New Urbanism in the Greater Toronto Area: A case study of Angus Glen and Cornell in the town of Markham (Ontario).

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UMI
NEW URBANISM IN THE GREATER TORONTO AREA:
A CASE STUDY OF ANGUS GLEN AND CORNELL
IN THE TOWN OF MARKHAM

by

Carl Johannsen

A Thesis
Submitted to the College of Graduate Studies and Research
through the Department of Geography
in Partial Fulfillment of the Requirements for
the Degree of Master of Arts at the
University Of Windsor

Windsor, Ontario, Canada

2000

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ABSTRACT

During the post-war period the suburban regions of the Greater Toronto Area (GTA) experienced rapid population growth, and the majority of this growth was primarily accommodated through conventional community design methods. Conventional community design is characterized by low residential densities, segregated land use zoning, single detached homes and an almost total dependence on the automobile. Critics have labeled this pattern of growth as increasingly unsustainable, due to rising infrastructure costs rural, increasing rates of natural land loss, air and water pollution, worsening traffic congestion and unaffordable housing. During the last five years a number of communities based upon the principles of New Urbanism have been under development in the GTA, and are theoretically based upon design methods which are intended to assist in mitigating the problems associated with conventional design. However, the promise of New Urbanism offering a less unsustainable alternative in practice has been compromised, since many built examples of New Urbanism in North America have been developed without utilizing the full array of New Urbanist principles necessary for successfully mitigating the problems of conventional design. The purpose of this study was to evaluate the design characteristics of two communities, Cornell and Angus Glen, which have been labeled New Urbanist in the Town of Markham. A series of design indicators were employed and tested to see whether these communities conformed very closely to the principles of New Urbanism on a collective basis, or only incorporated superficial features for the purposes of marketing these communities to niche real estate markets. Both communities failed in conforming very closely to the principles of New Urbanism, primarily due to density and land use deficiencies. However, it was inferred that Cornell represented a definite step towards a pure New Urbanist community, and could be considered one of the closest examples in the GTA, and perhaps North America. Conversely, Angus Glen was found to be a ‘hybridized’ example of New Urbanism, since it happened to be more of a conventional community hidden behind a façade of lanes and heritage style architecture.
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1.0 Introduction

Post-war suburban growth in the Greater Toronto Area (GTA) has been primarily based on conventional community design (Tornal, 1993; Blais, 1995; Kar, 1999; Hume, 1999), characterized by low residential densities, segregated land-use zoning, single detached homes, and almost total dependence on the automobile (OGTA, 1991; Blais, 1995; Tornal, 1997; Hume, 1999). Critics have labelled this pattern of development as environmentally, economically and socially unsustainable, due to rising infrastructure costs, increasing pollution, accelerating rates of rural land loss, worsening traffic congestion, decreasing transit ridership, and unaffordable homes (Mumford, 1961; OGTA, 1991; Calthorpe, 1993; Roseland, 1998). Since the GTA is expected to grow by over 2 million people during the next 25 years, these problems promise to worsen if future growth continues to be accommodated in a conventional manner (OGTA, 1991; Blais, 1995; Hume, 1999).

Since the early 1990s a number of communities based upon New Urbanism have been under development in the GTA, in an effort by many local municipalities to mitigate the above problems associated with conventional design and future population growth (Province of Ontario, 1997). New Urbanism has been popularized in North America as an alternative community design method, employing heritage-style architecture, zero-lot line homes, grid road systems and rear alleys (Gabor, 1994; Wood-Brunet, 1994; Leeming, 1996; Province of Ontario, 1997). Besides differing from conventional design in terms of community image, proponents claim that New Urbanism, in theory, offers design and planning principles which assist in reducing the effects of particular problems of unsustainability inherent in conventional design (Calthorpe, 1993; City of Calgary, 1995; CMHC, 1997; Government of Western Australia, 1997; Roseland, 1998, Van Vliet et al, 2000). These principles are quite similar to key methods of sustainable community design theory, and include the development of a compact urban form to reduce infrastructure costs and utilize less land; the incorporation of mixed uses (retail, employment) with higher residential densities to achieve viable transit facilitation and less automobile dependence; and an inclusion of mixed housing types and affordability ranges (Duany and Plater-Zyberk, 1992; Calthorpe, 1993).

The premise of New Urbanism offering a less unsustainable community model can only be valid if actual built examples incorporate the above fundamental design and planning principles (Roseland, 1998). However, there is evidence that due to the current development realities of the North American residential market, actual built examples of New Urbanism rarely incorporate all the relevant principles on a collective basis (Campsie, 1994; Southworth, 1997; Kar, 1999). Some advocate that many built examples of these communities are market-
hybridized forms which do not assist in reducing unsustainability in a significant way, because they lack appropriate densities, housing mix, retail/services/employment provision, and transit facilitation (Bookout, 1992; Winburn, 1992; Atash, 1994; Chandler, 1997).

This thesis involves an evaluation of two existing examples of New Urbanism, Cornell and Angus Glen, located in the GTA municipality of Markham, and is intended to contribute to the debate of whether New Urbanism in practice results in a significantly different development pattern relative to conventional design (Kar, 1998). This evaluation employed a series of indicators and a control group of conventionally designed communities, in order to determine whether or not Cornell and Angus Glen conformed very closely to the principles of New Urbanism, as prescribed by its proponents. The closer the characteristics of these communities conformed to these principles, the more they could be considered less unsustainable than their conventional counterparts (within the contexts of particular problems associated with conventional design). Ashton Meadows and Rouge Fairways, located in Markham also, constituted the conventionally designed communities utilized for the case study control group. This study is necessary to determine the extent New Urbanism has been applied in the candidate communities in Markham, in order to determine if these communities represent worthy steps towards reducing unsustainability in the GTA, or conversely, whether it adds to the body of evidence suggesting that these communities are only conventional communities hidden behind facades of heritage-style architecture, lane ways and aggressive 'community living' marketing schemes (Curry and Gurstein, 1993; Campsie, 1994; Lehrer and Milgrom, 1996; Robbins, 1998).
2.0 Literature Review

The following literature provides the basis for formulating a methodology appropriate for evaluating the match between the theory and practice of New Urbanism in the Town of Markham. The characteristics and problems associated with conventional community design in North American metropolitan regions will be outlined first, followed by a discussion of the concept of sustainable development (SD) and the methods of sustainable community design. Next, the principles of New Urbanism will be outlined, along with empirical evidence supporting it and criticisms illustrating the hybridization of New Urbanism due to market pressures. Lastly, the problems associated with conventionally designed communities in the Greater Toronto Area (GTA) will be discussed, followed by an illustration of provincial, regional and local government policy responses to the problems of conventional design which set the stage for the emergence of New Urbanism in the GTA.

2.1 Conventional Community Design: A North American Phenomenon

Since the end of World War II the urban landscape of North America has changed considerably, evolving from compact, transit oriented and centralized cities to low-density, decentralized and automobile dominated metropolitan regions (Knox, 1994). Historically the majority of post-war metropolitan growth has occurred in suburban areas, and this growth has primarily been based upon conventional design and planning principles (Mumford, 1961; Angotti, 1993; Kunstler, 1993; Calthorpe, 1993; Langdon, 1994). Many of these principles have been derived from a number of early modernist planning and design influences, including Howard’s Garden Cities, Perry’s neighbourhood unit, Stein’s Radburn community, Wright’s Broadacre City and Le Corbusier’s La Ville Contemporaine (Duany and Plater-Zyberk, 1992; Kunstler, 1993, 1997; Calthorpe, 1993; Knox, 1994; Langdon, 1994; Fulton, 1996). The primary features of conventionally designed communities are as follows (Duany and Plater-Zyberk, 1992; Kunstler, 1993; Calthorpe, 1993; Roseland, 1998):

- Low residential densities and large lot sizes;
- large dwelling setbacks;
- rigidly separated uses through single use, Euclidean zoning (residential, retail and employment areas are separated by distances conveniently reached only by automobile) (see Figure 1 and 2);
- single detached homes comprise majority of dwellings, and residential areas are segregated by housing types and densities (see Figure 1);
• garage dominated streetscapes and a general lack of sidewalks (see Figure 3);
• hierarchical curvilinear road systems with wide arterials, crescents and cul-de-sacs (see Figure 3); and
• a dominance of private space over public space.

The growth of conventionally designed suburban regions in North America has been primarily driven by a cultural preference for single detached, two-garage homes situated in low-density suburbs, and massive public investments in transportation infrastructure for the automobile (Mumford, 1961; Duany and Plater-Zyberk, 1992; Calthorpe, 1993; Kunstler, 1993; Hodge, 1994; Roseland, 1998). Also, conventionally designed communities have been typically mass-produced for mass consumption (Levittown, N.Y., being the first example), in order to accommodate strong consumer demand for suburban housing, which in turn has historically been a product of rising automobile ownership, cheap energy, the expansion of the middle class, and the flight of labour and capital from central cities (Fishman, 1987; Kunstler, 1993; Knox, 1994). Suburban regions in North American metropolises have evolved from the residential bedroom communities of the 1950s to more specialized, contemporary ‘post-suburban’ or ‘techno-burb’ landscapes complete with their own employment/retail/entertainment base clustered in ‘suburban downtowns’ or ‘edge cities’ (Fishman, 1987; Garreau, 1991; Knox, 1994). Despite this suburban evolution, the automobile has remained the dominant form of transportation, low densities are the norm outside of suburban downtowns, conventional design policies and practices continue to be condoned and utilized by both the municipal planning authorities and private sector developers, and suburban regions are still growing in population and capital investment relative to central cities (Fishman, 1987; Kunstler, 1993; Calthorpe, 1993; Alexander and Tomalty, 1994; Tomalty, 1997; Holtz, 1996).

The continued development of sprawling metropolitan regions via conventional design methods in Canada and the United States has generated considerable criticism from planning academics and professionals as being increasingly unsustainable, due to worsening problems associated with conventional community design which threaten the economic viability, environmental carrying capacity and quality of life in these metropolitan regions (Rees, 1991; Kunstler, 1993; Calthorpe, 1993; Perks and Van Vliet, 1993; Ewing, 1994, 1997; Tomalty, 1997;
Figure 1: Separation of Uses: Conventional Community Design (Toronto Star, Dec. 5, 2000)
Roseland, 1998). Furthermore, these problems have been implicated in contributing to or even exacerbating larger supra-regional and global problems such as climate change (global warming) and rapid resource depletion (Rees, 1991; Rees and Roseland, 1992; Van Vliet, 1994). These problems include (Calthorpe, 1993; Kunstler, 1993; Roseland, 1998):

- high land requirements for large lot single detached homes, regional shopping centres and campus-style office parks in low-density conventional communities devours agriculturally viable and ecologically significant lands at increasing rates;

- high physical infrastructure costs due low-density, sprawling pattern of development;

- high per capita auto emissions, water pollution, energy use and inefficient public transit due to low-density, dispersed land use patterns;

- high volumes of stormwater runoff from low density ex-urban development;

- unaffordable housing prices due to rising infrastructure costs and suburban land development pressures;

- increasing socio-economic exclusion through the continued development of communities (with primarily single detached homes) which no longer reflect contemporary demographic realities of declining household sizes and stagnating incomes; and

- segregation of income groups by separation of residential densities and housing types.

Deepening concern over the local, regional and supra-regional problems associated with conventional design methods over the past two decades has motivated urban theorists, professional planners, urban designers, architects and politicians to consider alternative methods of urban design and development, specifically those based upon the ideals of sustainable development theory (Roseland, 1998).

2.2 Sustainable Development Theory

During the past two decades, concerns over problems of resource depletion, global warming, and economic and social inequity due to the expansion of global capitalism and accelerating rates of urbanization (within both developed and developing economies) have prompted political efforts to harmonize development with environmental and economic health, and social equity for the benefit of everyone in the global community (Perks and Van Vliet, 1993; Roseland, 1998). These efforts are collectively based upon the broad concept of sustainable development (SD), which was defined by the World Commission on Environment and Development in its report, Our Common Future (1987), as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Despite being criticized as ambiguous and aimed at maintaining the economic
status quo of the developed world (O’Connor; 1994; Marcuse, 1999), this definition has politically legitimized concerns for the environment, economy and society at the global, regional and local scales, and has also stimulated increased awareness of unsustainable practices (Roseland, 1998).

Among the many definitions and concepts of SD, the more equity-minded and detailed concepts forwarded by Jacobs (1993), Roseland (1998), and Perks and Van Vliet (1993) prove to be valuable for the context of this study. Jacobs stresses SD theory must recognize environmental considerations in economic policy making, to facilitate successful realization of necessary parallel economic and environmental objectives. SD also requires inescapable commitment to social equity, requiring a fair distribution of wealth, resources and environmental costs and benefits between areas of varying standards of living within global, national and metropolitan contexts. Roseland reinforces this position by stating environmental, economic and social problems need to be addressed with equal importance. SD policies aimed at these problems must be integrated into one focussed approach, thus SD must become a pro-active strategy to develop sustainability. Roseland also notes that the success of SD is more dependent upon the pattern of economic growth than the amount of growth, and strategies encouraging the efficient use of urban space are crucial for reducing unsustainability. This stance is reinforced by E.P. Fowler (1991), who argues that ecologically sensible settlements can only be successfully attained by changing basic patterns of land use, in addition to existing environmental protection policies involving recycling programs, tree plantings and the banning of chlorofluorocarbons. Furthermore, Perks and Van Vliet believe strategies aimed at changing patterns of land use need to be implemented at local and regional municipal levels; the collective application of these strategies could greatly assist in reducing unsustainability at the metropolitan level and ultimately at the national and global levels.

2.21 Sustainable Community Design

Sustainable community design (SCD) discourse is based upon the SD concepts discussed above (Van Vliet et al, 2000). While SD is concerned with addressing environmental, economic and social unsustainability at the supra-regional and global levels, SCD is an alternative design and planning strategy which aims to reduce the unsustainable characteristics inherent in conventional community design and development, by way of employing methods for changing current and future patterns of growth in metropolitan areas (Alexander and Tomalty, 1994; Van Vliet, 1994; White, 1996; Roseland, 1998; Van Vliet et al, 2000).

The application of SCD methods for changing growth patterns involves the development of communities (and ultimately urban/metropolitan structures), in which the improvement of local
and regional environmental integrity, social equity, and economic viability and efficiency can be realized (relative to conventionally designed communities), now and into the future (Perks and VanVliet, 1993; Grant, 1993; White, 1996; Roseland, 1998). As with sustainable development, these methods ensure environment, economy and society are addressed on an equal and interdependent basis when addressing problems associated with conventional development (Alexander and Tomalty, 1994). These methods are as follows (Curry and Gursstein, 1993; Van Vliet, 1994; City of Calgary, 1995; Tomalty, 1997; Government of W. Australia, 1997; Roseland, 1998, CMHC, 2000):

**Environmental Methods:** communities can reduce air, water and soil pollution, reduce resource consumption and waste, and protect natural systems through the placement of mixed use environments (retail, employment) closer to higher density residential areas to promote walking, cycling, better public transit articulation; more compact urban forms; treatment of storm water and sewage on-site; local food production in community gardens; on-site recycling of organic wastes; and district heating and water conservation.

**Economic Methods:** communities can reduce the costs of development, operating and maintenance costs through more compact, higher density forms which use less infrastructure, and emphasizing infill and transit supportive development which utilizes existing municipal and/or regional services and infrastructure.

**Social Methods:** communities can reduce social and economic inequality by: providing urban forms which are socially diverse, through the provision of various types of housing and on-site retail, service, educational and employment opportunities; containing affordable (because of less infrastructure costs through a higher density compact form) and flexible types of housing; and providing meaningful public spaces which foster a sense of place and community.

It is important to stress that sustainable community development discourse primarily involves methods of reducing unsustainability, rather than creating communities based on pre-conceived goals and criteria (Van Vliet, 1994). To infer these methods offer a final, sustainable solution would be wrong; these methods can only work towards reducing the effects of unsustainable conventional development.

The implementation of sustainable community design can be quite difficult in the GTA and other metropolitan areas since many current community design practices are more oriented towards economic interests over those of environment and society (Roseland, 1998). Additionally, many local and regional municipal planning policies in Canada (which typically involve over-engineered 'gold-plated' development standards) have not been flexible enough to accommodate the majority of less unsustainable development strategies and methods, and many methods such as district heating, on-site food production and composting, on-site energy production, co-housing and car-sharing are currently economically impractical and politically
unpopular (Perks and Van Vliet, 1993; Alexander and Tomalty, 1994; Gordon and Richardson, 1997; CMHC, 2000).

A number of community concepts which employ design and planning methods parallel to those of SCD have emerged in North America over the last twenty years (Van Vliet, 1994; CMHC, 1995). These communities include eco-villages, co-housing communities, and those based upon New Urbanism (CMHC, 1995). New Urbanism has become the most popular alternative community design concept to be employed in North America, partially due to its attempt to aesthetically improve the suburbs through architectural revivalism and the re-introduction of pedestrian oriented streetscapes (Kunstler, 1993). However, New Urbanism has also become the most favourable alternative design option for Canadian municipalities wishing to address sustainability issues, because of its potential for mitigating some of the most pressing problems associated with conventional design (White, 1996).

2.3 New Urbanism

New Urbanism has received increasing attention in Canada and the US as an alternative to modernist conventional design and development since its first application at Seaside, Florida in 1982 (Kunstler, 1993; Langdon, 1994). The leading proponents of New Urbanism are US architects/planners Andres Duany and Elizabeth Plater-Zyberk (DPZ), and Peter Calthorpe (Kunstler, 1997). During the last two decades DPZ’s Traditional Neighbourhood Developments (TNDs) and Calthorpe’s Transit Oriented Developments (TODs) have been developed across North America (Katz, 1994; Bogorad, 1999) (see Figures 4 and 5). Drawing on design influences from the City Beautiful movement (Nolen and Unwin), Howard’s Garden Cities and post modern architectural/urban theorists such as Krier, Alexander, and J. Jacobs, DPZ and Calthorpe developed the principles of New Urbanism in response to their increasing dissatisfaction with conventional urban design methods and the resultant sprawling, automobile dependent landscapes in US metropolitan areas (Duany and Plater-Zyberk, 1992; Calthorpe, 1993; Katz, 1994). Calthorpe highlighted the need for a new alternative through his critique of the inadequacies and inherent environmental, economic and social unsustainability of conventionally designed development in The Next American Metropolis (1993):

"The old suburban dream is increasingly out of sync with today's culture. Our household makeup has changed dramatically, the work place and work force have been transformed, average family wealth is shrinking, and serious environmental concerns have surfaced. But we continue to build post-World War II suburbs as if families were large and had only one bread winner, as if the jobs were all downtown, as if land and energy were endless, and as if another lane on the freeway would end traffic congestion" (Calthorpe, 1993)
Figure 4: Traditional Neighbourhood Development (Calthorpe, 1993)

Figure 5: Transit Oriented Development (Calthorpe, 1993)
Both DPZ and Calthorpe have designed communities which revive notions of urbanism in suburbia, by shunning modernist ideals of separated use zoning and density-segregated housing, arterial/collector road systems, endless rows of look-alike single detached homes in 'cookie cutter' or 'pod' residential communities, and automobile dominance (Duany and Plater-Zyberk, 1992; Calthorpe, 1993). DPZ and Calthorpe aim to re-create a sense of community, reduce the dominance of the automobile, and address demographic changes by accommodating diverse residential populations and providing affordable housing through employing higher residential densities and compact form, a mix of housing types, mixed uses, 'main street' style community centres, a grid road network, increased transit facilitation, pedestrian scale designs and heritage-style architecture in their communities (Langdon, 1994; Christofordis, 1994; Leeming, 1996; Kunstler, 1997; Roseland, 1998).

As DPZ's and Calthorpe's communities sprang up across North America, the popularity of New Urbanism as an alternative to conventional design grew rapidly (Kunstler, 1997). During the expansion of New Urbanism’s influence, the Congress of The New Urbanism (CNU) emerged as the primary organization representing the movement (Fulton, 1996). Originally composed of a small number of pioneering proponents (DPZ, Calthorpe, M. Corbett, S. Polizides, Krier, A. Krieger) of New Urbanism, the CNU now contains over 500 members. The formation of the CNU in 1993 politically consolidated the myriad of existing New Urbanist concepts prescribed by a growing number of practitioners into a legitimized, focused effort against the perceived problems of conventional design (Kunstler, 1997). The general New Urbanist design principles advocated by the CNU are primarily based upon the original design and planning concepts formulated by DPZ and Calthorpe (Fulton, 1996, Kunstler, 1997). More specifically, the fundamental planning and design principles commonly prescribed by the proponents of New Urbanism, and the benefits associated with them, are as follows (Duany and Plater-Zyberk, 1991; Calthorpe, 1993; Gabor and Lewinberg, 1997):

I. More Compact Urban Form

- Increased average densities (over 17 units per gross hectare) relative to conventional design (average 12 units per gross hectare);

- medium and higher density areas (apartments, row houses and townhouses) mixed in with lower density areas (single detached dwellings), ancillary suites (flats above rear alley garages) are permitted also (see Figures 6, 7, 8); and

- smaller average lot size for single detached dwellings (ie. 10 by 30 metres).

Benefits: Reduces hard infrastructure costs through the use of less materials, resulting in more affordable homes, and less land requirements for housing. Also, mixed and affordable housing
promote a diverse social environment through the inclusion of traditional families, single parent families, singles and empty nesters within the same locale.

II. Integration of a Mix of Land Uses

- Retail, educational, community service and employment uses are to be made available to community residents within their communities, and are to be integrated into community nodes or centres, and are to be within walking distance 5 minutes for the residents of the community (see Figures 4,5,9);

- neighbourhoods should be defined by a 400 metre radius from centre to edge, mixed uses should be placed at the centre and schools near the edge of the neighbourhood (see Figures 4,5,7,10); and

- public green space is situated to reinforce retail and residential areas by creating places suitable for public gatherings, and placed within two blocks of any residence.

Benefit: Mixed use nodes allow residents to live, work, shop and play within their own communities, providing walkable access to retail and community services for everyone, reducing non-work automobile trips within and outside of the neighbourhood. Along with higher residential densities, also provides opportunities for increased public transit articulation through placing transit stops near or at mixed use nodes, which will assist in further reducing automobile trips and vehicle miles travelled (VMT).

III. Street Pattern and Environment

- Reduced road right of ways, rear lanes are encouraged, and on-street parking is permitted;

- curvilinear, hierarchical street systems are to be avoided, instead utilizing a grid system of connector and local streets which provide direct routing to neighbourhood nodes, transit stops and other destinations;

- sidewalks are to be used extensively and placed on both sides of streets;

- residential setbacks should be no more than 25 feet from sidewalks, and commercial setbacks are to be adjacent to the sidewalk (where possible) (see Figure 11);

- activities in nodes should be oriented in a ‘main street’ format (see Figure 12); and

- residential garages are to be hidden to the rear, side or recessed into the front of dwellings.

Benefit: Reduced right of ways result in lower infrastructure costs per unit, and direct street routing encourages walking and cycling, providing easier access to nodes and transit stops (thus increasing the favourability of transit). Setbacks, node activities and the hiding of garages foster a safe, pleasant pedestrian oriented environment.

IV. Regional Integration

- Regional land use planning utilizing New Urbanist principles should be integrated within a larger transportation network which emphasizes public transit rather than freeways (see Figure 13); and

- focus on reurbanization of infill areas as well as suburban development opportunities.
Figure 6: Differing Lot Sizes for Mixing Densities (Government of Western Australia, 1997)

Figure 7: DPZ Model of TND (Katz, 1994)
Figure 8: Ancillary Unit over Rear Lane Garage (Katz, 1994)

Figure 9: Community Centre or Node Concept Plan (TOD) (Calthorpe, 1993)
Figure 10: Neighbourhood 400 metres from Centre to Edge  (Government of Australia, 1997)

Figure 11: Minimal Dwelling Setbacks  (Katz, 1994)
Figure 12: Main Street-Style Retailing (Katz, 1994)

Figure 13: New Urbanism and Metropolitan Form (Calthorpe, 1993)
IV. Regional Integration Continued

**Benefit:** Organizes growth on a regional basis to be compact, nodal and transit supportive, which helps to preserve open space, reduce regional infrastructure costs, air pollution and energy use through reduced automobile trips.

Proponents of New Urbanism believe that the application of the above principles, which are quite similar to certain SCD methods discussed earlier, will reduce the unsustainable effects of particular problems which are a consequence of conventional design. Furthermore, proponents also believe that collective application of these principles will result in less unsustainable communities (Duany and Plater-Zyberk, 1992; Calthorpe, 1993; CMHC, 1995, 1997; Kunstler, 1993, 1997; Langdon, 1994; City of Calgary, 1995; Newman and Kenworthy, 1996; White, 1996; Government of Western Australia, 1997; Roseland, 1998). Both DPZ and Calthorpe articulate this assertion by stating their community designs (TNDs and TODs) could ultimately become more affordable for working and single parent families, transit supportive, and cost effective for business and government (in terms of reducing local and regional requirements for infrastructure) (Duany and Plater-Zyberk, 1992; Calthorpe, 1993; Katz, 1994). Calthorpe (1993) also stresses these communities could accommodate regional metropolitan growth on an aggregate basis with minimized environmental impacts, less land consumed, less traffic generated and less pollution produced.

2.4 Empirical Research and Criticisms of New Urbanism

The following section will outline empirical examples which support the above claims of New Urbanism's proponents (and also those of SCD), by showing that the application of their principles do indeed assist in mitigating particular problems associated with conventionally designed development. Criticisms associated with New Urbanism will also be reviewed, in order to illustrate barriers and challenges to the successful implementation of the principles of New Urbanism in the contemporary North American market. Discussion of these criticisms is also essential for understanding the market-hybridization of New Urbanism. Research and criticisms regarding compact form will be discussed first, followed by mixed uses and higher densities.

2.4.1 Compact Form: Lower Infrastructure Costs, Affordability and Land Savings

2.4.1.1 Benefits of Compact Form

Studies which infer higher densities result in reduced infrastructure costs date back to 1955, when Wheaton and Schussheim analyzed hypothetical development patterns in Massachusetts to determine impacts on municipal costs regarding density, size of settlement and
distance from city centre. They found the costs of water supply, sewers and roads decreased as residential density increased and lot width decreased, due to a reduction in the length of streets and lineal feet of utilities on a per unit basis. In 1956 the Lower Mainland Regional Planning Board in British Columbia analyzed the utility and servicing costs (road paving, road and ditch maintenance and water supply costs) of three zones of varying population density in the City of Surrey (Tomalty, 1997). Like Wheaton and Schussheim, the Board found these costs to be considerably higher in lower density areas than in higher density areas.

In 1974, the Real Estate Research Corporation conducted perhaps the most widely known study on the issue of compact form, The Costs of Sprawl (1974). Three communities types were analyzed: a low density sprawl community (entirely single detached dwellings), a high density community (40 percent high-rise apartments, 30 percent walk-up apartments, 20 percent townhouses, and 10 percent clustered single detached dwellings), and a community which combined elements of low and high density communities. The study revealed low density sprawl was more expensive in terms of economic and environmental costs, and these costs were particularly significant for the proportion borne by local governments (RERC, 1974). Downing and Gustely (1977) used the RERC data to study differences in public costs for different housing types, and found that the capital costs for single detached homes were considerably higher than higher density types such as row houses and apartment highrises. This inference is reinforced in a study by the Urban Land Institute (1989) in the US which found the capital costs per dwelling at 12 units per hectare (typical of low density, predominantly single detached dwelling communities) to be $26,000 (1987 US dollars), $20,000 at more compact densities of 25 units per hectare (with a mix of housing types) and $17,000 at 37 units per hectare (ULI, 1989).

Two recent studies regarding compact form and infrastructure costs in the Canadian context were produced by CMHC (1995) and Marshall Macklin Monaghan (MMM) (1994). The CMHC study explored differences in costs between a conventional design and a hypothetical theoretical New Urbanist design in Nepean, Ontario (both communities were compared on an equal area basis). The study found the total life-cycle cost (over a 75 year period) of the infrastructure in the New Urbanist plan was 7.5 percent less than the conventional plan, in terms of emplacement, operating and maintenance costs. Furthermore, the life-cycle savings for linear infrastructure (roads, sanitary sewers, utility connections, water distribution and stormwater management) were between 29 to 37 percent per unit (CMHC, 1995). The per unit cost savings were attributed to increases in residential density, which spread the cost of infrastructure over more units (Tomalty, 1997).
The MMM study was situated in Markham, comparing a hypothetical New Urbanist community (actually an early design conception of the Cornell community to be evaluated in this thesis; 42 hectares) with two existing conventional designs (80 and 90 hectares), with each community containing 1,070 units. This community design was based closely on the principles of New Urbanism, employing a higher density (25.5 units per gross hectare) compact form, mixed uses, grid street systems with rear lanes, and inter-mixed housing types. One conventional community, Mintleaf, contained almost all large-lot single detached homes (density of 11.9 units per gross hectare). The other community, Armadale (density of 13.5 units per gross hectare), contained a mix of small lot and large lot single detached homes, semi-detached and townhouses, set within a conventional curvilinear street design (MMM, 1994). The conclusion estimated Cornell's first time infrastructure costs on a per unit basis to be 15 percent less than Armadale and to 25 percent less than Mintleaf, due to its compact form, higher densities, mixed housing types and less above and below-grade infrastructure requirements per unit (MMM, 1994).

Regarding compact form and reduced infrastructure costs leading to more affordable housing, CMHC (1994) conducted a study in the Regional Municipality of Ottawa-Carleton which assessed the infrastructural costs for a pilot affordable housing project using alternative development standards (quite similar to New Urbanist design principles). The study revealed savings of $4,000 per unit compared to a similar-sized conventional development, savings which could be passed on to homebuyers (CMHC, 1994). The 1995 CMHC study discussed above also stressed that the reduction of infrastructure emplacement costs of $5,151 per unit could result in the reduction of housing costs by approximately $5,000, assuming that the savings are passed on the consumers (CMHC, 1995).

The 1974 RERC study also provided an important inference regarding land savings from compact form, stating that the higher density developments in the study could potentially preserve 18 to 57 percent of the land area which would otherwise be devoured by a low-density, sprawling community. Ewing (1991, 1996) verified these claims with empirical studies of actual communities, where he found the RERC percentages to be very close to reality. A study in New Jersey comparing hypothetical urban growth scenarios (low density sprawl to a more compact, mixed use development) over a twenty year period (1990-2010) found that 175,000 acres of prime agricultural land would be saved from development if compact form design methods were employed on a state-wide basis (Pollard, 2000).
2.4.1.2 Criticisms

The promise of New Urbanism providing affordable housing through lower infrastructure costs has come under fire. Campsie (1994) has remarked that housing prices at Seaside are more oriented towards those in the market for a second vacation home, and a study by Bogorad (1999) of New Urbanist developments in Washington D.C. (Kentlands and Lakelands) listed dwelling prices 10 to 15 percent higher than those in surrounding conventionally designed developments. The higher prices were partially attributed to the high costs of building rear lanes and lower than theoretical densities (15 units per hectare overall), which were caused by considerable public and municipal government resistance to high densities (Bogorad, 1999). The MMM study (1994) lends credibility to Bogorad's findings, as a scenario comparing a lower density Cornell community to the Armadale community actually resulted in higher infrastructure costs on a per unit basis (five percent higher) for Cornell relative to Armadale. These costs only fell to 15 percent lower than Armadale when Cornell's density was increased 14 percent (from 33.5 to 47 percent higher density than Armadale) (MMM, 1994). Regarding this dilemma, Leeming (1999) acknowledges that housing prices in the first phases of a New Urbanist development may be quite high due to massive up-front infrastructure costs (lanes), thus affordable housing may only be realized at full build out of the community (assuming higher densities will be included).

Another interesting aspect of housing affordability in existing New Urbanist communities involves dwellings being sold at premiums not only because of higher infrastructure costs per unit, but also because of their exclusive nature (relative to typical dwellings in conventionally designed communities), a function of increased architectural detailing and 'heritage' themed community contexts (D'Amour, 2000). In a study conducted by Eppli and Tu (1999), it was found that homebuyers paid an average US$20 000 premium for single detached dwellings in New Urbanist communities in the Washington DC metropolitan area, relative to similar dwellings in adjacent suburban developments. While these findings are similar to Bogorad's, Eppli and Tu used a multiple regression model to estimate the sale prices for dwellings using lot size, house size, location market characteristics and other lesser variables; densities and the costs of rear lanes were not factored in. Through this specific method, Eppli and Tu inferred that New Urbanist dwellings sold for a premium simply because of their increased desirability to consumers relative to dwellings in conventionally designed communities (Eppli and Tu, 1999). Bogorad (1999) reinforces this by pointing out that a significant portion of the US residential housing market is enthusiastic about New Urbanism (approximately 25 to 33 percent), and this market is willing to pay a premium to live in a New Urbanist community, a statistic which implies that New Urbanism has become a housing alternative only for the middle to upper classes
Lehrer and Milgrom (1996) and Robbins (1998) take this a step further, noting that expensive dwellings and the use of rigid architectural and design principles in New Urbanist developments actually create enclave-like communities which fail in fostering socio-economic difference and diversity.

The principle of mixing housing types in New Urbanist communities to accommodate affordable housing (without segregation) within compact urban forms has also come under criticism. Kar (1998) found that mixing housing types in New Urbanist developments in the GTA has been hindered by class-based conditioning, as dwellings other than single detached are perceived to be inhabited by 'poor people'. This inference is based on a New Urbanist example in Vaughan where sales of single detached homes facing semi-detached homes were slower than areas of exclusively single detached homes, a situation which may lead developers to create homogenous zones of housing types (which is typical of conventional design) in future New Urbanist developments (Kar, 1998; Bogorad, 1999). Kar's finding is consistent with studies by Klein and Sears (1983), the City of Vancouver (1986) and the Advisory Committee on Regulatory Barriers to Affordable housing (1991), which found residents of low density communities commonly resist higher density housing because they believe it will affect community property values, and increase traffic volumes and crime (Tomaly, 1997).

Lastly, regarding criticisms of compact form, Gordon and Richardson (1997) dismiss the need to preserve open space through compact forms, stating that North America is not running out of open space and metropolitan areas are not encroaching on reserves of critically important agricultural land. Gordon and Richardson (1997) also point out that a compact metropolitan region may actually deprive outlying rural farm economies by moving much needed economic activity (such as the right to sever and sell parcels of their land) further away from farmers.

2.4.2 Mixed Uses and High Densities: Less Automobile Dependence

2.4.2.1 Transportation Benefits of Higher Densities and Mixed Uses

Studies by Cervero (1991), Cervero and Wu (1994) and Cervero and Radisch (1996) within New Urbanist-like environments suggest that mixed uses, higher densities and increased pedestrian orientation promote less dependence on the automobile. In 1991 Cervero conducted land use and transportation studies of high density, mixed use suburban centres in the US (such as Bellevue, Washington; Perimeter Centre, Atlanta; South Coast Metro, Orange County), to determine if there was a positive correlation between mixed uses, high densities and increased public transit and walking trips. Based upon random samples collected at 83 buildings in the activity centres, Cervero found that high densities, mixed uses and limited parking generally
resulted in higher transit and walking trips. Another important study by Cervero and Wu (1994) using the 1985 American Housing Survey found that having retail services (local grocery, convenience) within 300 feet of one's residence encouraged trips by non-automobile modes, and beyond 300 feet retail activities encouraged trips by automobile. The study also found that the presence or absence of neighbourhood shops and other mixed uses proved to be strong predictors of mode choice for non-work trips.

The 1996 study conducted by Cervero and Radisch compared modal splits between a community with characteristics very similar to theoretical New Urbanism (an old streetcar suburb, now serviced directly by the Bay Area Rapid Transit line; density: 2194 units per square mile) and a conventional suburban community (serviced by rapid transit, but pedestrian access to the station is difficult; density: 655 units per square mile) in the San Francisco metropolitan area. The study found that residents in the New Urbanist-style community averaged a 10 percent higher share of non-work trips by non-automobile modes than did residents of the conventional community. Furthermore, compact, mixed use and pedestrian oriented streetscapes and street networks appeared to have the strongest effects on access trips to BART stations for work trips, particularly in inducing higher shares of pedestrian or cyclist access trips in the New Urbanist-like community (Cervero and Radisch, 1996).

Higher density urban forms have also been found to have positive effects on vehicle miles travelled (VMT), energy consumption and automobile emissions. Downing and Gustely (1977) found that air pollution from automobile use was 20 to 30 percent less and fuel consumption was considerably lower in more compact communities. Hotzclaw (1991) also found that doubling residential densities reduces annual VMT by 20 to 30 percent on a per capita basis.

Regarding transportation benefits from applying the principles of New Urbanism on a regional level, Newman and Kenworthy (1996) identify the Greater Vancouver Regional District (GVRD) as being one of the most sustainable metropolitan regions in North America due to policies which prescribe intensifying housing near frequent transit service, the development of compact, mixed use urban villages near frequent transit service and the development of high density mixed use suburban town centres near Light Rapid Transit (SkyTrain) stations. Due to these land use policies, the GVRD exhibits high levels of transit (123 trips per person in 1991, compared to an average of 64 for 13 large US cities in 1990). According to Newman and Kenworthy, these policies and the absence of urban freeways contribute greatly in controlling urban sprawl and its associated problems.
2.4.2.2 Criticisms

Perhaps the most commented-on criticism of New Urbanism involves the lack of or slow development of mixed use nodes which are needed to assist in reducing automobile dependence. Bookout (1992) and Bogorad (1999) found that the New Urbanist main street in DPZ's Kentlands development near Washington D.C. was modified to a more conventional mall form, due to the financial fears of the developer and its lending institution. In the GTA, Kar (1998) found that the New Urbanist development of Montgomery Village had not attracted retailers yet to develop its main street, and now the community consists only of residential dwellings. Furthermore, the convenience store in the New Urbanist community of Morrison Common in Oakville went out of business, due to neighbourhood residents patronizing larger retailers in conventional developments outside of the community.

The lack of New Urbanist-style retail can be attributed to retailers not willing to take the risk of locating in the pedestrian oriented neighbourhoods prescribed by New Urbanism, when instead they can enjoy relative financial security by locating in proven locations, such as a strip mall on a major arterial (Chandler, 1997). Also, with the growth of new retailing currently favouring big-box power centres, and the tendency of suburban consumers to utilize their automobiles for all their trips further diminishes the effectiveness of New Urbanist pedestrian-oriented main streets in the suburbs (Clayton, 1997). Southworth (1997) found that pedestrian connections to mixed use centres were weak at Kentlands and Laguna West (in Sacramento), and about half the residences at Laguna West were more than 10 minutes walking distance away from the neighbourhood centre. Regarding the locating of employment uses in mixed use nodes, Curry and Gurstein (1993), Fulton (1996) and Clayton (1997) have commented that creating sizeable employment bases in a New Urbanism setting could be quite difficult, due to ingrained commuting patterns, consumer preference, and a lack of adequate space in New Urbanist settings necessary for a variety of employment generation needs.

Regarding the supposed benefits of New Urbanism regarding public transit facilitation and automobile use, Atash (1994) comments that only four out of ten New Urbanist communities developed in the US in 1991 contained provisions for public transit articulation, thus 6 of these communities remained entirely automobile dependent (which then may involve increased automobile trip generation in these communities relative to conventionally designed communities, depending on densities). In a study of Bamberton, a now-cancelled DPZ project on Vancouver Island, Curry and Gurstein (1993) concluded that lack of adequate transit articulation, considerable distance from employment areas such as Victoria, and a lack of in-community employment opportunities reduced Bamberton to a typical bedroom community. Southworth
(1997) reinforces this point by illustrating a lack of regular transit service to Laguna West has made the community automobile dependent rather than transit oriented.

2.5 The Hybridization of New Urbanism

The above criticisms of New Urbanism indicate a failure to successfully apply the principles of New Urbanism to their fullest extent in developed examples. New Urbanism has become subject to 'hybridization' due to municipal zoning policies which continue to prescribe conventional design, the pressures of a residential market oriented towards fulfilling consumer demand for communities based on conventional design (involving a clear preference by most consumers for low-density single detached housing), and rising automobile dependence (Kar, 1998). In many locales there is also political resistance by municipal councils and the public against New Urbanism, due to perceived concerns over higher densities and designs encouraging mixed housing types causing lower property values and increased crime (Tomalty, 1997; Kar, 1998). Even in municipal policy contexts which encourage New Urbanist design principles, many developers are not willing to take the risk to develop New Urbanist communities to their fullest extent because of market realities (Chandler, 1997). Clayton (1993) offers this prediction regarding the hybridization of New Urbanism:

"...we will see a number of neotraditional (New Urbanism) housing developments built across Canada which will appeal to a broader spectrum of buyers than buyers to date. However, it is likely that developers and builders will be incorporating the more saleable features of the neotraditional concept into their otherwise conventional developments. The widespread introduction of neotraditional communities is not in the cards even if they do not incorporate the integration of housing with shopping and workplaces-which most will not." (Clayton, 1993)

This statement illustrates the hybridization of New Urbanism resulting in the development of conventional communities which incorporate some principles/characteristics of New Urbanism, such as laneways and Victorian-style architectural detailing. These more marketable features are typically used to attract niche or move-up buyers to 'heritage-style' or 'community living' themed communities (Kar, 1998). Isin (1993) takes this a step further, by stating that New Urbanism is nothing more than a marketing gimmick which strives to only produce Disneyland-type streetscapes designed to appeal to suburbanites' romantic sentimentality for the past. In this context, the partial or ineffective application of theoretical New Urbanism in reality has also resulted in doubts as to whether New Urbanism can contribute to reducing unsustainability inherent in conventional design on a collective or even individual problem basis, a point noted by Curry and Gurstein (1993):

"the question remains whether these new planned communities are sustainable-they still have a wasteful duplication of infrastructure and services, often an inefficient transportation system with a
dependency on the automobile for trips outside the community, and scarce social services and cultural amenities. Nor do they address ecological concerns that critique the dominance of the private house as the building block of the community." (Curry and Gurstein, 1993)

2.6 Conventional Community Design in the GTA and the Emergence of SCD Policy

The purpose of this section is to first illustrate the specific problems associated with conventional design in the Greater Toronto Area (GTA) (see Figure 14), and then discuss specific responses to these problems involving SCD strategies, in order to contextualize the emergence of New Urbanism in the GTA and in the Town of Markham. Concerns over metropolitan unsustainability have recently emerged in the GTA, as it is projected to grow by over 2 million people to a total of 6.67 million by 2021, with the majority of growth occurring in suburban regions (Blais, 1995; Tomalty, 1997).

2.6.1 Conventional Community Design in the GTA

The GTA experienced explosive suburban growth during the post-war period, evidenced by the tripling of population in the suburban York and Peel regions relative to declining rates of population growth in Toronto (Tomalty, 1997). This growth has been largely based upon conventional community design, which in the GTA's case was epitomized by E.P. Taylor's Don Mills suburban community (Kar, 1998). Don Mills embodied all the characteristics of modernist conventional community design, utilizing single use zoning, segregated high and low-density residential areas, regional retailing centres, a firm commitment to the automobile, and a surrounding green belt to protect the enclave from the perceived urban ills of Toronto (Hume, 1999). This formula was duplicated en masse throughout the GTA, greatly assisted by GTA municipalities who financed regional infrastructure emplacements (Tomalty, 1997; Hume, 1999). The growth of suburban areas in the GTA was also facilitated by a provincial freeway building program (400, 401, 403, 404, 410, 427, QEW) during the 1960s and 70s, which effectively opened up new areas for 'brush-fire' suburbanization through improved automobile accessibility (Knox, 1994; Tomalty, 1997). Consequently, 85 percent of total GTA population growth occurred in the suburban regions of Halton, York, Peel and Durham between 1971 and 1986, and per capita automobile ownership in the GTA has doubled since 1964 (Province of Ontario, 1992; Tomalty, 1997).

The continued accommodation of population growth through conventionally designed development in the GTA has become perceived as increasingly unsustainable by planners, politicians and citizens alike, due to growing economic, environmental and social problems common to fast-growing North American metropolitan regions (OGTA, 1990; ORTEE, 1992;
Tomalty, 1997; Kar, 1998; Hardcastle, 1998). These problems are as follows:

- Infrastructure costs (sewers, water mains, roads, freeways, utilities) typical of conventional design in suburban regions are becoming prohibitively expensive for both municipalities and consumers (Tomalty, 1997; Kar, 1998). Blais (1995) estimates that over $90 billion will be required for infrastructure emplacement in the GTA over the next 25 years, if conventionally designed development continues business-as-usual;

- the growth of low-density suburban regions in the GTA has resulted in considerable increases in autos per household, daily auto trips, and vehicle miles travelled (VMT), causing longer commuting times and slower movements of goods (Tomalty, 1997). The provision of more freeways to alleviate congestion is extremely expensive, and these improvements only solve the problem in the short term, as increased conventionally designed development will generate more traffic (Calthorpe, 1993; Tomalty, 1997);

- worsening traffic congestion in the GTA is compromising the ability of the GTA to remain economically competitive in the global economy. $1.9 billion of the $6.4 billion total annual costs of goods movement in the GTA (1986) is due to traffic congestion (Tomalty, 1997);

- continued emphasis on conventional community development will result in increasingly inefficient public transit systems in suburban areas, due to low densities (Province of Ontario, 1992);

- conventionally designed development in the GTA has high land requirements for low-density single detached home communities, thus large amounts of agricultural and natural lands are lost to suburban development (ORTEE, 1992; Roseland, 1998). Continuing conventional development also threatens environmentally significant areas such as the Oak Ridges Moraine and the Niagara Escarpment (OGTA, 1991);

- air pollution from automobiles is also expected to increase if development continues business-as-usual, due to increasing commuting, VMT and lack of adequate transit facilitation (ORTEE, 1992; Tomalty, 1997);
increasing percentages of the GTA population are being excluded from conventionally designed communities due to homes being too expensive or large, since these communities are primarily composed of large-lot single family homes catering to traditional nuclear families (Calthorpe, 1993). Changing demographic conditions in the GTA have resulted in smaller family sizes and rising percentages of single parent families and empty nesters, and housing demand is consequently shifting towards smaller single detached homes, semidetached homes, row houses and apartment units (Bourne, 1991; Province of Ontario, 1994; CMHC 1995; Tomalty, 1997; Kar, 1998); and

- non-automobile owners (30 percent of people in the GTA have little or no access to automobiles) are increasingly being prevented from fully participating in suburban life (i.e. driving to the mall to buy goods) because of segregated land uses, automobile dependence and infrequent transit service typical of conventionally designed development (Roseland, 1998).

Realizing that the continued development of a low-density decentralized metropolitan region was no longer acceptable, planners and politicians in the early 1990s began to explore alternative methods of accommodating the GTA's projected population growth by utilizing certain principles of sustainable community design theory (OGTA, 1991; Curry and Gurstein, 1993; Tomalty, 1997; Van Vliet et al. 1998; Roseland, 1998).

2.6.2 SCD Initiatives in the GTA

Increasing concerns over growth related issues and the problems associated with conventional design prompted the province to undertake a number of regional planning exercises in the GTA during the late 1980s and early 1990s (Tomalty, 1997). A number of regional and local responses soon followed, each reflecting an emerging provincial government mandate to create and foster an environmentally, economically and socially sustainable quality of life in the GTA, through strategies aimed at effectively managing population growth and urban development (OGTA, 1991). These strategies were primarily based upon the methods of SCD, and the implementation of many of these methods into planning policies and reports at all levels of government eventually led to the emergence of communities based upon New Urbanism in the GTA (Tomalty, 1997; Kar, 1998).

Initial efforts to deal with metropolitan population growth issues and the problems of conventional design in the GTA were led by the provincial government in 1988, with the incorporation of key elements of SCD theory into provincial policy statements on housing (Kar, 1998). Primarily intended to deal with the lack of affordable housing in the GTA, these statements also required municipalities to pay greater attention to the health of natural systems and develop more compact, affordable, economically efficient, diverse and transit-supportive communities (Tomalty, 1997; Kar, 1998). Another important initiative by the province involved the establishment of the Greater Toronto Coordinating Committee (GTCC) in 1987, in order to
provide a forum for the discussion of GTA-wide issues, and the Office for the Greater Toronto Area (OGTA) in 1988, a regional agency with a mandate to co-ordinate provincial policies affecting growth and development in the region (Tomalty, 1997).

The most important accomplishment of the GTCC and the OGTA involved commissioning IBI Group to formulate a study comparing a series of future urban development scenarios for the GTA. The Urban Structures Concept Study was completed in 1990 and again updated in 1996, and it provided a crucial basis for influencing new regional and local municipal urban structure and growth management policy recommendations favouring SCD methods as future alternatives to conventional design in the GTA (Tomalty, 1997). Three potential models of urban structure scenarios for accommodating rapid population growth in the GTA over a 25 year period were analyzed and reviewed from a variety of perspectives: a Spread model based on business-as-usual low density conventionally designed development, a Central model based on compact and mixed use development primarily directed into then Metropolitan Toronto (now just Toronto), and a Nodal model based on compact form and mixed uses concentrated in and around existing municipal centres, such as North York, Mississauga and Scarborough (OGTA, 1991) (see Figure 15).

Figure 15: The Nodal Land Use Concept (OGTA, 1992)
The most significant findings of the IBI study involved substantial infrastructure costs savings for the central and nodal models relative to the spread model, 14 percent and 10 percent respectively (Tomalty, 1997). Also, the central model offered the most efficient use of land and energy resources and was the least stressful on the environment (OGTA, 1991). The nodal model offered a more viable intermediate between the central and spread, providing a greater range of housing types, transportation modes and human services, while also reducing per capita resource requirements and pollution levels (OGTA, 1991; Tomalty, 1997). In a detailed look at the capital costs (roads, freeways, sewers, watermains, transit articulation) implied by each model, Blais (1995) estimated that more compact, mixed use and infrastructure efficient development patterns could save approximately $12.2 billion in hard infrastructure capital costs (during the period 1995-2021), relative to the spread option. Furthermore, when cost savings related to air pollution, health care, congestion, parking and land acquisition costs are factored in, the total annual costs savings of containing sprawl could total $1 billion annually (Blais, 1995). Most importantly, Blais concluded the primary benefits of these savings included reductions of the provincial deficit, the aggregate cost of housing (potentially making home-ownership more accessible to lower income households) and the cost of doing business in the GTA (Blais, 1995).

The IBI study was distributed to local and regional GTA municipalities, provincial ministries and non-governmental stakeholders for input and discussion, and the majority of the responses favoured a nodal growth pattern due to increased opportunities for diverse housing types, higher densities, increased population/employment mixes and transit articulation (OGTA, 1991). Another important result of the study involved the acceptance of nodal design and development strategies by the five regional governments of the GTA, in order to effectively guide future regional development and mitigate the negatives of sprawl (Tomalty, 1997). The broad endorsement of a nodal development form was complemented in 1990 and 1992 by the provincial transportation plan for the GTA (Let's Move) and the OGTA Working Group on Infrastructure report (Tomalty, 1997). Both documents encouraged the development of a hierarchical, nodal urban structure (with strong suburban centres) served by an expanded rapid transit system and the broad implementation of transit supportive design and planning policies (higher densities and mixed uses at transit-articulated nodes and along transit corridors), in order to shape more environmentally, economically and socially sustainable land use patterns in the GTA (Tomalty, 1997).

The acceptance of compact nodal development principles at the regional municipal level, and the heavy influence of the provincial policy statements on housing resulted in the incorporation of policies encouraging a nodal urban structure and higher density community
designs (with mixed/affordable housing types) at the local municipal level in the early 1990s (Tomalty, 1997). Concurrently, the Ministry of Housing and Municipal Affairs also produced alternative development standard documents in 1995 and 1997 (Making Choices and Breaking Ground) to further encourage developers and local municipalities to develop affordable and compactly designed communities (Province of Ontario, 1995, 1997). The successful accommodation of future population growth and the provision of affordable housing as per provincial policies became a priority for many local municipalities during this time, along with addressing rising infrastructure costs in an increasingly restrained fiscal environment (Hardcastle, 1998; Kar, 1998). However it was not until the successful introduction of New Urbanism into the municipality of Markham in 1993 that a more complete array of SCD methods, as required by provincial policy and recommended by the OGTA, became increasingly applied in actual community developments and considered for implementation into local municipal Official Plans across the GTA (Kar, 1998).
3.0 Study Area

3.1 New Urbanism in Markham

Markham is a municipality of 190,000 residents located in the suburban York Region, about 25 kilometers northeast of the Toronto CBD. Long perceived as an affluent bedroom community, Markham has matured into an employment and service centre during the past 25 years, and has recently been touted as Canada's 'high-tech' capital (Town of Markham, 1999). Due to excellent accessibility (Highways 7 and 404) and a business friendly environment, Markham is home to over 700 high technology companies, including IBM Canada, Sun Microsystems, Apple Canada, and Lucent technologies (Town of Markham, 1999). Markham possesses a strong potential for population growth, and the population is expected to rise to 260,000 over the next 15 years, due to a growing economy and increasing ease of accessibility (Town of Markham, 1998).

Over the past 35 years, traditional urban development in Markham has been dominated by Don Mills-style conventional community development (Johnston, 1999). However in the late 1980s Markham planners, politicians and citizens recognized that future population growth could not continue to be accommodated through conventional design. The rejection of this approach was based on a combination of growing local concerns over infrastructure costs and the provision of affordable housing, and pressure from the province and regional GTA governments to encourage policies aimed at the development of communities which effectively address problems associated with conventionally designed development (Tomalty, 1997; Kar, 1998). An alternative to conventional design presented itself to Markham politicians and citizens in 1989, when the provincial government decided to develop a demonstration community for 27,000 residents based upon provincial policy in East Markham (Kar, 1998). The province retained DPZ to design the community, and the resultant New Urbanist master plan (now referred to as Cornell) was well received by both politicians and the public (Kar, 1998). A short time later another New Urbanist community, Angus Glen (designed by Toronto-based Planning Partnership Inc.), was proposed for a site in north Markham. By 1995, both Cornell and Angus Glen were approved for development, and a number of other communities based upon New Urbanism were being proposed for development (Cousens, 1997). Concurrently, other GTA municipalities such as Oakville, Vaughan and Orangeville began to host New Urbanist developments also, as New Urbanism began to be perceived as a design and planning method which could successfully mitigate problems associated with conventional development in GTA (Wood-Brunet, 1994; Leeming, 1996; Urban Strategies, 1997; Gabor and Lewinberg, 1997; Hertel, 1999).
The successful acceptance of the Angus Glen and Cornell master plans was a crucial step to further development of New Urbanism in Markham, as municipal staff incorporated the principles of New Urbanism into an official plan amendment (No. 5) in 1997 outlining objectives for future development (Kar, 1998). Amendment No. 5 encourages the development of higher density, transit supportive communities within an urban expansion area, complete with mixed use zoning, allowance of secondary suites and ancillary units, alternative engineering standards, alternative street patterns, and more affordable, mixed housing types (Town of Markham, 1998). Additional policies include limiting low-density development to 60 percent of total units, and 25 percent of units are to be affordable (Town of Markham, 1998).

3.2 Angus Glen and Cornell

Currently there are a number of communities based upon New Urbanism under development in Markham, but only Cornell and Angus Glen were currently built out large enough (both are over 40 hectares) to be evaluated according to indicators derived from the principles of New Urbanism. Generally, studies evaluating New Urbanism have been conducted on developments which have been (or are close to being) built out, and these communities were typically over 40 hectares (Bookout, 1992; MMM, 1994; Cervero and Radisch, 1996; Southworth, 1997; Bogorad, 1999). Furthermore, Angus Glen and Cornell were chosen for study because they have received a significant amount of attention in planning circles and municipal politics, through coverage in literature and by the popular media in the GTA and across Canada (Gabor, 1994; Wood-Brunet, 1994; Campsie, 1994; Leeming, 1996; Province of Ontario, 1997; Town of Markham, 1997; Urban Strategies, 1997; Gabor and Lewinberg, 1997; Hume, 1999). These communities have been declared to be ‘more liveable’ and ‘more sustainable’ by their designers, municipal politicians and commentators (Wood-Brunet, 1994; Angus Glen Development Corporation, 1995; Law Development Corporation, 1995; Leeming, 1996; Province of Ontario, 1997; Cousens, 1997).

Through the development of numerous communities based upon New Urbanism and the encouragement of this development by Amendment No. 5, Markham has become a ‘Centre of Excellence for New Urbanism’ in North America (Kar, 1998). In a recent Town of Markham advertising supplement, Mayor Donald Cousens reinforced the popularity of New Urbanism and the municipality’s commitment to the application of New Urbanist principles in all new developments:

“Our communities can afford to be built this way and things will be forever different in Markham. New Urbanism principles now predominate in the planning of all new developments in Markham. The public and Council have come to expect it. Some developers continue to resist the
neo-traditional concepts, yet we in Markham want to change the complexion of our streetscapes. Those who co-operate will find faster approvals than those who don't." (Town of Markham, 1997)

Despite this strongly worded commitment to New Urbanism in Markham, it remains to be seen to what extent Cornell and Angus Glen actually reflect the design principles of New Urbanism, given other built examples have typically failed to fulfill their original objectives due to market and political pressures (Campsie, 1994; Southworth, 1997; Robbins, 1998).

3.3 Conventionally Designed Community Control Groups

In order to conduct an evaluation of the design characteristics of Angus Glen and Cornell, two conventionally designed communities, Ashton Meadows and Rouge Fairways, were chosen to act as the case study control groups. These communities were chosen according to four criteria: they had been developed without any claims of utilizing principles of New Urbanism (designed and approved for development before Amendment No. 5 came into effect); they were typical conventional design examples of urban development occurring in Markham since the late 1980s/early 1990s (Johnston, 1999); they were less than 10 years old; and they were similar in size to the New Urbanist communities to control for differences in scope and scale.

Furthermore, Ashton Meadows was paired with Angus Glen and Rouge Fairways was paired with Cornell (see Figure 16). The purpose of these pairings was to compare the characteristics of Angus Glen and Cornell to Ashton Meadows and Rouge Fairways, to gauge if the New Urbanist communities are actually significantly different (and thus perhaps less unsustainable) than recently developed conventional communities in Markham. More specifically, the pairing of the particular communities was determined as follows:

1. Communities in each pair were in close proximity to each other, in order to control for physical and socio-economic environmental constraints; these communities had to be in the same municipality to control for economic, political and planning policy constraints;

2. Communities had to be developed within 10 years of each other in order to reduce the uncertainty associated with using unit costs for a comparison of hard infrastructure costs between the New Urbanist and conventionally designed communities and evaluating housing affordability; and

3. Communities had to be of similar size (minimum size of 40 hectares) and at the same stage of development.
Figure 16
Location of Study Communities in Markham
(Town of Markham, 1998)
3.4 Case Study Community Profiles and Pairing

3.4.1 Cornell Community Profile

The Cornell community (see Figure 17) was located in east Markham, with the site bounded by Ninth Line and the Mintleaf on its western side and agricultural land and the Little Rouge River valley on its northern, eastern and southern margins. The community was also located close to the Markham By-pass, Highway 7 and the future Highway 407. Formerly the site of the Christian Reesor and Elizabeth Cornell farm, this development is eventually slated to contain over 10,000 dwelling units, twelve schools, three community centres, a major retail and employment centre at Highway 7, and over 9,000 jobs on 975 hectares by 2020. The community evaluated in this study consisted of the first stage (out of nine) of the total development and comprised 62.36 hectares, developed between 1997 and 2000.

3.4.2 Rouge Fairways Community Profile

Rouge Fairways (see Figure 18) was also located in East Markham, about 7 km southwest of Cornell, and bounded by 14th Avenue to the north, an Ontario Hydro 500 kilovolt transmission line and the Parkview golf course to the west and south, and the Rouge River to the east. The community, which totals 65.8 hectares, began development in 1994 and is nearing completion.

3.4.3 Case Study Pairing

Following the above community pairing methodology outlined in the Study Area, Cornell and Rouge Fairways were paired for this evaluation because they were both located in a predominantly middle class area of Markham, were developed upon relatively flat terrain formerly used for agriculture uses, both sites were free of major topographical/natural features such as woodlots, wetlands, rivers, lakes, hills and depressions, and both were developed during a similar time period. Thus economic and physical conditions could be assumed to be relatively similar between the two communities. Since the communities were developed within 10 years of each other, the development standards utilized for both communities could also be considered similar. Thus any comparisons between the two communities regarding infrastructure cost as a function of density, street system characteristics and housing mix, can be made without having to account for differences in engineering contexts. Lastly, both communities were of similar size and at the same stage of development (very close to build out) to control for potential differences in scale (again important when considering potential economic comparisons).
3.4.4 Angus Glen Community Profile

The Angus Glen community (see Figure 19) was located in north Markham, bounded by Kennedy Road on its eastern edge, Major Mackenzie Drive to the north, Angus Glen Golf Course to the west, agricultural land and York Downs Golf Course to the south. Similar to Cornell, Angus Glen has been being developed on the former farm of Arthur Stollery, a champion horse breeder. Stollery became inclined to develop a golf course oriented community in the 1970s, and this desire became reality in 1993 when design work first began on Angus Glen. Designed by Toronto-based Planning Partnership, Angus Glen will contain 1,250 dwelling units, one elementary school, two neighbourhood centres and five neighbourhood parks on 130 hectares after build out. The community evaluated in this study consisted of the first stage of this development, and comprises 39.5 hectares. Development started in 1997, with work now beginning on a new phase just to the north of the existing community.

3.4.5 Ashton Meadows Community Profile

Ashton Meadows (see figure 20) was located in north west Markham, about four kilometers almost due west from Angus Glen. The community comprises the oldest portion of the larger Cachet Woods subdivision, bounded by Markham Estates to the north, an Ontario Hydro 125 kilovolt transmission line to the east, 16th Avenue and Cachet Centre shopping centre to the south, and Woodbine Avenue to the west. Highway 404 and Buttonville Airport are less than two kilometers to the west. The community, which totals 93.2 hectares, began development in 1991 and was nearing completion at the time of this study.

3.4.6 Case Study Pairing

Following the methodology outlined in Study Area, Angus Glen and Ashton Meadows were paired together because they were both situated in an upper-middle class to upper class residential area within Markham, were developed upon relatively flat land free of lakes, rivers, woodlots, hills and depressions, and both were developed within 10 years of each other. This pairing allowed similar economic and physical conditions, and both communities could be considered to be in the same development and engineering standard context. Thus any comparisons between Angus Glen and Ashton Meadows regarding economic benefits as a result of density, street system characteristics and housing mix could be made without having to account for potential differences. Lastly, since both communities were of a different size, care was taken in the analysis to account for any potential distortions due to scale differences.
4.0 Hypothesis

Based on the preceding literature review and study area chapters, a series of design indicators and a control group of conventionally designed communities were utilized for the evaluation of Angus Glen and Cornell. These indicators allowed the procurement of relevant community characteristics for the purpose of first determining the extent Angus Glen and Cornell conform to the principles of New Urbanism, and then determining the degree of difference between the New Urbanist communities and conventional communities within the same locale. Following Curry and Gurstein (1993) and Southworth (1997), the indicators for the evaluation were grouped under the general headings of built form, land use, transportation, and social benefit. In terms of specific indicators, density was included under built form; types of mixed uses and orientation were included under land use; transit articulation and street system were included under transportation; and housing mix, affordability, and dwelling value distribution were included under social benefit.

Based upon the use of the above indicators and a conventional control group for the evaluation of New Urbanism in Markham, the hypothesis for this study was as follows:

The built form design characteristics of the candidate New Urbanist communities, derived from the given indicators, are (collectively) very close to the principles prescribed by New Urbanism. Density, land use and housing mix (in order of importance) will be considered the most important indicators for determining if the candidate communities conform very closely to the principles of New Urbanism.

Following the rationale of the hypothesis and the claims forwarded by New Urbanism's proponents, the closer the built form characteristics of Angus Glen and Cornell conformed to New Urbanism, the more these characteristics could be considered less unsustainable than the those of their conventional counterparts (given the characteristics of the conventional communities were found to be less favourable than those of the New Urbanist examples). However, if some or all of the characteristics of Angus Glen and Cornell failed to conform to the principles of New Urbanism, then these communities were labelled as hybridized. If this was the case, the degree of hybridization depended on the number of characteristics which did not closely conform to New Urbanist principles. The method to determine this degree of hybridization is explained in the following methodology section.
5.0 Methodology

The following methodological framework outlines an evaluation of the community design characteristics of Angus Glen and Cornell. Two case studies were undertaken (involving the two community pairings discussed in Study Area) to facilitate a potential literal replication of results (Yin, 1994). The first case study involved the East Markham Group, containing Cornell and Rouge Fairways, and the second case study involved the North West Markham Group, containing Angus Glen and Ashton Meadows.

5.1 Data Sources and Collection

Multiple sources of evidence were used, starting with primary sources of data such as subdivision agreements, site plans, secondary plans, transportation studies, public works expenditure reports, real estate reports and statistics, and official plan amendments (Yin, 1994). Interviews of municipal and consulting planners, engineers and developers were important for gathering additional evidence and suggestions for the evaluation methodology. Lastly, numerous and extensive field research visits were undertaken to gather additional information, and to take photographs necessary for visual analysis.

5.2 Evaluation Indicators

As discussed in the a priori model, the evaluation of Angus Glen and Cornell employed a series of specific design indicators including density, mix use orientation, transit articulation, street and circulation system, housing mix, dwelling price distribution and affordability. These indicators were used to obtain particular design characteristics of both communities in each case study group. The existing characteristics obtained for the conventional communities facilitated their role as a baseline control group. Angus Glen and Cornell were evaluated through two comparisons; their characteristics were compared to the principles of New Urbanism, and also compared to the characteristics of the conventional control group communities.

5.2.1 Indicator and Analysis Considerations

Before undertaking the analysis of the Angus Glen and Cornell, it is important to identify how the individual design indicators were qualitatively weighted in terms of their importance. This is especially important regarding the hybridization issue, as some lacking indicators may have a more profound effect than others. It is also important to note that the principles of New Urbanism are intended to be applied on a collective basis to achieve certain benefits which may potentially mitigate the problems associated with conventional community design (Duany and
Plater-Zyberk, 1992; Calthorpe, 1993). These principles act interdependently to achieve the following primary environmental, economic and social benefits (primary principles responsible for these benefits are given also):

- Reduced infrastructure costs and more affordable homes: higher density, reduced road pavement widths, diverse housing mix.

- Less land requirements: higher density.

- Less automobile dependence (less energy use, pollution, congestion, expenditures on roadways and increased public transit usage): higher density, mixed land uses (retail, employment), diverse housing mix, frequent transit articulation, grid street system.

- More affordable housing and a diverse socio-economic environment: diverse housing mix, higher density, mixed land uses (retail, services).

- Compact, nodal metropolitan development patterns: higher density, mixed land uses (retail, employment), increased transit articulation.

Based on the above list, density was considered the most important indicator for evaluating Angus Glen and Cornell, since it plays a such a significant role in determining the key benefits of New Urbanism. Land use, transit articulation, housing mix, and street and circulation (in order of descending importance) indicators follow density, as these are crucial complementary theoretical principles to density for facilitating affordable housing and encouraging less automobile dependence. More specifically, orientation of land uses and housing mix characteristics were considered the next most important indicators after density for determining adherence to New Urbanist principles and/or degree of hybridization.

In addition to the design indicator list, a specific 'outcome' indicator was employed also. This indicator evaluated how the design characteristics of the study communities (density, housing mix and street system) affected hard infrastructure costs on a per dwelling unit basis, in order to determine if the existing design characteristics of Angus Glen and Cornell resulted in cheaper development costs (on a per dwelling unit basis) relative to the conventionally designed communities of Ashton Meadows and Rouge Fairways. The results of this outcome indicator were then compared to New Urbanist benefits found in empirical and theoretical literature.

The evaluation indicators are listed below, along with the methods utilized to obtain the characteristics, and the principles/benefits of New Urbanism (as discussed in the literature review) for each specific indicator. Critical values have been also provided to serve as benchmarks which the design characteristics for Cornell and Angus Glen needed to measure up to in order to conform 'very closely' to the principles of New Urbanism.
DESIGN INDICATORS:

A. Built Form

**Density:** Gross and net density.

**Method:** Gross density was calculated by dividing total dwelling units in the community by total land area, and net density was calculated by dividing total dwelling units in the community by residential land area which excludes, roads, lanes, open space, parks, schools, commercial and employment uses (Roseland, 1998). Density was expressed as dwelling units per hectare and units per acre.

**New Urbanist Principle:** Gross density minimum of 17.3 units per hectare or 7 units per acre-16.5 units per hectare would be considered 'very close' (90 percent of the prescribed density) (Calthorpe, 1993; City of Calgary, 1995; White, 1996).

B. Land Use

**Mixed Use Orientation:** Types of land uses and their orientation to each other within the community.

**Method:** Relevant information was obtained through extensive site visits, consultation with municipal and private planners and secondary plans.

**New Urbanist Principle:** Retail, community service and employment activities should be present within the community and oriented into a node which is within a 400 metre distance of the majority of dwellings (90 percent) in the community. Since the community parcels of Cornell and Angus Glen were incomplete, 60 percent was considered as a majority in terms of orientation of mixed uses to dwellings (according the principles of New Urbanism, at full build out 90-100 percent of dwellings should be within 400 metres of a mixed use node). Activities in the nodes should be oriented into a ‘main street’ configuration with minimal setbacks from roadways (10 to 15 feet), and 1 to 4 acre parks should be placed within 2 blocks (300 metres) of any resident. (Duany and Plater-Zyberk, 1991; Calthorpe, 1993).

C. Transportation

**Transit Articulation:** Frequency of public transit service during peak and non-peak periods, transit connections to regional rapid transit, and orientation of transit stops in community (in terms of distance to furthest away dwellings and proximity to mixed uses).

**Method:** Information for this indicator was acquired through Markham Transit schedules, transportation plans and interviews with municipal transportation planners.

**New Urbanist Principle:** A minimum 15 minute service frequency during peak hours (including service to rapid transit stations), and 90 percent of community dwellings should be within 400 metres of transit stops, which should also be sited near (within 100 to 200 meters direct walk) of mixed use environments (Calthorpe, 1993).

**Street System:** Street pattern, road pavement widths (in metres), ease of pedestrian travel through community, and sidewalk emplacement.

**Method:** Information was obtained through site maps, surveyor reports and site visits, and site maps were used to communicate street patterns, ease of pedestrian travel and sidewalk emplacement. In order to measure ease of pedestrian travel, a pedestrian shed calculation was used to determine what percentage of
community residents who resided in dwellings within 400 metres of a destination could actually access the destination within a five minute walk along roads and paths. This calculation involved measuring actual 400 metre distances along all roads and paths radiating out from a destination, and determining how many dwellings within a 400 metre radius of this destination are actually within a 400 metre walking distance. Also, road pavement widths were obtained from field observations and averaged.

**New Urbanist Principle:** A grid-like street system should be employed (complete with lanes), with sidewalks on both sides of street, to provide shorter, direct routing for pedestrians to community destinations. Ideally 60 percent of dwellings within 400 metres of a destination should be within a 5 minute walk due to street and path routing (Government of Western Australia). Also, residential road (not including main streets and avenues) pavement widths should average around eight metres (Duany and Plater-Zyberk, 1992; Calthorpe, 1993).

D. **Social Benefit**

**Housing Mix:** Proportion of single detached, semi-detached, town homes, and apartments dwellings in community.

**Method:** The relative proportions of dwellings was calculated using site plans.

**New Urbanist Principle:** There should be a maximum 65 percent single detached dwellings, and dwelling types should be interspersed throughout the community on a block by block basis (Gabor and Lewinberg, 1997).

**Affordability:** Proportion of dwelling units which were considered 'affordable'.

**Method:** Values obtained from the Property Assessment Database at the Town of Markham, and price listings provided by community homebuilders. The assessment values were calculated by the Ontario Property Assessment Corporation (OPAC) using a complex multiple regression model, and are intended to reflect a 1996 market value for the GTA. Dwellings under $180 000 were considered to be affordable (based on a definition that affordable housing is accessible to the lowest 60th percentile of the annual income distribution for Markham, which ranges from $10 000 to $80 000) (Regional Municipality of York, 2000).

**New Urbanist Principle:** While there is no definite dollar value or dwelling proportion prescribed by proponents for affordable housing (although there should be at least some affordable housing), Amendment No. 5 for the Town of Markham requires 25 percent of all dwellings should be affordable (under $180 000) within the new urban service area (not specific communities). Thus for this indicator, no real target value was used; whichever community contains the higher percentage of affordable housing will be considered more affordable (Town of Markham, 1998).

**Dwelling Price Distribution:** The distribution of dwelling values throughout the community, on a block by block basis.

**Method:** Values for dwellings were obtained through the Property Assessment Database at the Town of Markham, and homebuilder price listings. The value distribution was analyzed by calculating the average value and range of values for individual blocks via an SPSS database, in order to identify value-based patterns (ie. dispersed, concentric, concentrated).

**New Urbanist Principle/Benefit:** Residential blocks and areas should exhibit a wide range of values typical of affordable, middle class and upper class housing, in order to foster a diverse socio-economic environment. Also, average dwelling values per block should be dispersed throughout the community, not concentrated into particular locales (which is typical of conventional design) (Duany and Plater-Zyberk, 1992).
OUTCOME INDICATOR:

**Hard Infrastructure Emplacement Costs:** Hard infrastructure costs on a per-unit basis for storm and sanitary sewers, water mains, service connections (water, storm, sewer), pavement, curbs and sidewalks.

**Method:** Following CMHC (1995), both New Urbanist and conventionally designed communities were the same size in total area, to compare total costs for developing the parcels and percentages of land utilized for roads and residential uses. Also, each community exhibited similar percentages of non-residential uses, to isolate the effects of density, lot frontage, road pavement widths, and housing mix have upon infrastructure costs on a per unit basis for each particular community. If the communities within the case study pair were of slightly different sizes, then same sized parcels taken from each community were compared also.

Each community and/or parcel was picked carefully to ensure that all dwellings in the New Urbanist communities had access to rear lanes (given their garages are at the rear of the dwellings). Similarly, all dwellings in the conventionally designed communities were to have access to a roadway. In order to eliminate the possibility of skewed cost comparisons, large arterials which have been already constructed to serve future portions of the community were removed and/or reduced to a residential scale (8-11 metres wide depending on existing standards for the particular community) if the road fronted dwellings.

Total costs and costs per unit were calculated using a series of unit costs (1993 dollars) for hard infrastructure components, obtained from the engineering firm Marshall Macklin Monaghan (1994). The unit costs allowed an equal cost comparison between the communities in each case study, regardless if they have been developed 1 or 10 years apart. These unit costs were also specific to the cost of wages and materials in Markham, being based upon on residential construction contracts tendered in Markham between 1987 and 1993 (MMM, 1994):

- **Pavement:** $30 per square metre
- **Earthworks (grading):** $85 per metre of road
- **Watermains:** $122 per metre of road
- **Sanitary Sewers:** $121 per metre of road
- **Storm Sewers:** $295 per metre of road ($120 for lanes)
- **Raised Medians:** $95 per metre of road (curbs only)
- **Curbs:** $84 per metre of road ($50 for lanes)
- **Sidewalks:** $56 per metre on one side of road
- **Service Connections (to dwellings):** $460 (watermain); $325 (storm); $450 (sanitary)

To calculate total costs for each community, total road length and total pavement areas were obtained from measuring road lengths and widths via community site plans and site visits. Service connections were multiplied by total units. These total costs were then divided by total units to obtain hard infrastructure costs per unit.

**New Urbanist Principle/Benefit:** New Urbanist communities have lower per unit infrastructure costs than conventionally designed communities, thus housing may be more affordable and regional infrastructure costs may decline also (Calthorpe, 1993; MMM, 1994; CMHC, 1995, 1997).

**Comparison Methodologies**

As described above, the hard infrastructure costs (on a per dwelling unit basis) and total infrastructure costs for each community were compared on an equal-sized area parcel basis. Where communities in a case study group were of significantly different sizes, the methodology was modified in order to conduct more accurate comparisons using carefully chosen equal sized parcels.
Cornell and Rouge Fairways

Before the cost comparison was undertaken, it is important to note that each parcel was also picked to ensure that every dwelling contained in the parcels had access to a road (for Rouge Fairways) and a lane (Cornell). The completed Bur Oak Avenue section located at the northeast edge of the existing Cornell community was reduced from 16 metres wide to 8 metres, to eliminate a potentially skewed cost comparison. The 40 dwellings along Ninth Line represented a unique design characteristic of Cornell, as these homes did not directly front a residential street. In terms of servicing, it was assumed for the homes which only have access to a rear lane that watermain and sanitary sewer pipes were laid underneath the lanes rather than under roads, as with the rest of Cornell.

Lastly, some sections of lanes (intended to service the next stage of town homes along Bur Oak Avenue) were removed from the parcel because they did not directly service dwellings or provide access to lanes which service dwellings. Rouge Fairways did not require any major changes.

Angus Glen and Ashton Meadows

Since the community sizes of Angus Glen and Ashton Meadows were markedly different, the infrastructure costs comparison methodology employed for Cornell and Rouge Fairways was slightly modified. Three separate comparisons were undertaken; the first compared both communities as is, the second compared a 21 hectare parcel of Angus Glen containing a 36 percent housing mix to an equally sized Ashton Meadows parcel of entirely single detached homes, and the third compared same sized parcels (21 hectares each) of Angus Glen and Ashton Meadows containing entirely single detached homes. Emphasis was placed upon comparisons involving equal sized parcels, to obtain more accurate costs on a per unit basis and necessary land use information (ie. densities, proportion of road area/length to residential area) for the cost comparison analysis. Also, as with the Cornell and Rouge Fairways comparison, each dwelling unit was required to have access to either a road or a lane, in order to maintain a fair comparison of parcels with equal infrastructure proportions.
6.0 Analysis

The following analysis evaluated the communities of Cornell and Rouge Fairways, contained within the East Markham case study group, then Angus Glen and Ashton Meadows in the North West Markham case study group, via the design indicators outlined in the methodology chapter. For each specific indicator, the characteristics found for the New Urbanist communities were first compared to the principles of New Urbanism, and then compared to the characteristics of its conventional 'control-group' counterpart. This two step evaluation was conducted one indicator at a time, and the results of these individual indicators were discussed following each indicator and also at the end of each case study analysis.

Following the evaluation, the next step was to determine if the design characteristics of Angus Glen and Cornell, specifically density, street system and housing mix, resulted in particular outcomes regarding the theoretical benefits of New Urbanism, versus their conventional counterparts. This involved examining hard infrastructure costs on a per unit basis, and this step was crucial in determining if Angus Glen and Cornell offered lower infrastructure costs per unit (relative to their conventional counterparts), assuming that their design characteristics are close to the principles of New Urbanism and markedly more favourable than their conventional counterparts. Conversely, if the design characteristics of Angus Glen and Cornell did not closely follow the principles of New Urbanism, and were either marginally favourable or less favourable than their conventional counterparts, it was important to determine if Angus Glen and Cornell were actually more expensive (per unit) to develop than conventionally designed communities.

6.1 Analysis of East Markham Group: Cornell and Rouge Fairways

6.1.1 Design Indicators and Characteristics

A. Built Form

Density

Cornell: To obtain the gross density of Cornell, the total number of dwelling units in the community, 1001, was divided by the total land area of the community, 62.39 hectares or 154.17 acres (Town of Markham, 1997, 1998, 1999). Thus 1001 units / 62.39 hectares (or 154.17 acres) = 16.05 units per gross hectare (or 6.5 units per gross acre). To obtain net density, the total number of units was divided by residential land area which excludes roads, lanes, open space, parks, schools, commercial and employment uses, 29.41 hectares or 72.68 acres. Thus 1001 units / 29.41 hectares (or 72.68 acres) = 34.03 units per net hectare (or 13.77 units per acre).
Rouge Fairways: The gross density of Rouge Fairways was calculated by dividing total units, 671, by total land area of the community, 65.80 hectares or 162.59 acres (Town of Markham, 1993; 1994; 1995; 1999). Thus 671 / 65.80 hectares (or 162.59 acres) = 10.19 units per hectare (or 4.13 units per acre). For net density, total units were divided by net residential area, 36.60 hectares (or 90.44 acres). Thus 671 / 36.60 hectares = 18.33 units per hectare (or 7.42 units per acre).

Discussion

The gross density of Cornell (16.05 units per ha) fell short of the gross density recommended by the principles of New Urbanism (17.3 units per hectare). This slightly lower gross density was probably due to the small percentage of high-density apartment dwellings present in the Cornell community (4.8 percent of total dwellings); according to the principles of New Urbanism, this number should be closer to 10 percent (Lennertz, 1994). However, as the Cornell development progresses towards full build-out over the next 20 years, gross density will likely increase as higher percentages of high density apartments are to be included in future phases (Town of Markam, 1997a). Conversely, possible changes in Markhams’ local economy and planning policy environment may result in lower densities than now witnessed. Despite this uncertainty, it was evident that the current phase of Cornell did not conform very closely to the density principles of New Urbanism, as required by the hypothesis. This inference is based on the gross density Cornell (16.05 units per hectare) attaining 80 percent of the gross density prescribed by New Urbanism, based on a range between 11 units per hectare (near typical density for a conventionally designed community) and 17.3 units per hectare. If Cornell’s density is to be considered very close to the density principle of New Urbanism, then it should be above at least 90 percent of the gross density prescribed.

Rouge Fairways exhibited a gross density typical of conventional development in Markham and across North America: approximately ten units per hectare or four units per acre (Calthorpe, 1993; Langdon, 1994; Gabor and Lewinberg, 1997; Kunstler, 1997; Johnston, 1999). Compared to Cornell, Rouge Fairways’ gross density and net density were 36.5 and 46 percent lower than Cornell, a situation which could be primarily attributed to the use of smaller average lot sizes for single detached homes and a range of lot sizes (for other housing types such as semi-detached and town homes) within Cornell. This situation was especially significant since both communities contained approximately the same amount of open space (21 percent). In this case, Cornell had a clear gross and net density advantage over Rouge Fairways.
B. Land Use

Mixed Uses and Orientation

Cornell

Types of Land Uses: Within the existing Cornell community, a broad spectrum of non-residential land uses was either found to exist or was slated for definite future development. These included two elementary schools (to be developed), a place of worship (to be developed), two neighbourhood parks (approximately two hectares each), five small parks (or parkettes averaging about one-third hectare in size), a mixed use central neighbourhood node containing retail space and other services, home offices and an adjacent health care facility (see Figure 21).

The central neighbourhood node, known as 'The Mews', was found to be located at the intersection of Country Glen Road and Cornell Park Avenue. The Mews was configured as a singular main-street style retail/residential building, with 48 apartments located above street-level shops and services. The south facing section of the retail shops and apartments was set back about fifteen to twenty feet from Cornell Park Avenue (see Figure 22) and the west-facing section fronted a one-third hectare community parkette or 'green', complete with a tot lot, grass, trees and benches (see Figure 23). The orientation of the green with the retail and residential uses of the node, along with higher density housing types (townhouses) immediately adjacent to the node, created a community public space and meeting area for community events and recreation.

Regarding community services situated at the node, a coffee shop and its patio were found to be located at the junction of the two node building sections, and these facilities could be considered the community social focal point. Other services located within this neighbourhood node included a chiropractor office, pharmacy, dentist, salon, convenience store, dry cleaners and the Royal Bank. A parking lot for residents and patrons was found behind the node. The node was also configured so that individuals coming from the parking lot side can access the services and apartment entrances quite easily, without having to walk around to the 'front' of the building (see Figure 24).

Further retail and service opportunities near the neighbourhood node may appear with the next phase of development for Cornell. Adjacent (to the east) of the existing Cornell community, the Bur Oak corridor is planned to include street-level retail shops along Bur Oak Avenue, which is intended to eventually become the central corridor and transit spine of the entire Cornell community. However, the buildings along Bur Oak have been designed to be flexible in their use; initially after development these dwellings will contain only residential uses, and commercial uses will only move into these spaces once there is a sufficient population to support those activities (Wayman, 2000). Therefore, it can be assumed that the existing neighbourhood node
Figure 24: Cornell: Mews Parking Lot (Author)

will be the only locale for Cornell residents to obtain convenience goods and services (without leaving the community) for at least 5 to 10 years.

The services contained in the neighbourhood node building also offered limited employment uses for residents of Cornell, as did the adjacent Markham-Stouffville hospital. Cornell was also found to contain 24 ancillary units located above garages in rear lanes throughout the community, some of which had been converted into home offices.

All the parks in Cornell were oriented so that community dwellings only fronted directly onto either parks or roads that ran immediately adjacent to these parks. The existing parkettes contained grass, paths and benches, and in some cases mature trees which had been protected from development (see Figure 25).
**Orientation of Land Uses:** In terms of its orientation to residential uses, the node was found to be located approximately central within the Cornell community (see Figure 26), with over 70 percent of Cornell dwellings within a 400metre radius. The dwellings outside of the 400 metre radius are probably going to be eventually captured in the 400 metre radius of future retail services located along Bur Oak Avenue and/or in a future phase located just north of the existing community (Town of Markham, 1997a). Regarding parkland orientation, every dwelling within Cornell was found to be within two blocks (or 300 metres) proximity of either neighbourhood parks or parkettes (see Figure 27).
Rouge Fairways

Types of Land Uses: Within Rouge Fairways, an elementary school, a three hectare neighbourhood park and a small retail plaza were found to exist and/or were in the process of being developed (see Figure 28).

The retail plaza, although not developed yet, will probably be of a conventional 'strip-mall' nature (Rouge Fairways, 1999). Located at the extreme north-western corner of the community, on the corner of 14th Avenue and Havelock Gate, the plaza will be ideally situated to access primarily automobile traffic. Stores will be consolidated under one building and set back from 14th Avenue and Havelock Gate with a parking lot. Rouge Fairways did not contain any real employment uses, other than very limited employment opportunities from the future retail plaza.

The neighbourhood park was found to contain a tot lot, a water park-style fountain, a softball field, a soccer field and a parking lot. A trail system adjacent to Little Rouge Creek will be developed beyond the neighbourhood park, to offer passive recreational uses to residents.

Orientation of Land Uses: The location of the retail plaza on 14th Avenue and Havelock Gate allowed only 18 percent of dwellings in Rouge Fairways to be within 400 metres of the plaza (see Figure 29), thus a large majority of the community might be inclined to use their automobiles to access this plaza or drive elsewhere (the nearest convenience store was located in Box Grove, about one and a half kilometers away) to obtain convenience goods (Cervero, 1994).

Regarding access to parkland and open space, 93 percent of dwellings within Rouge Fairways were within two blocks or 300 metres of a neighbourhood park or school playground. However, when only the neighbourhood park, with its passive and active recreational uses, was considered, only 23 percent of total dwellings were found to be within 300 metres of this amenity (see Figure 30).

Discussion

In terms of following the principles of New Urbanism for Land Use, Cornell conformed very closely. The wide variety of retail, service, educational and recreational uses and opportunities, and the presence of a neighbourhood mixed-use node within Cornell represented definite steps towards the community emulating the land use principles of New Urbanism. It is important to stress that the existing phase of Cornell (including the adjacent Markham-Stouffville hospital) did not contain enough employment uses to support more than 10 percent of its current population, thus the vast majority of residents must commute to outside employment areas by either transit or automobile. A majority of Cornell dwellings (70 percent) were found within 400
metres of the neighbourhood node, which exceeds the 60 percent critical value outlined in the methodology. This parcel of Cornell is slated to have retail located within 400 metres of the dwellings located in the northern section of the parcel, and thus this parcel will probably have a clear majority (80 percent+) of dwellings within 400 metres of mixed uses within five to ten years. Furthermore, any dwelling within Cornell was within two blocks of a parkette and/or a neighbourhood park.

The types and orientation of non-residential uses within Rouge Fairways was found to be typical of conventional community design in Markham and the GTA. Retail zoning was located along an arterial to capture the automobile-oriented market rather than the pedestrian or transit oriented market. The only true park was placed at the margins of the community, out of feasible pedestrian reach for a substantial proportion of the community. Compared to Cornell, it was evident that Rouge Fairways offered less opportunity to access retail service and recreational opportunities by pedestrian means. Given that the location of the retail plaza in Rouge Fairways resulted in poor pedestrian access, residents are more likely to 'burn a liter of gas to get a liter of milk' than residents of Cornell (Gabor, 1994). Thus Cornell demonstrated a clear advantage over Rouge Fairways in terms of mixing land uses and encouraging less automobile dependence.

C. Transportation

Cornell

Transit Articulation: Cornell was found to be directly serviced by two Markham bus routes, Number 1 and Number 5. Number 1 stops at Markham-Stouffville Hospital and runs to the Finch TTC (subway) station on Yonge Street, with service every 15 minutes during rush hours (5:45-9:00 / 3:00-6:15) and every 30 minutes during the rest of the day (for both weekdays and all day Saturday). This route traverses Markham (east/west) on Highway 7, a primary employment corridor. Number 5 currently runs through Cornell along Country Glen Boulevard and Cornell Park Avenue; when the northern section of the existing community is fully built out, this route will run up to White's Hill and on to Ninth Line. Number 5 runs along 16th Avenue to Bathurst Street in Richmond Hill, and is a rush hour-only route with a 30 to 40 minute service frequency. No direct transit routing from Cornell to any of Markham's three GO Train stations was found to exist, although the Markham GO station was located a three minute automobile drive away. At full build-out, service is to be increased along the Number 1 route (including service to Markham GO), and Bur Oak Avenue is to become the community's central transit spine. Also, a new route servicing Cornell during rush hour to Finch Station and Vaughan/Brampton is proposed to run along a transitway to be developed in the median of the 407 Highway (Town of Markam, 1999a).
Three transit stops were found either within or adjacent to the Cornell community (see Figure 31). The stop for both Number 1 and Number 5, located on Church Street, was found to be immediately northwest of the Markham-Stouffville hospital and just south of the existing community. Since Number 1 runs directly from Cornell to Finch Station, it could be considered a crucial transit route for reducing dependence on the automobile for commuting to Toronto. However, this was the only stop for Number 1 in the vicinity of Cornell, and only 18.7 percent of dwellings in the community were within 400 metres of the stop. The stop was close to higher density housing forms (town homes) along the southern edge of Cornell, but there were no mixed uses nearby to further encourage transit trips (Province of Ontario, 1992; Calthorpe, 1993; Cervero, 1994).

The two other stops for the Number 5 are located at the corners of Country Glen Road and Cornell Park Avenue, and Cornell Park Avenue and Ninth Line. The stop on Ninth Line was situated close to higher density housing along Cornell Park Avenue, and located to exclusively serve Cornell residents west of Country Glen Road and Mintleaf residents on the other side of Ninth Line. The stop at Country Glen and Cornell Park was situated very close to the mixed-use node and represented the best opportunity to encourage more trips by transit (see Figure 32) (Cervero, 1991).

At the time of this study the dwellings outside the radii on Figure 31, situated around Country Glen and White’s Hill, were not fully built out yet. The Number 5 route is slated to run up White’s Hill as soon as this section becomes populated, thus the entire community will be within 400 metres of three transit stops. However, Number 5 route does not have a high enough service frequency to get many drivers out of their cars and into transit (Province of Ontario, 1992; Calthorpe, 1993), and the Number 1 may be too inconvenient (in terms of walking distance) for the majority of residents to use, especially in poor weather. Number 5 does offer transfers on Numbers 68B and 129A on 16th Avenue to connect with 53 on Steeles to get to Finch Station during rush hours, but this may be also too inconvenient for effectively encouraging Cornell residents to commute by transit.

*Street System:* The street system of Cornell could be classified as a classic grid, complete with rear lanes servicing all dwellings within the community (with the exception of the apartments contained in the neighbourhood node building, which are serviced by a parking lot). Cornell was found to utilize ‘connector’ streets (such as Country Glen and Cornell Park) with pavement widths averaging 11 to 12 meters and local residential streets with pavement widths of 8 metres.
(see Figure 33). These connector streets are intended to eventually connect to future phases of Cornell, and have distinct boulevard treatments complete with raised sodded medians and street trees (see Figure 34). Rear lanes averaged 4.15 metres in width, and 1.5 metre wide sidewalks (marked in heavy outline on Figure 33) were provided along both sides of each local residential street and connector roads.

In Cornell, the use of grid streets and lanes should potentially allow the majority of residents living in dwellings within 400 meters of a particular destination to easily access destinations via a five minute walk. It is important to note that a 400 metre proximity of a dwelling to a destination may not guarantee a five minute walk; the actual walking distance within this radius depends of the layout of the road system, block length and available paths, sidewalks and pavement routes (Government of Western Australia, 1997). In order to determine what proportion of Cornell residents living in dwellings within 400 metres of a destination could actually access destinations via a five minute walk, a pedestrian shed (ped shed) calculation was used. The ped shed is expressed as a percentage of dwellings within a five minute walk, calculated by measuring out 400 metre lengths along all roads, lanes and paths which lead to the
destination in question. Only dwellings within the radius in which the 400 metre lengths reach were counted as being within a 5 minute walk of the destination. Using the Number 5 transit stop situated near the neighbourhood node as an example of a major destination in Cornell, it was found that 78 percent of residents living in dwellings located within the 400 metre radius centered on the transit stop could access the stop with a 5 minute walk (see Figure 35).

**Rouge Fairways**

*Transit Articulation:* Rouge Fairways was found to be serviced by Number 2A every 45 minutes between 6:30-8:45 am and 3:05-7:15 pm. 2A runs along 14th Avenue to meet up with Number 2 at Esna Park Drive, which carries on along John Street (a subdivision collector road) to Yonge Street and Finch Station. Number 2A does run along a secondary employment corridor, but the low frequency of service and a lack of mixed uses within 400 metres of stops within the community probably won't encourage many Rouge Fairways residents to use transit for commuting trips (Province of Ontario, 1992). Also, it may be possible to transfer from Number 2A to Number 8 at Kennedy Road to access the Steeles GO station, but the inconvenience of
transferring buses may prompt Rouge Fairways commuters using GO to just drive to the station and park and ride.

All of the 7 transit stop locations within Rouge Fairways were located on Boxwood Crescent; 2A travels both ways along the crescent, with four stops eastbound and three westbound (see Figure 36). With this many stops in one direction, over 95 percent of dwellings in Rouge Fairways were within 400 metres of 2A over a period of ten minutes (i.e. the 400 metre radius around the stops will move as the bus moves through the community, creating a collective coverage situation), with the exception of dwellings at the extreme south end. There was also a stop north the future retail plaza, across the four lane arterial of 14th Avenue.

Street System: Rouge Fairways possessed a curvilinear, hierarchical street system typical for a conventionally designed community, utilizing both collector and local residential streets. Boxwood Crescent acts as the primary collector road, ranging in width from 18 metres at 14th Avenue to 11 metres within the community (see Figure 37). Local residential streets average 8 metres in width. Sidewalks are used sparingly in Rouge Fairways, as only Havelock Gate and Boxwood Crescent have them on both sides of the street, and Bluebell Drive and Upper Ridge Court on one side of the street.

Pedestrian travel between destinations in conventionally designed communities utilizing curvilinear street systems and long blocks (such as Rouge Fairways) can become difficult, thus community residents may become more dependent on their automobiles (see Figure 38). Long blocks without bisecting paths typically need to be walked around to access destinations on the other side of the block, and the use of crescents and cul-de-sacs to ‘dead-end’ streets (which would otherwise lead to other major streets) can cut off easy access to transit stops or retail/open space uses, if access paths are not used also. To illustrate how a curvilinear street system in Rouge Fairways discourages pedestrian travel, the ped shed calculation used for Cornell was utilized. Using the Number 2A transit stop near the elementary school as an example destination (probably the most significant pedestrian destination within the community, with the exception of the retail plaza at Havelock Gate and 14th Avenue), and assuming the homes backing on to the school yard had no gates leading to the school yard and there is a path between Teversham Court and the school yard, it was found that 53 percent of the dwellings within 400 metres of the transit stop were within an actual five minute walk (see Figure 39).
Figure 38: Long Blocks in Rouge Fairways (Author)
Discussion

In terms of transit service, Cornell did not perform as well as it does for the preceding indicators, due to the majority of its bus service being offered only during the weekday rush hour at 30 to 40 minute intervals. The only 15 minute service at this time was only easily accessible through pedestrian means for 19 percent of the community. However, transit frequency will probably increase as successive phases of Cornell are built out and density and land use mix increases (Town of Markham, 1996).

Transit frequency is not really a New Urbanist principle to evaluate Cornell by, but it is a function of density and land use mix, so it did lend some insight into how Cornell performed according to the principles of New Urbanism. The more appropriate principle to evaluate Cornell with was transit stop orientation, since pedestrian access and close proximity of transit stops to mixed uses (within 100 to 200 metres) is crucial to encouraging increased transit trips. Given that the existing stops (and the definite future stop at White's Hill) provided 100 percent coverage for Number 5 route over a space of 5 minutes, then Cornell could be deemed to conform closely to New Urbanist principles. While there is no definite percentage coverage prescribed by New Urbanism for what percentage of dwellings should be within 400 metres of a transit stop, the Province of Ontario's Transit Supportive Land Use Planning Guidelines (1992) and the City of Calgary Sustainable Suburbs Study (1995) studies, both of which recommend land use and transportation policies similar to those of New Urbanism, recommend 90 and 95 percent respectively. Using these benchmarks, it seems that with the addition of the White's Hill transit stop that Cornell will achieve these benchmarks. However, existing deficiencies which prevented Cornell from being a good example of New Urbanism included poor coverage for Number 1 and lack of mixed use orientation for Number 5 stops on Church Street and Ninth Line. Furthermore, if one isolated Number 1 as the only relevant stop and route servicing Cornell, then this community would definitely fail to come very close to the New Urbanist principles for transit coverage and become characterized as a predominantly automobile dominated community.

Comparing to Rouge Fairways, Cornell offered marginally better transit service in terms of service times, routing and coverage (for both Number 1 and 5). However, as mentioned above, Cornell would fare worse than Rouge Fairways in reducing automobile dependence if only Number 1 service was considered. Although 2A's service frequency was less, it provided superior coverage throughout the community. Despite this poor coverage, Cornell did possess excellent potential for future transit upgrades as development continues. Thus 10 to 15 years hence Cornell will probably exhibit superior transit coverage and service to regional employment destinations and subway/GO Train stations relative to Rouge Fairways.
Regarding street systems, Cornell conformed very closely to New Urbanist principles. The grid street system complete with lanes, sidewalks on both sides and narrow pavement widths for local residential streets (average 8 metre width) were exactly what Andres Duany/Elizabeth-Plater-Zyberk and Peter Calthorpe typically prescribe.

Comparing to Rouge Fairways, Cornell’s smaller pavement widths, traffic calming measures and use of sidewalks on every street will probably create a friendlier pedestrian environment (Burden, 1998). Cornell also demonstrated a greater ease of travel between destinations for pedestrians (this reasoning can be applied to automobiles also) relative to Rouge Fairways, as Cornell’s short blocks, streets and lanes provide resulted in shorter routing distances. Also, Cornell’s ped shed percentage (78 percent) was 18 percent above the minimum prescribed (60 percent) by the Government of Australia’s Liveable Neighbourhoods (1997) urban design guidelines, which are directly based upon the principles of New Urbanism. In Rouge Fairways, the use of very long blocks along Boxwood Avenue and crescents (Grandlea Crescent and Bretton Circle) resulted in longer routing distances. Pedestrians will have to walk right around these long blocks, a situation which could double pedestrian travel times and lower transit ridership levels on Number 2A, despite the good coverage the route provides throughout the community.

D. Social Benefit

Cornell

Housing Mix: Cornell was found to contain a diverse mix of housing types, including narrow-lot single detached homes, semi-detached homes, town homes, apartments and ancillary units located above garages (see Figure 40). Out of a total of 1001 units, 432 were single detached (43.2 percent), 165 were semi-detached (16.5 percent), 355 were town home (35.5 percent) and 48 were apartments (4.8 percent). Ancillary units were not included in total units, but currently 24 such units exist (see Figure 41). These units were found to be primarily used for more affordable rental housing, containing one bedroom apartments complete with bathroom and kitchen facilities.

Perhaps the most interesting feature of Cornell regarding housing mix was how dwelling types were intermixed with each other on a block-by-block basis. Good examples of this occurred along Country Glen Road and Cornell Meadows, to the west and north of the neighbourhood mixed use node. Along Country Glen Road from Cornell Park to Cornell Common, town homes, semidetached and single detached homes all shared the same street front (see Figure 42). This example was repeated many times throughout Cornell, although higher
density housing types (semis and towns) were concentrated in higher proportions around the neighbourhood node and along connector streets serviced by transit (Country Glen, Cornell Park and White's Hill), relative to single detached homes. This concentration was probably intended to facilitate higher frequency transit service and provide a concentrated market environment for retail services (Province of Ontario, 1992; Langdon, 1994).

The use of a grid system and lanes also contributed to an interesting streetscape in Cornell. Rear lanes allowed garages to be placed at the rear of dwellings, effectively narrowing lot widths and the setbacks of the dwellings (Province of Ontario, 1995). Thus dwellings were found to be very close (within 5 to 15 feet) to sidewalks and streets (see Figure 34). Dwellings in Cornell also exhibited a high degree of architectural detailing, based upon vernacular architectural traditions gleaned from existing examples of the Reesor/Cornell farm house and buildings along Markham's old Main Street (see Figure 43).

Figure 43: Cornell: Architectural Detailing (Author)

Affordability: Based on dwelling price lists obtained from the Cornell homebuilders of Law, Ballantry, Mattamy and Beaverbrook, it was found that approximately thirteen percent of Cornell's dwellings were priced below $180,000. These dwellings included the apartments of the Mews, town homes and a few bungalows; all of the semi-detached and single detached dwellings in Cornell were priced above $190,000.
**Value Distribution:** Cornell possessed a quite diverse housing mix terms of in dwelling type and also distribution, and also value distribution throughout the community. The residential blocks nearest to the Mews exhibited the greatest range of dwelling values, since these blocks contained single detached, semi-detached and town home dwellings generally intermixed with each other. For example, the block bounded by Cornell Park Avenue, Walkerville Road, Country Glen Road and Spring Meadow Road (numbered 1 on Figure 40), which contained 26 town homes, 6 semi-detached dwellings and 12 single detached dwellings, a price range of $164,000 to $334,000 was found, with an average dwelling price of $212,000. This intermixing of dwelling types and prices would probably allow the inclusion of a broad range of income earners, as this block contained 6 dwellings that could be considered affordable (less than $180,000) and two dwellings priced above $290,000. This intermixing of dwelling types and prices on a per block basis was duplicated throughout the Cornell community, although some blocks, such as the one bounded by Settlement Park Avenue, Country Glen Road and The Meadows Avenue (numbered 2 on Figure 40), exhibited a lower range of dwelling prices ($219,000 to $279,000) and a more homogenous housing mix. The most affordable housing in Cornell was found concentrated in the Mews apartments (starting at $129,900) and the Cornell Brownstones along the small finished section of Bur Oak Avenue (range between $139,000 to $195,000). However, these concentrations of more affordable housing were either in small quantities and/or interspersed with more expensive housing, which again might contribute to a more diverse mix of income earners within the same locale.

**Rouge Fairways**

**Housing Mix:** Rouge Fairways contained only one type of dwelling type: single detached homes (see Figure 44). The architectural detailing of these homes was also consistent with surrounding conventionally designed communities. The homes were also dominated by two or three car garages and setback from the street by as much as 30 feet.

**Affordability:** Based on 1996 OPAC values, the lowest dwelling value found within Rouge Fairways was $207,000. The values for the single detached homes ranged from $207,000 to $393,000, and the average value was $285,590. Based on these values, Rouge Fairways did not offer any affordable housing as defined in the Methodology Section.
**Value Distribution:** Since Rouge Fairways was comprised entirely of single detached homes and the community was a good example of conventional design, one might expect the average dwelling values to be spread homogeneously throughout the community, or segregated into specific areas of differing value (Calthorpe, 1993; Langdon, 1994; Kunstler, 1997). Furthermore, the range of dwelling values on specific blocks would most likely indicate that these blocks contained dwellings which were only available to one or two income brackets (those being upper-middle and upper class) (Duany and Plater-Zyberk, 1992; Calthorpe, 1993). Using 1996 OPAC data, it was found that dwelling values were generally distributed (on a per block basis) in a relatively homogenous fashion, exhibiting an average range of values between $250,000 and $325,000. Although some blocks such as Havelock and Bluebell/Ridely (numbered 1 and 2 on Figure 44) demonstrated a range as high as $143,000, the distribution of dwelling values could still be considered homogenous because the values indicated that only upper middle to upper class income earners could afford the dwellings in these particular blocks. The lowest dwelling values ($207,000) and a $118,000 range were found in the blocks along Havelock Gate (numbered 1 on Figure 44). However, these dwelling values and range of values probably preclude the inclusion of lower middle class income earners in a relatively homogenous dwelling value environment. The distribution of average dwelling values throughout the community was relatively even, although higher average values were found in the Bretton/Grandeau Block, Sparta Court and Upper Ridge Court (numbered 3, 4, 5 on Figure 44).

**Discussion**

The housing mix found at Cornell was found to be very close to the principles of New Urbanism, with a 64 percent single detached dwellings (New Urbanism prescribes a maximum of 65 percent), diverse mix of dwelling types and the intermixing of these types and values on a block by block basis. Regarding housing mix, Cornell conformed perhaps the closest to any New Urbanist principle, and represented a radical departure from the entirely single detached dwelling orientation of Rouge Fairways. In this respect Cornell offered a greater choice of housing than Rouge Fairways. Cornell also offered more affordable housing, but did not meet the 25 percent requirement outlined in the methodology. Perhaps the most important finding with respect to Cornell’s housing mix was that the majority of dwelling types and prices found in the community were generally intermixed with each other on a block-by-block basis.
6.2 Design Characteristics Summary: Cornell and Rouge Fairways

Based on the above characteristics for density, land use, transit articulation, street system and housing mix, it could be inferred that Cornell comes somewhat close to being an example of New Urbanism in actual built form—but not close enough to be considered a very close or model example (thus Cornell could be considered a slightly hybridized example). Although it was found to be somewhat lacking in terms of transit facilitation and housing affordability, and possessing a lower than prescribed density, Cornell nevertheless exhibited land use and housing mix characteristics which were very close to the principles of New Urbanism. Cornell also fared well against its conventionally designed ‘control’ community counterpart. The characteristics of Rouge Fairways were quite typical of conventional design in the GTA, exhibiting low density, segregated land uses, a curvilinear, hierarchical street system and a non-existent housing mix, but the community did exhibit reasonable transit coverage for pedestrian access to transit stops.

Since Cornell conformed somewhat closely to the principles of New Urbanism in actual built form and was found to be more favourable than its conventional counterpart, it is reasonable to draw some inferences about the benefits Cornell may provide over its conventional counterpart due to its design characteristics, based on empirical evidence discussed in the literature review. The higher density, diverse housing mix and narrower pavement widths found in Cornell may offer reduced infrastructure (pavement, pipes, curbs) emplacement costs on a per unit basis, which may translate into lower dwelling prices, relative to Rouge Fairways and probably other similar conventional communities in Markham (CMHC, 1995). Also, the higher densities may allow municipalities to collect increased per hectare revenues (CMHC, 1996), while reducing municipal and region wide hard infrastructure requirements (Blais, 1995). Another benefit of Cornell’s higher density is a more compact urban form, which reduces land requirements for development (CMHC, 1995; Pollard, 2000). The higher densities, land use mix and orientation, diverse housing mix and grid street system within Cornell also provide excellent opportunities to reduce dependence on the automobile and increase transit use for primarily commuting trips (Cervero, 1994), which will contribute to reducing energy use, automobile congestion and air pollution. Lastly, a diverse housing mix and mixed land uses will probably provide a more affordable and socio-economic diverse environment relative to Rouge Fairways.

6.3 Infrastructure Cost Outcome Indicator

Following the research regarding the infrastructure costs savings (on a per unit basis) associated with compact urban forms outlined in the literature review, it is reasonable to infer that Cornell probably exhibits an economic cost benefit relative to Rouge Fairways, primarily because
Cornell's gross density (16.05 units per hectare) is 36.5 percent higher and net density (34.03 units per hectare) 43.6 percent higher. To determine if these inferences could be applied to Cornell, a further investigation into determining if this predicted cost benefit actually existed (and if so, the degree of this benefit) was then undertaken, using the hard infrastructure pricing methodology outlined in the methodology chapter.

6.3.1 Comparison Characteristics

Following a careful selection process, two same-sized parcels (58.36 hectares) were chosen for both Cornell and Rouge Fairways. The Cornell parcel (see Figure 45) contained 973 units, and Rouge Fairways 571 (see Figure 46). This equalization of land areas for the two communities resulted in slight changes in both gross and net densities: Cornell's rose to 16.67/35.9 (gross/net) units per hectare (very close to the density principle of New Urbanism) and Rouge Fairway's density dropped slightly to 9.78/17.94 units per hectare. Both parcels also contained the same amount of open space (21.60 hectares-including schools, parks and vacant land), which allowed a comparison of the total residential and road areas for Cornell and Rouge Fairways, and the effective isolation of the effects of lot size (density), road widths and housing mix had upon infrastructure costs per unit for both parcels.

6.3.2 Cornell Costs

Following the 1993 unit costs for pavement, grading, watermains, sanitary sewers, storm sewers, curbs, sidewalks and service connections outlined in the Methodology chapter, the total infrastructure cost for Cornell was found to be $10 227 506.25, and the cost per unit (973 units) was found to be $10 511.31 (detailed costs are outlined in the Appendix).

6.3.3 Rouge Fairways Costs

The total infrastructure cost for Rouge Fairways was found to be $6 608 677, and cost per unit (571 units) was found to be $11 573.87.
6.3.4 Cost Comparison

Cornell's infrastructure cost per unit ($10,511.31) was found to be 9.2 percent less than Rouge Fairways ($11,573.87). Thus the inference that Cornell's close conformance to New Urbanist principles resulting in economic benefits (in terms of hard infrastructure cost savings on a per unit basis) relative to Rouge Fairways was found to be accurate. Relative to the studies outlined in the literature review regarding the economic benefits of compact form, the higher density Cornell parcel was fairly consistent with these findings. However, these cost savings were not as significant as those found in the MMM Study (1994) outlined in the literature review, which found Cornell to be 15 percent cheaper than a conventionally designed community.

The hypothetical Cornell community used in the MMM study had a 21 percent higher gross density than the existing community, thus its cost per unit would be spread over more units. The lower gross and net densities exhibited by the existing Cornell community allowed the high cost of the grid street system and rear lanes (comprising 30 percent of total pavement costs) to lower cost savings on a per unit basis (Bogorad, 1999; Heslip, 2000; D'Amour, 2000). The high cost of grid roads and lanes could be attributed to the block layout and use of both rear lanes and road frontage for the majority of dwellings, a function of Cornell's conformance to New Urbanist principles regarding street system and density. Cornell possessed 15.2 percent more pavement length per dwelling unit and 15 percent more land area occupied by pavement than Rouge Fairways (pavement lengths are given in the Appendix). The effect lanes and the grid roads have on costs per unit (relative to only roads in Rouge Fairways) was especially significant when one examined total infrastructure costs for both communities. Cornell's total infrastructure cost was 35 percent more than Rouge fairways ($10,334,156 vs. $6,687,442), and both parcels were of the same size. However, since Cornell contained 41 percent more dwellings, the added cost of the grid road system and lanes was spread over many more dwelling units.

The lowering of the cost savings margin, compared to research outlined in the literature, could significantly reduce the chance the economic benefits realized by the application of New Urbanist design principles in Cornell will translate into significant dwelling price reductions, relative to dwellings in conventionally designed communities (Bogorad, 1999). In fact, since dwellings in New Urbanist communities tend to exhibit 10 to 15 percent price premiums relative to dwellings in conventionally designed communities (Bogorad, 1999; Eppli and Tu, 1999; D'Amour, 2000), these cost savings on a per unit basis may only result in increased profits for the land developer and homebuilders.
6.4 Analysis of North West Markham Group: Angus Glen and Ashton Meadows

6.4.1 Design Indicators and Characteristics

A. Built Form

Density

Angus Glen: The gross density of Angus Glen was obtained by dividing total units in the community, 467, by total land area, 39.5 hectares or 97.60 acres (Town of Markham, 1996, 1997c). Thus 467 units / 39.50 hectares (or 97.60 acres) = 11.82 units per hectare (or 4.78 units per acre). Net density was obtained by dividing total units by residential land area, 19.93 hectares or 49.25 acres. Thus 467 units / 19.93 hectares (or 49.25 acres) = 23.43 units per hectare (or 9.48 units per acre).

Ashton Meadows: To obtain the gross density of Ashton Meadows, total units, 948, were divided by 93.20 hectares (or 230.30 acres) (Town of Markham, 1990, 1991). Thus 948 units / 93.20 hectares (or 230.20 acres) = 10.17 units per hectare (or 4.12 units per acre). Net density could not be calculated at the time of this particular thesis due to lack of data.

Discussion

The gross density of Angus Glen, 11.82 units per hectare, fell well below the New Urbanist principle of 17.3 units per hectare. This density only attained 13 percent of the gross density prescribed by New Urbanism (based on a range between 11 units and 17.3 units per hectare, where 11 is the typical density for a conventionally designed community), and was more reflective of those found in conventionally designed communities south of Angus Glen, and just a little higher than the density found in Ashton Meadows (10.17 units per hectare). Angus Glen’s gross density could be expected to increase, assuming that this supposedly New Urbanist development may have higher density parcels awaiting development in future phases. However, after further perusal of the land use schedule and population/dwelling projections contained in the Angus Glen Secondary Plan (1994), any significant increases in density are not likely to occur and densities are expected to remain around 11 units (gross) and 26 units (net) per hectare. The lower density found at Angus Glen was probably a function of the developer catering to a predominantly upper class residential move-up market, as evidenced by the inclusion of 5,500 – 7,000 square foot homes on 22 by 55 metre lots (one-fifth hectare) at the southern edge of the existing community (Dexter, 1999).

The gross density of Ashton Meadows, like Rouge Fairways, was typical of conventionally designed communities in the GTA. Despite including a number of medium and
high density town homes in the community, the above average sized single detached dwelling lots (20 by 30 metres) and a series of half acre to acre lots on its northern edge kept densities low. Compared to Angus Glen, Ashton Meadow’s density was only 14 per cent lower, far below the significant gross density difference found between Cornell and Rouge Fairways (35 percent). In this respect, Angus Glen had only a marginal density advantage over Ashton Meadows, a situation which could seriously compromise Angus Glen’s ability to mitigate key problems associated with conventional design through a more compact urban form.

B. Land Use

Mixed Uses and Orientation

Angus Glen

Types of Land Uses: Existing land uses either found or slated for definite future development within Angus Glen included a two hectare neighbourhood park, a 0.8 hectare village ‘green’, an elementary school (to be developed) and a neighbourhood retail centre containing up to 80 000 square feet of commercial floorspace (to be developed) (see Figure 47).

The neighbourhood retail centre is to be located at the extreme north east of the eventual developed community (about 280 metres north of the presently existing community) at the intersection of Major Mackenzie Drive and Kennedy Road. Based on design concepts and renderings, the retail centre may be developed as a hybrid combination of a New Urbanist main street style node and a conventional strip-retail plaza. The centre will probably be composed of individual buildings oriented so that one side of these buildings directly fronts a street, and the other side faces an interior parking lot. This hybrid approach seems to be an attempt to create a retail centre which primarily caters to an automobile market but also attempts to provide some sort of a pedestrian friendly environment and orientation to adjacent future medium and low density housing (town homes and single detached homes, respectively). Like the neighbourhood node at Cornell, the retail outlets will most likely have entrances for patrons coming from the parking lot and from the community. The services to be offered at the retail centre will offer very limited employment opportunities to residents of Angus Glen, since many employees in retail positions would probably have to find more affordable housing off-site.

Similar to Cornell, the two parks in Angus Glen were situated so that dwellings fronted onto streets running adjacent to these parks. The larger neighbourhood park contained a tot lot, a softball diamond and a soccer field. The rectangular village green (see Figure 48) was located approximately central in Angus Glen, and had town homes fronting along roads that ran adjacent
to three sides of the green and single detached homes fronting a street running along the remaining side of the green. Surrounding the green with dwellings acted to reinforce it as a well-traveled and perhaps a safer public space, and the green itself contained a tot lot, an outside running path, benches, and a central grassed area accented with planted groups of trees. Both the green and the neighbourhood park contained community kiosks with Canada Post super boxes and a community notice board.

**Orientation of Land Uses:** The retail centre is to be positioned to primarily access automobile traffic, which will result in only 33 percent of current dwellings in Angus Glen to be within 400 metres of the centre (see Figure 49). This number will probably increase to almost 50 percent when future medium density residential areas are developed around centre. However, the location of the retail centre at the corner of Major Mackenzie and Kennedy will create a unique situation where half of Angus Glen is located within an approximate 5 minute walk of retail services, while the other half will range from being just out of reach to almost a 12 to 15 minute walk away. Dwellings along Angus Glen Boulevard and the Fairways, and the estate homes located around Royal Troon Crescent were found to be between 600 and 950 meters away from
the retail centre, making residents in these dwellings more likely to either drive their automobiles to the retail centre or to the convenience centre located on the corner of Kennedy and 16th Avenue two and half kilometres away.

The central orientation of the village green, in addition to the massing of medium and low density housing (town homes and single detached homes) along its edges, make this park the most important public and recreational focal point within Angus Glen. 87 percent of the community’s dwellings were found to be located within 2 blocks or 300 metres of the green. The 13 percent not within 2 blocks included the estate homes on Royal Troon Crescent. The neighbourhood park was also situated within 2 blocks of 78 percent of all dwellings in Angus Glen. When the orientation of the neighbourhood park and the green within the community were both considered, 99 percent of dwellings in Angus Glen were found to be within 2 blocks of high quality public space and parkland (see Figure 50).

Ashton Meadows

Types of Land Uses: Ashton Meadows contained a broad range of land uses, including an elementary school site, a secondary school site (to be developed), a ten hectare community park, a two hectare ‘conservation area’, a child care centre (located in the Ashton Meadows elementary school), a community centre (located in Kinsmen Village-a high density housing complex), an adjacent small convenience retail centre, and an adjacent four hectare neighbourhood shopping centre. However, it was quite evident through the following analysis that these land uses were poorly integrated with residential areas (see Figure 51).

The neighbourhood shopping centre (Cachet Centre), located at the corner of 16th Avenue and Woodbine, contained 33 stores, including a gas station, three coffee and donut shops, video store, various restaurants, a grocery store, a pharmacy, three banks, a walk-in clinic, dentist and other retail and service uses. The centre was laid out in classic conventional shopping plaza style, with an L-shaped row of shops set far back from the arterial roads by a three hectare parking lot (see Figure 52). The small convenience retail centre was found to be located just across 16th Avenue, adjacent to the southern edge of Ashton Meadows. This centre was also configured as a conventional shopping plaza, and contained a video store, a convenience store, pizza place, hair salon and a donut shop (see Figure 53).

The neighbourhood park contained a softball diamond, soccer and football fields and a parking lot, and could be considered a major regional sports destination. Also, the tot lot and a water park-like fountain found within this park were situated closer to the higher density areas of Ashton Meadows.
Figure 52: Ashton Meadows: Cachet Centre (Author)

Figure 53: Ashton Meadows: Small Retail Centre (Author)
**Orientation of Land Uses:** In terms of location and orientation to the residential portions of Ashton Meadows, it seems that Cachet Centre was developed without pedestrians in mind. The rear of the shopping centre, characterized by a blank façade punctuated by service doors and massive garbage dumpsters, faced the southern portion of the Ashton Meadows community, and created an uninviting, veritable 'dead space' for pedestrians (Langdon, 1994). The rear of the centre was fenced off and separated from dwellings along Towson Road by a creek. The only pedestrian access route that involved an approximate 5 minute walk from dwellings to the Centre ran from Calvert Road, through the parking lot of the Manadir Community Centre (located at Calvert and Woodbine Avenue), and through a hole in the fence. Through this route, 5.3 percent of dwellings were within 400 metres of the Cachet Centre. The proportion of dwellings within 400 metres of the small retail centre of 16th Avenue was not much higher at 7 percent, and this centre was much easier to access via pedestrian means (see Figure 54). The neighbourhood park was located centrally within Ashton Meadows, but only 43 percent of dwellings were located within two blocks (see Figure 55).

**Discussion**

Similar to Cornell, Angus Glen will eventually possess a mix of recreational, educational, retail and other uses and limited employment uses required by the land use principles of New Urbanism; however, it is evident that these retail service uses will be incorporated through a hybrid approach. The planned configuration and location of the retail centre within Angus Glen underscored this approach, being primarily oriented to the automobile market and designed more along the lines of a conventional shopping plaza than a pedestrian friendly retail main street. The location of the centre at the extreme north east corner of the community could also encourage many Angus Glen residents to access the centre via automobile, thus the incorporation of mixed uses into the community will probably not reduce automobile dependence to a significant degree. Even after full build out of this section of the entire Angus Glen community, mixed uses will not be within 400 metres for a majority of the dwellings in the community. Despite retail and other uses being incorporated in hybridized form, recreational uses within Angus Glen closely followed the principles of New Urbanism, as the majority of dwellings were within 2 blocks of excellent recreational and public spaces.

Although Angus Glen did not conform very closely to the land use principles of New Urbanism, it did compare favourably to Ashton Meadows. The effective segregation of retail and other services from residential areas in Ashton Meadows and the consolidation of parkland into large parcels are typical characteristics of a conventionally designed community (Langdon, 1994;
Kunstler, 1997; Government of Western Australia, 1997, Ewing, 1997). This segregation and lack of effective design considerations for improving pedestrian connections between residential areas and the Cachet Centre effectively discourages pedestrian travel to this destination, making Ashton Meadows residents almost totally dependent on their automobiles for obtaining goods and services, and even accessing recreational uses within their own community (with the exception of the small percentage of dwellings located within 400 metres of the small retail centre on 16th Avenue).

C. Transportation

Angus Glen

Transit Articulation: Angus Glen was found to be serviced by one transit route, the Number 8, which maintains a service frequency of 30 minutes during weekday rush hour periods only, running down Kennedy Road to the Milliken GO Train Station. Number 8 also meets Number 1 at Highway 7 for commuters going on to the Finch TTC station. Although this route may not encourage increased non-work transit trips due to its service frequency, it does offer commuters more convenient access to Toronto-bound GO Trains via transit compared to Cornell, thus some work trips (or portions of) by automobile originating in Angus Glen could be eliminated. The transfer to Number 1 at Highway 7 could be considered an excellent method of accessing rapid transit via conventional transit, but again the inconvenience of transferring buses may cause Toronto-bound commuters to use their automobiles to access rapid transit park and ride lots or for the entire work trip instead.

There were three transit stops in Angus Glen, located at the intersections of Prospector’s Drive and Glen Village Road, Angus Glen Boulevard and Prospector’s Drive, and Angus Glen Boulevard and Kennedy Road (see Figure 56). A fourth stop is planned at The Fairways and Prospector’s Drive as soon as the dwellings along this street are built out. Currently Number 8 runs through the community from neighbouring Berzy Village along Angus Glen Boulevard and looping around the village green back to Angus Glen Boulevard and Kennedy Road. The stop at the village green represented the best opportunity within Angus Glen to encourage more commuting trips by transit, being located at the community social focal point and surrounded by a predominantly town homes (see Figure 57). Furthermore, the presence of a kiosk adjacent to the stop provided shelter for commuters from the elements while the other stops were unsheltered. When the locations of all three stops were considered (they were all within 400 metres of each other), 87 percent of dwellings were within a 400 metre radius of transit stops, with exception of the estate homes along Royal Troon crescent. With respect to current transit coverage guidelines,
Angus Glen came quite close to the coverage prescribed by the Province of Ontario (1992) and the City of Calgary (1995). The addition of the fourth stop will most likely increase this coverage to over 90 percent.

**Street System:** Angus Glen's street system was found to be based upon a grid road structure, short blocks and the use of rear lanes for the majority of dwellings within the community. Angus Glen Boulevard acted as the primary 'connector' street between Kennedy Road and the future western portion of the community, and has a pavement width ranging from 6.5 to 12 metres. Local residential streets and lanes were found to exhibit average widths of 7.5 and 5 metres respectively (see Figure 58). While Angus Glen's local residential streets were narrower than those of Cornell, the lanes were one metre wider, a situation which could impact infrastructure costs dramatically (see Figures 59 and 60). An interesting aspect of Angus Glen's street system was the use of various traffic 'calming' methods (Burden, 1998), including traffic circles at Angus Glen Boulevard and Prospector's drive and at The Fairways and Prospector's Drive, and intersection 'chokers' and parking embayments along boulevards and major streets. For example, the pavement width of Angus Glen Boulevard averaged 11 metres wide between Prospector's
Drive and Potter's Wheel Road and then narrowed to 6.5 metres wide at the intersection (see Figure 61). The choke point effectively constricted pavement area at stops, which will most likely force drivers to slow down; the reduction in pavement width also created parking embayments in front of dwellings. Sidewalks were emplaced on one side of all residential streets throughout the community, and major streets and boulevards had them on both sides.

The use of grid streets and lanes in Angus Glen could potentially allow the majority of residents living in dwellings within 400 metres of a particular destination to easily access destinations via a five minute walk. Following the rationale given the preceding case study analysis, a ped shed calculation was used to determine what proportion of Angus Glen residents living in dwellings within 400 metres of the bus stop at the village green can actually access this destination via a five minute walk. After measuring out 400 metres along all potential paths to the stop, it was found that 96 percent of the residents could access transit stop within 5 minutes, which far exceeds the ped shed coverage recommended by the Government of Western Australia (1997) (see Figure 62).

Figure 61: Angus Glen: Traffic Calming Measures (Author)
Ashton Meadows

Transit Articulation: Ashton Meadows was found to be serviced by Number 7 to Richmond Hill (along 16th Avenue) every 45 minutes during the week day rush period only, and Number 4, which runs to Markville Mall and Mintleaf subdivision adjacent to Cornell. Number 4 runs every 30 minutes during weekday rush periods and every 60 minutes during weekdays and on Saturdays. Number 7’s only stop in Ashton Meadows was located at Rodick Road and Woodbine Avenue, and the stops for Number 4 were spaced out along Rodick and Calvert Road at 150 to 200 metre intervals (see Figure 63). Also, all the stops were on one side of Rodick, which acts as the community’s transit spine, and were easily accessible to residents living in the high density Kinsmen Village between Rodick and Rachel Crescent. Furthermore, the transit stops along Rodick and Calvert collectively captured 98 percent of all dwellings in the community. However, the lack of mixed uses near the stops, lack of adequate transit service to major employment areas within Markham, and a time consuming route to Markville Mall (40 minutes by bus, 15 minutes at most by automobile) probably limited the extent of increased trips by transit (Cervero, 1994). In this respect Ashton Meadows could still be considered an almost totally automobile dependent community, with the automobile being required for every trip, ranging from commuting to getting a cup of coffee at the Cachet Centre.

Street System: Ashton Meadows was an excellent example of community serviced by a true arterial-collector-local street hierarchical curvilinear street system. The primary collector, Rodick Road, was 14 metres wide and four lanes, and Calvert, Macrill, Towson and Rachel were all 11 metres wide, followed by residential streets which averaged 8 metres wide (see Figure 64). As with Rouge Fairways, sidewalks were almost nonexistent on residential streets and only appeared on both sides of Rodick and Calvert Roads. Throughout Ashton Meadows it seemed that asphalt was laid down on a very liberal basis; at the intersection of Rodick and Calvert Road, the pavement was almost 20 meters wide for the accommodation of turning lanes.

Since Ashton Meadows possessed a curvilinear, hierarchical street system, one might expect that pedestrian travel to destinations, such as the transit stops of Rodick Road, would be more difficult than a grid street system. Using a transit stop on Rodick Road as an example, a ped shed calculation determined this assumption to be true. Only 54 percent of the single detached dwellings within a 400 metre radius of the stop were within an actual 5 minute walk, primarily due to the use of very long blocks along Forester, Dubourg and Dufmies Drives (see Figure 65).
Discussion

Angus Glen conformed closely to the New Urbanist principle regarding transit stop orientation, as almost all the required percentage of community dwellings were found to be within 400 meters of a transit stop. Unfortunately the low service frequency of the Number 8 probably will not encourage an aggregate increase in work and non-work transit trips, thus Angus Glen did not conform closely to the New Urbanist principles for transit articulation. This low frequency was most likely due to low ridership projections for the community, a direct result of the lower residential densities of Angus Glen (Province of Ontario, 1992). However, the direct routing of the Number 8 to the GO Train station did provide a convenient transit access option for commuting by train to Toronto.

Comparing to Ashton Meadows, Angus Glen only possessed an advantage regarding transit service because of the direct routing Number 8 provides to the GO station. Ashton Meadows did have a higher proportion of dwellings within 400 meters of transit stops, but the street system used for the single detached home areas made a 5 minute walk to these transit stops by many residents of these dwellings impossible.

Angus Glen’s street system followed New Urbanist principles very closely, although some streets only had sidewalks on one side. With the exception of Royal Troon Crescent, the use of a grid street system and rear lanes provided a myriad of paths for the majority of community residents to access community destinations within a 5 minute walk. Compared to Ashton Meadows, Angus Glen exhibited slightly narrower pavement widths on residential streets, and also narrower widths of major streets and boulevards.

D. Social Benefit
Angus Glen

Housing Mix: Angus Glen was found to contain three types of dwelling types, including large lot executive style single detached homes with attached garages (on the side of the home, no lanes), small lot single detached homes (with garages on rear lanes) and town homes (see Figure 66). Out of total of 467 units, 299 were single detached homes (64 percent-11 percent of which were executive homes) and 168 were town homes (36 percent).

Although Angus Glen contained almost equal proportions of low density and medium density housing, these two housing types were not intermixed on a block by block basis and throughout the community to any significant degree. The executive homes are all concentrated around Royal Troon Crescent, and where The Fairways meets Angus Glen Boulevard (see Figure 67). Small lot singles tended to be concentrated together west of the village green and north of
the neighbourhood park, and almost all the town homes were concentrated into an area centered on Glen Gate Road. The only mixing of housing types on a single block occurred adjacent to the village green and along Angus Glen Boulevard near Kennedy Road. This housing mix pattern reflected a definite segregation of housing types by location within the community, and most likely also by dwelling value.

Dwellings within Angus Glen received an amount of architectural detailing equivalent to Cornell, as the developer aimed to create a fusion between architectural styles found in the old town site of Unionville 3 kilometers south of the community, and styles found in some of DPZ's New Urbanist communities near Washington D.C (see Figure 68). Streetscapes closer to the village green reflected a definite urban character, as the dwelling setbacks were only 15 feet (see Figure 69). However, the lower density environment found in around Royal Troon Crescent created a streetscape more similar to a low density conventional subdivision.
**Affordability:** Based on 1996 OPAC data and new home prices obtained from Brookfield and Kylemore homes, it was found that Angus Glen did not possess any affordable housing as defined in the methodology chapter. The most affordable housing option within Angus Glen included zero-lot line town homes, which currently sell at a minimum of $192,000. Although these prices could be considered quite affordable considering the residential context surrounding Angus Glen, these prices still narrowed the range of potential income earners residing within the community.

**Value Distribution:** According to the principles of New Urbanism, dwelling values should be interspersed on a block by block basis and throughout the community (Duany and Plater-Zyberk, 1992; Kunstler, 1997; Government of Western Australia, 1997). In the case of Angus Glen, average dwelling prices (on a block by block basis) increased moving away from the town homes centred around Glen Gate Road towards the estate homes around Royal Troon Crescent (numbered 1 on Figure 66). The range of values in the town home area was relatively low and reinforced the homogeneity of the housing mix; this area will most likely cater to one or two income earner groups. The Royal Troon homes area did exhibit a higher range of values, but the minimum and maximum values of this range ($750,000 to $1,000,000+) definitely characterized this area to be affordable only to higher upper class income earners. Although Angus Glen exhibited a concentration of housing types in specific locales (similar to conventionally designed communities), the range of dwelling values in the blocks to the immediate west and south of the village green exhibited a range of dwelling values (from a range of $171,000 to $188,000) which indicated a somewhat broad range of income earners could live on the same block. Using the Port Rush/Angus Glen Boulevard block (numbered 2 on Figure 66) as an example, the placement of small lot singles along Port Rush Trail and large lot singles along Angus Glen Boulevard included homes valued at $222,000 to $410,000. Another good example involved the Muirfield block (numbered 3 on Figure 66); this block included town homes fronting the village green, small lot singles along Muirfield Trail and Port Rush Trail and larger lot singles along The Fairways. Dwelling values ranged from $223,000 to $385,000 in this block, a range which may facilitate the inclusion of a broader range of income earners. However, it is important to note that the dwelling values on this block increased from the village green towards The Fairways, reflecting a pattern still indicative of dwelling value segregation typically found in conventionally designed communities.
Ashton Meadows

**Housing Mix:** Ashton Meadows contained the same proportion of single detached homes (64 percent) and town homes (36 percent) as Angus Glen. However, these housing types were more rigidly separated and concentrated in specific locales within the community, typical of Don Mills type conventional design (see Figure 70). Eight estate homes on half acre and one acre lots lined the northern boundary of the community; large lot singles were located in the areas bounded by Rodick Road, Woodbine Avenue, the Ontario Hydro Corridor and south of Calvert Road, and medium and high density town homes were all concentrated between Rodick Road, Woodbine Avenue and Ashton Meadows Park. Medium density town homes lined both sides of Rachel Crescent, and the high density town homes were located in three pod-like enclaves (see Figure 71). The 187 town homes located between Rodick and Rachel, a part of Kinsmen Village, included 25 percent rent subsidized dwellings and the remainder were available at some of the lowest rents in Markham (Heslip, 2000). Based on these locational patterns of housing types, it seemed that the size and price and/or rents of dwellings in Ashton Meadows increased almost on a concentric basis moving from Kinsmen Village to the edge of the community.

The architectural detailing of both single detached homes and town homes was quite similar to surrounding examples in conventionally designed communities, and the single detached dwellings were found to be dominated by massive three car garages and 25 to 35 foot setbacks (see Figure 72)

**Affordability:** Based on 1996 OPAC data, it was found that Ashton Meadows contained 36 percent affordable housing as defined in the methodology (dwellings priced below $180 000). As discussed in housing mix, the entire constituent of affordable housing within the community was concentrated in the area around Rachel Crescent and Rodick Road. The value of single detached homes in Ashton Meadows ranged between $273 000 and $778 000, with an average value of $397 000.

**Value Distribution:** In terms of the distribution of average dwelling prices (on a block by block basis) throughout Ashton Meadows, it was quite evident that dwelling prices increased outward on a concentric basis from the Rachel Crescent town home area to the northern, eastern and southern edges of the community. The highest average dwelling values were found along the northern edge of the community (estate homes abutting Markham estates), within the cul-de-sacs of Schooner Crescent, Frisby Court and Dollar Court, and along the northern sections of Moses and Forester Crescents (numbered 1, 2, 3, 4 and 5 on Figure 70). Regarding the distribution of
Figure 71: Ashton Meadows: Town Homes in Kia Village (Author)

Figure 72: Ashton Meadows: Architectural Detailing for a Single Detached Dwelling (Author)
dwelling values on a block by block basis, it was also evident that specific blocks probably contained a narrow to very narrow range of income earners. This was especially evident for the town homes along Rachel (value range of $6 000-numbered 6 on Figure 70) and blocks such as Moses/Schooner and Forester. The ranges for both these single detached dwelling blocks were quite large at $154 000 and $142 000, yet the minimum and maximum dwelling values for these blocks were between $273 000 and $474 000. Despite the large range, this situation probably limited the range of income earners who could reside in these areas.

Discussion

The housing mix found at Angus Glen did exhibit a mix of housing prescribed by New Urbanism in terms of percentage of dwelling types (a 65 percent maximum for single detached homes is typically prescribed), but the dwelling types tended to be separated into specific areas of the community. Angus Glen was found to be more similar to Ashton Meadows than Cornell in terms of mixing housing types and values on a block by block basis, and thus cannot be considered to be in conformance with the principles of New Urbanism. Although the separation of housing types and values in Angus Glen was not as rigid as Ashton Meadows, it still reflected a more conventional approach to community design, where the segregation of housing types and values might be perceived to be necessary to sell homes faster (and at higher prices) and maintain property values (Klein and Sears, 1983; Kar, 1998). The location of estate homes on Royal Troon Crescent in Angus Glen is a good example of this, as homes in this area must be of an executive nature (as controlled by a special residential control policy in the Angus Glen Secondary Plan), in order to be more ‘compatible’ with adjacent executive homes in the Devil’s Elbow community and both Angus Glen and York Downs Golf Course environments (Town of Markham, 1994). Following the rationale of Klein and Sears (1983) and Kar (1998), the location of only larger lot single family homes adjacent to the Royal Troon Crescent area was probably an attempt to ‘buffer’ the property values within this executive enclave from the potential negative influences of the higher density dwelling types concentrated around Glen Gate Road. This situation is very similar to Ashton Meadows, as dwelling values were found to rise in a concentric fashion from the high density town home area to the estate homes on the northern edge of the community. Lastly, Ashton Meadows displays a considerable advantage compared to Angus Glen in terms of affordable housing, yet the inclusion of this housing within the north west Markham residential context could be considered an anomaly. If this affordable housing concentration was removed and Ashton Meadows’ housing mix and value characteristics became more similar to adjacent communities, Angus Glen would offer more affordable housing,
although only in terms of providing a broader range of housing types and purchase choice (Pease, 2000).

6.5 Design Characteristics Summary: Angus Glen and Ashton Meadows

Based on the above evaluation of Angus Glen according the principles of New Urbanism, and using the conventionally designed community of Ashton Meadows as a study control, it could be inferred that Angus Glen represents a hybridized example of New Urbanism. This inference is based on design characteristics which showed that Angus Glen possessed near conventional densities, a segregation of dwelling types, and a retail centre out of feasible reach of pedestrians for 50 percent of the community. The most significant factor behind the hybridization of Angus Glen involved the lack of appropriate densities, and a point made by Dexter (1999) in the New Homes Section of the Toronto Star reinforces this:

"While (Angus Glen) has much of the flavour of a well-designed New Urbanism community, housing densities aren’t as high as with other such projects around Greater Toronto… the lanes are extra wide, homes have brick facing all around and rear lane garages are nicely designed and not jammed together." (Dexter, 1999)

Although Angus Glen conformed very closely to the principles of New Urbanism when considering the street system, pedestrian accessibility, and locations of parks and transit stops within the community, these characteristics did not diminish the fact that Angus Glen was in fact more of a low density conventional community which has been repackaged as heritage-themed (Lehrer and Milgrom, 1996).

Following Dexter’s remarks, it is evident that Angus Glen possessed the flavour of New Urbanism (streets, lanes and heritage-style architecture), but unfortunately it is not enough to create a community which could assist in mitigating the problems associated with conventional design. Higher densities, mixed land uses and a diverse and interspersed housing mix are essential ingredients in developing communities which accurately reflect the principles of New Urbanism (Lennertz, 1994; Kunstler, 1997). Based on Angus Glen’s existing characteristics, it seems that the higher density principle of New Urbanism is still having trouble gaining acceptance in the GTA, even in a policy environment which encourages higher densities (Amendment No.5). Furthermore, Dexter’s remarks also imply that higher density is an undesirable aspect of New Urbanism which Angus Glen has successfully eliminated, in order to effectively develop and market an exclusive heritage themed or ‘life-style’ development which caters to upper middle to upper class home buyers.
Since Angus Glen only closely conformed to some of the principles of New Urbanism and should be considered a hybridized example, it is reasonable to draw some further inferences about Angus Glen relative to Ashton Meadows. Although Angus Glen on the whole performed better than Ashton Meadows, this performance is not significant enough to risk inferring that Angus Glen offers a less unsustainable alternative based on empirical and theoretical research. Since Angus Glen’s gross density is close to that of Ashton Meadows, any infrastructure cost savings on a per unit basis could either be negligible or actually negative. Given the high added costs of lanes utilized for the grid street system, the infrastructure costs on per unit basis for Angus Glen may even exceed those of Ashton Meadows (MMM, 1994; CMHC, 1995). If these cost savings are marginal or in fact negative, the potential for developing more affordable housing based on infrastructure cost savings relative to conventional designs will be negated. Angus Glen’s lower density will also not contribute to reducing land requirements or regional infrastructure costs versus its conventional counterpart, and the municipality will probably not obtain increased tax revenue on a per hectare basis (CHMC, 1996). Lower densities and the remoteness of the retail centre, relative to the majority of community residents, will probably encourage more automobile trips versus in-community walking trips and work transit trips and probably won’t prompt increases in transit service in the future. However, the grid street system does allow for very high percentage of community residents to access park and transit stop locations within a reasonable five minute walk. Lastly, the lack of significant intermixing of housing types and values and affordable housing within Angus Glen effectively maintains income bracket segregation and exclusion, as witnessed in conventionally designed communities (Kunstler, 1997).

6.6 Infrastructure Costs Outcome Indicator

Following the literature regarding densities and its effect of infrastructure costs outlined in the literature review, and based on the above inferences regarding Angus Glen, it reasonable to infer that Angus Glen does not offer significant infrastructure cost saving relative to Ashton Meadows on a per unit basis. There is also a possibility that Angus Glen may even cost more to develop on a per unit basis. However, since it was impossible to accurately infer how much of a cost difference Angus Glen exhibited relative to Aston Meadows, the hard infrastructure of both Angus Glen and Ashton Meadows were priced out and compared using the same unit cost methodology employed for the comparison of the costs of Cornell and Rouge Fairways.
6.6.1 Comparison Characteristics

The first comparison involved the complete communities of Angus Glen (467 dwelling units; 39.5 hectares) and Ashton Meadows (948 dwelling units; 93.20 hectares) without any adjustments made or limitations considered. Both communities contained different proportions of open space (Angus Glen-17.5 percent; Ashton Meadows-21 percent). Since Angus Glen exhibited only a 14 percent higher gross density, and given that the 35 percent higher gross density exhibited by Cornell over Rouge Fairways resulted in only a 9.3 percent cost savings, it was likely that Angus Glen's per unit infrastructure costs would be similar to or perhaps more than Ashton Meadows (see Figures 73 and 74). The second comparison examined how Angus Glen, as an example of a hybridized New Urbanist community which exhibits a diverse housing mix (only in terms of housing type proportions and lot sizes), narrower pavement widths, but also has lower than prescribed densities, compared to a low density, conventionally designed community composed entirely of single detached homes and serviced by roads with wide pavement widths. Both parcels were 21.26 hectares each (Angus Glen contained 288 dwelling units and Ashton Meadows 182, Figures 75 and 76 respectively); these parcels also contained no open space in order to conduct an equal comparison of density and street system characteristics without having to account for potential distortions of open space. The removal of open space increased the gross density of the Angus Glen parcel to 13.25 units per hectare (or 5.36 units per acre). The use of only single detached homes for the Ashton Meadows parcel resulted in a gross density of 8.63 units per hectare (or 3.5 units per hectare), a density which was more indicative of surrounding conventionally designed parcels in Cachet Woods and north west Markham as a whole. The inclusion of high density town homes in Ashton Meadows could almost be considered an anomaly, since housing types other than single detached homes were not found in the surrounding area. The Angus Glen example contained 36 percent town homes and 64 percent single detached homes. The executive homes around Royal Troon Crescent were included in this parcel, because they were indicative of Angus Glen’s low density. This comparison will be useful for isolating the costs of a grid street system and lanes relative to conventional, curvilinear street systems.

The third comparison involved the same sized parcels (no open space either) used in the second comparison, but the Angus Glen parcel was composed of entirely single detached homes (Angus Glen contained 239 units and Ashton Meadows 182, Figures 77 and 76 respectively). The gross density of the Angus Glen parcel was 11.34 units per hectare (or 4.59 units per acre), and the gross density of the Ashton Meadows parcel remained the same. This last comparison was employed to identify how single detached lot sizes and the costs of lanes and a grid street
system influence the infrastructure costs of low density, single detached dwelling based New Urbanism, compared to a conventional design of similar density, same housing mix, but possessing larger lot sizes and a curvilinear street system.

6.6.2 Comparison One

6.6.2.1 Angus Glen Complete Costs (467 dwelling units / 39.5 hectares)

Following the 1993 unit costs for pavement, grading, watermains, sanitary sewers, storm sewers, curbs, sidewalks and service connections outlined in the Methodology chapter, the total infrastructure costs for Angus Glen Complete was found to be $6,694,457.50, and cost per unit (467 units) was found to be $14,335.03 (detailed costs are outlined in the Appendix).

6.6.2.2 Ashton Meadows Complete (948 units / 93.20 hectares)

The total infrastructure cost for Ashton Meadows complete was found to be $11,827,090.50, and the infrastructure cost per unit (948 units) was found to be $12,475.83.

6.6.2.3 Cost Comparison

The infrastructure cost per unit for Angus Glen ($14,335.03) was found to be 13 percent more expensive than Ashton Meadows ($12,475.83). Angus Glen was more expensive due to a lower density (which is partially due to the use of large lots on Royal Troon Crescent) and the use of rear lanes, and wider pavement widths for the rear lanes (Hardcastle, 1998). The additional costs of pavement for Angus Glen's use of a grid street system and rear lanes relative to the costs of only roads for Ashton Meadows became evident when considering pavement length on a per dwelling unit basis. Angus Glen exhibited over sixteen metres of pavement per dwelling unit and Ashton Meadows exhibited ten and a half metres of pavement per dwelling unit (a 34 percent difference). However, it is also important to note that the high density concentration of town homes centered on Rachel Crescent, and the narrow pavement widths that were used in these housing complexes drove costs per unit down significantly for Ashton Meadows. Furthermore, since Ashton Meadows was the one of the only conventional communities in the area to currently incorporate higher density housing, it may be an unfair comparison to Angus Glen if one only considers the immediate geographic context of northwest Markham. Regardless, it seems that the low density of Angus Glen put this hybridized example of New Urbanism at an infrastructure cost disadvantage to Ashton Meadows. This point is especially relevant when the density of Angus Glen is increased to that of Cornell (16.05 units per hectare). Assuming this high density
could be achieved through a change in lot size only, the higher density would increase total housing units to 634, and drop infrastructure cost per unit to 9.5 percent below Ashton Meadows.

6.6.3 Comparison Two

6.6.3.1 Angus Glen Parcel 1 (288 units / 21.26 hectares)

Housing Mix: 184 single detached homes (64 percent) and 104 town homes (36 percent)

The total infrastructure cost for Angus Glen Parcel 1 was found to be $4 266 975.50, and the infrastructure cost per unit (288 units) was found to be $14 815.89.

6.6.3.2 Ashton Meadows South (182 units / 21.26 hectares)

Housing Mix: 100 percent single detached dwellings

The total infrastructure cost for Ashton Meadows South was found to be $3 169 346.50, and the infrastructure cost per unit was found to be $17 414.

6.6.3.3 Cost Comparison

The infrastructure costs per unit for the Angus Glen parcel ($14 815.89) was found to be 15 percent less than Ashton Meadows South ($17 414), primarily because of a 35 percent higher gross density. In this case, the smaller average lot sizes of Angus Glen, which was a function of its housing mix, resulted in a higher density and thus more units to spread total costs over. Also, the very wide pavement widths exhibited by Ashton Meadows South drove up costs for that parcel. However, the added cost of lanes was quite evident in this comparison, as the total infrastructure cost for the Angus Glen parcel was 31 percent more than Ashton Meadows South. This parcel of Angus Glen possessed twelve percent more pavement length per dwelling unit than Ashton Meadows South; this decrease in pavement length relative to Angus Glen Complete was primarily due to the inclusion of town homes in this comparative example.

6.6.4 Comparison Three

6.6.4.1 Angus Glen Parcel Two (239 units / 21.26 hectares)

Housing Mix: 100 percent single detached homes

The total infrastructure cost for Angus Glen Parcel Two was found to be $4 368 634, and the infrastructure cost per unit was found to be $18 278.80.
6.6.4.2 Ashton Meadows South (182 units / 21/26 hectares)

Total infrastructure cost and infrastructure cost per unit were the same as Comparison Two.

6.6.4.3 Cost Comparison

The above figures show that the added cost of lanes and the extra linear feet of piping required for the wider widths of single detached dwelling lots for the Angus Glen parcel effectively drove up infrastructure costs on a per unit basis as densities decreased (pavement length on a per dwelling unit basis for this particular parcel of Angus Glen was 29 percent higher than Ashton Meadows South). With a 17 percent decrease in density (from 13.54 to 11.24 units per hectare), a direct result of removing the town homes, infrastructure costs per unit for Angus Glen ($18 278.80) became 4.7 percent more expensive than Ashton Meadows South ($17 414). Although the density of this particular parcel of Angus Glen was still higher than Ashton Meadows South, this density was not close to the New Urbanist principle, thus the added costs of the grid street system and rear lanes again resulted in higher infrastructure costs on a per unit basis. This finding is similar to the MMM study (1994), which predicted that the added expense of grid street systems and rear lanes for New Urbanist examples could result in higher costs per unit regardless of the higher density of the New Urbanist example. In this case, it seems that when the residential density of this parcel of Angus Glen (regardless of housing mix—as smaller lot singles could replace the Royal Troon homes to increase density also) falls below 11.90 units per hectare (4.82 units per acre) the added pavement costs eliminates any infrastructure cost savings relative to Ashton Meadows South.

This comparison illustrates that communities which employ New Urbanist street systems and rear lanes but still retain residential densities slightly above (by 2 or 3 dwelling units per hectare) or similar to conventionally designed communities actually become the more expensive option for developing a community. This situation probably effectively precludes the inclusion of more affordable housing in the hybridized New Urbanist example, even if the dwellings within this hybridized example were not sold at a premium relative to surrounding conventionally designed communities.
### Cornell

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### Angus Glen

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7.0 Conclusion

7.1 Cornell: A Definite Step Toward Pure New Urbanism

Based on the above analysis, the design characteristics of Cornell conformed somewhat closely to the principles of New Urbanism prescribed by the Congress of the New Urbanism (CNU). However, the hypothesis pertaining to Cornell cannot be accepted since all of the design characteristics of Cornell could not be considered very close to the principles of New Urbanism (see Table 1 for Cornell Evaluation Results). Some of the design characteristics found in Cornell did indeed conform very closely to the principles of New Urbanism: a node containing a range of land uses was found to be within 400 metres of the majority of dwellings in the community, a diverse and interspersed housing mix was found, and a classic grid street system allowing a greater ease of pedestrian access was found to exist. However, Cornell was found to be lacking in transit coverage and articulation, housing affordability, and most importantly, density. While transit articulation and coverage are important regarding automobile dependence, the lower than prescribed density of Cornell was the primary reason the hypothesis was rejected, since density figures heavily in almost all of the theoretical design benefits of New Urbanism, as discussed in the literature review and methodology. The gross density of Cornell measured just above 16 dwelling units per hectare, about 20 percent lower than the prescribed 17.3 units per hectare. If Cornell is to be considered to be very close to the principles of New Urbanism in terms of all characteristics, then the density should be closer to 90 percent of the density prescribed. However, it may be too early to judge Cornell on its density, since future parcels of the entire Cornell community will probably exhibit higher densities and thus push the overall gross density over 17.3 units per hectare. This increase in density will be contingent on continued market acceptance of higher densities by consumers, and a dedication by Markham Council and the developer Larry Law to stick closely to DPZ’s original design formula.

Despite a rejection of the hypothesis primarily due to a lower than prescribed density, Cornell could still be considered a definite step towards a built example of New Urbanism which fully conforms to the principles outlined in the literature review, given its very close conformance for many of the design indicators. While Cornell’s density was found to be lower than prescribed, it was still higher than Angus Glen, Rouge Fairways and Ashton Meadows, and may be one of the highest residential densities for a suburban community in the GTA. This higher density also resulted in a definite economic benefit in terms of infrastructure costs relative to conventional design, demonstrating that communities which follow the principles of New Urbanism (assuming their densities are close to those prescribed-i.e. above 16 units per hectare) can indeed realize a design outcome resulting in cost savings relative to conventionally designed communities

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exhibiting densities between 10 and 12.5 units per hectare. However, it is probable that these cost savings will not translate into savings in dwelling prices for consumers, given that dwellings in Cornell are probably being offered at premium prices relative to similar dwellings in nearby conventionally designed communities (Law, 1997; Eppli and Tu, 1999). Furthermore, even though the New Urbanist promise of providing affordable housing in their communities has been fulfilled at Cornell (approximately 13 percent of the dwellings are considered affordable), the current parcel of Cornell did not fulfil the 25 percent requirement outlined in Amendment No. 5.

According to literature regarding New Urbanism and sustainable community design, a more compact urban form (complete with mixed housing types) is supposed to result in infrastructure cost savings over lower density design, and these savings can then be passed on to homebuyers (Calthorpe, 1993; Lennertz, 1994; CMHC, 1995; City of Calgary, 1995; Roseland, 1998). Following this rationale, one could infer that the per dwelling costs savings exhibited by Cornell would result in more affordable housing relative to similar housing types found in Rouge Fairways and other similar communities. However, this promise has not come to fruition when other existing examples of New Urbanism have been compared to their conventional counterparts.

In a study of New Urbanist communities near Washington DC, Eppli and Tu (1999) found that single detached dwellings in these communities were sold at 15 to 20 percent premiums relative to similar dwellings in adjacent conventionally designed communities. Unlike Bogorad’s (1999) inference that these premiums could be primarily due to higher infrastructure costs, Eppli and Tu believe these premiums can be attributed to the exclusive nature of the communities and extensive use of architectural detailing (Eppli and Tu, 1999). Even Duany himself acknowledges that the attention to architectural detail, the creation of pedestrian-friendly streetscapes and the heritage theming inherent in many of his own projects results in higher sale prices (Wight, 1995). Duany has also used this situation to convince critics and developers that New Urbanist communities can be profitable investments (Wight, 1995).

The premiums associated with single detached homes and other dwelling types in US New Urbanist communities have been applied to Canadian examples also (Wight, 1995). While addressing a conference on New Urbanism in Toronto in 1997, Larry Law remarked that prospective Cornell residents “will be willing to pay a premium for the privilege of living in this desirable community”, and that despite higher up-front infrastructure and other development costs, “it is certainly more profitable to have higher densities” (Law, 1997). Law may be right that developing Cornell, despite its expensive infrastructure costs, will result in a measurable profit since Cornell quickly became the fastest selling major community in Ontario after the first
dwellings were offered on the market in 1997 (Town of Markham, 1997). However, since this thesis does not specifically analyze differences between sale prices of homes in New Urbanist and conventionally designed communities, it can only be assumed based on Law's remarks that some sort of premium exists regarding the sale prices of dwellings in Cornell. If this assumption is indeed correct, then Law Development may be accruing enhanced profits for developing Cornell instead of a typical conventional design, since dwellings are being sold at higher prices and the additional infrastructure cost savings per dwellings may be broadening their profit margin (also assuming that land costs and other market factors in determining the price of a dwelling in both communities are similar). If this is the case, two implications must be considered. First, the lure of higher profits due to dwelling unit price premiums and lower infrastructure costs per dwelling unit relative to conventionally designed communities may incite more developers to undertake development projects which closely follow the principles of New Urbanism. This may result in the development of more communities with more diverse housing and land uses mixes (characteristics which can greatly contribute to the creation of less unsustainable communities) while developers and the construction industry still make similar or greater profits than developing conventionally designed communities (CMHC, 2000). However, the other implication is not so optimistic, as these dwelling price premiums may preclude the inclusion of a significant percentage of low-income earners into these New Urbanist developments, regardless if diverse housing type choices are offered. The existence of these premiums could result in the development of communities which only accommodate income earners above a certain level, and thus the range of income earners within these communities will shrink.

Given Cornell's somewhat close collective adherence to New Urbanist principles (although density is less than prescribed, it was found to be quite high relative to other communities in Markham), and the fact that this community also compared favourably to Rouge Fairways, it can be inferred that Cornell generally offers a less unsustainable community design and development pattern relative to Rouge Fairways, and relative to other conventionally designed communities to Markham and the GTA which exhibit similar design characteristics to those of Rouge Fairways (Calthorpe, 1993; Roseland, 1998). In this respect Cornell may contribute to reducing the effects of particular problems associated with conventionally designed communities in Markham and the GTA, through increased land savings, greater potential for increased future transit articulation, greater opportunity to access goods/services and employment opportunities via non-automobile travel modes, potentially reduced energy use and automobile emissions, and offering a more diverse housing mix for the development of a community with a broader range of income earners living in the same locale. However, if Cornell's current density is maintained in
future community phases, this may limit transit ridership and the expansion of service, and may also preclude the inclusion of a higher percentage of affordable dwellings, despite the probable existence of dwelling price premiums (Law, 1997; Eppli and Tu, 1999).

7.2 Angus Glen: A Hybridized Example

Despite possessing a grid system of streets and rear lanes, narrow pavement widths, traffic calming features and heritage-style architectural detailing on its dwellings, Angus Glen could be characterized as hybridized example of New Urbanism, primarily due to a lack of adequate residential density and a retail centre which is easily accessible by pedestrian means for the majority of community residents, a low potential for increased future transit articulation, a largely homogeneous distribution of dwelling types and values, and a total lack of affordable housing (see Table 1 for Angus Glen Evaluation Results). Furthermore, the design outcome involving infrastructure costs on a per dwelling unit basis demonstrated the use of near-conventional densities in community developments could result a more expensive development form (on a per unit basis) than conventional design when a New Urbanist grid street pattern and rear lanes are employed. Although Angus Glen outperformed Ashton Meadows in terms of the design indicators, this performance was not convincingly better since Angus Glen failed to closely conform to the principles of New Urbanism.

The fact that Angus Glen exhibited residential densities similar to conventional design effectively will reduce the community’s ability to mitigate the problems associated with sprawl in the GTA, in terms of land savings and reducing dependence on the automobile through increased transit articulation. Furthermore, a relatively homogeneous distribution of dwelling values and lack of affordable housing will not assist in the creation of a more diverse socio-economic community environment by way of including and mixing a broad range of income earners and their families.

The fact that Angus Glen does not conform closely to the principles of New Urbanism and thus offer a less unsustainable alternative is not immediately evident to the casual or perhaps even a seasoned observer because Angus Glen looks like a good example of New Urbanism. It is difficult to gauge the density of the community from initial visual observation (especially if an observer has not seen the Royal Troon homes), nor is it evident that the dwelling types are generally concentrated into homogenous areas. With its lane ways, innovative parking embayments and intersection chokers, a community green and a high degree of architectural detailing, Angus Glen projects an image of progressive New Urbanist community, yet after closer
investigation it is evident that this community lacks the ability to effectively address the most pressing problems associated with conventional design in the GTA.

New Urbanism can be considered a form of post modern urban design since it represents a critique of high modernism (which is epitomized by conventional community design in the suburban context), and reaches back before the modern era to derive its form and pattern from the City Beautiful movement (Harvey, 1989; Knox, 1994). The development and emergence of New Urbanism has also been heavily influenced by postmodern urban theorists and architects such as Leon Krier (Harvey, 1989). Krier’s theories involved a rejection of single use zoning and designing around the automobile, instead favouring the creation of ‘complete and finite communities’ containing mixed uses situated within walking distance of each other, while also seeking the active restoration or recreation of traditional ‘classical’ urban values (also known as symbolic richness) (Harvey, 1989). Thus New Urbanism can be classified as a ‘neovernacular tradition’, employing historical symbolic features to create ‘rich’ buildings, streetscapes and communities (Knox, 1994).

Despite adding vernacular and historical tradition back into contemporary urban design theory, the neovernacular tradition of post modernism has been susceptible to becoming specifically tailored to ‘taste cultures’, where the symbolic richness of buildings and communities can be used essentially as ‘symbolic capital’ to attract niche buyers within a post modern capitalist economy which is increasingly characterized by market differentiation (Harvey, 1989, Knox, 1994). In this respect, Harvey (1989) believes that the ‘great blight of dullness’ of modernism, a phrase coined by postmodern urban theorist Jane Jacobs, actively sought to repress symbolic richness. This repression has now been converted into a great demand for diverse urban environments which are based on vernacular or imported ‘themes’; these environments have been almost exhaustively adorned with symbolic capital to attract specific segments of an incredibly diversified and fragmented post modern consumer culture, who are seeking places which can instil a sense of personal identity (Hannigan, 1998). However, Harvey (1989, 1989a) stresses that the application of symbolic capital and richness upon urban spaces can effectively obscure fundamental social, economic and perhaps environmental problems or deficiencies. Using the wildly successful post modern festival market in Baltimore as an example, Harvey notes that this environment portrays an image of urban revitalization and an exciting consumer experience to a middle class consumer culture, yet this revitalization lacks substance since the economic benefits of the festival market have not at all contributed to alleviating Baltimore’s central city problems of continuing deindustrialization, unemployment and urban poverty.
Applying the above theoretical context to this specific evaluation, it is evident that in both Angus Glen and Cornell traditional urban values (Unionville and Main Street Markham) have been recreated and symbolic capital in the form of architectural detailing and a grid street system have been extensively applied to attract home buyers which are 'hungry' for a new (sub) urban experience (Cousens, 1997; Lehrer and Milgrom, 1996). It seems this strategy has been successful, given the quick pace dwellings in both communities have been purchased (Law, 1997; Dexter, 1999). However, the fact that Angus Glen is a hybridized example of New Urbanism and will probably not contribute to mitigating the problems associated with conventionally designed communities presents a situation which is analogous to Harvey's Baltimore example. More specifically, Angus Glen can be considered to be a conventional community which has been 'packaged' using symbolic capital to attract move up market buyers who are seeking a themed environment which invokes a sense of identity and place (which has essentially been imported from Old Unionville) relative to conventional designs (Harvey, 1989; Hannigan, 1998). The New Urbanist heritage style detailing of Angus Glen offers a powerful image of a vibrant community based on 'traditional' values, yet since the community does not conform to the essential New Urbanist principles for creating a less unsustainable community, Angus Glen lacks substance in terms of achieving the aims of New Urbanism. Angus Glen represents a good example of a situation on which critics of New Urbanism have frequently commented: some developers tend to incorporate only the most marketable aspects of New Urbanism (those which exclusively provide image) when creating these communities, thus New Urbanism essentially becomes a new way to market (and disguise) conventionally designed communities through image (Lehrer and Milgrom, 1996).

DPZ, Calthorpe and other proponents consider the production of a vibrant community environment as only one part of the collection of environmental, economic and social benefits which can result from the application of New Urbanist principles (Duany and Plater-Zyberk, 1992; Calthorpe, 1993; Langdon, 1994; Kunstler, 1997; Roseland, 1998). Following this rationale, Cornell can be considered a more successful example of a community design based on New Urbanism because it possesses definite substance in terms of offering a less unsustainable design alternative relative to conventional design, while also conveying the image of a traditionally themed urban environment.

7.3 Cornell and Angus Glen Compared

Since both the existing phases of Cornell and Angus Glen have been designed and developed within the New Urbanist design and development context of Official Plan Amendment
No. 5, there are a number of explanations as to why Cornell is close to being a model New Urbanist community and Angus Glen appears to be a conventional community lurking beneath a New Urbanist veneer or 'garnish'. These explanations fall into three categories, including showcase effects, community developer intentions and location, and are discussed below. Lastly, a major similarity between the two communities is outlined, specifically involving the lack of affordable housing provision.

7.3.1 Showcase Effects

Cornell's close adherence to the principles of New Urbanism is primarily due to the fact this community was originally conceived as a showcase community for demonstrating the application of provincial housing policy formulated under former Liberal and NDP governments, specifically a community containing a significant proportion of affordable housing (50 percent of total dwellings) and mixed, transit supportive land uses (Hertel, 1999). However, after an angry reaction from Markhams' residents and council over the perceived spectre of an affordable housing 'project' abutting their community, the province decided to work more closely with the Town and Markham residents in designing and developing a community design more indicative of Markhams' heritage themed main street (Cousens, 1997). As outlined in the study area chapter, the province retained the services of DPZ to design a more politically compatible community (Hertel, 1999). Duany quickly won over Markham politicians and residents with a series of lectures and workshops extolling the virtues of New Urbanism, and the current New Urbanist design for Cornell was subsequently conceived and approved for development by the province, Markham Council and the voting public (Kar, 1998). Furthermore, the subsequent formulation of a rigid secondary plan (1994), the adoption of Amendment No. 5 (1998) and a dedication by Markham Council and Staff to apply the principles of New Urbanism in new communities throughout the new urban expansion area, has resulted in Cornell's first phase following the original DPZ designs very closely. In fact, Duany himself considers Cornell to be DPZ's 'absolutely flawless, best, flagship project' (Town of Markham, 1997); however, this assertion will only be true if future phases of Cornell exhibit higher densities than witnessed currently.

Angus Glen did not receive nearly as much publicity as Cornell as an example of New Urbanism, it was never intended to be a demonstration community for provincial housing policy, and it was designed and approved for development following Cornell's acceptance (Town of Markham, 1994, 1997; Cousens, 1997). Furthermore, the developer was probably not under any significant public or political pressure (unlike Law) to follow through on a promise of developing
a community closely based on textbook New Urbanism. Perhaps the fact that Angus Glen looks like a model New Urbanist community at first glance has most likely deflected many criticisms of this community really constituting a hybridized example of New Urbanism.

7.3.2 Developer Intentions

The close adherence of Cornell's existing design characteristics could be attributed to the dedication of the primary developer, Larry Law, to develop Cornell to the fullest extent of its original design as possible (Law, 1997). Although Law has stated that the design characteristics of New Urbanism employed in Cornell are exactly what consumers want as we enter the Twenty-first century (Law, 1997), this dedication, however, is probably not entirely based upon a benevolent attitude regarding New Urbanism. Law most likely went ahead with the purchase of the Cornell land from the province and development of the community in order to turn a substantial profit, since the development industry typically focuses on the sales potential of a project, not social or environmental needs or benefits (CMHC, 2000). Law also probably knew that the heritage image of New Urbanism would allow him to charge more per saleable frontage foot, which would more than pay for the added cost of lanes and perhaps increase profit margins due to reduced infrastructure costs on a per unit basis (Cousens, 1997). Lastly, since Law Development seems to have 'deep pockets', and thus more willing to take a potentially large risk in developing a high (total) cost project like Cornell, probably ensured that the original DPZ design has been reflected somewhat accurately in built form (Kar, 1998).

The image of Angus Glen emulating a New Urbanist community could be attributed to the fact that developer of Angus Glen, Patrick O'Hanlon, is trying to create Markham's "centrepiece lifestyle community, where people can live near there work and even see their kids married." (Dexter, 1999). O'Hanlon has also stated that consumers (particularly young professionals) are looking for a "friendly community to live in" which is based on the use of "quality architecture"; these statements imply that O'Hanlon is fully aware that the image of New Urbanism can be successfully used to market developments which are community-themed and reflect lost "family values" (Dexter, 1999). However, O'Hanlon most likely also understood that the addition of architectural detailing to dwellings and the use of lanes, traffic calming measures and a village green would result in price premiums for dwellings and thus higher potential profits relative to developing a conventionally designed community in the same location. O'Hanlon probably also understood that the location of the development, which is adjacent to Markham's estate home enclaves, might result in a price premiums and a larger profit margin despite
developing the community at near conventional densities (Kitagawa, 2000).

7.3.3 Location

Regarding location, it seems the broad application of New Urbanist design principles (especially higher densities and a diverse housing mix) within the Cornell community was not affected by the characteristics of adjacent dwellings and residents. Cornell is located adjacent to the predominantly middle class conventionally designed community of Mintleaf, which contains average sized single detached dwellings which typically resale for $250,000, and the existing adjacent dwellings in this community back onto Ninth Line. However, some of the Cornell’s most expensive single detached homes in front Ninth Line, and probably act as a minor buffer between the single detached homes of Mintleaf and the higher density dwellings within Cornell.

The location of Angus Glen in north Markham is perhaps the primary reason behind its near conventional density. It is evident in the Angus Glen secondary plan that this community was originally intended to cater to a upper-middle class clientele given its location, and not result in the development of a potentially undesirable community (because of the perceived ills of higher density housing) within a surrounding residential context which is dominated by estate homes averaging one million dollars in resale value. As discussed in the analysis, the projected densities for the fully developed Angus Glen community outlined in the secondary plan are not much higher than 11 units per hectare, and the dwellings constructed adjacent to the Angus Glen and York Downs Golf Courses and the Devils’ Elbow community (an estate home enclave) are governed under a special development control policy to ensure that residential development adjacent to these ‘prestige’ locations are ‘compatible’.

7.3.4 A Similarity: Lacking Social Sustainability

Cornell was found to possess a small proportion of affordable housing (approximately 13 percent) and Angus Glen was found to possess none, according to the definition used for affordable housing outlined in the methodology. It seemed in both communities the idea of social sustainability was essentially ignored, although superficial attempts were made by the developers to invoke a ‘sense of community’ among its primarily middle to upper class residents. Cornell did contain limited housing below $135,000, yet it could not really be considered a less socially unsustainable community relative to the GTA as a whole (although it was relative to Rouge Fairways). However, there is a chance that more affordable housing (priced below $135,000) may be included in the development of further phases of the community. Angus Glen could not be considered less socially unsustainable either, especially since it failed to conform even closely
to the principles of New Urbanism. The probability of housing priced below $135,000 being developed within Angus Glen is very low, given its location and move-up market orientation.

Although Cornell was found to be a definite step towards New Urbanism, it seemed that this community was more successful in addressing environmental and economic sustainability issues. Thus the idea of social sustainability remains marginalized in perhaps one of the nearest examples of New Urbanism in North America, and the provision of affordable housing in Markham will most likely remain segregated from more middle and upper class communities, instead of being somewhat integrated with middle and upper middle class dwellings according to the principles of New Urbanism. It is evident that the findings of Klein and Sears (1983) and Kar (1998) are somewhat relevant to this study, as negative perceptions associated with affordable housing are probably resulting in the creation of barriers to the inclusion of higher percentages of affordable housing within Cornell and the inclusion of any affordable housing within Angus Glen.

7.4 Policy Implications for Markham and the GTA

The fact that Cornell conforms somewhat closely to the principles of New Urbanism and offers a potentially less unsustainable design alternative to conventionally designed communities is a favourable indication that the goals of the provincial policy statements on housing, which encourage the development of compact communities containing transit supportive land uses and affordable housing, can be fulfilled collectively in reality. Furthermore, Cornell also demonstrates that compact, nodal and mixed-use communities encouraged by GTA regional municipalities and the Town of Markham can be successfully developed, and this case should be utilized as an incentive to actively encourage similar development throughout the five regional municipalities. However, it is important to also consider Angus Glen as an example of how communities using elements of New Urbanism which do not offer significant less unsustainable alternatives can still be developed within policy environments which advocate New Urbanist and/or SCD principles. If communities such as Angus Glen continue to be developed, the potential regional benefits of New Urbanism may not be realized and the perpetuation of conventionally designed development will continue behind an image of a less unsustainable alternative. Similarly, despite its close adherence to New Urbanist principles, it is imperative that the future phases of Cornell incorporate a better jobs to dwellings ratio, so Cornell fulfils its vision of becoming a compact, mixed use and transit supportive regional growth node. Lastly, the development of New Urbanist communities in the GTA should be balanced between greenfield and infill sites, in order to take advantage of existing regional infrastructure. Although
both Cornell and Angus Glen are greenfield developments, a major New Urbanist infill project (Markham Centre) along Highway 7 in Markham currently in the preliminary stages of development will assist in preserving additional agricultural and natural land within the municipality.

7.5 Limitations and Further Study

More detailed future research in terms of evaluating communities based upon New Urbanism might be assisted by using a more quantitative methodology, where each design indicator would be expressed in a numerical value, added up to achieve an aggregate score, and then compared to a critical value which suits a 'very close' example of New Urbanism (such as a score of 85-90 out 100). This method may allow a more clear-cut acceptance or rejection of hypotheses similar to the one used in this study, however it would be still important to include qualitative evaluation indicators since New Urbanism's principles are not all quantifiable by numbers or percentages.

The use of a more quantifiable methodology does present a potential problem in that each design indicator would have to be assigned a weight according to the role particular design characteristics have in providing the benefits which accrue from the employment of New Urbanist principles. For example, since density plays such a large role in determining many of the benefits, it would probably account for 40 to 50 percent of the aggregate score for a community. Since there are no references in the literature regarding weightings for indicators, the assignment of weightings would be at the discretion of the researcher and heavily dependent on their perception of which indicators are more important than others. More research is necessary regarding the appropriate weighting of specific design and/or sustainability indicators for the quantitative analysis and evaluation (using indicators which singularly and collectively reflect environmental, economic and social issues) of communities upon New Urbanism and SCD. Currently the majority of past and current research regarding the evaluation of these communities relies heavily on qualitative analyses and inferences (Curry and Gurstein, 1993; Grant, 1993; Perks and VanVliet, 1993; Langdon, 1994; Van Vliet, 1994; Southworth, 1997; Robbins, 1998, Hardcastle, 1998; Kar, 1998; Bogorad, 1999).

Attention must also be paid to the fact that many of the indicators used in this study and others are somewhat 'multicollinear', since they are interrelated and interdependent (to varying extents) with each other in terms of facilitating the benefits of New Urbanism. Care should be taken by future researchers to acknowledge this methodological difficulty, especially if statistical models are to be employed.
The inferences made for both Cornell and Angus Glen in this study were primarily based upon empirical evidence found in the literature. Despite examining hard infrastructure costs as an outcome of density, housing mix and street system characteristics, this study was somewhat limited in terms accurately predicting the extent Cornell and Angus Glen actually represent less unsustainable alternatives (or not) to conventional design. Only further study involving work and non-work trip travel behaviour modelling (following Cervero and Radisch, 1996) and determining the premium of New Urbanist dwellings relative to similar dwellings in conventionally designed communities (following Eppli and Tu, 1999) will provide the necessary empirical evidence to make inferences which are site specific for both Cornell and Angus Glen. Lastly, since both Cornell and Angus Glen were only in the first phases of their development, it will be important to revisit this analysis five to ten years hence to determine how these communities have evolved regarding their adherence to the principles of New Urbanism.

Further research regarding the politics of New Urbanism is also necessary in order to determine more definite answers as to why New Urbanism was accepted with such enthusiasm, and how it has been received by the public in Markham and other municipalities in the GTA. Although the mitigation of problems associated with conventional design was probably the primary reason municipalities embraced New Urbanism, perhaps there are other reasons (perhaps pertaining to tax revenues, or using elements of New Urbanism in communities to superficially address the provincial policy statements on housing) which may need to be sought out and examined. Another interesting research topic regarding the politics of New Urbanism would involve examining the reactions of residents who reside in conventionally designed communities adjacent to existing or proposed New Urbanist developments.

7.6 A Last Word on the Definition of New Urbanism

Given the evaluation outcomes for both Cornell and Angus Glen, it is evident that some of the communities in the GTA which have been (and continue to be) labelled as New Urbanist communities aren't really near examples, rather they conventional communities which have been dressed up with New Urbanist garnishes. Since the original aims of both DPZ and Calthorpe were to design and develop communities which provide environmental, economic and social benefits relative to conventionally designed communities, it seems that the title and definition of New Urbanism should only be reserved for communities which are conform closely (Cornell) or exactly (none as of yet) to the principles of New Urbanism. Conversely, communities which only utilize certain elements of New Urbanism for symbolic capital should be referred to perhaps as pseudo-New Urbanist or New Urbanist-like in the literature and media. These proposed titles are
necessary to identify that these communities are not as capable as near-New Urbanist communities in potentially mitigating the problems associated with conventional community design, since their projected image lacks the substance New Urbanism was originally intended to provide (Harvey, 1989a).
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9.0 Appendix: Infrastructure Cost Calculations

**Cornell Costs**

**Roads (including grading, watermains, sanitary and storm sewers and curbs):**

Road Length: 6 434.5 metres multiplied by earthworks ($85), watermains ($122), sanitary sewers ($121), storm sewers ($295) and curbs ($84).

Lane Length: 4 645.5 metres multiplied by storm sewers ($120) and curbs ($50)

Raised Medians: 900 metres x $95 = $ 85 500

Total: $6 153 687.5

**Pavement ($30 dollars per square foot):**

The Meadows = $240 (8 metres wide x $30) x 485.5 metres (road length) = $116 280
Settlement Park = $240 x 235.5 = $56520
Riverlands = $165 x 243 = $40 095
Spring Meadow = $240 x 349.5 = $83 880
Cornell Park = $420 x 35 + $336 x 188 + $360 x 200 + $240 x 90 = $170 468
Cornell Meadows = $240 x 219 = $52560
Cornell Common = $240 x 369 = $88 560
Donald Sim = $240 x 177 = $42 480
Christian Reesor = $336 x 178 = $42 720
Almira = $240 x 289.5 = $69 480
Pingel = $240 x 160.5 = $38 520
Glendennan = $240 x 177 = $42 480
Gowland = $240 x 262.5 = $63 000
Pascoe = $240 x 247.5 = $59 400
Country Glen = $360 x 24 + $336 x 892.5 + $240 x 36 = $317 160
Walkerville = $240 x 1102.5 = $264 000
White’s Hill = $420 x 35 + $336 x 286 + $330 x 120 + $240 x 33 = $157 316

Lanes: $124.5 x 4132 metres + $150 x 513 metres = $591 446.25

Total: $2 296 365.25

**Service Connections:**

973 dwelling units x $460 (watermain) = $447 580
973 x $325 (storm sewer) = $316 225
973 x $450 (sanitary) = $437 850

Total: $1 150 572
Sidewalks:

$647.6 \text{ metres} \times $111 (sidewalks on both sides of all roads in Cornell): $626\,881.50

Total infrastructure cost for Cornell: $10\,227\,506.25

Infrastructure cost per unit: $10\,227\,506.25 / 973 = 10\,511.31 \text{ per unit}

Rouge Fairways Costs

The infrastructure cost per unit for Rouge Fairways was calculated as follows:

Roads:

Road Length: 5520 metres x earthworks ($85), watermains ($122), sanitary sewers ($121), storm sewers ($295), and curbs ($84).

Total: $4\,185\,974

Pavement:

Havelock Gate = $315 \times 150 \text{ metres} = $47\,250
Ridely = $240 \times 315 = $75\,600
Bluebell = $240 \times 237 = $56\,880
Songbird = $240 \times 541.5 = $129\,960
Boxwood = $555 \times 47 + $495 \times 15 + $492 \times 10 + $420 \times 10 + $405 \times 60 + $375 \times 36 + $360 \times 12 + $315 \times 942.5 = $381\,637.5
Lemsford = $240 \times 825.5 = $198\,120
Norbury = $240 \times 338.5 = $81\,240
Bretton = $240 \times 772.5 = $185\,400
Grandlea = $240 \times 784.5 = $188\,280
Sparta = $330 \times 60 + $240 \times 120 = $48\,600
Upper Ridge = $300 \times 216 = $64\,800
Rouge Fairways = $225 \times 172 = $38\,700
River Forest = $225 \times 237 = $53\,325

Total: $1\,549\,792.50

Service Connections:

$571 \times $460 \text{ (watermain)}: $262\,660
$571 \times $325 \text{ (storm sewer)}: $185\,575
$571 \times $450 \text{ (sanitary sewer)}: $256\,950

Total: $705\,185

Sidewalks:

1511 \text{ metres} \times $111 = $167\,725.5
Total Infrastructure cost for Rouge Fairways: $6 608 677

Infrastructure cost per unit: $6 608 677 / 571 = 11 573.87

1. **Angus Glen Complete Costs (467 units / 39.5 hectares)**

   The infrastructure cost per unit for Angus Glen was calculated as follows:

   **Roads (including grading, watermains, sanitary and storm sewers and curbs):**

   Road Length: 5 150 metres
   Lane Length: 2 530.50 metres
   Raised Medians: 285 metres x $95 = $27 075
   Total: $4 013 637.50

   **Pavement:**

   Roads:

   Angus Glen Boulevard = $360 x 84 + $285 (averaged) x 1041 = $325 845
   Royal Troon = $240 x 486 = $116 640
   Fairways = $390 x 192 + $300 x 75 + $240 x 492 + $180 x 204 = $252 180
   Port Rush = $225 x 366 = $75 600
   Muirfield = $225 x 291 = $65 475
   Woodgrove = $225 x 307.5 = $69 187.5
   Angus Meadow = $225 x 395 = $88 875
   Glen Village = $225 x 72 = $16 200
   Potter’s Wheel = $225 x 79.5 = $17 887.5
   Prospector’s Drive = $330 x 387 + $195 x 27 = $132 975
   Glen Gate = $240 x 156 = $37 440
   Dancer’s Drive = $225 x 405 = $91 125
   Queen’s Plate = $225 x 219 = $49 275

   Lanes: $150 x 2530.5 = $379 575

   Total: $1 718 280

   **Service Connections:**

   467 x $460 (watermain) = $214 820
   467 x $325 (storm sewer) = $151 775
   467 x $450 (sanitary) = $210 150

   Total: $576 745
Sidewalks:

3475.6 metres x $111 = $385 795

**Total Infrastructure Costs for Angus Glen Complete:** $6 694 457.50

**Infrastructure Cost per unit:** $6 694 457.50 / 467 = $14 335.03

**Ashton Meadows Complete (948 units / 93.20 hectares)**

**Roads:**

Road Length: 10 033.50 metres

Total: $7 223 065.50

**Pavement:**

- Rodick = $600 x 45 + $555 x 69 + $525 x 276 + $408 x 904.5 = $683 325
- Calvert = $525 x 201 + $420 x 30 + $360 x 649 = $221 751
- Towson = $315 x 399 = $125 685
- Lazenby = $240 x 166.5 = $39 960
- Holmesdale = $240 x 339 = $81 360
- Hans = $240 x 333 = $79 920
- Tourane = $240 x 532.5 = $127 800
- Forester = $300 x 144 + $240 x 990 = $280 800
- Moses = $240 x 613.5 = $147 240
- Schooner = $750 x 36 + $240 x 136.5 = $58 680
- Dubourg = $240 x 586.5 = $140 760
- Pilgrim = $240 x 478.5 = $114 840
- Dumfries = $240 x 367.5 = $88 200
- Frisby = $780 x 76 + $240 x 35 = $67 680
- Macrill = $420 x 60 + $330 x 183 = $85 590
- Rachel = $408 x 81 + $360 x 60 + $330 x 424.5 = $194 733
- Dalthicks = $210 x 300 = $63 000
- Bates = $210 x 433.5 = $91 035
- Founders = $240 x 105 + $210 x 498 = $129 780
- Eyer = $240 x 670.5 = $160 920
- Dollar = $720 x 36 + $240 x 30 = $33 120

Total: $3 016 179

**Service Connections:**

- 948 x $460 (watermain) = $436 080
- 948 x $325 (storm sewer) = $308 100
- 948 x $450 (sanitary sewer) = $426 600

Total: $1 170 780
Sidewalks:

3757.4 metres x $111 = $417 066

Total infrastructure cost for Ashton Meadows: $11 827 090.50
Total infrastructure cost per unit: $11 827 090.50 / 948 = 12 475.83

2. **Angus Glen Parcel 1 (288 units / 21.26 hectares)**

   Housing Mix: 184 single detached homes (64 percent) and 104 town homes (36 percent)

Roads:

Road Length: 3 279.50 metres

Lane Length: 1621.50 metres

Raised Medians: 150 metres x $95 = $14 250

Total: $2 566 194

**Pavement:**

Roads:

Angus Glen Boulevard = $356 (average) x 479.4 = $170 700
Royal Troon = $240 x 486 = $116 640
Fairways = $390 x 192 + $300 x 75 + $240 x 492 + $180 x 204 = $252 180
Port Rush = $225 x 186 = $41 850
Murfiefield = $225 x 261 = $58 725
Woodgrove = $225 x 232.5 = $52 312.5
Angus Meadow = $225 x 38 = $8 550
Prospector’s Drive = $330 x 180 = $59 400
Dancer’s Drive = $225 x 205 = $46 125
Queen’s Plate = $225 x 163 = $36 675
Glen Gate = $240 x 156 = $37 440

Lanes: $150 x 1617.5 metres = $242 625

Total: $1 123 222.50

**Service Connections:**

288 x $460 (watermain) = $132 480
288 x $325 (storm sewer) = $93 600
288 x $450 (sanitary sewer) = $129 600
Total: $355,680

**Sidewalks:**

1999 metres x $111 = $221,879

**Total infrastructure cost for parcel:** $4,266,975.50

**Infrastructure cost per unit:** $4,266,975.50 / 288 = $14,815.89

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**Ashton Meadows South (182 units / 21.26 hectares)**

**Housing Mix:** 100 percent single detached dwellings

**Roads:**

Road Length: 2724.50 metres

Total: $1,933,291.50

**Pavement:**

Calvert = $525 x 156 + $360 x 469 = $250,740
Rodick = $525 x 66 + $408 x 274.5 = $146,646
Towson = $315 x 399 = $125,685
Lazenby = $240 x 166.5 = $39,960
Holmesdale = $240 x 339 = $81,360
Hans = $240 x 333 = $79,920
Tourane = $240 x 532.5 = $127,800

Total: $852,111

**Service Connections:**

182 x $460 (watermain) = $83,720
182 x $325 (storm sewer) = $59,150
182 x $450 (sanitary sewer) = $81,900

Total: $224,770

**Sidewalks:**

1434 metres x $111 = $159,174

**Total Infrastructure Costs for Ashton Meadows South:** $3,169,346.50

**Infrastructure cost per unit:** $3,172,858 / 182 = $17,414
3. **Angus Glen Parcel 2** (239 units / 21.26 hectares)
   Housing Mix: 100 percent single detached homes

**Roads:**

Road Length: 3 476.50 metres

Lane Length: 1 594.50 metres

Raised Medians: 75 metres x $95 = $7125

Total: $2 696 127.50

**Pavement:**

Roads:

Angus Glen Boulevard = $360 x 90 + $356 (average) x 479.4 + $330 x 156 + $300 x 75 + $270 x 20 + $195 x 75 = $295 605

Royal Troon = $240 x 486 = $116 640

Fairways = $240 x 492 + $180 x 204 = $154 800

Port Rush = $225 x 366 = $82 350

Muirfield = $225 x 261 = $58 725

Woodgrove = $225 x 232.5 = $52 312.5

Angus Meadow = $225 x 140 = $31 500

Potters Wheel = $225 x 79.5 = $17 887.5

Prospector’s Drive = $330 x 119 = $39 270

Lanes = $150 x 1898.7 metres = $284 805

Total: $1 133 895

**Service Connections:**

239 x $460 (watermains) = $109 940

239 x $325 (storm sewers) = $77 675

239 x $450 (sanitary sewers) = $107 550

Total: $295 165

**Sidewalks:**

2192 metres x $111 = $243 421.50

**Total Infrastructure cost for Angus Glen Parcel Two:** $4 368 634

**Infrastructure cost per unit:** $4 368 634 / 239 = $18 278.80
Ashton Meadows South (182 units / 21/26 hectares)

Calculations same as in Comparison Two

Total Infrastructure costs for Ashton Meadows South: $3,169,346.50

Infrastructure cost per unit: $3,169,346.50 / 182 = $17,414
VITA AUCTORIS

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