Master of Planning Independent Project

PRIVATE STREETS IN PUBLIC NEIGHBOURHOODS

THE CONSEQUENCES OF TOWNHOUSE DEVELOPMENT ON NEIGHBOURHOOD CONNECTIVITY IN SURREY BC

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PRIVATE STREETS IN PUBLIC NEIGHBOURHOODS:
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Contents

'The Suburbs Project' investigates new trends in the planning and development of residential environments.

1. PREFACE

During the summer of 2007, I worked with Professor Jill Grant at the Dalhousie School of Planning on a project funded in part by the Social Sciences and Humanities Research Council of Canada (SSHRCC) entitled "Theory and practice in planning the suburbs." Professor Grant's research asks how planning can bridge gap between theory and practice in the development of the suburbs. In my capacity as a research assistant on the project, I had the opportunity to visit a number of communities across Canada to interview planners, developers, and city councilors, and visit new residential neighbourhoods to investigate what new trends are emerging in Canada's suburban environments. One of the municipalities I visited was Surrey, British Columbia.

Surrey is one of the fastest growing municipalities in Canada, with double-digit rates of population increase in every census since 1981. Traditionally a suburban municipality, with large lots and a predominance of single detached housing, Surrey serves as a bedroom community for BC's Lower mainland

employment hubs such as Vancouver, Burnaby and Richmond. Land prices in Surrey customarily have been significantly lower than those in Vancouver, allowing families to live out their suburban dreams while still living within commuting distance of the city. This situation, however, is changing. In recent years, there has been a shift toward more density in Surrey.

The use of gates is a common practice to add value to a townhouse development. Surrey does not allow gated communities, but many builders erect 'ornamental gates,' which are left open and add a sense of security.

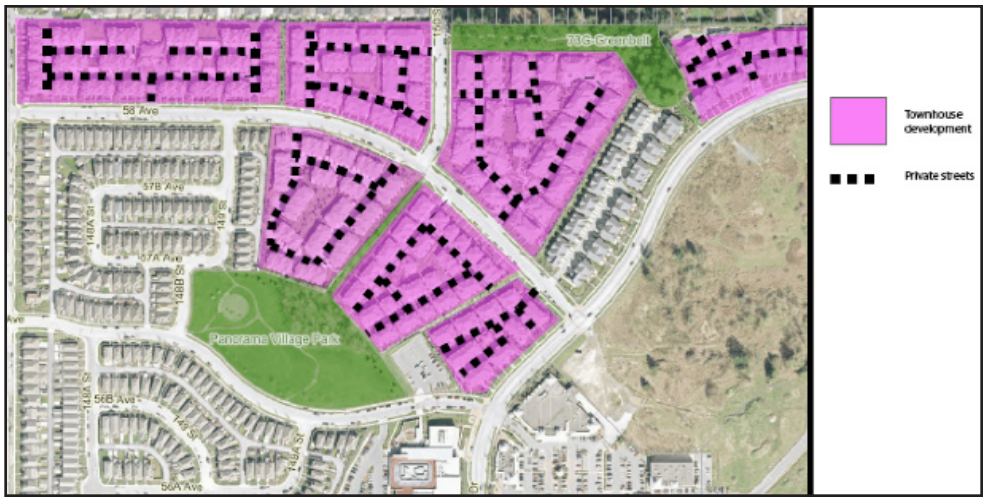
This shift towards density is a result of converging factors. On one hand, land prices in the Lower mainland have been rising exponentially through the nineties making the low density style of development Surrey is known for unobtainable for the type of people who are in the market for that product. Builders need to build at a higher density to make up for higher land costs and still be able to sell their houses. On the other hand, the City of Surrey's planning priorities shifted toward a more comprehensive planning model trying to make better efficiency of the remaining land in the municipality.

Builders often use landscaping to delineate private from public areas. Strata managment corporations hire private companies to do the maintenance.

In the late 1990s the city embarked on the 'neighbourhood concept planning' process (NCP). Based on current planning theories such as 'smart growth,' 'new urbanism,' and 'sustainable neighbourhood design,' the NCP process emphasizes public participation, mixing of uses and housing types, transit orientation, and designing better-connected neighbourhood centers. Currently, there are close to twenty NCP areas in Surrey in various stages of planning and development. Interviews with Surrey planning staff and private development companies showed a willingness to develop better, denser communities than Surrey had traditionally allowed. Surrey planning staff

and builders are increasingly looking toward the townhouse to bring the density of these communities up, and are allocating large amounts of space within NCP areas for townhouse development.

The form these townhouses are taking, however, is concerning. Rather than being integrated along the public streets within the subdivision, the townhouses are being developed in private enclaves on private streets. Entry features such as landscaping and signage separate the public street from the private development. I visited a number of newly developed communities while in Surrey. These neighbourhoods had all the ingredients of well planned communities. The built structure is developed at a human scale; everyday amenities, such as small grocery stores, video rental outlets, and coffee shops exist within walking distance; and parks, schools, and recreation centers, are all connected with convenient walking paths. However, walking around these neighbourhoods, I could not help but experience a feeling of disconnection. This disconnection is the result of the spatial organization of the neighbourhood, and most certainly



Many newly planned neighbourhoods in Surrey have the feel of a series of pods stuck together.

the prevalence of private enclave development. The abundance of these townhouse developments is affecting the performance of the neighbourhoods I visited. Often it felt as if I was walking along a series of pods stuck together rather than a cohesive community or well connected neighbourhood such as the Surrey planning staff talked about.

The effects these townhouse developments are having on the neighbourhoods they inhabit do not seem to be a concern for Surrey planners. In interviews with municipal and private planners and with city councilors, I found a general acceptance that townhouse developments increase density and as long as they follow proper architectural guidelines and 'address the street,' the projects fit into neighbourhoods well and provide a medium-density alternative to the ubiquitous single detached house. Yet, the townhouse developments seem to be creating a discongruity between many of the objectives set out in Surrey's planning policy, specifically in regard to the street patterns. I realized a need for greater research into the effect these developments are having in Surrey, especially as other municipalities look to develop in similar ways.

These experiences while in Surrey, and working on the suburbs project with Professor Grant are what have informed the research presented in this document, which investigates the effect of private streets in public neighbourhoods through the case study of Surrey BC.

2. INTRODUCING THE PROJECT

This chapter describes the project objectives and method and outlines the research program. The research examines the effect of private streets on neighbourhood connectivity through the case study of three new development areas in Surrey BC. The research shows the negative impact private streets can have on neighbourhood connectivity even in areas where the planning objective has focused on increased connectivity.

Good neighbourhood connectivity is a concept planners value in the creation of new communities. Well-connected street systems provide alternative routes for transportation and encourage alternative modes of travel such as taking transit, walking, and biking. While there is agreement on the benefits of good connectivity, there are different opinions on how to achieve good connectivity. More and more municipalities are introducing connectivity guidelines to ensure both the integration of new planning areas into the existing urban fabric, and to ensure the internal connectivity of new residential environments (Condon, 2004; Handy et al 2003). Often, though, private streets are not factored into the equation, because they are seen as peripheral to the public street system. As private streets become more common in new planning areas, the effect they have on connectivity becomes tremendously important. This research project uses three newly planned and developed neighbourhoods in Surrey, BC, as case studies into the effect of private streets on the connectivity of public neighbourhoods.

As private streets become more common in new planning areas, the effect they have on connectivity becomes tremendously important.

Private streets are often a main feature in new planning areas in Surrey. The question is: are these private streets undermining the planning objective of having a well-connected street system? Through this research project, I suggest this is so, and illustrate some of the negative effects private enclave townhouse developments are creating on overall neighbourhood connectivity.

This project uses the concept of connectivity to critically evaluate the effect townhouse developments are having on

the street systems within their immediate neighbourhoods. Connectivity is a concept lauded as a goal by almost all of the municipal figures in Surrey I spoke to, and is mentioned as an objective in Surrey's planning legislation (City of Surrey, 2003, 38 Policy B-32) and secondary plans (Urban Systems, 1996). While Surrey's bylaws do not set specific connectivity targets, the body of literature on connectivity clearly sets out acceptable levels of connectivity. The literature will inform the standards used to test the neighbourhoods in Surrey. A full description of the research question, objectives and method appears below.

The overall research question guiding the case study is:

• What effect do townhouse developments on private streets have on neighbourhood connectivity in new developments in Surrey, BC?

The project objectives guiding the research are:

• To explore the street pattern townhouse developments on private streets are creating on the suburban landscape in Surrey, BC and their effect on neighbourhood connectivity

• To understand how street design affects connectivity and accessibility

• To examine how well traditional connectivity tests account for private streets

• To understand the effect that private space and private streets have on overall neighbourhood connectivity and accessibility

• To examine the objective of a 'well connected street system' in new neighbourhoods with what is actually being developed

Research Method

As this project overlaps work done in "Theory and practice in the suburbs," I will spend some time describing those methods. Methods used in the summer of 2007 included reviewing Surrey's planning documents; interviewing private and municipal planners, developers and councilors; conducting visual surveys; and considering demographic information. The interview participants were selected based upon their suitability as participants in Surrey's planning and development process. In all, I interviewed 10 people in Surrey. Questions covered the topics of: new trends in the community; how ideas of smart growth and new urbanism have influenced policy; gated communities; private streets; and barriers to implementing planning objectives. Permission was given to use the interview data for this project as long as confidentiality is ensured. As such, where information from the interviews is used, no source will be provided, only a short description of the occupation of the interviewee, such as: "a senior Surrey planner" stated.

I identified three study areas within Surrey for this case study: South Newton, Rosemary Heights, and East Clayton, all of which are NCP areas as defined by the City of Surrey's secondary planning documentation. I chose these areas out of a possibility of 10 NCP areas currently under planning and development because they each represented the type of development that was

present within Surrey, as well as each represented unique aspects in their design. To assist with analysis, I received geographic information system (GIS) data from the City of Surrey, and created detailed base maps of each study area. Because GIS data only shows the public street system, the private streets had to be 'added' to the maps. I did so by referencing images and site maps of the private developments, as well as aerial photographs and development applications. Through this method I was, without exception, able to accurately add every private street within my study areas.

I also conducted a literature review investigating methods for testing connectivity. Through that literature search I selected a series of connectivity tests, which, when set up properly, illustrate the relationship between the townhouse developments and the greater neighbourhoods they inhabit. However, none of the tests specifically spoke to the relationship of the internal street network to the public street network as adequately as I would have liked. Therefore, I constructed a number of other tests to bridge that gap. I created one test, called the Distance to Public Street Test (DiPS test), which I felt did a better job highlighting the inaccessibility of the townhouse development from the public street system, thus highlighting the disconnection between the private and the public street patterns. I also created an appendix to this document which isolates and categorizes some of the street patterns found within the study areas.

Through analysis, I emphasize the effect the townhouse

developments have on the overall connectivity of the study areas. The analysis also includes a discussion of the connectivity tests themselves and how effective they are in dealing with private streets.

Report Outline

This report begins with an overview of the importance of connectivity, how planners use it and the best ways of measuring it. In this section, I introduce the notion of connectivity as more than just a planning objective: connectivity can be an analytical tool as well as serve as a critical discourse for planning theory. Connectivity is an essentially contested concept in planning; as such, it transcends definitive definition and is appropriated and given meaning in different ways by all planning theorists. I introduce a number of different ways of testing connectivity and settle on a series of tests best suited for this project.

The report then turns to the study areas themselves. I introduce some of the objectives expressed in the early planning stages of each neighbourhood and provide a description of the result based upon personal observations, photographs and GIS information. In this chapter, I also report the findings of the connectivity tests as they are applied to the study areas and provide analysis into the results.

In the conclusion, I draw some of the bigger implications of this study to light, and put it in the context of the larger research project being conducted by Professor Grant.

3. Connectivity: A Critical Discourse, An Analytical Device, A Tool For Planners

This chapter describes the concept of connectivity, its importance to planners, and how it is measured. Specific focus is given to the effect of private streets on neighbourhood connectivity and how to account for it. The chapter shows ways to set up traditional connectivity tests to account for private streets, as well as suggesting a new test that directly compares the private and public street patterns.

CONNECTIVITY AS A CONCEPT

What defines a good neighbourhood is often as simple as a well-connected street system. Handy et al. (2003, iv) claim, "The purpose of a street system is to connect spatially separated places and to enable movement from one place to another." Streets, often taken for granted by the general population, shape how we live (Southworth, Ben Joseph 2003). They dictate whether we drive or walk to our destinations and what route we take to get to those destinations. Streets are an expression of our values of lifestyle, health, and privacy. They form the skeletal structure of our cities and town. When planned well, street systems provide a variety of route choices, can accommodate various modes of travel, and are safe and enjoyable. Streets that display these characteristics are well connected.

When planned well, a street system provides a variety of route choices, can accommodate various modes of travel, and is safe and enjoyable. Streets that display these characteristics are considered well connected.

There is some confusion in the planning literature about the definition of connectivity. Connectivity is an essentially contested concept in planning, meaning different interests define the term in different ways to promote different agendas. Generally, connectivity is defined in terms of accessibility. El-Geneidy and Levinson (2006, 12) define it as a measurement of "the ease of reaching valued destinations." Connectivity is further defined by Handy and Niemeier (1997, 1175), "as the spatial distribution of potential destinations, the ease of reaching the destinations, and the magnitude, quality and character of the activities found there." Litmann (2007, 2) defines it slightly differently. He claims connectivity "refers to people's ability to reach goods, services and activities, which is the ultimate goal

of most transport activity."

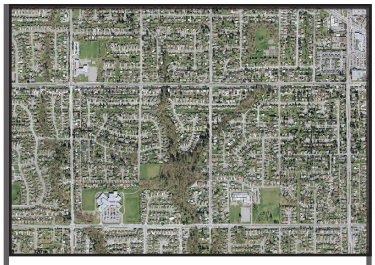
Connectivity for this project is defined in narrower terms than some of these broader interpretations. While many of these authors talk of connectivity in terms of its physical and social elements, I refer to connectivity as a spatial measurement of neighbourhood permeability and route directness. One of the limitations of this study is that variables such as road speeds and quality, and intensity of uses at destinations, are not included. However, at its most basic level, a neighbourhood's strength begins with its street pattern. While all the other variables are important contextually, the expression of the street pattern on the neighbourhood is what I am investigating. Connectivity is the tool I am using to evaluate the pattern and its performance.

Why Connectivity Matters

Connectivity is a particularly important factor to consider in evaluating neighbourhood design. Laurence Aurbach (2007, online http://pedshed.net/?cat=4) argues, "Network connectivity is the single most important element of sustainably-built cities and towns." Handy, Paterson and Butler (2003, iv) state, "The connectivity of the street network influences the accessibility of potential destinations in a community and has important implications in travel choices, emergency access, and, more generally, quality of life." Litman (2007) argues that good connectivity can increase the use of alternative modes of transportation, by shortening the distance to destinations and increasing the enjoyability of the trip. Well connected streets

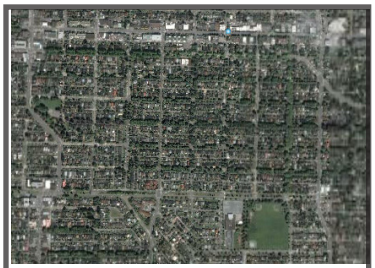
encourage walking by providing a variety of route choices and direct links to destinations. Not only does good connectivity reduce the total number of driving trips, it also encourages pleasure and leisure walking resulting in overall health benefits for the community (Ewing and Cervero, 2001; Reilly and Landis, 2003). Studies have also shown well connected streets increase water pressure and quality in residential subdivisions, as well as allow better access for municipal emergency services (Condon, 2004).

Planners can use connectivity criteria to direct development in healthy ways. Successful examples of the use of connectivity measures can be found in Portland, Oregon; Fort Collins, Colorado; and Cary, North Carolina among other places. Communities can set specific connectivity rules development must follow, such as restricting the use of cul-de-sacs and dead ends, or can provide incentives for developers to meet connectivity objectives. A growing number of municipalities are testing ways of ensuring good connectivity (Condon, 2004).



Typical post war street patterns feature curvilinear streets and cul-de-sacs emphasizing a seperation of land uses

Given these incentives, it seems to be common sense to develop neighbourhoods in a way that maximizes connectivity. However, the product being developed in many suburban areas, features poorly connected private enclaves in the form of cul-de-sacs and developments on private streets. Despite the incentives for a well connected street system, developers often prefer to build poorly connected subdivisions. The reason is simple and shortsighted: economics. Housing value is positively correlated with privacy and reduced traffic. Poorly connected subdivisions,



Grid street patterns allow for greater permeability and movement throughout a subdivision, and allow for connection to other subdivisions creating a cohesive urban fabric.

with curving streets, traffic calming measures and cul-de-sacs reduce traffic in residential areas thus raising housing value, but also encouraging vehicular use. Opposition to building more connected networks cite higher road construction costs.

Suburban Street Patterns

Notions of what makes a good street pattern have changed over time. 'The grid' was the system typically used in North American town planning until the twenties and thirties. Sometime between the world wars planner's "love affair" with the grid ended (Vernez-Moudon, Untermann, 1987, 134). Arguments against the grid were that it created boring, unoriginal street patterns, which did not conform to the natural topography (Morris, 2005). The post war building boom witnessed a revolt against the grid, as the masses fled the city into the suburbs. Planners promoted a style of development separating residential development from other land uses. Communities like Levittown in the US and Don Mills in Canada exemplified this planning direction. Technicians and traffic engineers emphasized a hierarchical street system to protect humans from vehicles. In effect though, the planners in the post war era surrendered the streets to the automobile. To calm traffic around residential environments, curvilinear streets and cul-de-sacs became the norm, increasing small city blocks into 'super blocks.' Consumer tastes embraced this planning direction as popular media portrayed suburban life on the cul-de-sac as the norm. For suburbanites the super block broken into cul-de-sacs

"...suburban residents have come to expect the exclusivity and isolation from public civic life that is built into the suburban template."

Laurence Aurbach

and curvilinear streets offered exclusivity, privacy and safety. Aurbach (2007) claims, “Many suburban residents have come to expect the exclusivity and isolation from public civic life that is built into this suburban template.”

This planning approach, however, received harsh criticism from various groups. Symptoms such as increased traffic, pollution, and increases in violence are attributed to suburban environments planned in the post war period (Morris 2005, Duany et al. 2000, Langdon 1994). Connectivity as a concept became increasingly important in the critical discourse against the post war planning paradigm. For those who rallied against suburban sprawl, the cul-de-sacs represented the epitome of all that was wrong with planning. Langdon (1994, 44) argues, “cul-de-sacs do not encourage walking or biking,” because of the lack of choices available along the way and the abruptness of traveling from the sheltered cul-de-sac to the collectors and arterials, which are the only ways to travel to reach destinations. Cul-de-sacs, while still technically part of the public system, become private enclaves, the sole use of the inhabitants of the cul-de-sac, this forces traffic to the collector and arterial system. Land is used less efficiently, and density is not created to support local business or transit. Thus, the cul-de-sac’s effect on the traditional version of the urban neighbourhood was to break it apart into its separate uses and spatially separate them from one another, in essence ‘disconnecting’ them.

Urban designers wishing to revert to a traditional form of urbanism, and develop communities based upon a better

connectedstreetsystem,founditimpossibleundermostmunicipal planning regulations. The proponents of the post war planning regime institutionalized the cul-de-sac style of development into municipal code. The urban design community had little recourse but to develop the neighbourhoods they wanted under private ownership and run the communities as condominium corporations or as homeowner or resident associations (Nelson 2003). Private ownership allowed the designers to subvert the strict subdivision laws. Building new communities as private communities comes at a higher financial cost to residents, but for those enticed by the marketing of exclusivity and safety, the extra cost is a small price to pay. Communities, such as Seaside Florida, were financially successful and proved a model for other developers to follow.

Private street patterns often differ greatly from surrounding street patterns because of conflicting interests for their design.

The result of the shift to build outside of municipal jurisdiction, has been a land-developer led movement to create privatized towns and communities with the privatization of traditionally municipal services such as garbage collection, road maintenance and security, and most importantly, the legal right to keep out those deemed unwelcome. Observers tracking the growing inequality between the wealthy and poor in North America have taken note, and many important critical assessments of the growth of private communities have been written (Blakely & Snyder 1997, McKenzie 2003, Low 2003).

Municipalities have begun to realize the need for a new planning approach, as the financial, economic, and social consequences of suburban sprawl became evident.

Municipalities are lifting many of the restrictive zoning, land use, and transportation regulations of the post war era, allowing for greater flexibility in street design. Planning departments began to rewrite plans to encourage the mix of uses and housing types within neighbourhoods, and promote well connected and pedestrian friendly public streets. Nevertheless, the privatization, or condoification, of the suburbs is continuing at a quickening pace. The consequences of this trend towards privatizing the street network is just beginning to be studied.

There are numerous ways of measuring connectivity, and many variations on those methods. It is important to find the appropriate measurement for a given site and objective.

PRIVATE STREETS AND CONNECTIVITY

In Canada, usually these private communities are within established municipal boundaries, often at the urban fringe. Increasingly however, municipalities are allocating large areas of land for private enclaves within master planned neighbourhoods. Private communities, outside of municipal control, often result in interesting internal street patterns, frequently divergent from the surrounding street patterns. Sometimes the private communities themselves dictate the external pattern of the neighbourhoods they inhabit. Grant and Curran (2007, 745) note that private streets, "reconstruct a route that would conventionally have been a public street;" and that they "compromise the traditional Canadian understanding of the public realm." One or two of these communities in a large neighbourhood may not have a noticeable impact. When the number of dwelling units inside the private development matches the number of dwelling units on the public system

then there is cause for concern. Instead of a cohesive mixture of housing types, these neighbourhoods can become a series of enclave pods stuck together.

Private communities are attractive for municipalities because they garner a high amount of tax revenue, while requiring little in the way of public services. Private communities in most jurisdictions have to look after their own garbage collection, snow removal, and street repairs – services that are usually provided by the municipality. While there are financial incentives for the municipalities to encourage these communities, there are inherent social and spatial problems with allowing private streets. Developers look toward private communities to subvert the municipalities' road guidelines and can build at a higher density. McKenzie (2003, 207) notes, "Developers ...have found that (private communities) allow them to build at higher densities. Private streets can be narrower than public ones, leaving more land for lots." In doing so, however, developers often subvert the initiatives municipalities have for street design. For instance, if a municipality may be trying to institute measures to ensure a well connected street system, such as is the case in Surrey, a private road system may instead try to create a street system which maximizes the availability of developable land. Thus, the municipality's concerns for building a well-connected community may have a certain street design outcome conflicting with that of a private community with a purely profit motive. The street system created by the profit motive may circumvent the municipality's goal of a well-connected street system.

The effect private streets have on neighbourhood connectivity has not been extensively studied. There are intuitive conclusions one can reach when looking at the effect of private streets on connectivity. One hypothesis is that private streets create a larger grain to the street system (Grant, Curran 2007), affecting among other things the walkability of a neighbourhood. Another assumption is that private communities fragment the urban landscape, creating direct implications on the connectivity of the overall street network.

Measuring Connectivity

Testing connectivity from an analytical perspective, and setting standards for levels of connectivity from a regulatory point of view, are integral tools for planners. Researchers and planners using connectivity tests must be clear on precisely what they are testing and find the appropriate set of tests to use. There are numerous ways of measuring connectivity, and many variations on those methods. It is important to find the appropriate measurement for a given site and objective.

Krizek (2003), in opperationalizing his test measuring neighbourhood accessibility (NA) suggests breaking up a study area into 150m cells and measuring intersection density, employment figures, housing stock, and street pattern giving a score to each cell, then adding up all the cells to find the overall neighbourhood accessibility. Ewing (1996) suggests, in his connectivity index test, that a measure of the ratio between nodes and links in a neighbourhood is an effective way of measuring

connectivity. Municipalities, when doing subdivision review look at measures such as block size and intersection spacing to ensure connectivity (Handy et al. 2003). Cervero and Kockleman (1997), describe a test measuring the density of street intersection as an effective way of assessing street network connectivity. Each of these, and other connectivity tests, have strengths and weakness to them depending on the street pattern, scale of study area, and objective of the study. Litman (2007) argues, to get an accurate reading of connectivity, multiple tests should be used, as certain tests have their individual strengths and biases.

Often, the traditional measures of connectivity do not take into account private space and specifically the relationship between private and public space. For instance, Handy et al. (2003) describes a few connectivity tests used by municipalities to evaluate new subdivision proposals. In all of the tests described, none deal directly with private streets, other than to out right ban them in some situations (Handy et al 2003). There is, however, evidence suggesting private space influences connectivity in a profound way (Grant, Curran 2007).

While a number of tests exist to measure connectivity, only a limited number of test were suitable for this study. I chose tests that looked specifically at the 'spatial' aspect of the street rather than at the 'uses' found within the neighbourhood. 'Uses' based tests focus more on regional issues, such as employment clusters and retail areas. This study specifically looks at small neighbourhoods, so these regional tests did not fit with the objectives of the project.

4. Tests Used In This Study

The following section overviews the connectivity tests used in this project and describes each test commenting on its strength, how it was administered, and some of its limitations. The four tests, “Route Directness,” “Connectivity Index.,” “Block Size and Intersection Spacing,” and “Distance to the Public Street,” are all set up to emphasize the relationship of the public enclave to its larger neighbourhood.

ROUTE DIRECTNESS TEST

The route directness test evaluates the ratio of the distance between two points from a "as the bird flies" measurement, and then from an on the ground measurement, following the street pattern and established pedestrian routes (Hess, 1997; Randall, Baetz, 2001). Communities with good connectivity should provide a number of routes to any given destinations giving travelers choice and the opportunity to take a different route back from the way they came. Well connected communities should offer direct routes to destinations. A critique of the post war planning focus, is that residential environments became isolated from all other land uses, with only a single route usually along a major arterial had to be traveled to conduct even the most basic daily activities. In evaluating neighbourhood design or creating policy for neighbourhood design, using a route directness measurement can be an effective way to ensure good connectivity.

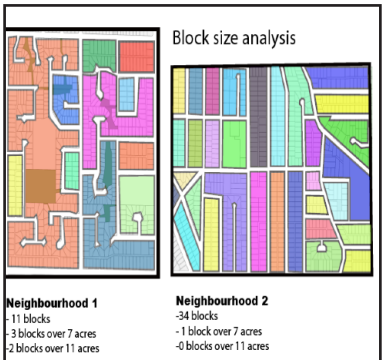
In municipalities where these types of tests are used, a standard measure is usually established. Handy (2003, 23) reports, that the regional government for the Portland, Oregon area included such standards in their street connectivity criteria. Their guidelines are as follows: "For motor vehicles, the shortest distance from any local origin over public streets to a collector should be no more than two times the straight line, and for pedestrians, the distance should be no more than 1.5 times the straight-line distance."

• How the test was administered

For each study area in Surrey, I identified 26 points from which to take measurements. I chose points that were within, abutting and away from the townhouse developments to try to measure the effect the townhouse developments were having on the route directness in abutting blocks. From each point, I took a direct distance measurement, or an 'as the bird flies' measurement, to the neighbourhood shopping area, a bus stop, and the closest arterial connection. For the shopping area and the bus stop locations, I measured the shortest possible pedestrian route taking advantage of any designated pedestrian paths where available. For the arterial and again for the shopping area, I took a vehicular measurement following the established street network. Where possible, I also made note if there was the opportunity to cut through one of the private townhouse developments, and made a measure of that distance as well. Once the readings were taken, they were put in an excel chart to analyze the trends.

In analysis, I looked for trends between increases in route directness and the presence of townhouse developments. I used the standard levels set out in the literature, which were 1.5 times the actual distance to any given walking destination, and 2 times the actual driving distance, as minimum levels of acceptability. Intuitively, I was working under the assumption that if there was a correlation between increased route directness and the townhouse developments, that the presence of the townhouse developments on private streets were in essence reducing the connectivity of the overall neighbourhood. For each neighbourhood, I determined if the route directness test showed a reduction in connectivity being caused by the townhouse development.

One of the challenges to this test is linking the townhouse development to the decrease in route directness - in essence causation. For those points that measured above acceptability, I found difficulty in determining whether the presence of townhouse developments were in fact causing the reduction, or if the reduction were endemic to the total neighbourhood. In analysis, I expound upon this concern over causation.



The more blocks within a given neighbourhood, the greater the route choice and overall permeability. Block size and connectivity are intrinsically linked.

BLOCK SIZE AND INTERSECTION SPACING

Block size and intersection spacing testing involves measuring the actual physical dimensions of city blocks. Well connected neighbourhoods are made up of lots of small blocks and intersections. The more blocks within a given area, the

greater the route choice and overall permeability. Block size and connectivity are intrinsically linked. In the post war era, block size increased, surrounded by arterials and connectors, in which residential pods were constructed (Marshall 2005). Within the blocks typically one would find cul-de-sacs and curvilinear mid-block collectors set up to dissuade through traffic. Neo-traditional town planners have argued that the bringing the blocks down to a human scale size is key in creating more pedestrian friendly accessible subdivisions.

Handy et al (2003) shows that municipalities trying to reduce the size of the blocks do so in two ways. First, they put limits on the area within each block, between 7 and 11 acres being the upper limits for residential neighbourhoods; and second, they put limits on the space between intersections. Through these two tools, planners can decrease the grain size of the neighbourhood increasing route choice, thus creating better connectivity. Fort Collins, Colorado limits block sizes to 11 acres or less, intersections between local streets at 600 feet (180 meters) and connections to arterials at no less than a quarter mile apart (Handy, 2003). Conover, North Carolina, has a maximum block length requirement of 400 feet (120 m) by 1200 feet (360 m) (Handy, 2003). In addition to using block size and intersection spacing testing as regulatory tools, they can also be used for analysis of existing subdivisions.

• How the test was administered

To begin, I identified all blocks over 7 and 11 acres in each

study area. I then measured the length of every link within the study areas and identified a neighbourhood average, as well as highlighting those links that were greater than 150m and greater than 200m. The distances and acreages I selected, were based upon a best practices search through the literature. Surrey does not have limits on intersection spacing limits on local streets, only arterials. Once all of the blocks and links over the acceptable limits were identified, I identified the townhouse developments within the study areas and looked for instances where block size was above an acceptable limit and the presence of private streets. Intuitively, if there was a correlation between larger block size and the presence of the townhouse developments, credibility would be added to the hypothesis that the private streets were

Townhouse developments in the East Clayton NCPstudy area increase the block size and link length of surrounding streets

expanding the scale of the blocks, thus negatively affecting the connectivity.

In analysis, I wanted to see if 1) There was indeed a relationship between the larger links and the private enclaves, and 2) whether the private streets, if public could reduce the grain size by providing further permeability in the neighbourhood, or if the internal system was so divergent from the public system that it would have no effect. Very often, these internal systems are required to have more than one entry point for emergency vehicles, but usually block all but one entry to restrict through traffic. With this second query, I was interested in the option of reconstructing a public route through these developments and if that was possible.

Municipalities often require secondary road accessways for emergency vehicles. Frequently, they are barricaded to stop everyday through-traffic.

THE CONNECTIVITY INDEX

The Connectivity index, or the link node ratio test, is a test used by planners to analyze and ensure connectivity. The test measures the ratio between nodes, which are defined as any street intersection or street end, such as a cul-de-sac, and links, which are the street lengths between the nodes. The rationale for the test is that a well-connected street system will have a higher number of links in comparison to nodes, meaning few cul-de-sacs and dead ends, and many 'four way' intersections. Municipalities set limits on the ratio such as 1.2 (Cary, North Carolina) or 1.4 (Orlando, Florida) (Handy, 2003). The ratio ranges usually from 1.0, for a cul-de-sac heavy subdivision to 2.5 for a perfect grid. Ewing (1996, 57) argues a score of 1.4 is a

"nice target for network planning purposes." Communities may choose to implement a connectivity index to allow for flexibility and innovation in design. Proponents of the connectivity index argue, that other methods of regulation, such as intersect spacing or block size density, do not allow designers to adapt to site-specific topography or land features (Handy, 2003). In addition, the connectivity index, in theory ensures that new development connects with old development (Ewing 1996).

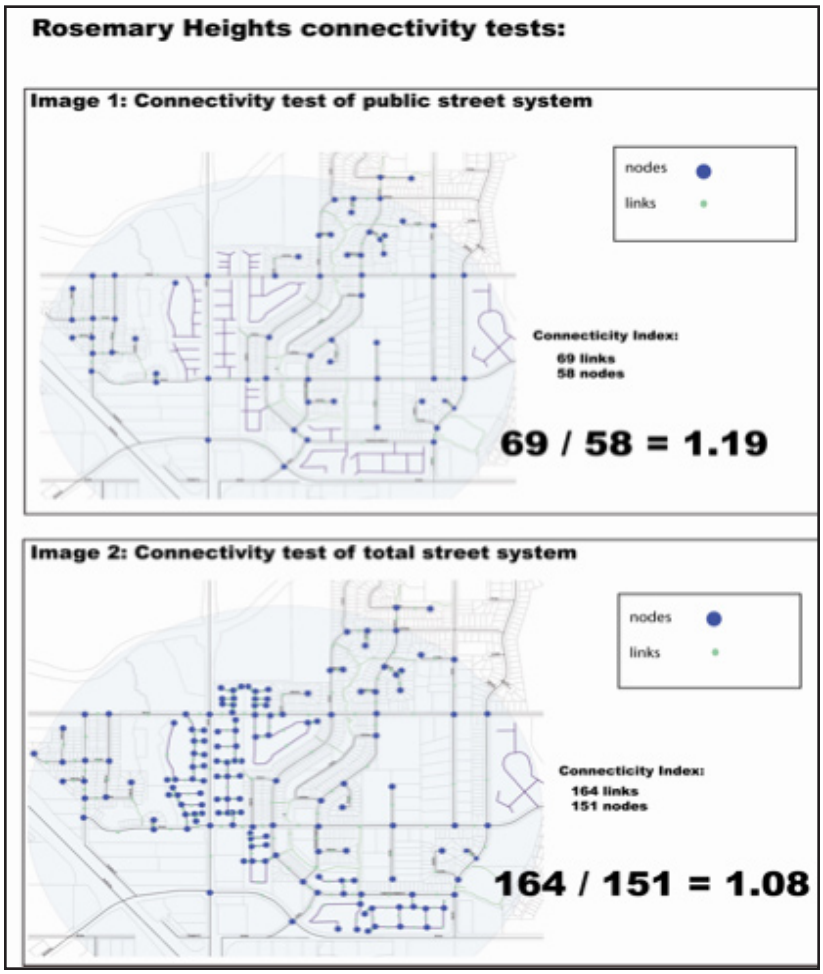
I chose this particular test because it allows for direct comparison between the connectivity of the Surrey public street network and the total street network including the private streets. By measuring the difference, the effect of the private streets on the overall network is highlighted.

- **How the test was administered**

Reid Ewing's (1996), Best Development Practices, describes the method for administering the connectivity index test. He writes, "From the literature on networks, a simple measure of connectivity is the number of street links divided by the number of nodes, or link ends (including cul-de-sac heads). The more links relative to nodes, the more connectivity." Following Ewing's method, I created two overlays for each of the study areas identifying all of the nodes and links. The first overlay illustrated the nodes and links of the public system; the second test showed the nodes and links of the public system with all of the private streets added in. I took connectivity readings from both overlays by finding the ratio of nodes to

links. I also conducted separate internal connectivity tests for each townhouse development, however this did not prove to be fruitful as the test did not perform well at such a small scale.

In analysis, I did not measure the study areas against any particular connectivity objective. What I looked for was the difference between the connectivity ratio of the public street system and of the public and private street system together, and whether the addition of the private streets lowered the overall connectivity of the neighbourhood. If the connectivity of the overall system was lowered, intuitively one could assume that the internal street network of the townhouse developments both differ from the external public street system and are designed



to reduce through-traffic, much like a cul-de-sac or gated communities are designed to do.

- **Limitations to the connectivity index**

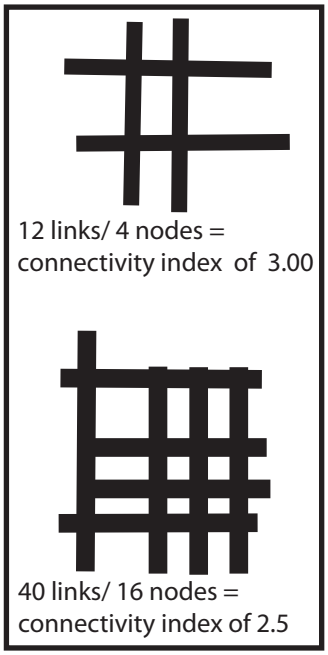
The connectivity index unapologetically favors the grid system above any other urban form. This in itself is a problem. Good connectivity can be created without a grid. According to Handy (2003, 68), "a traditional rectangular grid may not be the only way to achieve a community's objectives. Langdon (2004, 4) also echoes this point. He writes, "The fundamental goal of connectivity requirements are to increase the number of connections and the directness of routes…This does not require a uniform grid." Experimentation with alternative, hybrid designs for street networks might produce a radically new approach to meeting connectivity objectives."

"The fundamental goal of connectivity requirements are to increase the number of connections and the directness of routes… This does not require a uniform grid."

Philip Langdon

The connectivity index also does not take into consideration route distance or block size. If for example one were to apply the connectivity index to a rural area with a perfect grid, the results of the test would assume the area was a walkable community although common sense suggests otherwise. Further to this, the connectivity index does not take into consideration the quality of the walking environments along the streets which are being tested.

Another drawback is its inability to analyze at a small-scale level. When looking at the townhouse developments, usually we are talking about less than 10 streets. When only a few streets are put into the calculations the numbers are not consistent. Take for example a perfect grid. With four streets



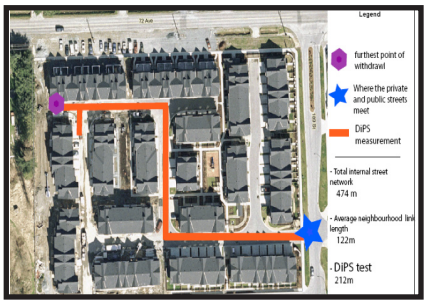
One of the limitations of the connectivity index is its inconsistency small scales

intersecting at right angles four nodes are created and 12 links resulting in a connectivity index of 3.00. When the perfect grid is increased to four streets intersecting four others creating 16 nodes and 40 links, the resulting index value lowers to 2.5. When trying to analyze the internal pattern these townhouse developments create, the connectivity index is not very useful because of the limited number of streets in each development.

DISTANCE TO THE PUBLIC STREET (DiPS test)

While studying the neighbourhood maps, I often found a difference in the street pattern created by the private streets, from the one created by the public streets. I felt the traditional tests did not highlight that relationship as adequately as I would have liked so I created some other measures for this project that looked at the direct relationship between the townhouse developments and the neighbourhoods they inhabit. The DiPS test is a simple test that measures the distance, from the furthest point within a private street, to where that street intersects with the public street system.

The DiPS test highlights the relationship between the private and public space in spatial terms. It is a measure of withdrawal. Through analysis, I compared the DiPS test measurement to the average link length in the larger neighbourhood. Townhouse developments with lower DiPS test readings have less of an impact on the neighbourhood than townhouse developments with higher readings. Subsequently, where the difference between the DiPS test and the average link

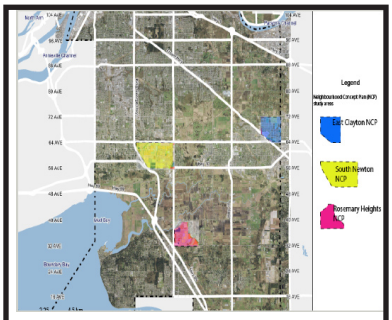


5. The Case Study: Townhouse Developments In Surrey BC

This chapter introduces the planning environment in Surrey, and gives brief histories of each of the study areas. The chapter also describes the results of the connectivity tests as applied to the study areas. I emphasize the relationship between the street pattern created by the townhouse developments and the overall neighbourhood connectivity.

Surrey BC is one of the fastest growing municipalities in Canada. With its continually shrinking availability of land and aggressive development industry, the municipality is looking towards alternative forms of development to meet its growth needs. Where large-lot subdivisions were the norm in the post war years, in the contemporary environment planners are looking to encourage a more compact form of development. Adding to the shortage of land, questions of environmental responsibility continue to take prominence on the planning agenda, further facilitating the shift away from low-density suburban development. When interviewed, a Surrey city council member claimed, "There has been an enormous shift to density in the city recently."

Surrey is located in BC's lower Mainland 30 kilometers from Vancouver.



All three study areas are identified neighbourhood growth centers.

Increasingly, the municipality is looking at townhouse developments to satisfy these density requirements. Over half of all new development in the city is being developed in a multi family form, with a large proportion of that as condominium townhouses. Typically, the townhouse developments consisting of 15 buildings, and close to 80 dwelling units, on 5-acre plots of land, are built on private streets with single entrances. While these developments are usually found within larger master planned communities, their internal street network diverges significantly from the surrounding network.

CONNECTIVITY IN SURREY

Surrey planners are well aware of the benefits of connectivity. In many of its new neighbourhood plans, the city

tries to introduce the grid system to take advantage of the benefits of increased connectivity. A senior planner with the city stated, "Through the neighbourhood planning process we are trying to make sure we have good connectivity." However, by supporting the development of so many townhouse developments on private streets, the city may be undermining its own attempts to increase connectivity. These townhouse projects, developed on private streets, often have only one entrance and have entry features representing a clear separation between private and public space. It is no accident that there is only one entrance. Surrey's CPTED guidelines argue for a clear separation of space to control entry and exit to assist in surveillance. Ewing (1996) reports that the access control method used by Surrey is only one way which CPTED literature proposes to guard space. Ewing (1996, 59) writes, "In the field of crime prevention through environmental design, two distinct perspectives vie for influence. The 'defensible space perspective' emphasizes social control. From this perspective, public streets and streets should be designed to encourage natural surveillance and territorial attitudes; the more people on the street, the better. The 'opportunity perspective 'emphasizes access control. Public streets and spaces should be designed for difficulty of entry and escape; the fewer potential victims and offenders on the street the better." It is clear that Surrey this chosen this latter interpretation with serious implications on the residential neighbourhoods they are developing.

"Through the neighbourhood planning process we are trying to make sure we have good connectivity."

Senior City of Surrey Planner

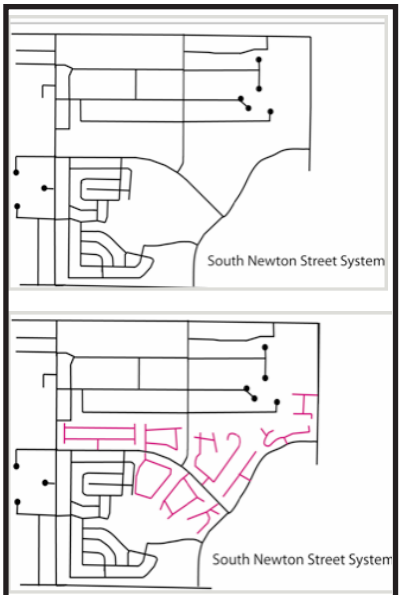
Study Areas

All three of the neighbourhoods chosen for this study were designated to be mixed use urban villages and all are typical of the current trends in development in Surrey, yet they each have unique aspects. The Rosemary Heights area in South Surrey is adjacent to a luxurious golf course community. The South Newton Area was one of the first neighbourhoods designed through the NCP process and had amendments to the original plan to increase its density. In addition, the South Newton area is directly adjacent to an older cul-de-sac development, part of which is in the study area. This contrast allows for interesting connectivity comparisons between the townhouse enclaves and the cul-de-sac developments. Finally, the East Clayton area was developed under new urbanist principles, with the specific goal of creating a sustainable community. One of the principal goals of the East Clayton plan was to create a well-connected street system, and yet large tracts of land were set aside for townhouse development on private streets. The contrast in connectivity within this community is interesting. A more in-depth description of each study area is included in the research findings.

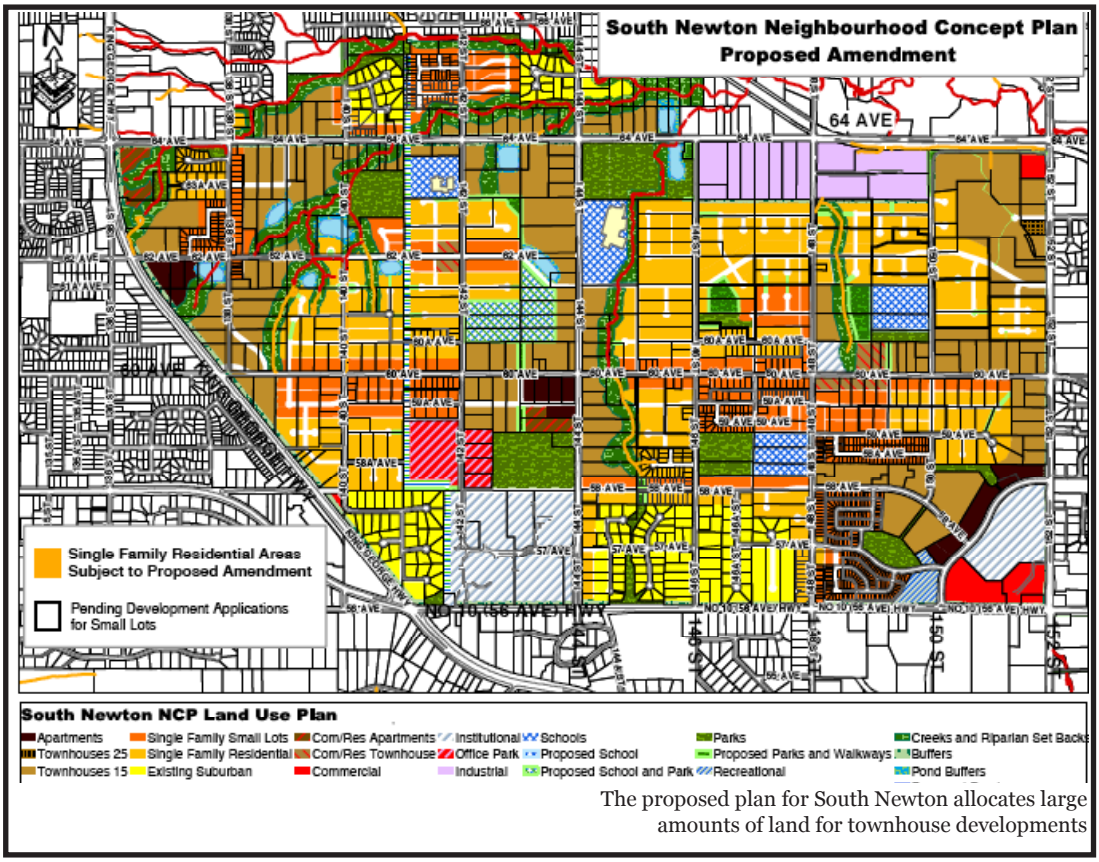
South Newton

Originally zoned in the late 1990s, the South Newton area was one of the first NCP designations planned by the municipality, and has the largest population planned for any NCP. The 1000 acre site in central Surrey had previously been rural land. The

original zoning saw 42% of the land designated to a mixture of single detached densities from 2- 10 upa, 22% multi family, 22% commercial, and the rest was planned as streets and open space, with a total expected population of 18, 000 residents. As build out began the higher density single-detached units developed quickly along with the townhouse multi-family designations. As progress continued, however, there was a shift in the housing market in Surrey, towards higher density. City staff received amendments to the South Newton NCP for higher density zones. It was evident that to satisfy this demand, amendments to the NCP approved in 1999 would need to be made. In 2004, public consultation and staff recommendations led to council passing an amended South Newton NCP lowering the amount of low-density housing.



The addition of the private streets into the street network changes the look of the South Newton street system.



The proposed plan for South Newton allocates large amounts of land for townhouse developments

To date, only a small section of the total South Newton NCP has been developed. Development has mostly occurred within and around the commercial area at the corner of 152nd and Hwy 10, where there is a 'village' style shopping center and a YMCA recreational complex. Building continues to the West. Directly abutting the shopping district is a circumference of townhouse development, with some single detached residences behind them. Another interesting point of interest with this area is its adjacency to an older subdivision, which would in theory benefit from the amenities the new subdivision provides. Having these two neighbourhoods so close, and sharing amenities, gives the opportunity for some direct comparison between a cul-de-sacs heavy subdivision and the neighbourhood concept planned (NCP) neighbourhood with private streets.

• Connectivity test results for South Newton

The tests for the South Newton area are illustrative of how townhouse developments affect neighbourhood connectivity. The neighbourhood is planned to be a walkable mixed-use neighbourhood. The route directness test, however, shows the plan and the reality are vastly different. Of the 14 readings taken within the NCP area, only four points fell below the 1.5 times distance for walking and 2 times the distance for driving minimum measurement. While seven of the 14 points fell within the limit for the walking measurements, four of the seven were on the cusp of acceptability. Because the subdivision does have a central park and is serviced by walking paths, the

walking results, albeit not great, were better than the vehicular results. In the driving categories, within the NCP area, three areas were over the twice the actual distance, three more were very close to the two times the distance mark. In regard to the townhouse developments in the neighbourhood, there did seem to be a correlation between readings that were higher and their adjacency to the townhouse developments.

Where the interesting comparison comes in, is when the readings of the older subdivision is included in the test. The older area of the neighbourhood, with cul-de-sac developments, had four of the twelve points well above the accepted 2 times the distance for vehicular travel, and another three very close to the limit. For the walking distances, many of the readings were, not surprisingly, also above the 1.5 times the distance level, but not much above. Of the twelve points, with two readings done at each point (one going to the bus stop and one going to the shopping center), only three were above the 2 times the distance level. The other twenty-one readings most were just slightly above the 1.5 times the distance level, with only eleven being under the level. The category that the older part of the subdivision scored best in was, not surprisingly, the route directness to the arterial. What these numbers and comparisons suggest, is that while the older subdivision has cul-de-sacs, the townhouse developments of the new area break up the street system in a similar manner.

The connectivity test readings for South Newton area overall are low. The total connectivity index reading, within the NCP area disregarding the private street system, is 1.19. When

the neighbouring cul-de-sac heavy subdivision is added to the equation the number reduces to 1.16. Now, staying within the NCP area and adding the private street system data into the equation the total connectivity ratio is 1.09 a reduction from the already low figure of 1.19 and a lower reading than the same street system with the cul-de-sac subdivision included. These findings suggest that the form the streets are taking within the townhouse developments have a similar, if not worse, impact, on overall neighbourhood connectivity than a development with a cul-de-sac street form.

The block size and intersection spacing test for this neighbourhood show somewhat of a correlation between the presence of townhouses and lowered connectivity. Because of the distribution pattern of the townhouses, with all nine townhouse developments on only three blocks, it is hard to draw any strong conclusions. Nevertheless, the results for the block size and intersection spacing test are as follows. Of the three blocks with townhouse developments on them none were under 7 acres and two were well above 11 acres. Of all the rest of the blocks in the study area, counting 8, only three were above 7 acres. Of the 46 street lengths counted in the study area 11 were greater than 150m, of those: 3 were adjacent to townhouse developments. Of the 14 that were over 200m, 5 were adjacent to a townhouse development. Again this test gave rather inconclusive results as to the effect of the townhouse developments on neighbourhood connectivity.

Finally, the results of the DiPS test echo some of the

preceding tests' conclusions. The tests were administered on both the townhouse developments and for comparisons sake, the test was also administered on the neighbouring cul-de-sac subdivision, treating the cul-de-sac as a private streets. The average DiPS test reading from any given townhouse development is a little over 210 meters, with seven of the nine readings being over 150 meters, and three of the readings over 200 meters. The 210-meter average is almost a whole one-third longer than the average link within the subdivision, which is 133 meters.

Rosemary Heights

Traditionally the area south of 40th avenue and east of the King George Hwy (Hwy 99) was rural. The city used the highway as a border to urban growth and withheld services to the area to enforce the border. However, as development pressure in the early 1990s challenged the traditional notions of 'pattern' in Surrey, the development community looked toward that area as a potential for growth. The city, hesitant to extend municipal services to the area, made some stipulations about the type of development that would go there. The plan was to put in quality development that would increase the profile of the South Surrey area.

The result was the Morgan Creek Golf Course, and surrounding Morgan Creek community, a community of lavish, luxury residences, including two gated communities and a multitude of single detached 'signature' enclaves such as the Magnolia, a development of single detached houses with a large

entry feature delineating its border from the other developments in the subdivision. The areas adjacent to the Morgan Creek area benefited from the development and were opened up for development by the city through the secondary planning process. The area, known as 'Grandview Heights,' included five master planned neighbourhoods, which are in various stages of planning, development, and build-out. Rosemary Heights was one of the first communities to come out of Grandview Heights. The NCP planning process for Rosemary Heights began in 1995. Urban Systems did the public consultation and subsequently the plan for the neighbourhood. The plan called for a mix of uses and housing types. Designers placed a commercial core at the center of the development with a mix of residential types, including clustered single detached housing of various sizes, and townhouse development. 19 hectares of the development, of the 101 hectares proposed for residential growth (Urban Systems, 1995), was proposed for townhouse development, representing over a third of all the dwelling units in the plan. Few stipulations were put on the large lots allocated to the townhouse developments.

A large stone fence annonces your arrival to the Magnolia, subdivision a residential enclave in Morgan Creek

The internal street systems were not planned by Urban Systems as part of the neighbourhood plan. The private streets of the townhouse developments are treated as driveways and are labeled as such in the Urban System report (Urban Systems, 1995, 3-20). Individual developers and builders have subsequently bought the areas allocated to townhouse development and created their own internal street pattern in each development.

This lapse in planning, which allows individual developers to create divergent street system within the allocated areas, has led to a reduction in the overall connectivity of the Rosemary Heights neighbourhood

Connectivity testing in Rosemary Heights

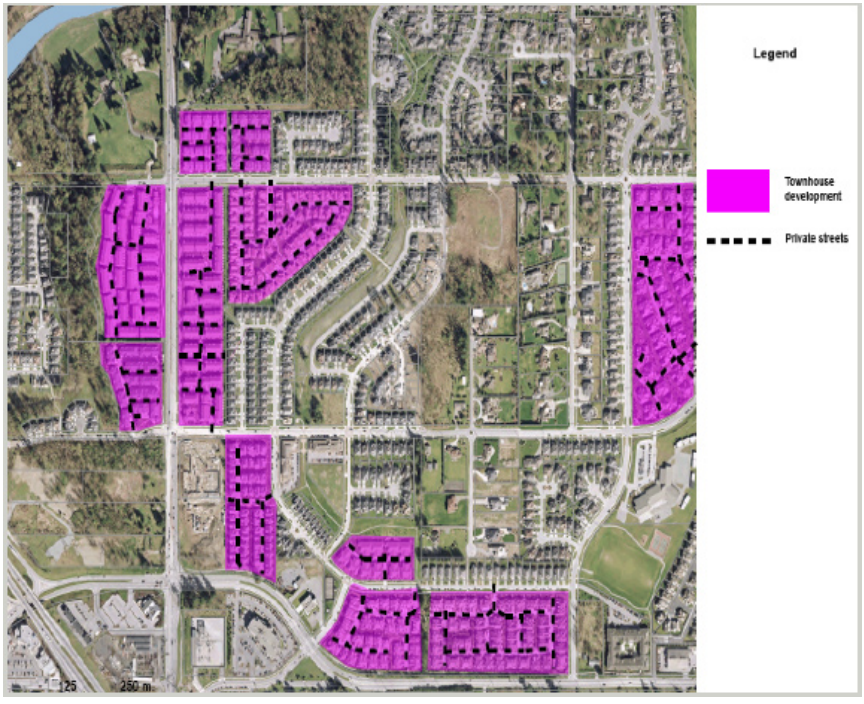
The route directness test for Rosemary Heights provides some evidence of the effect the townhouse developments have on overall neighbourhood connectivity. Of the 26 readings taken, 7 points were above the acceptable level of 1.5 times the actual distance. This is a surprising number given the emphasis on walking trails in the original plan. The interesting thing to note is, the instances where the walking distance was over the 1.5 times the actual distance were not all within the townhouse developments themselves. Three of the seven readings were taken from residential lots on public streets. All three of the points, however, traveled by, or through, a townhouse development. This fact illustrates directly the effect townhouse developments have on the overall connectivity of the neighbourhood. The street pattern created by the townhouse developments disrupts the planned street pattern. The results of the driving route directness are a little more encouraging. The tests were taken from the 26 points to the nearest arterial and local shopping district. Only six of the total measurements were above the 2 times the distance threshold. There were, however, eight other measurements close to the 2 times the distance level.

Individual developers and builders have subsequently bought the areas allocated to townhouse development and created their own internal street pattern in each development.

The connectivity index test for the Rosemary Heights

area shows low levels of overall connectivity within the Rosemary Heights neighbourhood. The connectivity index of the public street network is 1.19, well below what would be considered a well connected neighbourhood. Despite the low levels, however, there is still a noticeable difference in the readings when the private streets are included. When the public and private streets are measured together, the index lowers to 1.08. This 0.11 drop is a testament to the differences in the street pattern between the townhouse developments' private streets and the planned street pattern of the Rosemary Heights neighbourhood.

The block size tests for Rosemary Heights further illustrate the effect townhouse development have on this neighbourhood. For instance, the average link size of a street lining one of the ten-townhouse developments is over 260 meters, well above the level most conventional municipalities would consider proper for good connectivity. Of all of the other linkages, the average



Large areas of land were allocated to townhouse development to raise the density and profitability of the Rosemary Heits project.

length is just over 140 meters, or 120 meters on average shorter than the links surrounding the townhouse developments. When all the linkages are put together the average length rises to a little more than 177 meters, a full thirty meters longer than the average neighbourhood measurement.

For the Rosemary Heights area the block size is significantly larger in those blocks with townhouse developments within. Of the 14 discernible blocks in the study area, six are above 11 acres in size, and of those six, five have at least one townhouse development in it. The other block greater than 11 acres has a park and elementary school in it.

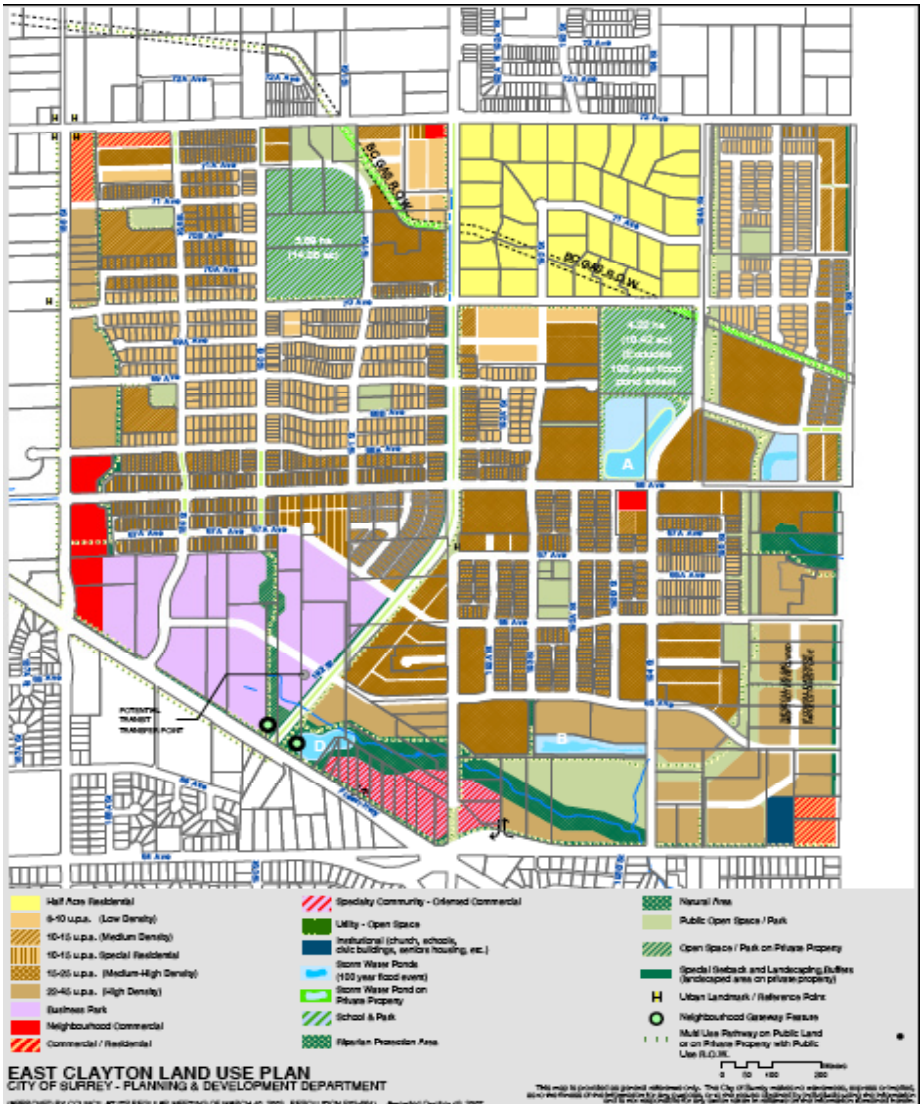
The DiPS test for the Rosemary Heights area shows a wide variety of results. The average DiPS test measurement is almost 300 meters, well above a desirable amount in a neighbourhood with an average link length of 140m. What is interesting about the Rosemary Heights private developments is, with only a few exceptions, they could easily link to the public system without a major change to the internal street configuration. If policy called for greater connection of the townhouse developments to the public street system, serious reductions in DiPS test reading would occur. It has been the desire of the builder to purposely have only one entrance to increase the buildable land and exclusivity, further illustrating the contradictory interests of the developer and residents of the neighbourhood who would benefit from greater connectivity.

East Clayton

East Clayton was designed through a collaboration between Patrick Condon of the University of British Columbia (UBC) and BFW Developments in Langley BC. The East Clayton project started when the development company assembled a large tract of land close to the Langley border. The company pressured the city to make a neighbourhood plan for the area. The municipality was worried about downstream drainage in the area. At the same time, Condon was asking the municipality for a five-acre test area to implement some of the ideas he had been working on for a sustainable community. Condon had certain principles of sustainability he wanted to implement in the area. The principles encouraged densification, a mix of uses, a respect for the natural environment and a well connected street system (Condon, 2003). The municipality, eager to encourage sustainable development facilitated a relationship between Condon and the developer, resulting in a much larger test area than Condon had first imagined. The result is an innovative neighbourhood which has been held up as a model of sustainability (Boei, 2003).

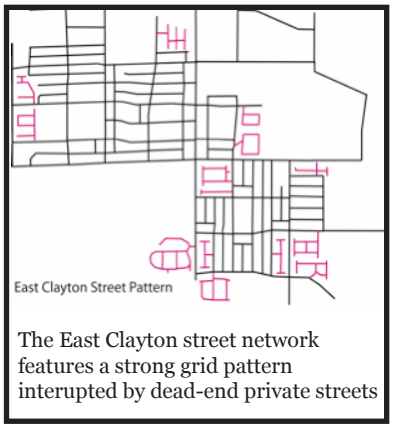
Although several of the principles of sustainability embraced in the design of East Clayton, talk of a well connected street system, the East Clayton NCP designated many acres of the land area to townhouse condominium projects. While the entire area was meticulously planned, the sections set aside for the townhouse developments are vacant of any street design whatsoever and like the example in Rosemary

Heights were set aside for individual builders to build as they like. The zoning (RM 30, RM 45) allows almost any as of right development that fits with the existing architectural design guidelines and density requirements. The result has been a number of developments with internal street networks largely divergent from the master planned network. Instead of following the grid system of the rest of the subdivision, the street systems within the zones designated for townhouse development end up as branching or looping dead ends (see appendix 2: townhouse



development street patterns). These 'lapses' in planning have an observable effect on the connectivity of the immediate areas surrounding the townhouse developments.

Connectivity testing in East Clayton



The East Clayton street network features a strong grid pattern interupted by dead-end private streets

The Connectivity index, or link node ratio, test for East Clayton shows the intention to create a well connected street system was successful. It also shows how the townhouse developments, which represent over a third of the units in the neighbourhood, affect that well intentioned plan. The overall neighbourhood connectivity not considering the tangle of private streets within the townhouse developments, comes out at an impressive 1.48. When the private streets are added into the test the index value drops to 1.25, which is still congruent with a walkable community according to some of the literature, but is surely not an exemplary example of connectivity, especially in a community lauded as a model of good planning.

The Block size tests in East Clayton are telling as well. The study area has 62 blocks total, only 16 of which are over 7 acres in size. Of those 16 blocks, 13 have one or more townhouse developments in them. Two others are zoned suburban with larger lots on them. Another is slated for future development, and may be broken up in time. Of the 15 townhouse developments in the study area, nine are on blocks of 7 acres or less, and four are on blocks larger than 11 acres.

Furthermore, all of the blocks that feature townhouse developments have links over 150m in length. Only three

townhouse developments of the 15 do or could connect to more than one public street decreasing the block size. Of those three, only one actually connects on both sides to vehicular traffic. The other two developments have elected to block off the alternative exits with barricades, which presumably would come down in the case of an emergency. This small number of streets that could connect to the public system testifies to the disruption to the original planned grid street system.

The DiPS test for East Clayton also shows the divergence of the townhouse developments' street pattern from the public street pattern. The average DiPS test measurement is 175 meters, or a full 50m longer than the average link size in the neighbourhood. In fact, only four of the 15 townhouse developments measured less than 150 meters to a public roadway. In addition, four of the measurements scored well over 200m. If, however, all of the townhouse developments in the study area that were able to connect to a second street, or have a functional second opening the number of developments that scored over 200 meters would be reduced from four to zero. Of those seven developments which scored between 150 and 200 meters, over half would be reduced to below the 150 meter length.

Of the 15 townhouse developments in the study area, nine are on blocks of 7 acres or less, and four are on blocks larger than 11 acres.

The route directness test for East Clayton echoes the previous tests' results, and further shows the negative impact of allowing private enclaves in a neighbourhood specifically designed to build community and have good connectivity. All of the readings taken on the public streets rated below the 1.5

route directness ratio threshold for walking and only one result was above the acceptable limit for driving. Of the readings taken within the townhouse development 6 scores were above the acceptable level for walking and 2 were above for driving. While the outlying areas of the neighbourhood were not specifically affected by the presence of the townhouse developments, those residents within the developments experienced lower readings. These findings are significant given research showing that people living in private communities are already more predisposed to drive than others those who live on public streets (Burke & Sebaly 2001).

People who live in private communities are more predisposed to drive than residents living in similar public neighbourhoods.

Burke & Sebaly

6. CONCLUSION

Connectivity is an important concept in neighbourhood design. This study has shown that the townhouse developments in Surrey are having a negative impact on connectivity in the neighbourhoods they inhabit, and has suggested some reasons for that. The townhouse developments on private streets increase the grain size of the neighbourhood, reduce the amount of route choice, lower the connectivity index reading, and allow residents to retreat into private enclaves. This should be of concern to planners. When designers do not consider the private streets as a genuine part of the neighbourhood street network, good intentions can be significantly undermined. As the trend in planning has switched from an automobile focused paradigm to a more balanced transportation focus, planners must look at concepts such as connectivity with greater vigor.

Evidently, Surrey planners see connectivity as an important concept. However, allocating large areas of land within planned public neighbourhoods for private development leads

invariably to reductions in overall connectivity. The motive of individual developers is to make as much profit as possible on each project. To make profit, the builder must sell as many units as possible, and to do so needs to build as many units as possible. When I interviewed a builder in Surrey, it was clear that the profit motive, and getting as many units within each site as possible, was more important than any other concern. He told me, "If you start to make it cuter and fancier, you end up dropping units. Then the numbers don't look as good. It is like a balancing act because we want to make the site attractive because we want to sell it." This profit motive and the objectives of the planner usually differ. More connections to the public street system reduces the amount of land that could be used for additional units and removes some of the exclusivity and privacy of the development, perhaps lowering the value. Planners though, must transcend this dilemma and have faith in investors that can create residential environments that benefit the public good at the same time as being financially viable.

The townhouse developments on private streets increase the grain size of the neighbourhood, reduce the amount of route choice, lower the connectivity index reading, and allow residents to retreat into private enclaves.

As other municipalities look to Surrey's neighbourhood concept planning process, and the East Clayton development, as models of suburban growth, this research should provide some caution. On the one hand, Surrey recognizes the need for building in sustainable ways, with an emphasis on good connectivity and is willing to look toward current planning theory to work toward those goals. On the other hand, though, much of the planning and building of the road network is designed and constructed through private interest, even in

the heart of many public neighbourhoods and communities. To address this discongruity Surrey and other municipalities must set specific connectivity objectives and congruent bylaws which will ensure that all aspects of the street system within public neighbourhoods are built in a way which leads towards common goals. Connectivity objectives are easy to set, can be clearly interpreted and enforced, and have immediate impacts on new residential areas. To be effective, however, if municipalities choose to allow private streets they must also be subject to the connectivity requirements. This report has shown the negative influence not considering private streets can have on neighbourhood connectivity.

7. BIBLIOGRAPHY

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APPENDIX 1: SOUTH NEWTON RESULTS

Test Results **SOUTH NEWTON**	Effect of townhouse development on neighbourhood connectivity
Overall Neighbourhood Connectivity	Poor
Route directness test	Negative effect
Connectivity test (link node ratio)	Negative effect
Link length test	Inconclusive*
Block size test	Inconclusive*
DiPS test	Negative effect

* The results were deemed inconclusive because while the results were well below acceptablility, it is not possible to attribute the poor results to the the presence of the townhouse developments, as opposed to just the overall neighbourhood design.

APPENDIX 2: ROSEMARY HEIGHTS RESULTS

ROSEMARY HEIGHTS	development on neighbourhood connectivity
Overall neighbourhood connectivity	Moderate
Route directness test	Negative effect
Connectivity test (link node ratio)	Negative effect
Link length test	Inconclusive*
Block size test	Inconclusive*
DiPS test	Negative effect

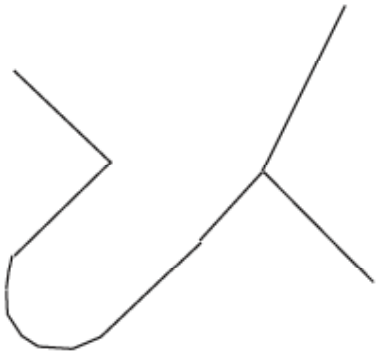
* The results were deemed inconclusive because while the results were well below acceptablility, it is not possible to attribute the poor results to the the presence of the townhouse developments, as opposed to just the overall neighbourhood design.

APPENDIX 4: EAST CLAYTON RESULTS

TEST **East Clayton**	Effect of the townhouse development on neighbourhood connectivity
Overall neighbourhood connectivity	Good
Route directness test	Negative effect
Connectivity test (link node ratio)	Negative effect
Link length test	Negative effect
Block size test	Negative effect
DiPS test	Negative effect

APPENDIX 5: PRIVATE STREET TYPOGRAPHY

Townhouse development street pattern



Development name: Forest Gate

Study area: South Newton

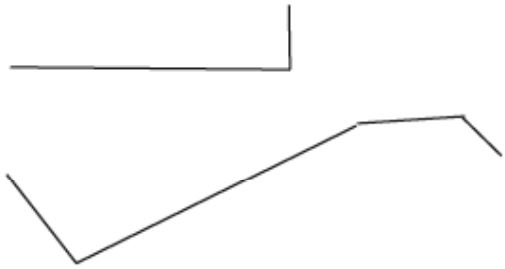
Pattern type: Two-branch looping dead end

total length: 240m

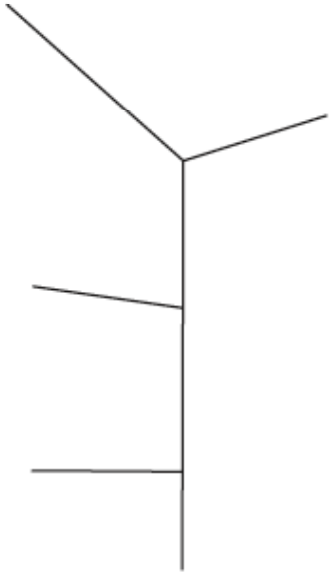
DiPS test:

Connectability: n/a

Surrounding street pattern



Townhouse development street pattern



Development name: Ferngrove

Study area: Rosemary Heights

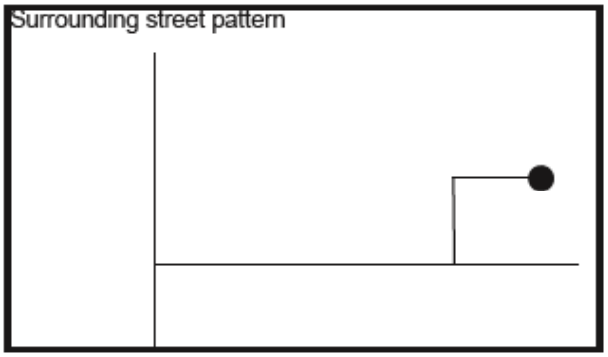
Pattern type: Four-branch dead end

total length: 198m

DiPS test: 108m

Connectability: possible

Surrounding street pattern



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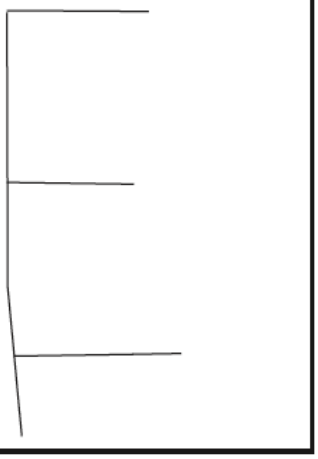
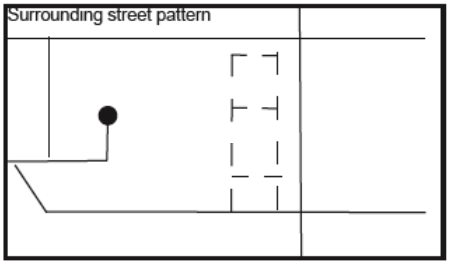


Development name: Sereno
Study area: Rosemary Heights
Pattern type: Three-branch dead end
total length: 322m
DiPS test: 244m
Connectability: not possible

Surrounding street pattern



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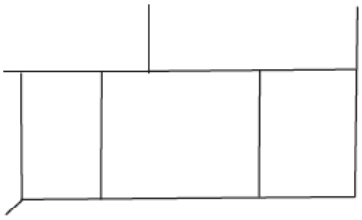
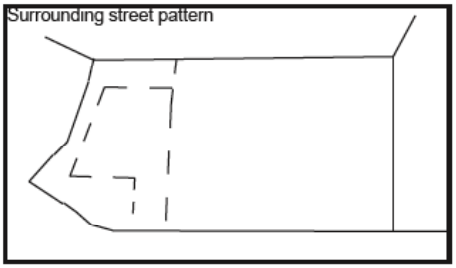


Development name: Carrington
Study area: Rosemary Heights
Pattern type: One- branch three-block dead end
total length: 849m
DiPS test: 263m
Connectability: possible

Surrounding street pattern



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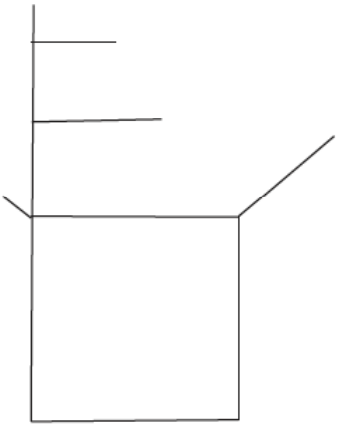
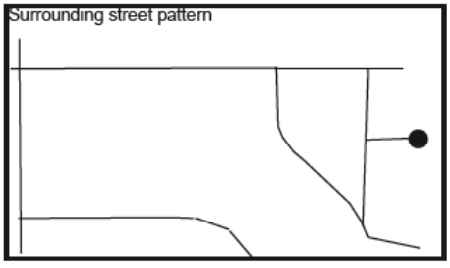
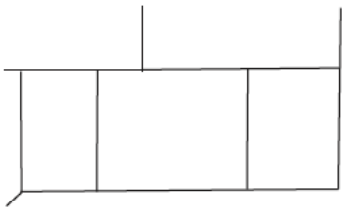


Development name: Rockwell
Study area: Rosemary Hights
Pattern type: Three-branch one-block dead end
total length: 552m
DiPS test: 210m
Connectability: possible

Surrounding street pattern

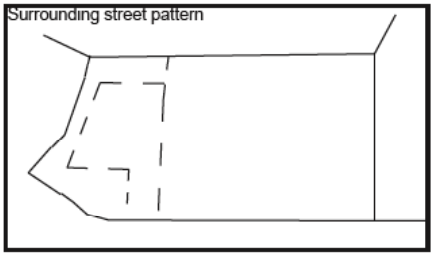


Townhouse development street pattern



Development name: Carrington
Study area: Rosemary Heights
Pattern type: One- branch three-block dead end
total length: 849m
DiPS test: 263m
Connectability: possible

Surrounding street pattern



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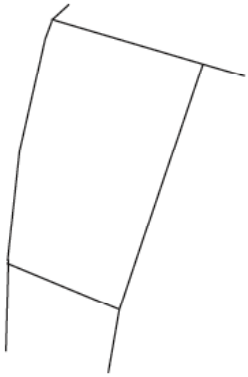
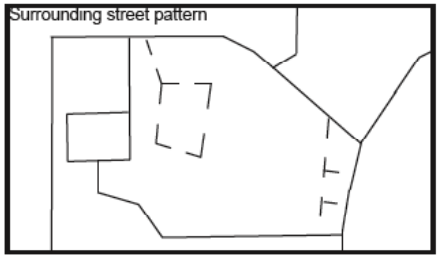


Development name: Highbrae
Study area: South Newton
Pattern type: Three-branch one block dead end
total length: 368m
DiPS test:
Connectability: not possible

Surrounding street pattern



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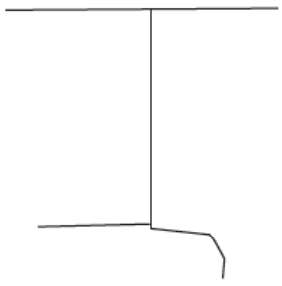

Development name: Unnamed I
Study area: South Newton
Pattern type: Three-branch dead end
total length: 178m
DiPS test:
Connectability: not possible

Surrounding street pattern