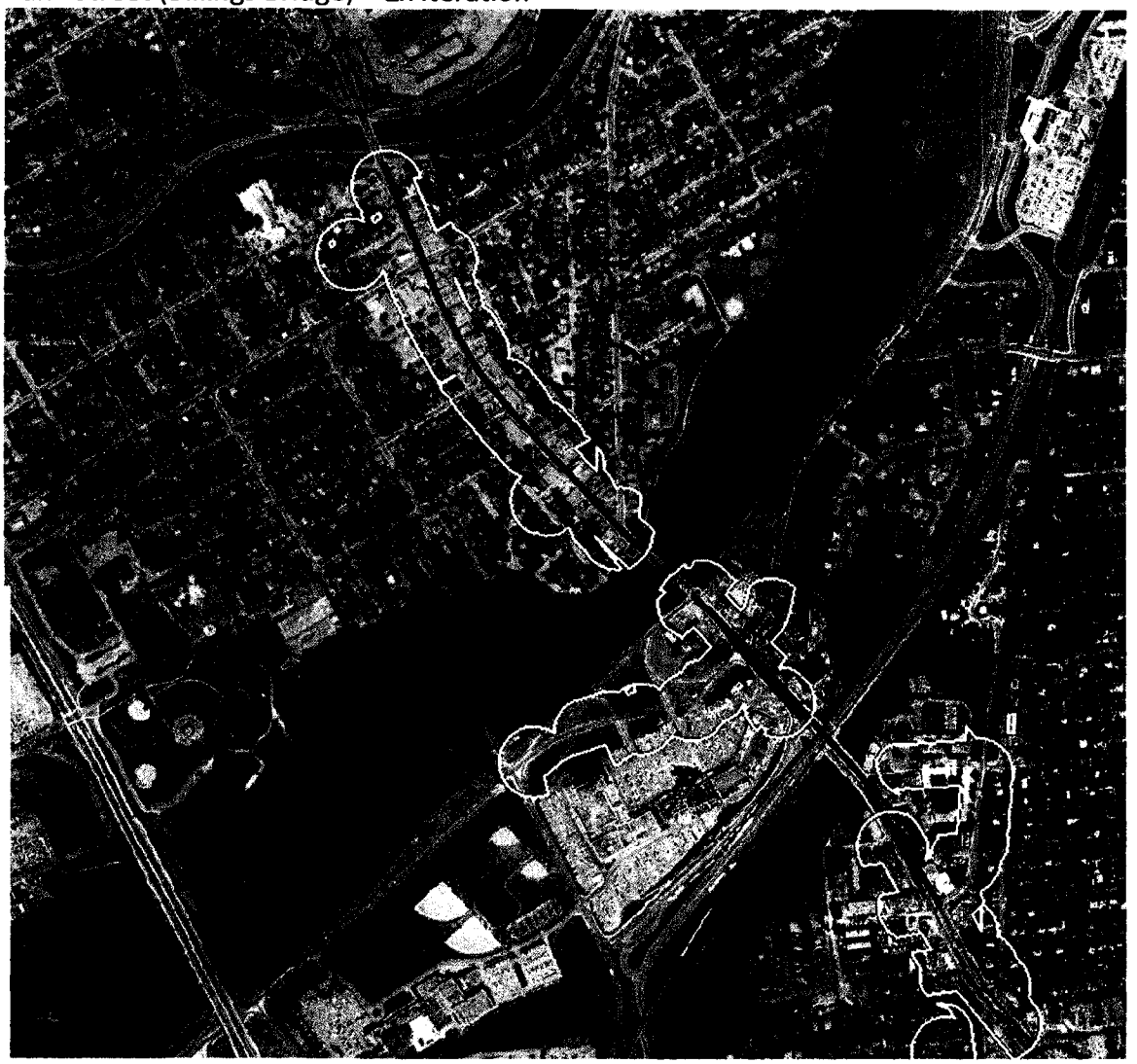
Bank Street (Billings Bridge) – Land Use Defined Boundaries (North is ↑)

Bank Street (Billings Bridge) – Average Iteration

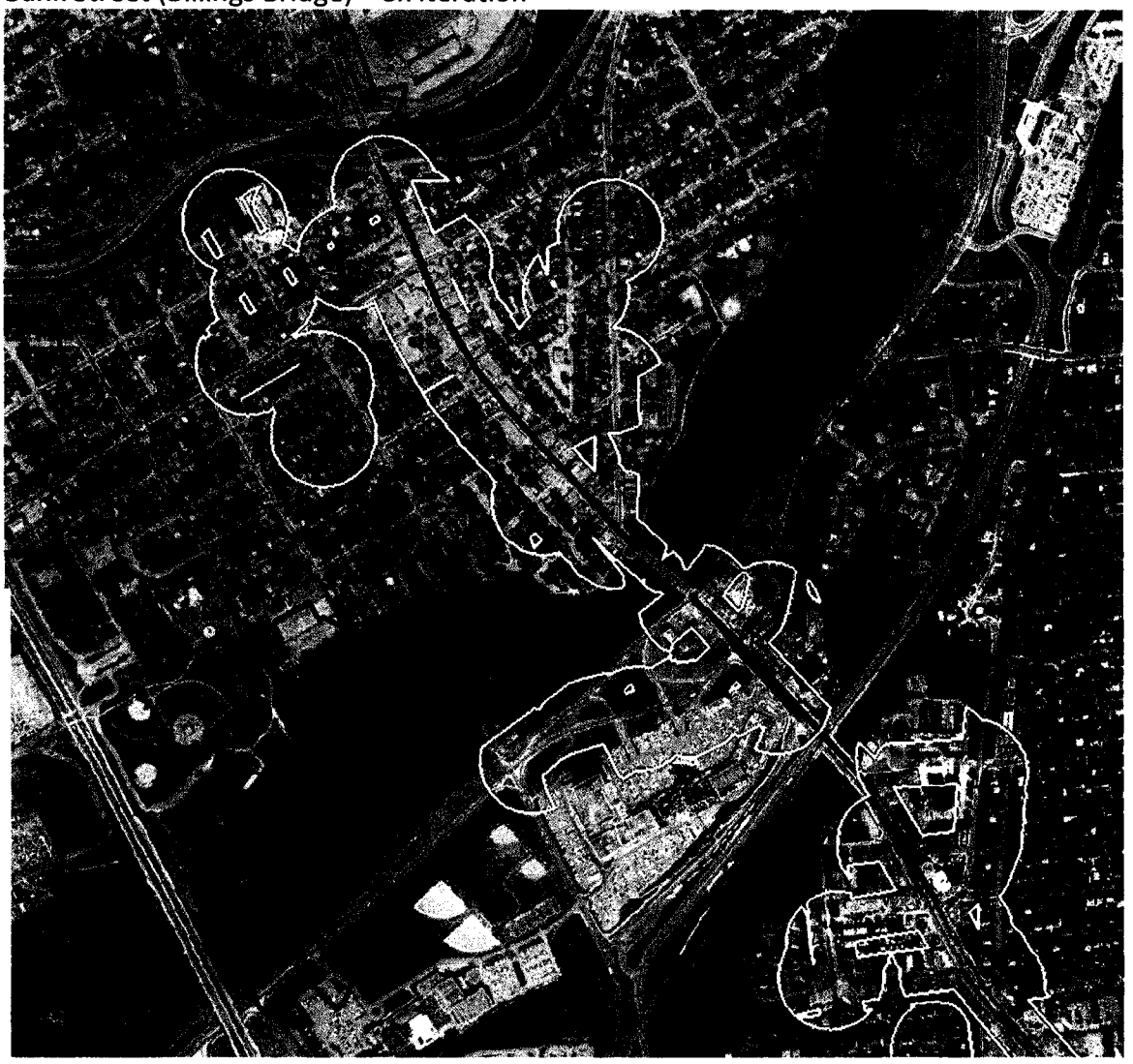


Bank Street (Billings Bridge) – 1x Iteration

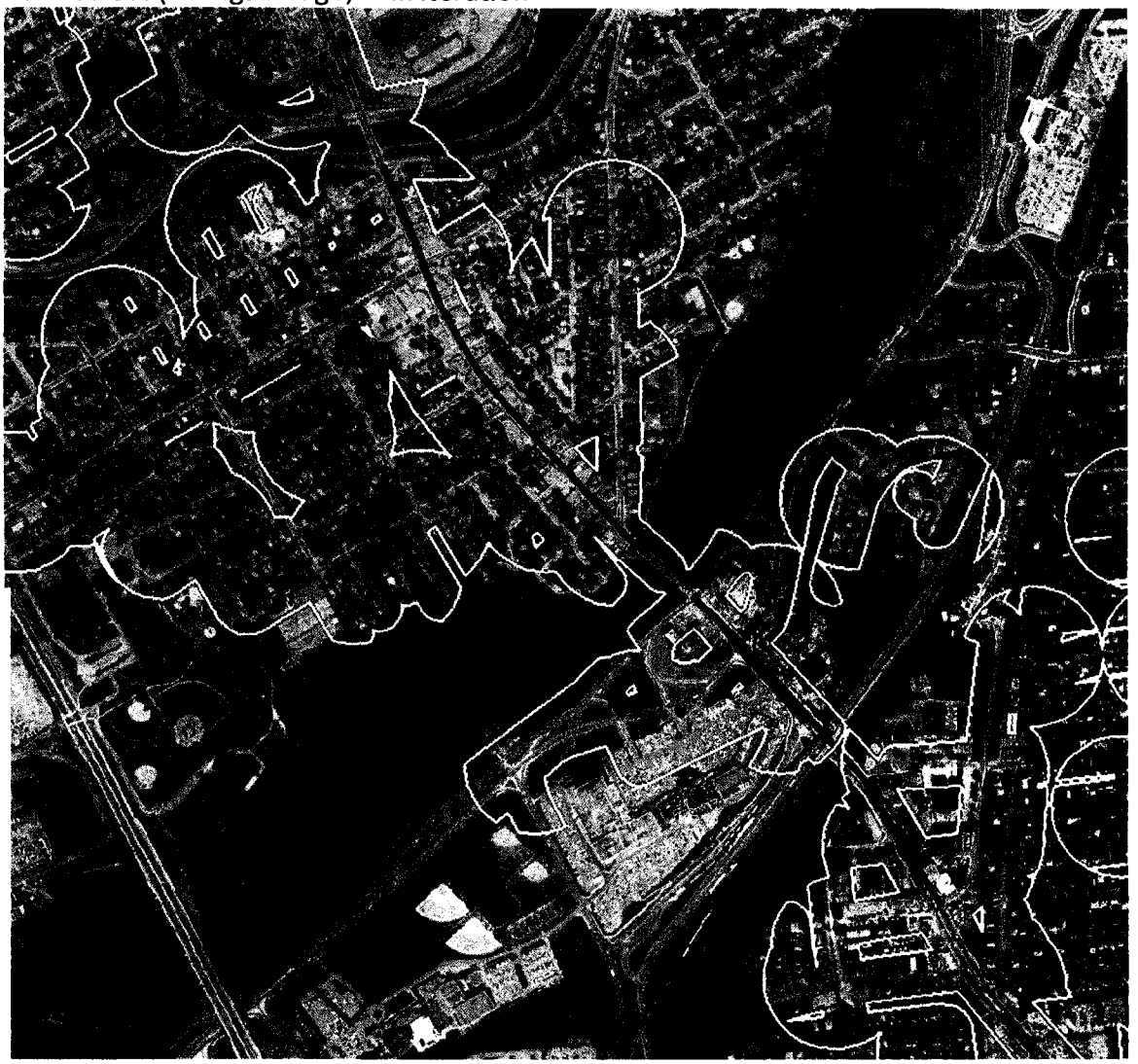
Bank Street (Billings Bridge) – 2x Iteration



Bank Street (Billings Bridge) – 3x Iteration

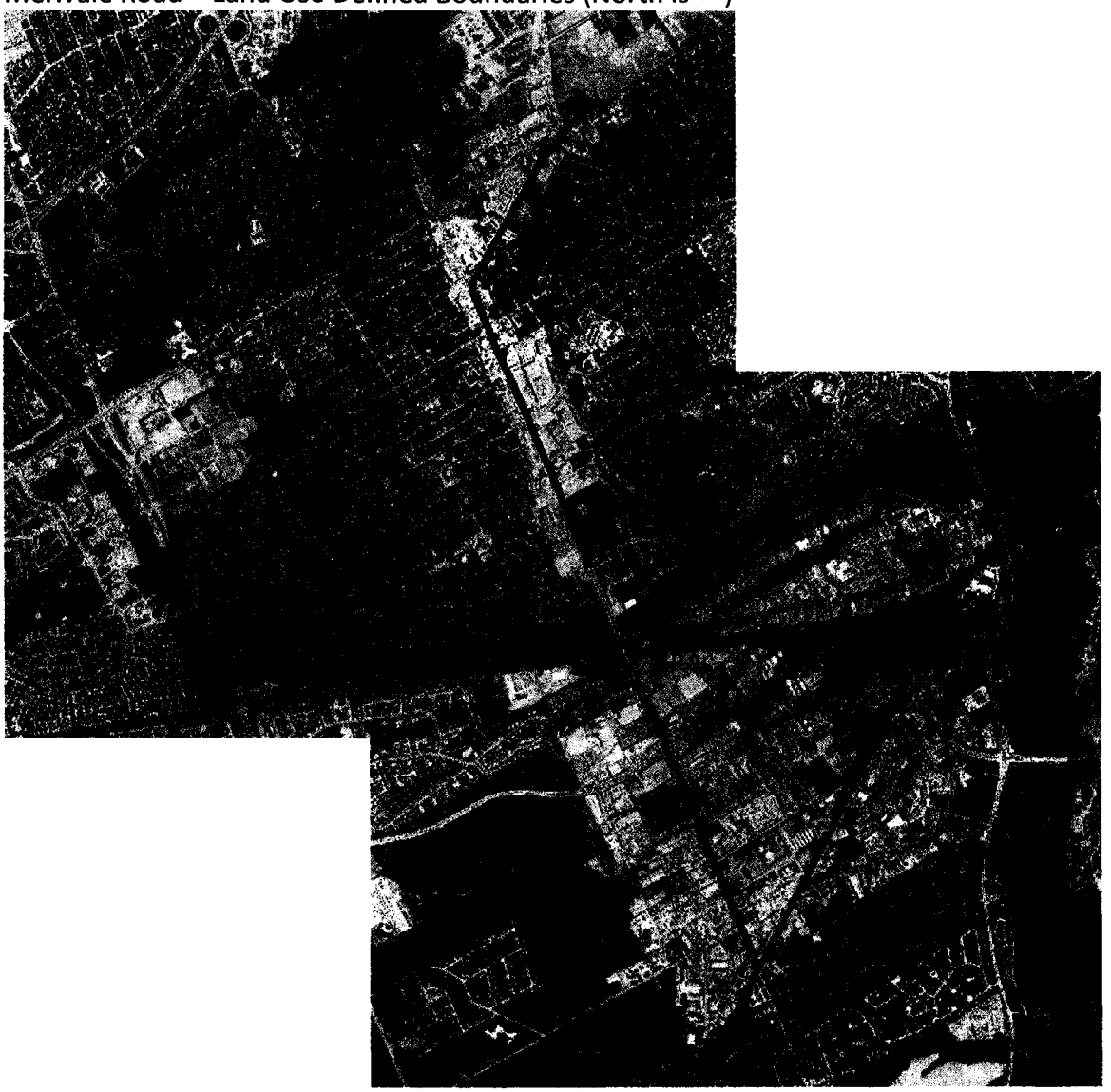


Bank Street (Billings Bridge) – 4x Iteration

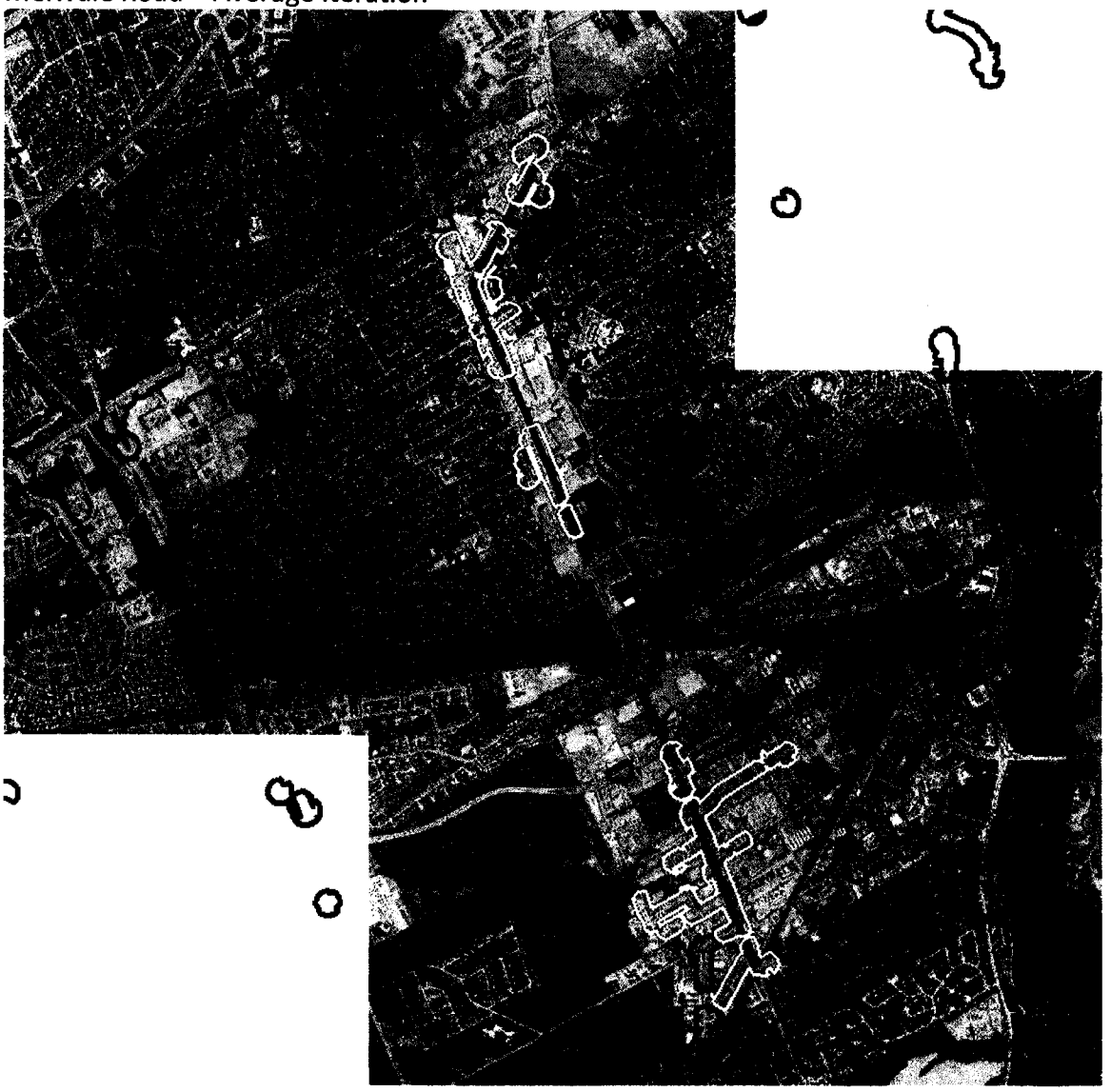


Bank Street (Billings Bridge) – 5x Iteration

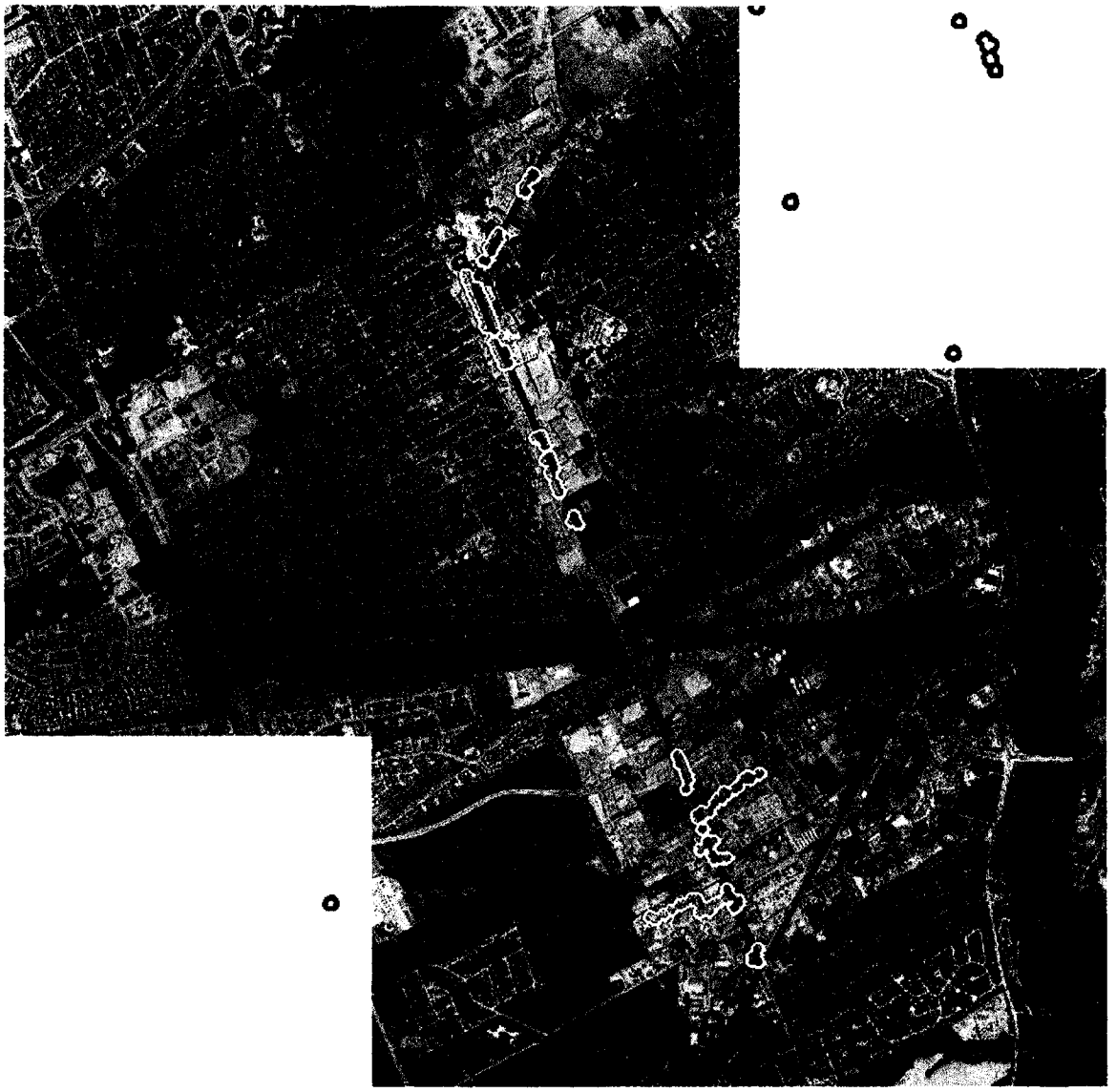
Merivale Road – Land Use Defined Boundaries (North is ↑)



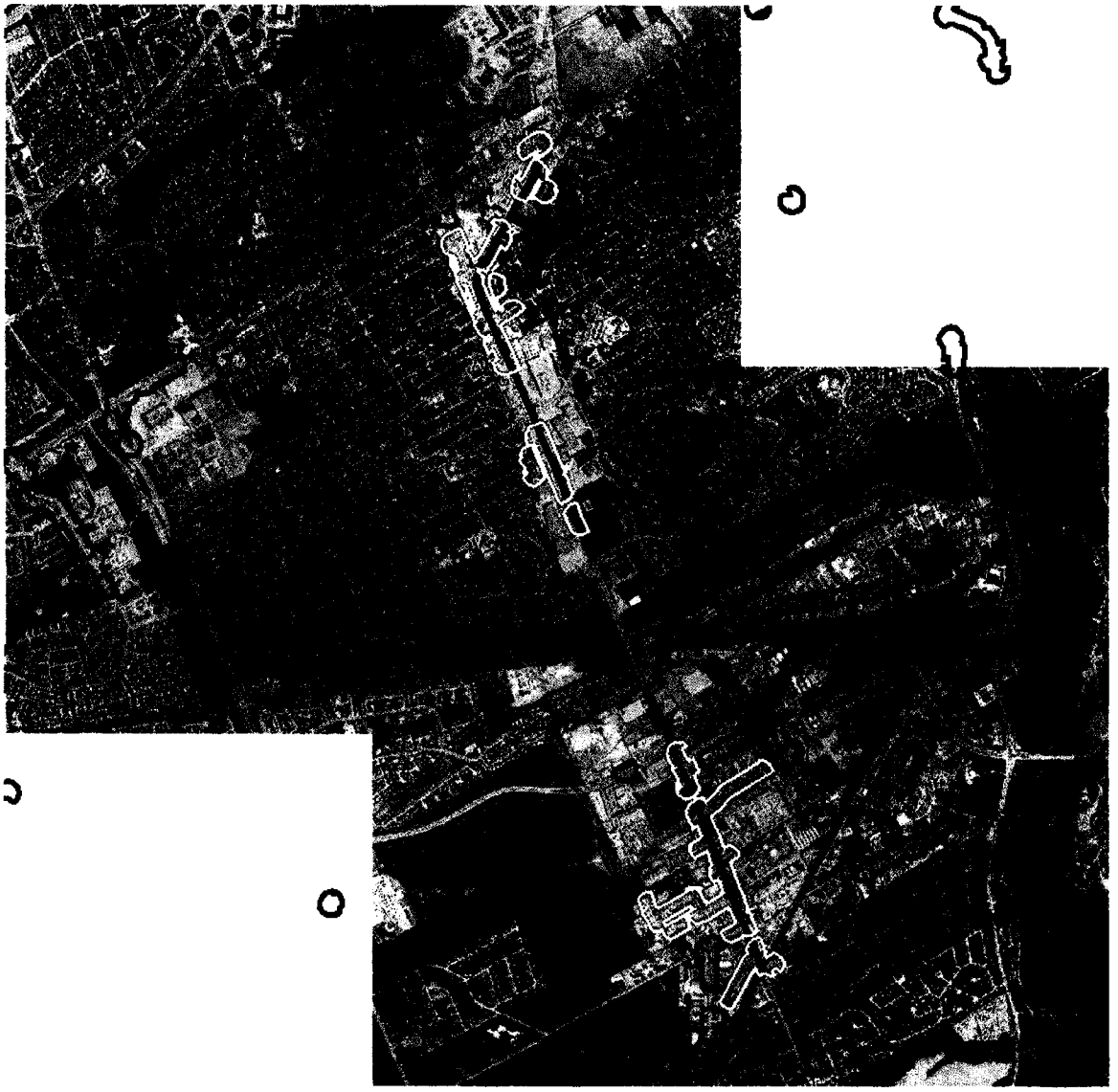
Merivale Road – Average Iteration



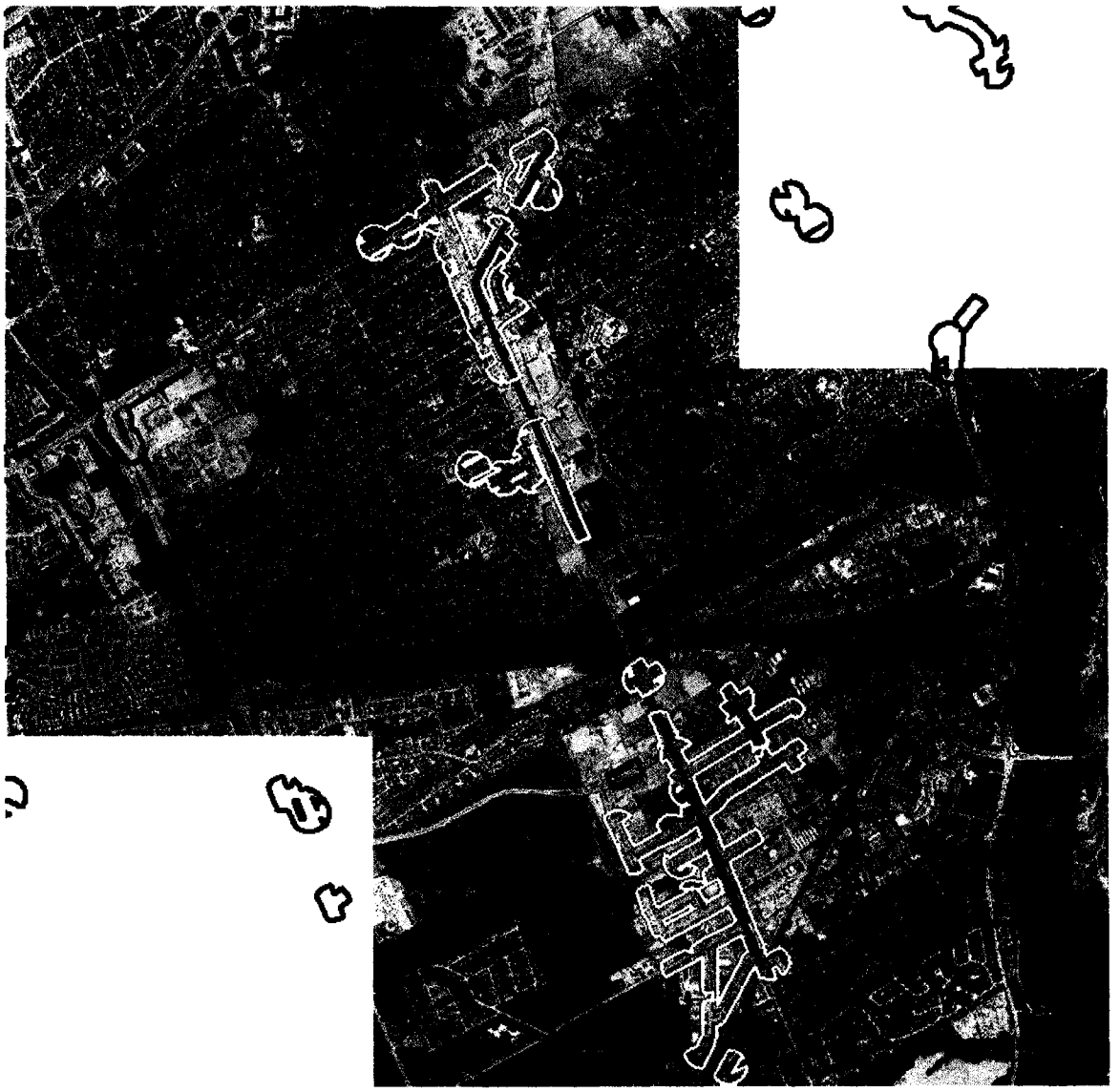
Merivale Road – 1x Iteration



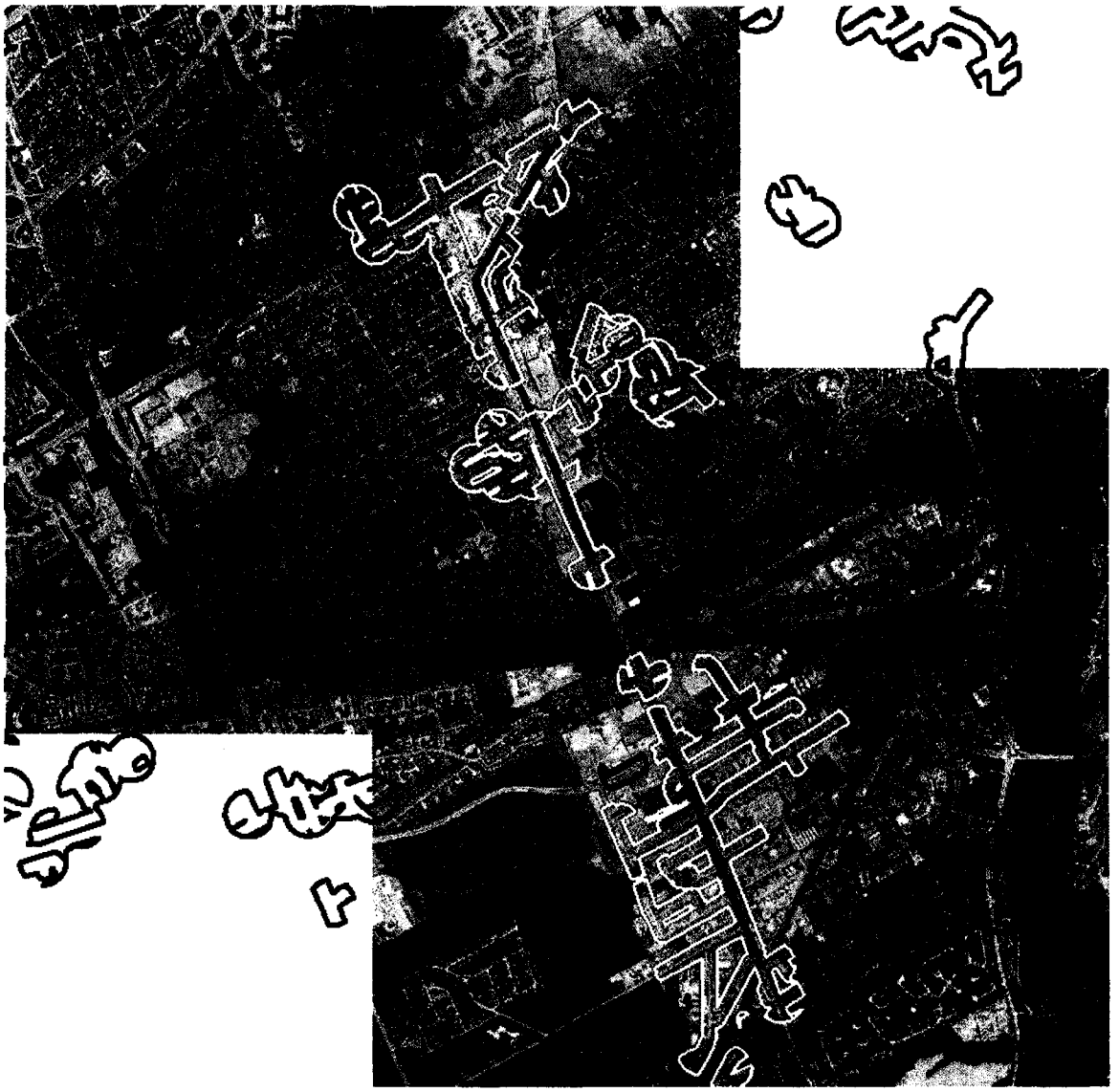
Merivale Road – 2x Iteration



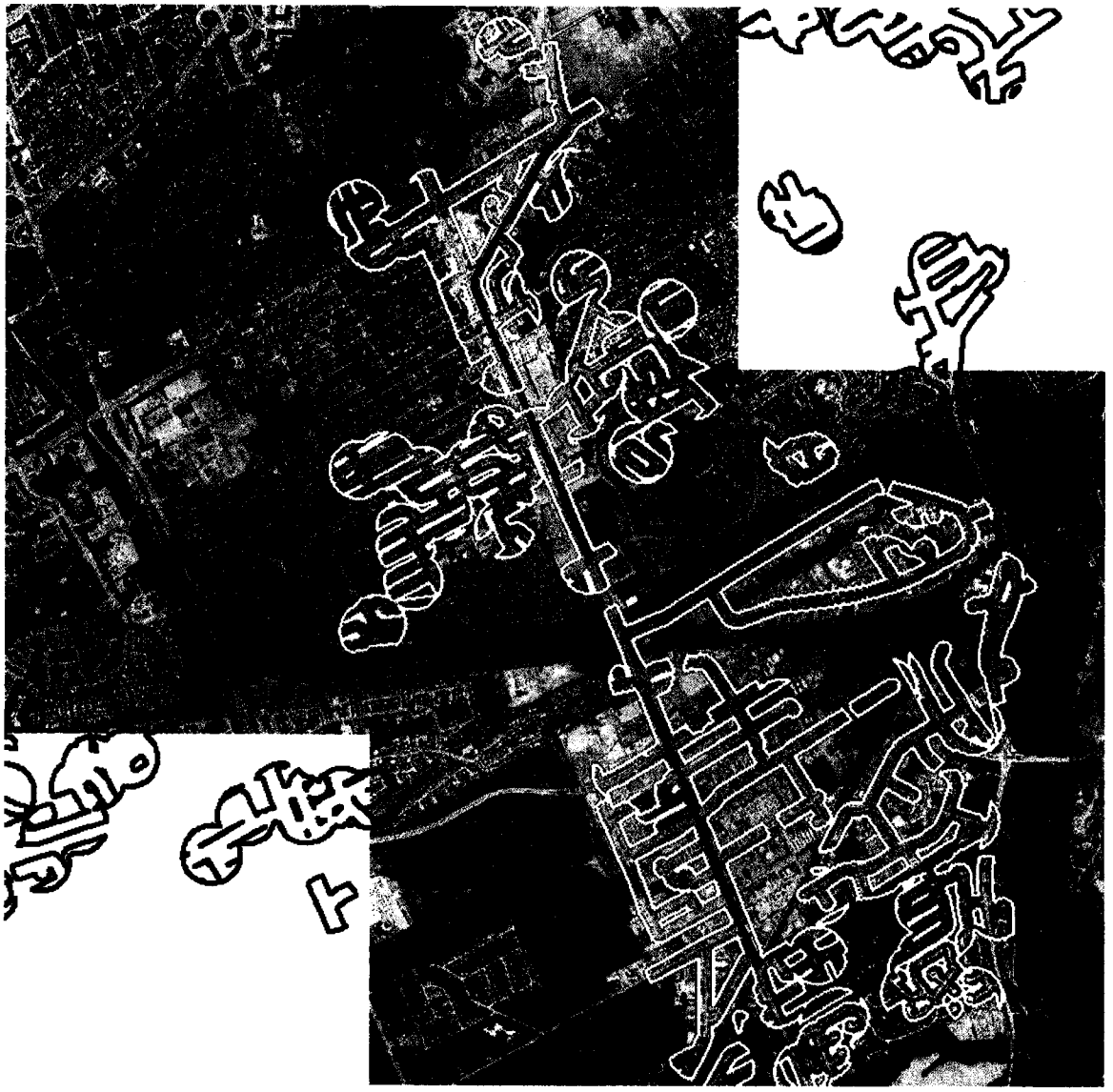
Merivale Road – 3x Iteration



Merivale Road – 4x Iteration



Merivale Road – 5x Iteration



Appendix B

Point + Fixed Entity Detection Maps

The following maps represent the generated polygons for the point only cluster detection for the three study areas with their specific areas of interest:

B1. Sudbury CMA
   a. CBD
   b. Four Corners

B2. Kitchener CMA
   a. Waterloo CBD
   b. Kitchener CBD
   c. Cambridge Hwy 24

B3. Ottawa CMA
   a. CBD and Inner City
   b. Bank Street (Glebe)
   c. Carling Avenue
   d. Bank Street (Billings Bridge)
   e. Merivale Road

Each area of interest contains five maps: The "Original", The Average Iteration, and the 1-3x Iterations. All maps are orientated with North on the left side of the page unless otherwise stated.

The legend for all maps is as follows:

RED (dots)	"Original" Area
	Detected Area
BLACK	Detected Areas Outside of Area of Interest

B.1 Sudbury CMA

Sudbury Central Business District – Land Use Defined Boundaries

Sudbury Central Business District – Average Iteration

Sudbury Central Business District – 1x Iteration

Sudbury Central Business District – 2x Iteration

Sudbury Central Business District – 3x Iteration

Four Corners – Land Use Defined Boundaries

Four Corners – Average Iteration

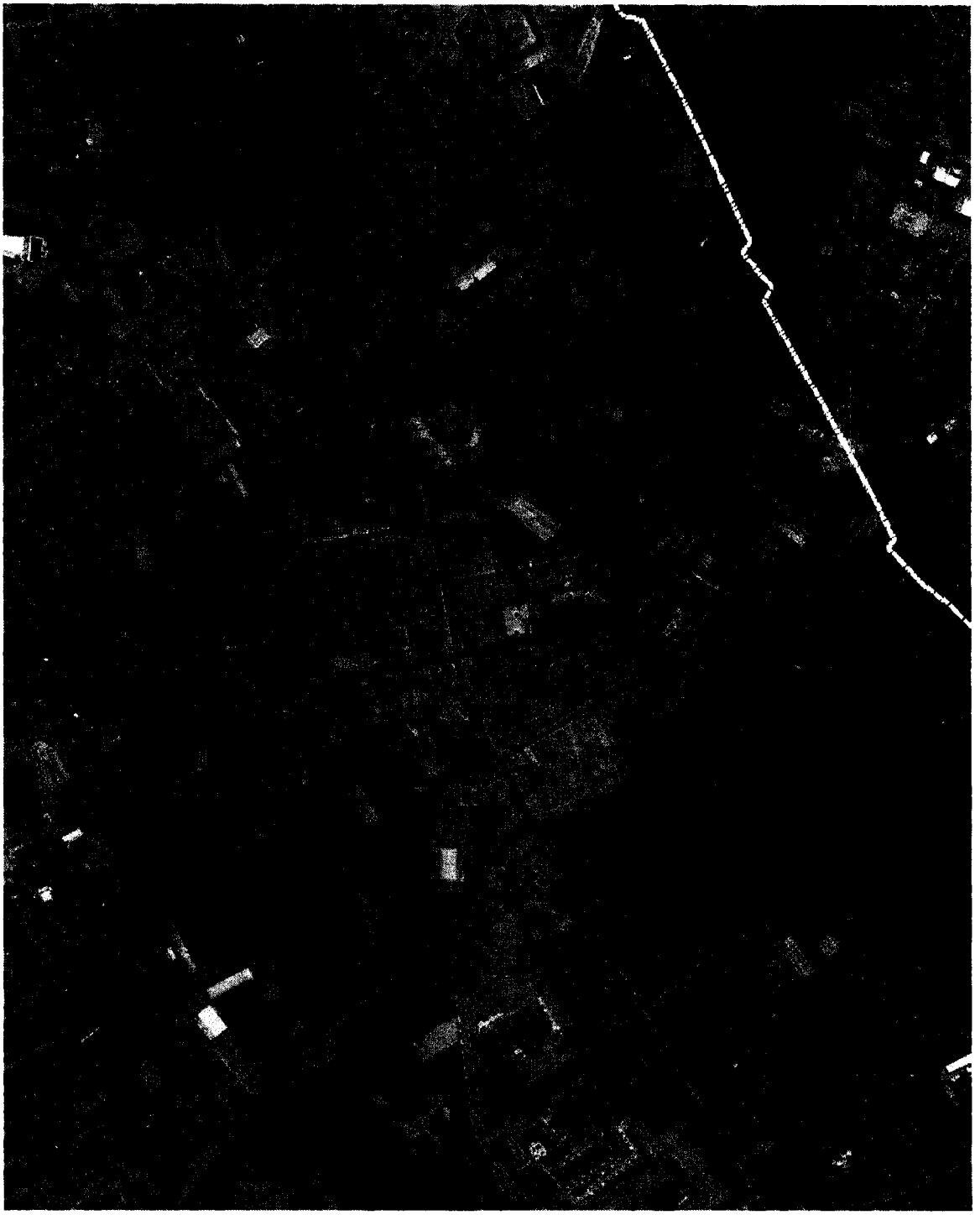
Four Corners – 1x Iteration

Four Corners – 2x Iteration

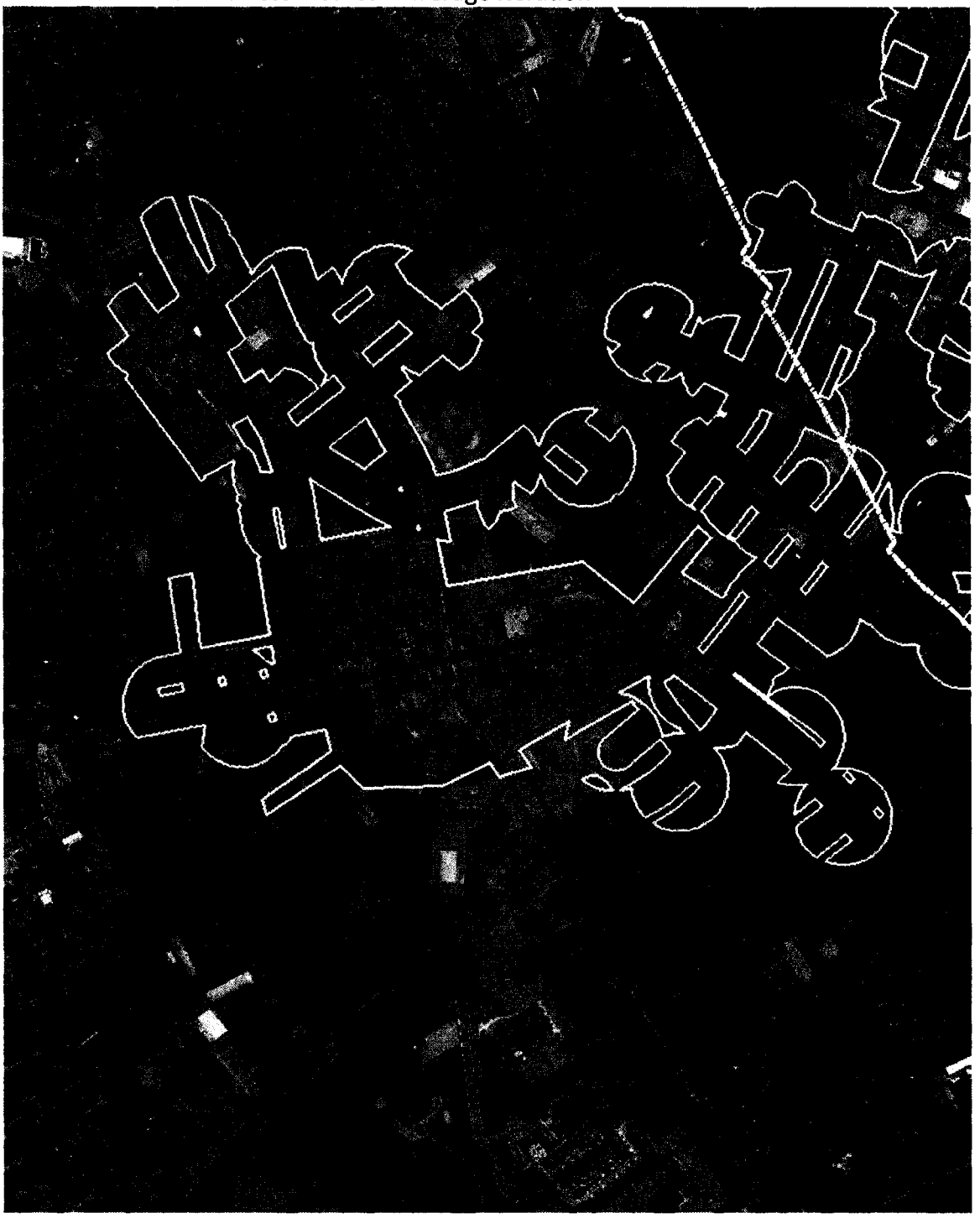
Four Corners – 3x Iteration

B.2 Kitchener CMA

Waterloo Central Business District – Land Use Defined Boundaries

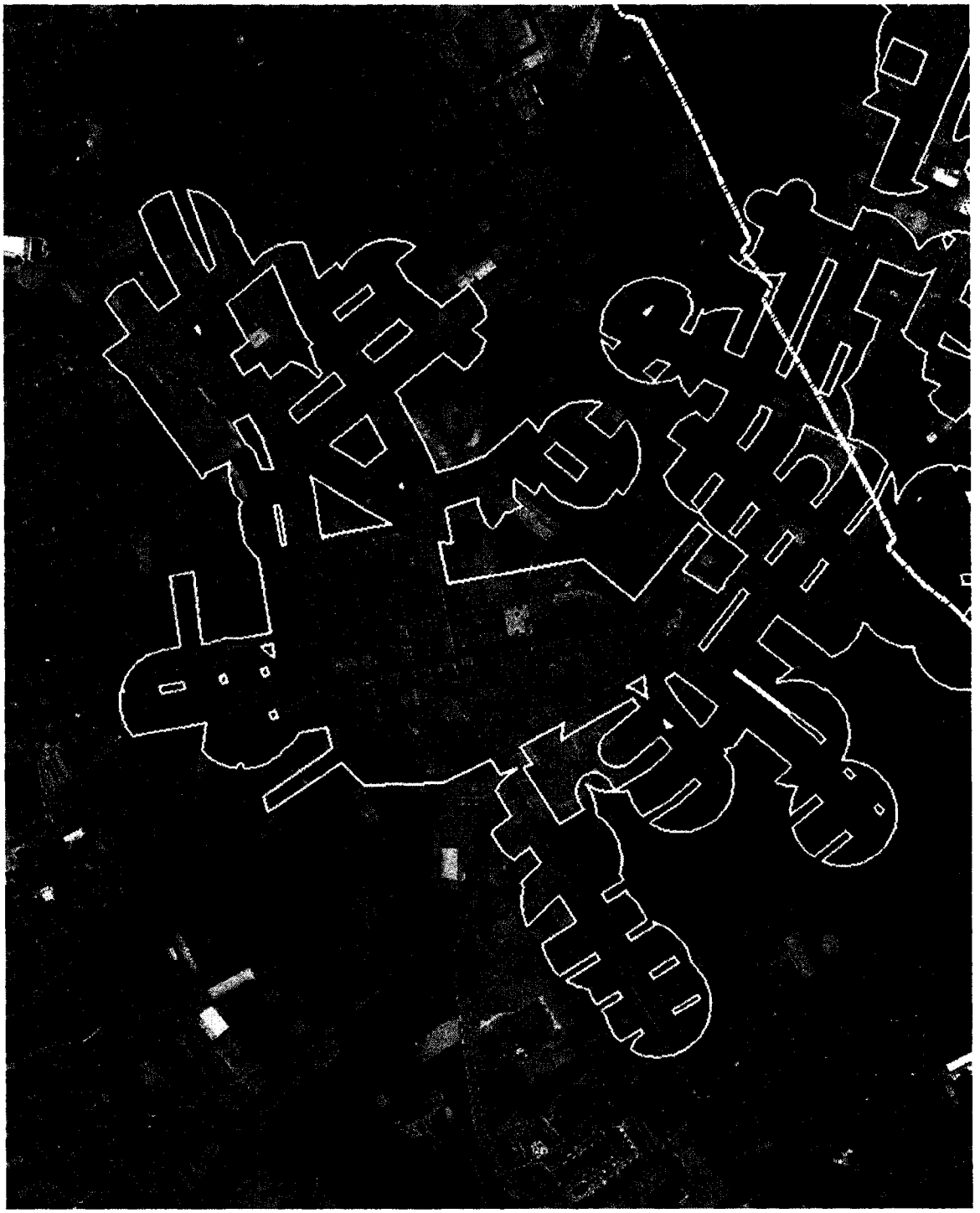


Waterloo Central Business District – Average Iteration



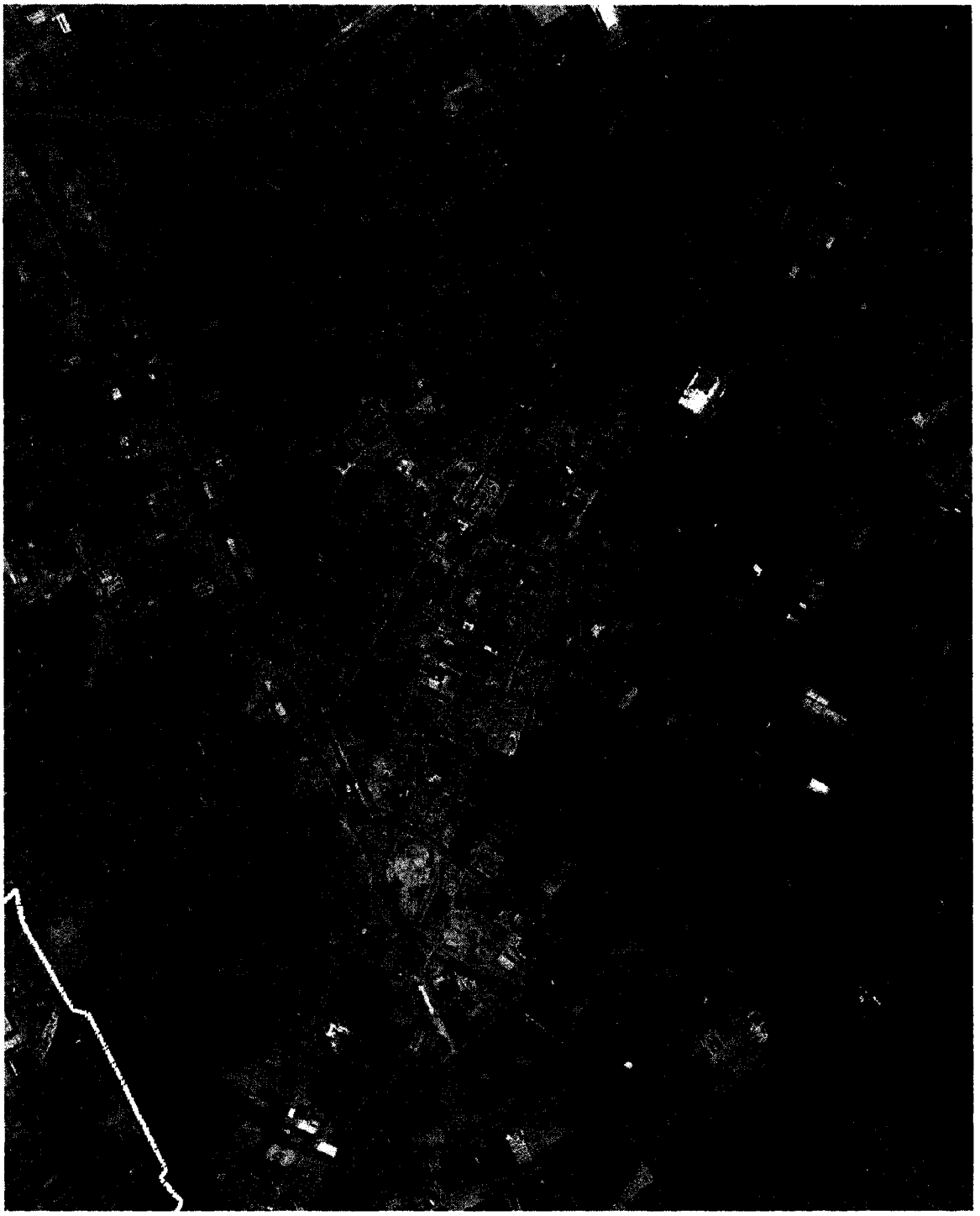
Waterloo Central Business District – 1x Iteration

Waterloo Central Business District – 2x Iteration



Waterloo Central Business District – 3x Iteration

Kitchener Central Business District – Land Use Defined Boundaries

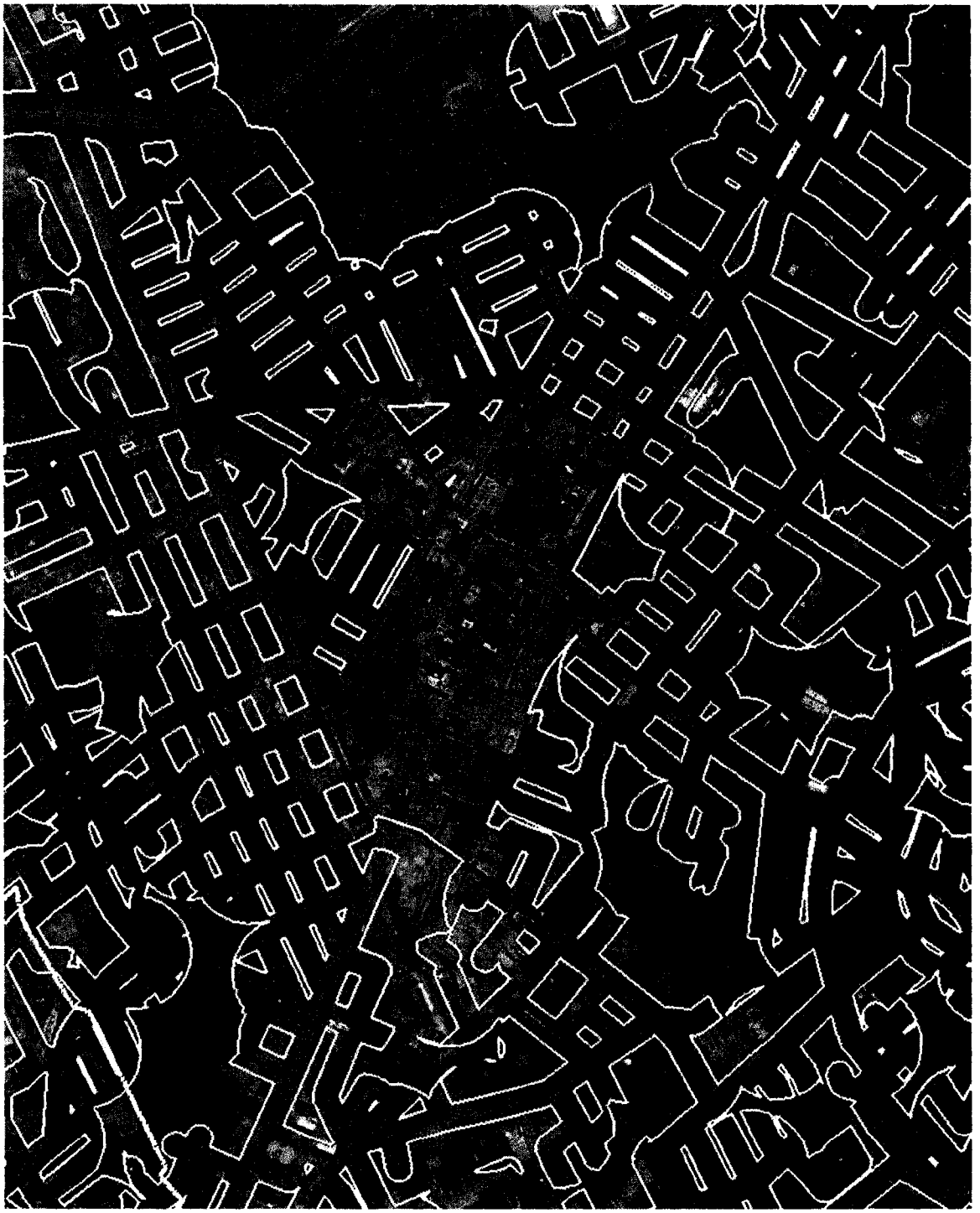


Kitchener Central Business District – Average Iteration

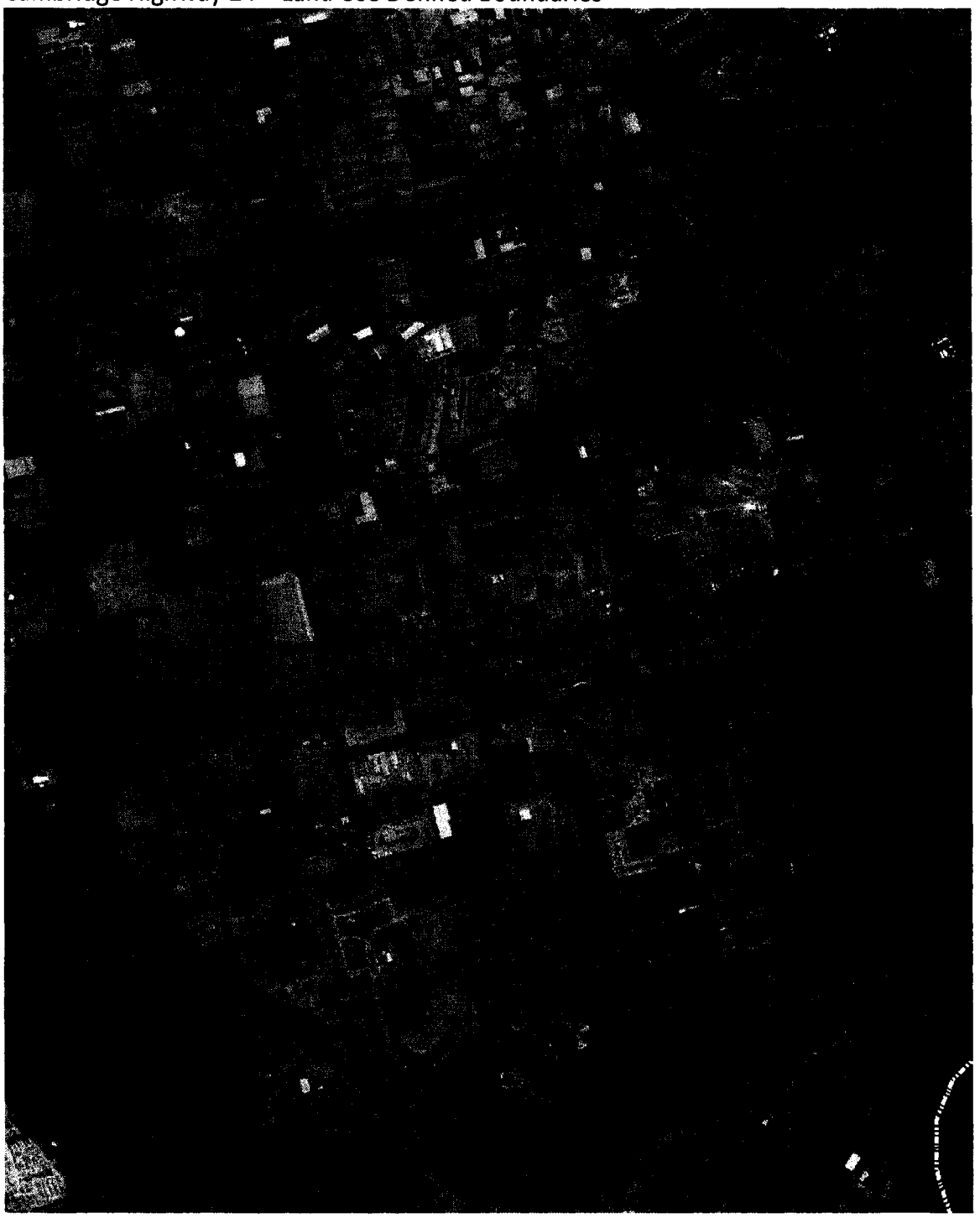
Kitchener Central Business District – 1x Iteration

Kitchener Central Business District – 2x Iteration

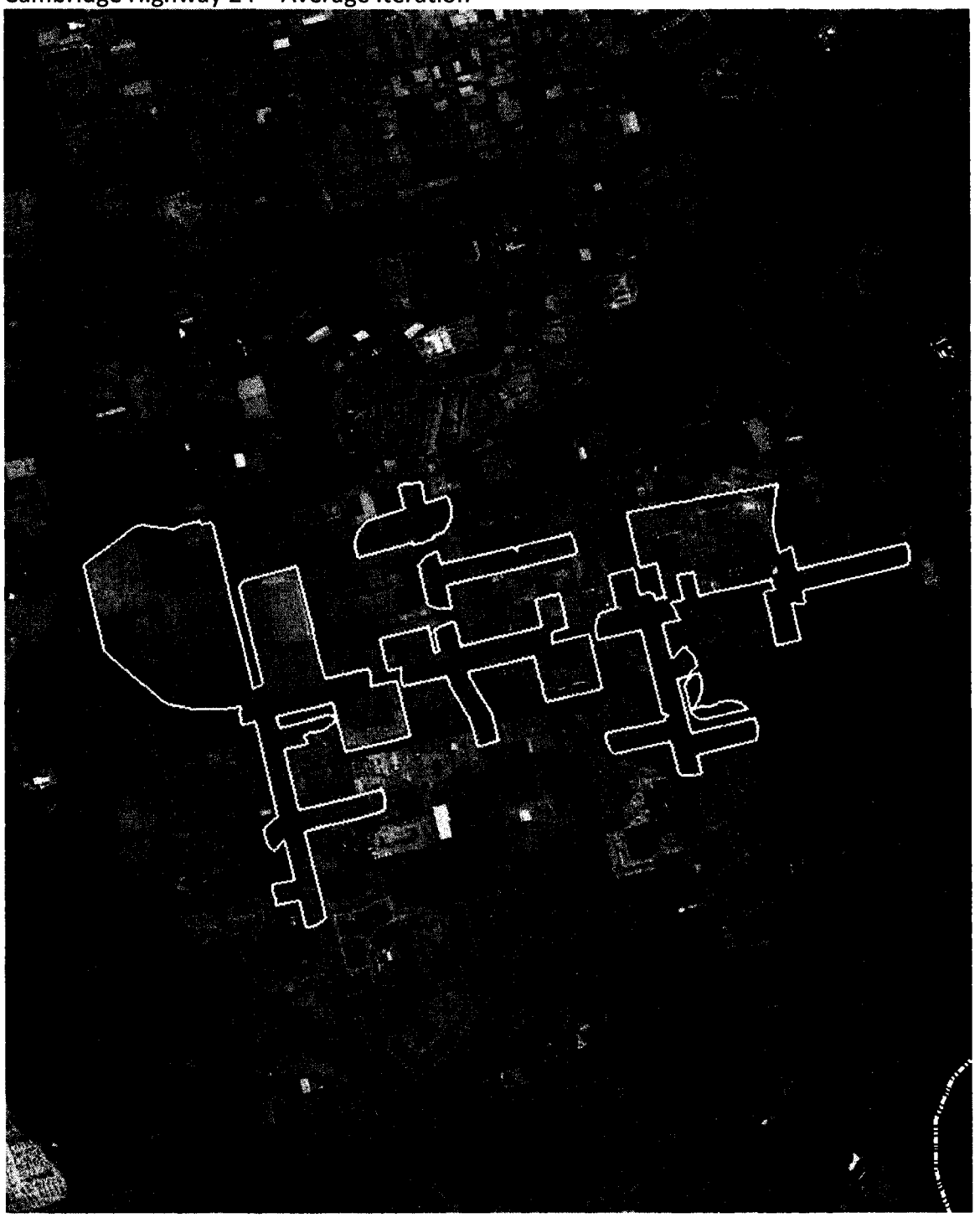
Kitchener Central Business District – 3x Iteration



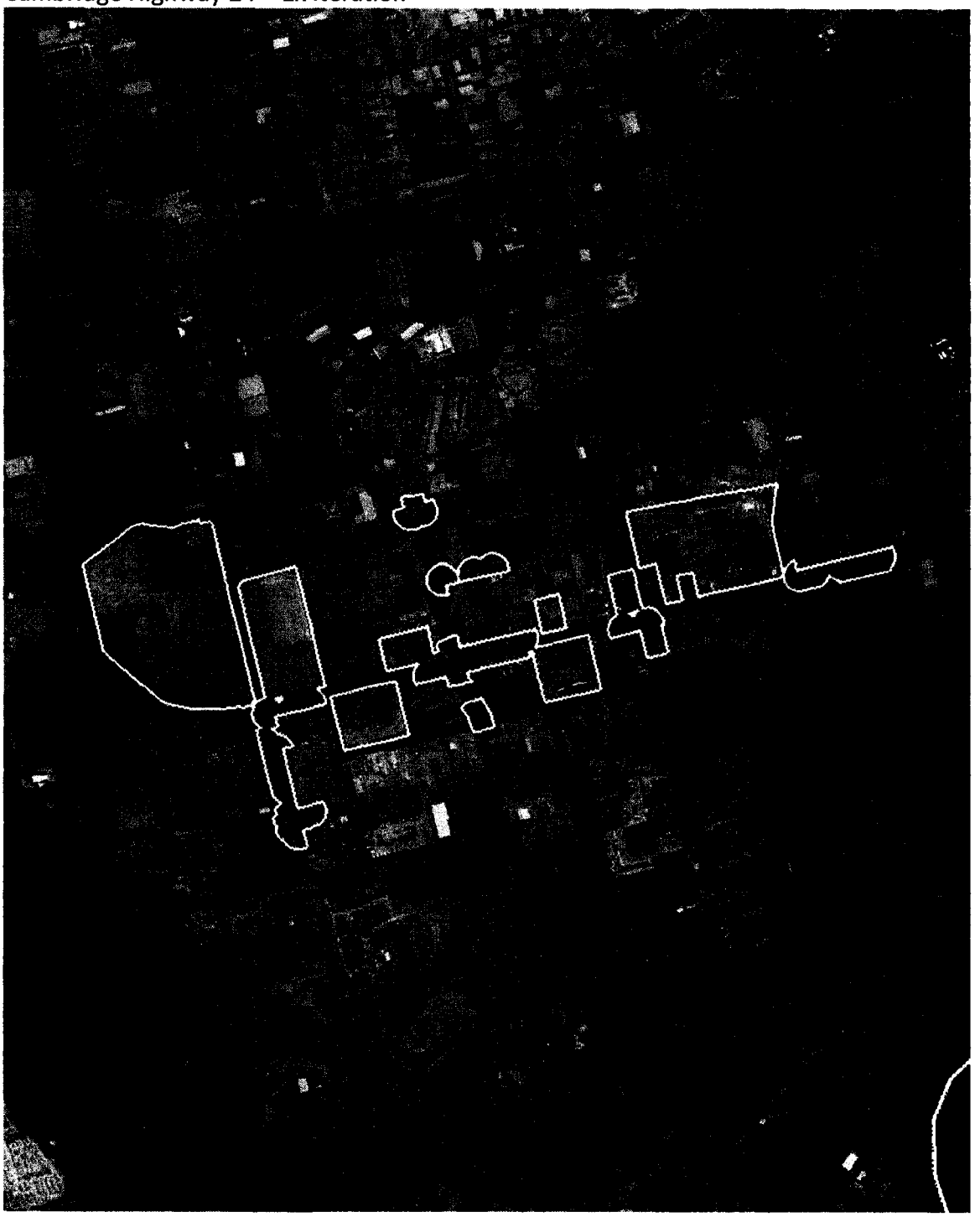
Cambridge Highway 24 – Land Use Defined Boundaries



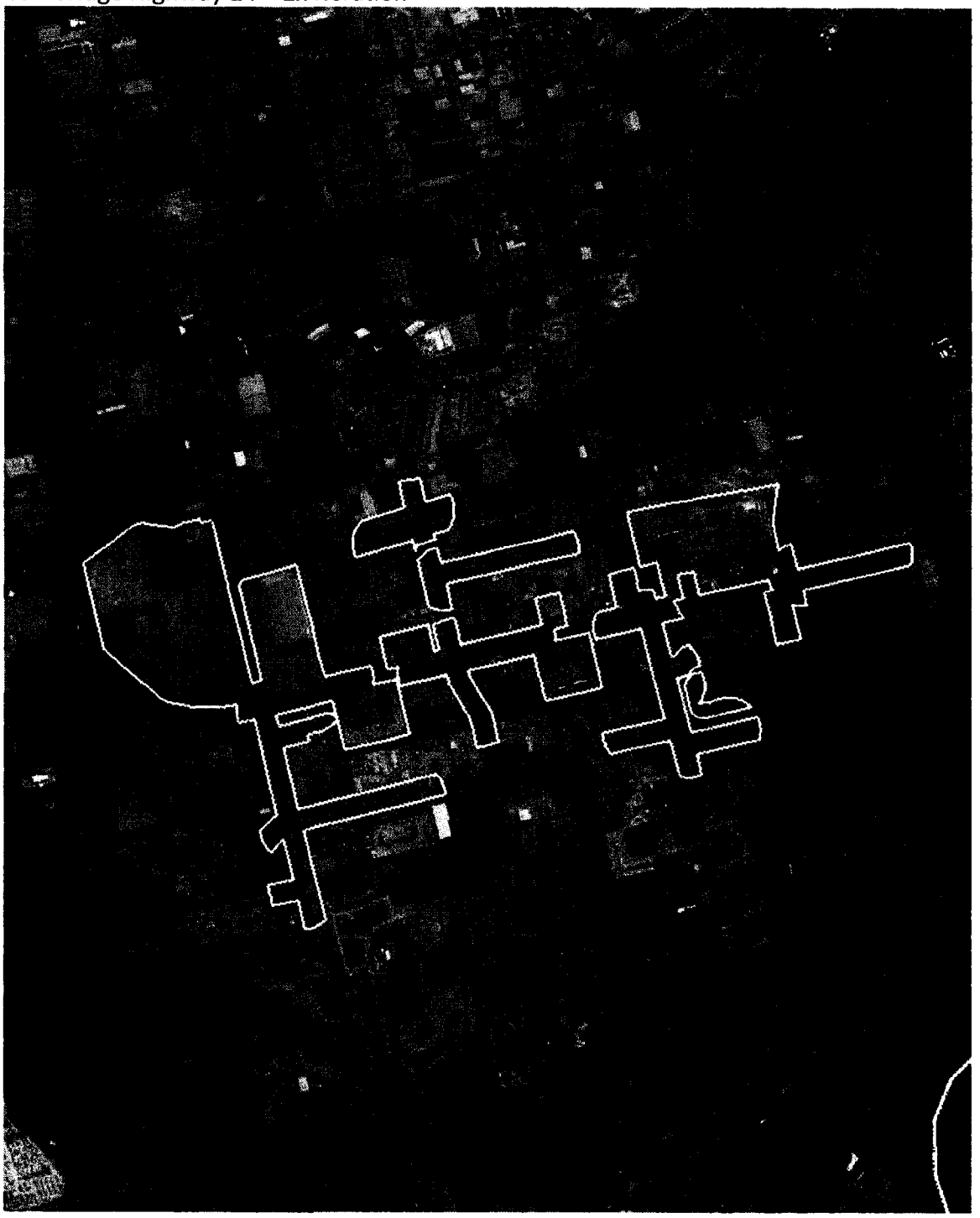
Cambridge Highway 24 – Average Iteration



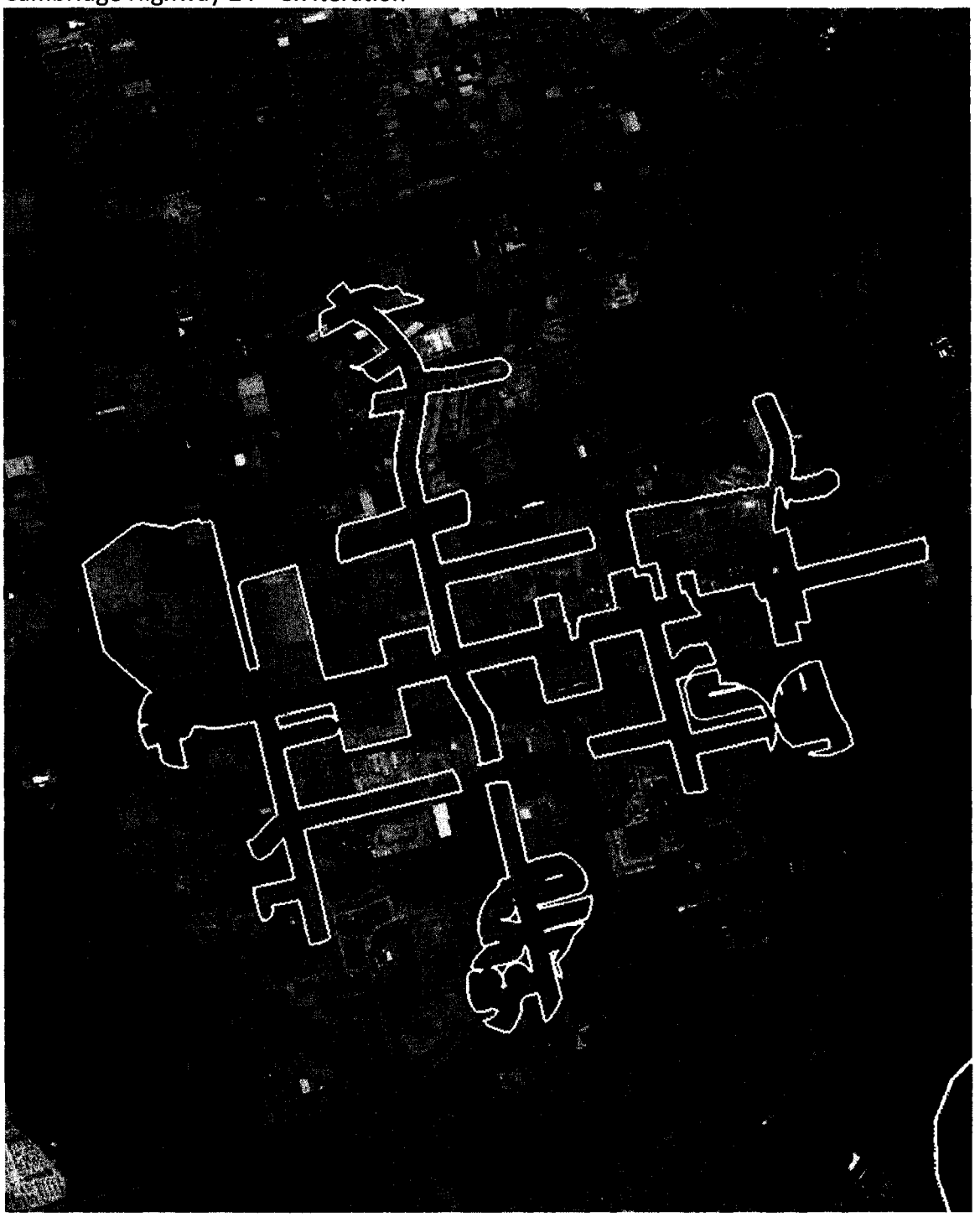
Cambridge Highway 24 – 1x Iteration



Cambridge Highway 24 – 2x Iteration



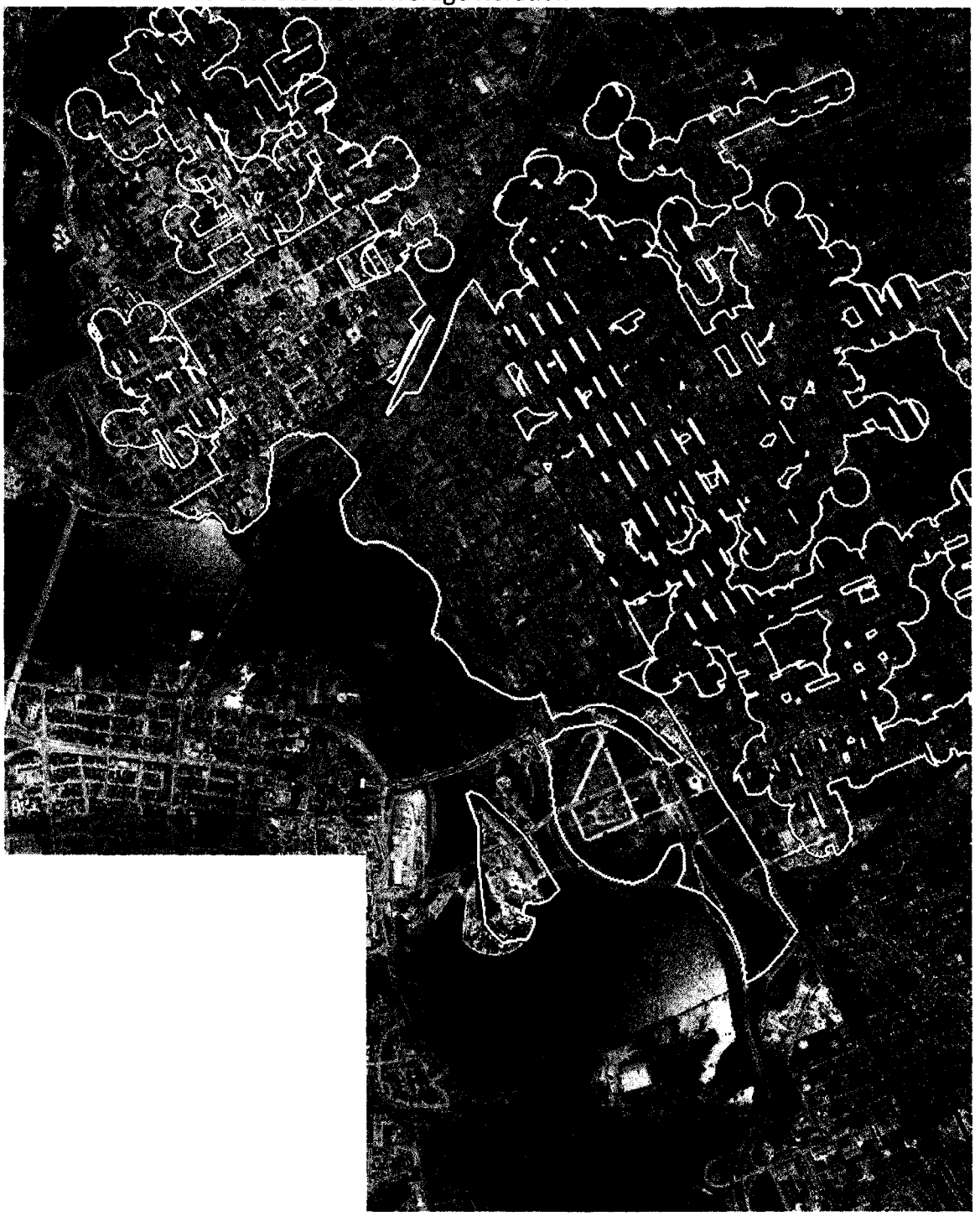
Cambridge Highway 24 – 3x Iteration



B.3 Ottawa CMA

Ottawa Central Business District – Land Use Defined Boundaries

Ottawa Central Business District – Average Iteration



Ottawa Central Business District – 1x Iteration

Ottawa Central Business District – 2x Iteration

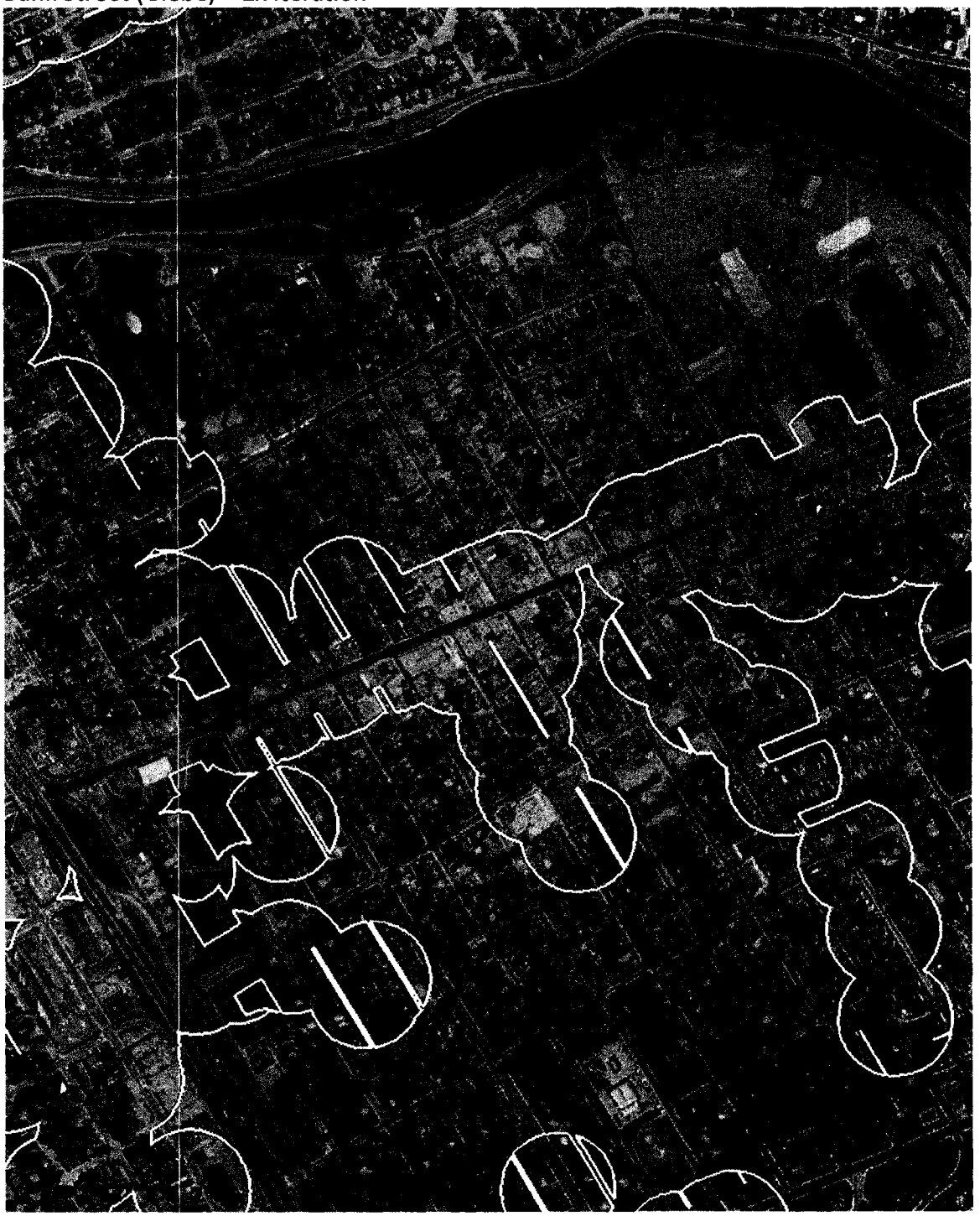
Ottawa Central Business District – 3x Iteration

Bank Street (Glebe) – Land Use Defined Boundaries

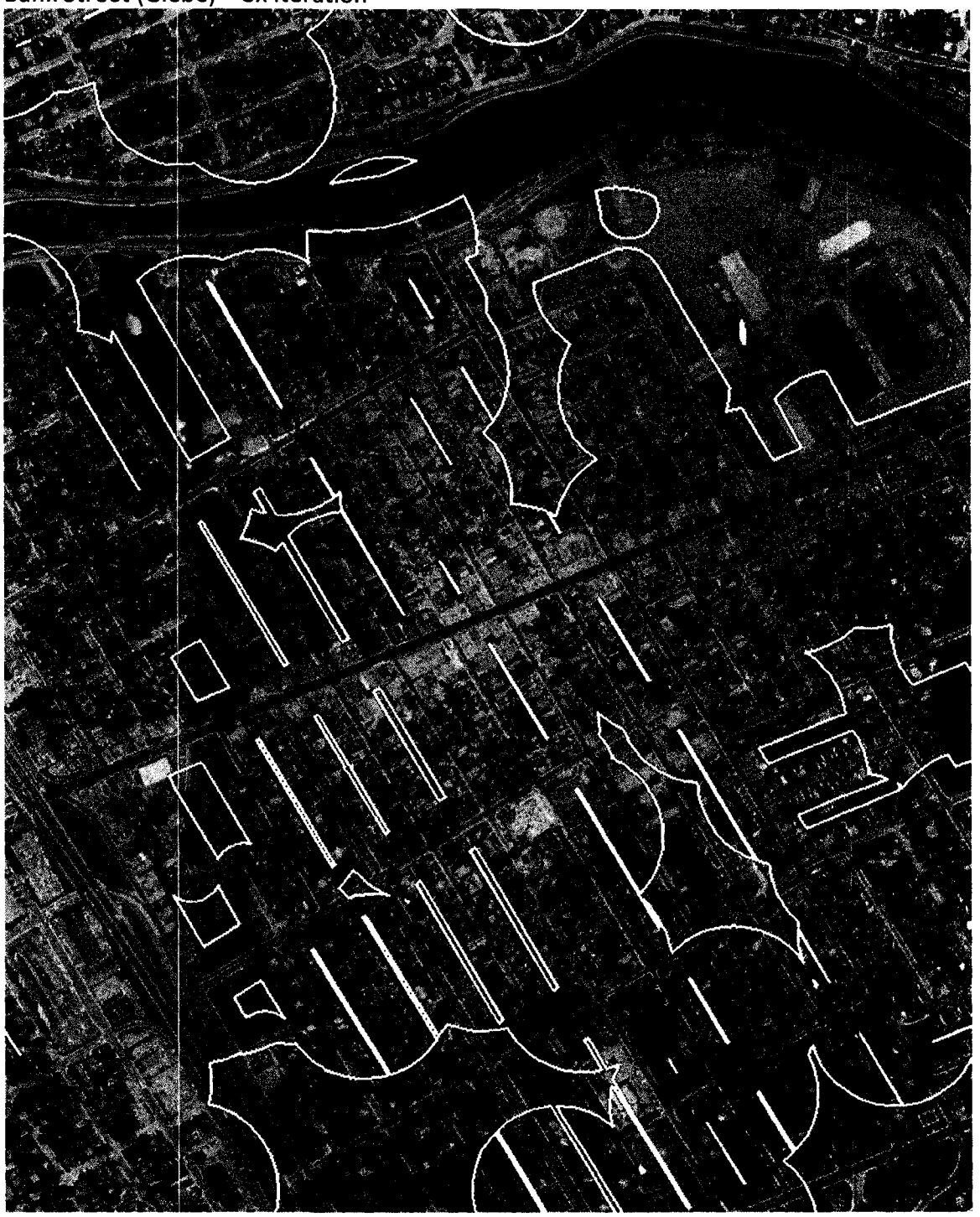
Bank Street (Glebe) –Average Iteration

Bank Street (Glebe) – 1x Iteration

Bank Street (Glebe) – 2x Iteration

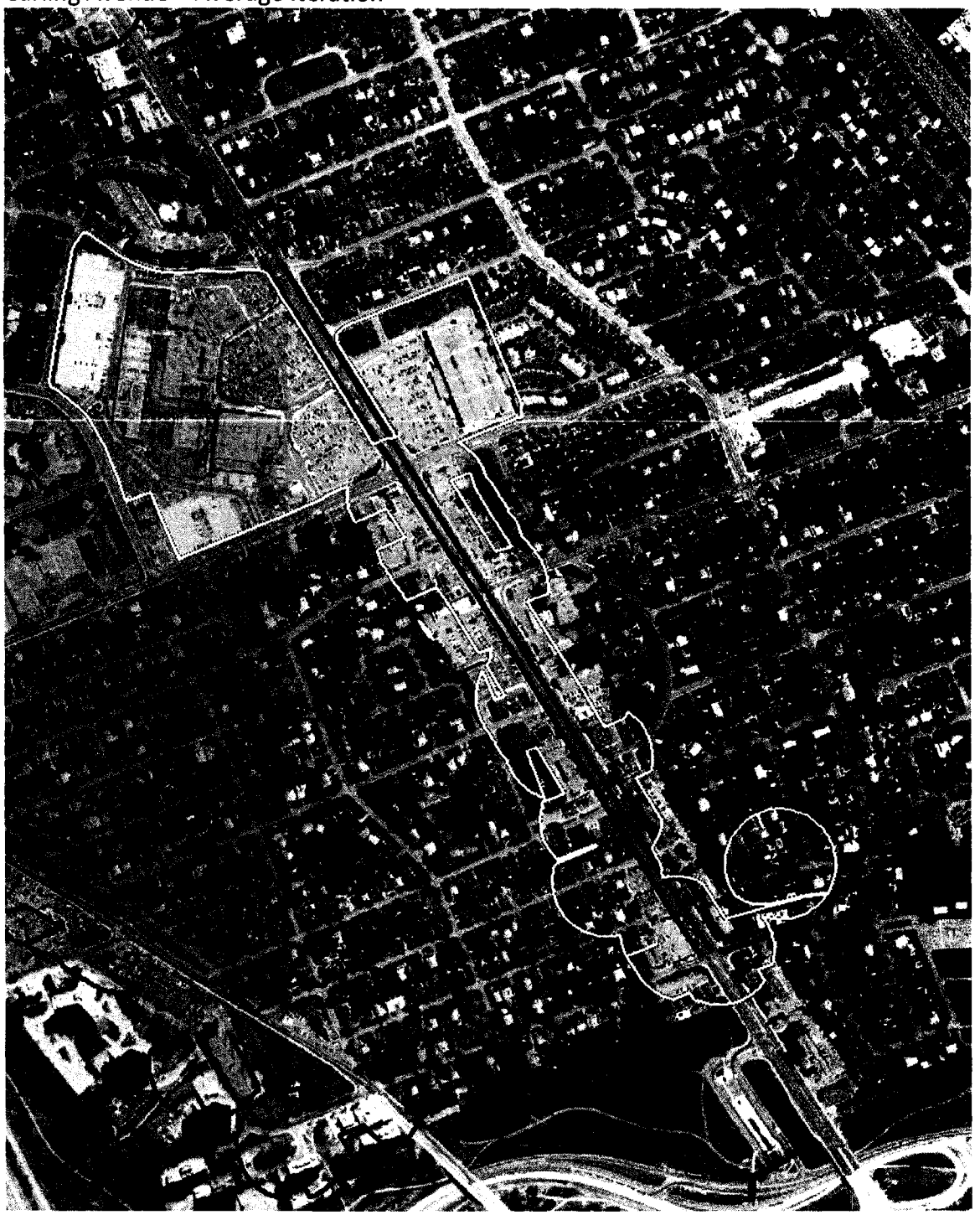


Bank Street (Glebe) – 3x Iteration

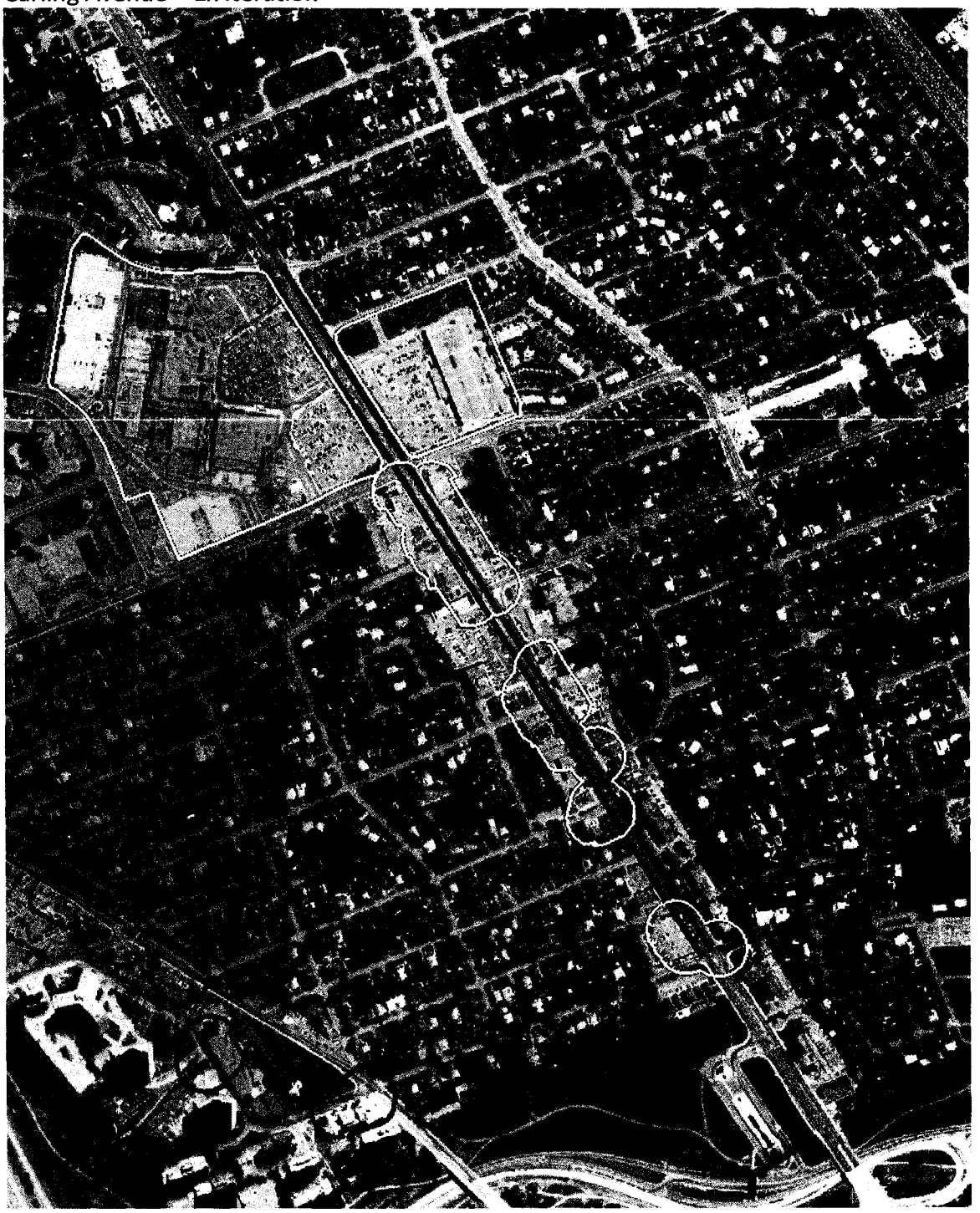


Carling Avenue – Land Use Defined Boundaries

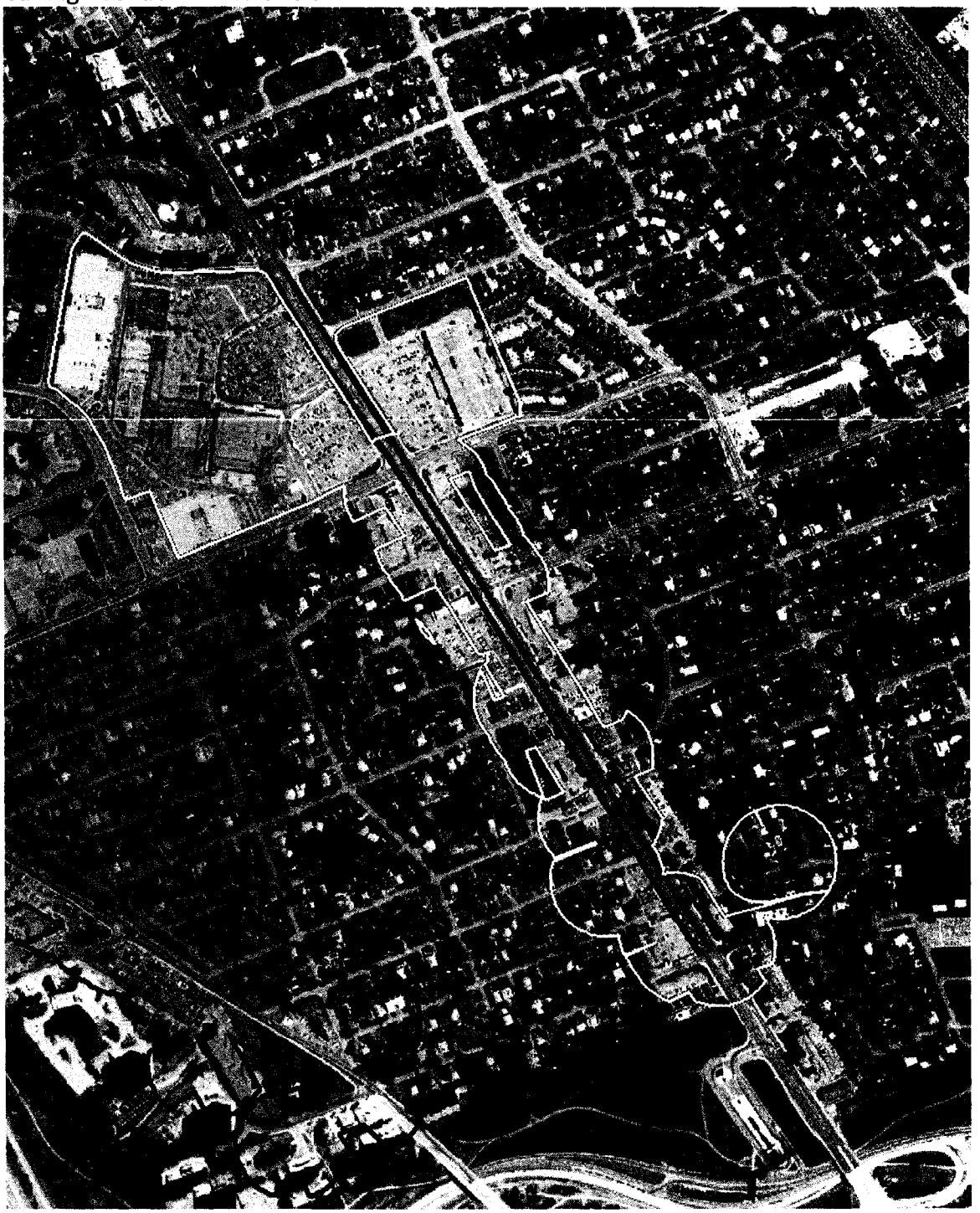
Carling Avenue – Average Iteration



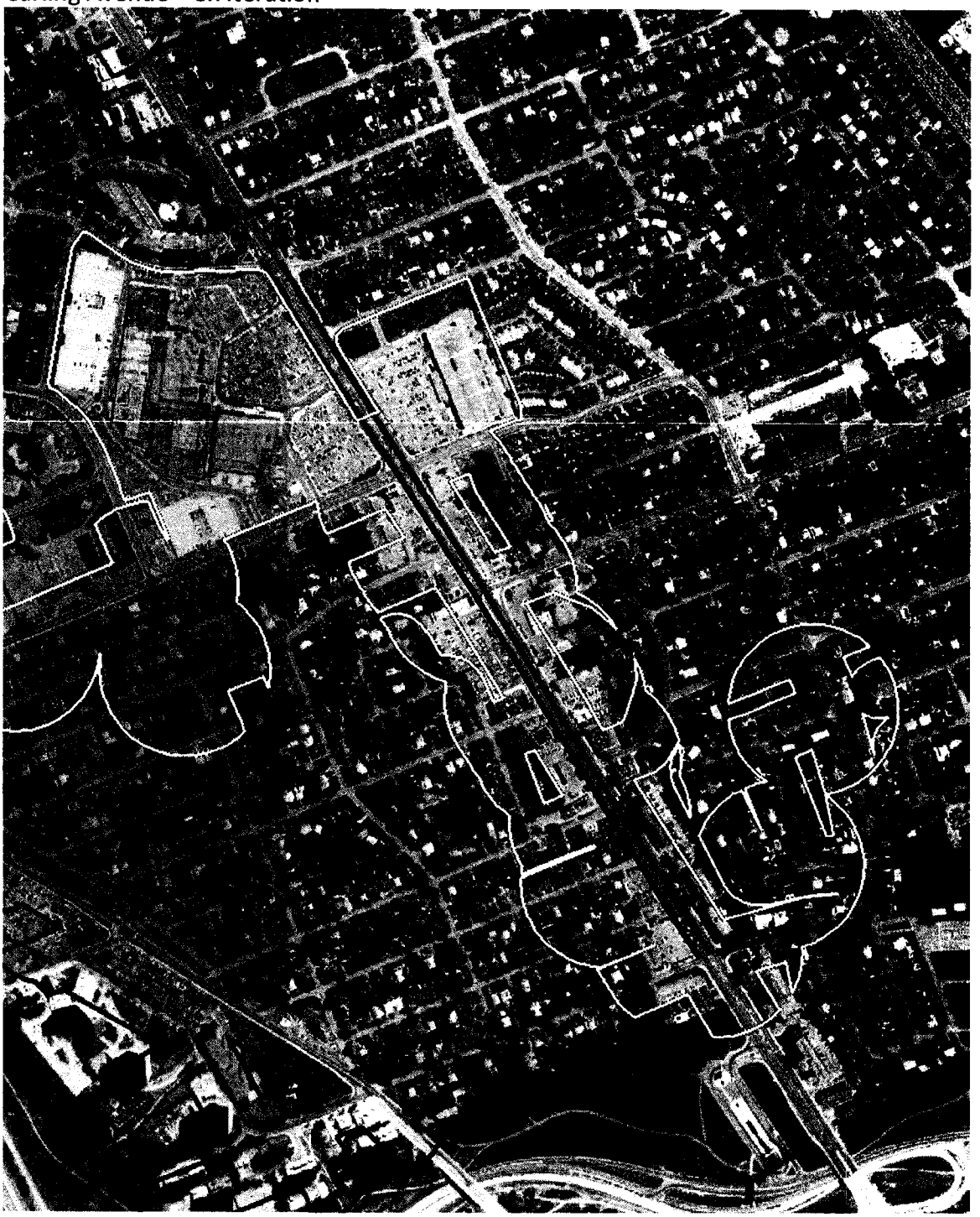
Carling Avenue – 1x Iteration



Carling Avenue – 2x Iteration

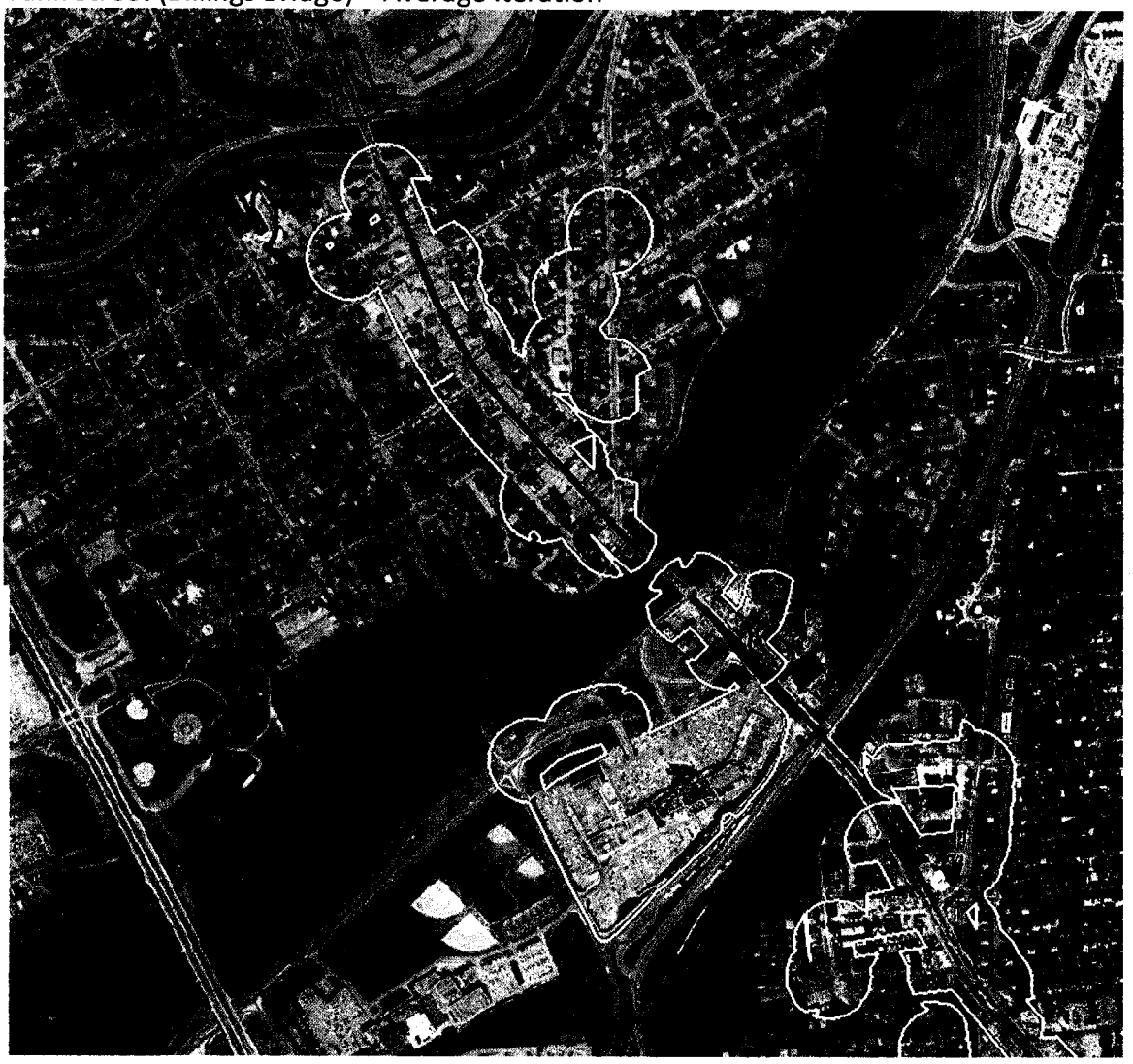


Carling Avenue – 3x Iteration

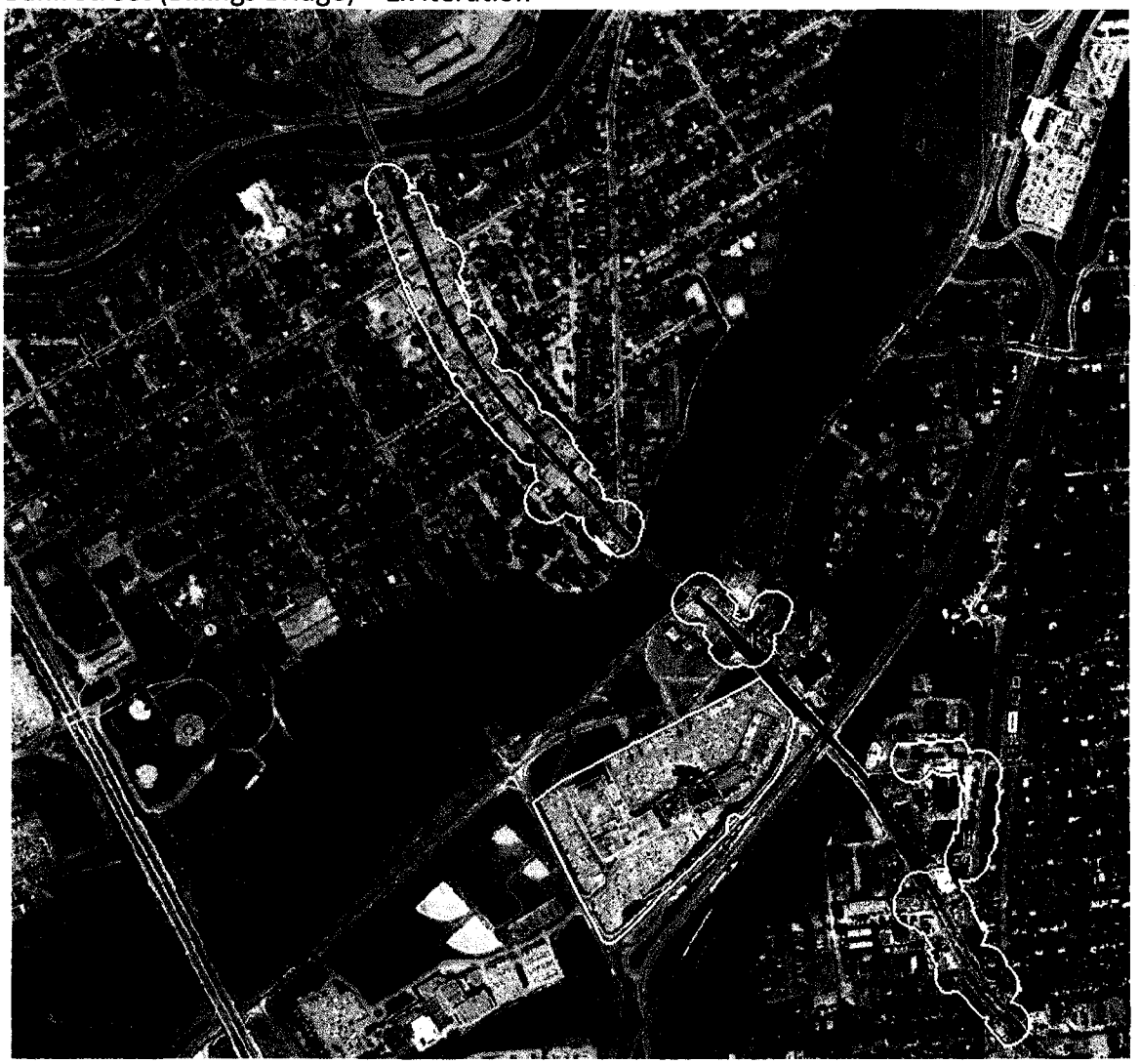


Bank Street (Billings Bridge) – Land Use Defined Boundaries (North is ↑)

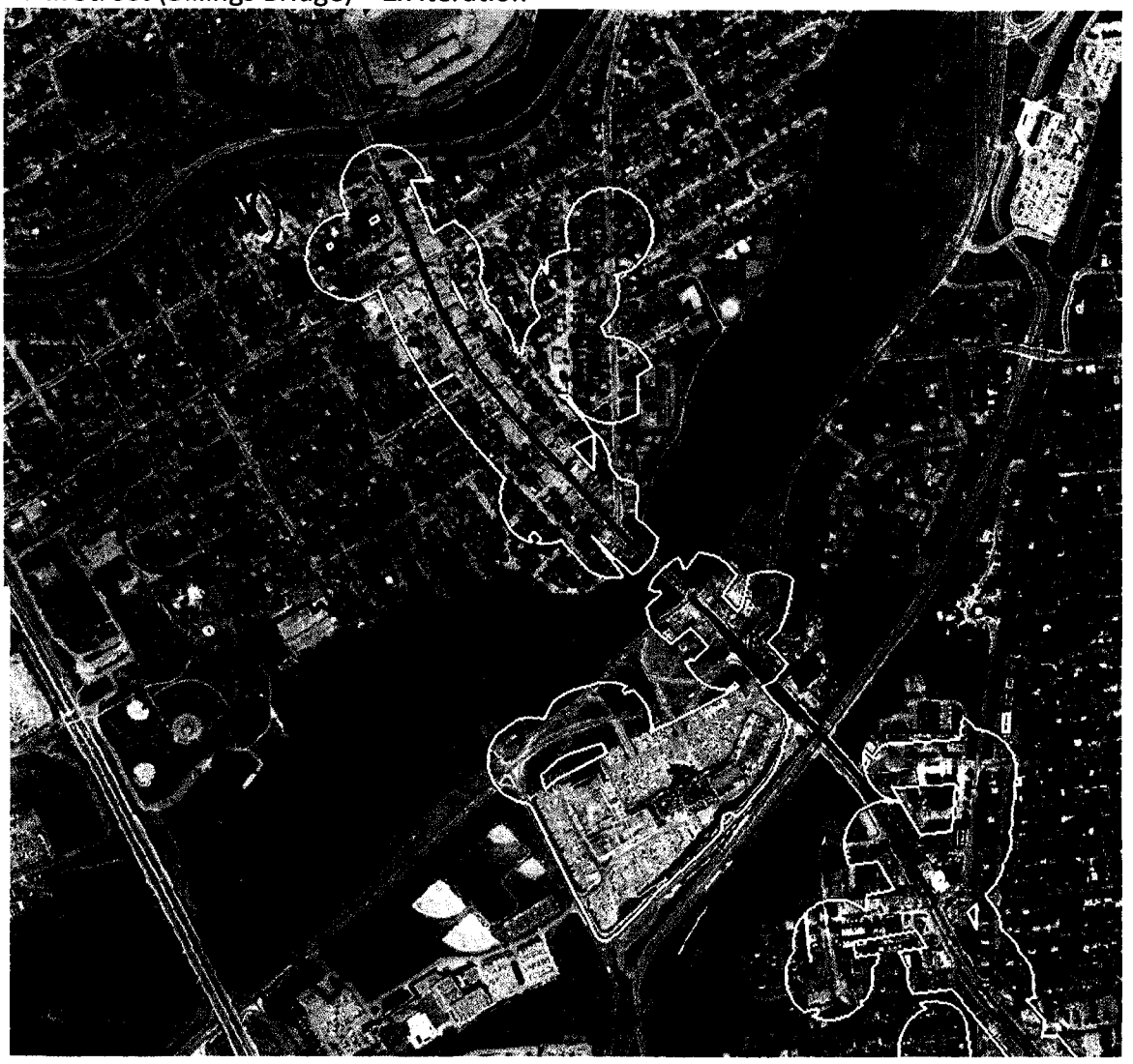
Bank Street (Billings Bridge) – Average Iteration



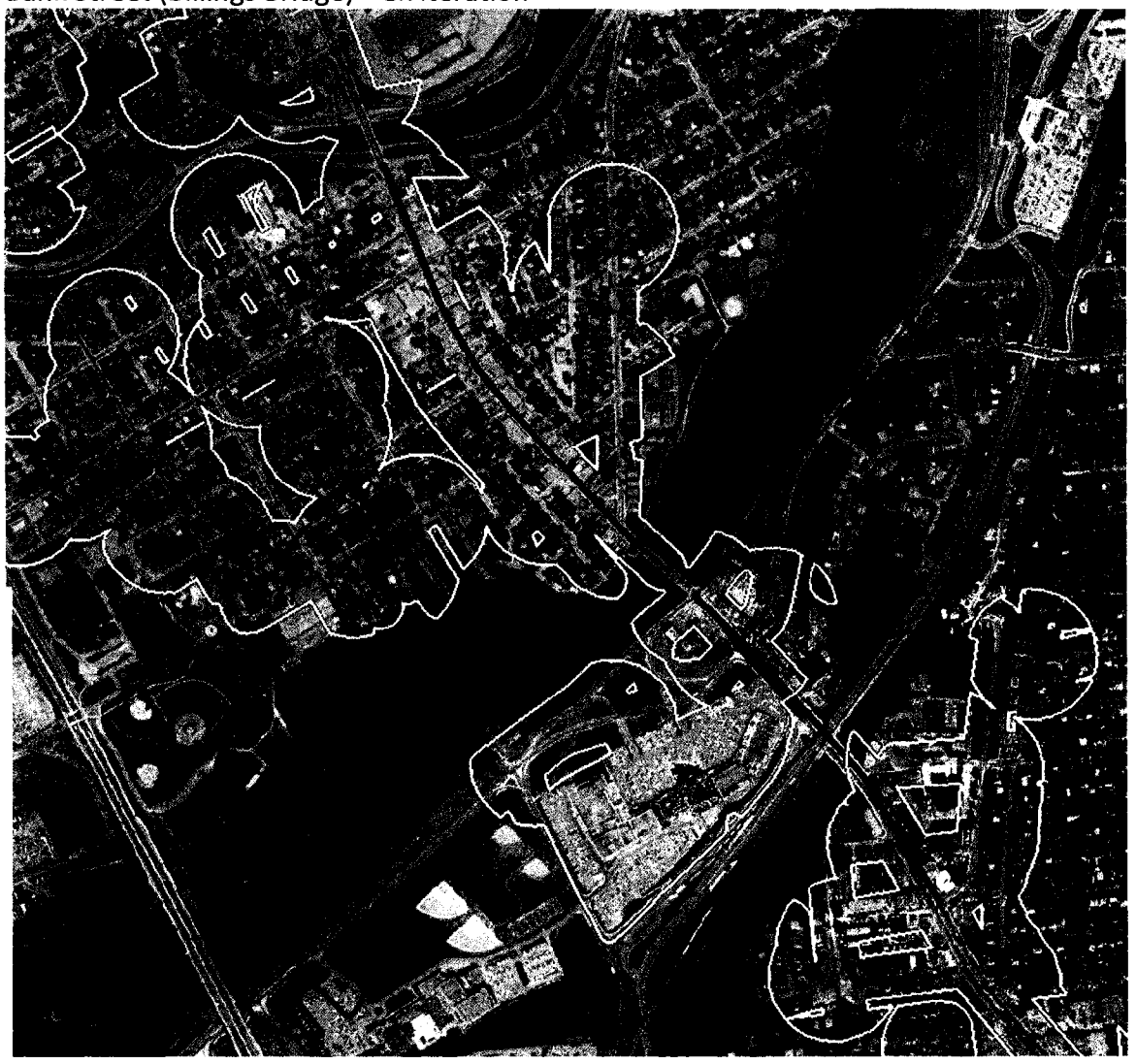
Bank Street (Billings Bridge) – 1x Iteration



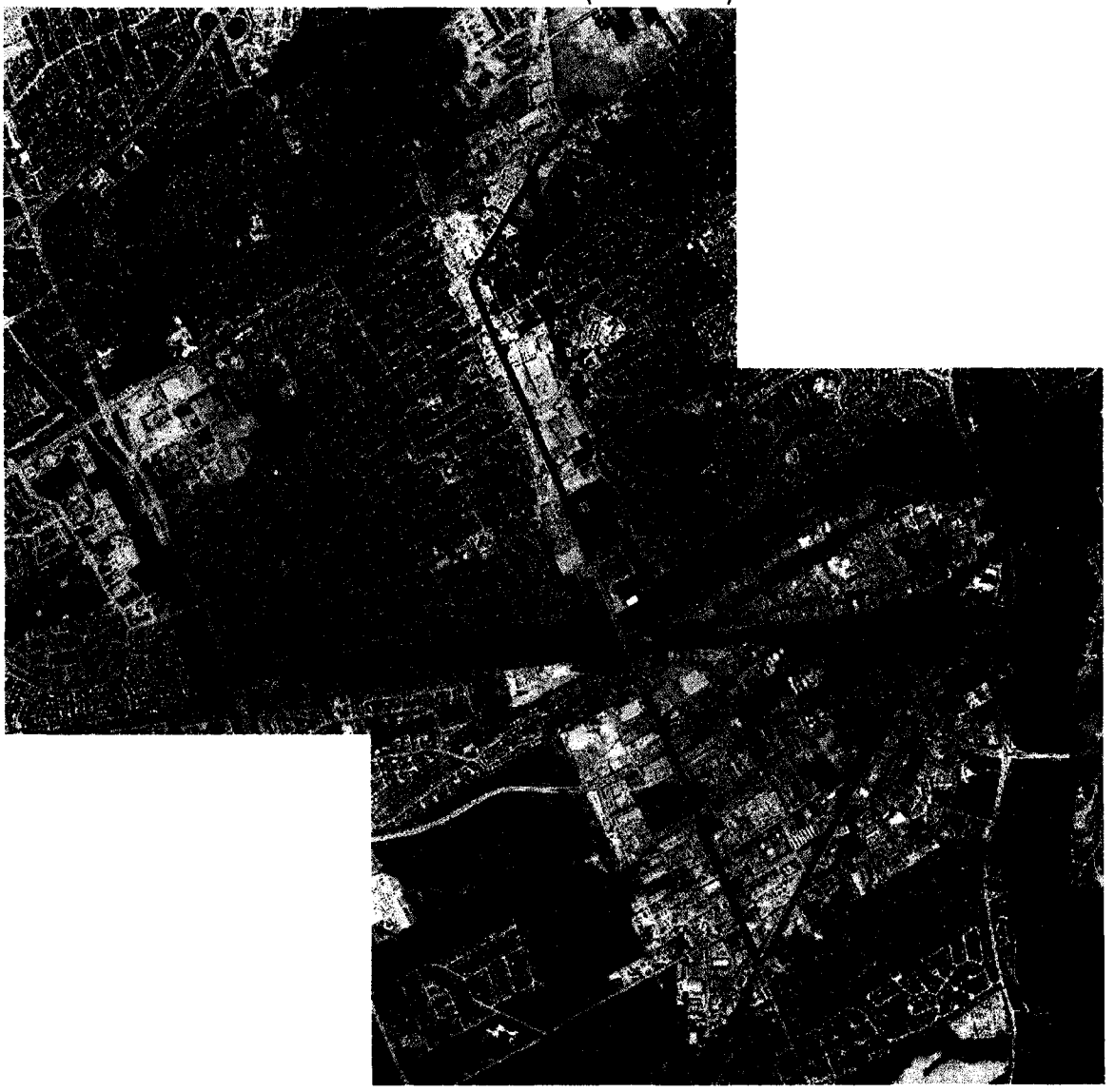
Bank Street (Billings Bridge) – 2x Iteration



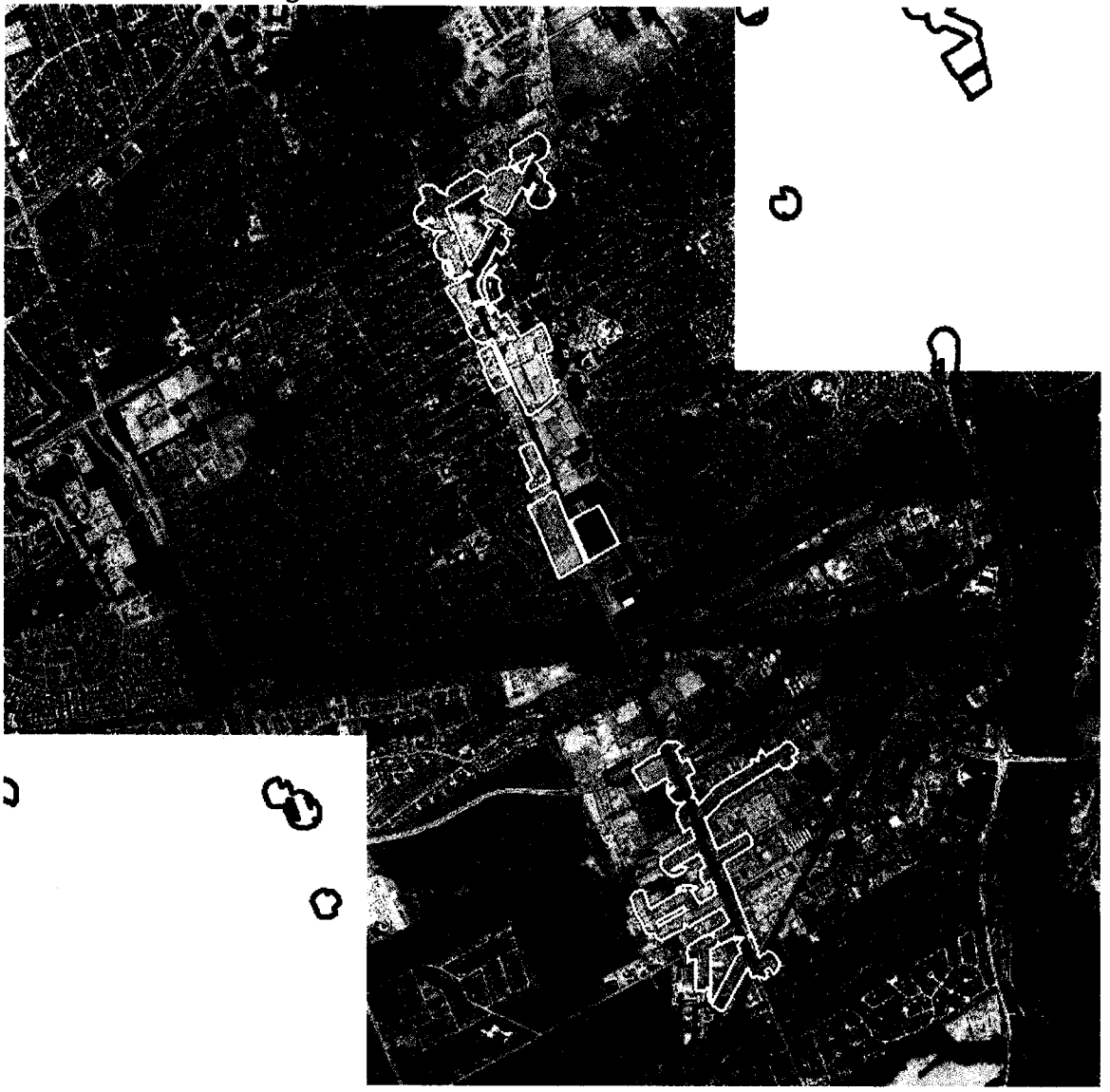
Bank Street (Billings Bridge) – 3x Iteration



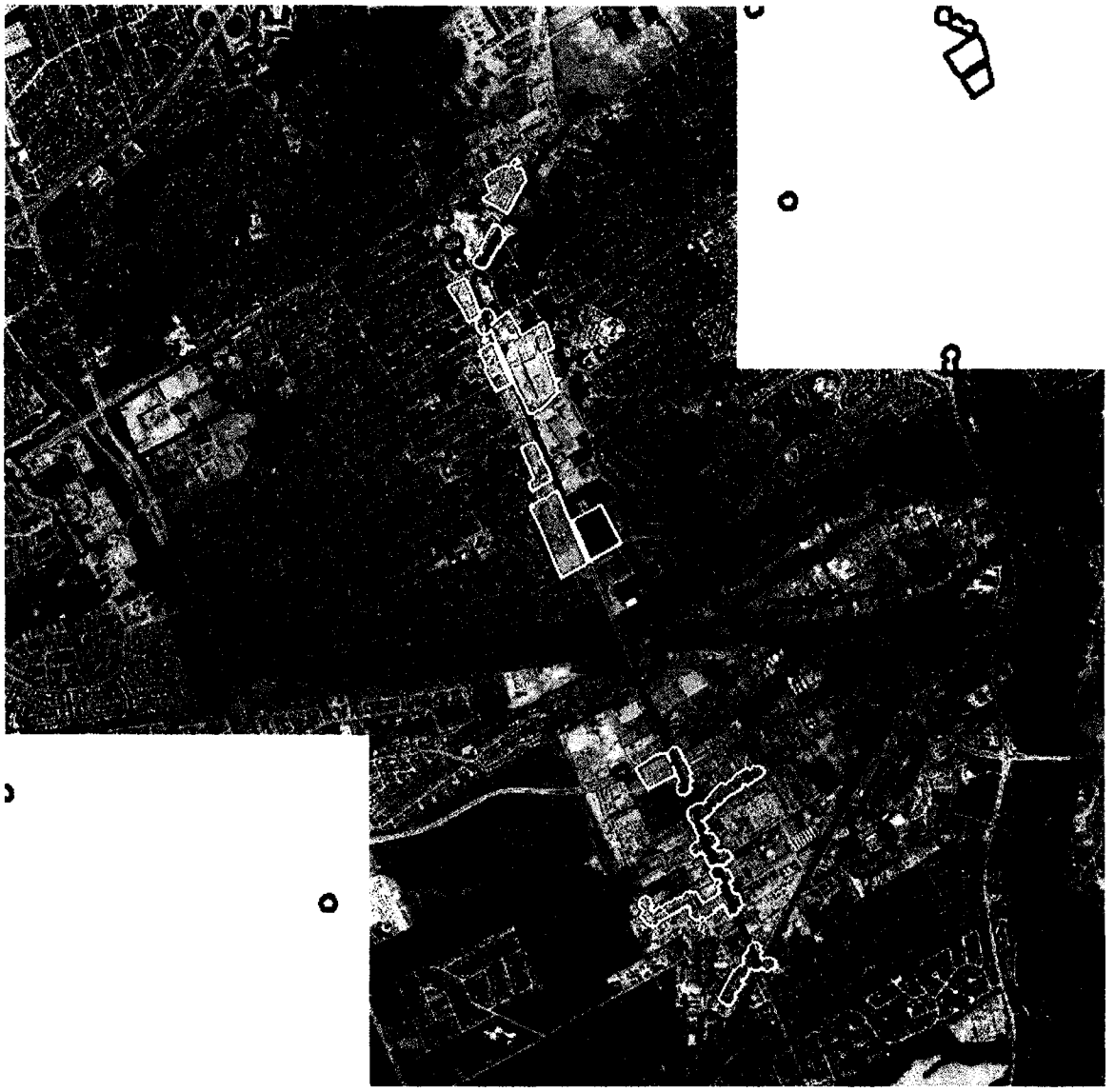
Merivale Road – Land Use Defined Boundaries (North is ↑)



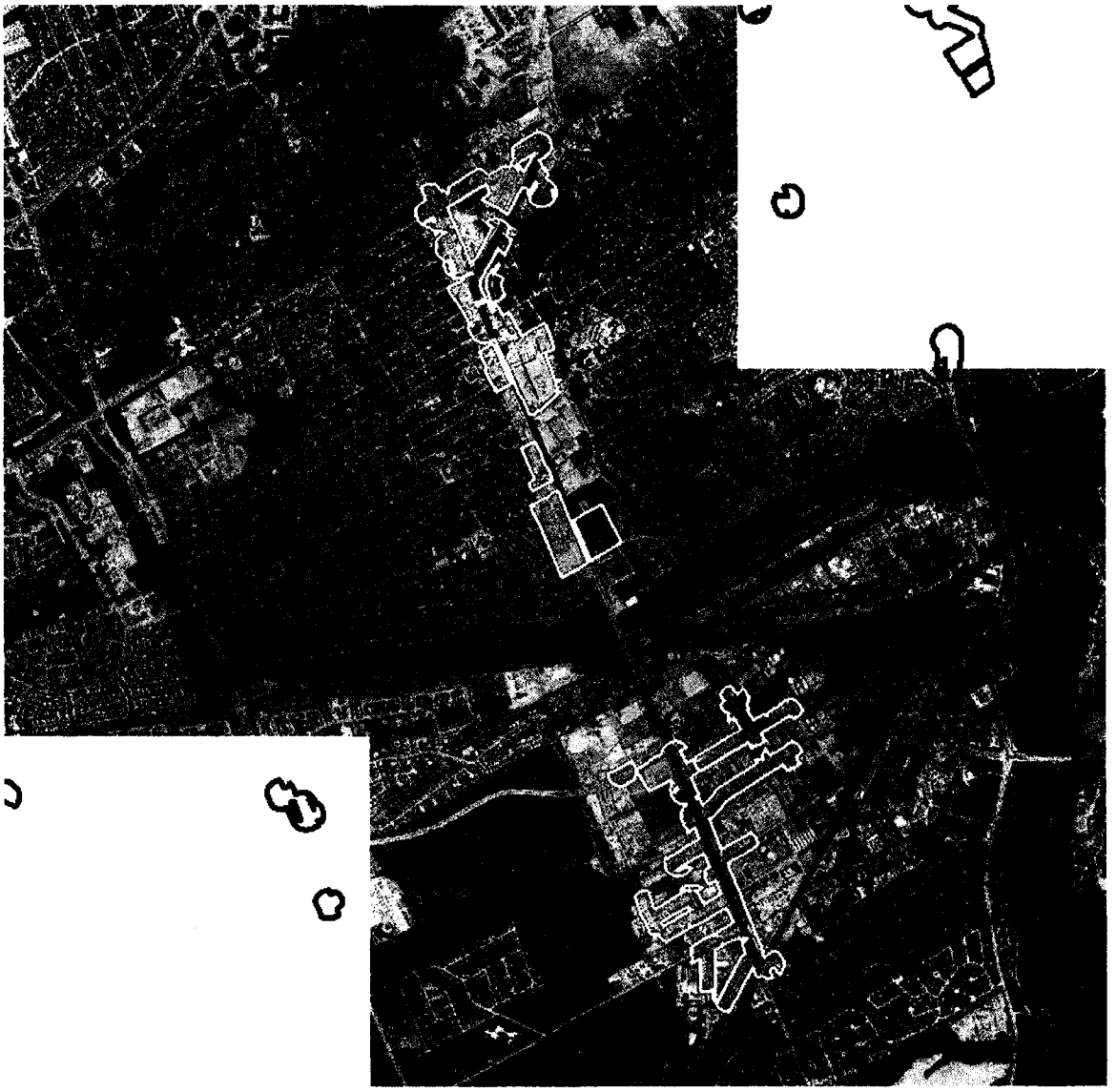
Merivale Road – Average Iteration



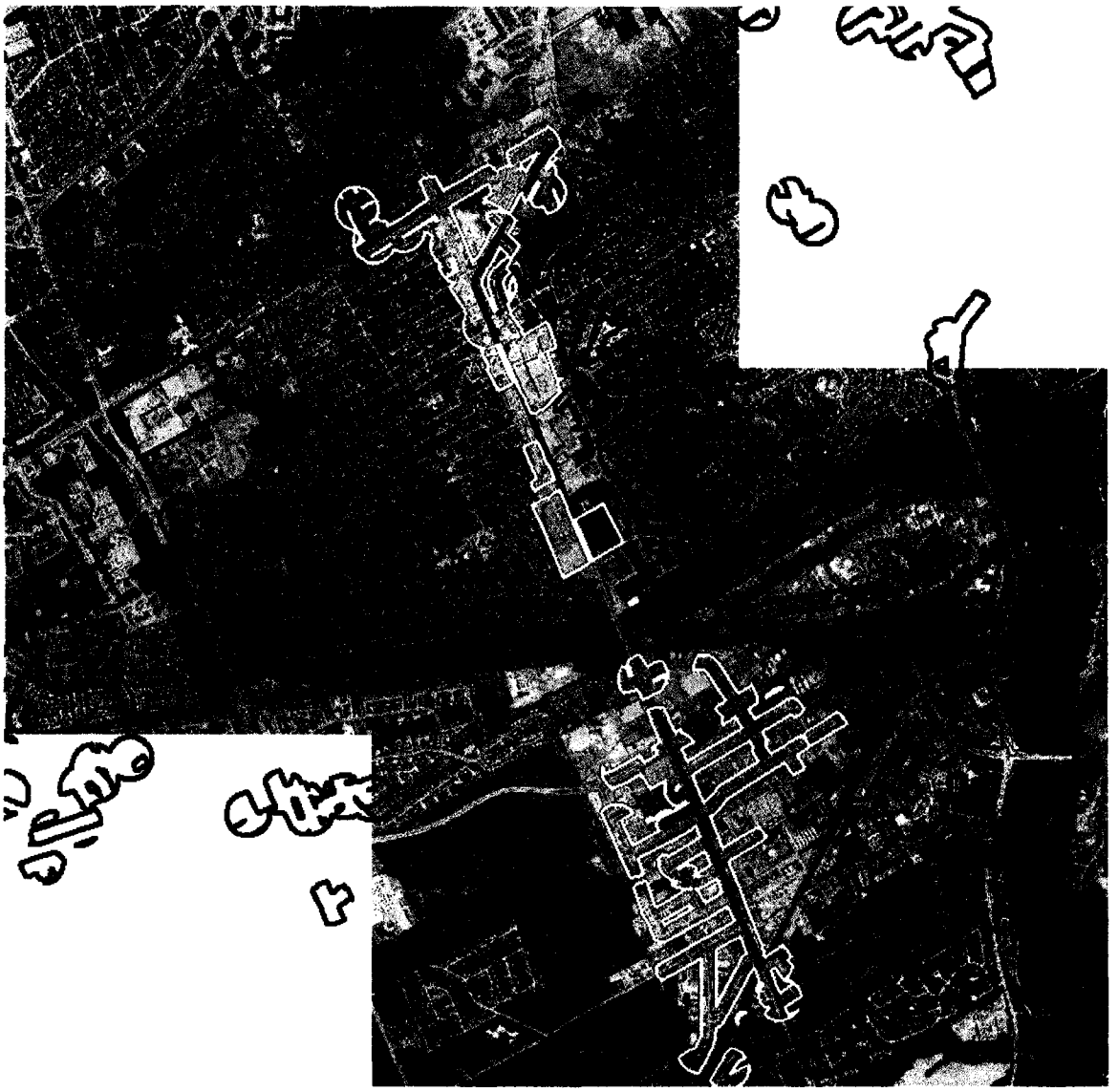
Merivale Road – 1x Iteration



Merivale Road – 2x Iteration



Merivale Road – 3x Iteration



Appendix C

Land Use Comparison

The following maps represent the land use comparison between the derived commercial clusters for Kitchener (point and point + fixed entity) and the commercial parcels for the same area.

C1. Kitchener CMA
   a. Region of Waterloo
   b. Waterloo CBD
   c. Kitchener CBD
   d. Cambridge Hwy 24

Each area of interest contains ten maps:

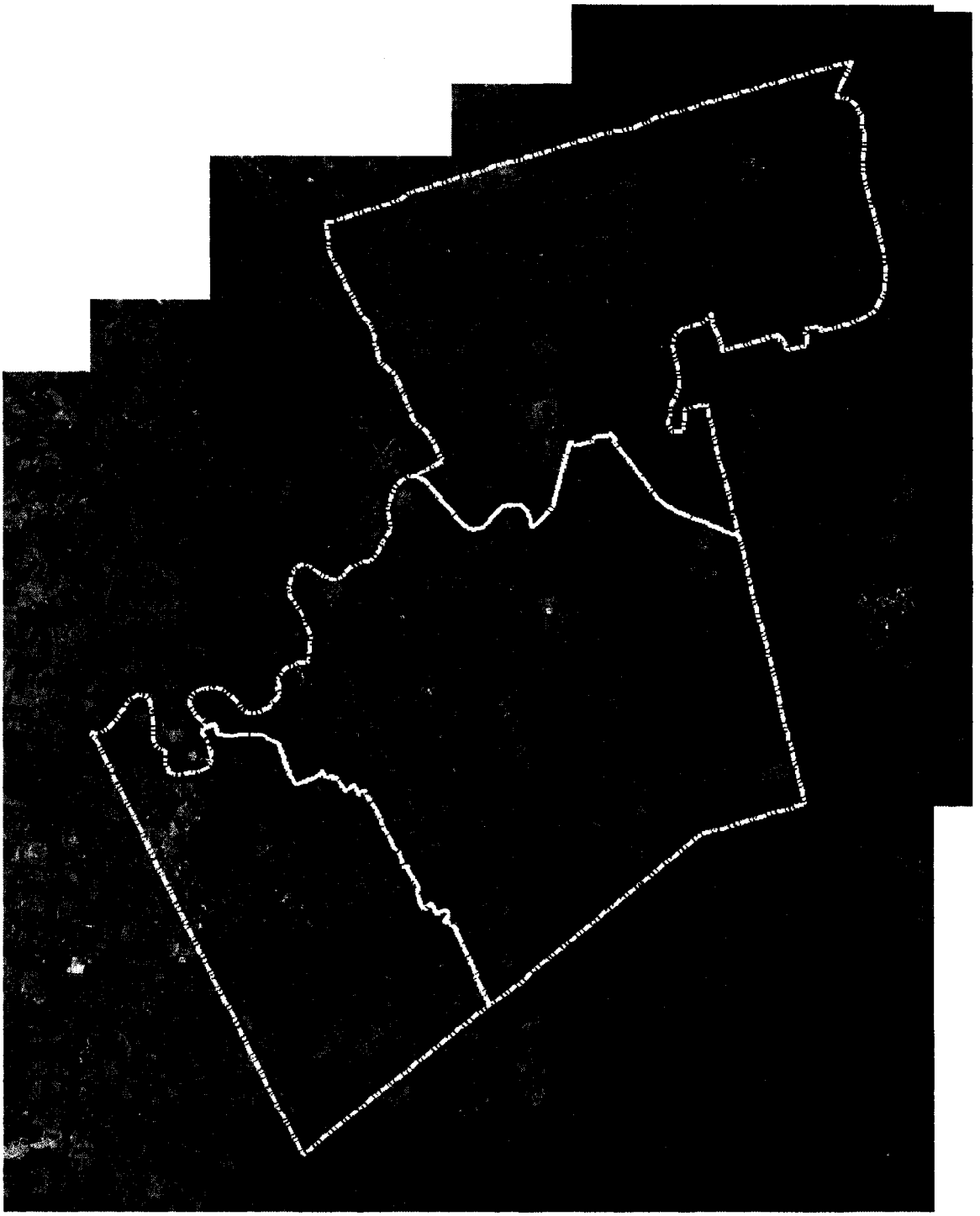
- The "Original",
- Point Only
   a. The Average Iteration,
   b. 1-5x Iterations.
- Point + Fixed Entity
   a. The Average Iteration
   b. 1-3x Iterations

All maps are orientated with North on the left side of the page unless otherwise stated.

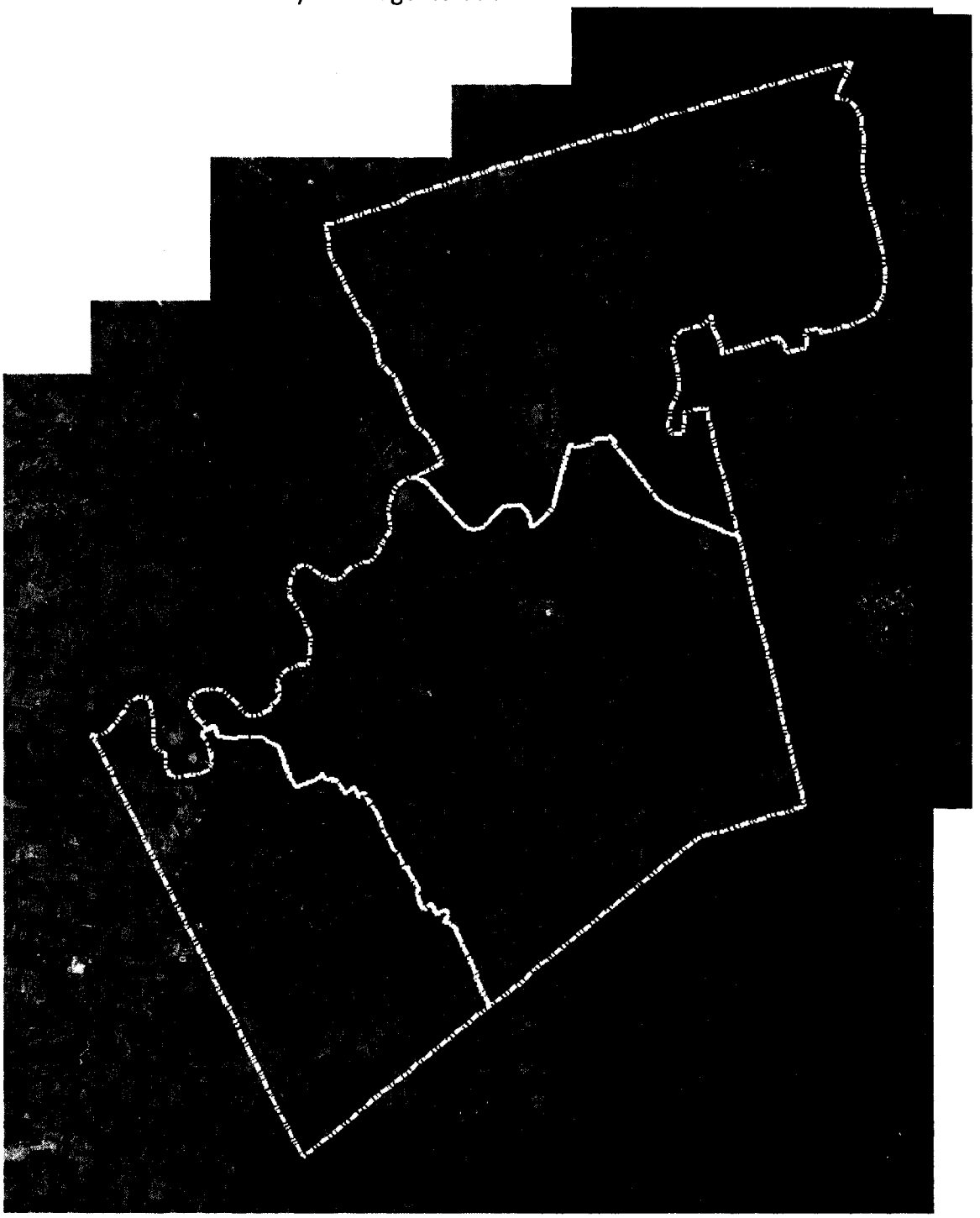
The legend for all maps is as follows:

RED (dots) and/or **MAGENTA**	"Original" Area
	Detected Area
BLACK	Detected Areas (For localized areas of interest these represent areas outside of the area of Interest

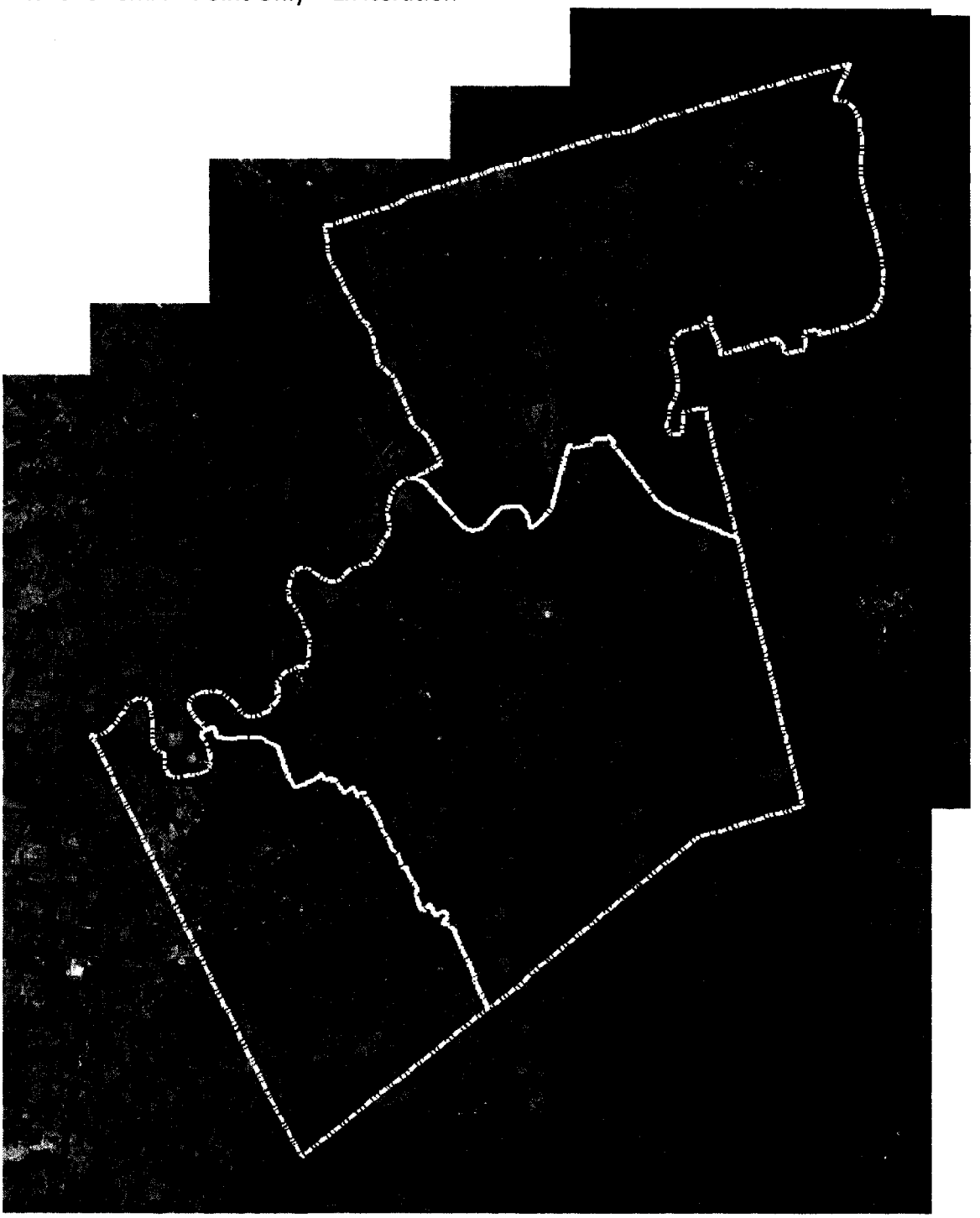
Kitchener CMA – Commercial Parcels and Land Use Planning Boundaries



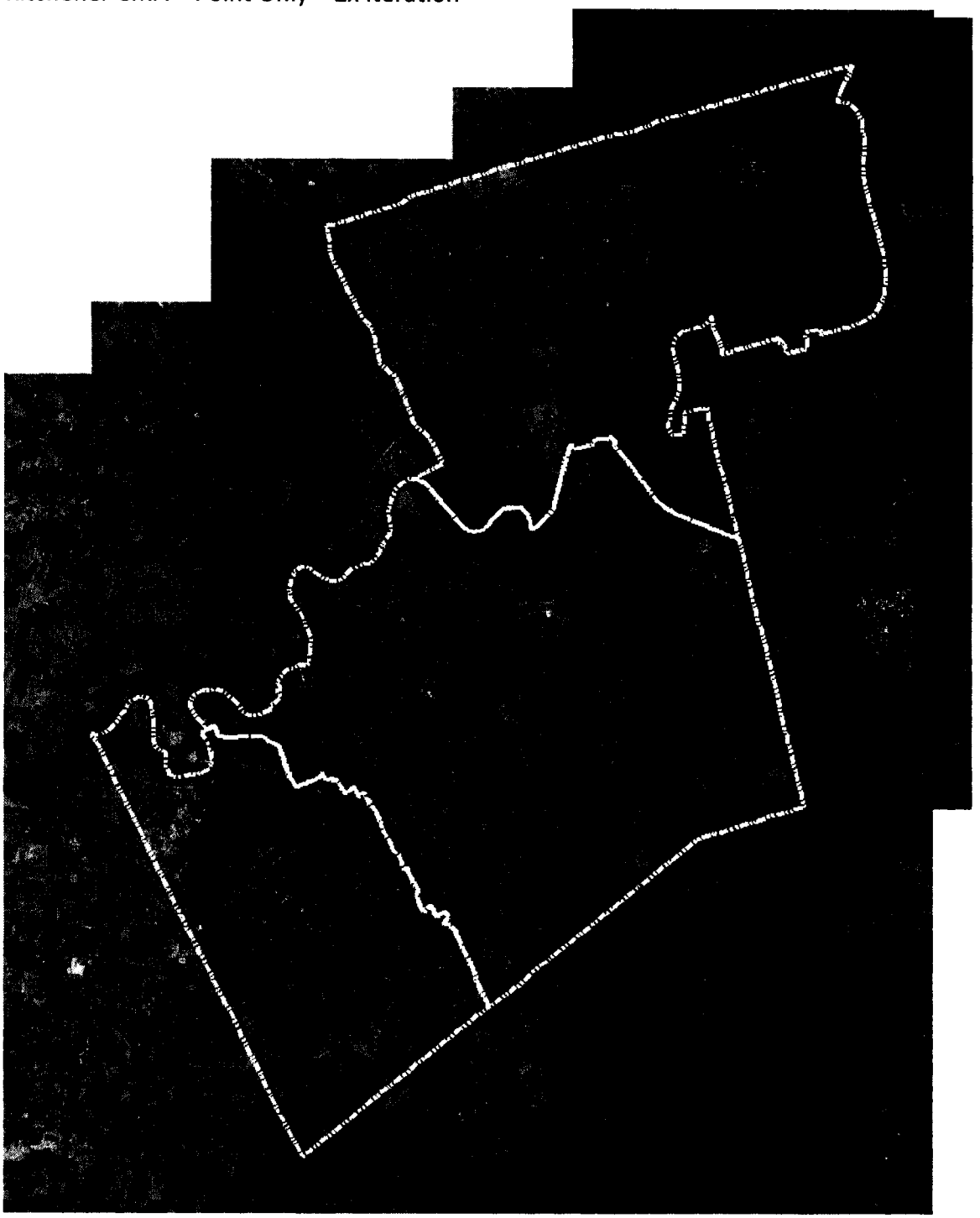
Kitchener CMA – Point Only - Average Iteration



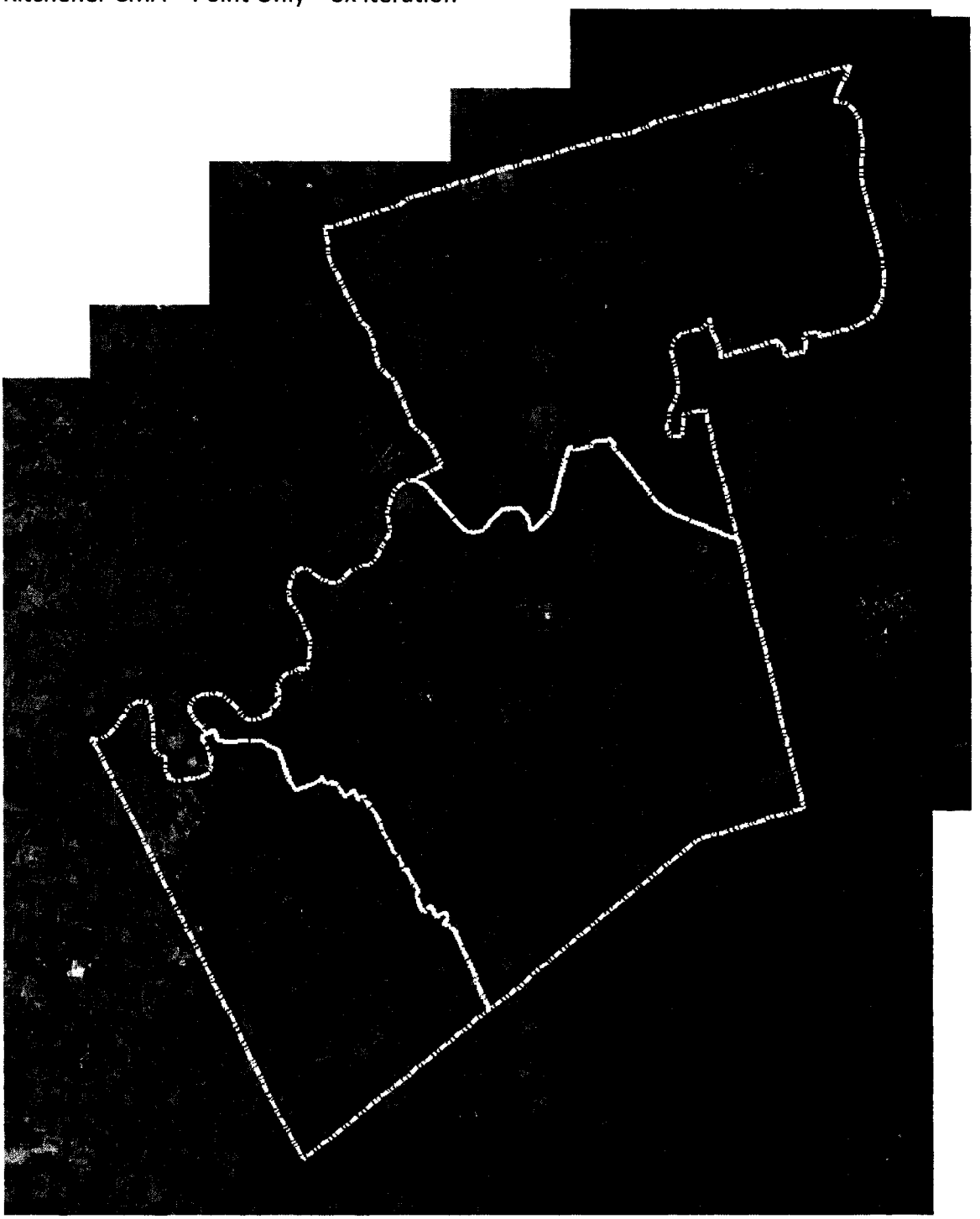
Kitchener CMA – Point Only – 1x Iteration



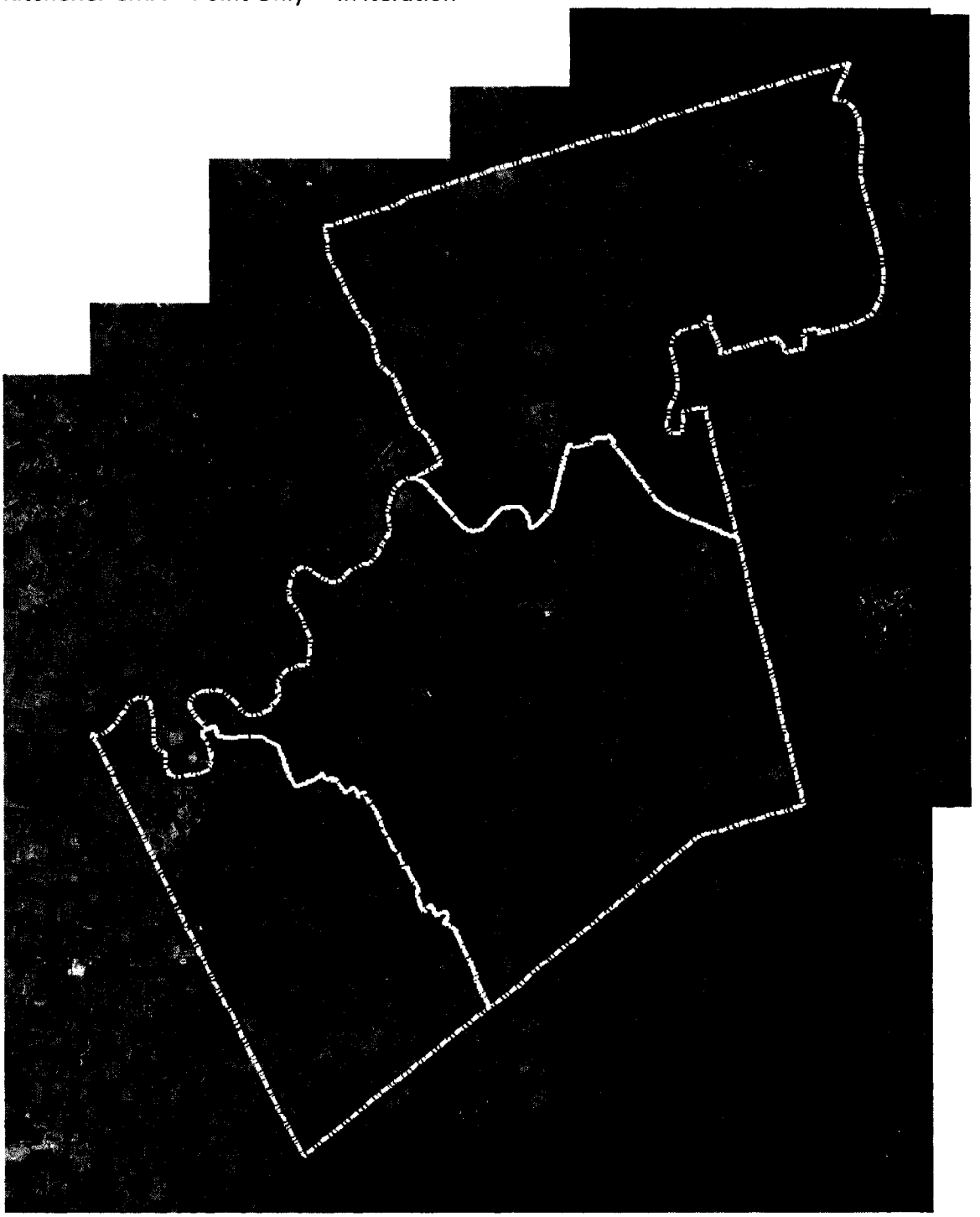
Kitchener CMA – Point Only – 2x Iteration



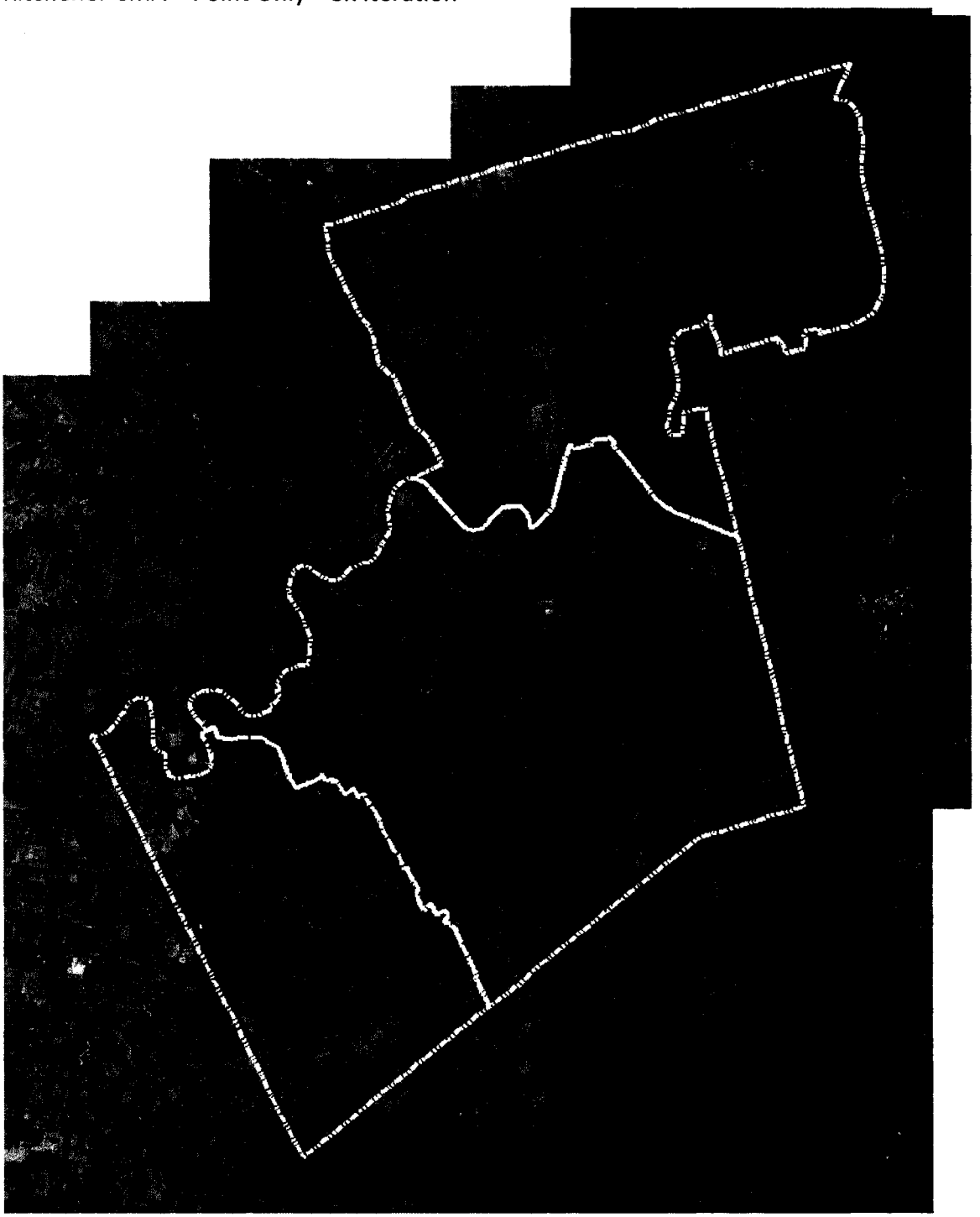
Kitchener CMA – Point Only – 3x Iteration



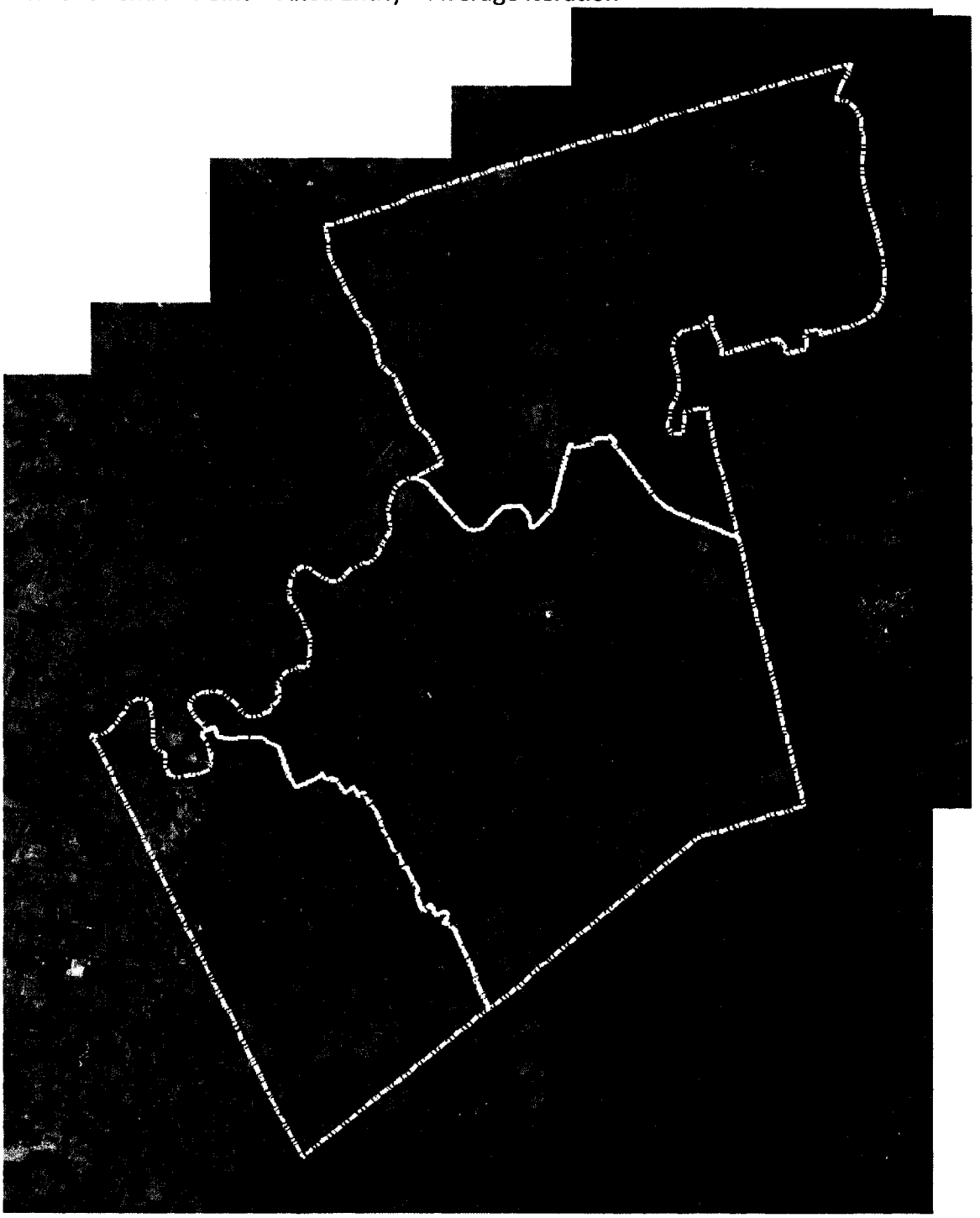
Kitchener CMA – Point Only – 4x Iteration



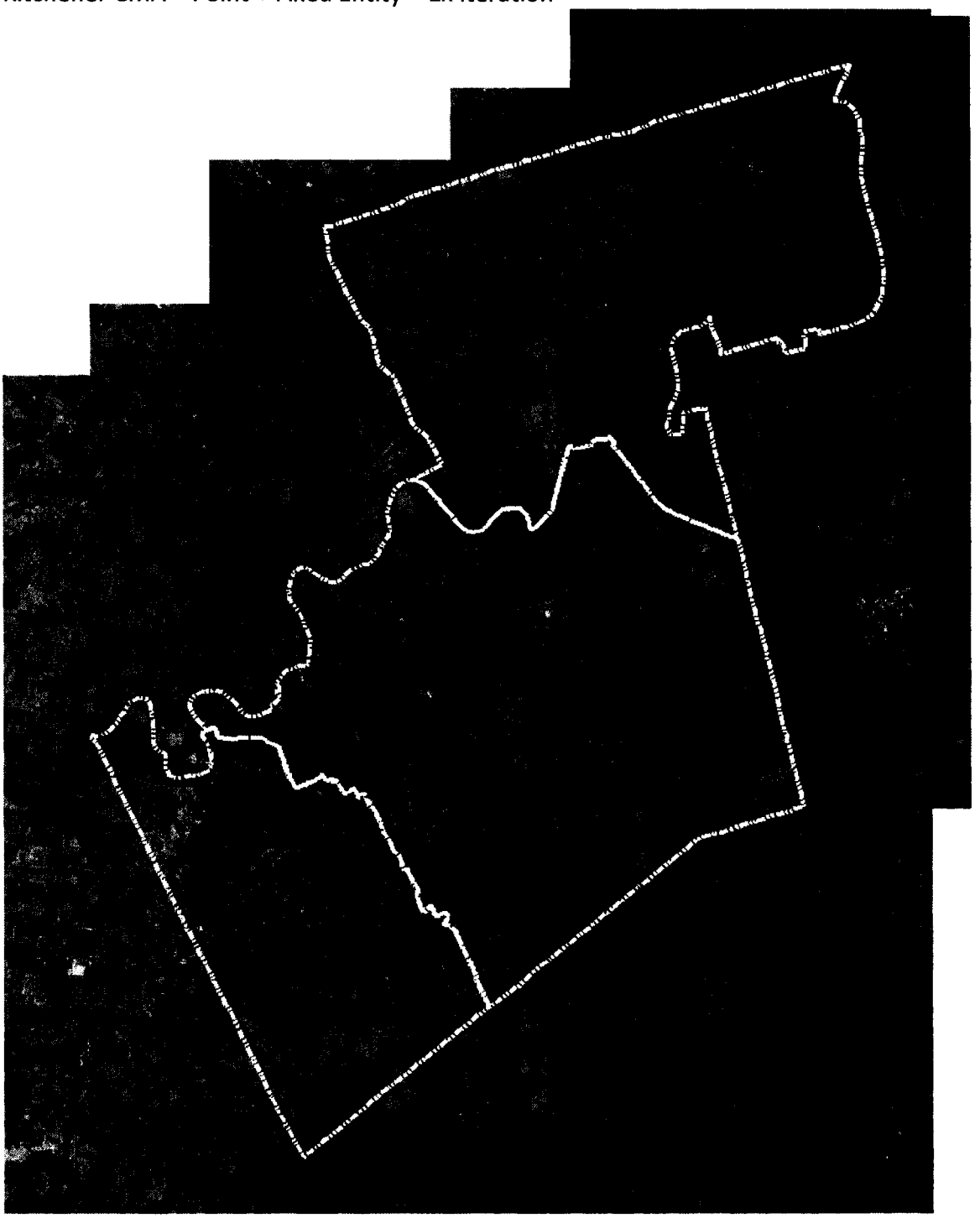
Kitchener CMA – Point Only – 5x Iteration



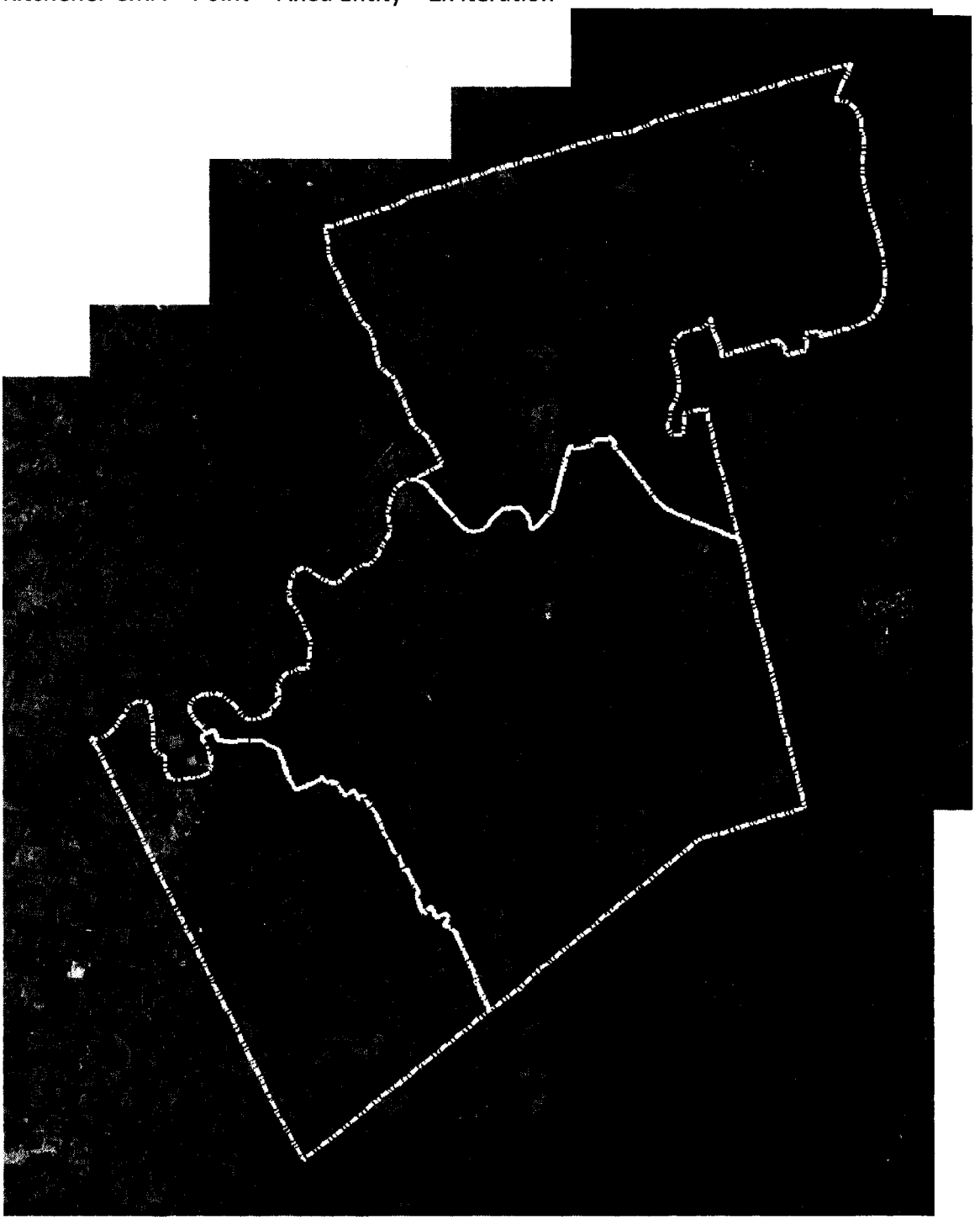
Kitchener CMA – Point + Fixed Entity – Average Iteration



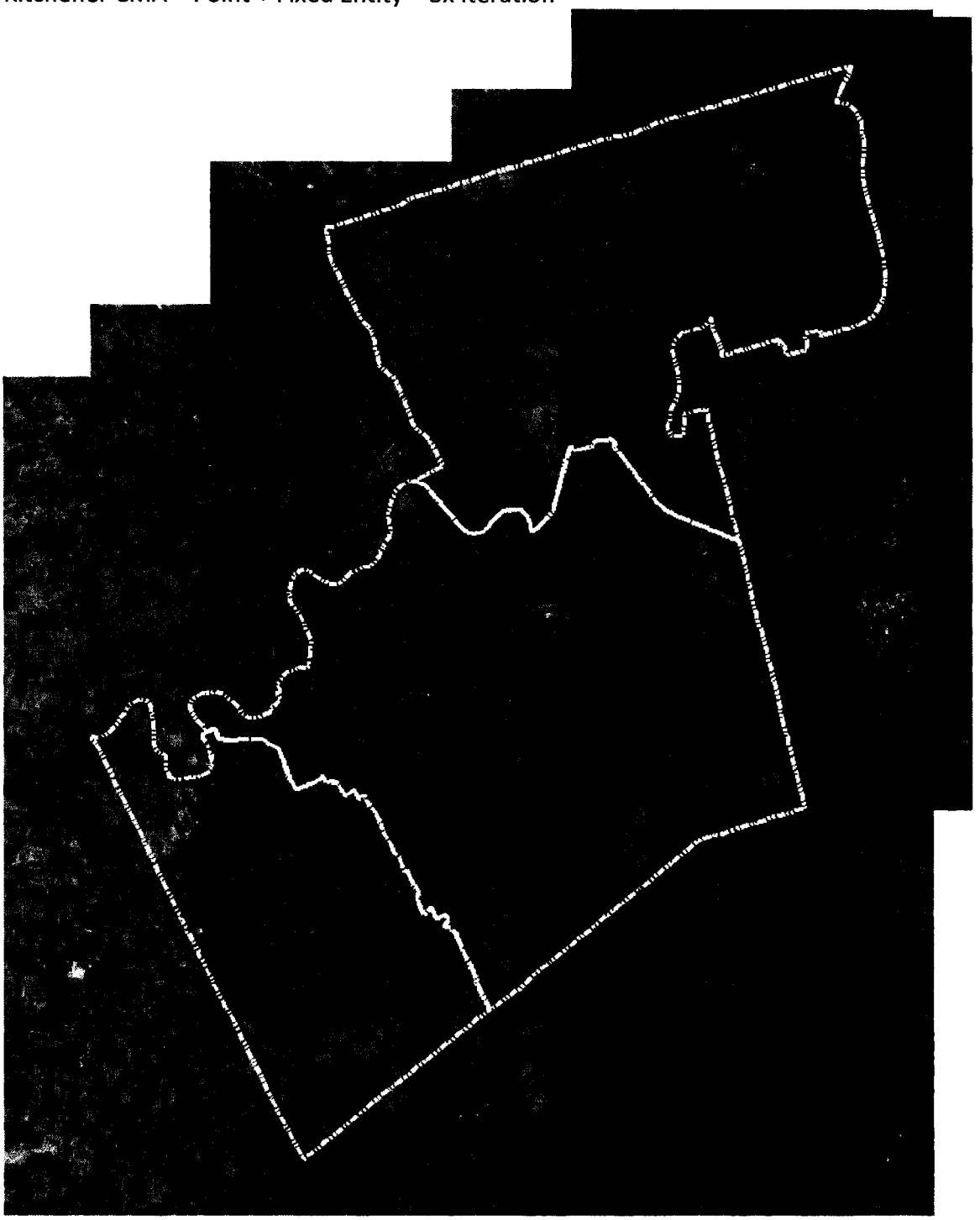
Kitchener CMA – Point + Fixed Entity – 1x Iteration



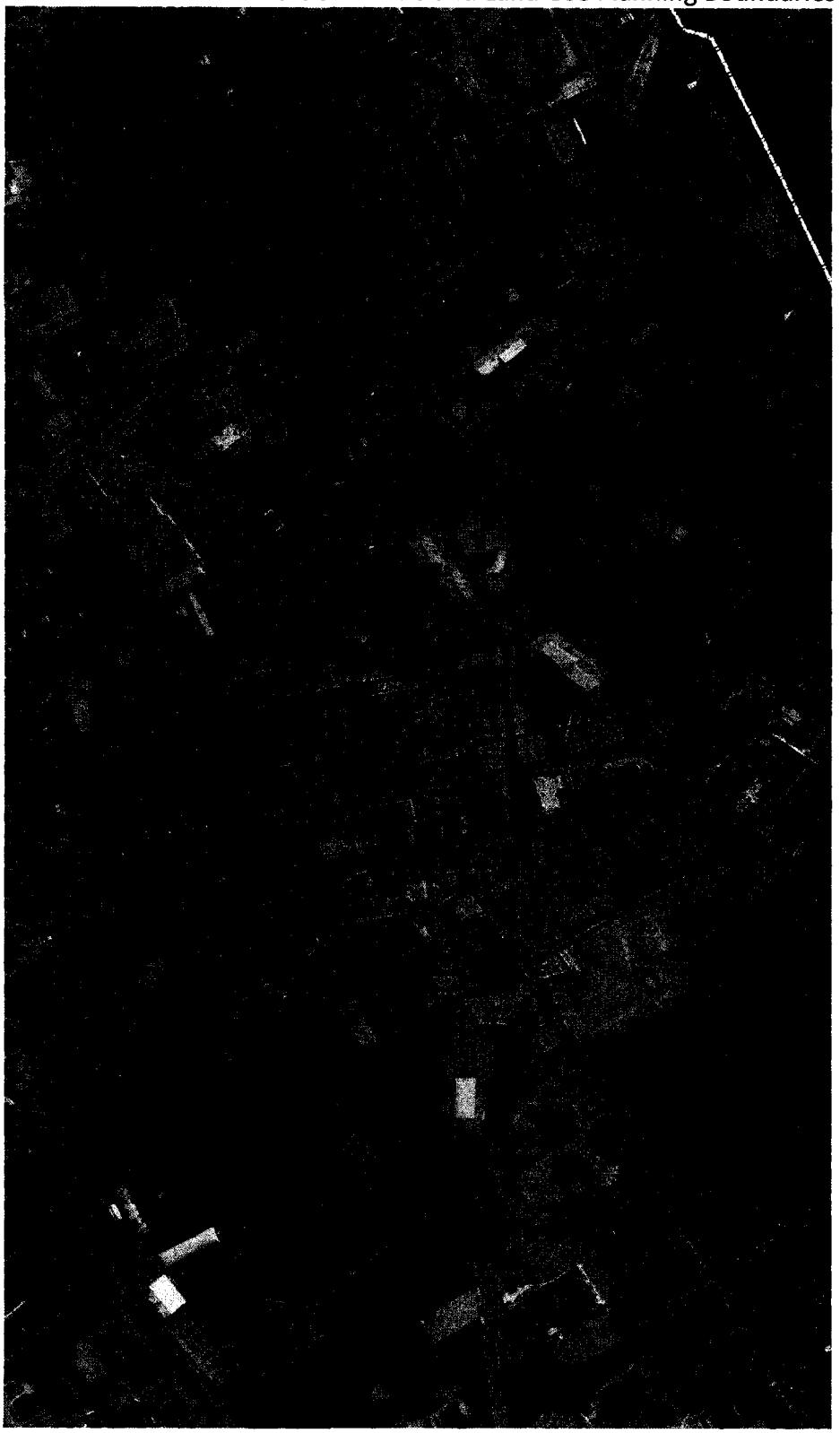
Kitchener CMA – Point + Fixed Entity – 2x Iteration



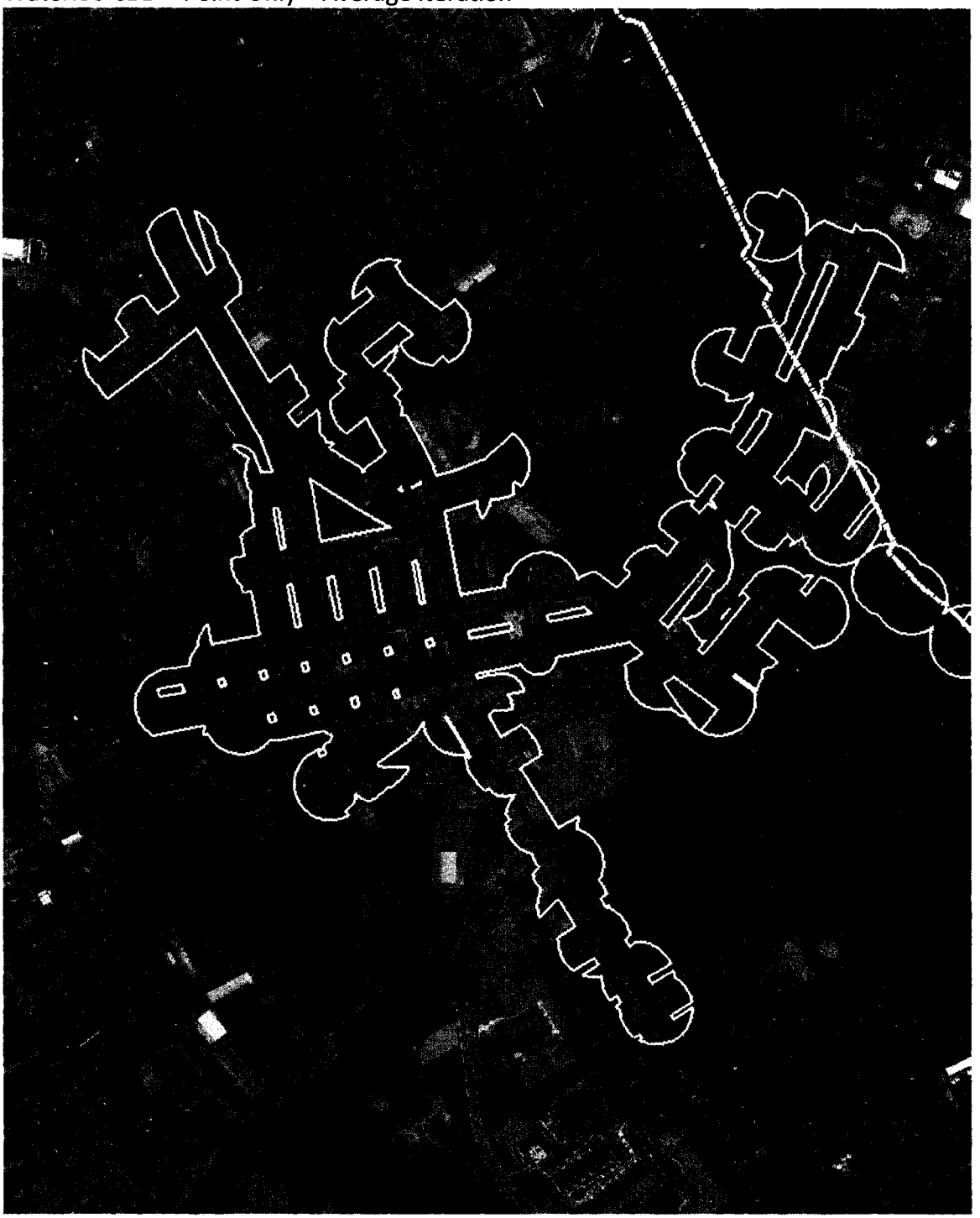
Kitchener CMA – Point + Fixed Entity – 3x Iteration



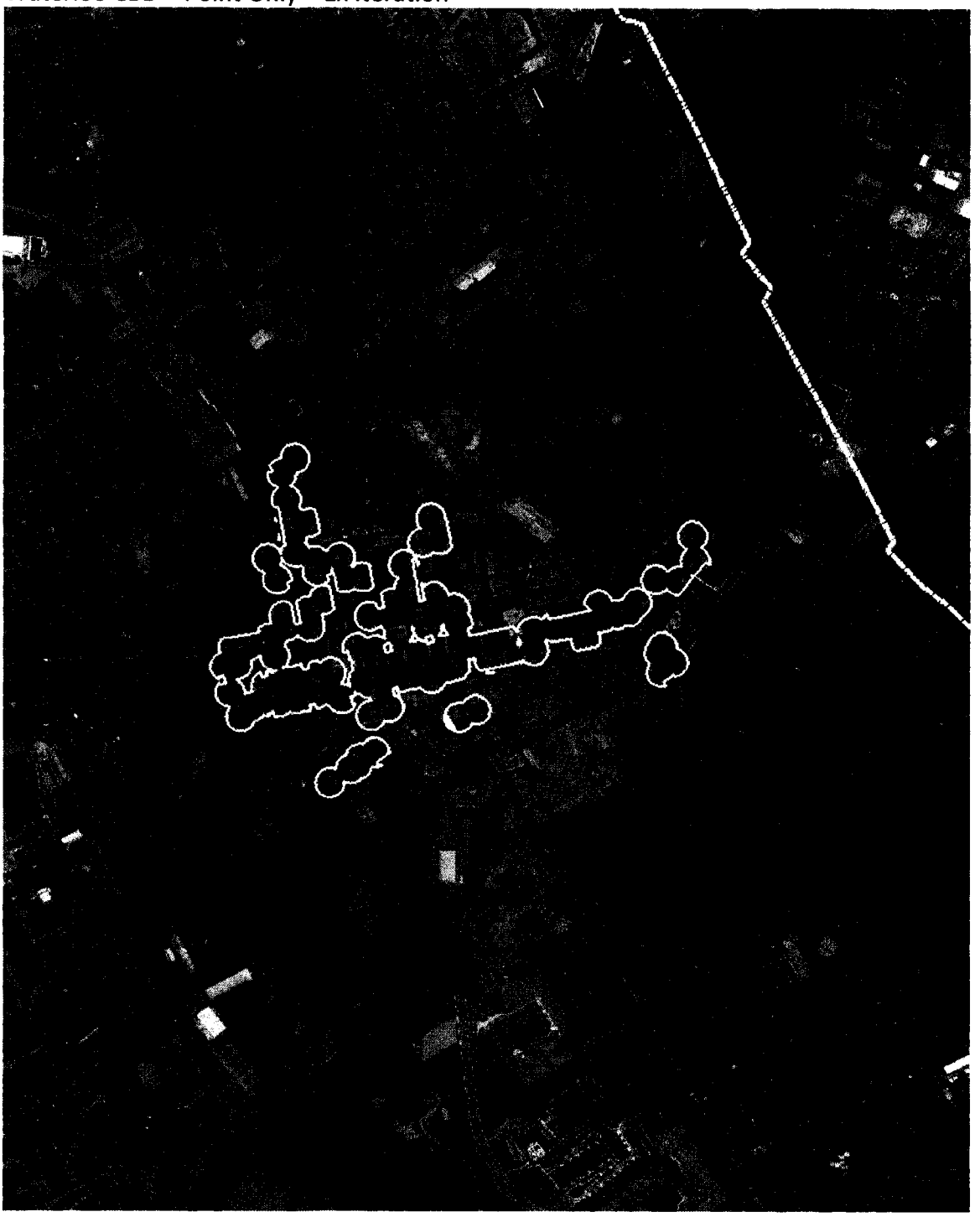
Waterloo CBD – Commercial Parcels and Land Use Planning Boundaries



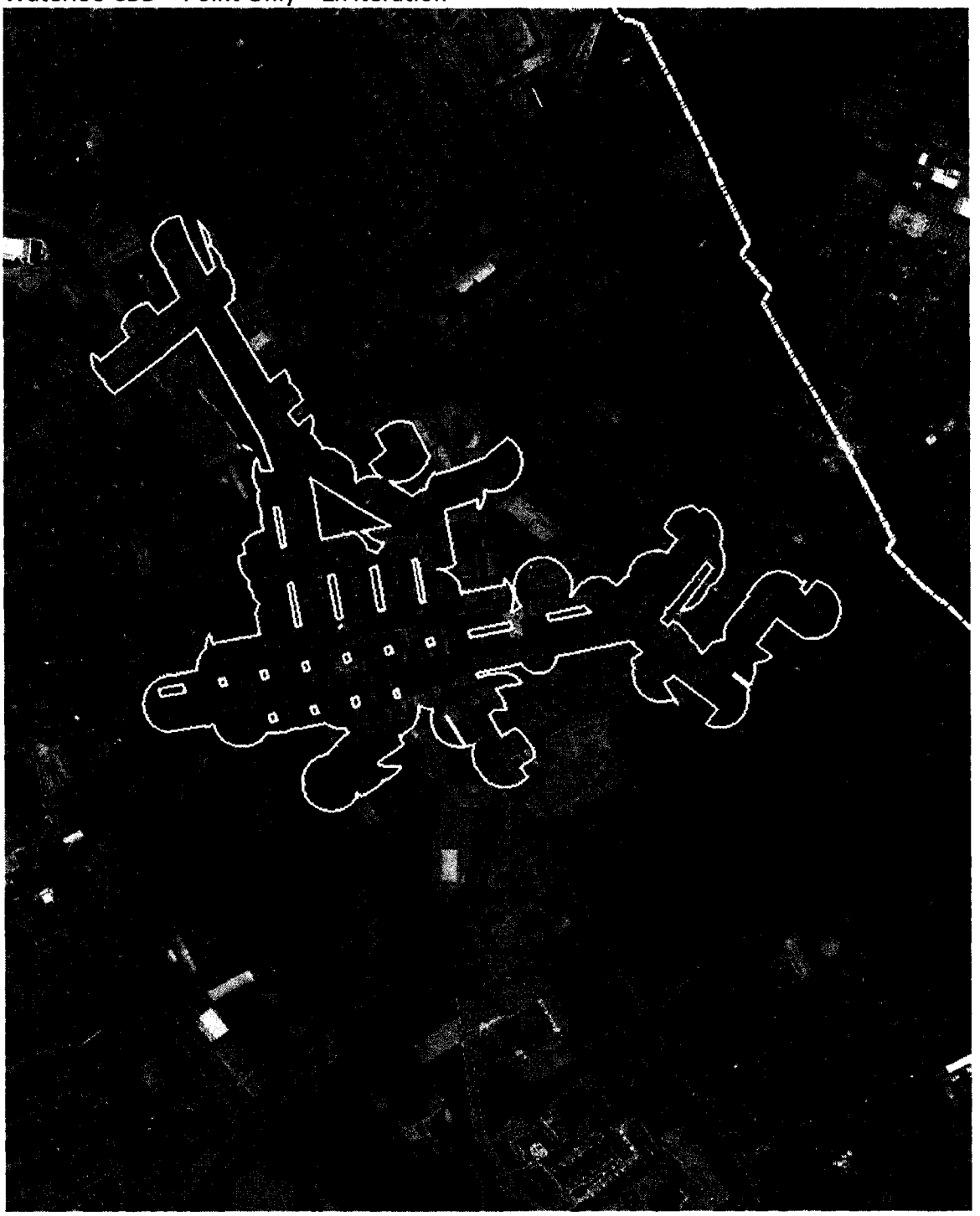
Waterloo CBD – Point Only – Average Iteration



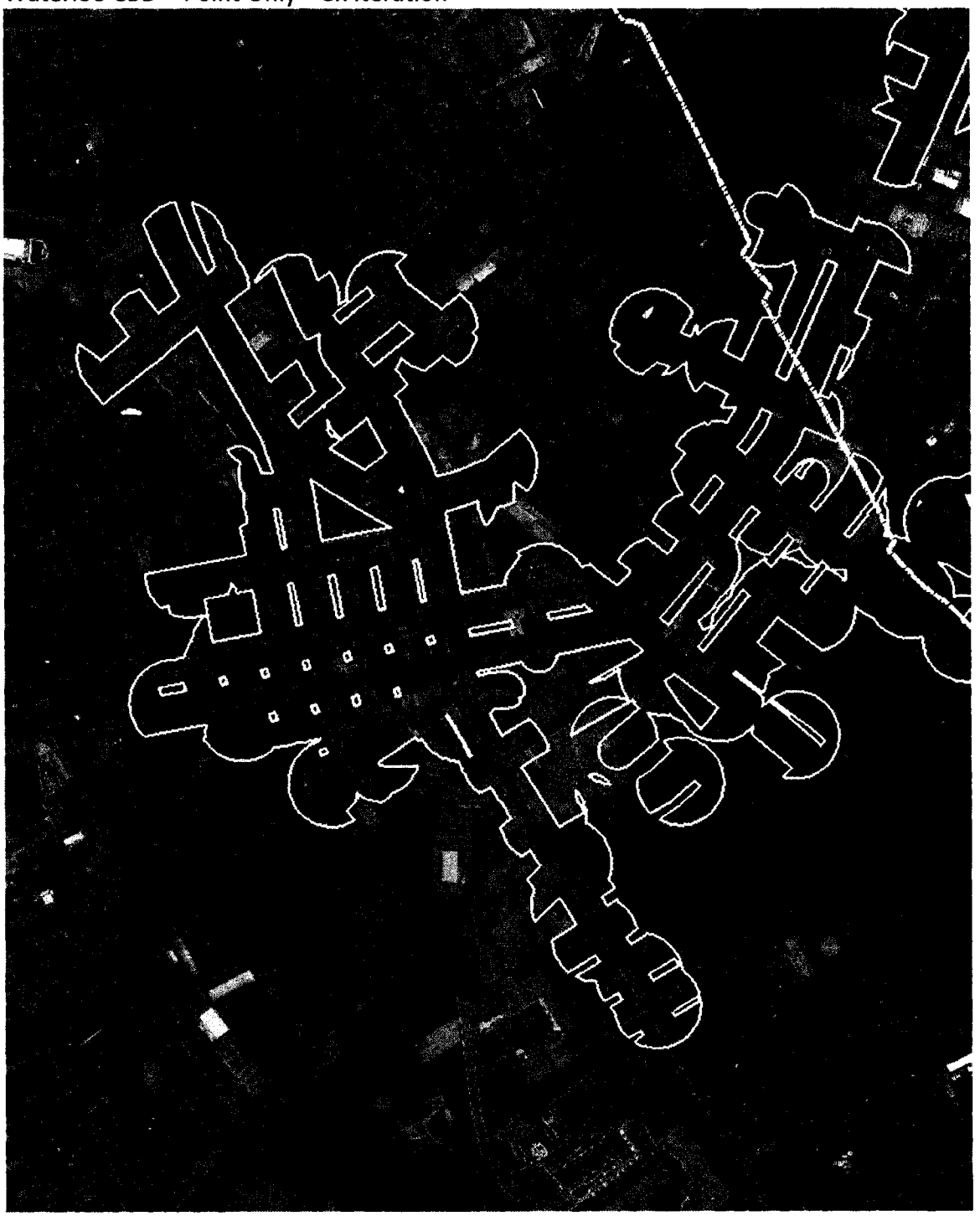
Waterloo CBD – Point Only – 1x Iteration



Waterloo CBD – Point Only – 2x Iteration



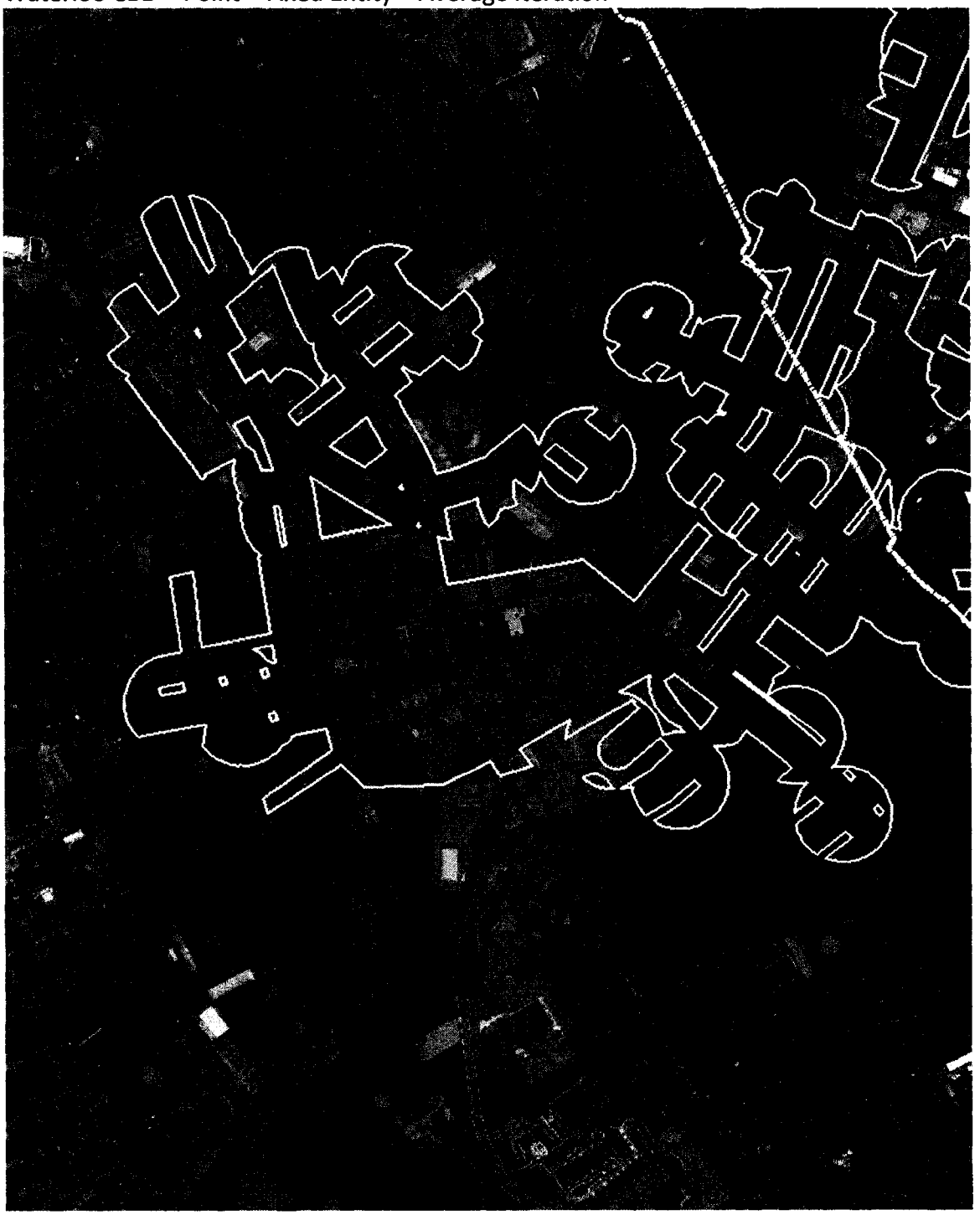
Waterloo CBD – Point Only – 3x Iteration



Waterloo CBD – Point Only – 4x Iteration

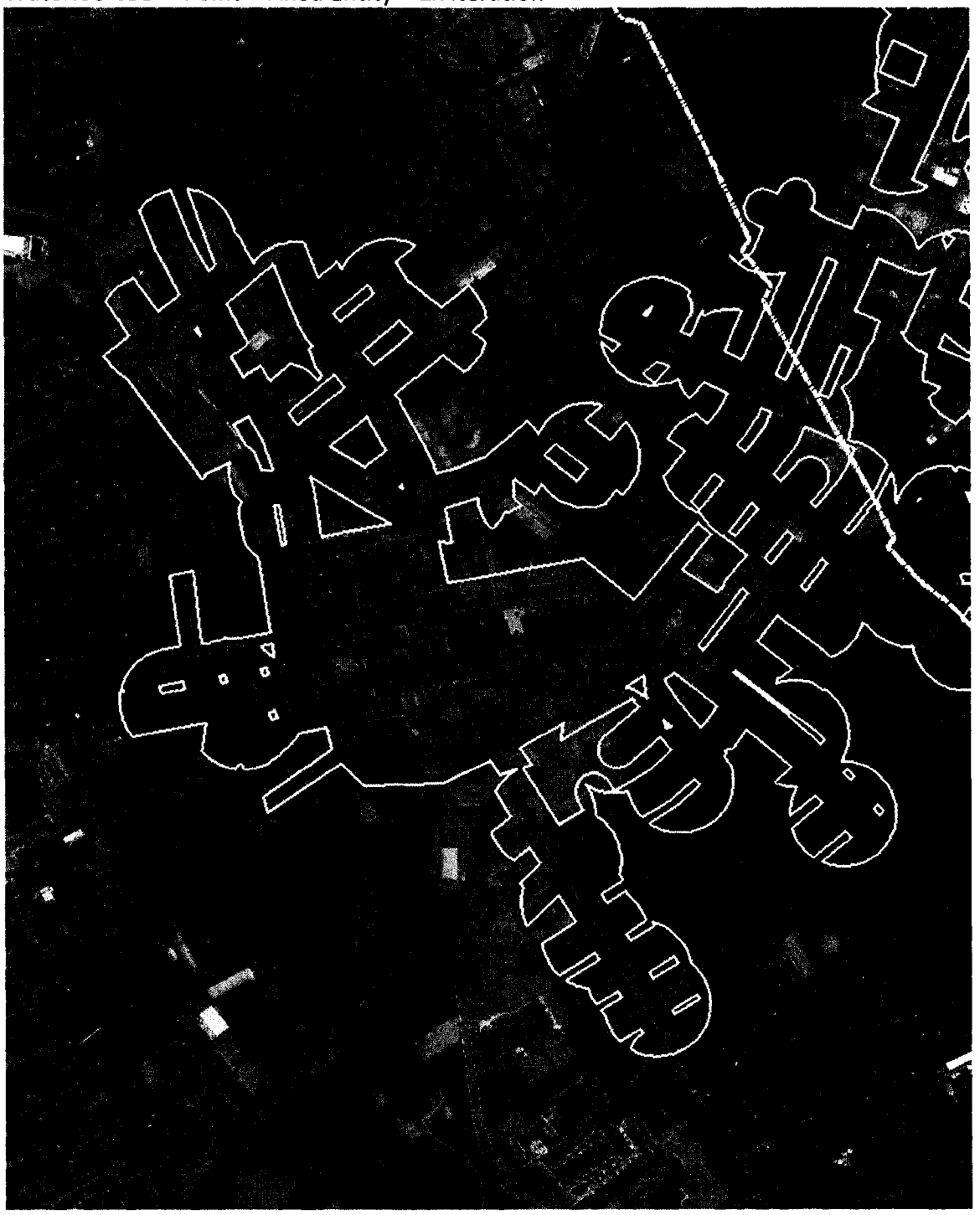
Waterloo CBD – Point Only – 5x Iteration

Waterloo CBD – Point + Fixed Entity – Average Iteration



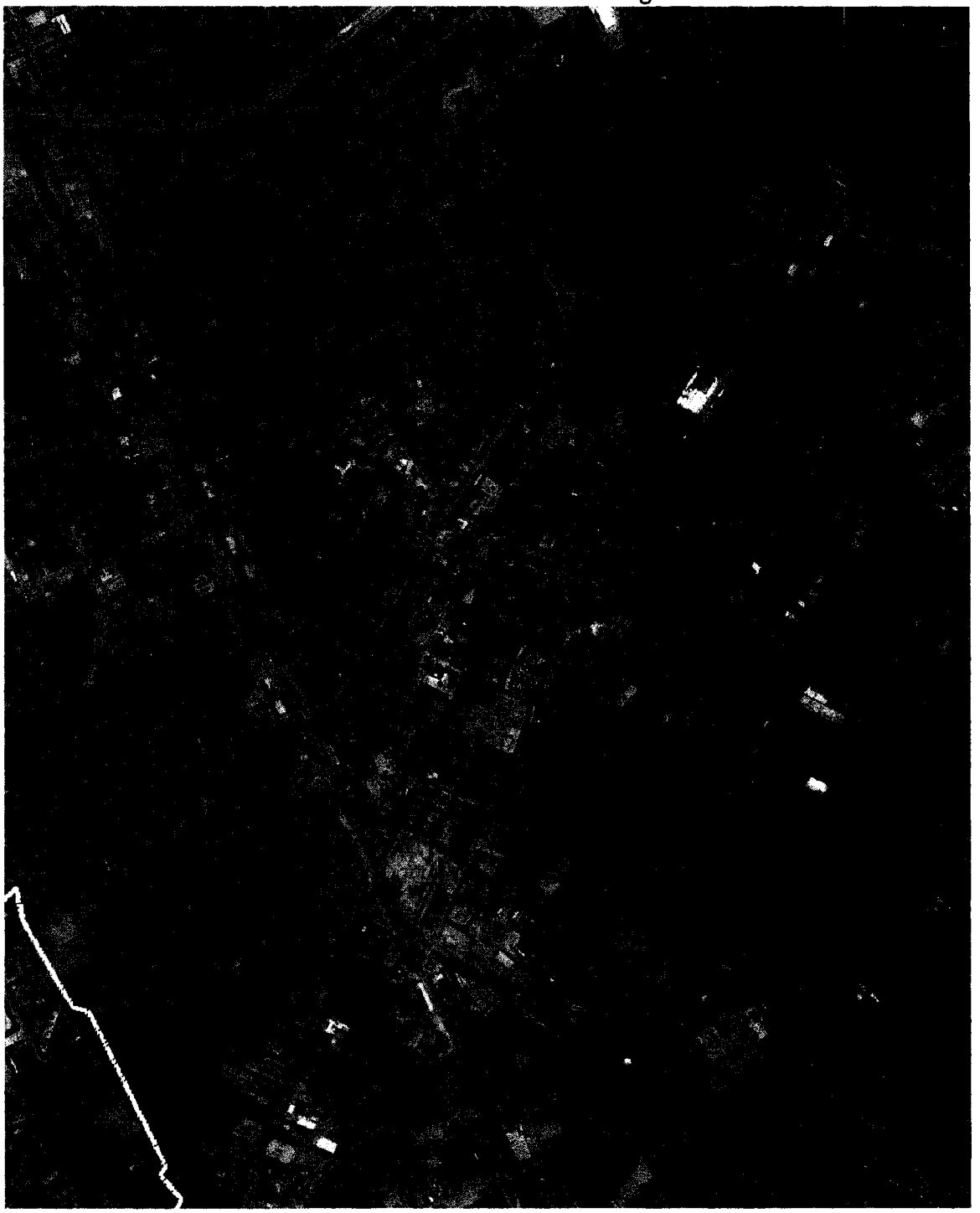
Waterloo CBD – Point + Fixed Entity – 1x Iteration

Waterloo CBD – Point + Fixed Entity – 2x Iteration

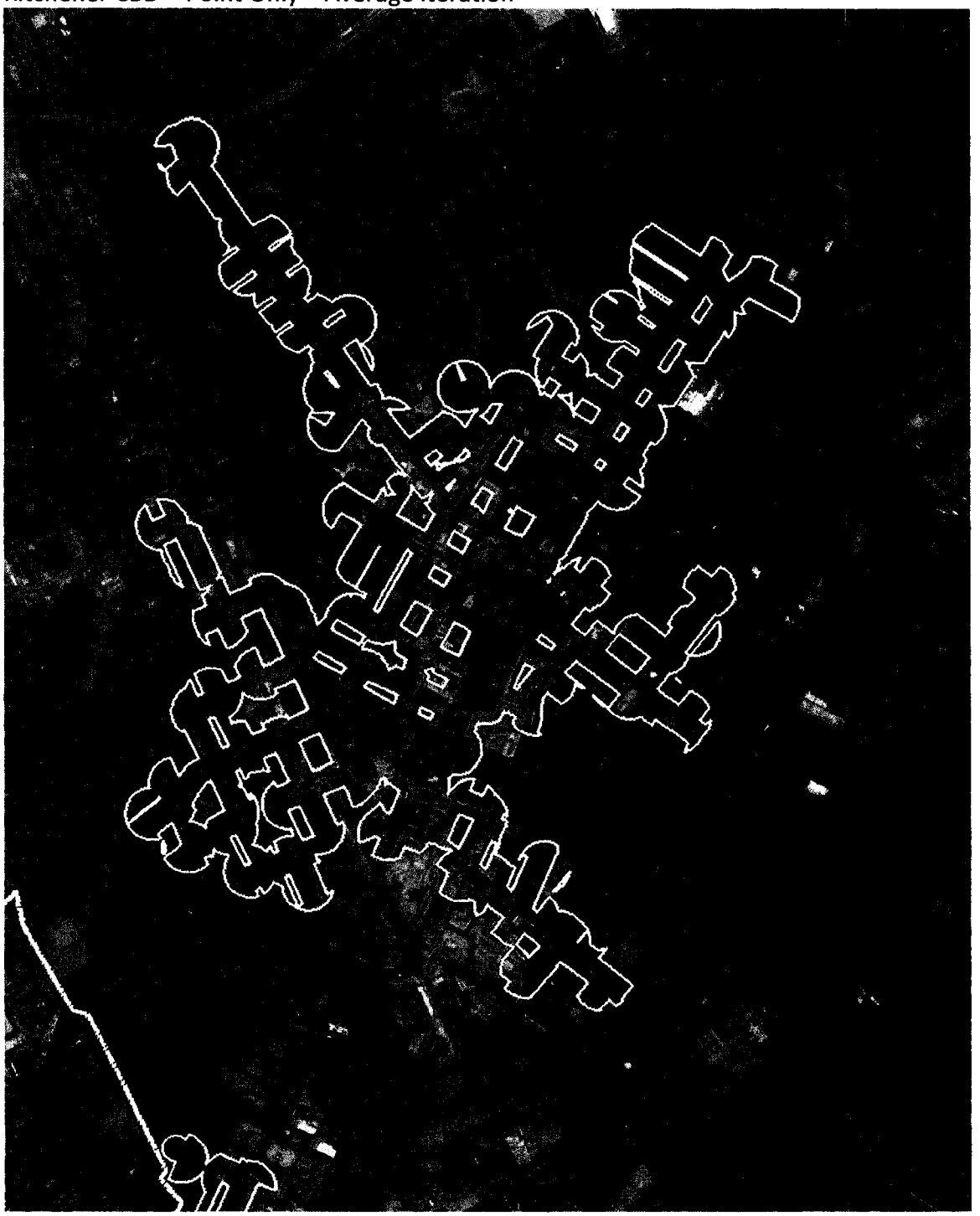


Waterloo CBD – Point + Fixed Entity – 3x Iteration

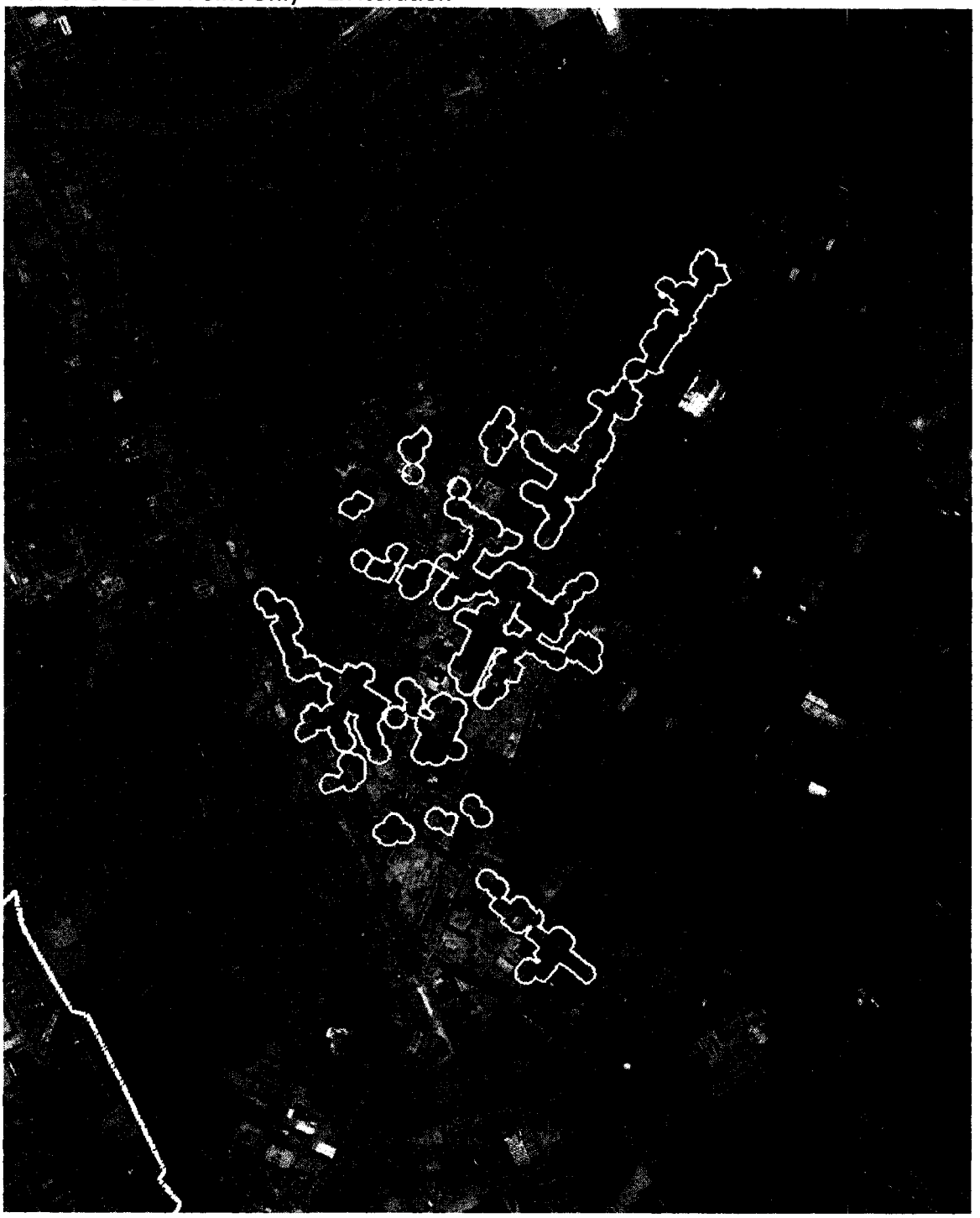
Kitchener CBD – Commercial Parcels and Land Use Planning Boundaries



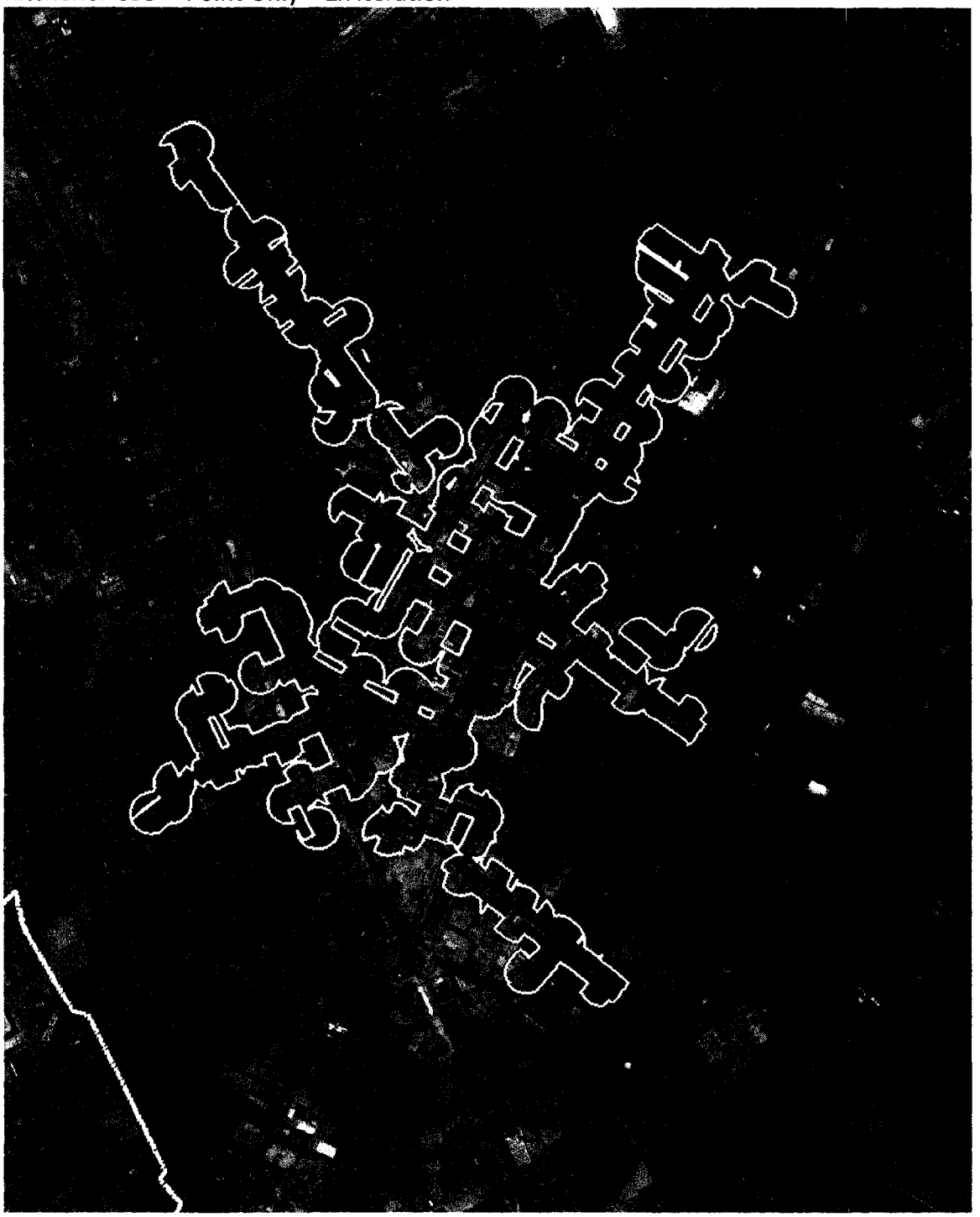
Kitchener CBD – Point Only – Average Iteration



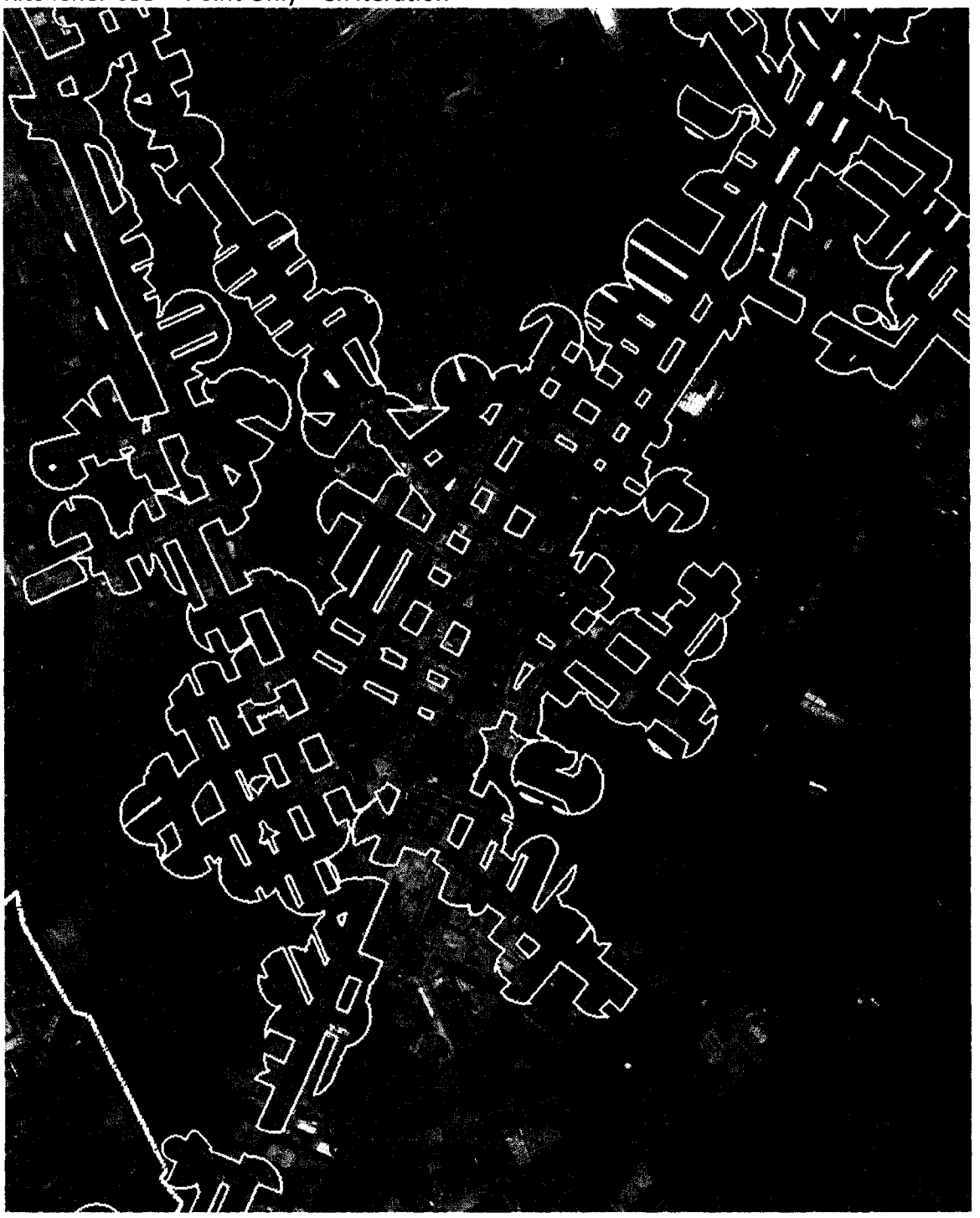
Kitchener CBD – Point Only – 1x Iteration



Kitchener CBD – Point Only – 2x Iteration

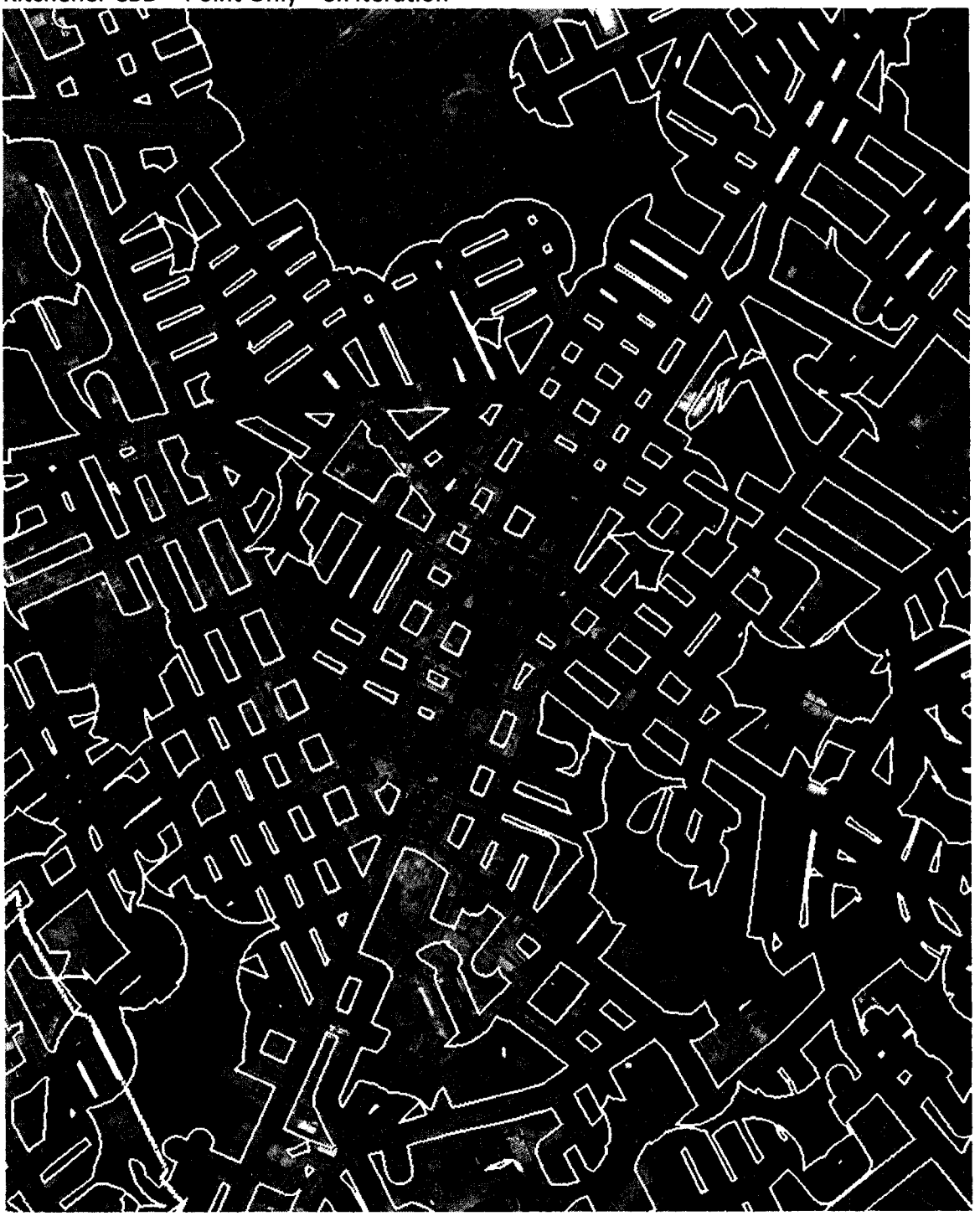


Kitchener CBD – Point Only – 3x Iteration



Kitchener CBD – Point Only – 4x Iteration

Kitchener CBD – Point Only – 5x Iteration

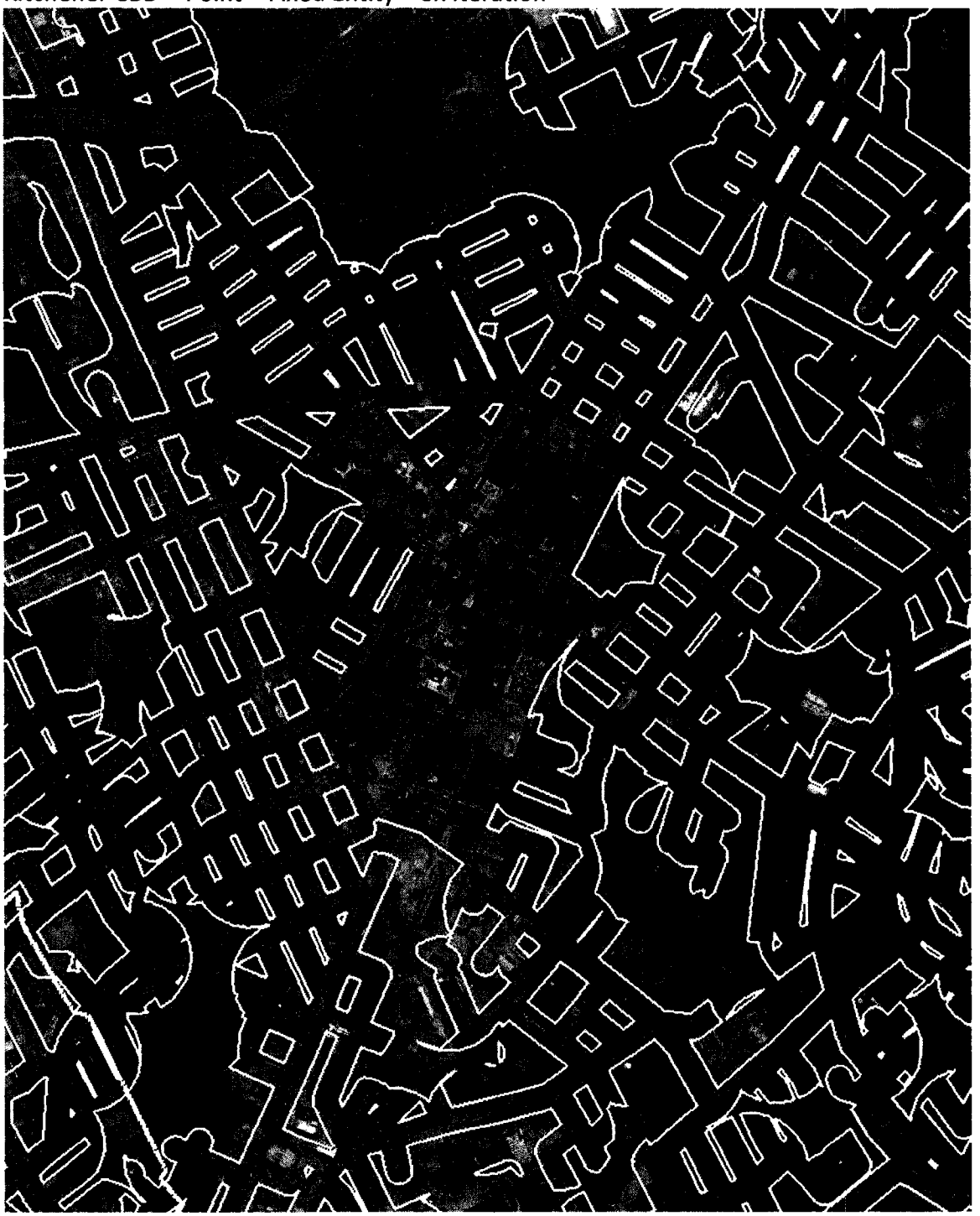


Kitchener CBD – Point + Fixed Entity – Average Iteration

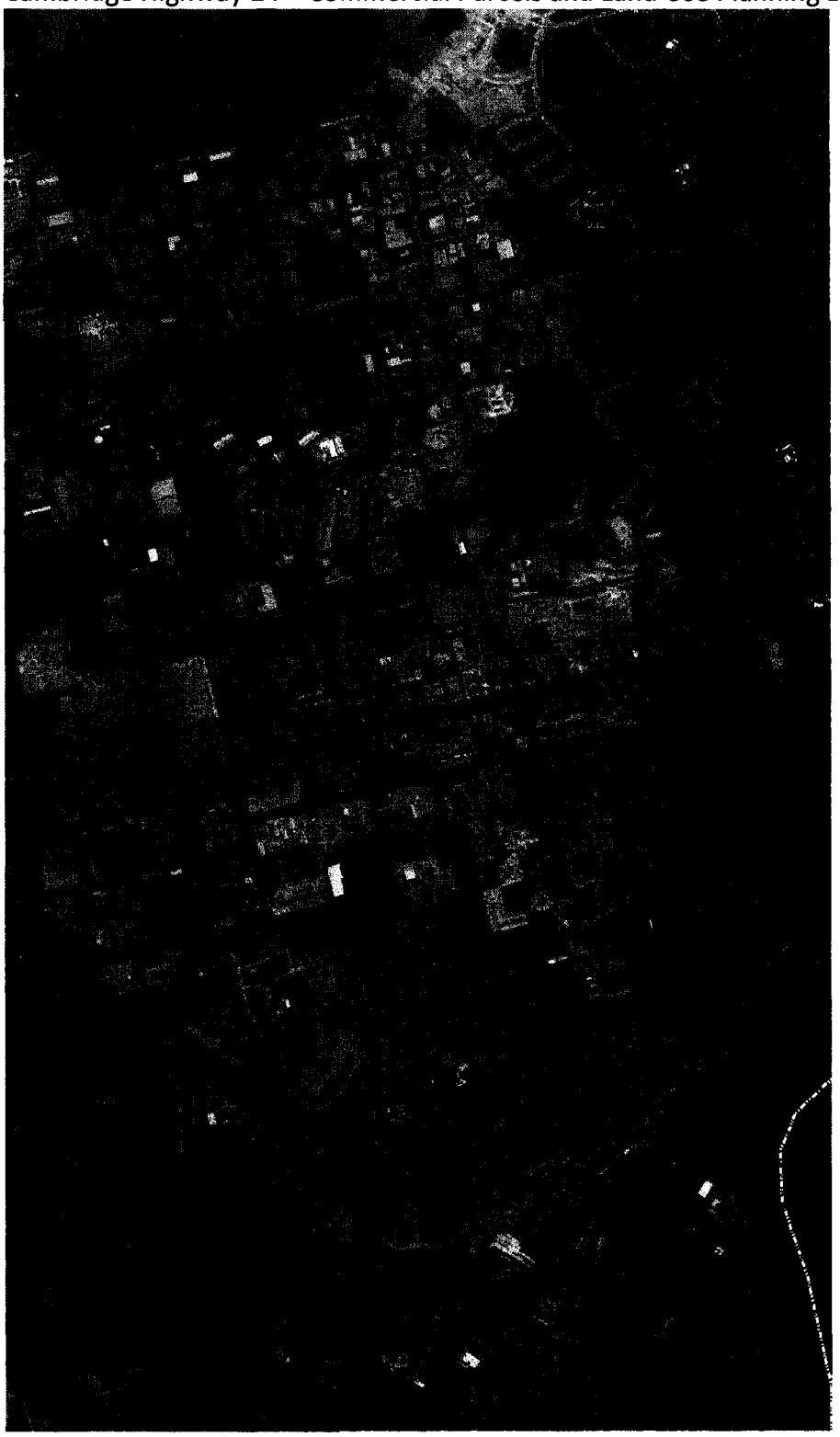
Kitchener CBD – Point + Fixed Entity – 1x Iteration

Kitchener CBD – Point + Fixed Entity – 2x Iteration

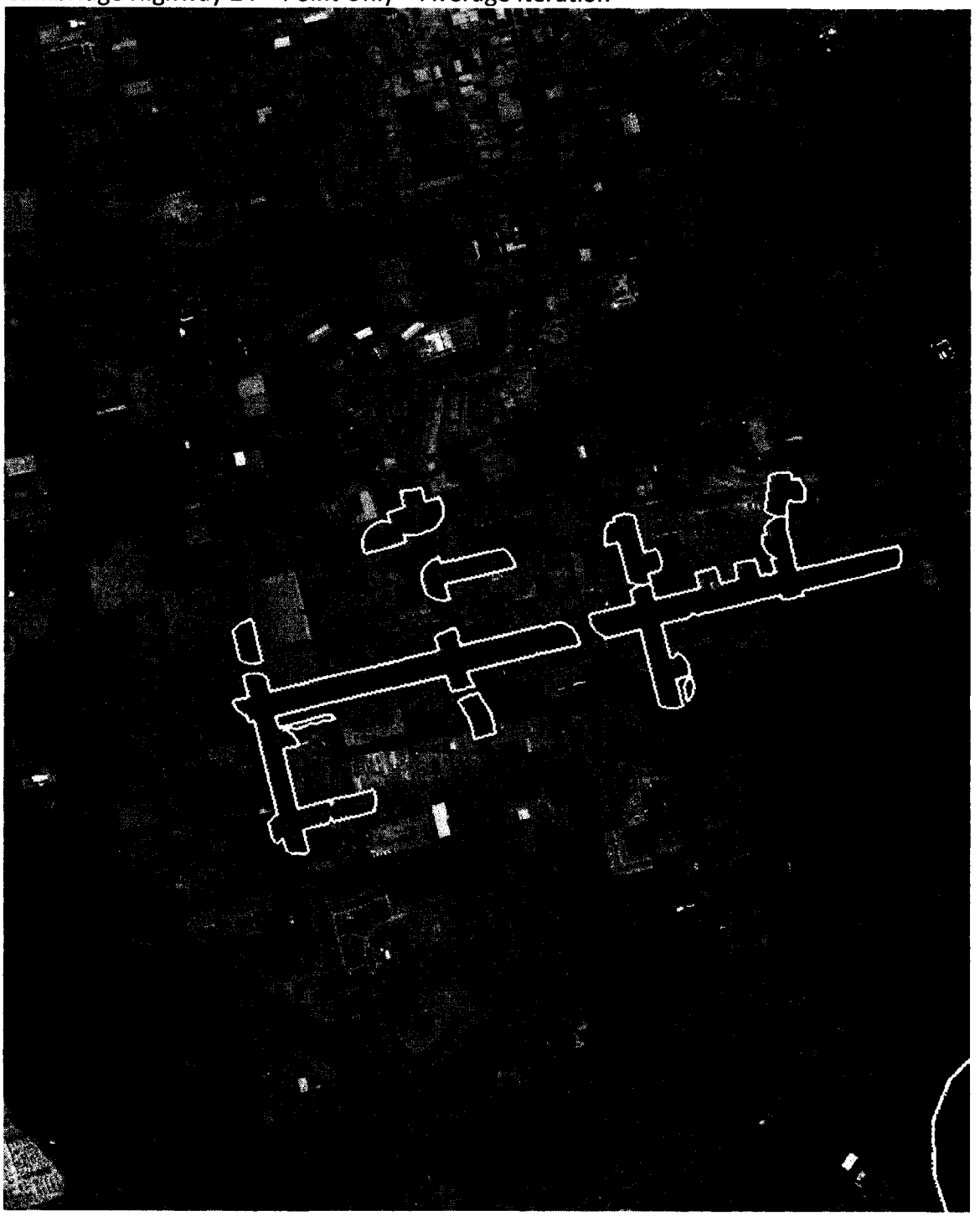
Kitchener CBD – Point + Fixed Entity – 3x Iteration



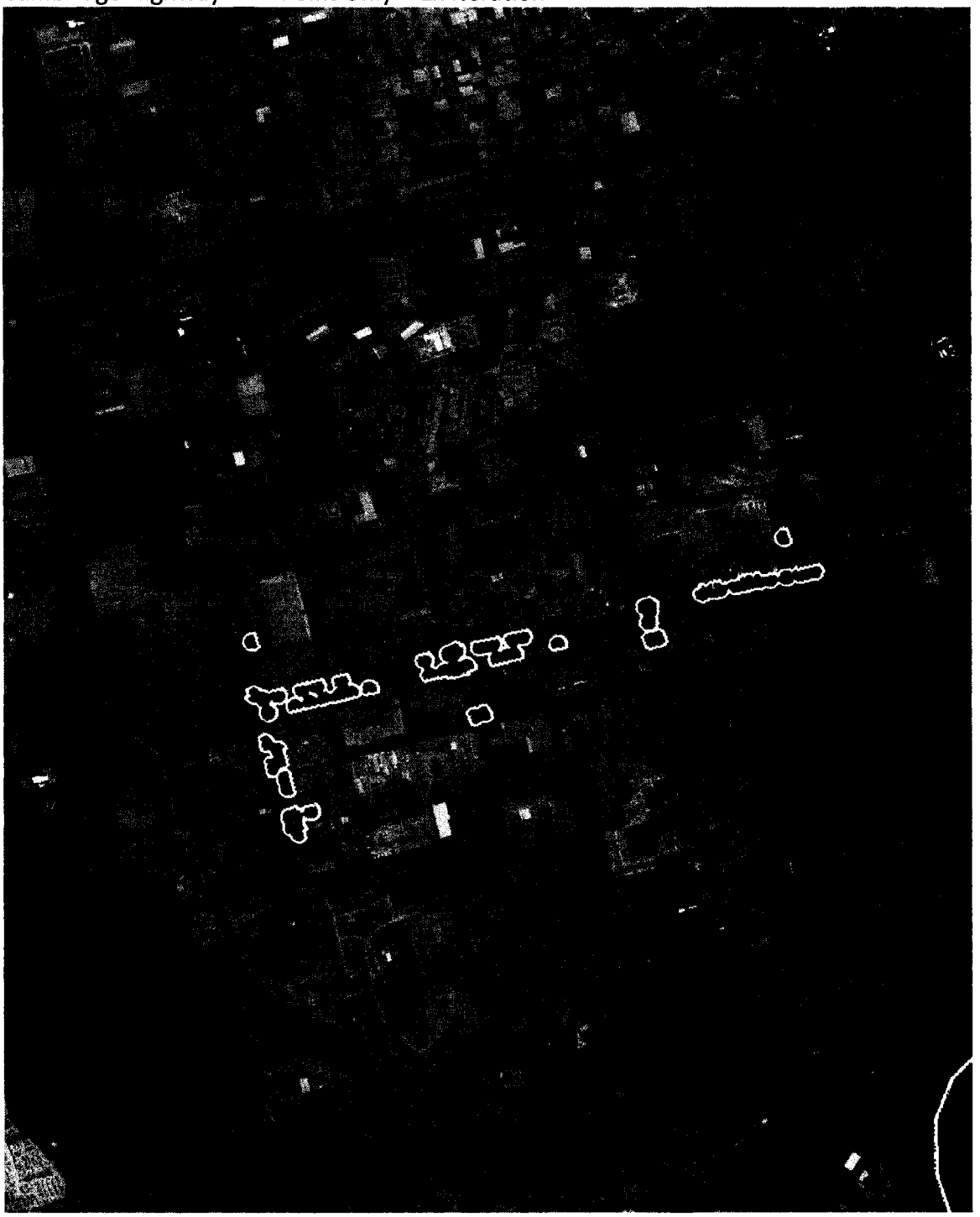
Cambridge Highway 24 – Commercial Parcels and Land Use Planning Boundaries



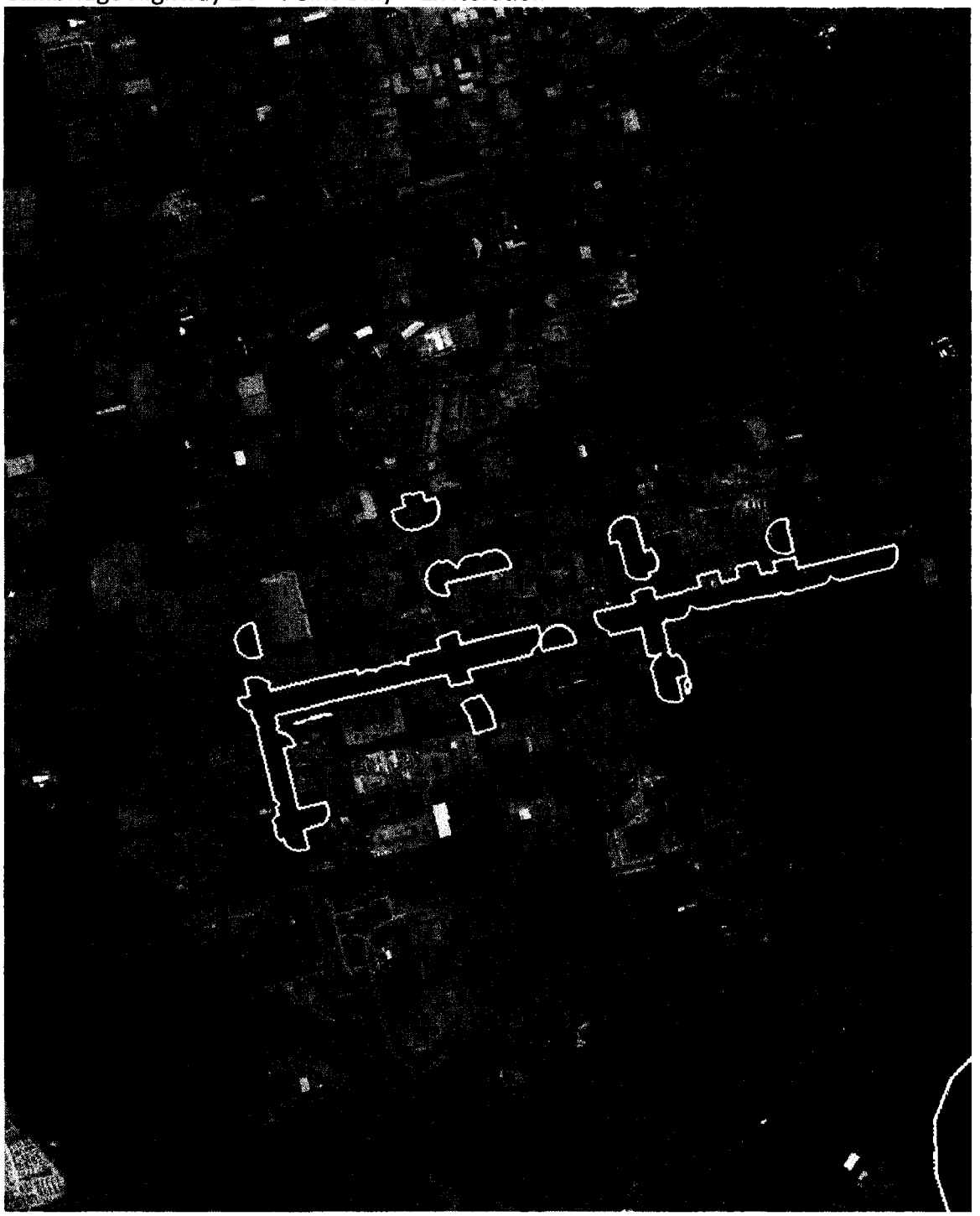
Cambridge Highway 24 – Point Only – Average Iteration



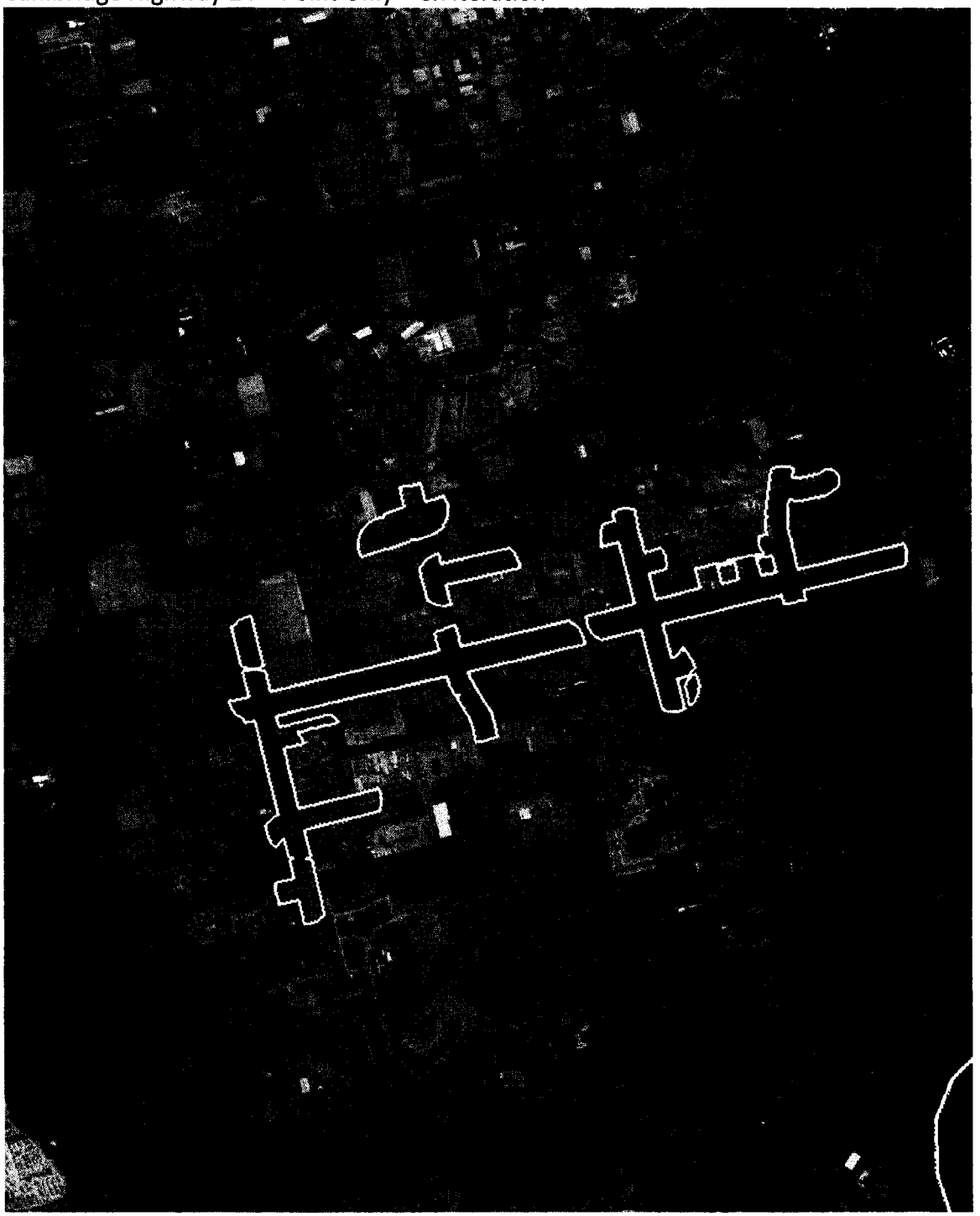
Cambridge Highway 24 – Point Only – 1x Iteration



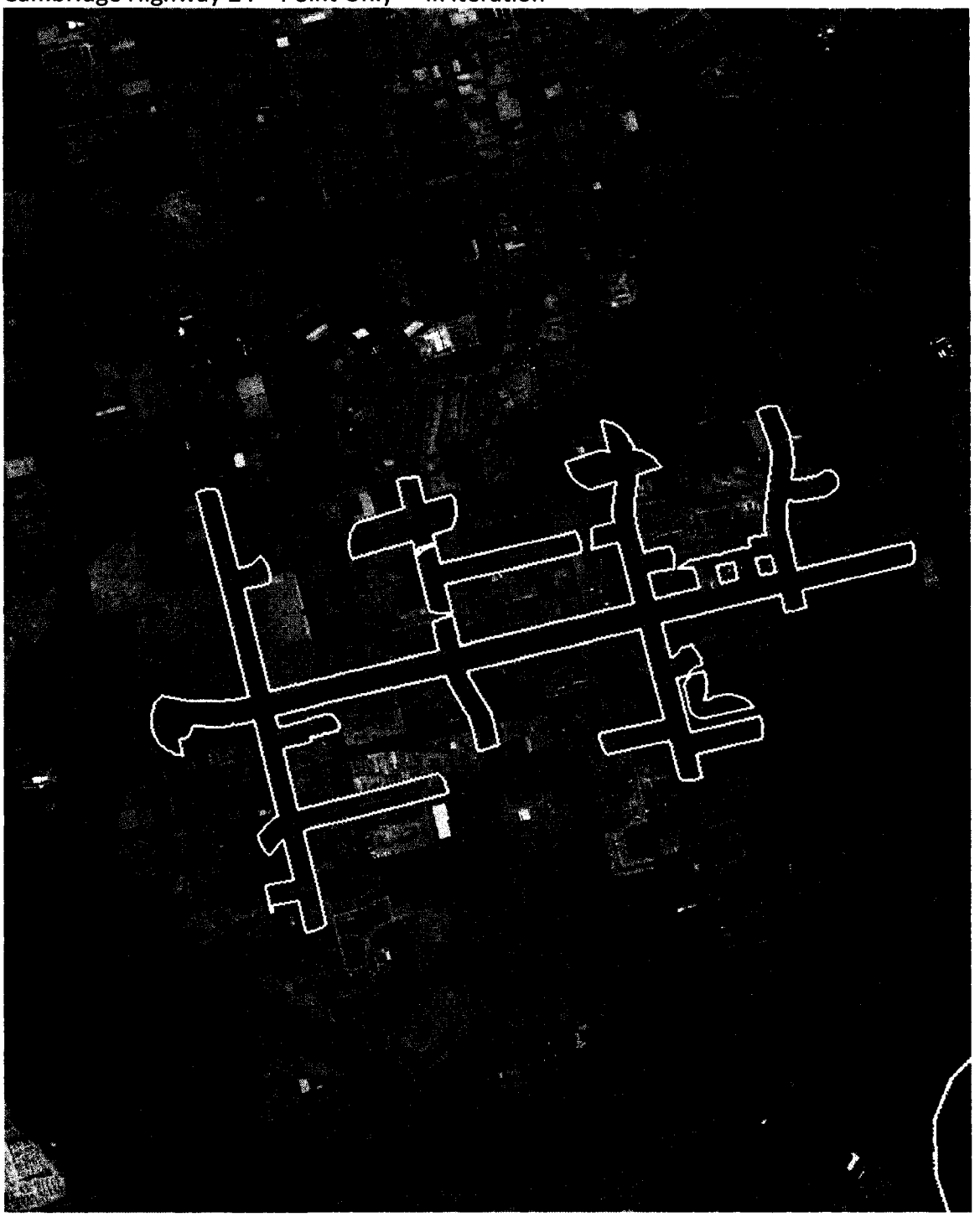
Cambridge Highway 24 – Point Only – 2x Iteration



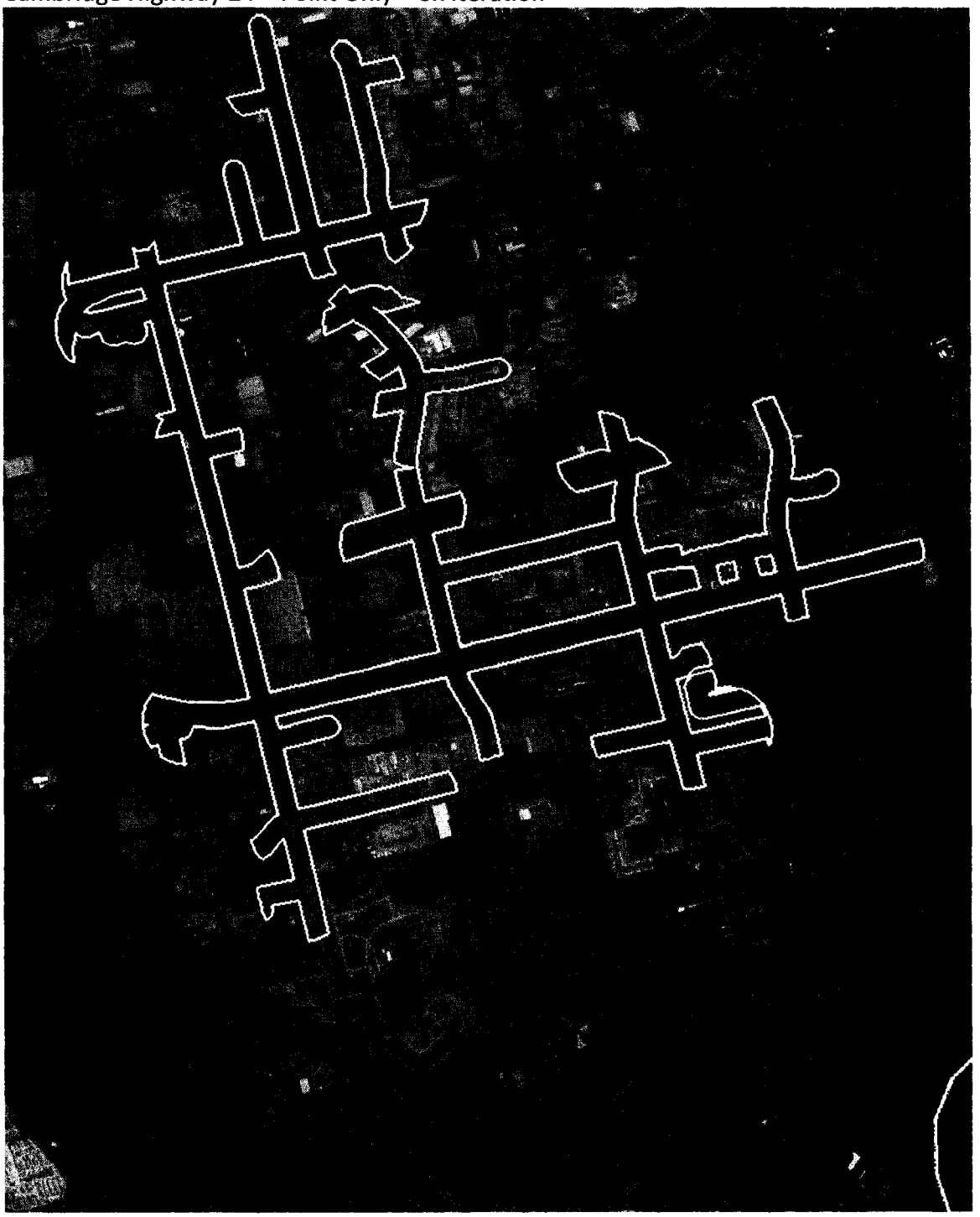
Cambridge Highway 24 – Point Only – 3x Iteration



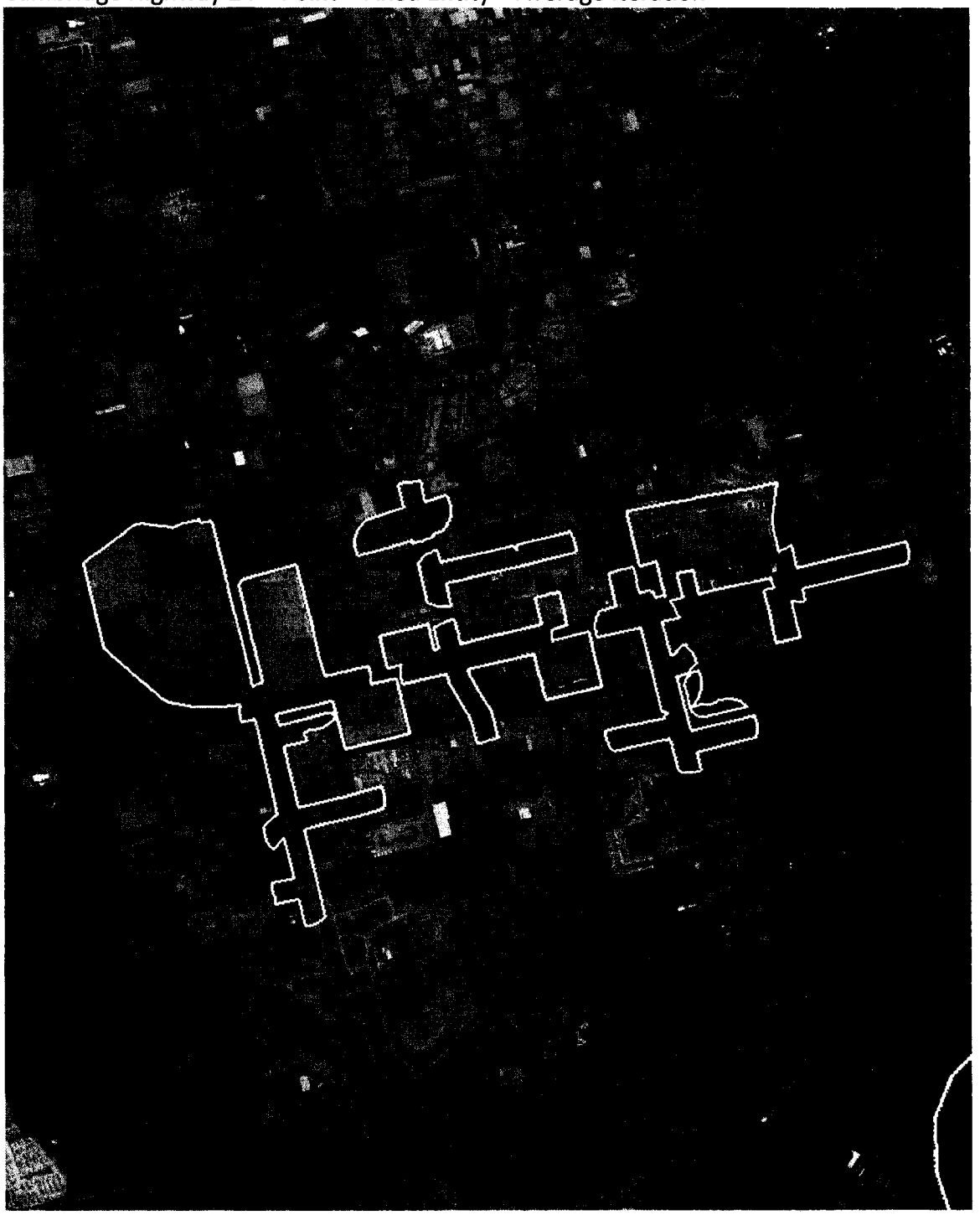
Cambridge Highway 24 – Point Only – 4x Iteration



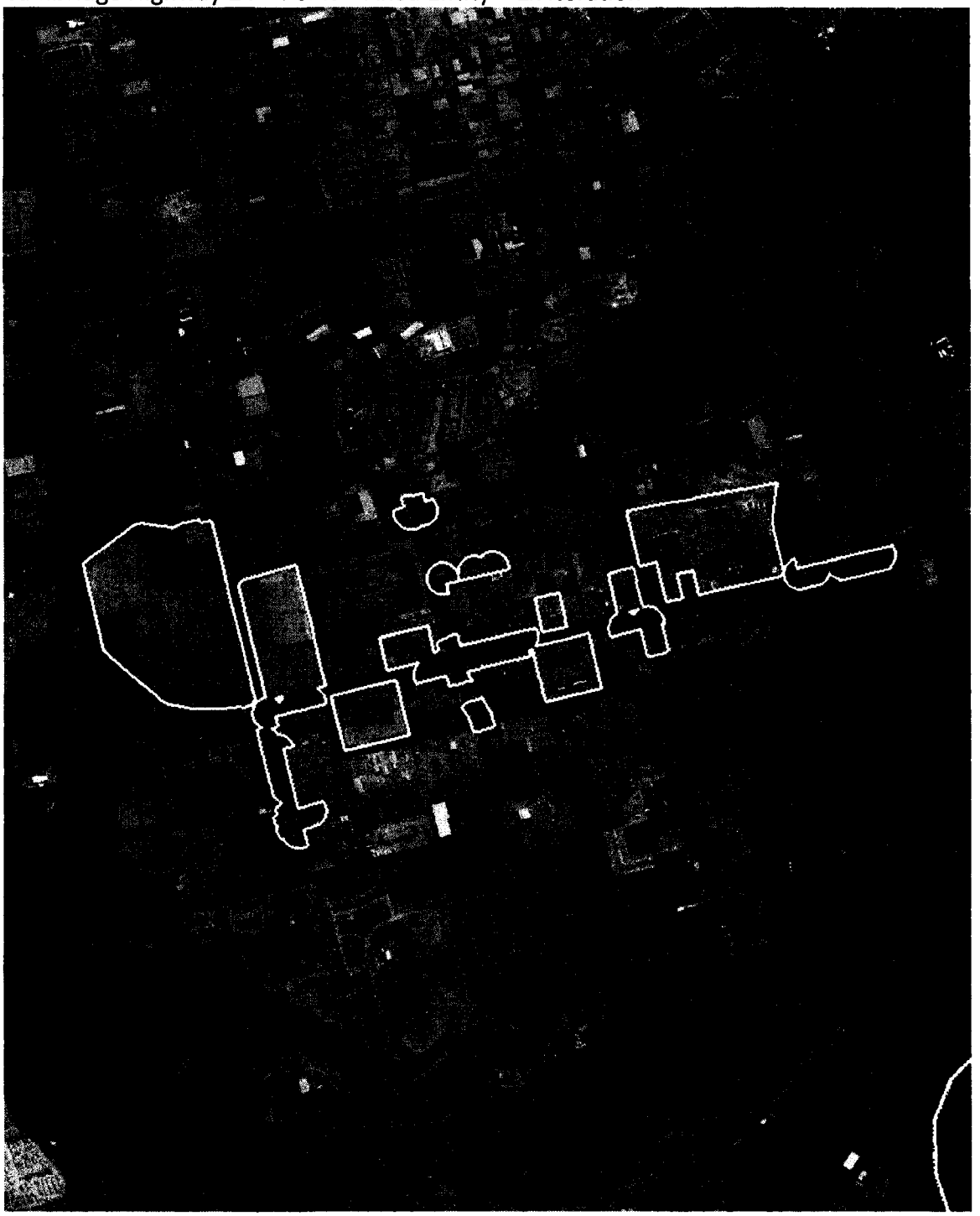
Cambridge Highway 24 – Point Only – 5x Iteration



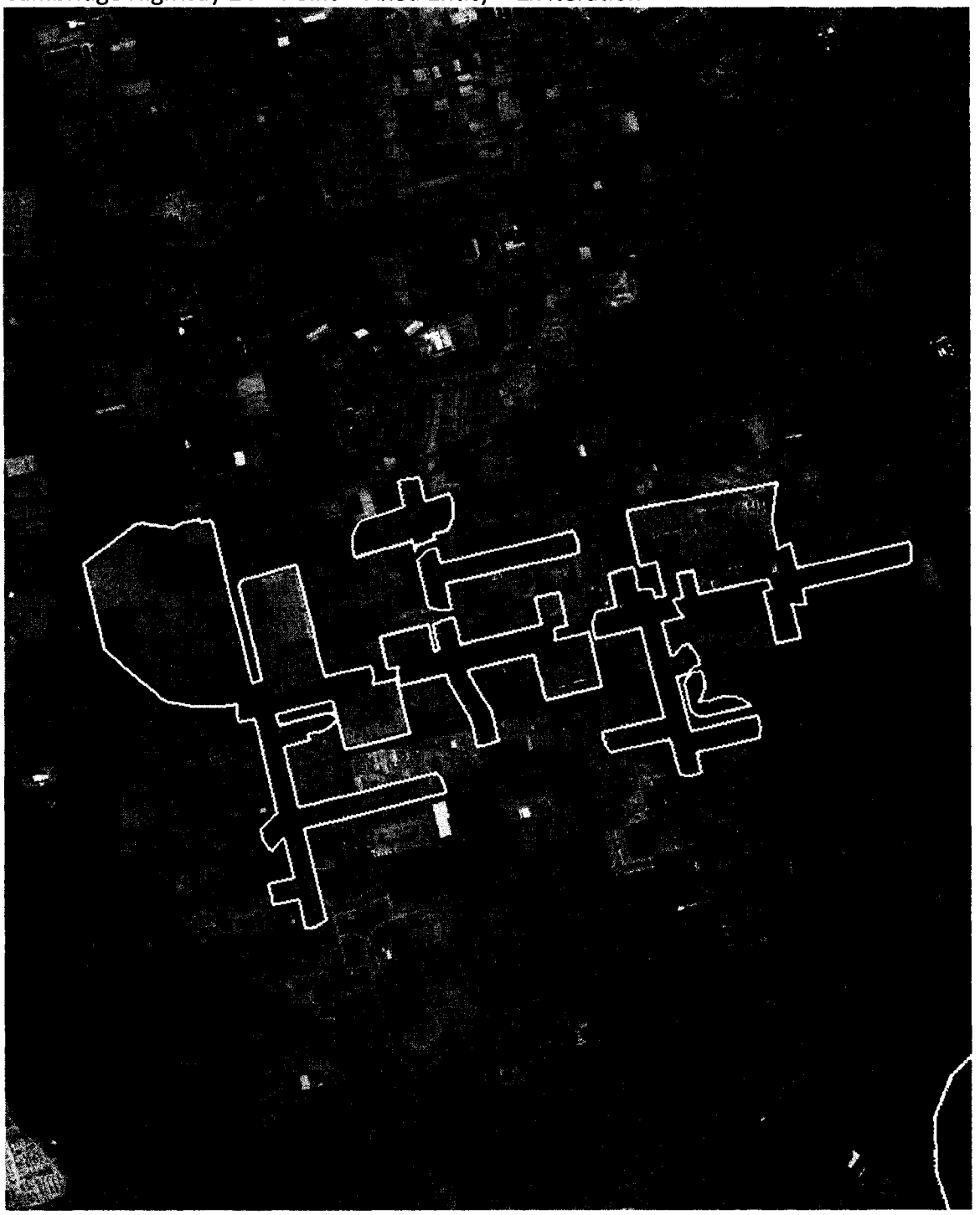
Cambridge Highway 24 – Point + Fixed Entity – Average Iteration



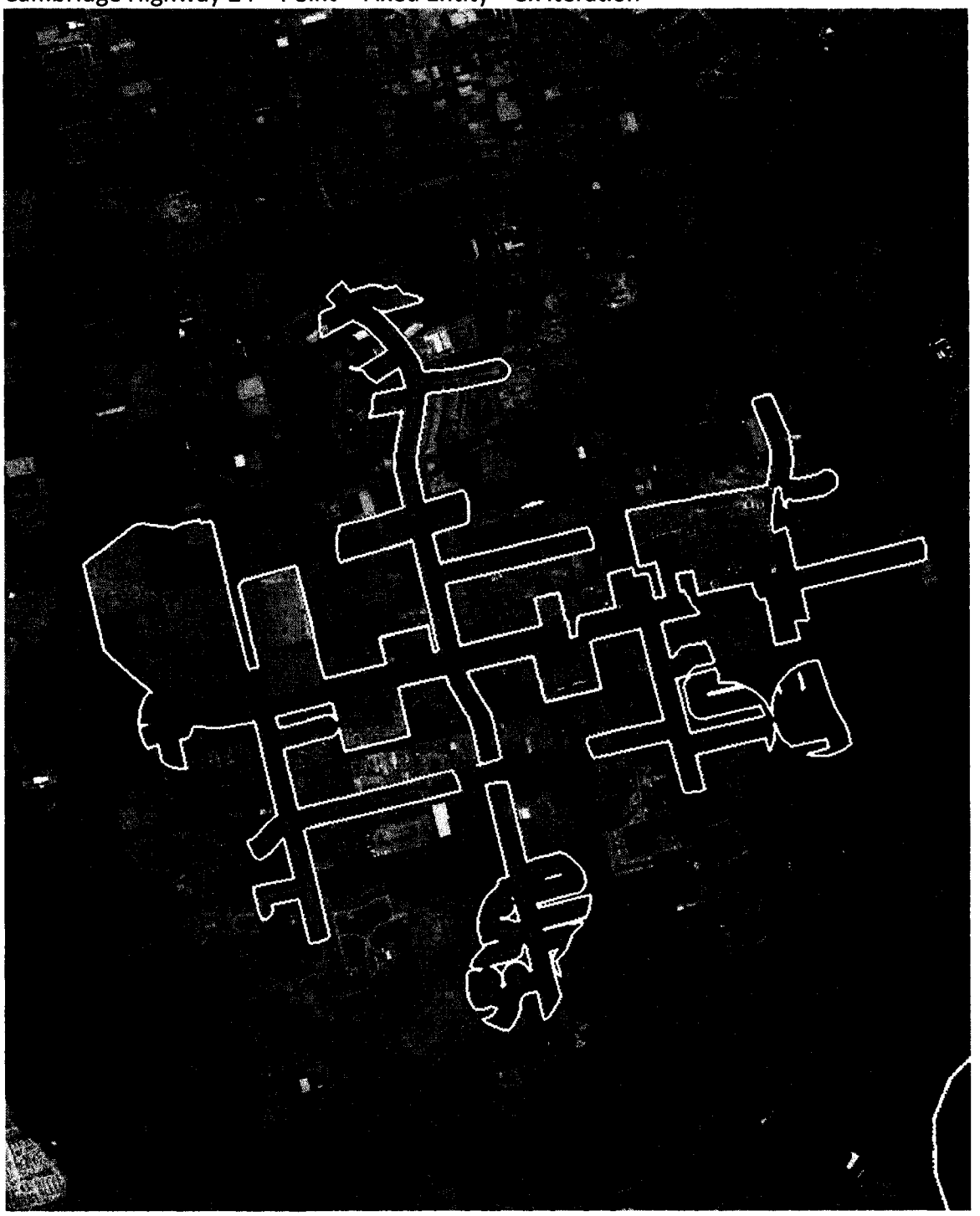
Cambridge Highway 24 – Point + Fixed Entity – 1x Iteration



Cambridge Highway 24 – Point + Fixed Entity – 2x Iteration



Cambridge Highway 24 – Point + Fixed Entity – 3x Iteration



Works Cited

The following citations represent material that has been used either directly or indirectly in the writing of this dissertation.

Adams, D. (1995). "The British Commercial Development Industry." European Planning Studies **3**(4): 531-862.

Adams, D., A. Disberry, et al. (2002). "Retail Location, Competition and Urban Redevelopment." The Services Industries Journal **22**(3): 135-148.

Adolphe, L. (2001). "A Simplified Model of Urban Morphology: An application to an Analysis of the Environmental Performance of Cities." Environment and Planning A **28**: 183-200.

Alperovich, G. (1995). "The Relationship Between Income Equality and City Size: A General Equilibrium Model of an Open System of Cities Approach." Urban Studies **32**(6): 853-862.

Alzubaidi, H., C. Vignali, et al. (1997). "Town Centre Versus Out-of-Town Shopping: A Consumer Perspective." International Journal of Retail and Distribution Management **25**(2): 78-89.

Anas, A. (1987). Modelling in Urban and Regional Economics. New York, Harwood Academic Publishers.

Anas, A., R. Arnott, et al. (1998). "Urban Spatial Structure." Journal of Economic Literature **36**(3): 1426-1464.

Anderson, W. P., P. S. Kanaroglou, et al. (1996). "Urban Form, Energy, and the Environment: A Review of Issues, Evidence and Policy." Urban Studies **33**(1): 7-35.

Arentze, T. A., A. Borgers, et al. (2000). "A Knowledge-Based System for Developing Retail Location Strategies." Computers, Environment and Urban Systems **24**: 489-508.

Arentze, T. A. and H. J. P. Timmermans (2000). "A Spatial Decision Support System for Retail Plan Generation and Impact Assessment." Transportation Research Part C **8**: 261-380.

Arnold, S. J. (2000). "Editorial: Market Impacts of Large Format Retailers." Journal of Retailing and Consumer Services **7**: iii-v.

Arnold, S. J., J. Handelman, et al. (1998). "The Impact of Market Spoiler on Consumer Preferences (or, what happens when Wal-Mart comes to town)." Journal of Retailing and Consumer Services **5**(1): 1-13.

Atkinson, P. M. and N. J. Tate (2000). "Spatial Scale Problems and Geostatistical Solutions: A Review." Professional Geographer **52**(4): 607-623.

Axenov, K. E., E. Bondarchuk, et al. (1997). "The New Retail Trade in Services and Their Emerging Location Patterns in St. Petersburg." GeoJournal **42**(4): 403-417.

Banai, R. (1998). "The New Urbanism: An Assessment of the Core Commercial Areas, with Perspectives from (Retail) Location and Land-Use Theories, and the Conventional Wisdom." Environment and Planning B **25**: 168-185.

Barrett, H., D. Storey, et al. (2001). "From market place to marketing place: Retail change in small country towns - The changing urban hierarchy." Geography **86**: 159-163.

Batty, M. (1999). "Editorial: A Research Programme for Urban Morphology." Environment and Planning A **26**: 475-476.

Batty, M. (2001). "Polynucleated Urban Landscapes." Urban Studies **38**(4): 635-655.

Bell, D. R. and J. M. Lattin (1998). "Shopping Behaviour and Consumer Preference for Store Price Format: Why "Large Basket" Shoppers Prefer EDLP." Marketing Science **17**(1): 66-88.

Bell, S. J. (1999). "Image and Consumer Attraction to Intraurban Retail Areas: An Environment Psychology Approach." Journal of Retailing and Consumer Services **6**: 67-78.

Benito-Gonzalez, O., M. Greatorex, et al. (2000). "Assessment of Potential Retail Segmentation Variables: An Approach Based on Subjective MCI Resource Allocation Model." Journal of Retailing and Consumer Services **7**: 171-179.

Bennett, R. J., D. J. Graham, et al. (1999). "The Location and Concentration of Businesses in Britain: Business Clusters, Business Services, Market Coverage and Local Economic Development." Transactions of the Institute of British Geographers **24**(4): 393-420.

Benoit, D. and G. P. Clarke (1997). "Assessing GIS for Retail Location Planning." Journal of Retailing and Consumer Services **4**(4): 239-258.

Berke, P. R. and M. M. Conroy (2000). "Are We Planning for Sustainable Development: An Evaluation of 30 Comprehensive Plans." Journal of the American Planning Association **66**(1): 239-258.

Bernat, G. A. (1999). "Economic Growth Theory: Clustering and the Rise of the South." Review of Regional Studies **29**(1): 1-12.

Berry, B. J. L. (1959). "Ribbon Development in the Urban Business Pattern." Association of American Geographers **49**: 145-154.

Berry, B. J. L. (1963). Commercial Structure and Commercial Blight. Chicago, University of Chicago.

Berry, B. J. L. (1997). "Long Waves and Geography in the 21st Century." Future **29**(4/5): 301-310.

Berry, B. J. L. and J. B. Parr (1988). Market Centres and Retail Location. New Jersey, Prentice Hall.

Black, D. and V. Henderson (1999). "A Theory of Urban Growth." Journal of Political Economy **107**(2): 252-284.

Bloom, P. N. and V. G. Perry (2001). "Retailer power and supplier welfare: The case of Wal-Mart." Journal of Retailing **77**(3): 379-396.

Boal, F. W. and D. B. Johnson (1965). "The Funcitons of Retail and Service Establishments on Commercial Ribbons." The Canadian Geographer **IX**(3): 154-169.

Bond, D. (2002). "GIS and Spatial Analysis in Urban and Regional Research." Retrieved Jan 21, 2002, from http://www.car.busmgt.ulst.ac.uk/papers/gis.pdf.

Borchert, J. G. (1998). "Spatial Dynamics of Retail Structure and the Venerable Retail Hierarchy." GeoJournal **45**: 327-336.

Bourne, L. S. (1971). The Internal Structure of the City: Readings on Space and the Environment. Toronto, Oxford University Press.

Bourne, L. S. (1987). "Evaluating the Aggregate Spatial Structure of Canadian Metropolitan Areas." The Canadian Geographer **31**(3): 194-208.

Bourne, L. S. (1989). "Are New Urban Forms Emerging? Empirical Tests for Canadian Urban Areas." The Canadian Geographer **33**(4): 312-328.

Bourne, L. S. (1989). On the Spatial Structure of Metropolitan Areas in Canada: A Discriminant Analysis. Toronto, Centre for Urban and Community Studies.

Bourne, L. S. (1996). "Presidential Address -- Normative Urban Geographies: Recent Trends, Competing Visions and New Cultures of Regulation." The Canadian Geographer **40**(1): 2-16.

Bourne, L. S. (1996). "Reinventing the Suburbs: Old Myths and New Realities." Progress in Planning **46**(3): 163-183.

Bourne, L. S. (1997). "Polarities of Structure and Change in Urban Systems: A Canadian Example." GeoJournal **43**(3): 339-349.

Bourne, L. S. (1998). "Wither Urban Systems? A Commentary on Research Needs and the Marketing of Ideas." Canadian Journal of Regional Science **XXI**(3): 335-339.

Bourne, L. S. and A. Lorius (1999). "How Similar are Urban Neighborhoods in Canada? A Classification Based on External Environments." Canadian Journal of Urban Research **8**(2): 143-171.

Brail, R. K. and L. L. Wiggins. (2002). "Using GIS in Urban Planning Analysis." Retrieved Jan 21, 2002, from http://www.ivav.unive.it/stratema/cupum/pdf/G0.pdf.

Bridge, G. and R. Dowling (2001). "Microgeographies of Retailing and Gentrification." Australian Geographer **32**(1): 93-107.

Broadway, M. J. (1995). "The Canadian Inner City 1971-1991: Regeneration and Decline." Canadian Journal of Urban Research **4**(1): 1-19.

Broadway, M. J. and G. Jesty (1998). "Are Canadian Inner Cities Becoming More Dissimilar? An Analysis of Urban Deprivation Indicators." Urban Studies **35**(9): 1423-1438.

Bromley, R. D. F. and C. J. Thomas (1993). Retail Change. London, UCL Press Limited.

Bromley, R. D. F. and C. J. Thomas (1993). "The Retail Revolution, the Careless Shoppper and Disadvantage." Transactions of the Institute of British Geographers **18**(2): 222-236.

Brooks, G. R. (1995). "Defining Market Boundaries." Strategic Management Journal **16**: 535-549.

Brown, S. (1986). "Crisis-Response and Retail Change in Belfast City Centre." Irish Geography **19**: 83-91.

Brown, S. (1987). "The Complex Model of City Center Retailing: An Historical Application." Transactions of the Institute of British Geographers **12**(1): 4-18.

Brown, S. (1987). "The Microlocational Perceptions of City Center Retailers." Transactions of the Institute of British Geographers **12**(3): 337-344.

Brown, S. (1991). "Retail Location: The Post Hierarchical Challenge." International Review of Retail Distribution and Consumer Research **1**(3): 367-381.

Brown, S. (1993). "Micro-Scale Retail Location: Condrella or Ugly Sister?" International Journal of Retail and Distribution Management **21**(7): 10-20.

Brown, S. (1994). "Retail Location at the Micro-Scale: Inventory and Prospect." The Services Industries Journal **14**(4): 542-576.

Buckwalter, D. W. (1990). "Diverse Retail Structure and Christaller's Separation Principle in Medium-Sized Metropolitan Areas." Growth and Change **21**(2): 15-33.

Bunting, T. E. and P. Filion (1994). Assessing Urban Renewal: The Changing Geography of Main Street and the Public Sector Connection. Public Issues: A Geographical Perspective. J. Andrey and G. J. Nelson. Waterloo, University of Waterloo Department of Geography: 159-181.

Bunting, T. E. and P. Filion (1999). "Dispersed City Form in Canada: A Kitchener CMA Case Example." The Canadian Geographer **43**(3): 268-287.

Bunting, T. E. and P. Filion, Eds. (2000). Canadian Cities in Transition: The Twenty-First Century. Toronto, Oxford University Press.

Bunting, T. E. and H. Millward (1998). "A Tale of Two CBDs I: The Decline and Revival (?) of Downtown Retailing in Halifax and Kitchener." Canadian Journal of Urban Research **7**(2): 139-167.

Burt, S. and L. Sparks (2003). "E-Commerce and the Retail Process: A Review." Journal of Retailing and Consumer Services **10**: 275-286.

Burton, E. (2000). "The Compact City: Just or Just Compact? A Preliminary Analysis." Urban Studies **37**(11): 1969-2001.

Canada, Statistics. (2003). "Canadian Census." Retrieved November 21, 2003, from www.statcan.ca.

Casparis, J. (1969). "Shopping Center Location and Retail Store Mix in Metropolitan Areas." Demography **6**(2): 125-131.

Chorley, R. J. and P. Haggett (1967). Socio-Economic Models in Geography. London, Methuen.

Clark, G. L., M. P. Feldman, et al. (2000). Economic Geography: Transition and Growth. The Oxford Handbook of Economic Geography. G. L. Clark, M. P. Feldman and M. S. Gertler. New York, Oxford University Press: 3-17.

Clarke, G. (1998). "Changing Methods of Location Planning for Retail Companies." GeoJournal **45**: 289-298.

Clarke, G. (1999). Geodemographics, Marketing and Retail Location. Applied Geography: Principles and Practice. M. Pacione. London, Routledge: 577-592.

Clarke, G., H. Eyre, et al. (2002). "Deriving Indicators of Access to Food Retail Provision in British Cities: Studies of Cardiff, Leeds and Bradford." Urban Studies **39**(11): 2041-2060.

Clarke, I. (1993). Managing Location. Papers and Proceedings Proceedings Applied Geography Conferences. J. W. Frazier, B. J. Epstein, F. A. Schoolmaster III, K. G. Jones and N. J. Siller. Binghamton, SUNY Binghamton. **16:** 123-129.

Clarke, I., D. Bennison, et al. (1997). "Towards a Contemporary Perspective of Retail Location." International Journal of Retail and Distribution Management **25**(2): 59-69.

Clarke, I., A. G. Hallswort, et al. (2004). "Retail Competition and Consumer Choice: Contextualizing the "Food Deserts" Debate." International Journal of Retail and Distribution Management **32**(2): 89-99.

Clarke, M. and A. G. Wilson (1985). "The Dynamics of Urban Spatial Structure: The Progress of a Research Programme." Transactions of the Institute of British Geographers **10**: 427-451.

Cliquet, G. (2000). "Large Format Retailers: A French Tradition Despite Reactions." Journal of Retailing and Consumer Services **7**: 183-195.

Coffey, W. J. (1998). "Urban Systems Research: An Overview." Canadian Journal of Regional Science **XXI**(3): 327-334.

Coffey, W. J. (2000). "The Geographies of Producer Services." Urban Geography **21**(2): 170-183.

Coffey, W. J. and R. D. Polèse (1996). "Examining the Thesis of Central Business District Decline: Evidence from the Montreal Metropolitan Area." Environment and Planning A **28**: 1795-1814.

Cohen, S. B. and G. K. Lewis (1967). "Form and Function in the Geography of Retailing." Economic Geography **43**(1): 1-42.

Combes, P.-P. (2000). "Economic Structure and Local Growth: France 1984-1993." Journal of Urban Economics **47**: 329-355.

Corporation, City of Greater Sudbury Economic Development (2000). "Demographic Profile." 2003.

Crewe, L. (2000). "Geographies of Retailing and Consumption." Progress in Human Geography **24**(2): 275-290.

Crewe, L. (2001). "The Besiged Body: Geographies of Retailing and Consumption." Progress in Human Geography **25**(4): 629-640.

Crewe, L. (2003). "Geographies of Retailing and Consumption: Markets in Motion." Progress in Human Geography **27**(3): 353-362.

Crewe, L. and M. S. Lowe (1995). "Gap on the Map? Towards a Geography of Consumption and Identity." Environment and Planning A **27**: 1877-1898.

Crowe, W. A. and M. E. Siemonsen (1996). Canadian Retailing Strategy. Toronto, Neilson Canada.

Cullen, B. and A. Whelan (1997). "Concentration of the Retail Sector and Trapped Brands." Long Range Planning **30**(6): 906-916.

d'Astous, A. (2000). "Irritating Aspects of the Shopping Environment." Journal of Business Research **49**: 149-156.

Davies, R. L. (1972). "Structural Models of Retail Distribution: Analogies with Settlement and Urban Land-Use Theories." Transactions of the Institute of British Geographers **57**(November): 59-82.

Davies, W. K. D. (1989). Towards a Conceptual Integration of Urban Systems Literature. The Changing Geography of Urban Systems: Perspectives on the Developed and Developing World, Pamplona, International Geographical Union Commission on Urban Systems in Transition.

Davies, W. K. D. (1997). "Sustainable Development and Urban Policy? Hijacking the Term in Calgary." GeoJournal **43**(4): 359-369.

Davies, W. K. D. (1998). "Urban Systems Research: Unfullfilled Promises?" Canadian Journal of Regional Science **XXI**(3): 349-356.

Davies, W. K. D. and T. Baxter (1997). "Commercial Intensification: The Transformation of a Highway-Orientated Ribbon." GeoForum **28**(2): 349-356.

Davies, W. K. D. and D. T. Herbert (1993). Communities within Cities: An Urban Social Geography. London, Bellhaven Press.

Davies, W. K. D. and R. A. Murdie (1991). "Consistency and Differential Impact in Urban Social Dimensionality: Intra-Urban Variations in the 24 Metropolitan Areas of Canada." Urban Geography **12**(1): 55-79.

Davies, W. K. D. and R. A. Murdie (1993). Measuring the Social Ecology of Cities. The Changing Social Geography of Canadian Cities. L. S. Bourne and D. F. Ley. Montreal, McGill-Queen's University Press: 52-76.

Davies, W. K. D. and R. A. Murdie (1994). The Social Complexity of Canadian Metropolitan Areas in 1986: A Multivariate Analysis of Census Data. The Changing Canadian Metropolis: A Public Policy Perspective. F. Frisken. Toronto, Canadian Urban Institute: 203-236.

Dawson, J. (2000). "Viewpoint: Retailer Power, Manufacturer Power, Competition and Some Questions of Economic Analysis." Journal of Retail and Distribution Management **28**(1): 5-8.

Dawson, J. A. (1972). "Retail Structure in Groups of Towns." Regional and Urban Economics **2**(1): 25-65.

Dawson, J. A. and L. Sparks (1987). "Issues for the Planning and Retailing in Scotland." Scottish Planning Law and Practice **18**: 38-40.

Dennis, C., D. Marsland, et al. (2002). "Central Place Practice: Shopping Centre Attractiveness Measures, Hinterland Boundaries and the UK Retail Hierarchy." Journal of Retailing and Consumer Services **9**: 185-199.

Dholakia, R. R. (1999). "Going Shopping: Key Determinants of Shopping Behaviour and Motivations." International Journal of Retail and Distribution Management **27**(4): 154-165.

Doucet, M. (2003). "The Department Store Shuffle: A study of Rationalization and Locational Change in a Large Metropolitan Market." Progress in Planning **60**: 93-110.

Du, G. (2001). "Using GIS for Analysis of Urban Systems." GeoJournal **52**: 213-221.

Duckman, M., K. Mason, et al. (2001). "A Formal Approach to Imperfection in Geographic Information." Computers, Environment and Urban Systems **25**: 89-103.

Dumas, M. (1997). "Productivity Trends in Two Retail Trade Industries, 187-1995." Monthly Labour Review **July**: 35-39.

Faludi, R. (1992). "Emerging Retail Development Trends in Canada." Urban Sprawl **November**: 30-34.

Fan, W., F. Treyz, et al. (2000). "An Evolutionary New Economic Geography Model." Journal of Regional Science **40**(4): 671-965.

Farhangmehr, M., S. Marques, et al. (2000). "Consumer and Retailer Perceptions of Hypermarkets and Traditional Retail Stores in Portugal." Journal of Retailing and Consumer Services **7**: 197-206.

Farhangmehr, M. and P. Veiga (1995). "The Changing Consumer in Portugal." International Journal of Research in Marketing **12**: 485-502.

Fellmann, J., A. Getis, et al. (1995). Human Geography: Lanscapes of Human Activity. Toronto, Wm. C. Brown Publishers.

Filion, P. and T. E. Bunting (1993). "Local Power and Its Limits: Three Decades of Attempts to Revitalize Kitchener's CBD." Urban History Review **27**(1): 4-16.

Filion, P. and T. E. Bunting (1996). Space and Place: The Social Geography of the Dispersed City. The Dynamics of the Dispersed City: Geography and Planning Perspectives on Waterloo Region. T. E. Bunting and K. Curtis. Waterloo, University of Waterloo Department of Geography: 273-301.

Filion, P., T. E. Bunting, et al. (1999). "The Entrenchment of Urban Dispersion: Residential Preferences and Location Patterns in the Dispersed City." Urban Studies **36**(8): 1317-1347.

Foot, D. K. (1998). Chapter 5: The New Rules of Retail. Boom Bust and Echo 2000. Toronto, Macfarlane Walter & Ross: 107-147.

Forsberg, H. (1998). "Institutions, Consumer Habits, and Retail Change in Sweden." Journal of Retailing and Consumer Services **5**(3): 185-195.

Forsyth, A. (2000). "Analyzing Public Space at a Metropolitan Scale: Notes on the Potential for Using GIS." Urban Geography **21**(2): 121-147.

Franckowiak, E. N. (1978). Location and Percpetion of the Hierarchical Structure of Retail Centres. Ann Arbot, University of Michigan Department of Geography.

Gallimore, W. P. (1993). Using GIS to Measure Relative Retail Accessiblility Differential. Papers and Proceedings Proceedings Applied Geography Conferences. J. W. Frazier, B. J. Epstein, F. A. Schoolmaster III, K. G. Jones and N. J. Siller. Binghamton, SUNY Binghamton. **16:** 71-79.

Garner, B. (1967). Models of Urban Geography and Settlement Location. Socio-Economic Models in Geography. R. J. Chorley and P. Haggett. London, Methuem: 303-360.

Garner, B. J. (1966). The Internal Structure of Retail Nucleations. Evanston, Department of Geography Northwestern University.

Genest-Laplante, E. (1998). Specialized Big-Box Stores: Statistics Canada Service Indicators. Ottawa, Statistics Canada.

Gerhard, U. (2001). "Shopping and Leisure: New Patterns of Consumer Behaviour in Canada and Germany." Die Erde **132**: 205-220.

Gibbs, A. (1987). "Retail Innovation and Planning." Progress in Planning **27**: 1-67.

Gielens, K. and M. G. Dekimpe (2001). "Do international entry decisions of retail chains matter in the long run?" International Journal of Research in Marketing **18**(3): 235-259.

Gijsbrechts, E., G. Swinnen, et al. (1995). "The Changing Consumer in Belgium." International Journal of Research in Marketing **12**: 389-403.

Girling, C. L. and K. I. Hepland (1997). "Retrofitting Suburbia: Open Space in Belelvue, Washington USA." Landscape and Urban Planning **36**(4): 301-313.

Glaeser, E. L. (2000). The New Economics of Urban and Regional Growth. The Oxford Handbook of Economic Geography. G. L. Clark, M. P. Feldman and M. S. Gertler. New York, Oxford University Press: 83-98.

Glaeser, E. L., J. Kolko, et al. (2001). "Consumer City." Journal of Economic Geography **1**: 27-50

Goheen, P. G. (1998). "Public Space and the Geography of the Modern City." Progress in Human Geography **22**(4): 479-496.

Goldman, A. (2001). "The Transfer of Retail Formats into Developing Economies: The Example of China." Journal of Retailing **77**: 221-242.

Gomez-Insausti, R. (2003). "The Spatial Structure of the Canadian Business/Commercial Sector: A Study in Supply-Side Segmentation." Progress in Planning **60**: 13-34.

Goss, J. (1993). "The "Magic of the Mall": An Analysis of Form, Function, and Meaning in the Contemporary Retail Environment." Annals of the American Association of Geographers **83**(1): 18-47.

Gregson, N., L. Crewe, et al. (2002). "Shopping, Space and Practice." Environment and Planning D: Society and Space **20**: 597-617.

Griffith, D. A. and R. F. Krampf (1997). "Emerging Trends in US Retailing." Long Range Planning **30**(6): 847-852.

Grunert, K. G., S. C. Grunert, et al. (1995). "The Changing Consumer in Germany." International Journal of Research in Marketing **12**: 417-433.

Guy, C. M. (1975). Consumer Behaviour and its Geographical Impact. London, George Over Ltd.

Guy, C. M. (1994). The Retail Development Process: Location, Property and Planning. London, Routledge.

Guy, C. M. (1995). "Retail Store Development at the Margin." Journal of Retailing and Consumer Services **2**(1): 25-32.

Guy, C. M. (1998). "Alternative-Use Valuation, Open A1 Planning Consent, and the Development of Retail Parks." Environment and Planning A **30**: 37-47.

Guy, C. M. (1998). "Classification of Retail Stores and Shopping Centres: Some Methodological Issues." GeoJournal **45**: 255-264.

Guy, C. M. (1999). Retail Location Analysis. Applied Geography: Principles and Practice. M. Pacione. London, Routledge: 450-462.

Guy, C. M. and D. Bennison (2002). "Retail Planning Policy, Superstore Development and Retailer Competition." International Journal of Retail and Distribution Management **30**(9): 431-434.

Hahn, B. (2000). "Power Centres: A New Format in the United States of America." Journal of Retailing and Consumer Services **7**: 223-231.

Hallsworth, A. G. (1993). Land Use Planning and Regulations in Britain and Canada - Some Associations with Local Democracy. Papers and Proceedings Proceedings Applied Geography Conferences. J. W. Frazier, B. J. Epstein, F. A. Schoolmaster III, K. G. Jones and N. J. Siller. Binghamton, SUNY Binghamton. **16:** 117-123.

Hallsworth, A. G. (1997). "Rethinking Retail Theory: Circuits of Power as an Interative Paradigm." Geographical Analysis **29**(4): 329-338.

Hallsworth, A. G. (2001). "Commentary: Further Reflections on the Arrival of Wal-Mart in the United Kingdom." Environment and Planning A **33**: 1709-1716.

Hallsworth, A. G., M. Taylor, et al. (1997). "The US Food Discounter's Invasion of Canada and Britain: A Power Perspective." Agribusiness **13**(2): 227-235.

Hankins, K. (2002). "The Restructuring of Retail Capital and the Street." Tijdschrift Voor Economische En Sociale Geografie **93**(1): 34-46.

Hartshorn, T. A. (1992). Interpreting the City: An Urban Geography. New York, John Wiley and Sons.

Hecht, A. and T. E. Bunting (1996). Birth Pains of a New Regional Shopping Centre, Cambridge Mall: Theories, Tools and Speculations of the Geographer in the Retail Planning Forum. The Dynamics of the Dispersed City: Geography and Planning Perspectives on Waterloo Region. T. E. Bunting and K. Curtis. Waterloo, University of Waterloo Department of Geography: 273-301.
Henderson, V. and A. Mitra (1996). "The Urban Landscape, Developers and Edge Cities." Regional Science and Urban Economics **26**: 613-643.

Hernandez, T. (2003). "Retail Restructuring: A Geomatics-Based Analysis of the Home Improvement Sector." Progress in Planning **60**: 35-53.

Hernandez, T. and D. Bennison. (1998). "Explaining Retail GIS." Retrieved Jan 21, 2002, from http://indigo.ie/~issprs/pdfs/si15_5.pdf.

Hernandez, T., D. Bennison, et al. (1998). "The Organizational Context of Retail Location Planning." GeoJournal **45**: 299-308.

Ho, T.-H., C. S. Tang, et al. (1998). "Rational Shopping Behaviour and the Option Value of Variable Pricing." *Management Sciecne* **44**(12): S145-S160.

Howe, D. and W. A. Rabiega (1992). "Beyond Strips and Centres: The Ideal Commercial Form." Journal of the American Planning Association **58**(2): 213-219.

Hsu, C.-I. and I.-J. Tsai (1999). "Logistics Cost, Consumer Demand, and Retail Establishment Density." Papers in Regional Science **78**: 243-263.

Ingene, C. A. (1983). "Consumer Attitudes Towards the American Retail System." Papers of the Regional Science Association **53**: 175-188.

Jackle, J. A. and R. L. Mattson (1981). "The Evolution of a Commercial Strip." Journal of Cultural Geography **Spring**: 12-25.

Jamal, A. (2003). "Retailing in a Multicultural World: The Interplay of Retailing, Ethnic Identity, and Consumption." Journal of Retailing and Consumer Services **10**: 1-11.

Jones, K. (1984). Specialty Retailing in the Inner City: A Geographic Perspective. Toronto, York University Department of Geography.

Jones, K. (1999). Case Studies on the Impact of the Internationalization of Retailing in Canada. K. G. Jones. Toronto, Centre for the Study of Commercial Activity: 42.

Jones, K. (2000). Dynamics of the Canadian Retail Environment. Canadian Cities in Transition: The Twenty First Century. T. E. Bunting and P. Filion. Toronto, Oxford University Press: 404-422.

Jones, K. (2003). "Spatial Fluctuations in the Health of the Consumer Serives Sector Within a Metropolis: A Business/Commercial Geomatics Analysis." Progress in Planning **30**: 75-92.

Jones, K. and M. Doucet (2000). "Big-Box Retailing and the Urban Retail Structure: The Case of the Toronto Area." Journal of Retailing and Consumer Services **7**: 233-247.

Jones, K. and M. Doucet (2001). "The Big Box, The Flahship, and Beyond: Impacts and Trends in the Greater Toronto Area." Canadian Geographer **45**(4): 494-512.

Jones, K., S. Kamikihara, et al. (1998). "Dallas-Fort Worth: Commercial Structure and Change." Progress in Planning **50**(4): 237-289.

Jones, K. and J. Simmons (1993). Location, Location, Location. Toronto, Neilson Canada.

Kloosterman, R. C. and S. Mustern (2001). "The Polycentric Urban Region: Towards a Research Agenda." Urban Studies **38**(4): 623-633.

Knox, P. (1987). Urban Social Geography: An Introduction. New York, Longman Scientific and Technical: 120-138.

Krider, R. E. and C. B. Wienberg (1997). "Spatial Competition and Bounded Reality: Retailing at the Edge of Chaos." Geographical Analysis **29**(1): 16-34.

Kulke, E. (1992). "Structure Change and Spatial Response in the Retail Sector in Germany." Urban Studies **29**(6): 965-977.

Kumar, N. (1997). "The Revolution in Retailing: From Market Driving to Market Driven." Long Range Planning **30**(6): 830-835.

Laaksonen, P., M. Laaksonen, et al. (1998). "The Changing Consumer in Finland." International Journal of Research in Marketing **15**: 169-180.

Lahti, P., R. Martamo, et al. (1998). "GIS-Based Toolbox for Urban Analysis (Urban Form, Economics and Ecology)." Retrieved Jan 21, 2002, from http://terra.geomatics.kth.se/~hans/C4_Final_Conf/COST_Final_PDF/PLKiruna898.pdf.

Lambkin, M. and F. Bradley (1995). "The Changing Consumer in Ireland." International Journal of Research in Marketing **12**: 449-466.

Langston, P., G. P. Clarke, et al. (1997). "Retail Saturation, Retail Location and Retail Competition: An Analysis of British Grocery Retailing." Environment and Planning A **29**: 77-104.

Langston, P., G. P. Clarke, et al. (1998). "Retail Saturation: The Debate in the mid-1990s." Environment and Planning A **30**: 49-66.

Lea, A. and J. W. Simmons (1995). Location Allocation Modesl for Retail Site Selection. Toronto, Centre for the Study of Commercial Activity: 42.

Lee, R. (2002). "'Nice Maps, Shame About the Theory'? Thinking Geographically about the Economic." Progress in Human Geography **26**(3): 333-355.

Leeflang, P. S. H. and W. F. van Raaji (1995). "The Changing Consumer in the European Union: A 'Meta-Analysis'." International Journal of Research in Marketing **12**: 373-387.

Léo, P.-Y. and J. Philippe (2002). "Retail Centres: Location and Consumer's Satisfaction." The Services Industries Journal **22**(1): 122-146.

Leszczyc, P. T. L. P., A. Sinha, et al. (2000). "Consumer Store Choice Dynamics: An Analysis of the Competitive Market Structure for Grocery Stores." Journal of Retailing **76**(3): 323-345.

Leszczyc, P. T. L. P. and H. J. P. Timmermans (2001). "Experiemental Choice Analysis of Shopping Strategies." Journal of Retailing **77**: 493-509.

Ley, D. F. (1983). A Social Geography of the City. New York, Harper & Row: 55-92.

Libin, K. (2002). "The Last Canadian Retailer." Canadian Business(March 18): 31-40.

Lo, C. P. (1997). "Dispersed Spatial Development: Hong Kong's New City Form and its Economic Implications After 1997." Cities **14**(5): 273-277.

Longey, P. A., M. F. Goodchild, et al. (2001). Geographic Information System and Science. West Sussex, John Wiley and Sons.

Longley, P. A. (2003). "Geographical Information Systems: Developments in Socio-Economic Data Infrastructures." Progress in Human Geography **27**(1): 114-121.

Longley, P. A. and R. J. Harris. (2002). "Towards a New Digital Infrastructure for Urban Analysis and Modelling." Retrieved Jan 21, 2002, from http://www.casa.ucl.ac.uk/urgent/urgen2.pdf.

Longley, P. A. and V. Mesev (2000). "On the Measurement and Generalisation of Urban Form." Environment and Planning A **32**(3): 473-488.

Lorch, B. and M. J. Smith (1988). "Shopping Centre Sales Promotions and Consumer Behaviour: A Marketing Geography Case Study." Canadian Geographer **32**(1): 56-62.

Lord, J. D. (2000). "Retail Saturation: Inevitable or Irrelevant?" Urban Geography **21**(4): 343-360.

Lowe, M. S. (2000). "Britain's New Shopping Centres: New Urban Forms?" Urban Studies **2000**(37): 2.

Lowe, M. S. and N. Wrigley (2000). "Retail and the Urban." Urban Geography **21**(7): 640-653.

Loxton, M. (1995). "The Landscape of Retail." Built Environment **1995**(21): 1.

MacEachern, A. M. (1998). "Cartography, GIS and the World Wide Web." Progress in Human Geography **22**(4): 575-585.

MacEachern, A. M. (2000). "Cartography and GIS: Facilitating Collaboration." Progress in Human Geography **24**(3): 445-456.

Madison, J. H. (1976) Changing Patterns of Urban Retailing: The 1920s. Business and Economic History **Volume**, 102-111 DOI:

Marcon, E. and F. Puech (2003). "Evaluating the Geographic Concentration of Industries Using Distance Based Methods." Journal of Economic Geography **3**: 409-428.

Marjanen, H. (1995). "Longitudinal Study on Consumer Spatial Behaviour With Special Reference to Out-of-Town Shopping." Journal of Retailing and Consumer Services **2**(3): 163-174.

Martin, D., P. Longley, et al. (1994). "The Use of GIS in the Analysis of Diverse Urban Databases." Computers, Environment and Urban Systems **18**(1): 55-66.

McGurr, P. T. and S. A. DeVaney (1996). "Patterns of Retail Change: A Comparison of Metropolitan and Nonmetropolitan Counties in Indiana 1972-1992." Journal of Regional Analysis and Policy **26**(2): 35-47.

Miller, C. E., J. Reardon, et al. (1999). "The effects of competition on retail structure: An examination of intratype, intertype, and intercategory competition." Journal of Marketing **63**(4): 107-120.

Millward, H. and T. E. Bunting (1999). "A Tale of Two CBDs II: The Internal Retail Dynamics of Downtown Halifax and Downtown Kitchener." Canadian Journal of Urban Research **8**(1): 1-25.

Millward, H. and L. Winsor (1997). "Twentieth-Century Retail Change in the Halifax Central Business District." The Canadian Geographer **41**(2): 194-201.

Moomaw, R. L. and A. M. Shatter (1996). "Urbanization and Economic Development: A Bias Towards Large Cities." Journal of Urban Economics **40**: 13-37.

Moran, L. R. and C. P. McCully (2001). "Trends in Consumer Spending, 1959-2000." Survey of Current Business(March): 1521.

Moreno-Jiménez, A. (2001). "Interurban Shopping, New Town Planning and Local Government in Madrid Metropolitan Area." Journal of Retailing and Consumer Services **8**: 291-298.

Morgan, B. S. (1991). The Emerging Retail Structure. London: A New Metropolitan Geography. K. Hoggart and D. Green. London, Edward Arnold: 123-141.

Morganosky, M. A. (1997). "Retail Market Structure Change: Implications for Retailers and Consumers." International Journal of Retail and Distribution Management **25**(8): 269-274.

Morganosky, M. A. and B. J. Cude (2000). "Large Format Retailing in the US: A Consumer Experience Perspective." Journal of Retailing and Consumer Services **7**: 215-222.

Morrill, R. (1987). "The Structure of Shopping in a Metropolis." Urban Geography **8**(2): 97-128.

Mosher, A. E., B. D. Keim, et al. (1995). "Downtown Dymamics." Geographical Review **85**(4): 497-517.

Muhlbacher, H., M. Botschen, et al. (1997). "The Changing Consumer in Austria." International Journal of Research in Marketing **14**: 309-319.

Muncaster, R. W. (1998). "New Format Retailing and the Commercial Structure of the Region of Waterloo."

Munroe, S. (2001). "Retail Structural Dynamics and the Forces Behind Big-Box Retailing." The Annals of Regional Science **35**: 357-373.

Munton, R. (1997). "Engaging Sustainable Development: Some Observations on Progress in the UK." Progress in Human Geography **21**(2): 147-163.

Murad, A. A. (2003). "Creating a GIS Application for Retail Centers in Jedday City." International Journal of Applied Earth Observation and Geoinformation **4**: 329-338.

Mushinski, D. and S. Weiler (2002). "A Note on the Geographic Interdependencies of Retail Market Areas." Journal of Regional Science **42**(1): 75-86.

Neda, K. (1997). "Recent Trends on the Retail Location in the Urban Retailing System: A Case Study of Kushiro, Hokkaido." Geographical Review of Japan **70 (Ser. B)**(1): 41-56.

Neda, K. (1998). "A New Classification of Retail Areas: A Case Study of Kushiro City, Hokkaido." Science Reports of the Institute of Geoscience **19**(A): 57-81.

Neda, K. (1998). "Review of Studies on the Urban Retailing System." Human Geography **50**(4): 363-382.

Newman, A. J., D. K. C. Yu, et al. (2002). "New Insights into Retail Space and Format Planning from Customer-Tracking Data." Journal of Retailing and Consumer Services **9**: 253-258.

Nilsson, O. S. and H. S. Solgaard (1995). "The Changing Consumer in Denmark." International Journal of Research in Marketing **12**: 405-416.

Nunn, S. (2001). "Planning for inner-city retail development - The case of Indianapolis." Journal of the American Planning Association **67**(2): 159-172.

Pacione, M. (2001). "Models of urban land use structure in cities of the developed world." Geography **86**: 97-119.

Page, S. E. (1999). "On the Emergence of Cities." Journal of Urban Economics **45**: 184-208.

Péron, R. (2001). "The Political Management of Change in Urban Retailing." International Journal of Urban and Regional Research **25**(4): 847-878.

Peterson, R. A. and S. Balasubramanian (2002). "Retailing in the 21st Century: Reflections and Prologue to Research." Journal of Retailing **78**: 9-16.

Pipkin, J. S. (1993). "A Partioning Model of Urban Retail Structure." Geographical Analysis **25**(3): 179-198.

Poole, R., G. P. Clarke, et al. (2002). "Grocery Retailers and Regional Monopolies." Regional Studies **36**(6): 643-659.

Popkowski, P. T. L. and H. J. P. Timmermans (2001). "Experimental Choice Analysis of Shopping Strategies." Journal of Retailing **77**: 493-509.

Post, S. S. and R. M. Stein (2000). "State Economies, Metropolitan Governance and Urban-Suburban Economic Dependence." Urban Affairs Review **36**(1): 46-60.

Potter, R. B. (1980). "Spatial and Structural Variations in the Quality Characteristics of Intra-Urban Retailing Centres." Transactions of the Institute of British Geographers **5**(2): 207-228.

Potter, R. B. (1981). "The Multivariate Functional Structure of the Urban Retailing System: A British Case Study." Transactions of the Institute of British Geographers **6**(2): 188-213.

Potter, R. B. (1982). The Urban Retailing System: Location, Cognition, and Behaviour. Aldershot, Gower Publishing Company Ltd.

Potter, R. B. and C. D. Beaumont (1984). "Parsimonious Multivariate Classifications of Urban Retailing Systems." Professional Geographer **36**(3): 353-358.

Press, D. L. (1994). "Planned Shopping Centres." New Zealand Geographer **50**(2): 14-18.

Proudfoot, M. J. (1937). "City Retail Structure." Economic Geography **13**: 425-8.

Rams, E. M. (1976). Analysis and Valuation of Retail Locations. Reston, Reston Publishing Company Inc.

Randall, J. E. (1998). "Reflections on Urban Systems Research." Canadian Journal of Regional Science **XXI**(3): 341-348.

Reid, R. and S. Brown (1996). "I Hate Shopping! An Introspective Perspective." International Journal of Retail and Distribution Management **24**(2): 4-16.

Relph, E. (1991). "Suburban Downtowns in the Greater Toronto Area." The Canadian Geographer **35**(4): 421-425.

Reynolds, J. (1998). "Methodological Problems of Intercultural Comparisons of Retail Environments." GeoJournal **45**: 245-254.

Rinehart, S. M. and D. Zizzo (2000). "The Canadian and US Retailing Sectors: Important Changes Over the Past 60 Years." Journal of Retailing and Consumer Services **2**(1): 33-47.

Ritsema Van Eck, J. R. and T. de Jong (1999). "Accessiblity Analysis and Spatial Competition Effects in the Context of GIS-Supported Service Location Planning." Computers, Environment and Urban Systems **23**: 75-89.

Robertson, K. A. (1995). "Downtown Redevelopment Strategies in the United States: An End of the Century Assessment." Journal of the American Planning Association **61**(4): 429-437.

Robertson, K. A. (1997). "Downtown Retail Revitalization: A Review of American Development Strategies." Planning Perspectives **12**: 383-401.

Robertson, K. A. (1999). "Can Small-City Downtowns Remain Viable." Journal of the American Planning Association **65**(3): 270-283.

Roseland, M. (2000). "Sustainable Community Development: Integrating Environmental, Economic, and Social Objectives." Progress in Planning **54**: 73-132.

Rousey, S. P. and M. A. Morganosky (1996). "Retail Format Change in US Markets." International Journal of Retail and Distribution Management **24**(3): 8-16.

Rowley, G. (1984). "Data Bases and Their Integration for Retail Geography: A British Example." Transactions of the Institute of British Geographers **9**(4): 460-476.

Sack, R. D. (1992). Place, Modernity and the Consumer's World. Baltimore, Johns Hopkins University Press.

Sadahiro, Y. (2001). "Analysis of Surface Changes Using Primitive Events." International Journal of Geographic Information Science **15**(6): 523-538.

Sadahiro, Y. (2001). "A PDF-Based Analysis of the Spatial Structure of Retailing." GeoJournal **52**: 237-252.

Sasaki, K. and S.-I. Mun (1996). "A Dynamic Analysis of Mulitiple-Centre Formation of a City." Journal of Urban Economics **40**: 257-278.

Sawada, M. (2002). Nearest Neighbour Analysis. Ottawa, Department of Geography.

Scheer, B. C. and M. Petkov (1997). "Edge City Morphology: A Comparison of Commercial Centres." Journal of the American Planning Association **64**(3): 298-310.

Severin, V., J. J. Louviere, et al. (2001). "The Stability of Retail Shopping Choices Over Time and Across Countries." Journal of Retailing **77**: 185-202.

Sheller, M. and J. Urry (2000). "The City and the Car." International Journal of Urban and Regional Research **24**(4): 737-757.

Sherman, E. and M. T. Topol (1996). "Anticipating the Impact of New Technologies on Retailing." Journal of Retailing and Consumer Services **3**(2): 107-111.

Simmons, J. W. (1964). The Changing Pattern of Retail Location. Chicago, The University of Chicago.

Simmons, J. W. (1966). Toronto's Changing Retail Complex. Chicago, University of Chicago.

Simmons, J. W. (1991). "The Regional Mall in Canada." The Canadian Geographer **35**(3): 232-240.

Simmons, J. W. (2003). Cities in Decline: The Future of Urban Canada. Toronto, Centre for the Study of Commercial Activity: 8.

Simmons, J. W., P. Barbiero, et al. (2000). Exploring a National Database of Commercial Activity: Research Report 2000-12. Toronto, Centre for the Study of Commercial Activity.

Simmons, J. W. and K. Jones (2003). "Growth and Change in the Location of Commercial Activities in Canada: With Special Attention to Smaller Urban Places." Progress in Planning **60**: 55-74.

Simmons, J. W., K. Jones, et al. (1998). "International Comparisons of Commercial Structure and Policy Implications." Progress in Planning **50**(4): 291-313.

Simmons, J. W., K. Jones, et al. (1998). "The Need for International Comparisons of Commercial Structure and Change." Progress in Planning **50**(4): 207-215.

Simmons, J. W. and S. Kamikihara (1998). "Barcelona: Commercial Structure and Change." Progress in Planning **50**(4): 217-232.

Simmons, J. W. and S. Kamikihara (1998). "Nagoya: Commercial Structure and Change." Progress in Planning **50**(4): 233-251.

Simmons, J. W. and S. Kamikihara (1999). The Internationalization of Commercial Activities in Canada. Toronto, Centre for the Study of Commercial Analysis.

Simmons, J. W. and M. Yeates (1998). "Toronto: Commercial Structure and Change." Progress in Planning **50**(4): 253-272.

Sirgy, M. J., D. Grewal, et al. (2000). "Retail Environment, Self-Congruity, and Retail Patronage: An Integrative Model and Research Agenda." Journal of Business Research **49**: 127-138.

Smith, M. F. (1999). "Urban versus Suburban Consumers: A Contrast in Holiday Shopping Purchase Intentions and Outshopping Behaviour." Journal of Consumer Marketing **16**(1): 58-73.

Srinivasan, S. (2002). "Quantifying Spatial Characteristics of Cities." Urban Studies **39**(11): 2005-2028.

Storie, C. D., C. Oakley, R. Muncaster (2002). "The Emergence of New-Format Retailing into the Commercial Structure of Cambridge, Ontario, Canada: A GIS-Based Analysis." Canadian Journal of Regional Science **XXIV**(3): 505-524.

Sui, D. Z. (1998). "GIS-Based Urban Modelling: Practices, Problems and Prospects." International Journal of Geographic Information Science **12**(7): 651-671.

Swartz, J. (2000). "Changing Retail Trends, New Technologies, and The Supply Chain." Technology in Society **22**: 123-132.

Swinyard, W. R. (1997). "Retailing Trends in the USA: Competition, Consumers, Technology and the Economy." International Journal of Retail and Distribution Management **25**(8): 244-255.

Sybrandy, A. and R. Tuninga (1992). "A Systems Approach to Measuring Retail Structure in Germany and the Netherlands." Mangerial and Decision Economics **13**(3): 267-278.

Thomas, C. J. and D. F. Bromley (2000). "City-Centre Revitalization: Problems of Fragmentation and Fear in the Evening and Night-Time City." Urban Studies **37**(8): 1403-1429.

Thomas, C. J. and R. D. F. Bromley (2003). "Retail Revitalization and Small Town Centres: The Contribution of Shopping Linkages." Applied Geography **23**: 47-71.

Thomas, R. W. (1972). The Retail Structure of the Central Area. The Retail Structure of Cities. London, London Institute of British Geographrs: 69-93.

Thompson, D. L. (1966). "Future Directions in Retail Area Research." Economic Geography **42**(1): 1-18.

Tokatli, N. and Y. Boyaci (1999). "The Changing Morphology of Commercial Activity in Instanbul." Cities **16**(3): 181-193.

Turnbull, G. K. (1995). Urban Consumer Theory. Washington D.C., The Urban Institute Press.

Van der Waals, J. F. M. (2000). "The compact city and the environment: A review." Tijdschrift Voor Economische En Sociale Geografie **91**(2): 111-121.

van der Waerden, P., A. Borgers, et al. (1998). "The Impact of the Parking Situation in Shopping Centres and Store Choice Behavviour." GeoJournal **45**: 309-315.

Varaldo, R. and G. Marbach (1995). "The Changing Consumer in Italy." International Journal of Research in Marketing **12**: 467-483.

Vias, A. C. (2003). "Bigger Stores, More Stores or No Stores: Paths of Retail Restructuring in Rural America." Journal of Rural Studies **20**: 303-318.

Vojnovic, I. (1999). "The environmental costs of modernism - An assessment of Canadian cities." Cities **16**(5): 301-313.

Walker, G., S. R. Phinn, et al. (2000). "Urbanites Creating New Ruralities: Reflections on Social Action and Struggle in the Greater Toronto Area." The Great Lakes Geographer **7**(2): 107-118.

Walmsley, D. J. and H. C. Weinand (1991). "Changing Retail Structure in Southern Sydney." Australian Geographer **22**(1): 57-66.

Wang, J. J. and J. ZXu (2002). "An Unplanned Commercial District in a Fast-Growing City: A Case Study of Shenzhen, China." Journal of Retailing and Consumer Services **9**: 317-326.

Wang, S. and K. G. Jones (2002). "Retail Structure of Beijing." Environment and Planning A **34**: 1785-1808.

Ward, D., S. R. Phinn, et al. (2000). "Monitoring Growth in Rapidly Urbanizing Areas Using Remotely Sensed Data." Professional Geographer **52**(3): 371-386.

West, D. S. (1993). "The Effects of Shopping Center Ownership on Center Composition in Planned and Unplanned Center Hierarchies." Papers in Regional Science **72**(1): 25-43.

Wheat, A. (2001). "Retail champs." Fortune **143**(8): 196-+.

Whelan, A., N. Wrigley, et al. (2002). "Life in a "Food Desert"." Urban Studies **39**(11): 2083-2100.

White, R. (1998). "Dynamic Integrated Urban Models." Canadian Journal of Regional Science **XXI**(3): 357-363.

White, R. and G. Englen (2000). "High-Resolution Integrated Modelling of the Spatial Dynamics of Urban and Regional Systems." Computers, Environment and Urban Systems **24**: 383-400.

Wikstrom, S. R. (1997). "The Changing Consumer in Sweden." International Journal of Research in Marketing **14**: 261-274.

Williams, C. C. (1992). "Impacts of the Regional Shopping Centres: Myths and Realities." Planner **78**(22): 8-10.

Williams, G. (1999). "Metropolitan Governance and Strategic Planning: A Review of Experience in Manchester, Melbourne, and Toronto." Progress in Planning **52**: 1-100.

Wilson, M. I. (2001). "Location, Location, Location: The Geography of the Dot Com Problem." Environment and Planning B: Planning and Design **28**: 59-71.

Wolfe, J. M. (2002). "Reinventing Planning: Canada." Progress in Planning **57**: 207-235.

Wrigley, N. (1998). "Understanding Store Development Programmes in Post-Property-Crisis UK Food Retailing." Environment and Planning A **30**: 15-35.

Wrigley, N. (2000). The Globalization of Retail Capital: Themes for Economic Geography. The Oxford Handbook of Economic Geography. G. L. Clark, M. P. Feldman and M. S. Gertler. New York, Oxford University Press: 292-316.

Wrigley, N. (2002). "'Food Deserts' in British Cities: Policy Context and Research Priorities." Urban Studies **39**(11): 2029-2040.

Wrigley, N., N. M. Coe, et al. (2005). "Globalizing Retail: Conceptualizing the Distribution-Based Transnational Corporation (TNC)." Progress in Human Geography **29**(4): 437-457.

Wrigley, N., C. M. Guy, et al. (2002). "Urban Regeneration, Social Inclusion and Large Store Development: The Seacroft Development in Context." Urban Studies **39**(11): 2101-2155.

Wrigley, N. and M. S. Lowe (1996). Retailing, Consumption, and Capital: Towards the New Retail Geography. London, Longman Group.

Wrigley, N. and M. S. Lowe (2002). Reading Retail:A Geographical Perspective on Retailing and Consumption Spaces. New York, Arnold Publishers.

Wu, F. (1998). "An Experiment on the Generic Polycentricity of Urban Growth in a Cellular Automatic City." Environment and Planning A **25**: 731-752.

Wu, F. and C. J. Webster (2000). "Simulating Artificial Cities in a GIS Environment: Urban Growth Under Alternative Regulation Regimes." International Journal of Geographic Information Science **14**(7): 625-648.

Wyatt, P. J. (1997). "The Development of a GIS-Based Property Information System for Real Estate Evaluation." International Journal of Geographic Information Science **11**(5): ??-??

Yeates, M. (1998). The North American City. Toronto, Addison-Wesley.

Yeates, M. (2001). "Yesterday as Tomorrow's Song: The Contribution of the 1960s "Chicago School" to Urban Geography." Urban Geography **22**(6): 514-529.

Yeates, M. (2003). "Editorial: Business/Commercial Geomatics and Planning." Progress in Planning **60**: 1-11.

Yeates, M. (2003). "Simulating the Demand for Consumer Service Space by Type of Supply-Side Channel." Progress in Planning **60**: 127-145.

Yeates, M. and D. Montgomery (1999). "The Changing Commercial Structure of Non-Metropolitan Urban Centres and Vacancy Rates." Canadian Geographer **43**(4): 382-399.