Appendix II

WEST CLAYTON

Neighbourhood Concept Plan

NCP

JULY 2015

CITY OF SURREY

West Clayton
Neighbourhood Concept Plan

Planning and Development &
Engineering Departments

City of Surrey
13450 104 Avenue
Surrey, British Columbia V3T 1V8

Approved by Council July 2015

CITY OF SURREY

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PART A

Planning, Land Use and Transportation

SECTION 1

Planning Background & Context

SECTION 1 - PLANNING BACKGROUND & CONTEXT

1.1 PLAN AREA

The West Clayton Neighbourhood Concept Plan (NCP) area lies predominantly to the west of 188 Street, north of Fraser Highway, east of the Agricultural Land Reserve (ALR) boundary and south of 80 Avenue. A small part of the Plan Area, comprising a narrow finger of land, also extends east of 188 Street between the north edge of the pre-existing East Clayton North NCP area and 74 Avenue. The West Clayton NCP area contains approximately 266 properties comprises a total of approximately 289 hectares (715 acres) as identified in *Figure 1.1.*

1.1.1 Plan Area Boundaries

During the initial planning stage for the West Clayton NCP Area, the Plan was divided into two distinct Areas – NCP Area #1 and NCP Area #2; with 76 Avenue as the dividing line between these two areas.

The reason for this division was that a preliminary review of the major infrastructure work required to support urban development in the Plan Area had revealed that there was a significant distinction between the extents of the infrastructure works that would be required for the area to the south of 76 Avenue versus the area to the north of 76 Avenue. This initial review showed that the development of the area on the north side of 76 Avenue would likely exceed the existing capacity of the North Cloverdale Pumping and Gravity System, possibly requiring more extensive upgrades of the pumping and gravity systems and, therefore, the development of that area could be delayed until the remaining Clayton area was ready for urban development to share the cost of the more extensive works. As a result, it was thought that Stage 2 of the NCP for each of the two areas would proceed at a different pace. However, a more detailed servicing analysis conducted in Stage 1 showed that significant upgrade works, possibly including the construction of a new pump station, will be required for the entire Plan Area. Therefore, the decision was made to remove the boundary between the two separate NCP areas, and proceed with the preparation of Stage 2 of the entire Plan Area as a single NCP Area as identified in Figure 1.1.

Following the above noted boundary creation process, Surrey City Council also included the West Clayton Extension area. This extension area is located north of the East Clayton North NCP and South of 74 Avenue. This amendment to the plan boundary is discussed in more detail in Section 1.2.

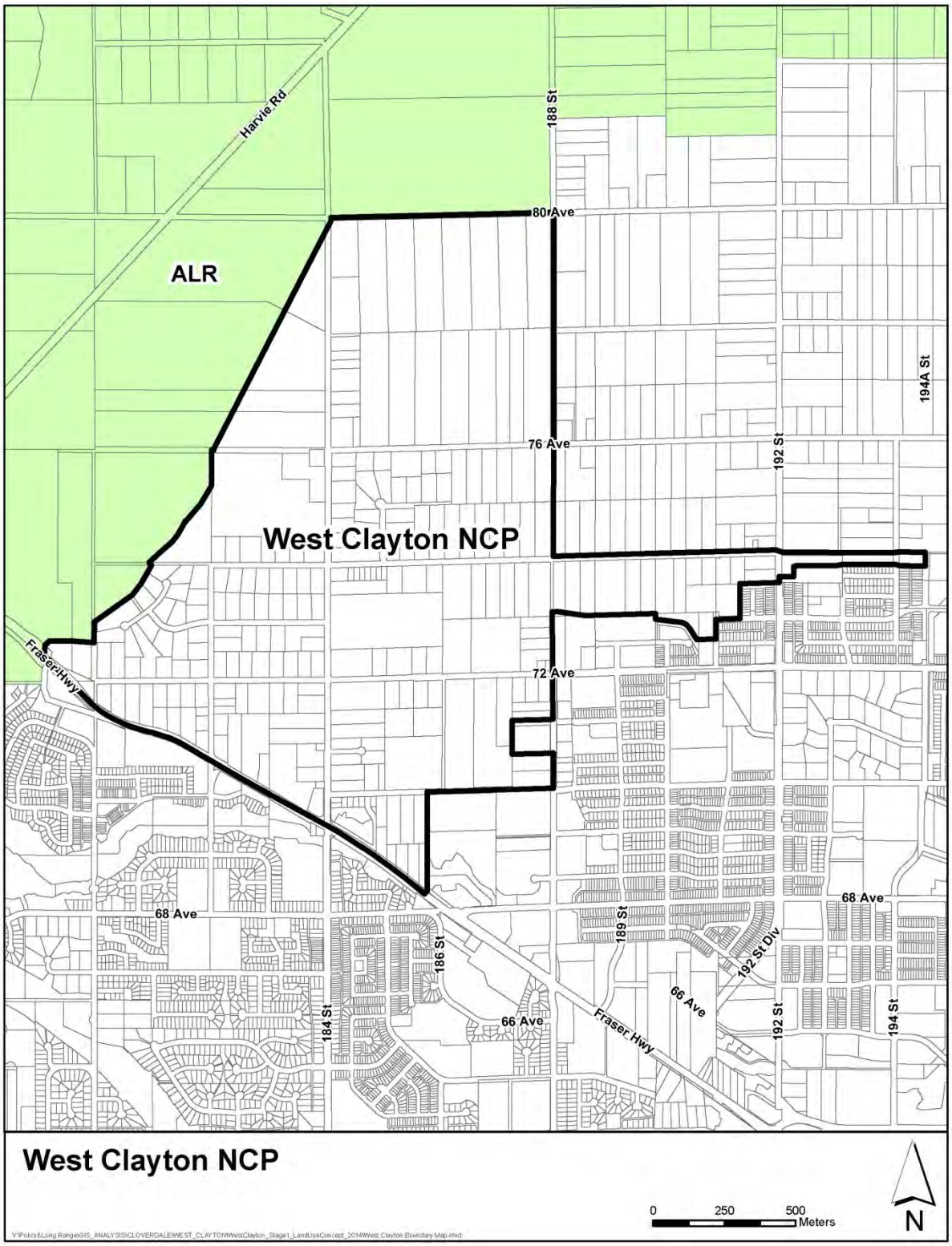


Figure 1.1 - West Clayton NCP Area Boundaries

1.1.2 Claytons Historic Context

Clayton was originally occupied in pre-contact time by the Katzie and Semiahmoo First Nations people, and historically included the neighbourhoods of West Clayton and East Clayton.

In the early 1880s, the Americans and English began to settle the area, making Clayton one of the oldest communities in Surrey. Clayton, formally known as Serpentine Flats and Clover Valley, was named after the Ohio home town of the first Postmaster John George in 1889. The first commercial logging was undertaken by the Royal City Mills in 1864. By 1919, Clayton had its own lumber mill (the Clayton Lumber Mill). Settlement grew as logging and other industries developed in the area. As the logs were depleted, agriculture became an increasingly important and ultimately the predominant industry. The economy of West Clayton was comprised of home-based agriculture, including raising chickens, bee keeping, ranching, and milling.

Adjacent Old Yale Road was one of the most important and historic trails through Surrey, connecting Clayton with the markets in New Westminster. Over the twentieth century, the community continued to grow as West Clayton's position as a transportation hub was established. Overtime, Clayton has remained primarily an agricultural area.

Claytons Agricultural Past

West Clayton's historically pastoral character is reflected in the many small buildings on large properties, supplemented by barns, garages, stables, silos and other agricultural structures. Many sites have mature trees, plantings, fields, and agricultural lands.

The evaluation of the area identified many houses, farm buildings, and natural features. Many of the built resources are modest in comparison to other parts of Surrey due to the rural character of the West Clayton area. As the area was historically primarily agricultural, the setting of the buildings is as important as the built heritage in understanding the growth and development of the area.

1.1.3 Current and Existing Uses

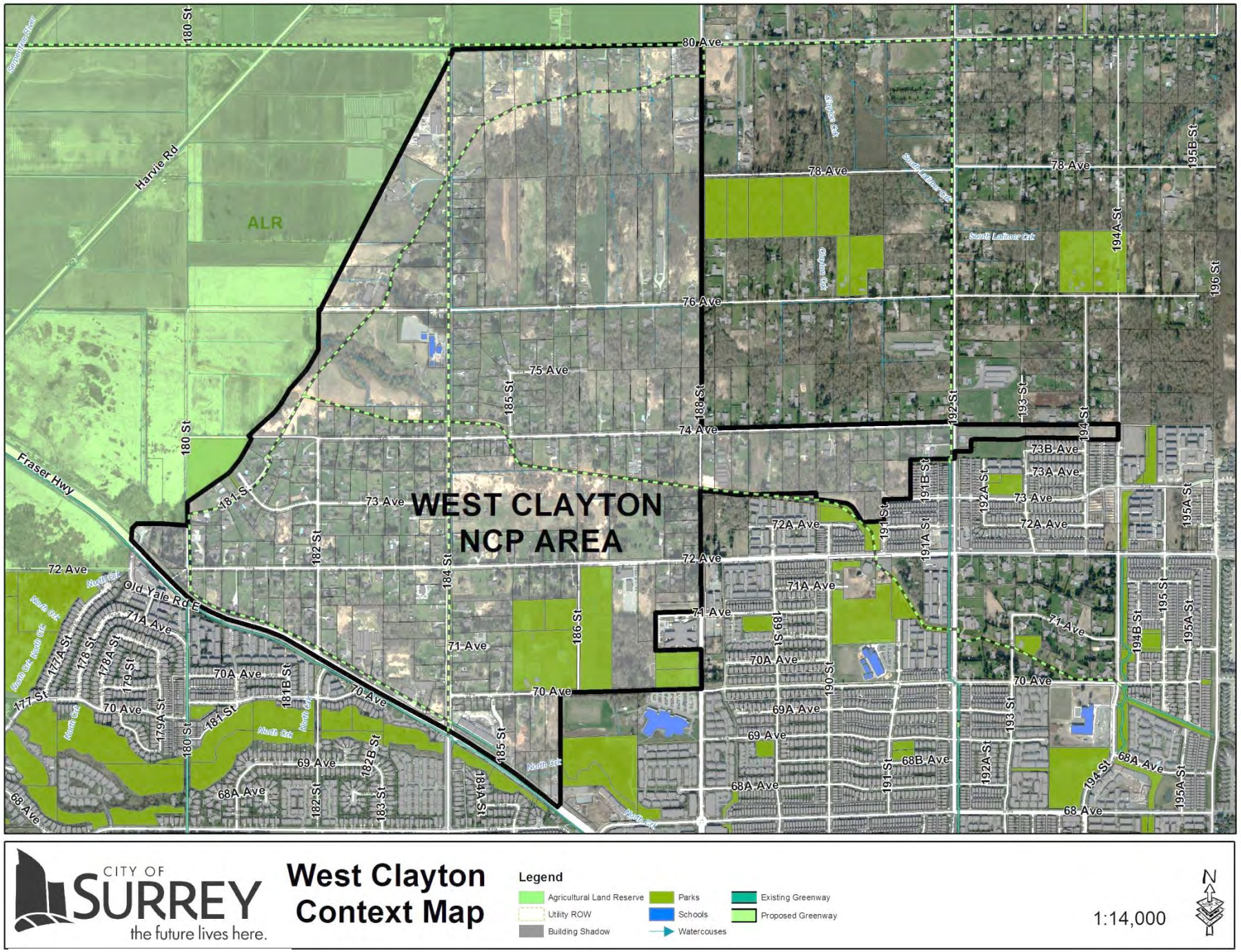
The West Clayton Plan area is generally characterized by its rural and semi-rural ambiance and contains larger lots ranging from one acre to about 10 acres in area; the majority zoned RA (One-Acre Residential Zone) south of 76 Avenue and are used primarily for residential acreage homes or hobby farming purposes as generally shown in Figure 1.2. The portion of the West Clayton Plan Area to the north of 76 Avenue is zoned A-1 (General Agriculture Zone) except for one lot, which is zoned A-2 (Intensive Agriculture Zone). Several commercial farm operations exist in this area, including poultry and beef operations and along the westerly edge of the NCP are several large agricultural parcels, straddle the NCP edge. Parts of these parcels lying within the NCP area typically contain barns and farmhouses and the remaining parts of the parcels, which are within the ALR outside of the NCP area, contain agricultural fields.

Several suburban enclaves within the NCP area contain estate homes on well-maintained one-acre lots, most notably an area to the north-west of 72 Avenue and 182 Street. This area is relatively isolated from the rest of the West Clayton area and provides good views of the adjacent farmland and distant views to the northwest.

Several City Parks and School sites are currently located in the plan area. Clayton City Park is located to the east of 184 Street on the north side of 70 Avenue. The City also owns three parcels of land to the east of the Clayton Park. The parcel adjacent to the park on the south side of 72 Avenue contains the

Hazelgrove Elementary School Annex that was leased to the Surrey School District on an interim basis while a new elementary school (Katzie Elementary) was constructed in East Clayton.

The other two City parcels fronting 188 Street are currently used for an off-leash dog park. Also, adjacent to the westerly NCP edge and south of 74 Avenue, the City owns a parcel designated as park. It is located within the ALR and is currently undeveloped. Clayton Elementary School is currently located southwest of 76 Avenue and 184 Street.



CITY OF SURREY
the future lives here.

West Clayton Context Map

Legend
- Agricultural Land Reserve
- Utility ROW
- Building Shadow
- Parks
- Schools
- Watercouses
- Existing Greenway
- Proposed Greenway

1:14,000

N

Figure 1.2 - West Clayton Context Map

1.2 PLAN INITIATION BACKGROUND

METRO VANCOUVER REGIONAL GROWTH STRATEGY

The West Clayton Area is designated as a *'future growth area'* within the Metro Vancouver Regional Growth Strategy. The West Clayton area is allocated to receive nearly 9% of Surrey's residential unit growth and over 5% of the population growth as part of the Region's Plan by 2041.

SURREY'S OFFICIAL COMMUNITY PLAN

The West Clayton NCP area is designated *'Suburban-Urban Reserve'* in the City of Surrey's Official Community Plan (OCP) as illustrated in Figure 1.2. Land within this designation is intended to support the retention of Suburban land uses in areas where future urban development is expected and is subject to City Council initiation and approval of a Neighbourhood Concept Plan.

CLAYTON GENERAL LAND USE PLAN

In 1999, Surrey City Council approved the Clayton General Land Use Plan (GLUP). It provided a conceptual reference for the exploration of detailed land use concepts for future neighbourhoods of Clayton and, as such, illustrated, in broad terms, the general land use pattern, including residential, commercial, work place, institutional and other land uses at densities appropriate to meet the overall objectives of the City. It also illustrates general locations of parks, schools, major greenways, the community structure, and sets out a general approach to providing engineering services to the area.

April 12, 2010

COR R080 - Council instruct staff to conduct a survey of the owners of the properties within and around the West Clayton area, to determine the level of support for the preparation of a NCP and directs staff to provide a report to Council on the survey results.

July 26, 2010

COR R180 - Council authorizes preparation of a Terms of Reference (TOR) to prepare an NCP for West Clayton Neighbourhood #1 and West Clayton Neighbourhood #2 lands.

February 28, 2011

COR R033 - Council authorizes staff to proceed with the preparation of West Clayton Neighbourhood #1 and West Clayton Neighbourhood #2 based on West Clayton NCP Terms of Reference.

June 25, 2012

COR R145 – Council authorizes staff to proceed with an NCP planning process for the West Clayton Extension area, in accordance with the Terms of Reference that have been previously approved for the development of NCPs in the West Clayton area.

December 16, 2013

COR R254 - Council approves the Stage 1 Land Use Concept for the West Clayton (Area #1 and Area #2) Neighbourhood Concept Plan ("NCP") and authorizes staff to undertake the Stage 2 component of the NCP planning process for the West Clayton NCP on the basis of the Stage 1 Land Use Concept.

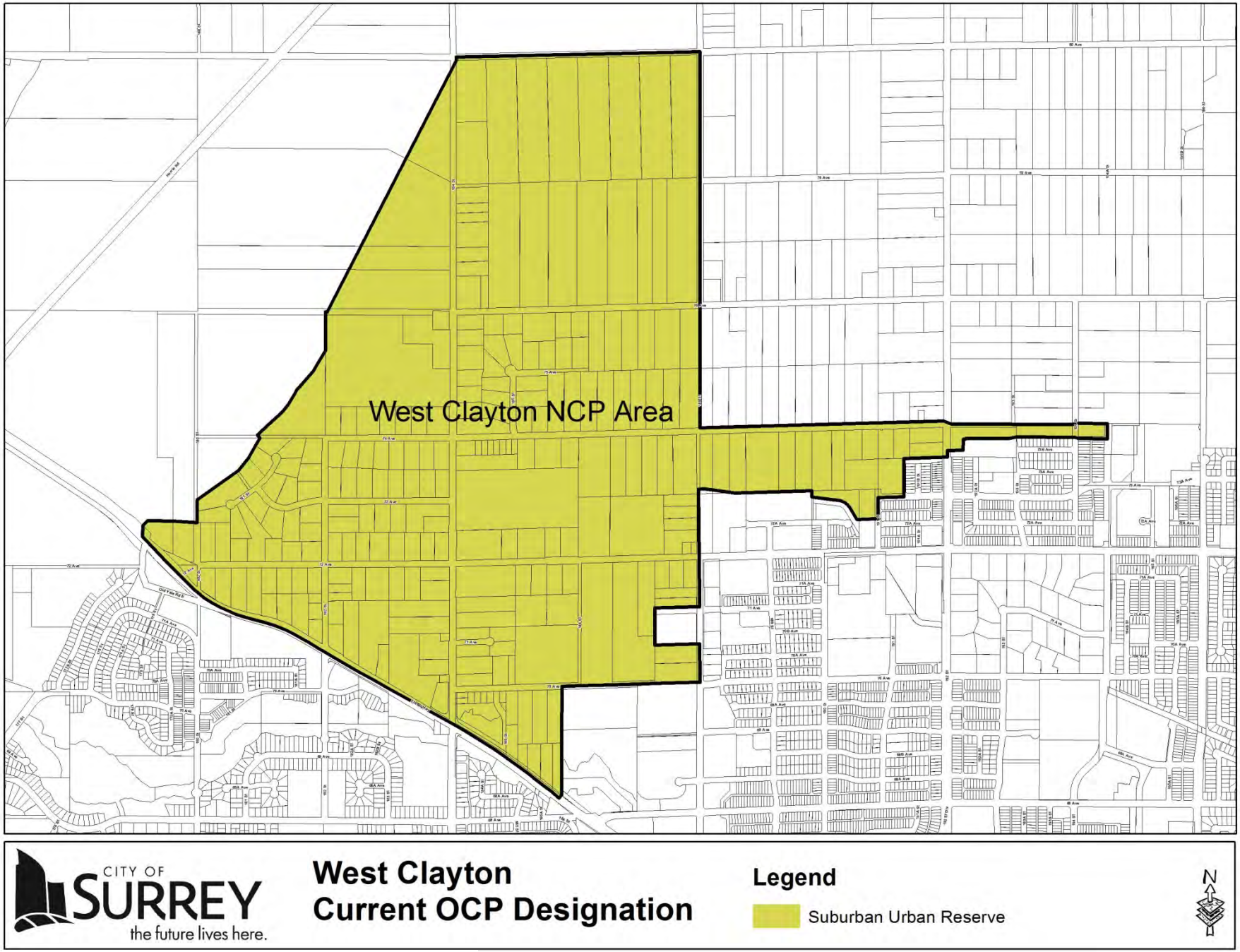


Figure 1.3- West Claytons Official Community Plan Designation

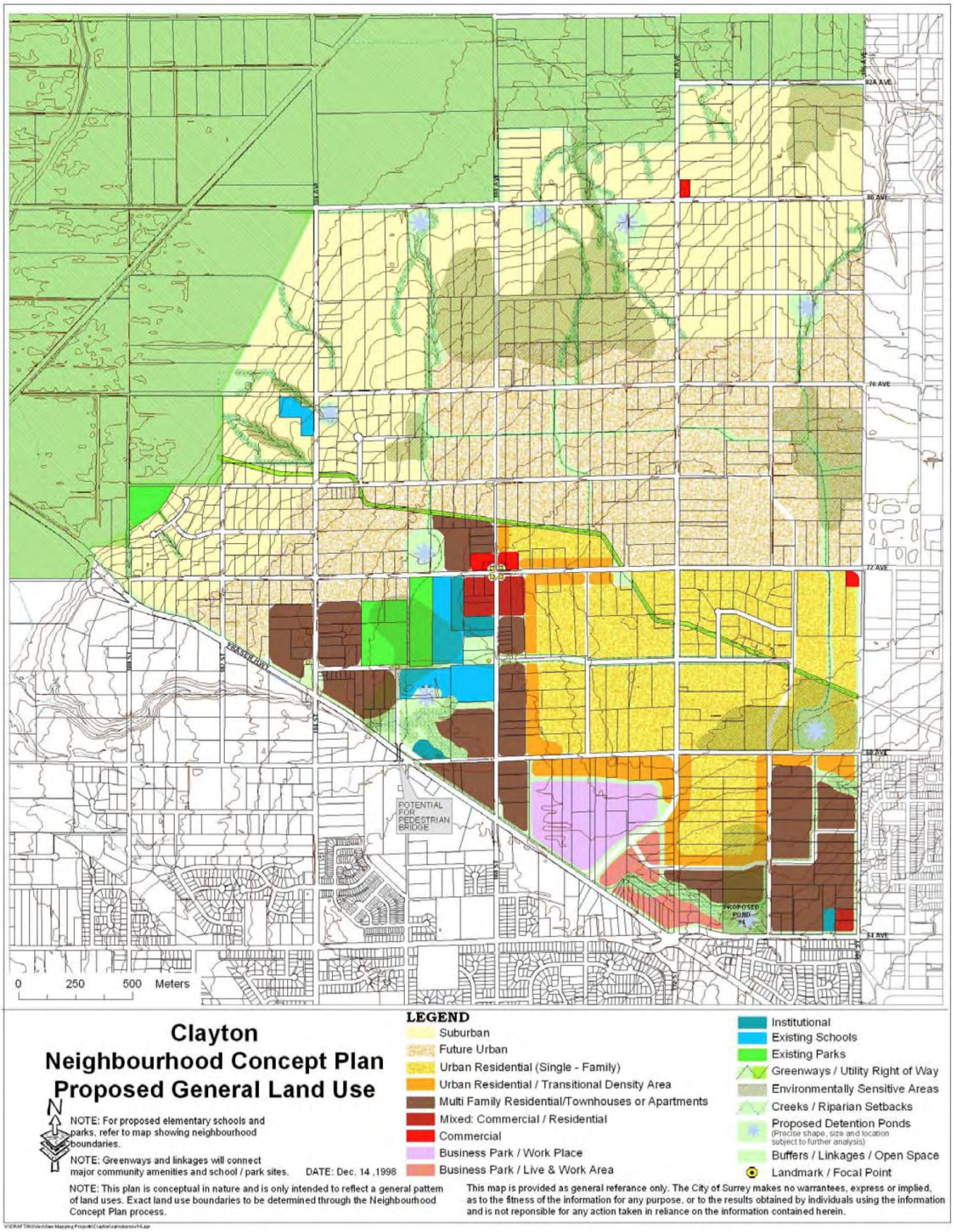


Figure 1.4 - Clayton General Land Use Plan 1999

1.3 COMMUNITY PLANNING FRAMEWORK

Community planning and development in Surrey is conducted and administered within a series of plans, policies and by-laws. These include the Metro Vancouver Regional Growth Strategy, Surrey Official Community Plan, Secondary and Neighbourhood Concept Plans, the Zoning By-law, as well as several other city bylaws and Provincial regulations.

Within the hierarchy of Plans, the Official Community Plan must conform to the Metro Vancouver Regional Growth Strategy while all the other Plans and By-Laws must conform to the Official Community Plan. Like the Regional Growth Strategy and the Official Community Plan, all other Plans within the hierarchy generally address the physical, social and economic aspects of the area for which they are prepared.

1.3.1 Land Use Planning Framework

1. Regional Growth Strategy
This Planning Strategy establishes the general nature of future development in the Region of Metro Vancouver and forms the framework within which Regional Growth boundaries and Official Community Plans are to be prepared. In this respect, the City of Surrey Official Community Plan functions as a link between the broad concepts of the Regional Plan and local conditions and municipal objectives in the City of Surrey.

2. The Official Community Plan (Bylaw)
The Surrey Official Plan provides general policies and guidelines for development and the provision of community services in the entire City and forms the basis for Secondary and Neighbourhood Plan formulation.

3. General Land Use Plans (GLUPs)
General Land Use Plans provide an overall planning framework in designated future urban growth areas of the city that will act as a guide for the preparation of future Neighbourhood Concept Plans.

4. Neighbourhood Concept Plans (NCPs)
NCPs, once completed, plan for the servicing, development, and ultimate build-out of neighbourhoods within a GLUP area. They are prepared because the general policies directing city-wide growth and development are rarely detailed enough to address the specific issues in an individual community or neighbourhood. Once adopted by Council, these Plans inform the OCP and are integrated into the OCP by formal amendments as development (which is consistent with the NCPs) is approved.

5. Zoning By-law
The City of Surrey Zoning By-law sets out detailed regulations for land use and development. Zoning is to be consistent with the objectives and policies of the OCP, and Neighbourhood Plans. The purpose of the Zoning By-law is to implement the policies of the various plans and provide standards for individual developments within the broad planning context.

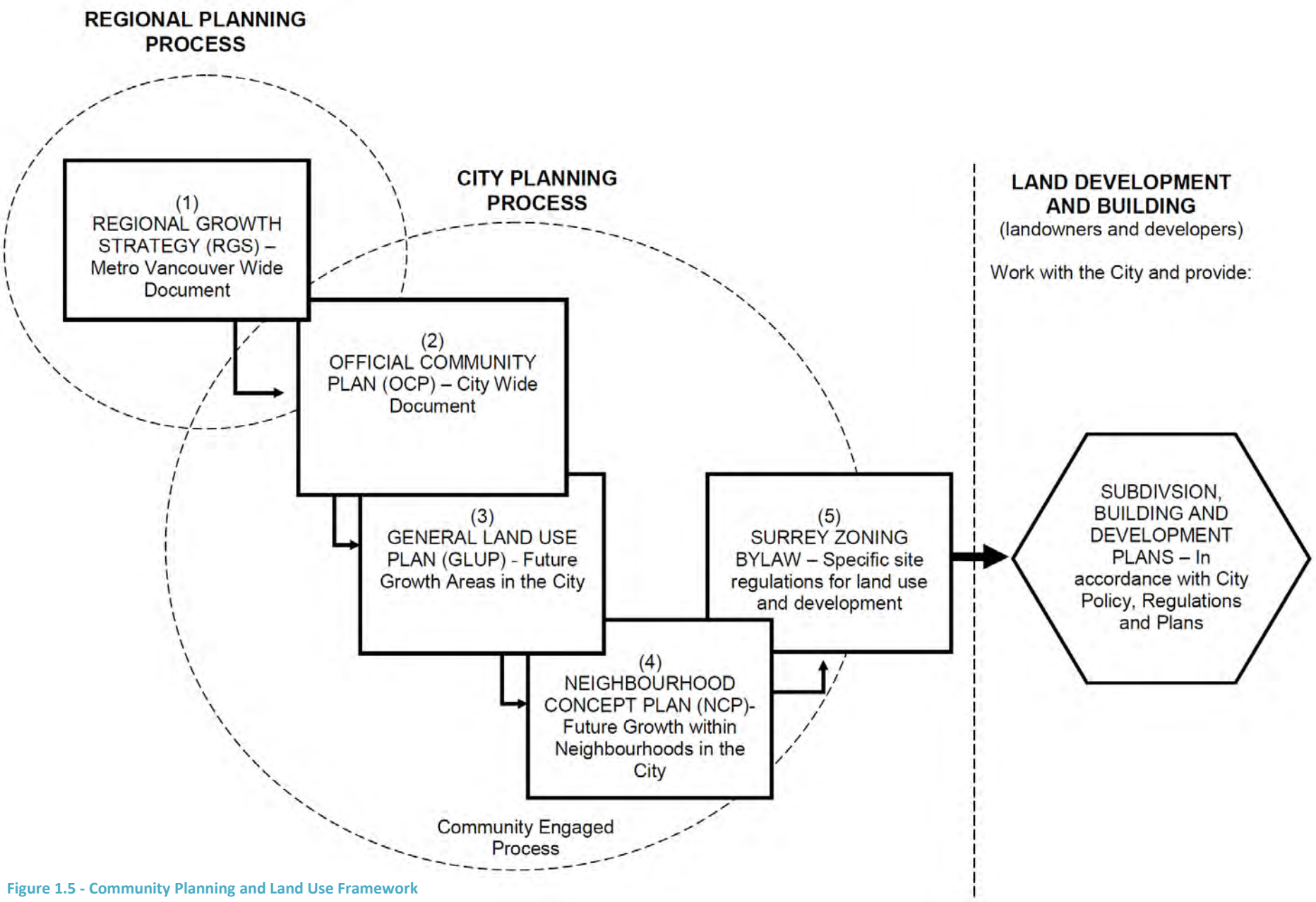


Figure 1.5 - Community Planning and Land Use Framework

1.4 OPPORTUNITIES & CHALLENGES

The West Clayton NCP addresses a number of opportunities and challenges inherent in the development of the Plan area to urban density, including transportation issues, high cost of servicing, agricultural land interface, and green space management.

1.4.1 Opportunities

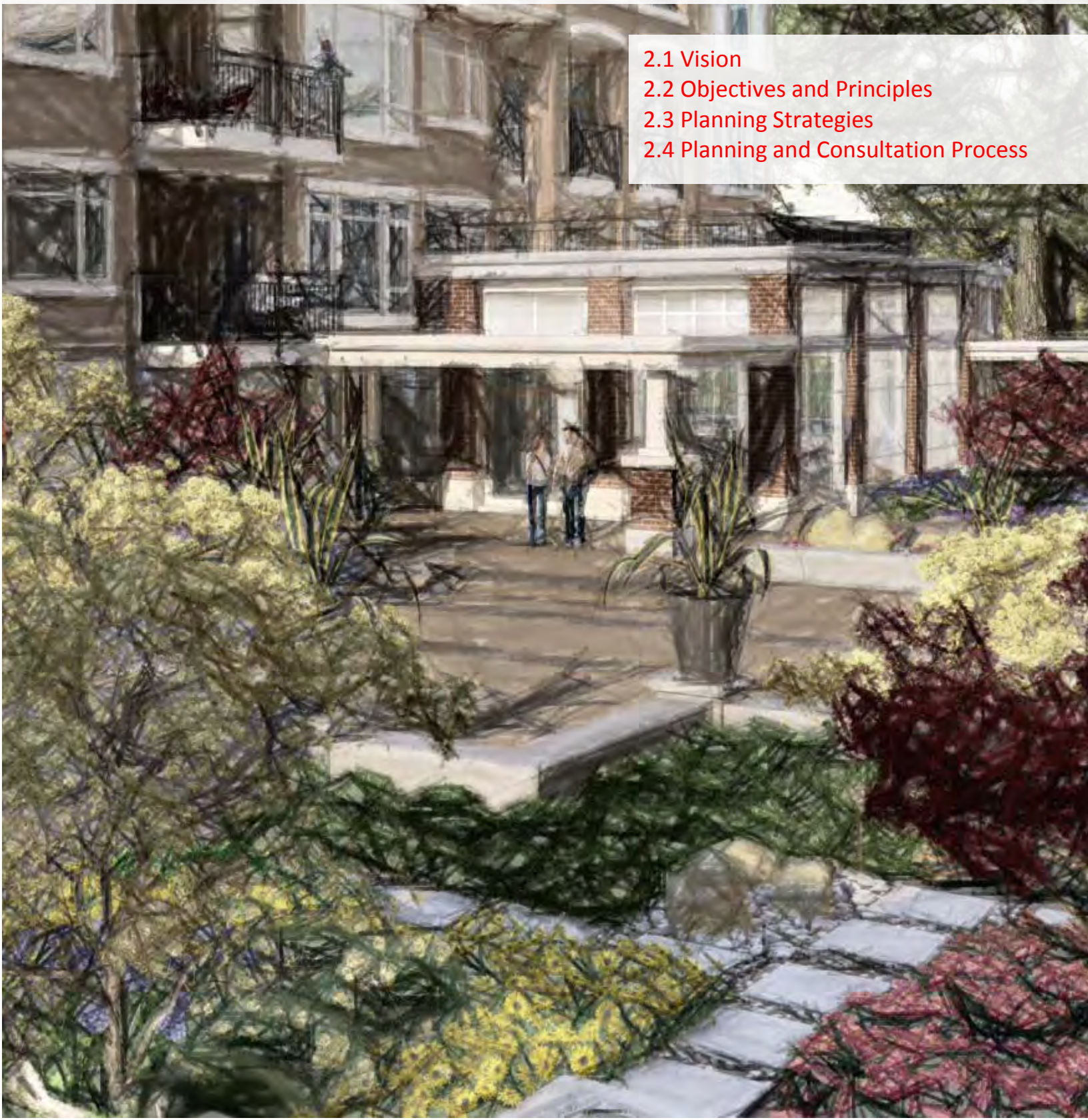
- To plan for the development of West Clayton as compact, walkable, transit-supportive urban neighbourhoods based on sustainable planning principles;
- To complete and reinforce "village centre" for Clayton at 188 Street and 72 Avenue envisioned in Clayton General Land Use Plan;
- To improve and construct 72 Avenue to arterial road standard, through Clayton, and provide a safe connection to Fraser Highway that would accommodate the projected east-west traffic demand;
- To support the future rapid transit along Fraser Highway by providing for medium to high residential density developments within walking distance of the transit service;
- To create a vibrant pedestrian-friendly mixed use neighbourhood centre at the future rapid transit station location on Fraser Highway at 184 Street;
- To protect and preserve the fish habitats and forest hubs and to provide for and enhance the wildlife connectivity;
- To protect the water quality and low-lying farmland from flooding by incorporating best management practices for stormwater as recommended by the Clayton ISMP report;
- To provide appropriate buffer and land use transition to the farmland in the ALR;
- To enhance public access and enjoyment of the view opportunities over and beyond the farmland;
- To enhance opportunities for outdoor recreation and accommodate the need for an indoor recreation amenity;
- To reduce the Greenhouse Gas emissions by offering bonus density commensurate with the level of energy efficiency in buildings, incorporating a district energy system as alternative source of energy for heating & cooling and by promoting the use of electric vehicles to reduce dependence on fossil fuel for driving;
- To create a sense of place and identity through urban design, place-making and by incorporating the history and heritage of the area through such means as protection, integration, commemoration and interpretation.

1.4.2 Challenges

- Construction of 72 Avenue to full arterial road standard while ensuring the impact is mitigated on the existing suburban enclave of well-maintained one-acre lots in the relatively isolated pocket of land to the north-west of 72 Avenue and 182 Street;
- Special Land use planning and road layouts in the areas constrained by a number of Class "A" and Class "B" watercourses;
- Land use planning and density transition and preservation of the existing landscape and hillside views cape adjacent to the ALR lands;
- Achieving fine-grid road layout in the area near the Fraser Highway given the land configuration and ensuring consideration and provision for appropriate noise and visual buffer from traffic and rapid transit in the future;
- Ensuring a network of connected Green Infrastructure by preserving large core habitat areas, ensuring connectivity between habitat areas and providing a diversity of habitat features consistent with the Surrey Biodiversity Conservation Strategy Green Infrastructure Network (GIN) plan.
- Achieving the "village centre" that is pedestrian-friendly and inviting, given the location on 72 Avenue, a 4-lane arterial road and 188 Street – a major collector;
- Achieving a "Transit Commercial Node" near the future Rapid Transit Stop along Fraser Highway that is pedestrian-friendly and inviting, given the location of 184 Street – a major arterial, and Fraser Highway a - major regional arterial.
- Implementing the bonus density incentive for energy efficiency and district energy system;
- Protecting and achieving appropriate integration of the historic and heritage assets identified by the Heritage Study.

SECTION 2

Planning Vision, Principles and Strategies



SECTION 2 Planning Vision, Principles & Strategies

2.1 VISION

West Clayton will be a community that is inclusive, integrated and diverse – mixing a diversity of housing types, populations of different ages, including seniors and youth, and a variety of lifestyles. It will be a healthy and sustainable community that will promote a sense of place, walkability, bicycling and transit as the preferred modes of travelling, universal accessibility, and preservation of natural areas, wildlife connectivity, while proiding a respectful transition between existing and new places, and energy efficiency and conservation.

Community amenities and services will be located within a convenient distance of most homes, with opportunities for access to nature and recreation provided through parks and greenways throughout the community, and opportunities for social interaction provided by creating outdoor public spaces for perchance meetings, festivals and public art, and by emphasizing street-friendly design.

Green spaces and clustering of homes along the agricultural interface will provide a respectful relationship with the neighbouring agricultural community and assist preservation of the hillside. Community's history, heritage and character will be respected and promoted in the creation of new places.

2.2 PRINCIPLES AND OBJECTIVES

The West Clayton NCP land use concept is linked to the Clayton General Land Use Plan (GLUP), which envisioned Clayton as a complete community with local village commercial nodes, transit/commercial and employment nodes, a mix of residential uses and densities, community facilities, schools, parks, pathways, open space and protected areas.

The Principles for the development of West Clayton were further refined through the community visioning process conducted during the Stage I Land Use Plan process. The Objectives and Principles are facilitated by specific strategies which led to the Land Use and Land Use Policies for the Area.

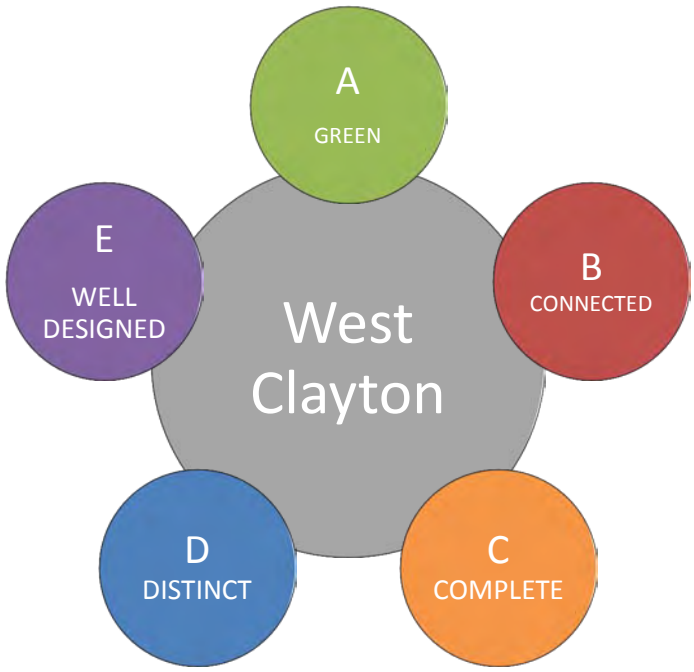
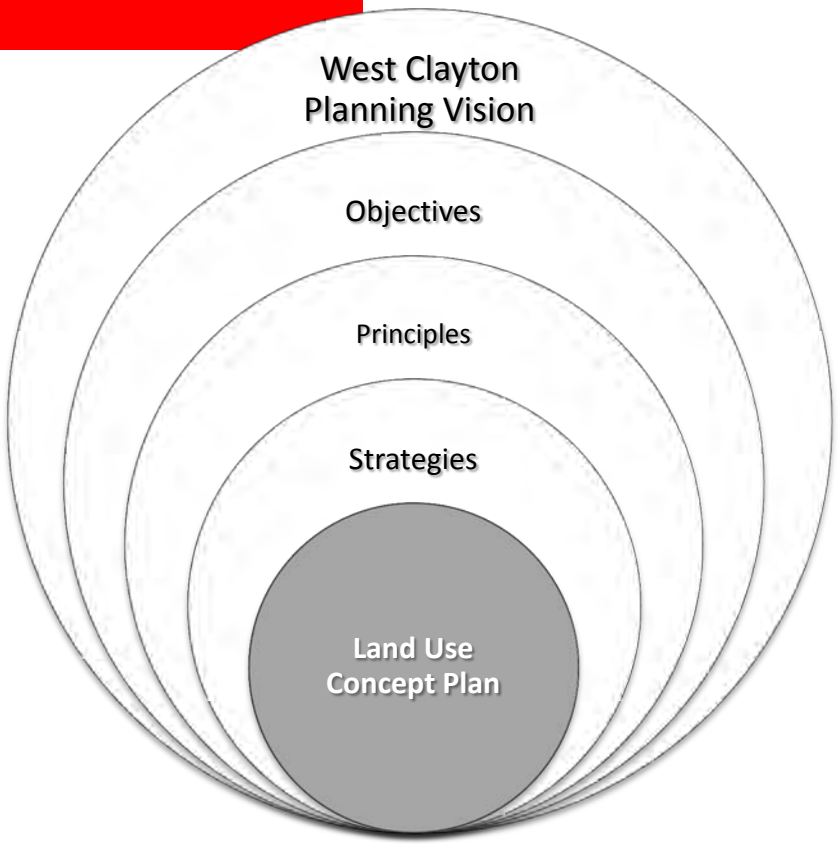


Figure 2.1 - West Clayton Objectives



2

A

2.2.1 GREEN

Principle 1. Provide an equitable distribution and access to high quality public parks and greenways throughout the NCP area, with parkland within walking distance of all new residences.

Principle 2. Protect, integrate and enhance environmentally sensitive and other natural areas to create a network of wildlife corridors and habitat hubs, and where appropriate, access to nature for people.

Principle 3. Connect parks, natural spaces and neighbourhood destinations with greenways and multi-use pathways.

Principle 4. Cluster and locate homes away from the environmentally sensitive areas and agricultural land uses.

Principle 5. Pursue the conveyance of riparian areas to the City through the subdivision and development process in order to ensure the consistent management of natural environmental values in riparian corridors.

2.2.2 CONNECTED

B

Principle 1. Create a compact community to promote walking and support transit.

Principle 2. Provide an interconnected street grid to allow multiple ways to disperse traffic, to provide choices to travel on foot, or by bicycle or car, and to provide safe and convenient access to transit.

Principle 3. Provide sites for neighbourhood parks and schools in convenient and equitably distributed locations that are easily and safely accessible on foot or by bicycle.

Principle 4. Provide opportunities in the neighbourhood for safe and convenient access to shopping, services and amenities within a short distance of most homes that is convenient for walking and bicycling.

Principle 5. Provide opportunities for access to fresh food by encouraging a provision of such amenities as garden commons or garden plots in multiple housing developments.

C

2.2.3 COMPLETE

Principle 1. Provide for a variety of housing types, densities and forms to accommodate a range of housing choices and lifestyles, while respecting the existing established residential areas.

Principle 2. Locate higher residential densities in proximity of the village centre at 72 Avenue and 188 Street, the future rapid transit station at 184 Street and Fraser Highway and in areas of lower environmental value.

2.2.4 DISTINCT

D

Principle 1. Promote a sense of place by providing special urban design at entrances to the neighbourhood, at the village centre, in proximity of the rapid transit station and other prominent locations. Emphasize contextual design and place-making, and include opportunities for public gathering places, festivals, public art, outdoor seating spaces and landscaping to provide comfort, texture and colour.

Principle 2. Reinforce the village centre as a focus for the Greater Clayton community and create a focus for the West Clayton neighbourhood around the future rapid transit station by providing a mix of commercial spaces and residential land uses, and outdoor public spaces at these locations, and by ensuring pedestrian oriented and people friendly spaces and buildings.

Principle 3. Protect the natural beauty, preserve historic and natural references and provide view corridors, as appropriate, and preserve, integrate and adapt, as necessary, West Clayton's heritage with buildings and landscapes.

Principle 4. Encourage street and pedestrian friendly site and building designs.

E

2.2.5 WELL DESIGNED

Principle 1. Provide a street grid and maximize street connectivity within the neighbourhood, and provide appropriate densities and mix of uses within 400-800 metres of the village centre and the rapid transit station to support transit and energy efficiency, sharing of waste energy between different land uses and consideration for district energy.

Principle 2. Maximize east-west oriented streets and development blocks for solar gain and energy conservation.

Principle 3. Provide policies and guidelines for energy-conserving and energy-efficient site layouts and buildings.

Principle 4. Provide appropriate residential land use and density to create transition to the existing established enclave of suburban homes to the west of 182 Street.

Principle 5. Provide for mitigation of impact from the traffic on Fraser Highway through appropriate buffer, building designs and site layouts.

2.3 PLANNING STRATEGIES

2.3.1 An Energy Shift Neighbourhood

West Clayton is intended to be the first neighbourhood for piloting innovative ideas to help reduce energy costs for residents and meet Surrey's commitment to reducing GHG emissions. For the first time, NCP included requirements for consideration of energy and energy Bonus criteria as a factor in land use planning.

As an initial step in planning with energy as a factor, an Energy Design Charrette was organized with City staff, consultants and BC Hydro and Fortis BC Gas representatives as co-participants in a hands-on land use design workshop to generate land use options and ideas that will contribute to reducing energy consumption and GHG emissions. After considering various opportunities and actions resulting from this Charrette, City Council recommended to:

"Adopt of a policy for providing a density bonus in return for a commitment from developers and builders to achieve increasing levels of energy efficiency beyond what would be expected under current energy codes and rating systems;" and

"Conduct a study for the potential of a district energy system and electric-vehicle charging stations in the neighbourhood."

The attributes of the West Clayton Land use Concept Plan have included the mixing of land uses to include characteristics which ensure energy-conscious planning and assist in achieving energy efficiency and conservation in support of the ENERGY Shift model neighbourhood:

STATEGY 1

Create a fine grid interconnected road network of predominantly east-west oriented streets and blocks.

STATEGY 2

Designate density concentrations in and around the neighbourhood commercial and village nodes and the Fraser Highway transit corridor.

STRATEGY 3

Building energy standards required for developments seeking to exceed the base density within NCP, and established additional density allowances.

2.3.2 A Sustainable Neighbourhood

The West Clayton NCP responds to the NCP's vision and reflects the planning principles and actions of the City of Surrey Sustainability Charter.

The NCP implements a number of specific actions set out under the Socio-Cultural (SC) Scope, Economic (EC) Scope and Environmental (EN) Scope of the City's Sustainability Charter included in **Appendix A-4.**

STATEGY 1

Support walking, cycling and transit use to reduce the need for the use of private vehicles by concentrating higher density residential development near planned rapid transit on Fraser Highway and near commercial areas, and by planning a grid of interconnected streets, greenways and walkways.

STATEGY 2

Create an interconnected system of natural areas and open space that conserves ecosystems and functions, while providing benefits to both wildlife and people with emphases on Biodiversity Corridors, Hubs and Sites within forest patches and the ALR edge.

STATEGY 3

Support mixed use (commercial and residential) and live-work, to add diversity to the housing opportunities

STATEGY 4

Provide energy-efficient buildings through density bonus incentives.

STATEGY 5

Support place-making through heritage preservation, character of public places and key streets, and view protection.

2.3.3 A Green Linked Neighbourhood

The West Clayton NCP is designed to include Biodiversity Conservation Strategy (BCS) corridors to maintain and enhance the City of Surrey's Green Infrastructure Network Plan (GIN). The Land use Concept therefore, generally manages for the Biodiversity Conservation Strategy (BCS) corridors proposed in the BCS Plan adopted by Council in July 2014.

Land identified within the BCS green infrastructure network will be achieved through a balance of parkland acquisition, gross density transfer and the conveyance of riparian areas through the rezoning and land development process..

The creation of green linkages in the West Clayton Land Use Concept Plan includes several strategies, including:

STRATEGY 1

Creation and enhancement of natural and active area Parks including eight new parks and the enhancement of Clayton Park;

STATEGY 2

Enhancement and streamside buffers for Riparian areas of Class "A", Class "AO" and Class "B" watercourses;

STATEGY 3

BCS (Biodiversity Conservation Strategy) corridors including Green Density Transfer (GDT) areas, portions of which are required for ALR buffer purposes including:

- A minimum of 15-metre/50-ft. wide ALR buffer and riparian area for relocated watercourses along 80 Avenue;
- A 5-metre/buffer area along the Fraser Highway;

STATEGY 4

Multi-use pathways to connect and supplement the designated Greenways, including:

- along the BCS Corridors edges, within (or adjacent to) the proposed right-of-way for a sanitary sewer main and the existing Fortis BC Gas right-of-way;
- along Fraser Highway, 184 Street, 72 Avenue and 80 Avenue.

STATEGY 5

Landscape buffer area proposed to the north-west of Fraser Highway and 180 Street along the future long-term extension of 72 Avenue to Fraser Highway. This buffer area will preserve an existing bald eagle's nest near the riparian forest of a Class "B" watercourse. Further, given its location at the edge of the NCP area and uphill travelling east on Fraser Highway, it will act as a landmark for the neighbourhood. A public art piece to identify and reinforce its landmark status should be installed in this park.

STRATEGY 6

A 10-metre (33-ft.) wide north-south corridor is required along the east side of 189B Street between 73 Avenue and 74 Avenue. (This will be dedicated as a wide boulevard.) It will accommodate a 6-metre (20-ft.) wide landscaped corridor.

This is not required as a BCS Corridor, but its purpose is to link greenway between the proposed park on 73 Avenue and riparian areas of the Class "A" and Class "B" coded watercourses to the north of 74 Avenue. The remaining 4 metres of the 10-metre corridor will be provided as a multi-use pathway. A greenway, to be required as a public right-of-way, is proposed within part of the Fortis BC Gas right-of-way. This greenway will provide an east-west connection, to the east of 184 Street, for pedestrians and recreational bicyclists.

2.4 PLANNING AND CONSULTATION PROCESS

To inform the neighbourhood planning process, a number of background studies, including reports on the existing and potential heritage resources, feasibility and requirements for commercial development, environmental resources, transportation plan, and integrated stormwater management plan were undertaken as well as several targeted consultation processes opportunities as generally described below and as illustrated in Figure 2.2.

2.4.1 Citizen Advisory Committee

A Citizens' Advisory Committee ("CAC") was formed and met regularly to provide advice and comments on plan as it was developed. There where ten meetings of the CAC over the entire planning process. The CAC included a cross-section of property owners from within the Plan area as well as representatives from neighbourhoods adjacent to the Plan area and three citizens representing the interests of the City at large.

Feedback on the vision, planning principles and land use directions and options were obtained through public open houses and from comment sheets that interested parties completed and forwarded to staff. Staff also held meetings with other stakeholders and workshops with youth to obtain input in the development of the land use concepts.

2.4.2 Public Open House Meetings

Three well-attended public meetings where held as part of Stage I of the NCP process and one additional public meeting was held for Stage II, as listed:

May 12, 2011

A start-up public meeting/open house was held to commence the NCP planning process.

June 20, 2012

A public meeting/open house was held to review and seek feedback on two initial land use options for the NCP.

October 23, 2013

A public meeting/open house was held to review and seek feedback on the preferred land use plan and the preliminary servicing strategy.

June 18, 2015

A public meeting/open house was held to review final land use concept and seek feedback on final serving and financial strategy.

A summary of the results of the public meeting(s)/open house(s) held is contained in **Appendix A-4**.

2.4.3 Interagency Meetings

Several meetings where held with an Inter-agency Committee comprised of representatives from utilities, Provincial ministries (Including ALC/MOA & MOT), as well as Metro Vancouver and TransLink. Several meetings also took place with staff of the Surrey School District all to ensure coordinated planning for schools in the area.

2.4.4 Youth Involvement

Five workshops were held with students from Clayton Elementary School and the Clayton Heights Secondary School to gather the perspectives of youth on the future neighbourhoods in West Clayton. A Youth Strategy document was established which ultimately influenced the creation of the West Clayton NCP planning principles.

2.4.5 City Committee Meetings

Presentations to receive early and ongoing feedback were also made to the Agriculture & Food Security Advisory Committee (AFSAC), the Heritage Advisory Commission (HAC), the Development Advisory Committee (DAC), the Environment & Sustainability Advisory Committee (ESAC), and the Transportation and Infrastructure Committee (TIC) at various stages in the Planning proces

STAGE 1

- Neighbourhood Survey to gage support for NCP
- Approve Boundary of NCP Area #1 and #2
- Council Approves NCP Study TOR Area #1 & #2
- Formation of CAC
- Initial CAC Meeting

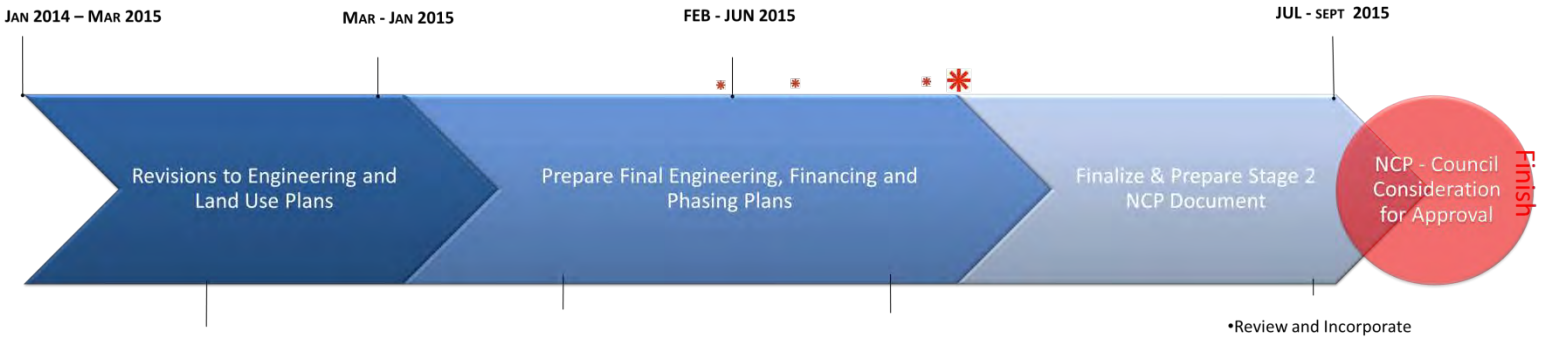
- Heritage Study
- Environmental Study
- Commercial Market Study
- Transportation Study
- Servicing Study
- Stakeholder & CAC Consultation

- Review Environmental Considerations
- Stakeholder & CAC Consultation
- Develop Vision, Planning Principles an two Land Use Options
- Council authorizes process for West Clayton Extension Area (June 2012)
- **Land Use Concept Options POH (Jun 2012)**

- Stakeholder & Agencies Feedback
- Stakeholder & CAC Consultation
- Review Environmental Considerations
- Develop Option C
- Council Update
- **Preferred Land Use Concept POH (Oct 2013)**

- Review and Incorporate Public Open House Feedback
- Work on 72 Avenue transportation Options Completed
- Report to Council with Stage 1 Plan
- **Council Approval of Stage 1 Plan (Dec 2013)**

STAGE 2



- Consultants work on Stage II Engineering Plans
- Modifications to Land Use and Stage 1 Engineering Plans
- Analyze Build out and Population Projections
- **Stakeholder Consultation**

- Finalize land use design and development guideliens.
- Consultants Prepare Plans:
  - ❑Transportation
  - ❑Sewer
  - ❑Water
  - ❑Financing
  - ❑Phasing
- **Stakeholder, Advisory Body and CAC Consultation**

- Engineering Strategies
- Stakeholder, & CAC Consultation
- Design and Planning and Development Guidelines
- Financing and Phasing
- Stage II Land Use Concept
- **Final Stage 2 POH (Jun 2015)**

- Review and Incorporate Public Open House Feedback
- Report to Council with Stage 2 Plan
- **Council Review and Approval of Stage 2 Plan (Jul - Sept 2015)**
- **Initiate Related Bylaw and Amendments**

Citizen Advisory Committee Meeting (CAC)

Public Open House Meeting (POH)

Figure 2.2 - West Clayton Planning Process Summary

SECTION 3
Land Uses

SECTION 3 – LAND USES

3.1 SUMMARY OF LAND USES

The West Clayton Neighbourhood concept plan shown in Figure 3.1, contains a range of residential, commercial, mixed use, institutional, park and recreation land uses including:

- a diversity of residential areas to accommodate a variety of future urban housing forms and densities (ranging from small single family and attached housing to townhouse and apartment buildings);
- two mixed-use commercial/residential and transit nodes;
- a small neighbourhood commercial site;
- a new recreation/community centre and library;
- a new secondary school and three elementary schools (one existing);
- nine parks, including Clayton Park and eight new parks, as well as three linear parks and BCS corridors.

3.1.1 Vision

"The West Clayton neighbourhood is envisioned as a compact and walkable neighbourhood, with a network of interconnected streets, greenways and walkways to distribute traffic and encourage walking cycling and use of public transit. The street network is designed to accommodate local transit service in the future and provide convenient access to the future rapid transit service along Fraser Highway. Neighbourhood amenities and facilities including parks, schools and neighbourhood shopping areas are located to be accessible by walking and cycling along safe walkways and greenways from all parts of the community. "

In addition to the built environment, a network of natural areas is proposed for protection and enhancement of the City's green infrastructure, including:

- Riparian areas associated with significant watercourses;
- Landscaped buffer areas on a portion of the land adjacent to the ALR for transition and hillside preservation;
- East West and North South Biodiversity Conservation Corridors as identified in detail in Section 3.5.3.

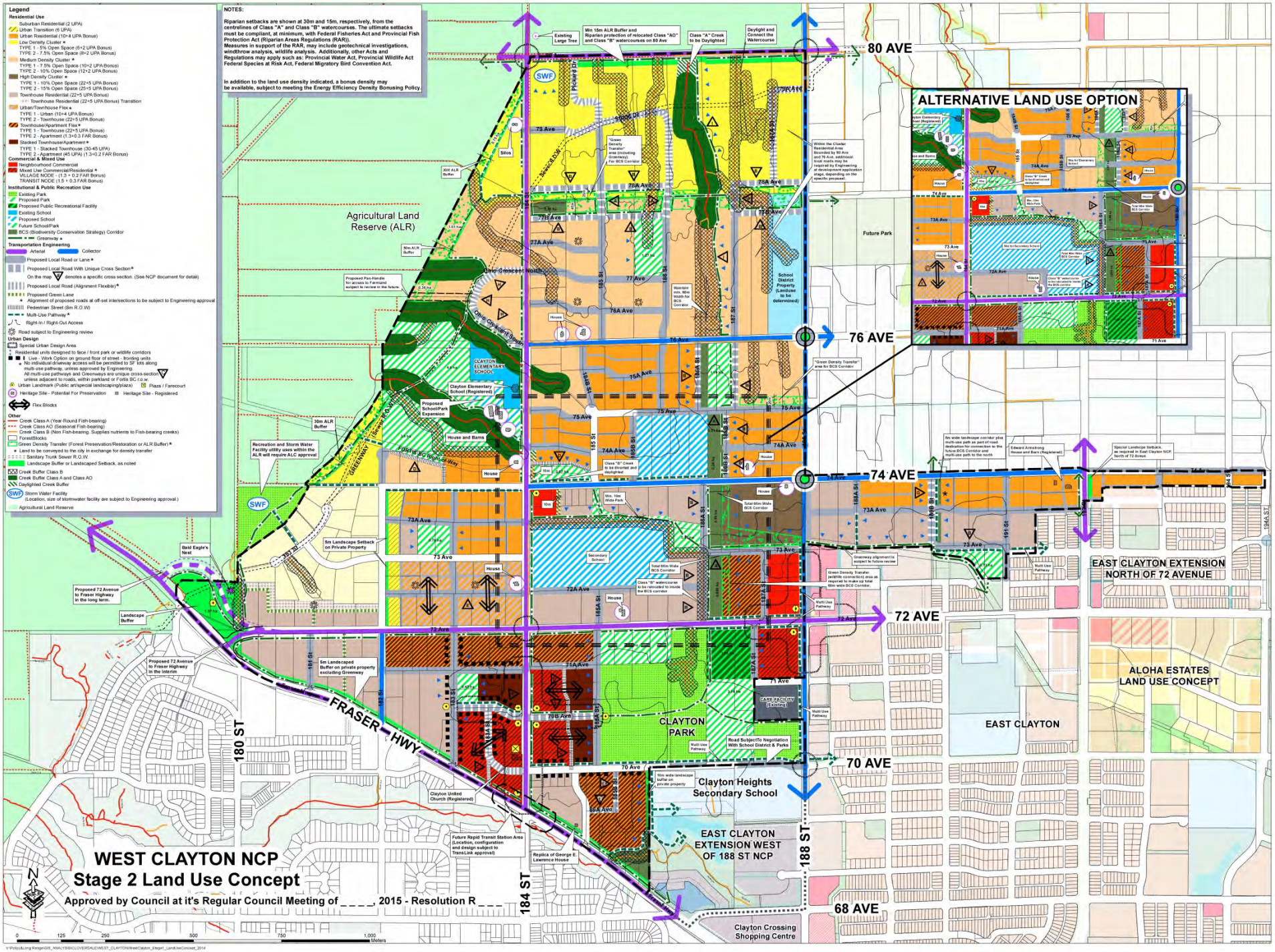


Figure 3.1 - West Clayton NCP Land Use Concept

3.1.2 Land Use Plan Statistics

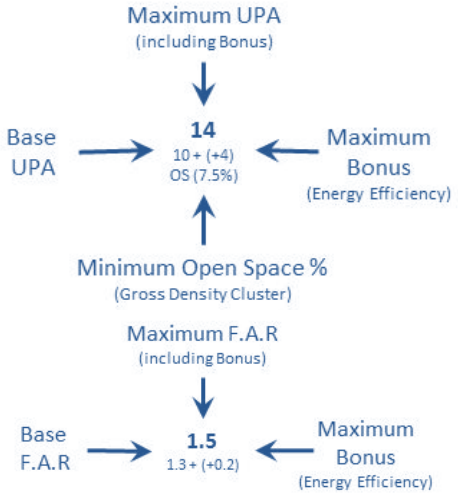
Table 3.1 provides a breakdown of the land uses projections with regard to land area, population and employment projections at full build-out of the West Clayton NCP area. The population projections noted below do not include Secondary Suites within single family developments.

West Clayton Land Use Concept Statistics						
Land Use	Acres	Area %	Low Units	High Units	Low Population	High Population
Existing Park	31.5	4.4%	0	0	0	0
Proposed Park	44.5	6.2%	0	0	0	0
Proposed Public Recreational Facility	4.2	0.6%	0	0	0	0
Wildlife Corridor	8.4	1.2%	0	0	0	0
Landscape Buffer	9.2	1.3%	0	0	0	0
Day-Lighted Creek Buffer	1.1	0.2%	0	0	0	0
Creek Buffers (A and AO Class)	25.0	3.5%	0	0	0	0
Future School/Park	3.0	0.4%	0	0	0	0
Existing Elementary School	3.0	0.4%	0	0	0	0
Proposed Elementary School	23.7	3.3%	0	0	0	0
Existing and Proposed Roads	187.3	26.2%	0	0	0	0
School District Property	8.6	1.2%	0	0	0	0
Neighbourhood Commercial	5.2	0.7%	0	0	0	0
Mixed Use Commercial/Residential	17.2	2.4%	1,013	1,266	1,418	1,772
Suburban Residential	22.1	3.1%	44	44	150	150
Low Density Cluster	66.3	9.3%	398	663	1,352	2,254
Urban Transition	2.7	0.4%	16	16	56	56
Urban Residential	54.1	7.6%	541	758	1,461	2,046
Medium Density Cluster	83.8	11.7%	838	1,173	2,262	3,166
Urban/Townhouse Flex	12.3	1.7%	123	333	333	898
Townhouse Residential	56.6	7.9%	1,246	1,529	3,364	4,128
Townhouse Residential Transition	2.5	0.4%	56	68	150	185
Townhouse/Apartment Flex	24.3	3.4%	607	655	1,638	1,769
Stacked Townhouse/Apartment	7.1	1.0%	213	319	575	862
High Density Cluster	9.8	1.4%	245	294	343	412
Total	**713.6**	**100%**	**5,340**	**7,119**	**13,103**	**17,699**

Table 3.1 - West Clayton NCP Land Use Plan Statistics

3.2 RESIDENTIAL LAND USES

Approximately 138 hectares (341 acres) of the West Clayton NCP area is designated for residential uses. A variety of housing densities and forms may be permitted within the residential designated lands. Unless mentioned otherwise, (such as within the Cluster Residential Areas) the densities are "net" densities to be calculated over "net" site area. Base Densities [Units per Acre (UPA) and in some designations Floor Area Rations (FAR)] may be increased based on Energy Efficiency Policy as provided in the example illustrated below, and as described in Sections 5.3 and 6.5.



Intent of Planning Guidelines

The intent of the residential area guidelines and are to encourage the development of a variety of housing types, densities, and forms that will provide a variety of housing options while still ensuring a strong and unified residential character for West Clayton while preserving environmental significant features where feasible.

PRINCIPLE 1

Provide for a variety of housing types, densities and forms to accommodate a range of housing choices and lifestyles, while respecting the existing established residential areas.

PRINCIPLE 2

Locate higher residential densities in proximity of the village centre at 72 Avenue and 188 Street, the future rapid transit station at 184 Street and Fraser Highway and in areas of lower environmental value.

PRINCIPLE 3

Provide opportunities in the neighbourhood for safe and convenient access to shopping, services and amenities within a short distance of most homes that are convenient for walking and bicycling.

PRINCIPLE 4

Cluster and locate homes away from the environmentally sensitive areas and agricultural interface.

PRINCIPLE 5

Provide appropriate residential land use and density to create transitions to the existing established enclave of suburban homes to the west of 182 Street.

PRINCIPLE 6

Provide opportunities for access to fresh food by encouraging a provision of such amenities as garden commons or garden plots in multiple housing developments.

PRINCIPLE 7

Provide a street grid and maximize street connectivity within the neighbourhood, and provide appropriate densities and mix of uses within 400-800 metres of the village centre and the rapid transit station to support transit and energy efficiency, sharing of waste energy between different land uses and consideration for district energy.

Summary of Land Use Descriptions

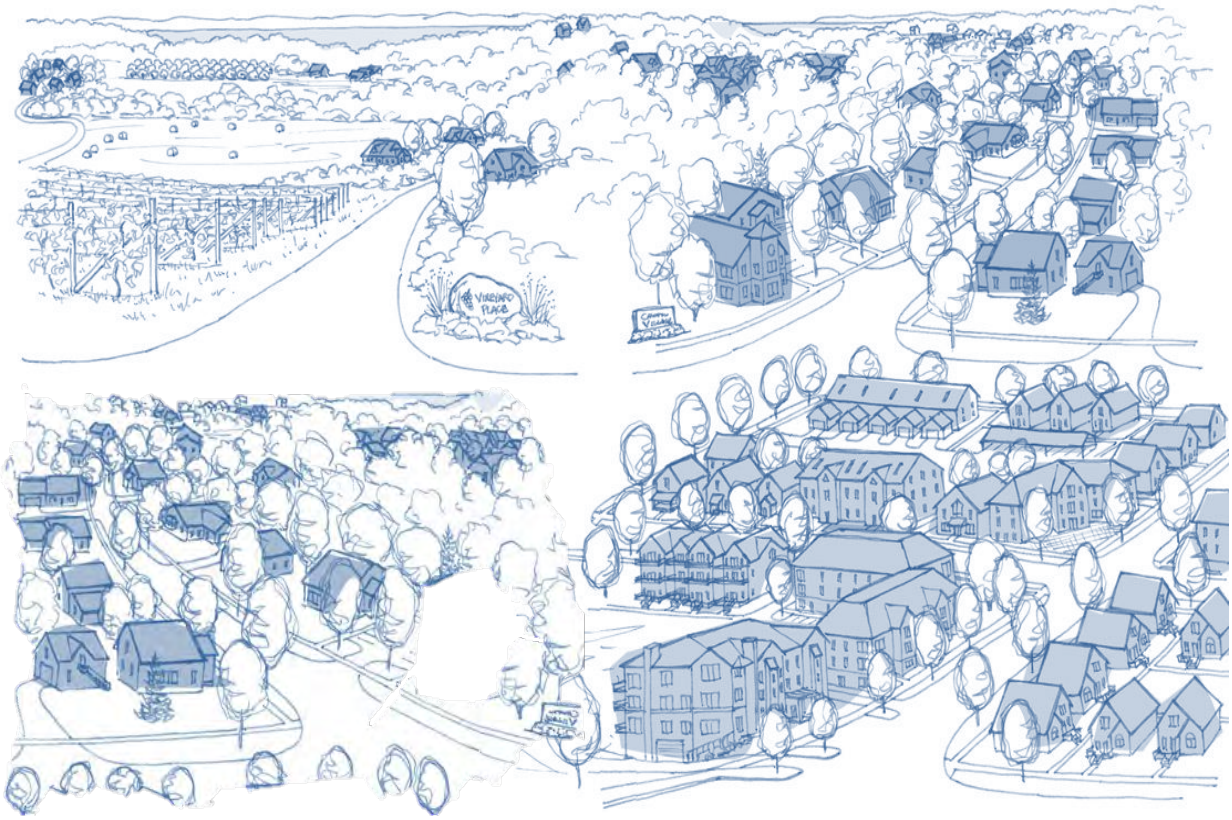
The West Clayton Land Use Plan identifies ten (10) designations allowing for primarily residential use, three (3) of which describe single family or two family densities, four (4) which describe ground oriented multiple family densities ranging from multiple attached housing to row house development, and two (2) which mainly describe higher density multifamily development consisting of townhouses and low-rise apartment developments.

Each of the land use designations are described in detail in section (3.2.1-3.2.10) and are summarized in Table 3.2-3.3, and Figure 3.2 below. Density Guidelines and typical zones are also provided sections (3.2.1-3.2.10) with a summary provided in Table 3.12 for convenience use.

Typical Land Use Planning Abbreviations:

Standard Land Use definitions abbreviations referenced throughout the Land Use Section include:

- FAR (Floor Area Ratio)
- UPA (Units Per Acre)
- NET (Net Density)
- GROSS (Gross Density)
- CD (Comprehensive Development Zone)
- OS (Open Space)



SUMMARY OF RESIDENTIAL AND COMMERCIAL/MIXED USE LAND USE DESIGNATIONS							
	Land Use Designation	Base Density UPA	*Energy Efficiency Density Bonus	Max Density (with Bonus)	Typical Building Height	Minimum Open Space % Required	General Building Form Description
Residential Designations							
	Suburban Residential	2 UPA Net	N/A	N/A	2-Stories	N/A	Intended for single family homes on large acreage lots and covers most of the existing enclave of 25 lots, located to the north-west of 72 Avenue and 182 Street. Existing lots range in size from 1 acre to 2.5 acres. One Secondary suite per unit may be permitted.
	Urban Transition	6 UPA Net	N/A	N/A	2-Stories	N/A	Intended for larger than traditional single family urban lots This designation provides a transition between future urban residential development and is intended to mitigates impact on the existing suburban lots on the west side of 182 Street. Lots may be no less than 20 metres in width. Buildings will be setback no less than 10 metres from 182 Street including a 5 m wide landscape buffer within the setback. Parking access to be provided by rear public lane. One Secondary suite per unit may be permitted.
	Urban Residential	10 UPA Net	+4 UPA	14 UPA Net	2-3 Stories	N/A	Intended for primarily single family detached or semi-detached and duplex ground-oriented units on urban size lots. This designation will provide a diversity of housing choices and may also include triplexes and manor houses within the same block or on street corners, subject to their impact being adequately addressed and the units being designed in keeping with appropriate design considerations. Parking access provide by rear public or private lanes.
	Townhouse Residential	22 UPA Net	+5 UPA	27 UPA Net	2-3 Stories	N/A	Intended for ground oriented Townhouses and Row house units in areas with access to major circulation routes, business districts and public amenities. Typical developments may consist of two-or-three story buildings that house multiple dwelling units (Strata of Fee Simple) and may provide some form of indoor and outdoor amenity spaces. Parking access provide by rear public or private lanes.
	Urban / Townhouse Flex: TYPE 1 (Urban Residential) TYPE 2 (Townhouse)	 10 UPA Net 22 UPA Net	 +4 UPA +5 UPA	 14 UPA Net 27 UPA Net	2-3 Stories	N/A	Intended for a mix of small lot single family detached or semi-detached residential units on urban lots and/or ground oriented Townhouses and Row house units in areas with access to major circulation routes, business nodes and public amenities. Typical developments may consist of two-or-three story buildings that house multiple dwelling units. Parking access provide by rear public or private lanes.
	Townhouse / Apartment Flex: TYPE 1 (Townhouse) TYPE 2 (Apartment	 25 UPA Net 1.3 FAR	 +2 UPA +0.2 FAR	 27 UPA Net 1.5 FAR	3-4 Stories	N/A	Intended for a mix of mid-rise apartments and ground oriented urban townhouses. Walk ability and pedestrian access are key considerations. Parking access is to provide by rear public or private lanes for townhouse developments and underground parking for apartments. Some form of indoor and outdoor amenity spaces are to be provided on site.
	Stacked Townhouse / Apartment: TYPE 1 (Staked Townhouse) TYPE 2 (Apartment)	 30-45 UPA Net 1.3 FAR	 0.2 FAR	 1.5 FAR	 3-4 Stories 4-6 Stories	N/A	Intended for mid-rise apartments with Townhouse base and underground parking. May include high-intensity stacked Townhouses and Low-Rise Walk-up apartment units surround central retail or transit areas with convenient access to neighbourhood amenities. Underground parking is preferred. Walk ability and pedestrian access are key considerations

Table 3.2 - Residential Land Use Designation Summary

Land Use Designation	Base Density UPA	*Energy Efficiency Density Bonus	Max Density (with Bonus)	Typical Building Height	Minimum Open Space % Required	General Building Form Description
Cluster Residential Designations (Open Space Preservation)						
Low Density Cluster: TYPE 1 – 5% OS TYPE 2 – 7.5% OS	6 UPA Gross 8 UPA Gross	+2 UPA +2 UPA	8 UPA Gross 10 UPA Gross	2-Stories	5% 7.5%	Intended for urban housing on a large development site, in the form of single-family or semi-detached dwellings on individual lots (or bare land strata lots for areas downslope of the Sanitary Sewer Trunk Main) or in the form of lower density ground-oriented multiple unit residential buildings with substantial public open space set aside. This designations maximum density should only be considered if there are special amenities such as mature vegetation, watercourse, riparian areas, ravines, slopes or the site development can contribute open spaces as parkland within Green Density Transfer areas.
Medium Density Cluster: TYPE 1 – 7.5 % OS TYPE 2 – 10% OS	10 UPA Gross 12 UPA Gross	+2 UPA +2 UPA	12 UPA Gross 14 UPA Gross	2-3 Stories	7.5% 10 %	Intended for urban oriented housing on a large development site. Housing forms may vary, from single-family dwellings, two-family dwellings or multiple attached dwellings with substantial public open space set aside. This designations maximum density should only be considered if there are special amenities such as mature vegetation, watercourse, riparian areas, ravines, slopes or the site development can contribute open spaces as parkland within Green Density Transfer areas.
High Density Cluster: TYPE 1 – 10% OS TYPE 2 – 15% OS	25 UPA Gross 25 UPA Gross	+2 UPA +5 UPA	27 UPA Gross 30 UPA Gross	2-3 Stories	10% 15%	Intended for urban townhouses on a large development site. Housing forms are intended to be multiple residential ground oriented dwellings and townhouses with substantial public open space set aside. May include some form of indoor and outdoor amenity spaces. Parking access provide by rear public or private lanes. This designations maximum density should only be considered if there are special amenities such as mature vegetation, watercourse, riparian areas, ravines, slopes or the site development can contribute open spaces as parkland within Green Density Transfer areas.
Commercial & Residential Commercial Mixed Use Designations						
Mixed Use Commercial/Residential: VILLAGE NODE TRANSIT NODE	1.3 FAR 1.5 FAR	+0.2 FAR +0.3 FAR	1.5 FAR 1.8 FAR	4-Stories 6-Stories	N/A	Intended to medium-rise, multiple unit residential buildings and related amenity spaces, which are to be developed in accordance with a comprehensive design. Built form intended to integrate commercial and residential uses in the same building. The ground floor of the buildings will be designed to accommodate small, pedestrian-oriented retail shops (as opposed to large-format retail), and personal and general service stores, all with their primary store entrances from the adjacent streets. Small-scale offices and other commercial businesses permitted, if provided, should be located above ground floor. Alternatively, if they are located within the ground floor, they should not occupy any street-fronting location on 184 Street.
Neighbourhood Commercial	0.5 FAR	N/A	N/A	1-2 Stories	N/A	A Neighbourhood oriented commercial area which promotes a mix of commercial, retail, restaurant, and office uses which serve the day-to-day needs of surrounding residents. It caters to shoppers in the immediate neighbourhood for convenience items, such personal care, groceries, dental and medical offices, etc.

Table 3.3- Summary of Cluster Residential and Commercial/Mixed Use Designations

3.2.1 Suburban

The SUBURBAN designation is consistent with the designation in the Official Community Plan (OCP). It is in keeping with the wishes of a majority of the lot owners who have expressed a desire to maintain the same suburban designation in the NCP. Given the relatively isolated location of this enclave, the Suburban designation is expected to remain unchanged for some years in the future.

The designation is intended for single family homes on large acreage lots and covers most of the existing enclave of 25 lots, located to the north-west of 72 Avenue and 182 Street. Existing lots range in size from 1 acre to 2.5 acres.

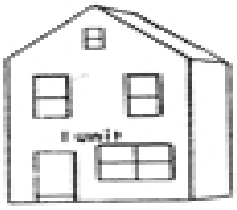
Max UPA
(including Bonus)

Base UPA → **2** ← Max Bonus

2 + (NA)

DEVELOPMENT CONSIDERATION FOR **SUBURBAN:**

- Densities within the SUBURBAN designation may range up to a maximum of 5 units per hectare (2 units per acre).
- Densities with the SUBURBAN designation may be calculated on a gross site area where sufficient parkland and/or community benefit are provided.
- Zones that may be acceptable within the SUBURBAN designation may include: One Acre Residential (RA), Acreage Residential Gross Density Zone (RA-G) Zones.



3.2.2 Urban Transition

The URBAN TRANSITION Designation is intended for larger than traditional single family urban lots but smaller than typical suburban lots. This designation provides a transition between future urban residential development is intended to mitigates impact on the existing suburban lots on the west side of 182 Street.

This designation is intended for lots along the east side of 182 Street between 72 Avenue and 74 Avenue.

Max UPA

Base UPA → 6 (6 + (NA)) ← Max Bonus

DEVELOPMENT CONSIDERATION FOR **URBAN TRANSITION:**

- Densities within the URBAN TRANSITION designation may range up to a maximum of 14.75 units per hectare (6 units per acre).
- Lots may be no less than 20 metres in width.
- Buildings will be setback no less than 10 metres from 182 Street.
- A 5 metre wide landscaped buffer with trees and shrubs adjacent to 182 Street is required. (A restrictive covenant should be registered over landscaped buffer to ensure it is maintained.)
- Vehicle access to the RESIDENTIAL TRANSITION area lots will be restricted to a rear lane.
- Zones that may be acceptable within the URBAN TRANSITION designation may include the Single Family Residential (RF) Zone.

3.2.3 Urban Residential

The URBAN RESIDENTIAL Designation is Intended for primarily single family detached or semi-detached ground-oriented units on urban sized lots. This designation will provide a diversity of housing choices and may also include option of triplexes and manor houses within the same block or on street corners, subject to their impact being adequately addressed and the units being designed in keeping with appropriate design considerations. Parking access will be provide by rear public or private lanes.

This designation is intended for lots in the areas:

- between 76 Avenue and 74 Avenue from 184 Street to the future 187 Street;
- west of 184 Street and both to the north and south of 74 Avenue;
- east of 188 Street between 74 Avenue and the future 73B Avenue.

Max UPA

Base UPA → **14** (10 + (4)) ← Max Bonus

DEVELOPMENT CONSIDERATION FOR **URBAN RESIDENITAL:**

- The Base Densities within the RESIDENTIAL TRANSITION designation may range up to a maximum of 24.7 units per hectare (10 units per acre) Net.
- With Energy Efficient Density Bonus Densities may be increased by up to 9.88 units per hectare (4 units per acre).
- Vehicle access to the Urban Residential area lots will generally be restricted to a rear lane.

TABLE 3.4 URBAN RESIDENTIAL – PLANNING GUIDELINES		
-DENSITY	**Max UPA (including Bonus)** ↓ Base UPA → **14** (10 + (+4)) ← Max Bonus	10-14 units per acre. A Bonus Density may be available. See **Energy Efficiency Density Bonus Policy**
POSSIBLE ZONES	The allowable zones on developable portions of the private properties may include: RF-12, RF-10, RF-SD, RM-10, RM-15 and site-specific CD.	
BUILT FORM	Primarily detached or semi-detached and duplex ground-oriented units on urban lots. To provide diversity and increase housing choices, triplexes, fourplexes, manor houses and small scale low density townhouse complexes may also be considered within the same block or in the adjacent area, subject to their impact being adequately addressed and the units being designed in keeping with design considerations.	
HERITAGE CONSIDERATIONS	Within this designation, the West Clayton Heritage Study identifies the following heritage resources: o House at 18377 74 Avenue as a potential heritage resource; and o The Edward Armstrong House and a barn located at 7381 192 Street, which are listed on the City's Heritage Register. See Heritage Strategy in Section 5.7.	
LANDSCAPED / PERMEABLE SURFACES	On-lot pervious surface equal to a consolidated infiltration area of a minimum of 10% of the lot area to be located in the front yard; and 800mm of pervious material on all pervious surfaces in the developable area of the lot. For details and additional requirements, see **Servicing, Drainage and Environment Section 8**	
MINIMUM LAND ASSEMBLY	May be required. See Land Consolidation Strategy	

3.2.4 Townhouse Residential

The TOWNHOUSE RESIDENTIAL Designation is Intended for ground oriented Townhouses and Row house units in areas with access to major circulation routes, business districts and public amenities. Typical developments may consist of two-or-three story buildings that house multiple dwelling units (Strata of Fee Simple) and may provide some form of indoor and outdoor amenity spaces. Parking access typically provide by rear public or private lanes.

This designation is intended primarily for lots in the areas:

- South of 74 Avenue both to the east and west of 188 Street, much of it bounded by the Fortis BC Gas right-of-way with a smaller area lying up to 73 Avenue east of the future 190 Street;
- To the west side of 182 Street both on the north and south sides of 72 Avenue with a portion of the designation on the north side of 72 Avenue shown as a transition area adjacent to the suburban lots.

Max UPA

Base UPA → **27** (22 + (5)) ← Max Bonus

DEVELOPMENT CONSIDERATION FOR TOWNHOUSE RESIDENITAL:

- The Base Density within the TOWNHOUSE RESIDENTIAL designation has a maximum of 54.3 units per hectare (22 units per acre) Net.
- With Energy Efficient Density Bonus Densities may be increased by up to 12.4 units per hectare (5 units per acre).
- Vehicle access to the Townhouse Residential area lots will be restricted to a rear lane.

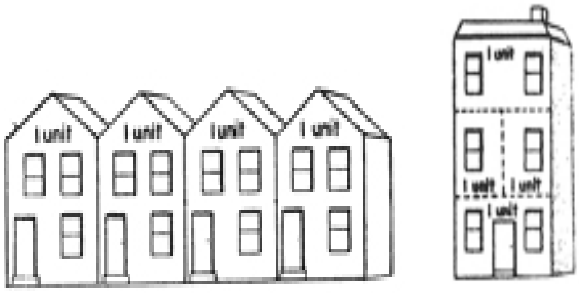


TABLE 3.5 TOWNHOUSE RESIDENTIAL – PLANNING GUIDELINES		
-DENSITY	**Max UPA (including Bonus)** ↓ Base UPA → **27** (22 + (5)) ← Max Bonus	▯ 22-27 units per acre. ▯ A Bonus Density may be available. See **Energy Efficiency Density Bonus Policy**
POSSIBLE ZONES	▯ The allowable zones on developable portions of the private properties may include: RM-23, RM-30 and site-specific CD.	
BUILT FORM	▯ Clusters of attached multiple ground-oriented units in a strata development and/or ground-oriented units on fee-simple lots and attached to adjacent units in a row. Along with the clusters of multiple attached units some semi-detached units may also be provided as part of a comprehensively designed strata development. ▯ Within the transition area adjacent to the suburban lots, to the north-west of 72 Avenue and 182 Street, the built form will need to be designed to address the interface issues of massing, scale, setback and privacy. ▯ At select locations, the ground floor of street-fronting units may need to be designed to facilitate the options for live-work. See Land Use Option – Live-Work in this Section. ▯ See Design Considerations.	
HERITAGE CONSIDERATIONS	▯ Within this designation, the West Clayton Heritage Study identifies the following houses as heritage resources: o House at 18535 72 Avenue as a potential resource; and o The George E. Lawrence House located within the townhouse complex at 6945 185 Street. It is on the City's Heritage Register. ▯ See Heritage Strategy.	
LANDSCAPED / PERMEABLE SURFACES	▯ BMP (Best Management Practices) measures may be required. ▯ 800mm of pervious material on all pervious surfaces in the developable area of the lot. ▯ For details and additional requirements, see Part 3 General Servicing, Section 3.3 Drainage Infrastructure.	
MINIMUM LAND ASSEMBLY	▯ May be required. See Land Consolidation Strategy	

3.2.5 Urban/ Townhouse Flex

The URBAN / TOWNHOUSE FLEX Designation will permit the options of developing:

TYPE 1 – URBAN RESIDENTIAL Designation uses and/or
TYPE 2 – TOWNHOUSE RESIDENTIAL Designation uses

This designation is intended to provide either a mix of small lot single family detached or semi-detached residential units on urban lots and /or ground oriented Townhouses and Row house units. Typical developments may consist of two-or-three story buildings that house multiple dwelling units. Parking access will be provide by rear public or private lanes.

This designation is intended for lots north of 72 Avenue, south of 73 Avenue, west of the URBAN TRANSITION Designation and east of 184 Street within a Flex Block alignment Option.

TYPE 1 - (Urban Residential)

Max UPA

↓

Base UPA → **14** (10 + (4)) ← Max Bonus

TYPE 2 - (Townhouse Residential)

Max UPA

↓

Base UPA → **27** (22 + (5)) ← Max Bonus

DEVELOPMENT CONSIDERATION FOR
URBAN / TOWNHOUSE FLEX:

- **TYPE 1 – (Urban Residential)** see URBAN RESIDENTIAL Designation for density, built form, description of uses and guidelines.
- **TYPE 2 – (Townhouse Residential)** see TOWNHOUSE RESIDENTIAL Designation for density, built form, description of uses and guidelines.

3.2.6 Townhouse / Apartment Flex

The TOWNHOUSE / APARTMENT FLEX designation will permit the option of developing townhouses or apartments or a combination of these two housing types. The intent is to enable innovative site layouts, built forms and development options within the context of the urban blocks.

Walk ability and pedestrian access are key considerations. Parking access is to provide by rear public or private lanes for townhouse developments and underground parking for apartments. Some form of indoor and outdoor amenity spaces are to be provided on site.

This designation is intended for lots :

- Between 71A Avenue and 72 Avenue and 182 Street and 185A Street;
- Between 183 Street and 184 Street and the north side of 71A Avenue; and
- From 185 Street up to the east boundary of the NCP area, adjacent to the Clayton Heights Secondary School – on the south side of 70 Avenue.

TYPE 1 - Townhouse

Max UPA

↓

Base UPA → **27** (25 + (2)) ← Max Bonus

TYPE 2 - Apartment

Max FAR

↓

Base FAR → **1.5** (1.3+ (0.2)) ← Max Bonus

DEVELOPMENT CONSIDERATION FOR TOWNHOUSE / APARTMENT FLEX:

- Densities within TOWNHOUSE / APARMENT designation may range as follows:

  TYPE 1 – Townhouse areas have a base net density of 61 unite per hectare (25 units per acre) up to a maximum of 66 units per hectare (27 units per acre) with Energy Efficiency Bonus.

  TYPE 2 – Apartment areas have a base Floor Area Ratio of 1.3 up to maximum 1.5 Floor Area Ration with Energy Efficiency Bonus.

- At select locations identified in the NCP, the ground floor of street-fronting units may need to be designed to facilitate the option for live-work.

TABLE 3.6 TOWNHOUSE / APARTMENT FLEX – PLANNING GUIDELINES		
DENSITY	TYPE 1 - Townhouse **Max UPA** **(including Bonus)** ↓ Base UPA → **27** (25 + (2)) ← Max Bonus	▯ Base density of 25 units per Acre Net. ▯ A Bonus Density of 2 additional units per acre may be available. See **Energy Efficiency Density Bonus Policy**
	TYPE 2 - Apartment **Max FAR** **(including Bonus)** ↓ Base FAR → **1.5** (1.3 + (0.2)) ← Max Bonus	▯ Base density of 1.3 Floor Area Ratio (FAR). ▯ A Bonus Density of 0.2 (FAR) for additional units per acre may be available. See **Energy Efficiency Density Bonus Policy**
POSSIBLE ZONES	▯ Multiple Family – RM-23, RM 30, RM-45 or a CD Zone is preferred to allow innovative developments in keeping with the intent of the flex designations.	
BUILT FORM	▯ May include detached or semi-detached units, townhouse clusters and 4-storey apartment buildings or another innovative built form, depending on the specific flex designation and subject to addressing the contextual and interface issues. ▯ At select locations, the ground floor of street-fronting units may need to be designed to facilitate the option for live-work. See Land Use Option – Live-Work in this Section	
HERITAGE CONSIDERATIONS	▯ Within this designation, the West Clayton Heritage Study identifies the following houses as heritage resources: o House at 18535 72 Avenue as a potential resource; and o The George E. Lawrence House located within the townhouse complex at 6945 185 Street. It is on the City's Heritage Register. ▯ See Heritage Strategy.	
LANDSCAPED / PERMEABLE SURFACES	▯ BMP (Best Management Practices) measures may be required. ▯ 800mm of pervious material on all pervious surfaces in the developable area of the lot. ▯ For details and additional requirements, see General Servicing, Section	
MINIMUM LAND ASSEMBLY	▯ May be required. **See Land Consolidation Strategy**	

3.2.7 Stacked Townhouse / Apartment Flex

The STACKED TOWNHOUSE / APARTMENT FLEX designation is intended to accommodate primarily up to 4 storey apartments buildings, buildings up to 6 storeys may also be considered, provided any interface issues are addressed. In combination with the apartment buildings, however, ground-oriented stacked townhouses may also be permitted subject to comprehensive development.

Walk ability and pedestrian access are key considerations. Parking access is to provide by underground parking for apartments. Some form of indoor and outdoor amenity spaces are to be provided on site.

This designation is limited to three locations in proximity of the future light rail transit station on Fraser Highway at 184 Street.

At two locations adjacent to the Clayton Community Park, Flex Block designation also applies. The Flex Block designation would permit the STACKED TOWNHOUSE/ APARTMENT FLEX designation to expand into the adjacent MIXED USE COMMERCIAL /RESIDENTIAL designation, subject to innovative design and comprehensive development.

Max FAR

Base FAR → **1.5** (1.3+ (0.2)) ← Max Bonus

DEVELOPMENT CONSIDERATION FOR **STACKED TOWNHOUSE / APARTMENT FLEX:**

- STACKED TOWNHOUSE / APARTMENT RESIDENTIAL designation has a base FAR of 1.3.
- With Energy Efficient Density Bonus, Densities may be increased by up to 0.2 FAR for a maximum of 1.5 FAR.
- At select locations identified in the NCP, the ground floor of street-fronting units may need to be designed to facilitate the option for live-work.

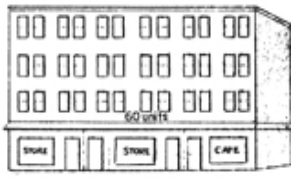


TABLE 3.7 STACKED TOWNHOUSE / APARTMENT FLEX – PLANNING GUIDELINES		
DENSITY	**Max FAR (including Bonus)** ↓ Base FAR → **1.5** (1.3 + (0.2)) ← Max Bonus	▯ Base density of 1.3 Floor Area Ratio (FAR). ▯ A Bonus Density of 0.2 (FAR) for additional units per acre may be available. See **Energy Efficiency Density Bonus Policy**
POSSIBLE ZONES	▯ The allowable zones on developable portions of the private properties may include RM-45 and site-specific CD. Only in combination with RM-45, RM-30 may be considered as a base zone for crafting of the CD Zone.	
BUILT FORM	▯ Stand-alone medium rise apartment buildings up to 6 storeys high or in combination with ground-oriented stacked townhouses. ▯ At select locations, the ground floor of street-fronting units may need to be designed to facilitate the option for live-work. See Land Use Option – Live-Work in this Section for design Considerations.	
LANDSCAPED / PERMEABLE SURFACES	▯ BMP (Best Management Practices) measures may be required. ▯ For details and additional requirements, see **Drainage and Environment Section**	
MINIMUM LAND ASSEMBLY	▯ May be required. See Land Consolidation Strategy	
DESIGN CONSIDERATIONS	▯ Provision for Urban Landmark at select locations may be required.	

3.2.8 Low Density Cluster

The LOW DENSITY CLUSTER designation is intended for urban oriented cluster housing on a large comprehensively planned development site, in the form of single-family dwellings or duplexes on individual lots *(or bare land strata lots for areas downslope of the Sanitary Sewer Trunk Main)* or in the form of lower density ground-oriented multiple unit residential buildings with substantial supplementary public open space set aside within the subdivisions in accordance with the West Clayton NCP planning guidelines.

A majority of the designation is provided for the area north of 78 Avenue, with a small area to the west of 184 Street and a second area to the north of 73 Avenue.

TYPE 1

Max UPA
(including Open Space Bonus)

Base UPA → **8** (6 + (2) OS (5%)) ← Max Bonus (With OS)

Minimum Open Space (OS) %

TYPE 2

Max UPA
(including Open Space Bonus)

Base UPA → **10** (8 + (2) OS (7.5%)) ← Max Bonus (With OS)

Minimum Open Space (OS) %

DEVELOPMENT CONSIDERATION FOR
LOW DENSITY CLUSTER:

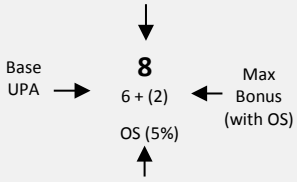
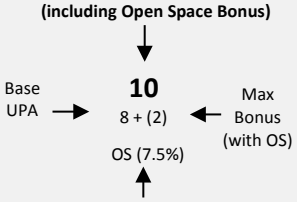
Densities within LOW DENSITY CLUSER designation may range as follows dependent upon Open Space provisions:

TYPE 1 –Base density of 14.8 unite per hectare (6 units per acre) up to a maximum of 19.7 units per hectare (8 units per acre) with 5% Open Space provided.

TYPE 2 – Base density of 19.7 unite per hectare (8 units per acre) up to a maximum of 24.7 units per hectare (10 units per acre) with 7.5% Open Space provided.

Open Space areas should be contiguous areas of significant environmental features and will be provided to the city in excess of standard 5% parkland subdivision dedication requirements..

TABLE 3.8 LOW DENSITY CLUSTER – PLANNING GUIDELINES

-DENSITY	**TYPE 1** **Max UPA** **(including Open Space Bonus)**  Minimum Open Space (OS) % **TYPE 2** **Max UPA** **(including Open Space Bonus)**  Minimum Open Space (OS) %	☐ If a minimum of 5% open space is conveyed to the city above standard 5% parkland subdivision dedication requirements, the application is considered under TYPE 1 and a base density of 6 units per gross acre may be applied to the site. ☐ If a minimum of 7.5% open space is conveyed to the city above standard 5% parkland subdivision dedication requirements, the application is considered under TYPE 2 and a base density of 8 units per gross acre may be applied to the site. ☐ An Energy Density Bonus may be available in tandem with the Open Space allocation being provided for up to 2 units per acre. See Energy Efficiency Density Bonus Policy. ☐ The open space allocation amounts within the Cluster designations are to be conveyed to the city above the typical prescribed parkland dedication requirements. ☐ This designations maximum density should only be considered, only if, there are special amenities such as mature vegetation, watercourse, riparian areas, ravines, slopes or the site development can contribute open spaces as parkland within Green Density Transfer areas and in association with the West Clayton Energy Efficiency Bonus Policy.
POSSIBLE ZONES	☐ On the basis of the Net Density resulting from the application of 6 to 8 units per acre Gross Density, the allowable zones on developable portions of the private properties may include: RC, RF, RF-G, RF-12, RF-SD, RM-10, and site-specific CD, provided that any development downslope of the sanitary main sewer right-of-way is required to be a strata development.	
BUILT FORM	☐ Preferably single detached units and/or semi-detached units (duplexes) within the transition areas close to the ALR. ☐ Other built forms such as 3-4 attached multiple residential unit clusters may also be considered within the transition areas and elsewhere in this designation, provided they are located farther from the ALR edge or are located within the interior of the site.	
HERITAGE CONSIDERATIONS	☐ Within this designation to the west of 184 Street, the West Clayton Heritage Study identifies the existing grain silo and the Clayton Hill (the hillside terrain and views) as potential heritage features. See **Heritage Strategy in Section 5.7**.	
LANDSCAPED / PERMEABLE SURFACES	☐ On-lot pervious surface equal to a consolidated infiltration area of a minimum of 10% of the lot area to be located in the front yard; and 800mm of pervious material on all pervious surfaces in the developable area of the lot. ☐ For details and additional requirements, see **Drainage and Environment Section.**	
GREEN INFRASTRUCTURE MANAGEMENT	☐ BCS Corridor conveyance as open space (Parkland) may be required. ☐ Tree retention and riparian area dedication may be required. ☐ See Green Density Transfer Area Guidelines in Section 5.2.	
BUFFER	☐ All or part of the density entitlement from the Green Density Area (the ALR Buffer along the ALR edge of 80 Avenue and/or the Forest Preservation/Restoration between 78A and 78B Avenue) on a site may be transferred to the developable portion of the same site. See Green Density Transfer Guidelines in section 5.2.	

	A Minimum of 30m wide along the ALR edge within the two Low Density Cluster designations to the west of 184 Street; and A minimum of 15m wide ALR buffer and riparian protection area for the existing Class "AO" and Class "B" watercourses along 80 Avenue.
MINIMUM LAND ASSEMBLY	May be required. See Land Consolidation Strategy

3.2.9 Medium Density Cluster

The MEDIUM DENSITY CLUSTER RESIDENTIAL designation is intended for urban oriented housing on a large development site. Housing forms may vary, from single-family dwellings, two-family dwellings or multiple ground oriented dwellings with substantial public open space set aside within the subdivisions in accordance with the West Clayton NCP planning Guidelines.

One portion of this designation is located to the west of 184 Street, and two other areas are located south of 76 Avenue (one to the east of 184 Street and the other on the west side of 188 Street.)

TYPE 1

Max UPA
(including Open Space Bonus)

Base UPA → **12** (10 + (2) OS (7.5%)) ← Max Bonus (With OS)

Minimum Open Space (OS) %

TYPE 2

Max UPA
(including Open Space Bonus)

Base UPA → **14** (12 + (2) OS (10%)) ← Max Bonus (With OS)

Minimum Open Space (OS) %

DEVELOPMENT CONSIDERATION FOR
MEDIUM DENSITY CLUSTER:

- **TYPE 1** –Base density of 25 unite per hectare (10 units per acre) up to a maximum of 30 units per hectare (12 units per acre) with 7.5% Open Space provided.
- **TYPE 2** – Base density of 30 unite per hectare (12 units per acre) up to a maximum of 34.5 units per hectare (14 units per acre) with 10 % Open Space provided.
- Open Space areas should be contiguous areas of significant environmental features and will be provided to the city in excess of standard 5% parkland subdivision dedication requirements.

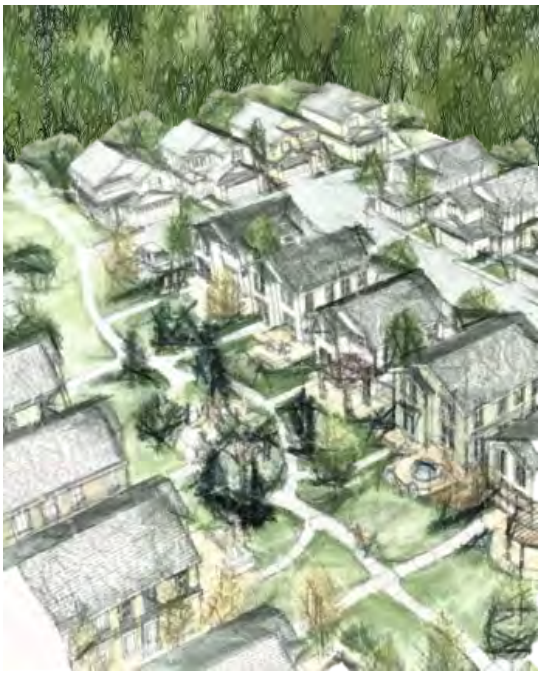


TABLE 3.9 MEDIUM DENSITY CLUSTER – PLANNING GUIDELINES		
-DENSITY	**TYPE 1** **Max UPA** **(including Open Space Bonus)** Base UPA → **12** ← Max Bonus (with OS) 10 + (2) OS (7.5%) Minimum Open Space (OS) % **TYPE 2** **Max UPA** **(including Open Space Bonus)** Base UPA → **14** ← Max Bonus (with OS) 12 + (2) OS (10%) Minimum Open Space (OS) %	☐ If a minimum of 7.5% open space is conveyed to the city above standard 5% parkland subdivision dedication requirements the application is considered under TYPE 1 and a base density of 12 units per gross acre may be applied to the site. ☐ If a minimum of 10% open space is conveyed to the city above standard 5% parkland subdivision dedication requirements the application is considered under TYPE 2 and a base density of 14 units per gross acre may be applied to the site. ☐ An Energy Density Bonus may be available in tandem with the Open Space allocation being provided for up to 2 units per acre. See Energy Efficiency Density Bonus Policy. ☐ The open space allocation amounts within the Cluster designations are to be conveyed to the city above the typical prescribed parkland dedication requirements. ☐ Density is to be calculated on the basis of the entire lot, only if, substantial open space and/or Agricultural Land Reserve buffers are provided in accordance with the West Clayton NCP and/or Farm Protection Development Permit Guidelines. If Open space is not provided, base density UPA is to be considered the maximum for the lot.
POSSIBLE ZONES	☐ On the basis of the Net Density resulting from the application of 10-12 units per acre Gross Density, the allowable zones on developable portions of the private properties may include: RC, RF-12, RF-10, RF-SD, RM-10, RM-15, RM-23 and site-specific CD, provided that any development downslope of the sanitary main sewer right-of-way is required to be a strata development.	
BUILT FORM	☐ Preferably single detached units and/or semi-detached units (duplexes) within the transition area close to the ALR and in the areas, south of 76 Avenue, adjacent to the Medium Density Residential (10-12 UPA) designation which is intended primarily to accommodate single family units. ☐ Other built forms such as 3-4 multiple residential unit clusters may also be considered within the transition area and elsewhere in this designation, provided they are located farther from the ALR edge or are located within the interior of the site.	
HERITAGE CONSIDERATIONS	☐ Within this designation to the west of 184 Street, the West Clayton Heritage Study identifies the following as potential heritage resources/features: o House at 18451 76 Avenue; o House at 18477 76 Avenue; o House at 18717 74 Avenue; and o The Clayton Hill (the hillside terrain and views). See **Heritage Strategy**.	
LANDSCAPED / PERMEABLE SURFACES	☐ On-lot pervious surface equal to a consolidated infiltration area of a minimum of 10% of the lot area to be located in the front yard; and 800mm of pervious material on all pervious surfaces in the developable area of the lot. ☐ For details and additional requirements, see **Drainage and Environment Section**	
GREEN INFRASTRUCTURE MANAGEMENT	☐ A minimum of 20-m wide corridor is required as a BCS Corridor for forest preservation, and to provide an east-west connection for the wildlife. An alternative to the location of this corridor, currently shown along 75 Avenue, may be considered depending on the site layout design, provided	

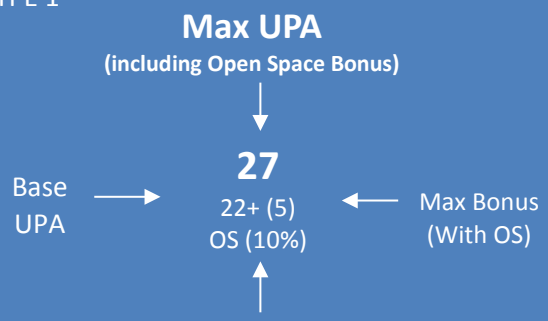
	an east-west forest connection is generally maintained. Recommendations from a qualified environmental consultant may be required to support the alternative location. This corridor is a Green Density Transfer area, which allows for the transfer of the density entitlement from it on a site to the developable portion of the remaining site. ☐ North of 76 Avenue, a minimum of 45-metre wide corridor is required for forest preservation and/or forest restoration or establishment purposes to support wildlife habitat. This corridor is located on the north side of the southerly road of the 78 Avenue couplets, adjoining the 25-metre corridor within the Low Density Cluster area. It is designated as a Green Density Transfer area. ☐ The total width of the forest corridor will be 70 metres between 184 Street and 188 Street, and it will function as a BCS Corridor. ☐ Tree retention and riparian area dedication may be required.
BUFFER	☐ Minimum of 50m wide landscape buffer along the ALR edge within the designation to the west of 184 Street. ☐ All or part of the density entitlement from the Green Density Area (the ALR Buffer along the ALR edge to the west of 184 Street and/or the Forest Preservation/Restoration along 78 Avenue) on a site may be transferred to the developable portion of the same site.
MINIMUM LAND ASSEMBLY	☐ May be required. See **Land Consolidation Strategy**

3.2.10 High Density Cluster

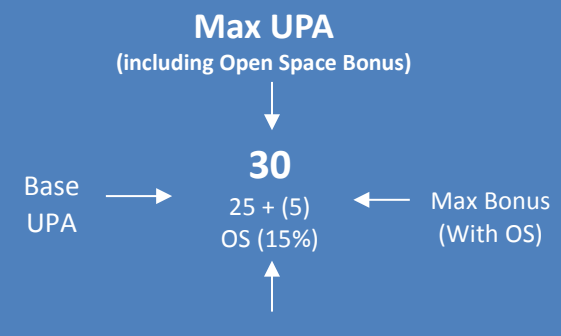
The HIGH DENSITY CLUSTER RESIDENTIAL designation is intended for urban oriented housing on a large development site. Housing forms are intended to be multiple residential ground oriented dwellings and townhouses with substantial public open space set aside within the subdivisions in accordance with the West Clayton NCP planning Guidelines.

This designation is located to the east of 186A street, west of 188 Street between 73 Avenue and 74 Avenue.

TYPE 1



TYPE 2



DEVELOPMENT CONSIDERATION FOR **HIGH DENSITY CLUSTER:**

- **TYPE 1** –Base density of 54.3 unite per hectare (22 units per acre) up to a maximum of 66.7 units per hectare (27 units per acre) with 10% Open Space provided.
- **TYPE 2** – Base density of 61.7 unite per hectare (25 units per acre) up to a maximum of 74.1 units per hectare (30 units per acre) with 15 % Open Space provided.
- Open Space areas should be contiguous areas of significant environmental features and will be provided to the city in excess of standard 5% parkland subdivision dedication requirements.

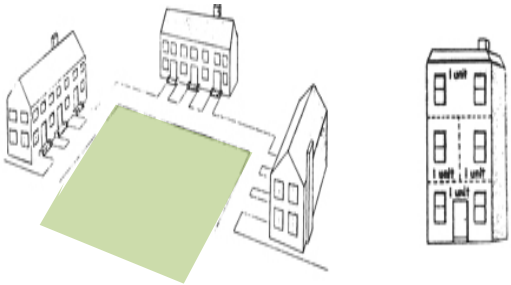


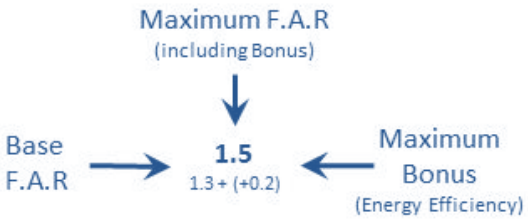
TABLE 3.10 HIGH DENSITY CLUSTER – PLANNING GUIDELINES

-DENSITY	**TYPE 1** **Max UPA** **(including Open Space Bonus)** Base UPA → **27** (22 + (5) OS (10%)) ← Max Bonus (with OS) ↑ Minimum Open Space (OS) %	☐ If a minimum of 10% open space is conveyed to the city above standard 5% parkland subdivision dedication requirements the application is considered under TYPE 1 and a base density of 22 units per gross acre may be applied to the site. ☐ If a minimum of 15% open space is conveyed to the city above the standard 5% parkland subdivision dedication requirements the application is considered under TYPE 2 and a base density of 25 units per gross acre may be applied to the site. ☐ An Energy Density Bonus may be available in tandem with the Open Space allocation being provided for up to 5 units per acre. See Energy Efficiency Density Bonus Policy. ☐ The open space allocation amounts within the Cluster designations are to be conveyed to the city above the typical prescribed parkland dedication requirements. ☐ Density is to be calculated on the basis of the entire lot, only if, substantial open space and/or Agricultural Land Reserve buffers are provided in accordance with the West Clayton NCP and/or Farm Protection Development Permit Guidelines. If Open space is not provided, base density UPA is to be considered the maximum for the lot.
	TYPE 2 **Max UPA** **(including Open Space Bonus)** Base UPA → **30** (25 + (5) OS (15%)) ← Max Bonus (with OS) ↑ Minimum Open Space (OS) %	
POSSIBLE ZONES	☐ On the basis of the Net Density resulting from the application of 22-25 units per acre Gross Density, the allowable zones on developable portions of the private properties may include: RC, RF-SD, RM-15, RM-23, RM-30 and site-specific CD, provided that development is restricted to areas north of the Gas ROW.	
BUILT FORM	☐ Clusters of attached multiple ground-oriented townhouse units in a strata development. Along with the clusters of multiple attached units, duplex/side-by-side detached units may also be provided as part of a comprehensively designed strata development.	
HERITAGE CONSIDERATIONS	☐ Within this designation the West Clayton Heritage Study identifies the House at 18772 74 Avenue as a potential resource. See **Heritage Strategy**.	
LANDSCAPED / PERMEABLE SURFACES	☐ On-lot pervious surface equal to a consolidated infiltration area of a minimum of 10% of the lot area to be located in the front yard; and ☐ 800mm of pervious material on all pervious surfaces in the developable area of the lot. ☐ For details and additional requirements, see **Drainage and Environment Section**.	
GREEN INFRASTRUCTURE MANAGEMENT	☐ Lands south of the BC Gas ROW are intended for forest preservation, and to provide extension of parkland via conveyance of open space to the city through a site specific zone. This area is Green Density Transfer area, which allows for the transfer of the density entitlement from it on a site to the developable portion of the remaining site. ☐ South of 74 Avenue, a minimum of 60 metre wide corridor is required for forest preservation and/or forest restoration or establishment purposes to support wildlife habitat. This corridor is located on the east side of the southerly road of the 186A Street adjoining the High Density Cluster area. 20 meters of the area adjacent to the Corridor is designated as a Green Density Transfer area. ☐ The total width of the forest corridor will be 60 metres between 186A and the High Density Cluster Residential area and it will function as a BCS Corridor. ☐ Tree retention may be required.	
MINIMUM LAND ASSEMBLY	☐ May be required. See **Land Consolidation Strategy.**	

3.3 COMMERCIAL, MIXED USE RESIDENTIAL AREAS

Approximately 9.1 hectares (22.4 acres) of the West Clayton NCP area is designated for NEIGHBOURHOOD COMMERCIAL OR MIXED USE COMMERCIAL /RESIDENTIAL uses. A variety of building forms may be permitted within the mixed used and commercial designated lands depending on their location.

Unless mentioned otherwise, Base Densities Floor Area Ratios (FAR) may be increased based on Energy Efficiency Policy as illustrated in the example below.



Intent of Planning Guidelines

The land use planning guidelines of the Commercial and Mixed Use areas support the following Planning Principles:

PRINCIPLE 1

Reinforce the Clayton village centre as a focus for the Greater Clayton community and create a focus for the West Clayton neighbourhood around the future rapid transit station by providing a mix of commercial spaces and residential land uses, and outdoor public spaces at these locations, and by ensuring pedestrian oriented and people friendly spaces and buildings.

PRINCIPLE 2

Provide opportunities in the neighbourhood for safe and convenient access to shopping, services and amenities within a short distance of most homes that are convenient for walking and bicycling.

PRINCIPLE 3

Encourage street and pedestrian friendly site and building designs.

PRINCIPLE 4

Provide a street grid and maximize street connectivity within the neighbourhood, and provide appropriate densities and mix of uses within 400-800 metres of the village centre and the rapid transit station to support transit and energy efficiency, sharing of waste energy between different land uses.

Commercial Nodes

Three Commercial nodes are provided in the Land Use Concept Plan and each of these nodes contain commercial and/or mixed use designations. The three neighbourhood nodes include:

1 Transit Station Node

The Transit Station Node is located along 184 Street between Fraser Highway and the future 71A Avenue. Fraser Highway from City Centre to 196 Street is a planned Frequent Transit Corridor in the Official Community Plan. A light rail transit station is proposed at the intersection of Fraser Highway at 184 Street. This area contains MIXED USE COMMERCIAL /RESIDENTIAL designations.

2 Village Centre Node

This neighbourhood Village Centre node is located at the intersection of 72 Avenue and 188 Street. Given its central location in Clayton and accessibility within about 10-12 minutes walking distance from the surrounding area, it has been envisioned as a Village Centre for Clayton in the 1998 Clayton General Land use Plan and recognized as such in the East Clayton NCP and East Clayton North NCP.

The proximity to the Clayton Community Park and the future Public Recreation, would reinforce is role as the village centre for the Clayton community. The central location and the future upgrading of 72 Avenue to its full arterial road standard connecting to Fraser Highway should attract a range of commercial businesses including a supermarket-type of store of approximately 4,100 sq. m. (45,000 sq. ft.) floor area, acting as an anchor for smaller retail stores and other businesses (See Commercial Study in APPENDIX A-2). While most of the office uses, such as professional offices, may gravitate towards the Transit Station Node, some of the offices may also locate at this node given its central location. To accommodate the expected range of commercial uses and to generate pedestrian traffic, Mixed Use Commercial/Residential and Commercial designations are provided at this node, as follows:

- MIXED USE COMMERCIAL/RESIDENTIAL to the south-west of 72 Avenue and 188 Street. The residential units, in addition to bringing pedestrian activity to the node, will also create active interface with the future community recreation centre in the adjacent Clayton Park; and
- NEIGHBOURHOOD COMMERCIAL to the north-west of this intersection.

3 Local Commercial Node

This Neighbourhood commercial node is proposed at the south-east corner of 74 Avenue and 184 Street. It is intended for small-scale neighbourhood convenience retail and service stores to meet day-to-day shopping needs of the residents living within the walking distance.

This area contains the NEIGHBOURHOOD COMMERCIAL designation.

3.3.1 Mixed Use Commercial / Residential

The MIXED USE COMMERCIAL/RESIDENTIAL designation is intended for medium-rise, multiple unit residential buildings and related amenity spaces, which are to be developed in accordance with a comprehensive design. The built form that integrates commercial and residential uses in the same building.

The ground floor of the buildings will be designed to accommodate small, pedestrian-oriented retail shops (as opposed to large-format retail), and personal and general service stores, all with their primary store entrances from the adjacent streets. Small-scale offices and other commercial businesses permitted, if provided, should be located above ground floor.

Parking access is to be provide by rear lane access parking lot and underground parking for apartments. Some form of indoor and outdoor amenity spaces are to be provided on site.

TYPE 1 – VILLAGE NODE

Max FAR

1.5

Base FAR → 1.3 + (0.2) ← Max Bonus

TYPE 2 – TRANSITE NODE

Max FAR

1.8

Base FAR → 1.5+ (0.3) ← Max Bonus

DEVELOPMENT CONSIDERATION FOR

MIXED USE COMMERCIAL/ RESIDENTIAL:

- Densities within MIXED USE COMMERCIAL / RESIDENTIAL designation may range as follows:

  TYPE 1 – VILLAGE NODE area has a base Floor Area Ratio of 1.3 up to a maximum of 1.5 Floor Area Ratio with Energy Efficiency Bonus.

  TYPE 2 – TRANSIT NODE areas have a base Floor Area Ratio of 1.5 up to maximum 1.8 Floor Area Ration with Energy Efficiency Bonus.

- At select locations identified in the NCP, the ground floor of street-fronting units may need to be designed to facilitate the option for live-work.

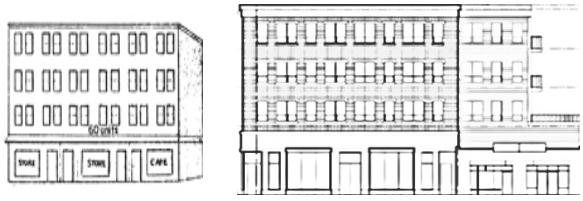


TABLE 3.11 MIXED USE COMMERCIAL / RESIDENTIAL – PLANNING GUIDELINES		
DENSITY	TYPE 1 – VILLAGE NODE **Max FAR** **(including Bonus)** Base FAR → **1.5** (25 + (2)) ← Max Bonus	□ Base density of 1.3 FAR. □ A Bonus Density of 0.2 FAR may be available. See **Energy Efficiency Density Bonus Policy** □ Buildings up to 4 Storeys
	TYPE 2 – TRANSIT NODE **Max FAR** **(including Bonus)** Base FAR → **1.8** (1.5 + (0.3)) ← Max Bonus	□ Base density of 1.5 Floor Area Ratio (FAR). □ A Bonus Density of 0.3 FAR for additional may be available. See **Energy Efficiency Density Bonus Policy** □ Building up to 6 Storeys
POSSIBLE ZONES		□ The allowable zones may include: RM-45, RM-70 and site-specific CD. C-15 may also be considered as a base zone for the CD Zone, subject to the height being restricted to the maximum allowable height in RM-45. A CD Zone is preferred to provide for innovative comprehensive developments.
BUILT FORM		□ Preferably a built form that integrates commercial and residential uses in the same building. The ground floor of the buildings will be designed to accommodate small, pedestrian-oriented retail shops (as opposed to large-format retail), and personal and general service stores, all with their primary store entrances from the adjacent streets. □ Small-scale offices and other commercial businesses permitted under the C-15 Zone, if provided, should preferably be located above ground floor. Alternatively, if they are located within the ground floor, they should not occupy any street-fronting location on 184 Street. □ Separate commercial and residential buildings may be permitted, provided that: o the ground floor of the stand-alone commercial building is designed to meet the same criteria as the criteria of the building which has commercial and residential integrated in the building, as noted above under the previous two bullets; and o The street-fronting portions of the ground floor of the stand-alone residential building are designed to facilitate the options for live-work, as described under Land Use Option – Live-Work. The live-work units should front onto and be directly accessible from the adjacent streets.
HERITAGE CONSIDERATIONS		□ Within this designation, the existing Clayton United Church building at 7027 184 Street is on the City's heritage register. Currently, it is used as Surrey Little Theatre for live theatre performances. The building should be preserved, as an integrated part of a comprehensive development within the same block and parking provision for the theatre use within the same block should be addressed. Incentives such as additional density, zoning variances, parking relaxations, etc. and other appropriate incentives may be considered. □ See Heritage Strategy.
LANDSCAPED / PERMEABLE SURFACES		□ BMP (Best Management Practices) measures may be required. □ For details and additional requirements, see Drainage and Environment Section
MINIMUM LAND ASSEMBLY		□ May be required. See Land Consolidation Strategy.

3.3.2 Neighbourhood Commercial

The NEIGHBOURHOOD COMMERCIAL designation is intended to promote a mix of commercial, retail, restaurant, and office uses which serve the day-to-day needs of surrounding residents. It caters to shoppers in the immediate neighbourhood for convenience items, such personal care, and groceries, including dental and medical offices. A supermarket-type of store of approximately 4,100 sq. m. (45,000 sq. ft.) floor area is preferred on the northern side of 72 Avenue and 188 Street.

Walk ability and pedestrian access are key considerations. Parking access is to provide by underground parking for any above ground office uses.

DEVELOPMENT CONSIDERATION FOR
MIXED USE COMMERCIAL/ RESIDENTIAL:

Densities within NEIGBHOURHOOD COMMERCIAL have a Floor Area Ratio of 0.5 but may consider an addition of up to 0.3 FAR for the site north of 72 avenue and west of 188 Street.

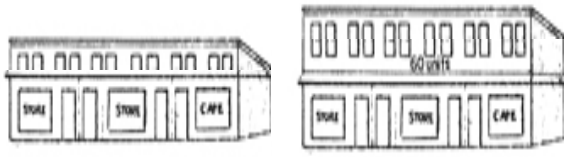


TABLE 3.12 NEIGHBOURHOOD COMMERCIAL – PLANNING GUIDELINES		
DENSITY	**Max FAR (including Bonus)** ↓ Base FAR → **0.5** ← Max Bonus 0.5 + (N/A)	□ 0.5 Floor Area Ratio (FAR)
POSSIBLE ZONES	□ The allowable zones may include: C-5, C-8 and site-specific CD. A CD Zone is preferred to provide for a comprehensive development.	
BUILT FORM	□ Buildings primarily 1 Storey up to 2 storeys. □ The street-fronting portions of the ground floor of the buildings will preferably be designed to accommodate small, pedestrian-oriented retail shops and personal and general service stores, all with their primary store entrances from the adjacent streets. A larger store such as a grocery store or drug store may be located preferably away from 188 Street or 72 Avenue locations. □ Small-scale offices and other commercial businesses, If provided, should preferably be located above ground floor. Alternatively, if they are located within the ground floor, they should preferably not occupy any street-fronting location. □ Small stores to provide retail and personal services. □ Any Dwelling units integrated within the buildings should be encouraged to bring activity to the area and to enhance safety and security, provided they are located on the second floor.	
LANDSCAPED / PERMEABLE SURFACES	□ BMP (Best Management Practices) measures may be required. □ For details and additional requirements, see General Servicing, Section	
Green Infrastructure Management	□ The existing Class "B" watercourse, currently located in a culvert under 184 Street, should be day lighted and relocated to the east of the Commercial development, within an appropriate riparian buffer straddling the commercial site and the adjacent multiple density residential site. □ See Interface Cross Sections.	
Minimum Land Assembly	□ May be required. See **Land Consolidation Strategy.**	
Design Considerations	□ Provision for Urban Landmark Feature may be required.	

3.3.3 Land Use Option: Live - Work

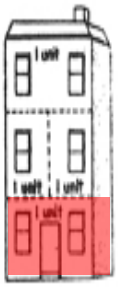
The LIVE-WORK designated areas are intended to allow up to 30% of the total floor area of a residential unit to be designed to accommodate a variety of low impact small-scale commercial uses such as: artist studios and galleries, businesses such as bakery, deli, coffee shops, hair-salons, custom tailors, computer service and professional office uses such as interior designers, lawyers, accountants, architects, etc.

DEVELOPMENT CONSIDERATION FOR **LIVE-WORK:**

LIVE-WORK may be considered generally within most of the residential designations subject to addressing the location-specific issues and as part of a Comprehensive Development zone. However, in order to reduce the impact of business-related activities and on-street parking that will be a requirement for live-work units, the Land Use Concept Plan specifically provides for the live-work option in select locations:

In the MIXED USE COMMERCIAL/RESIDENTIAL designation:

- Within the block bounded by 183 Street, 71 Avenue, 183A Street and 184 Street:
  - On the east side of 183 Street:
  - On the south side of 71 Avenue; and
  - On the west side of 183A Street.
- To the south-east of 71 Avenue and 183A Street:
  - On the East side of 183A Street; and
  - On the south side of 71 Avenue.
- To the East of 184 Street on the north side of 70 Avenue up to the Pedestrian Street.



←Residential

←Residential

←Live-Work Space

In the TOWNHOUSE/APPARTMENT FLEX designation

- Between 71A Avenue and 72 Avenue on both sides of 183 Street;
- Between 183 Street and 184 Street on the north side of 71A Avenue; and
- From 185 Street up to the east boundary of the NCP area, adjacent to the Clayton Heights Secondary School on the south side of 70 Avenue.

In the TOWNHOUSE RESIDENTIAL designation:

- Between Fraser Highway and 71A Avenue – on the west side of 183 Street; and
- Between 184 Street and 185 Street – on the south side of 70 Avenue.

In the STACKED TOWNHOUSE designation:

- To the south-west of 71A Avenue and 184 Street – on the south side of 71A Avenue; and on the north side of 71 Avenue.
- To the east of the Clayton Park, between the Pedestrian Street (185 Street alignment) and 185A Street – on the north side 0f 70 Avenue.

At the above-noted select locations, provision for live-work spaces at the ground floors of the street-fronting units will be strongly encouraged. On-street parking will be a requirement for these units. Additional dedicated live-work parking, if necessary, may be provided within the strata development site associated with the units as part of a compressive development.

3.4 INSTITUTIONAL USES

Approximately 15.5 hectares (33.8 acres) of the West Clayton NCP area is designated for School or Institutional Uses. The combined total Institutional and School uses account for about 5% of the entire NCP Area. Three elementary school sites have been identified on the Land Use Concept Plan, as well as one Secondary school site. A Recreation and Community Facility is proposed to be constructed north of Clayton Park along 72 Avenue adjacent to the Clayton Village Area. This facility may also include a Clayton Library facility.

Private Schools, Daycares, Assembly Halls and other such institutional uses have not been specifically located,. rather, general, criteria for such uses are as follows:

- Uses may be considered in Mixed us and Commercial Designations;
- Daycares would be suitable in residential areas, as well as areas in close proximity to schools.

Any future consideration of other institutional uses is preferred:

- along transit routes;
- on arterial or collector roads when possible close to commercial nodes;
- to include public amenities such as benches and seating, plaza areas, public art as part of the development where appropriate.

School Projections

The construction of two new elementary schools is a high priority in the Surrey School district's 5-year capital plan (awaiting Ministry of Education funding approval).

Student demand in West Clayton is to be relieved for by constructing 2-3 new elementary schools in the Clayton area and adding a potential addition to Clayton Elementary.

A new 1,500 capacity secondary school located along 184 Street between 74 Avenue and 72 Avenue is in the design phase and is scheduled to open in 2017.

Based on full build out of the West Clayton NCP it is estimated that 2,200 to 3,000 (plus) new students will be enrolled in schools from Kindergarten to Grade 12, [1,350 - 1,850 (plus) elementary students 850 – 1150 (plus) secondary students]. It is estimated that the Schools and future Recreation / Library facility combined will provide for 70-100 jobs within West Clayton.

Table 3.13 Summary of West Clayton Land Use Designation, Zoning and Density Potential Guidelines

ZONES	WEST CLAYTON NCP – LAND USE DESIGNATIONS											
	Suburban	Urban Transition	Low Density Cluster	Medium Density Cluster	High Density Cluster	Urban Residential	Townhouse Residential	Urban / Townhouse Flex	Stacked Townhouse / Apartment	Townhouse / Apartment Flex	Mixed Use Commercial / Residential	Neighbourhood Commercial
Single Family												
RA	○											
RH												
RC			○	○	○							
RF		○	○									
RF-G		○	○	○								
RF-12			●	○		○		○				
RF-10				●		●		○				
Two Family Residential												
RF-SD				●	○	●	○	○				
Multiple Family												
RM-10			●	○		○						
RM-15					○	●	○	○				
RM-23				●	○		○	●				
RM-30					●		●	●	○	○		
RM-45									○	○	○	
RM-70											●	
Commercial and Mixed Use												
C-4												○
C-5												○
C-15											○	
Comprehensive Development												
*CD		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
FORM / DENSITY GUIDELINES												
Base UPA **(+Bonus) =			6-8 *(+4)*	10 *(+4)*	22 *(+5)*	10 (+4)	22 *(+5)*	10-22 *(+2)*	25-45	30-45	45-60	
MAX UPA	**2 (Net)**	**6 (Net)**	**10 (Gross)**	**14 (Gross)**	**27 (Gross)**	**14 (Net)**	***27 (Net)***	***24 (Net)***	**45 (Net)**	**45 (Net)**	**60 (Net)**	
Base FAR **(+ Bonus) = **MAX FAR**		**0.52**	**0.5-0.6**	**0.5 - 0.7**	**0.5 - 0.9**	**0.6-0.7**	**0.9**	**0.7**	1.5 *(+0.3)* **1.8**	1.3 *(+0.2)* **1.5**	1.5 *(+0.3)* **1.8**	0.5 **0.5**
***Minimum Open Space %			5-7.5%	5-10%	10-15%							
Max Height	(30 ft.) 2-3 Stories	(30 ft.) 2 Stories + Basement	(31 ft.) 2 Stories + Basement	(36 ft.) 3 Stories	(43 ft.) 3 Stories	36 ft.) 3 Stories	(43 ft.) 3 Stories	(36 ft.) 2 – 3 stories	(60 ft.) 4- 6 Stories	(50 ft.) 4-Stories	(70 ft.) 4- 6 Stories	(30 ft.) 2 Stories +

○ Base Density Only

● With Energy Efficiency or Open Space Density Bonus

◆ Comprehensive Development Zone based on potential combinations of Zones identified above.

3.5 PARKS AND GREEN SPACE

Approximately 70 hectares (175 acres) of the West Clayton NCP is designated as an integrated system of parks, green spaces and environmental conservation areas (Figure 3.2).

Central to the system is Clayton Park, a large community level park which serves the broader Clayton Heights area.

There are eight (8) new neighbourhood parks planned throughout the NCP within walking distance of all new residents. Supplementing these neighbourhood parks are a number of linear parks and Biodiversity Conservation Strategy (BCS) corridors, riparian areas and Agricultural Land Reserve (ALR) buffers.

The parks and green spaces are connected through an integrated network of greenways and multi-use pathways to ensure all residents are safely and accessibly connected through the community.

Parks Planning and Design in Surrey is guided by a number of plans, strategies, guidelines and standards. These include the Parks, Recreation & Culture Strategic Plan, Parks Design Guidelines, Parks Standard Construction Documents as well as more thematic plans and strategies, such as the Dog Off-leash Strategy, Greenways Master Plan, Natural Areas Management Plan and the Playground Master Plan.

Within the hierarchy of plans, the *Parks, Recreation & Culture Strategic Plan* establishes the strategic direction for the provision and development of parkland in Surrey, including the general planning activities and needs identification for park amenities across the City.

Parks Design Guidelines provides a framework for the design and development of parks, including a design aesthetic that expects quality, focuses on the sustainability of park development and ensures a more consistent look and feel throughout Surrey's park system. The Parks Standard Construction Documents provide reference for staff and external consultants to guide specific and detailed park development processes.

Surrey's Parks, Recreation & Culture Department will manage and oversee the planning, design, construction and maintenance of all parks within the West Clayton NCP. Planning and design of each park identified within the plan will be completed in consultation with the future community.

3.5.1 Clayton Park

The West Clayton Parks, Recreation and Open Space Plan is centered on Clayton Park, an existing large integrated-use community level park with both passive and active amenities that attract residents from the surrounding neighbourhoods (Park Site A on Figure 3.2).

Clayton Park is home to a baseball diamond, playground, sports court, picnicking areas, pathways and trails, as well as the Clayton dog off-leash area and the Surrey Lawn Bowling Club. The park currently measures an area of over 11 Ha (28 acres), which includes approximately 9 hectares (22 acres) of forest and natural area, which includes the headwaters of a class B creek.

As part of the West Clayton NCP, Clayton Park will be expanded to an ultimate size of over 16 hectares (40.4 acres), creating an integrated central green hub for the community. The park will be improved with additional amenities to serve the growing community, such as new tennis courts, expanded athletic fields, playground upgrades, a youth park, a horticultural display garden, parking upgrades and other amenities identified through a future public consultation process. The park's natural areas will be retained with opportunities for nature play as well as additional forest pathways and trails. The northwest of the park is also the future home of a community centre for the residents of Clayton

3.5.2 Neighbourhood Parks

In addition to Clayton Park, the NCP will provide eight (8) new neighbourhoods parks, intended to serve the needs, and be within walking distance of local residents (see Figure 3.2). These neighbourhood parks will range in size from large, integrated parks with several active amenities, to urban mini parks and plazas. Where possible, neighbourhood parks will also include pockets of natural areas to serve both habitat and creative play purposes. They will each be designed through a public process to serve the needs of their immediate neighbourhood.

In total, the NCP will provide around 14 hectares (35 acres) of new neighbourhood parkland, spread between the following locations identified in Figure 3.2:

Park Site B is approximately 8.5 hectares (21 acres) and will be located next to Clayton Elementary School. The park features a unique topography, with sloping meadows and considerable natural area, including two fish bearing creeks. The park will offer unique views over the Serpentine lowlands, with opportunities for amenities such as viewing platforms, picnicking areas, disc golf, pathways and a play area. The park will also form part of the green buffer between the adjacent residential neighbourhoods and the ALR, and will protect a portion of BCS corridor (GIN #140), that runs along the western edge of the NCP. Given the size of this park it is anticipated a parking lot will be required with access from 184 Street. This future park site is highly visible from Hwy 15 and other arterial roads and as such is key to preserving the viewscape of a forested escarpment along the northwest edge of Clayton

Park Site C is a small neighbourhood park located in a medium density residential neighbourhood. Due to the projected density of surrounding areas, there will be a need for a play area, as well passive open space.

Park Site D is located within the mixed use transit node, within walking distance of the future LRT station and higher density multi-family developments. This urban mini-park will be more intensively programmed to take advantage of limited space, providing opportunities for an urban plaza with horticultural beds, seating areas and play. Lighting may be considered given the size and location of this park.

Park Site E is a small (0.48 ha) active park located next to the future high school along the central BCS corridor (GIN #141). Given its proximity to the high school, the park will be suited for youth oriented amenities, such as beach volleyball. The park will also provide an amenity node along the Hazelgrove Greenway.

Park Site F is a small (0.67 ha) passive park located along the Hazelgrove Greenway. In addition to providing open space, the site offers an opportunity to daylight an existing yellow coded stream currently piped along 184 Street.

Park Site G is approximately 1.25 hectares (3.13 acres) and will predominantly be a natural area neighbourhood park, reflecting the character of the surrounding lower density residential neighbourhood and the site's existing natural features. Potential amenities include an improved natural area, forest trails, a nature play area and passive open space. The site is home to the headwaters of a yellow coded creek and is adjacent to east-west BCS Corridor (GIN # 139).

Park Site H is located along the Hazelgrove Greenway adjacent to existing parkland in the East Clayton NCP area. When combined with the existing adjacent parkland this site will measure an area of approximately 2.2 hectares (5.5 acres). The site is bisected by a Fortis gas main, which limits larger active amenities, although provides opportunities for passive park amenities such as community gardens, bike tracks, pathways and passive open space.

Park Site I is approximately 1.19 hectares (3 acres) and is located along the central BCS corridor (GIN #141). The park offers opportunities for natural areas with complementary amenities such as forest trails, seating areas and children's nature play.

3.5.3 Linear Parks & Biodiversity Corridors

In addition to active parkland, the West Clayton NCP features a total of 8.75 hectares (21.5 acres) of linear park & Biodiversity Conservation Strategy (BC) corridors. These corridors are linear habitat areas that encourage the movement of species between fragmented hubs and site. They allow species to access new habitat features required to meet their life needs. They also support a pathway network which link active park sites and provide an integrated green network across the plan area. Although these corridors are predominantly natural areas, other amenities may include pathways, benches, viewpoints and open meadow.

Biodiversity Conservation Strategy (BC) corridors vary in corridor width and habitat requirements depending on the species they are intended to support and where they are located within the City. Corridors that have been identified within the BCS are all considered significant and a priority to establish. Each corridor has been identified by a Green Infrastructure Network (GIN) ID number, with corresponding recommendations for their implementation within the BCS. The development of BCS corridors within the NCP will correspond with the management objectives and best practices outlined within the BCS.

BCS Corridor (GIN #139)

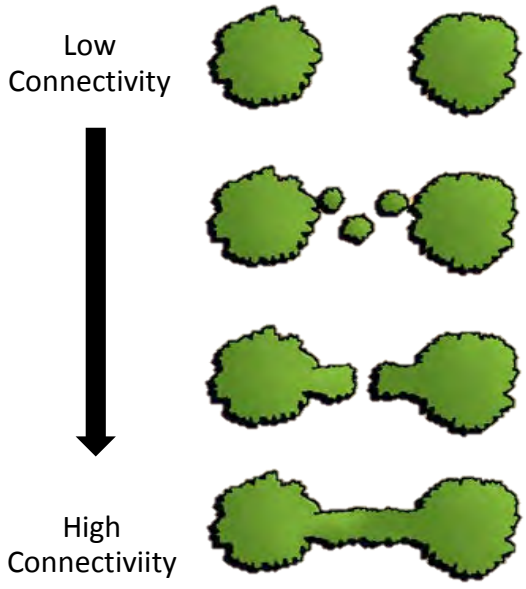
Located between 77B and 78A Avenue, this corridor provides wildlife connectivity between the ALR, BCS Corridor GIN # 140 and BCS Hub 'C' in the east (located in the future North Clayton NCP area). This area supports habitat for species at risk, with a target corridor width of 60m. The corridor is also the alignment of the Great Northerm Greenway, providing multi-use pathway connectivity across the northern portion of the NCP, and is adjacent to neighbourhood park site G.

BCS Corridor (GIN #140)

This BCS corridor has a target width of 50m which provides wildlife connectivity and ALR buffering along the western and northern edge of the plan area. The corridor provides important edge habitat for ALR field habitat, including an established forested corridor along the ALR perimeter. The corridor also provides a linkage with BCS Corridor GIN #139, as well as a neighbourhood park site B, and is host to the Great Northern Greenway providing multi-use pathway connectivity through the plan area.

Central BCS Corridor (GIN #141)

BCS corridor GIN # 141 provides wildlife and multi-use pathway connectivity through the central core of the plan area, linking North Creek (south of Fraser Highway) and Clayton Park with the northern BCS Corridor GIN #139, and neighbourhood park sites E and I. The corridor's multi-use pathway will connect with the Hazelgrove Greenway and Great Northern Greenway, providing safe and accessible off-street pedestrian and bicycle connections to the adjacent elementary and high school sites. This corridor has a target width of 60m, and should be naturalized and reforested as much as possible.



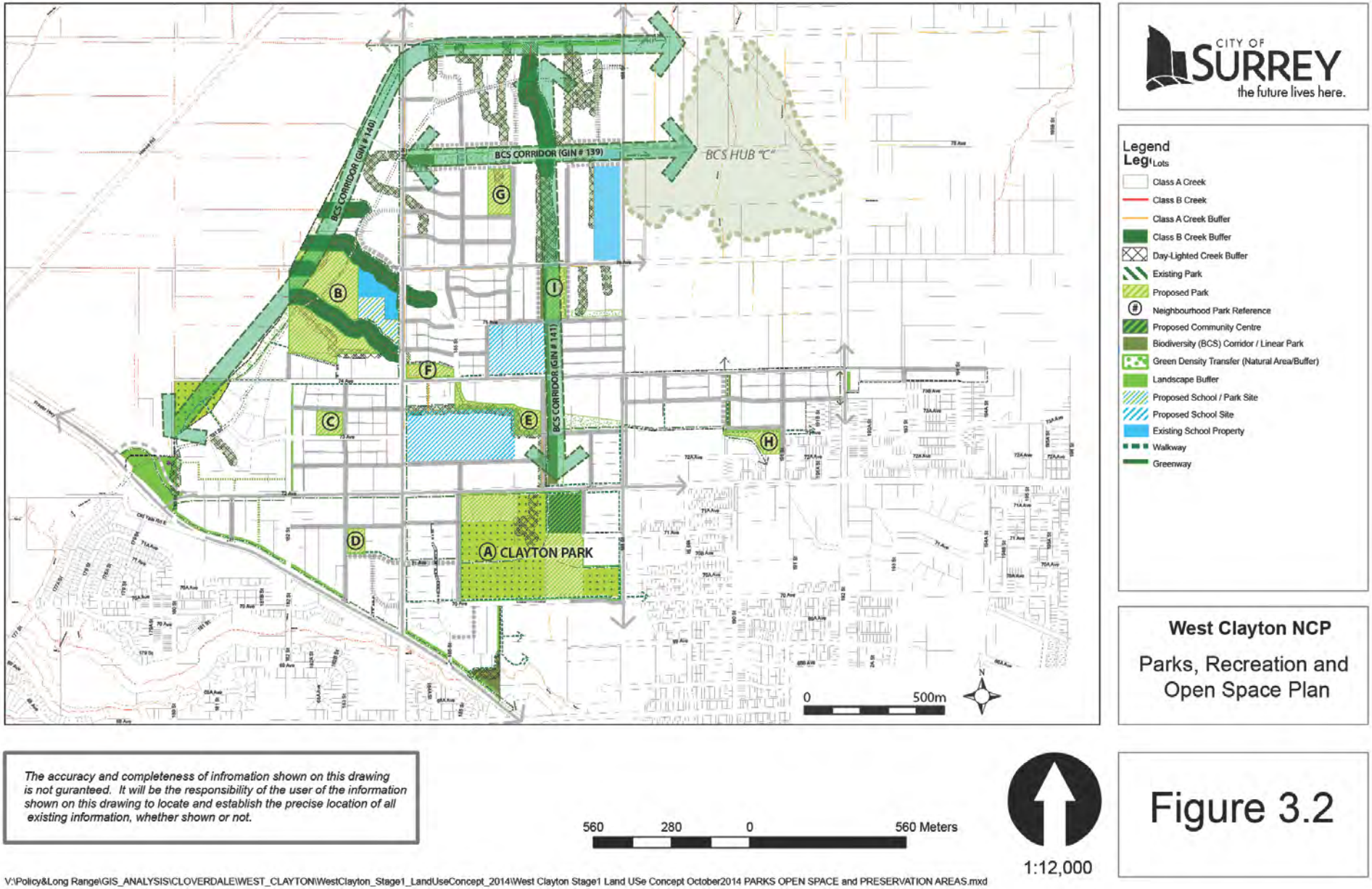


Figure 3.2 - Clayton Parks and Open Space Areas

3.5.4 Greenways & Multiuse Pathways

The West Clayton parks and green space system is connected through an integrated network of off-street greenways and multi-use pathways. These connections provide a convenient and accessible active transportation network, reducing dependencies on automobiles and linking residents with community amenities and services.

Great Northern Greenway

The Great Northern Greenway follows the alignment of BCS Corridor #'s 139 & 140, connecting with the Armstrong Greenway at 184 Street, as well as neighbourhood parks B & G. Portions of the greenway will follow the alignment of the sewer main, particularly at major creek crossing where it will take advantage of shared sewer-pathway bridge crossings. The greenway will connect with neighbourhoods south of Fraser Highway at the 72nd Avenue intersection.

Armstrong Greenway

The Armstrong Greenway is an on-street multi-use pathway that follows the alignment of 184 Street. It provides a direct connection between the future LRT station transit oriented development area with the residential neighbourhood to the north. It provides connections with a number of east-west multi-use pathways, including the Hazelgrove Greenway, Great Northern Greenway and Serpentine Flats Greenway.

Siddons Greenway

The Siddons Greenway follows the alignment of the central BCS Corridors (GIN #s 141), connecting Clayton Park and the future community centre and library with the residential neighbourhoods to the north. Like the Armstrong Greenway, it also provides connections with a number of east-west multi-use pathways, including the Hazelgrove Greenway, Great Northern Greenway and Serpentine Flats Greenway.

Hazelgrove Greenway

The Hazelgrove Greenway is a mixed on-street and off-street multi-use pathway that runs east-west through the centre of the NCP area, linking neighbourhood park B in the west with the East Clayton NCP in the east. Along the way the Greenway also connects with neighbourhood park sites E, F & I, the Armstrong and Siddons Greenway and the new high school site.

Serpentine Flats Greenway

The Serpentine Greenway follows the alignment of 80 Avenue, and forms the northern boundary of the NCP. It extends west across the ALR to Newton and East into Langley providing the NCP with regional greenway linkages.

Fraser Greenway

The Fraser Greenway is an on-street multi-use pathway that follows the alignment of Fraser Highway along the southern boundary of the NCP. The Fraser Greenway runs predominantly on the south side of Fraser Highway, with the exception that multi-use pathways are featured on both sides of Fraser Highway within the extents of the NCP. It continues northwest across the ALR to Fleetwood, and southeast into the Langley.

3.5.5 Riparian Areas

A total of 29 hectares (72 acres) of riparian area are located within the West Clayton NCP. This includes approximately 10.5 hectares of red coded (Class A) creeks, 18.2 hectares of yellow coded (Class B) creeks and 0.5 hectares of day-lighted creeks. The final amount and location of riparian areas will be subject to the approval of the Surrey Riparian Area By-law, and at minimum will comply with the Federal Fisheries Act and Provincial Fish Protection Act.

Riparian areas provide for limited or no public access as their function is to protect sensitive habitat areas, including the land around all significant creeks. In some cases, however, low impact natural area pathways should be encouraged along the edge of riparian areas, adjacent to residential development, as a means to provide neighbourhood connectivity, access to nature and to prevent residential encroachment. In such cases, riparian area fencing is required on the creek side of the path to limit access into sensitive habitat areas.

Riparian areas are considered undevelopable and are to be conveyed to the City through the development process, subject to the Surrey Riparian Area By-law, for long term management and protection.

SECTION 4
Transportation Network

4.1 EXISTING TRANSPORTATION NETWORK

At present, the City's existing road network in West Clayton is relatively sparse and discontinuous, with predominantly two-lane rural roads with stop control. The existing road network, laning, and traffic control are illustrated in Figure 4.1, and discussed in detail in the following sections.

4.1.1 Road Network

The development of West Clayton is intended to integrate into Surrey's existing and planned major road network. Existing arterial and collector roads within and adjacent to West Clayton are described below:

- Fraser Highway is a northwest-southeast arterial road that connects Surrey City Centre to Langley and Abbotsford, and runs along the southern boundary of West Clayton. Currently four lanes through much of Surrey, including West Clayton, in the future it will carry light-rail transit (LRT) from Surrey City Centre to Langley City Centre, which is anticipated to be primarily centre-running, subject to detailed design.

- 72 Avenue is an east-west arterial road that runs through West Clayton from Fraser Highway, where it was temporarily closed in 2003, to Glover Road and 216 Street in Langley. Although mostly two lanes at present, segments in developed areas in both Surrey and Langley have been widened to four lanes, reflecting its increasingly important role in carrying inter-municipal traffic.

- 76 Avenue is a two-lane east-west collector road that runs through West Clayton from 184 Street to the Langley border (196 Street).

- 80 Avenue is a two-lane east-west arterial road that forms the northern boundary of West Clayton and connects from 168 Street in Fleetwood to 216 Street in Langley. From 172 Street to 184 Street, 80 Avenue is fully within the Agricultural Land Reserve (ALR), and from 184 Street to 188 Street, it forms the southern boundary of the ALR. Any improvements to 80 Avenue within the ALR (and to any other road in the ALR) will be costly and difficult because of the need to pre-load and acquire property, and will be subject to approval from the Agricultural Land Commission.

- 184 Street is a north-south arterial road that runs through West Clayton and currently connects from 0 Avenue in South Surrey to 80 Avenue, but is planned to ultimately connect to Anniedale Road, immediately south of Highway 1, in the Anniedale-Tynehead NCP. 184 Street is two lanes except from 68 Avenue to 70 Avenue where it is four lanes. From 80 Avenue to 90 Avenue, 184 Street is at least partially in the ALR and any improvements have the same challenges as on 80 Avenue.

- 188 Street is a two-lane north-south collector road that forms the eastern boundary of West Clayton and connects from 52 Avenue to 72 Avenue, and again from 80 Avenue to Harvie Road. The Anniedale-Tynehead NCP plans for the connection of 188 Street from 52 Avenue to Anniedale Road. From 80 Avenue to 86 Avenue, 188 Street is at least partially in the ALR and any improvements have the same challenges as on 80 Avenue.

- 192 Street is a north-south arterial road that runs from 16 Avenue to 98A Avenue with discontinuities at 64 Avenue / Fraser Highway and Highway 1. While mostly two lanes at present, the segment from 68 Avenue to 72 Avenue has been widened to four lanes, but one lane per direction is currently being used for on-street parking.

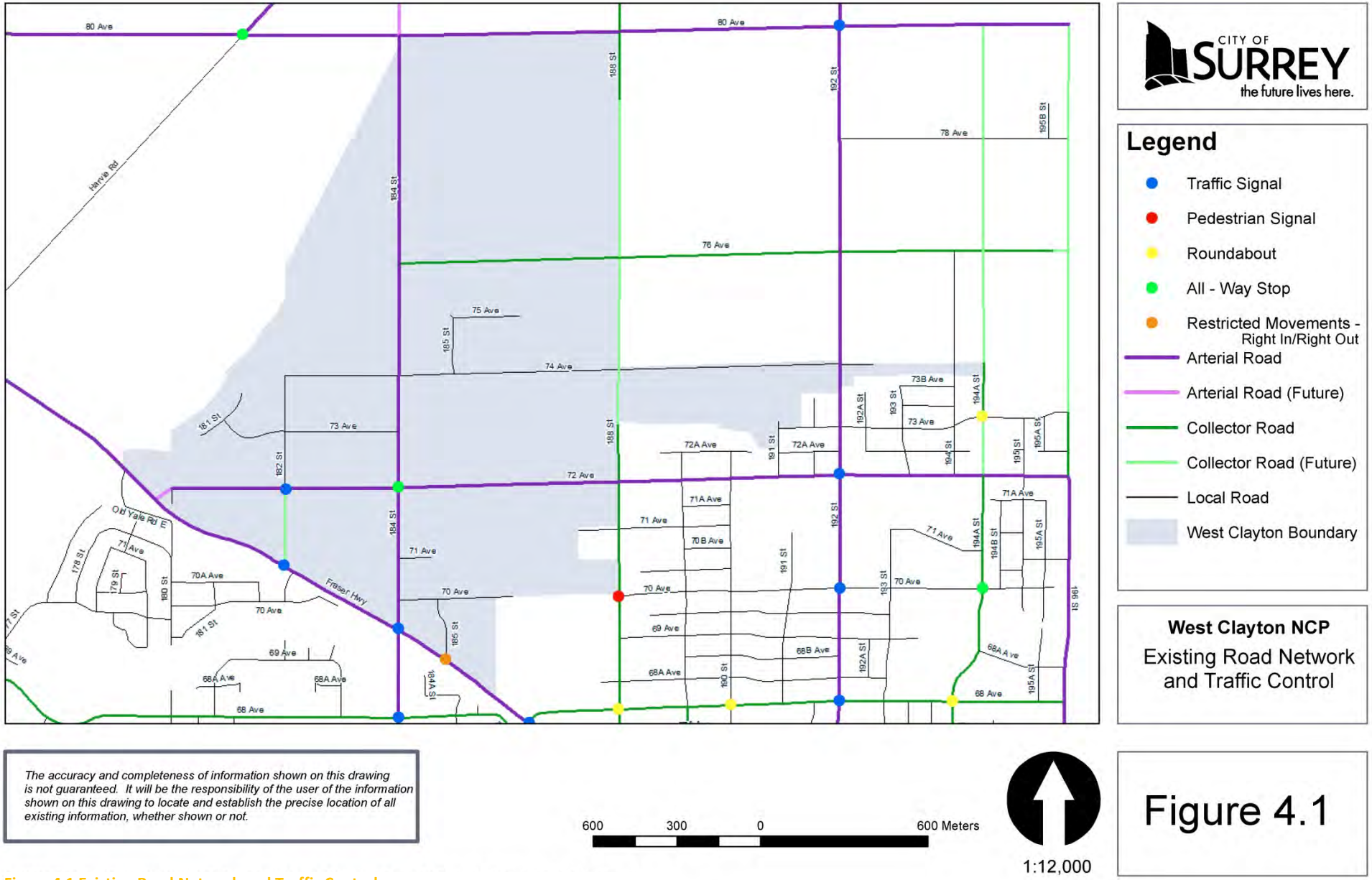


Figure 4.1 Existing Road Network and Traffic Control

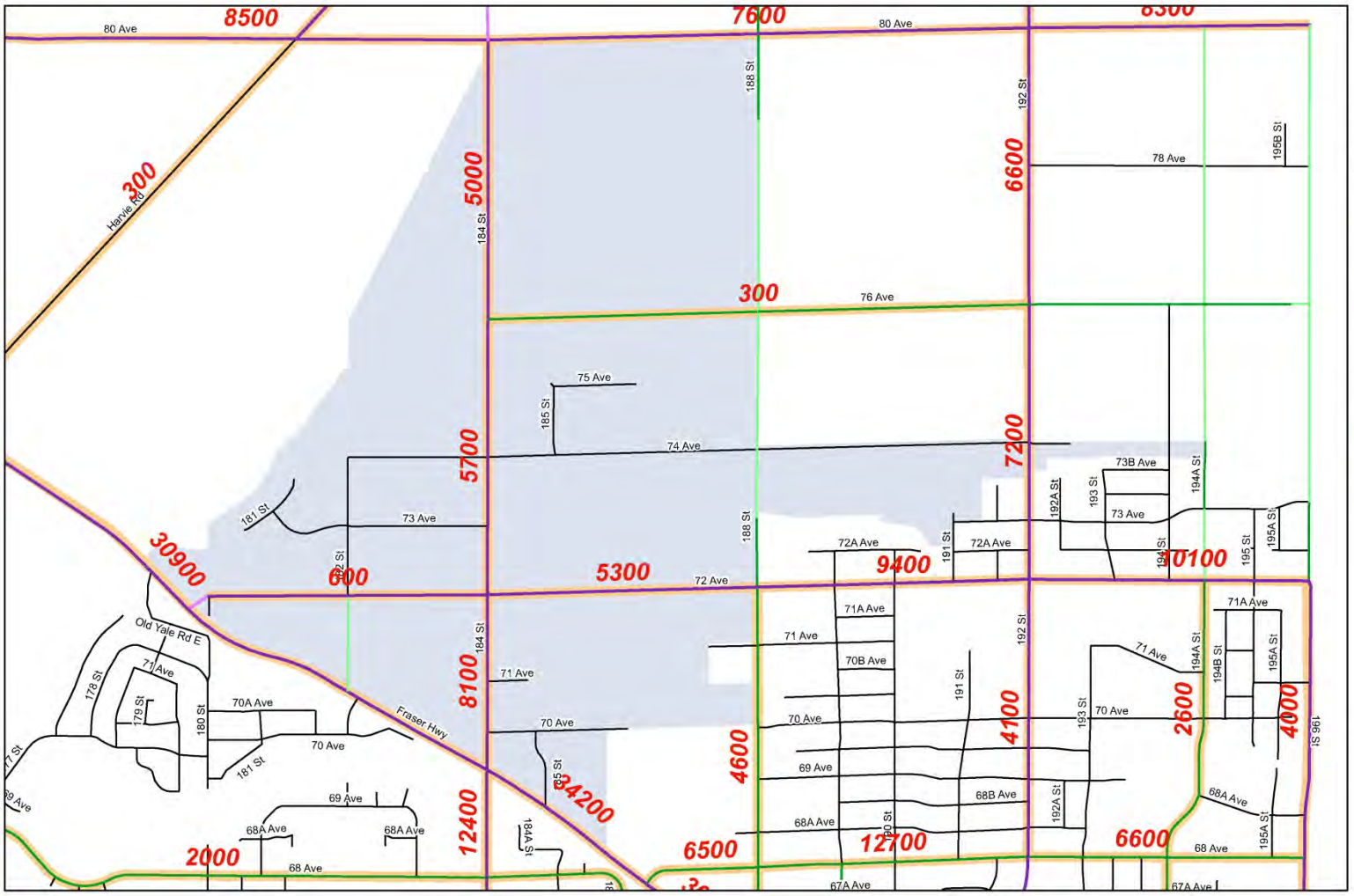
4.1.2 Recent Traffic Volume Growth

Existing traffic volumes in West Clayton are shown on Figure 4.2. While volumes on most roads within West Clayton are fairly low as a result of the predominately rural land use, they have experienced significant growth corresponding to the build-out of the East Clayton NCP over the last ten years, as well as the Willoughby community in Langley.

(A portion of 192 Street has experienced a traffic volume reduction as a result of the partial closure of 192 Street at 64 Avenue, and the construction of other road connections.) For the sake of comparison, select 2006 traffic volumes have been provided below in Table 4.1. Please note that some segments have been combined and averaged to allow direct comparison.

Table 4.1: 2006 and 2013/2014 Daily Traffic Volumes

Road Segment	2006 Daily Volume	2013/2014 Daily Volume	Change
72 Avenue, 184 Street to 188 Street	3100	5300	+71%
72 Avenue, 188 Street to 192 Street	3100	9400	+203%
80 Avenue, 184 Street to 192 Street	3700	7600	+105%
184 Street, Fraser Highway to 72 Avenue	6300	8100	+29%
184 Street, 72 Avenue to 80 Avenue	4600	5400	+17%
192 Street, 68 Avenue to 72 Avenue	5800	4100	-29%
192 Street, 72 Avenue to 80 Avenue	5600	6900	+23%
Fraser Highway, Highway 15 to 184 Street	24,500	30,900	+26%
Fraser Highway, 184 Street to 64 Avenue	20,700	32,300	+56%



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Legend

- Arterial Road
- Arterial Road (Future)
- Collector Road
- Collector Road (Future)
- Local Road
- 2013/2014 Traffic Volume
- West Clayton Boundary

West Clayton NCP

Existing Traffic Volumes

The accuracy and completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate and establish the precise location of all existing information, whether shown or not.

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Figure 4.2

Figure 4.2 Existing Traffic Volumes

4.1.3 Walking and Cycling Networks

As West Clayton is currently predominately rural in nature, nearly all existing roads in West Clayton are built to rural standards with no sidewalks or bike lanes, although they may have narrow shoulders and very low traffic volumes. The existing walking and cycling networks are illustrated on Figure 4.3, and described below.

184 Street from Fraser Highway to 76 Avenue has a narrow asphalt sidewalk on the west side, and 72 Avenue from 184 Street to 188 Street has a narrow asphalt sidewalk on the south side, which service Clayton Elementary School (7541 184 Street) and the former East Clayton Elementary School (18680 72 Avenue).

The open portion of 188 Street within West Clayton, from 70 Avenue to 72 Avenue, has an ultimate concrete sidewalk adjacent to the developed lands, and an interim asphalt sidewalk adjacent to the undeveloped lands.

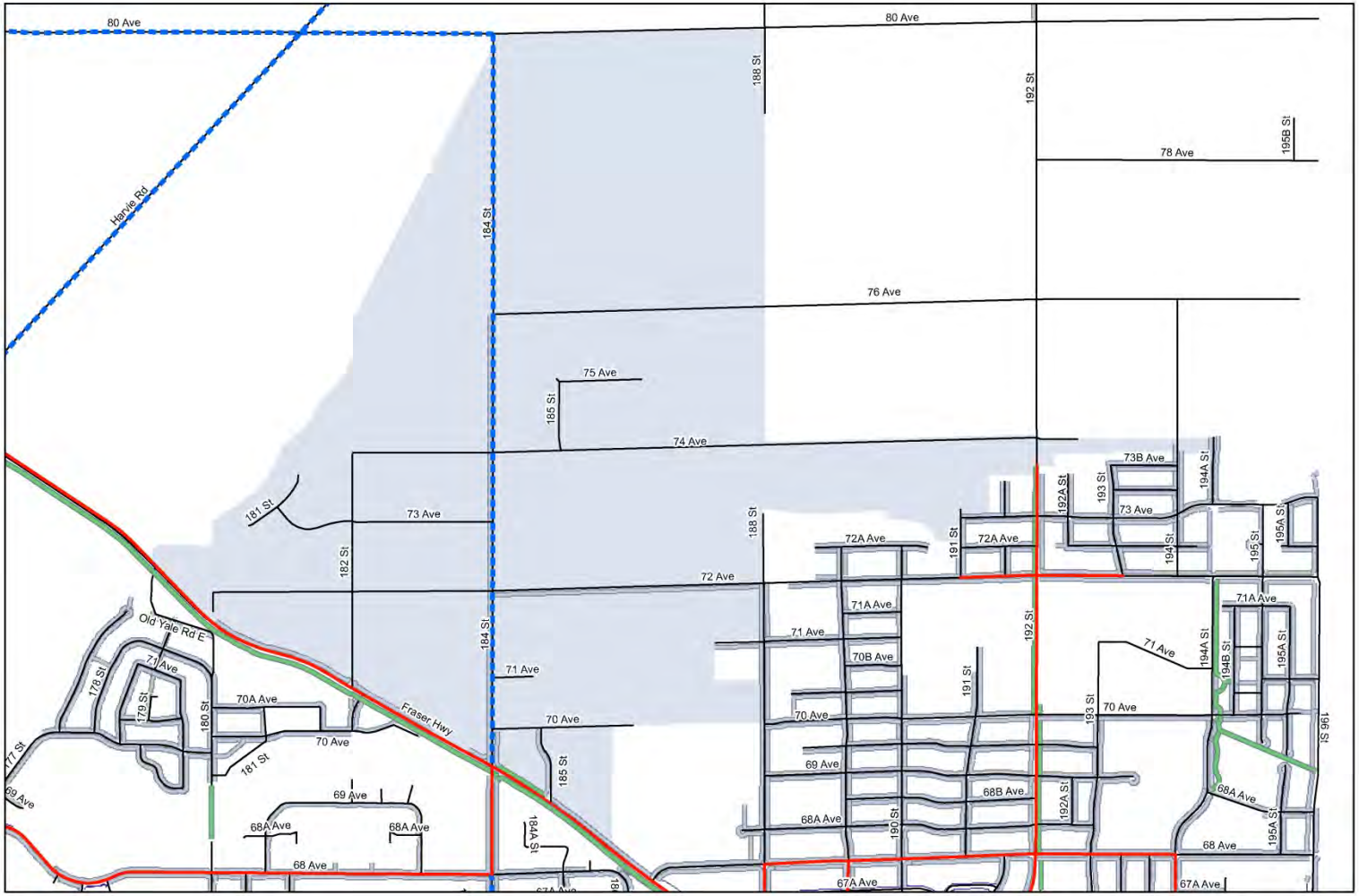
Fraser Highway has a concrete sidewalk on the north side, within West Clayton, from 180 Street to 68 Avenue, and two short segments of multi-use path, fronting recent developments. The south side of Fraser Highway has a multi-use path.

Within West Clayton, 184 Street and 80 Avenue are shared-traffic bike routes. Fraser Highway has bike lanes.

4.1.4 Transit Network

There is currently no transit service within West Clayton, but there is service on two boundary roads, Fraser Highway and 188 Street, as illustrated on Figure 4.4. The 502 and 503 run on Fraser Highway, and the C70 on 188 Street.

The 502 is part of the Frequent Transit Network (minimum 15-minute frequency, 15 hours a day, seven days a week) and connects Surrey Central Station to Langley Centre and Brookswood. The 503 provides limited-stop service between Surrey Central Station and Aldergrove. The C70 is a community shuttle with half-hour service that meanders through East Clayton and connects Cloverdale to Willowbrook.



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Legend

- Bike Lanes
- Multi-Use Pathway
- Shared Traffic Bike Route
- Sidewalks
- Road
- West Clayton Boundary

West Clayton NCP

Existing Walking and Cycling Networks

The accuracy and completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate and establish the precise location of all existing information, whether shown or not.

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Figure 4.3

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Figure 4.3 Existing Walking and Cycling Networks

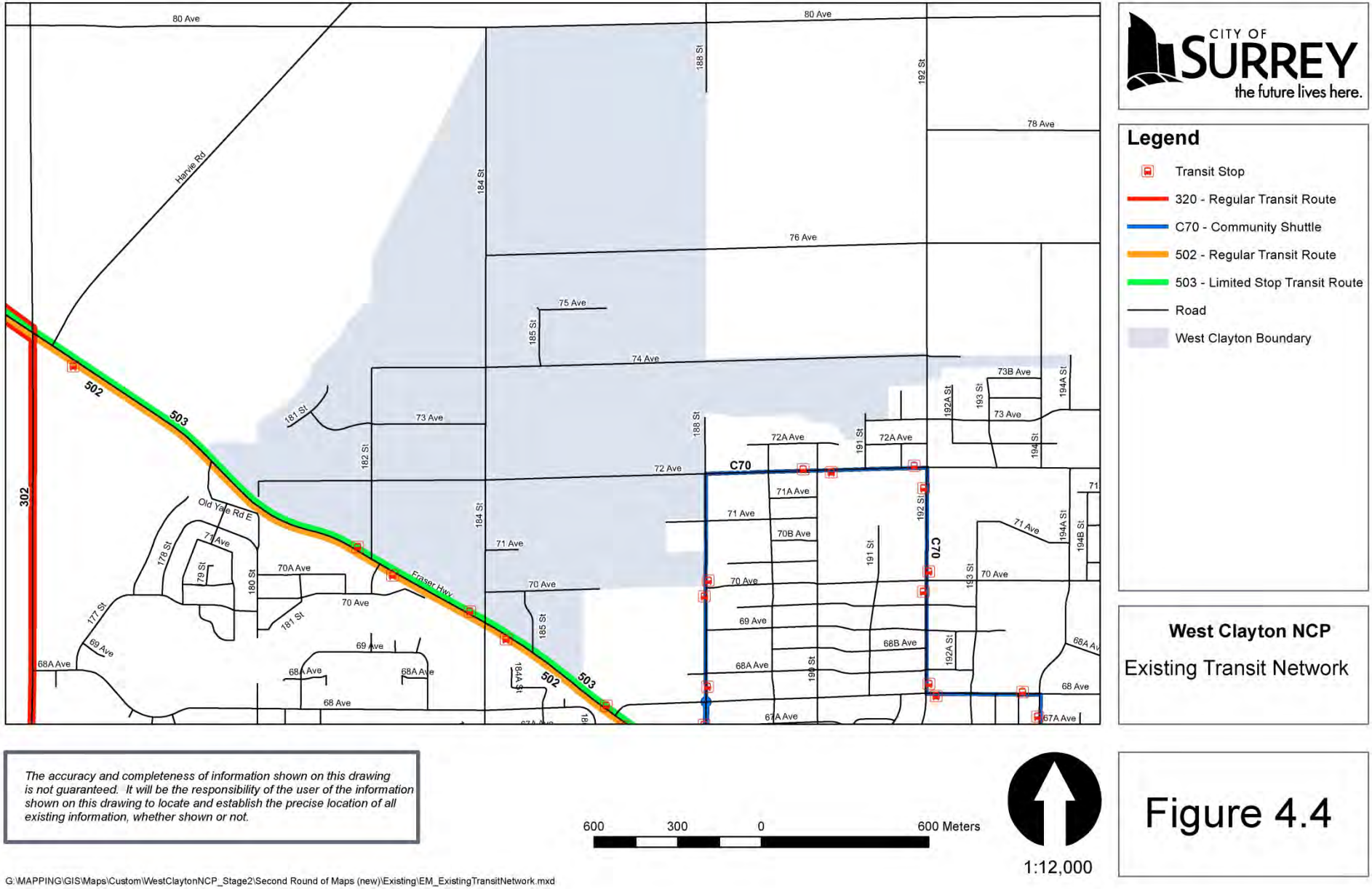

Figure 4.4 Existing Transit Network

4.2 SURREY TRANSPORTATION PLANS AND POLICIES

The transportation portion of this NCP has been developed based on the guiding principles identified in the City's Transportation Strategic Plan and supplementary Walking and Cycling Plans, and TransLink's South of Fraser Area Transit Plan.

In addition, it is consistent with the Highway and Traffic By-law, 1997, No. 13007 and other City policies and practices regarding traffic operation. Brief summaries of these plans and policies are provided in the following sections.

4.2.1 Transportation Strategic Plan

The Transportation Strategic Plan (2008) was developed to set out the vision, objectives and principles for transportation in Surrey. The Plan's six guiding principles are as follows:

1. Effective and efficient network management: Efficiently manage, maintain, and improve the transportation system for all modes
2. More travel choice: Promote alternative and sustainable travel choice and provide better accessibility to jobs, education, health, and recreation for all
3. Safer, healthier communities: Improve community safety, health, and quality of life
4. Successful local economies: Reduce congestion and support the sustainable economic development and vitality of Surrey
5. Protection of our built and natural environment: Reduce the impacts of transportation on the built and natural environment
6. Transportation integration: Promote integration between transportation and land use to reduce the need for travel and support trips by more sustainable modes

In support of these principles, the general road network objectives for West Clayton are:

- Provide an open, inter-connected and continuous grid or modified grid road network that is integrated with established and planned future roads within and surrounding the study area
- Provide a road network with blocks generally 100 x 200 metres in size
- Avoid the use of cul-de-sacs, unless required to avoid environmental or other impacts; if possible, favour loop roads over cul-de-sacs to ensure a minimum of two entry/exit points to all developments
- Align intersections of minor roads across major roads to provide better inter-connection of neighbourhoods and avoid offset T-intersections

4.2.2 Surrey Walking Plan

The Surrey Walking Plan (2011) recognizes that as everyone is a pedestrian at some point during every trip they make, walking is critically important to achieving the six broad goals of the Transportation Strategic Plan. The Walking Plan identifies a number of Actions for Change that have been used in the West Clayton NCP planning process, including:

- Promote community connectivity for all modes through the development of a finer grid network through NCPs and new development
- Promote land use patterns and densities that are supportive of transit services
- Encourage the development of mixed-use neighbourhoods
- Incorporate urban design principles that create a walkable environment
- Continue to promote the use of utility corridors for walking
- Continue to maximize enhanced greening guidelines for landscaping and street trees along walking routes

4.2.3 Surrey Cycling Plan

The Surrey Cycling Plan (2012) seeks to promote cycling as a viable, sustainable and growing alternative to the private car. It identifies a number of Actions for Change that have guided the West Clayton NCP planning process, including:

- Promote cycling connectivity through the development of a finer grid road network, through NCPs and new developments
- Expand the on-street cycling route network, using arterial and collector roads
- Expand the off-street cycling network as part of the greenways network
- Continue to partner with other City departments to ensure cycling facilities are built and cycling is facilitated with new developments, projects, and policies

4.2.3 Transit Planning

The Metro Vancouver Mayor's Council Regional Transportation Investments Plan provides a framework for the implementation of the Surrey Rapid Transit Study and the South of Fraser Area Transit Plan. Among other improvements, the Mayor's Plan specifies the construction of Light Rail Transit on Fraser Highway from Surrey City Centre to Langley City Centre in twelve years. Through the Surrey Rapid Transit Study, which has completed an initial phase of planning for rapid transit in Surrey, Fraser Highway has been identified as the highest-performing corridor, and the intersection of Fraser Highway and 184 Street, in West Clayton, has been identified as a station location for LRT. As such, it is important that the area around the station be planned to support rapid transit, in terms of type and mix of land use, density, walkability, a finer-grain road network, boulevard design, and urban design standards.

TransLink's South of Fraser Area Transit Plan (2007) provides a long-range transit plan for the region through 2031, including potential bus routes and service frequency. In and near West Clayton, the 2031 plan includes rapid transit service not only on Fraser Highway but also on 200 Street, frequent transit service (minimum 15-minute frequency, 15 hours per day, seven days a week) on 64 Avenue, local bus service (minimum 30-minute frequency) on 72 Avenue and 184 Street, and neighbourhood bus service (minimum 30-minute frequency) on 68 Avenue.

TransLink's service guidelines endeavour to situate bus stops so that at least 90% of residents and employees within urban areas are no more than 400 metres from transit service. A grid network supports this by reducing the walking distance between trip ends and transit stops.

4.2.4 Road Classification

The Surrey Road Classification Map (R-91), which is Schedule D to the Surrey Subdivision and Development By-law, 1986, No. 8830, is the key document upon which the planning, operation, and management of the City's transportation network is based. It is the base for establishing road allowance alignments and widths, and road cross-sections, determining transit routes, snowploughing priorities, traffic signal locations, and appropriate locations for traffic calming. Schedule K of the By-law, the Surrey Major Road Allowance Map, is used in tandem with the Road Classification Map and defines the road allowance requirements on a block-by-block basis for all major roads, to accommodate the servicing needs for the continued growth of the City, ensure consistency with the City's standard cross-sections for arterial and collector roads, and to reflect specific dedication requirements determined through major long-term transportation and planning studies.

As identified on the Maps, the City defines roads as one of the following classifications:

- **Provincial and regional highways** – generally controlled-access facilities that provide high-speed regional connections
- **Arterial roads** – generally carry through traffic from one part of the City to another with as little interference as possible from adjacent land uses, and may provide limited direct access to adjacent properties as a secondary function, although this is generally not desirable
- **Collector roads** – primary function is to distribute traffic between arterial roads, other collector roads, and local roads within an area, and may provide access to adjacent properties if required
- **Local roads** – lower-volume neighbourhood streets that provide community connectivity and access to individual properties

There are no provincial or regional highways in West Clayton.

The existing road classifications are shown on Figure 4.1. The existing road allowance requirements for arterial and collector roads in West Clayton are shown in Table 4.2. (Note that these roads may currently carry additional statutory right-of-way requirements.)

Table 4.2: Existing Major Road Allowance Requirements

Road	Classification	Road Allowance Width
72 Avenue	Arterial	30 m
76 Avenue	Collector	24 m
80 Avenue	Arterial	30 m
184 Street	Arterial	30 m
188 Street	Collector	24 m
192 Street	Arterial	34 m
194A Street	Collector	24 m
Fraser Highway	Arterial	42 m

4.2.5 Major Road Network

Metro Vancouver's Major Road Network (MRN) consists of over 600 kilometres of provincial highways and strategic municipal arterial roads. The MRN is overseen by TransLink, and they fund the maintenance of MRN roads and cost-share capital works with municipalities. The designation of a road as being part of the MRN is based on the road providing access to important activity centres in the region, and meeting criteria related to trip lengths, traffic volumes, transit ridership, and commercial vehicle demand. Within West Clayton, Fraser Highway is part of the MRN.

4.2.6 Access Management

The Highway and Traffic By-law, 1997, No. 13007 and Schedule A to the Surrey Subdivision and Development By-law, 1986, No. 8830, the Engineering Design Criteria Manual, regulate access to roads. The following policies for West Clayton are consistent with the By-laws, and can be summarized as follows:

- Provide primary access via local roads
- Maximize the number of access routes and permeability of the street system
- Manage direct access on arterial roads
- Require rear lane access for all residential land uses fronting arterial roads
- Minimize direct access on collector roads through the development of rear lanes or side streets, particularly in higher density and mixed-use areas to improve the pedestrian environment on the fronting streets and increase the on-street parking supply; if direct access is unavoidable, follow the principles of good access management in terms of location, spacing, sight distance, and permitted movements
- Restrict direct access across multi-use pathways
- Avoid frontage roads and gated private communities

4.2.7 Traffic Control

As part of the Transportation Strategic Plan, the City has recognized the need and importance of managing the transportation network on a day-to-day basis. Maintaining a safe and efficient transportation system with properly managed traffic operations is critical to supporting the efficient movement of goods, and regional and local traffic. As well, it reduces the potential for through traffic to use local streets.

Examples of good traffic control principles are:

- Consider roundabouts as alternatives to traffic signals, if conditions are appropriate.
- Plan for likely locations of traffic signals (all arterial/arterial and arterial/collector intersections) but only install when warrants are met based on traffic volumes, delay, and collision history.
- Install traffic calming devices on local roads as per the City's traffic calming policy.

4.3 TRANSPORTATION ANALYSIS

During Stage One of the NCP, a detailed traffic modelling analysis was undertaken, to validate the planned West Clayton road network. For the purposes of the analysis, build-out of the NCP was assumed, including completion of the road network and full implementation of the traffic control plan, and a horizon year of 2041 was used, to coincide with available traffic modelling and road network data for the rest of Surrey.

A key goal of the modelling was to review the alignment for the extension of 72 Avenue to Fraser Highway. The analysis confirmed that the connection of 72 Avenue to Fraser Highway west of the 18000 block was the optimal location for an interim connection,(as discussed in Section 4.4.2), as it would provide the most direct connection from West Clayton and points east to Fraser Highway, attract traffic from 68 Avenue (a heavily-used lower-order road), and reduce the traffic volumes through the intersection of Fraser Highway and 184 Street, which will already experience congestion as a result of high traffic volumes and the presence of an LRT station.

The long-term future extension of 72 Avenue west to 152 Street was not evaluated as it was outside the scope of the NCP modelling exercise.

A preliminary design of both the interim and ultimate connections of 72 Avenue to Fraser Highway was completed, to determine the exact alignment of these connections. Figure 4.5 shows these alignments.

The traffic modelling analysis has confirmed that the planned road network in West Clayton will operate satisfactorily as designed.

Figure 4.5

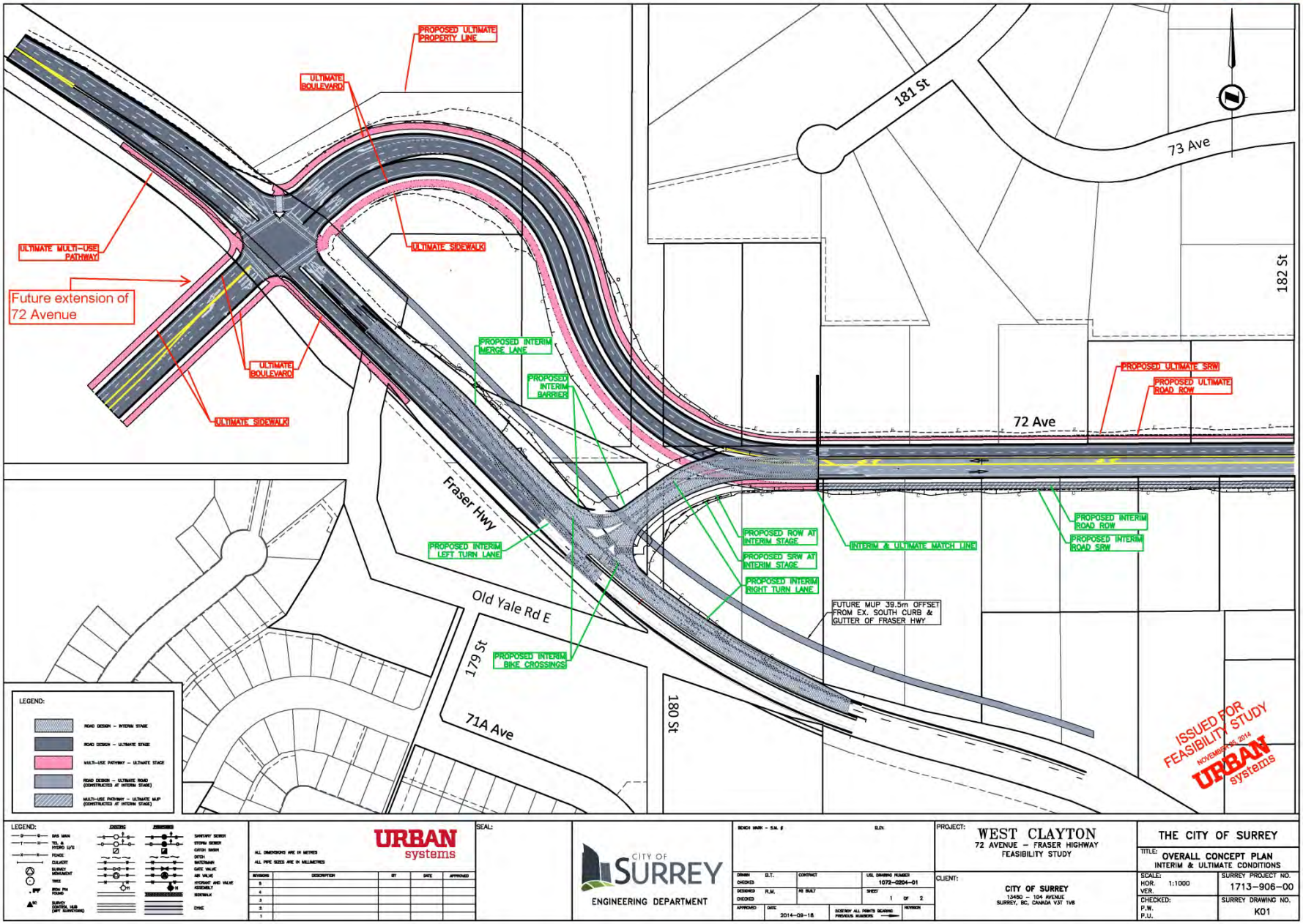

Figure 4.5 - Interim and ultimate Concept for 72 Avenue

4.4 PLANNED TRANSPORTATION NETWORK

The road network in West Clayton will be built as development occurs. As per the City's Surrey Subdivision and Development By-law, 1986, No. 8830, for collector and local roads, developers are obliged to construct the full length of their road frontage to current standards or as otherwise detailed in this NCP, measured from the middle of the road to the development site for roads bounding the site, and the full extent of roads within the site. It is acknowledged that this means that until build-out of West Clayton occurs, many roads will have gaps in the sidewalk, minimal pavement width, no streetlighting, or temporary curbs, but is consistent with the City's practice that development funds development, rather than the City funding development.

For arterial roads, Development Cost Charges (DCCs) are assessed and used to fund the ultimate road standard, constructed by the City according to relative priority among other projects in Surrey, as outlined in the Engineering Department's 10-Year Servicing Plan. However, to maintain the integrity of West Clayton's arterial roads in the interim, a strategy has been developed, which is detailed in Section 4.4.7.

For all roads, developers must also dedicate the necessary lands to accommodate the road, as well as all other engineering servicing (e.g. underground utilities).

While most road features (e.g. streetlights) are installed with the initial construction of a road, most traffic control measures are installed on an engineering warrant basis. That means that while many of these interventions, such as traffic signals, have been identified in this document, they are only installed once an engineering evaluation has been undertaken and concluded that the intervention is warranted, and then according to priority within the 10-Year Servicing Plan.

4.4.1 Road Network Overview

West Clayton is generally bounded by existing major roads: 80 Avenue (arterial) to the north, Fraser Highway (arterial) to the south, and 188 Street (collector) to the east, with 72 Avenue (arterial) running through the middle. The planned internal street network for West Clayton, illustrated in Figure 4.6, provides a well-connected grid road pattern and pedestrian and bicycle network that promotes the principles of the Transportation Strategic Plan and its supporting documents. Benefits of a grid network in the context of West Clayton include:

- Increased active mode share
- Increased transit mode share, and in particular increased walkability within the future LRT station catchment (an 800-metre radius around the Fraser Highway / 184 Street intersection)
- Multiple route options to increase network resiliency and improve emergency response time
- Reduced per capita vehicle travel, traffic congestion, and pollution emissions

In general, the West Clayton NCP has a grid network of 200 metre by 100 metre blocks. In addition to supporting the goals of the Transportation Strategic Plan, Walking Plan, and Cycling Plan, this is consistent with the set of planning principles adopted by the West Clayton Citizens' Advisory Committee early in the planning process, which included the following:

- Provide an interconnected street grid to allow multiple ways to disperse traffic, to provide choices to travel on foot, by bicycle, or by car, and to provide convenient access to transit.

However, the grid network has not been uniformly applied in all areas; where appropriate, it has been modified to accommodate natural and man-made constraints as well as the proposed development type. Factors include the following:

- Crossings of the riparian areas and wildlife corridor
- Constraints of the ALR, creeks and forest blocks, and school and park sites
- Existing property lines
- Topography
- The proportional relationship between density and connectivity
- Proximity to the future LRT station and the increased need for walkability

Where densities are higher and close to the future rapid transit station, where walkability is more important and where there is a greater need to distribute traffic, typical block sizes are in the range of 100 metres by 100 metres.

The road network is designed to provide connectivity both within West Clayton and to the adjacent transportation network, through the provision of a number of full-movement intersections onto 80 Avenue, 188 Street, and Fraser Highway, including the reconnection of 72 Avenue to Fraser Highway. As much as possible, it will distribute traffic through the neighbourhood so as to minimize the traffic impacts on any particular street. The road network also protects the ability to provide local road connections into and through the area that is designated "suburban" to the northwest of 72 Avenue and 182 Street so as to allow the redevelopment of this area in the future.

While the new roads within the network generally are centred on existing property lines, some occasional meanders are shown conceptually to indicate where intersections must align; the exact meander will be determined through design at the development stage.

Some roads are designated as “flexible alignment”, meaning that the exact alignment of the road can vary from the land use plan, as long as the intent of the road connection remains and intersection locations remain generally fixed.

Depending on the form of development within the cluster designations north of 76 Avenue, additional roads may be necessary in order to adequately service the development, and depending on any relocation (with proper approvals and compensation) of the riparian areas.

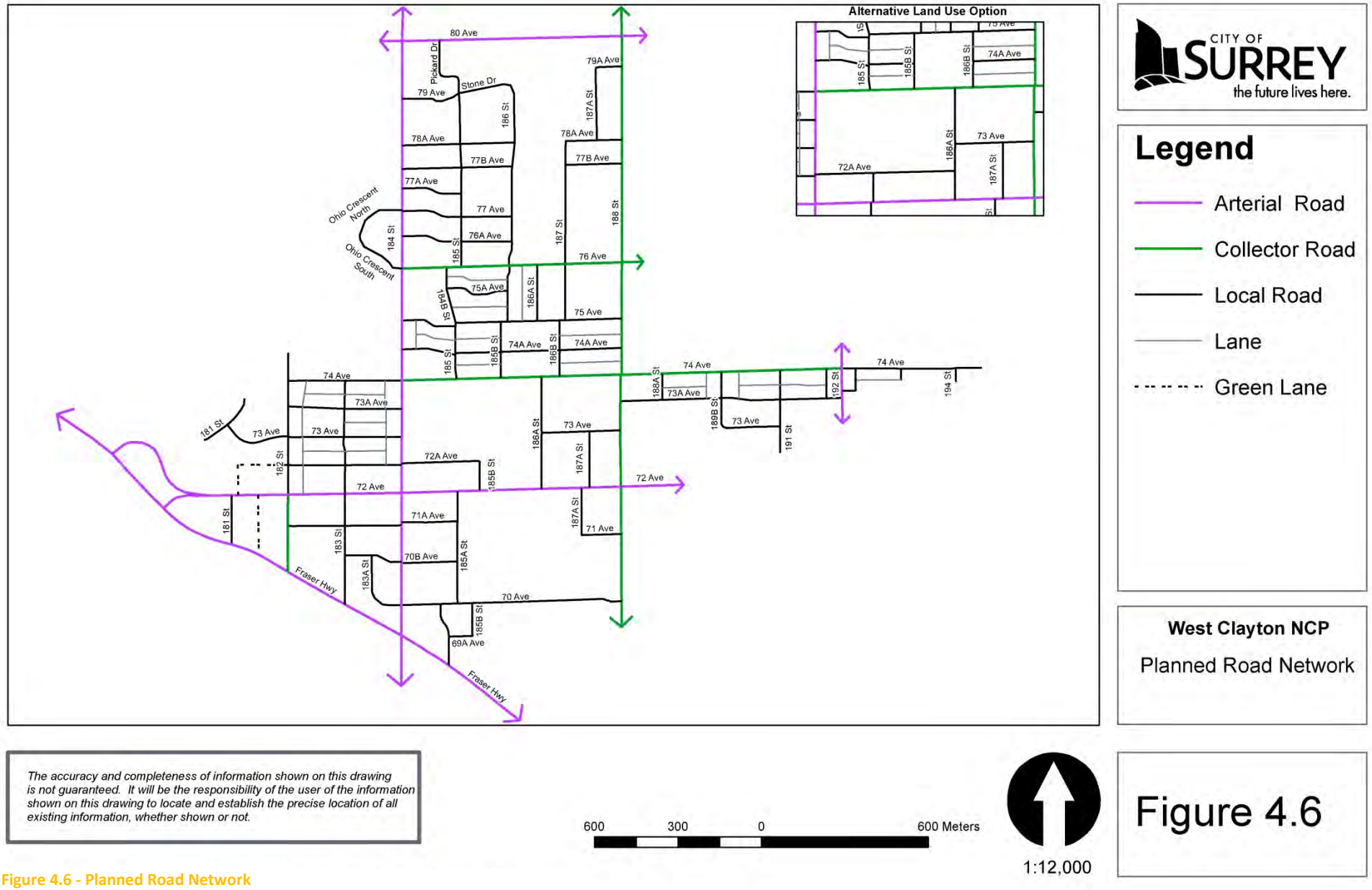

Figure 4.6 - Planned Road Network

4.4.2 Road Classification and Alignment Changes

While the majority of the new road network planned for West Clayton involves local roads, there are two classification changes (74 Avenue and 182 Street) and one alignment change (72 Avenue) to the Surrey Road Classification Map (R-91), with corresponding changes to the Surrey Major Road Allowance Map.

74 Avenue – Change to Classification

74 Avenue is currently a local road, but is proposed to be reclassified to a collector road from 184 Street to 192 Street as part of this NCP, in recognition of the increased demands on 74 Avenue due to the planned surrounding densities, and 74 Avenue's role in providing neighbourhood connectivity as a result of its existing alignment.

182 Street – Change to Classification

182 Street is currently a local road, but is proposed to be reclassified to a collector road from Fraser Highway to 72 Avenue as part of this NCP. This is in recognition of the increased demands on 182 Street due to its role in providing neighbourhood connectivity both for West Clayton NCP area and the Provinceton neighbourhood south of Fraser Highway via the planned signalized intersection at Fraser Highway.

72 Avenue – Change to Alignment

Within East and West Clayton, 72 Avenue is classified as an arterial road; however, in 2003, 72 Avenue was closed just east of Fraser Highway, in 18000 block. The East Clayton North Extension NCP first identified the need for the reconnection of 72 Avenue to Fraser Highway to provide a better east-west connection in the neighbourhood. In addition, growth in the future North Clayton NCP, in Anniedale, Tynehead, Port Kells, and in Langley will put extra pressure on 72 Avenue, making it critical that it be directly connected to Fraser Highway. Already between 2006 (the North Extension NCP was approved in 2005) and 2014, traffic volumes on 72 Avenue within East Clayton grew from 3100 to 9400 vehicles per day, a 203% increase.

A signalized connection of 72 Avenue to Fraser Highway slightly west of 180 Street is planned in the shorter term (shown in Figure 4.5), anticipated to occur in conjunction with a certain level of redevelopment along 72 Avenue, and dependent on traffic growth in West Clayton generally. The intersection location has been selected to minimize the impact on the suburban enclave in the NCP, provide a logical connection for pedestrians and cyclists to the North Creek Greenway located on the 180 Street alignment south of Fraser Highway, provide a crossing for potential future bus stops, and provide additional network options for the Provinceton neighbourhood south of Fraser Highway, when LRT is constructed and turning movements along Fraser Highway are further restricted.

A long-term connection of 72 Avenue to Fraser Highway approximately 350 metres northwest of 180 Street has also been identified (also shown in Figure 4.5), which would be built to facilitate an extension of 72 Avenue to Newton (at 152 Street). This intersection location and geometric design was selected to minimize impact on the ALR, environmental impact, construction cost, and property impacts, while maximizing road safety and efficient traffic operations. The connection of 72 Avenue to Fraser Highway in the 18000 block is anticipated to be retained in some form.

4.4.3 Walking Network

All of the roads within West Clayton are planned to have either a sidewalk or a multi-use path on either side, in keeping with City standards, separated from vehicle traffic by boulevards able to grow and sustain large street trees. Although the on-street walking network represents the backbone of the network, the NCP also includes a further network of pathways which diverge from the vehicular network, to further improve pedestrian connectivity within West Clayton and between West Clayton and neighbouring communities. Please note that the multi-use path network is discussed in more detail in Section 4.4.4.

In addition to Surrey's road standards and the walking network illustrated in Figure 4.7, the requirements listed below identify a number of other features to encourage walking and provide a safe and comfortable pedestrian environment in West Clayton. These include:

- Minimum 1.8 m sidewalks on both sides of arterial and collector roads (or multi-use pathways in lieu of sidewalks)
- Minimum 1.5 m sidewalks on both sides of local roads (or multi-use pathways in lieu of sidewalks)
- Wider sidewalks in areas of high pedestrian demand (e.g. adjacent to schools) through the use of an additional statutory right-of-way, rather than a reduced boulevard (details to be determined at the development stage)
- Construction of the ultimate sidewalk on arterial roads in conjunction with the development of the adjacent land (rather than in conjunction with the four-laning of the road)—see Section 4.4.7 for details
- Construction of interim curb returns on arterial roads in conjunction with the development of the adjacent land, in order to provide a reduced crossing distance until such time as the road is four-laned—see Section 4.4.7 for details
- Pedestrian-scale streetlighting along all multi-use pathways, whether adjacent to a roadway or off-street
- Curb bulges on both sides of local roads with 10.5 m or greater pavement width at all intersections, including T-intersections, except on the local road receiving leg at an arterial road intersection (curb bulges on local roads with 8.5 m pavement width may be considered at the development stage)
- Curb bulges on both sides of collector roads at all intersections, including T-intersections, unless left-turn lanes are planned
- Pedestrian crossings of arterial roads at 200-400 metre spacing, according to context, by including median refuge crossings (typically where vehicle movements are restricted) in addition to planned signalized locations
- Pedestrian signals or crosswalks with activated flashing lights, as well as full traffic signals; please note that these interventions, along with any marked and signed crosswalks, would be installed as warranted according to an engineering evaluation, as per City practices
- Requirement of lane access for single-family lots with multi-use paths across their frontage (i.e. no single-family driveway crossings of multi-use paths)
- Off-street multi-use pathways (pedestrian-cyclist streets) of sufficient width (8 metres) to maintain sightlines, accommodate streetlighting, and comply with Crime Prevention Through Environmental Design (CPTED) principles

Together, the features of the walking network will provide safe and comfortable routes for walking within the community and will reduce the need for local residents to drive to local shops, services, and schools, and support walking access to existing and planned transit services.

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Legend

- Multi-Use Pathway
- Sidewalk
- Road

West Clayton NCP

Planned Walking Network

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Figure 4.7

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Figure 4.7 - Planned Walking Network

4.4.4 Cycling Network

The City's standard road cross-sections include bike lanes on both sides of all collector and arterial roads. Traffic volumes and speeds on local roads are generally expected to be low enough to allow cyclists to comfortably share the road with vehicles. As mentioned in Section 4.4.3, a comprehensive multi-use path network has also been developed, to accommodate cyclists less comfortable with cycling on-street, and to increase connectivity. Some roads have both bike lanes and multi-use pathways, to ensure that a broad range of cyclists, from commuters to children, are comfortable cycling. The cycling network is shown in Figure 4.8.

Bike lanes on arterial and collector roads will be 1.8 metres wide. Bike lanes will generally be marked in segments of at least one block, and for both sides of a road at the same time. The interim arterial road standard, outlined in Section 4.4.7, includes bike lanes.

A robust multi-use pathway network is planned for West Clayton, to provide neighbourhood connections to schools, parks, transit, and shopping areas; to improve the cross-City cycling network; and to provide opportunities for recreational cycling. Six of the pathways form part of the City-level greenway network, and as such, have been named. The names are shown on Figure 4.8, and are explained in more detail in Section 4.4.9.

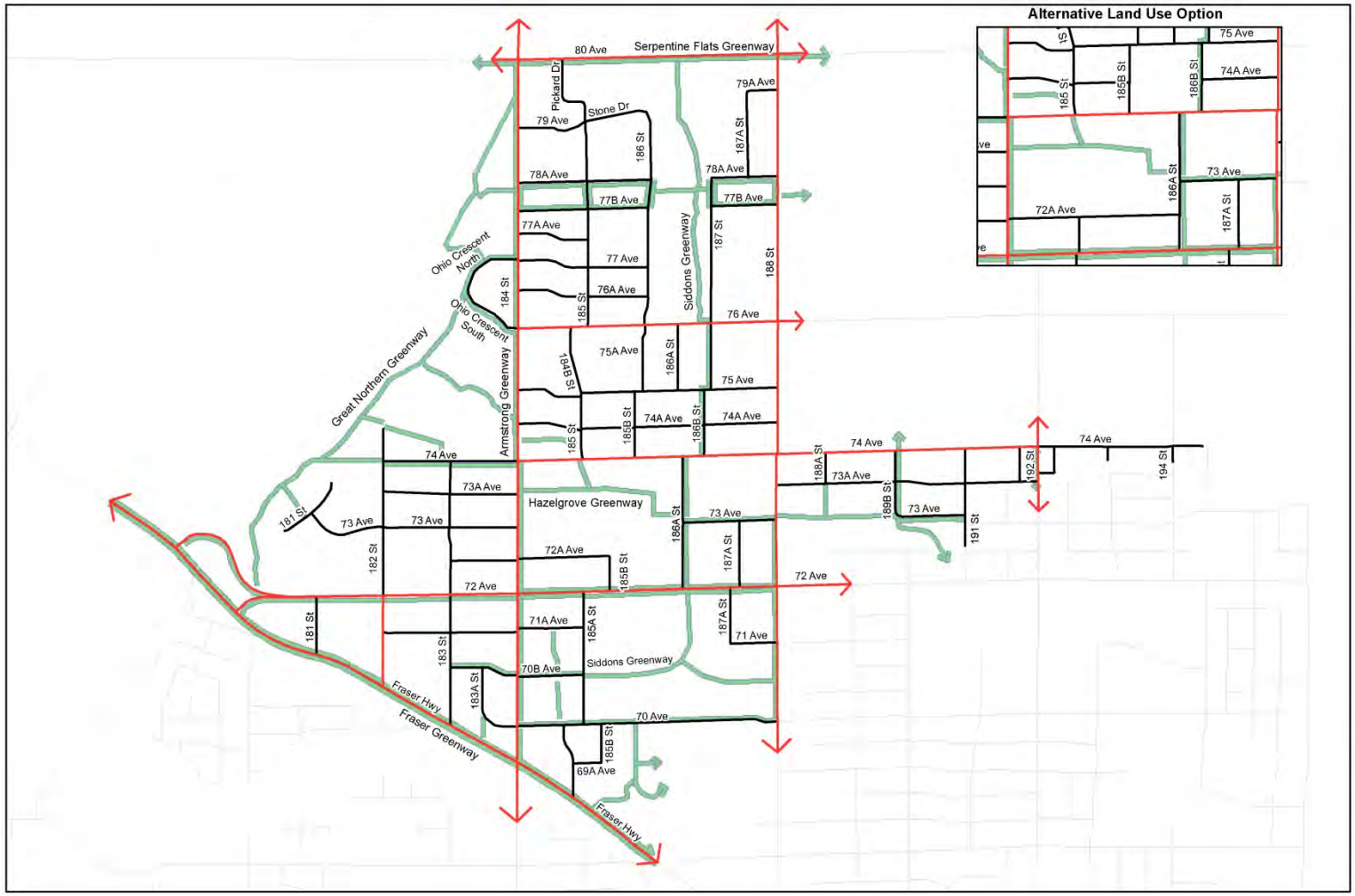
Multi-use pathways are asphalt and 4 metres wide, and available for use by cyclists, pedestrians, and other forms of non-motorized transport. On 184 Street within the commercial area around the LRT station (Fraser Highway to 72 Avenue), the cycling path and sidewalk will be separated, as discussed in more detail in Section 4.4.8. In addition to paralleling streets, the network takes advantage of two utility corridors, the Fortis gas corridor and the planned sanitary trunk corridor. It also takes advantage of riparian corridors, by providing public access between natural areas and private lands. The off-street path designs include street lighting and either one or two boulevards, to maximize safety and security in keeping with Crime Prevention Through Environmental Design (CPTED) principles.

The total corridor width of the off-street pathways is 8 metres. Figure 4.9 shows the typical cross-section C, used for all off-street multi-use pathways except for those running between active parkland and private property, which are shown in Figure 4.10 for typical cross-section D.

Cross-sections of on-street pathways are provided in Section 4.4.8 and described in Table 4.3 below.

Table 4.3: Off-Street Multi-Use Pathway Features

Cross-Section	Dedication	SROW	Sidewalks	Boulevards	Streetlighting
C	8 m	None	4 m MUP	2 m on both sides	Pedestrian lighting on one side
D	8 m	None	4 m MUP	4 m on non-park side	Pedestrian lighting on non-park side



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Legend

- Bike Lanes
- Multi-Use Pathway
- Road

West Clayton NCP

Planned Cycling Network

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Figure 4.8

Figure 4.8 - Planned Cycling Network

Figure 4.9

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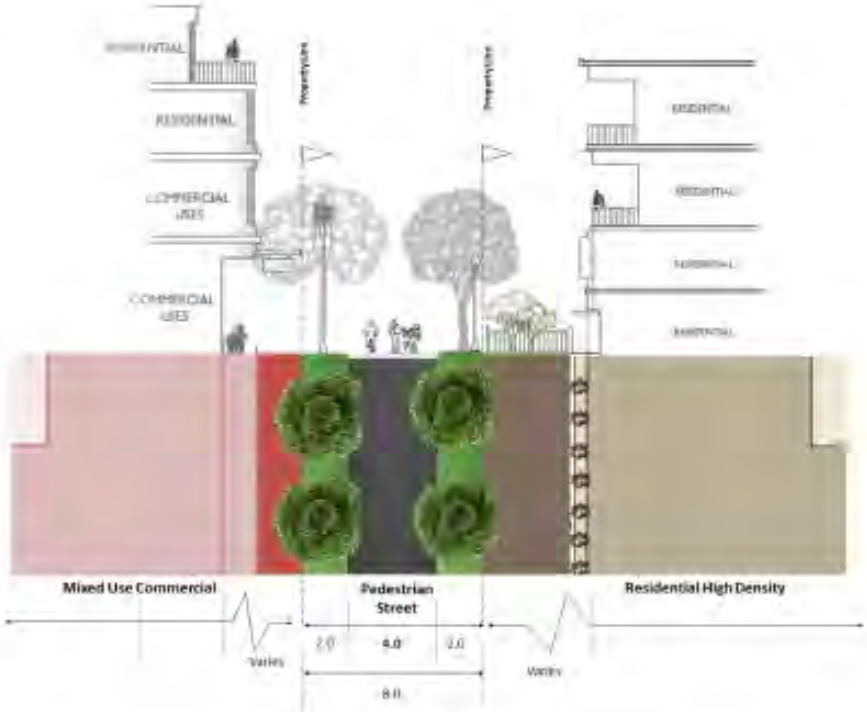

West Clayton Neighbourhood Concept Plan	8.0 M Pedestrian Street [Private Lands Both Sides)	Special Cross Section **C**

Refer to Section 4.4.4 and Table 4.3 for details.

Scale 1:100

Figure 4.9- Special Pedestrian Street Cross Section C

Figure 4.10

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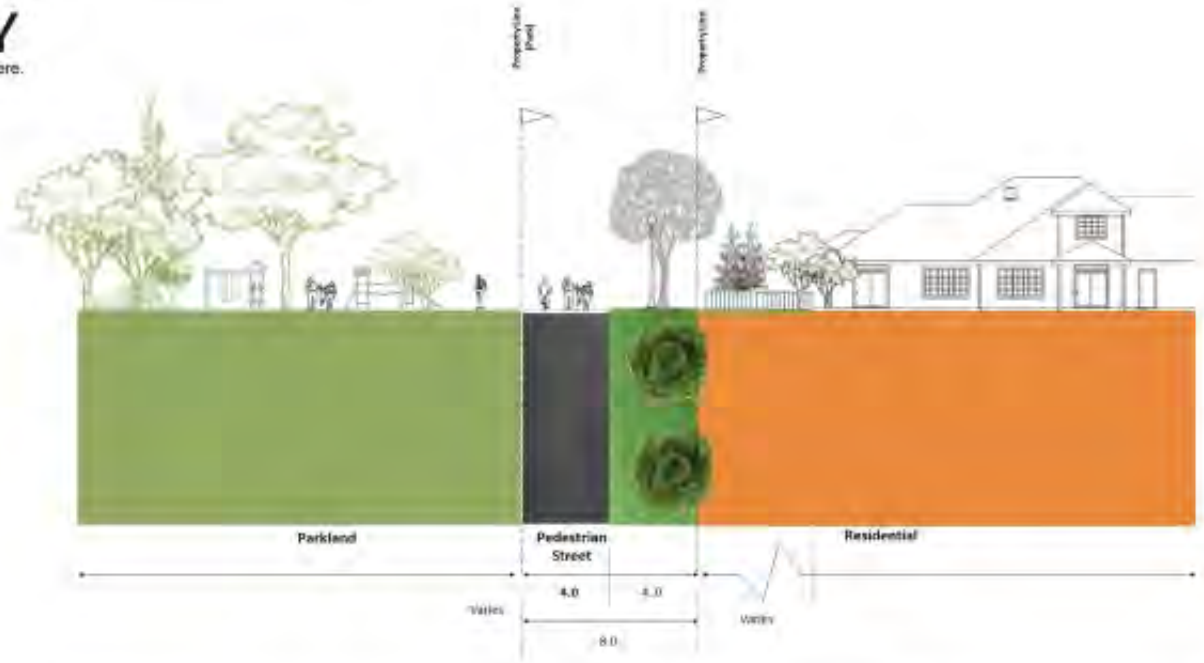


West Clayton Neighbourhood Concept Plan	8.0 M Pedestrian Street [Parkland and Residential Interface)	Special Cross Section **D**

Refer to Section 4.4.4 and Table 4.3 for details.

Scale 1:100

Figure 4.10 – Special Pedestrian Street Cross Section D

4.4.5 Transit Network

The NCP provides transit-supportive land uses and densities generally, and in particular where LRT is planned. In addition, in support of the delivery of successful transit service within the NCP and LRT on Fraser Highway, the planned road network provides routing options for future transit: Arterial and collector roads will generally be suitable and available for public transit service (as per service planning ultimately undertaken by TransLink and its subsidiary, Coast Mountain Bus Company).

To date, the South of Fraser Area Transit Plan has identified 72 Avenue and 184 Street as being a future transit route (as discussed in Section 4.2.3); but additional route planning will occur in the future, in collaboration with TransLink. Potential future bus stops for this route have been identified on Figure 4.11.

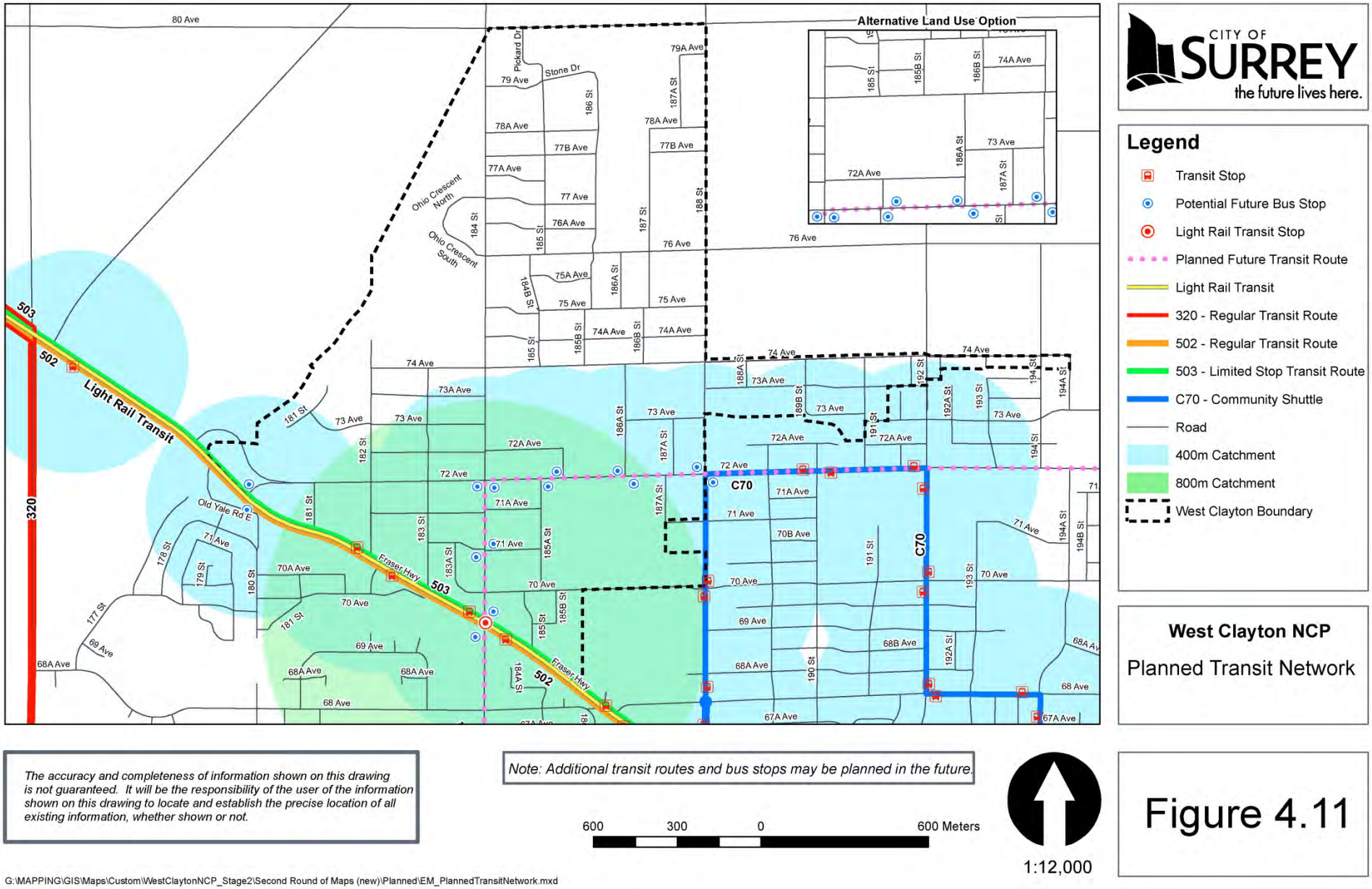
A bus stop is assumed to have a 400-metre catchment, or a five-minute walk. Bus stop locations will be determined as part of future transit service planning. In order to accommodate bus stops on collector roads, on-street parking will most likely need to be restricted in the vicinity of the stops.

Potential future bus stops have also been identified on Fraser Highway at 72 Avenue.

As noted in Section 4.2.3, an LRT station is planned at the intersection of Fraser Highway and 184 Street. In addition, higher-density development (mixed-use and residential) has been planned surrounding the station, and the finer-grain road network in this area, together will support increased walkability and access to the station. An LRT station is assumed to have an 800-metre catchment, which is equivalent to a 10-minute walk.

To accommodate LRT on Fraser Highway, as well as pedestrians, cyclists, and motor vehicles, an increased road allowance width is required, as discussed in Sections 4.1.4 and 4.4.8.

Figure 4.11 shows the bus stop and LRT station locations, and associated catchments.



The accuracy and completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate and establish the precise location of all existing information, whether shown or not.

Note: Additional transit routes and bus stops may be planned in the future.

G:\MAPPING\GIS\Maps\Custom\WestClaytonNCP_Stage2\Second Round of Maps (new)\Planned\EM_PlannedTransitNetwork.mxd

Figure 4.11

Figure 4.11 - Planned Transit Network

4.4.6 Traffic Control

The West Clayton NCP anticipates the need for a number of types of traffic control and access management, as shown on Figure 4.12.

Traffic signals are planned at all arterial-arterial and arterial-collector intersections. Where traffic signals aren't anticipated, median refuge crossings for pedestrians and cyclists are planned on arterial roads to accommodate greenway crossings, crossings at bus stops, and to allow neighbourhood connectivity. Traffic signals and crosswalks will be installed in accordance with the City's warrant procedures.

Roundabouts are planned at all collector-collector intersections, and will be installed in conjunction with development. Traffic circles are planned at select local-local intersections, and will be installed in conjunction with development.

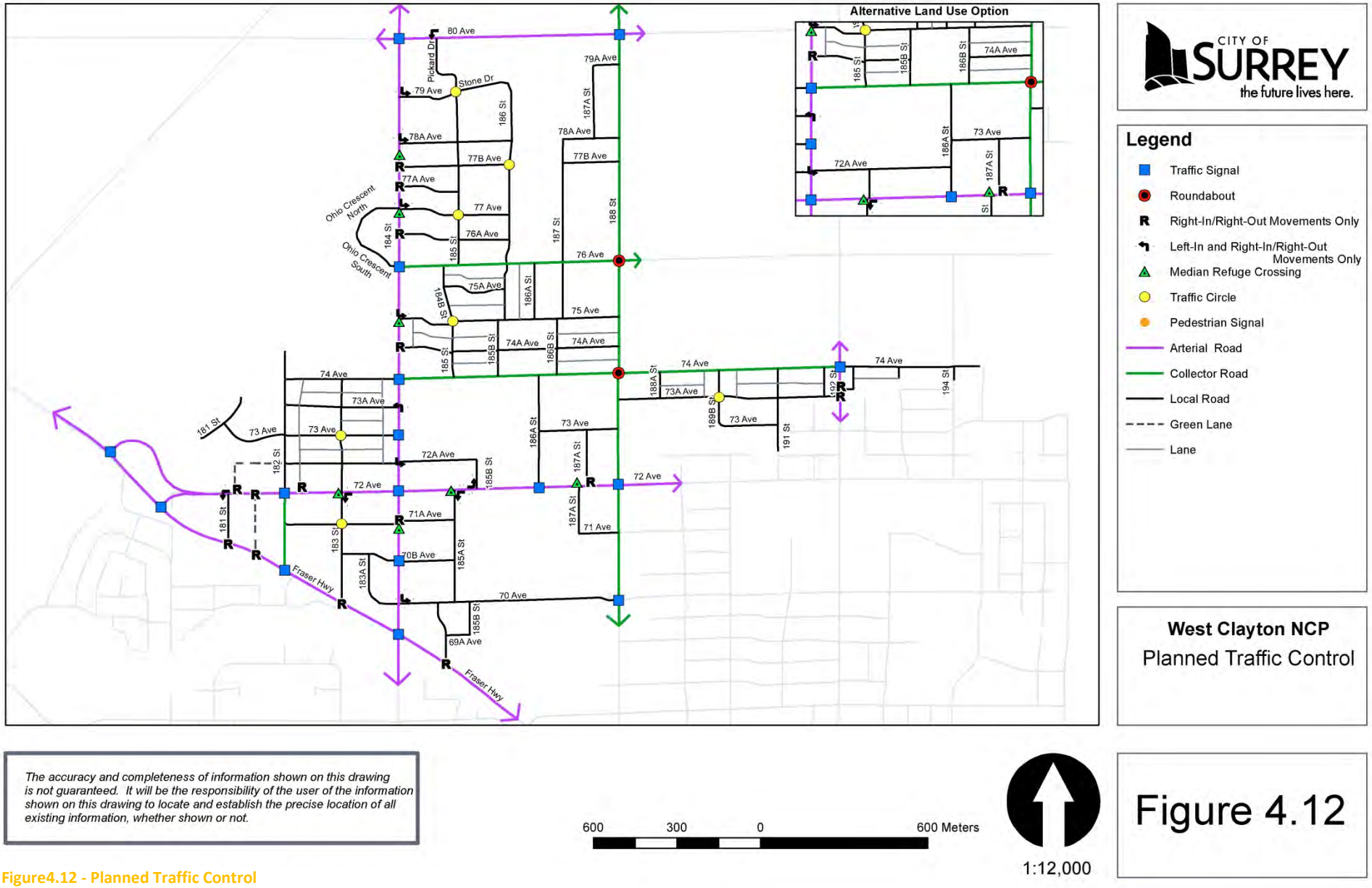
Where traffic signals aren't planned, certain turning movements will be restricted at arterial-local intersections, to maximize traffic safety and operations. Right turns into and out of the local road will be permitted at all of these intersections, and select intersections will accommodate left-turns into the local road.

To improve pedestrian safety and comfort, and discourage on-street parking in appropriate locations, curb bulges will be installed in the following locations:

- On both sides of local roads with 10.5 m or greater pavement width at all intersections, including T-intersections, except on the local road receiving leg at an arterial road intersection
- May be considered at the development stage on one side of local roads with 8.5 m pavement width
- On both sides of collector roads at all intersections, including T-intersections, unless left-turn lanes are planned
- Across lane entrances on local and collector roads

Curb bulges may be grassed or may contain rain gardens. If rain gardens are used, the associated plantings must be low to ensure pedestrian and driver sightlines are maintained.

Speed humps will be installed in back lanes and on local roads or collector roads fronting elementary schools (within the 30 km/h elementary school zone), in conjunction with development.



The accuracy and completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate and establish the precise location of all existing information, whether shown or not.

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Figure 4.12

Figure4.12 - Planned Traffic Control

4.4.7 Interim Arterial Roads

Most arterial roads within West Clayton are currently in a rural condition, with minimal pavement width, open ditches, no streetlighting, and no accommodation for pedestrians or cyclists.

As development occurs, additional lands are dedicated to accommodate the ultimate (four-lane) arterial road, which means that houses are set very far back from the existing pavement. In addition, most arterial roads are widened to their ultimate a number of years after development occurs, and as a result, the urban boulevard features are not constructed until that time.

In order to maintain road safety, minimize maintenance obligations for both homeowners and the City, provide pedestrian and cyclist facilities, and ensure an attractive public realm, a new interim arterial road cross-section has been developed, illustrated in Figure 4.13 and described in Table 4.4, to be constructed at the time of development. This includes the ultimate boulevard (sidewalk, streetlights, street trees, and grass), an interim boulevard (swaled grass), an interim curb, and minimal pavement widening to provide a road shoulder, which will double as a bike lane. Root barrier will be used to separate the ultimate and interim boulevards, and signs will be posted to advise residents of the location of the future curbline.

Table 4.4: Interim Arterial Road Features

No. of Lanes	Road Allowance	Statutory Right-of-Way	Pavement Width	Sidewalks	Bike Facilities
2	30 m	2 @ 0.5 m	9.6 m	2 @ 1.8 m	1.8 m bike lanes
		1 @ 0.5 m, 1 @ 2.7 m on multi-use path side		1 @ 1.8 m	
				4 m multi-use path	

Figure 4.13

Figure4.13 - Interim Arterial Road Standard

4.4.8 Road Cross-Sections

Roads are the City's largest public space, and the road cross-sections accommodate many uses and functions, including:

- Vehicle travel lanes
- Bike lanes
- Parking
- Sidewalks
- Multi-use pathways
- Street signs
- Streetlighting
- Trees and landscaping
- Hydro poles or underground power lines
- Sewer mains
- Water mains
- Storm sewer mains
- Ditches and swales
- Telecommunications lines
- Transit stops, shelters, and benches
- Garbage cans
- Fire hydrants

Standard Road Cross-Sections

The City has standard cross-sections for the new construction and the upgrading of arterial, collector, and local roads, as shown in Table 4.5 and illustrated in Figures 4.14, 4.15, and 4.16.

Table 4.5: Standard Road Features

Road Classification		**Design Features**					
Type	**Sub-Type / Land Use**	**No. of Lanes**	**Road Allowance**	**Statutory Right-of-Way**	**Pavement Width + Median**	**Sidewalks**	**Bike Facilities**
Standard Arterial Roads	Divided Urban	4 plus median/left-turn bays	30 m	2 @ 0.5 m	20 m	2 @ 1.8 m	1.8 m bike lanes
				1 @ 0.5 m, 1 @ 2.7 m on multi-use path side		1 @ 1.8 m	
						4 m multi-use path	
	Divided Rural	4 plus two-way left-turn lane		Variable, to accommodate ditches		0	1.8 m bike lanes
				Variable, to accommodate ditches and multi-use path			
						4 m multi-use path	
Standard Collector Roads	--	2 plus 2 parking lanes, or 2 plus left-turn lanes	24 m	2 @ 0.5 m	14 m	2 @ 1.8 m	1.8 m bike lanes
				1 @ 0.5 m, 1 @ 2.7 m on multi-use path side		1 @ 1.8 m	
						4 m multi-use path	
Standard Local Roads	Commercial	2	20 m	2 @ 0.5 m	11 m	2 @ 1.5 m	Shared traffic lane
	Medium- to high- density residential				10.5 m		
	Low-density residential		18 m		8.5 m		

Note: "Medium- to high-density residential" is generally RF-12 zoning and denser; "Low-density residential" is generally RF and less dense.

Figure 4.14

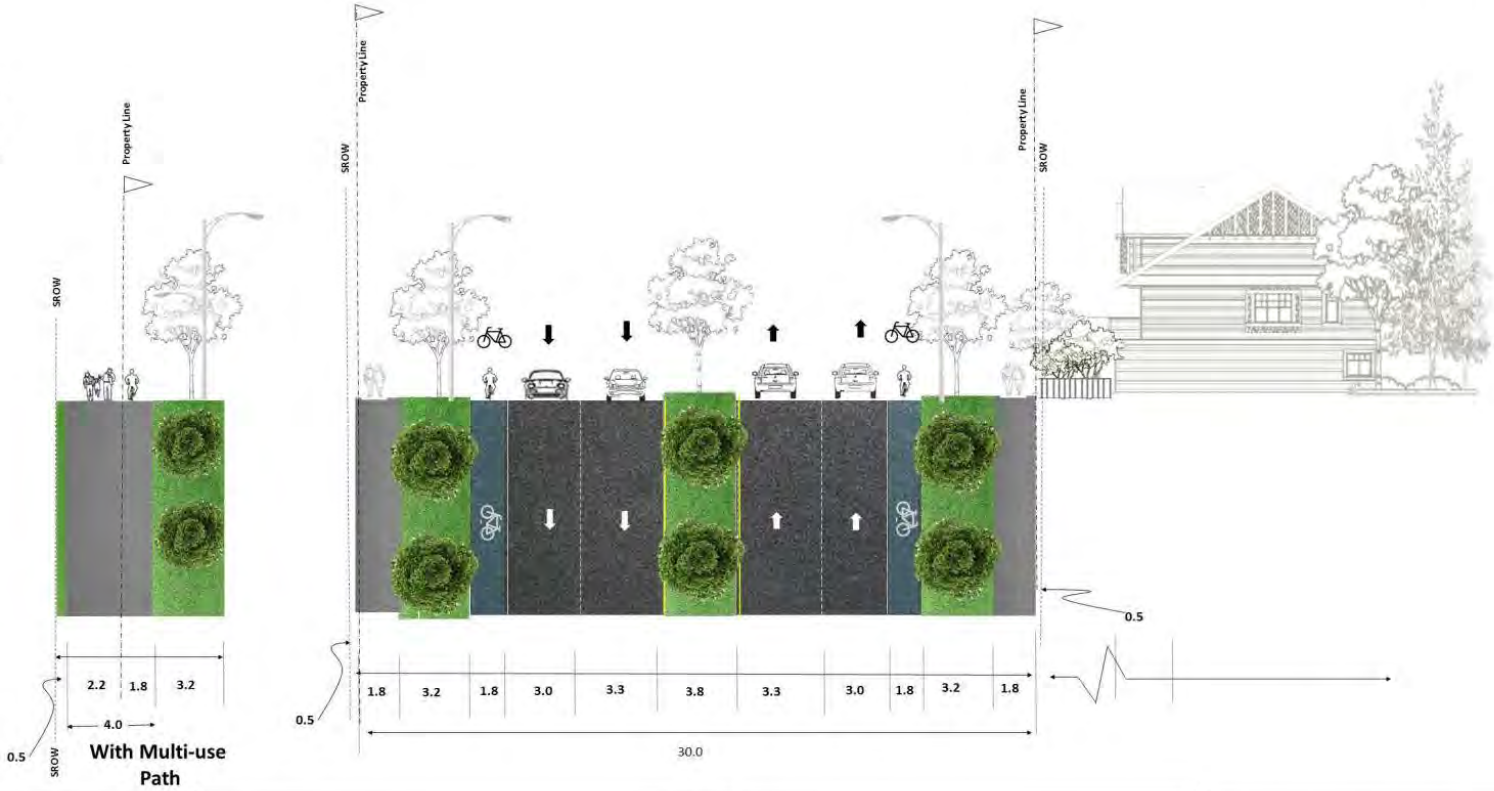

Figure 4.14 - Typical Arterial Cross Section

Figure 4.15

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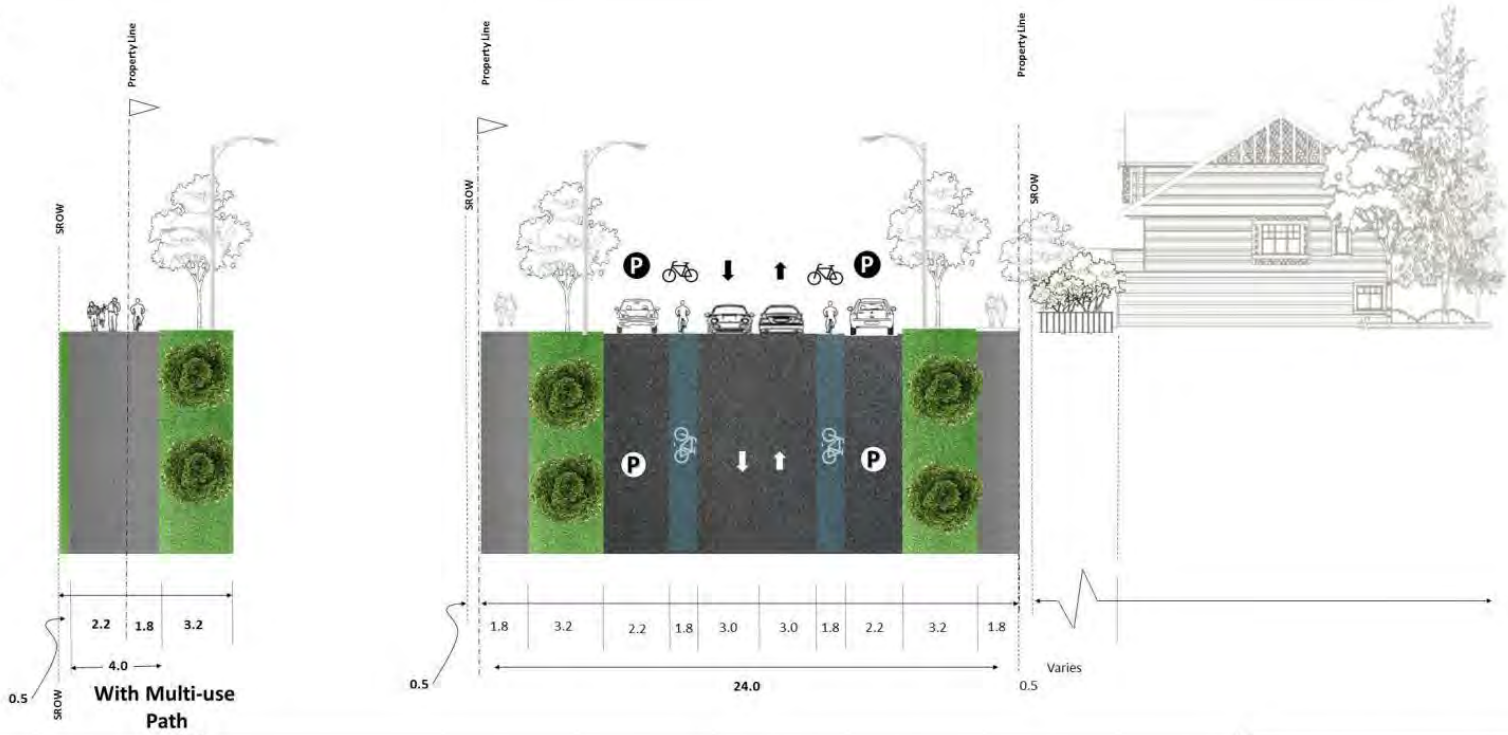


West Clayton Neighbourhood Concept Plan	24 M Standard (Typical) Collector Road	Standard Cross Section

Refer to Section 4.4.8 and Table 4.5 for details.

Scale 1:100

Figure 4.15 - Standard Collector Road Cross Section

Figure 4.16

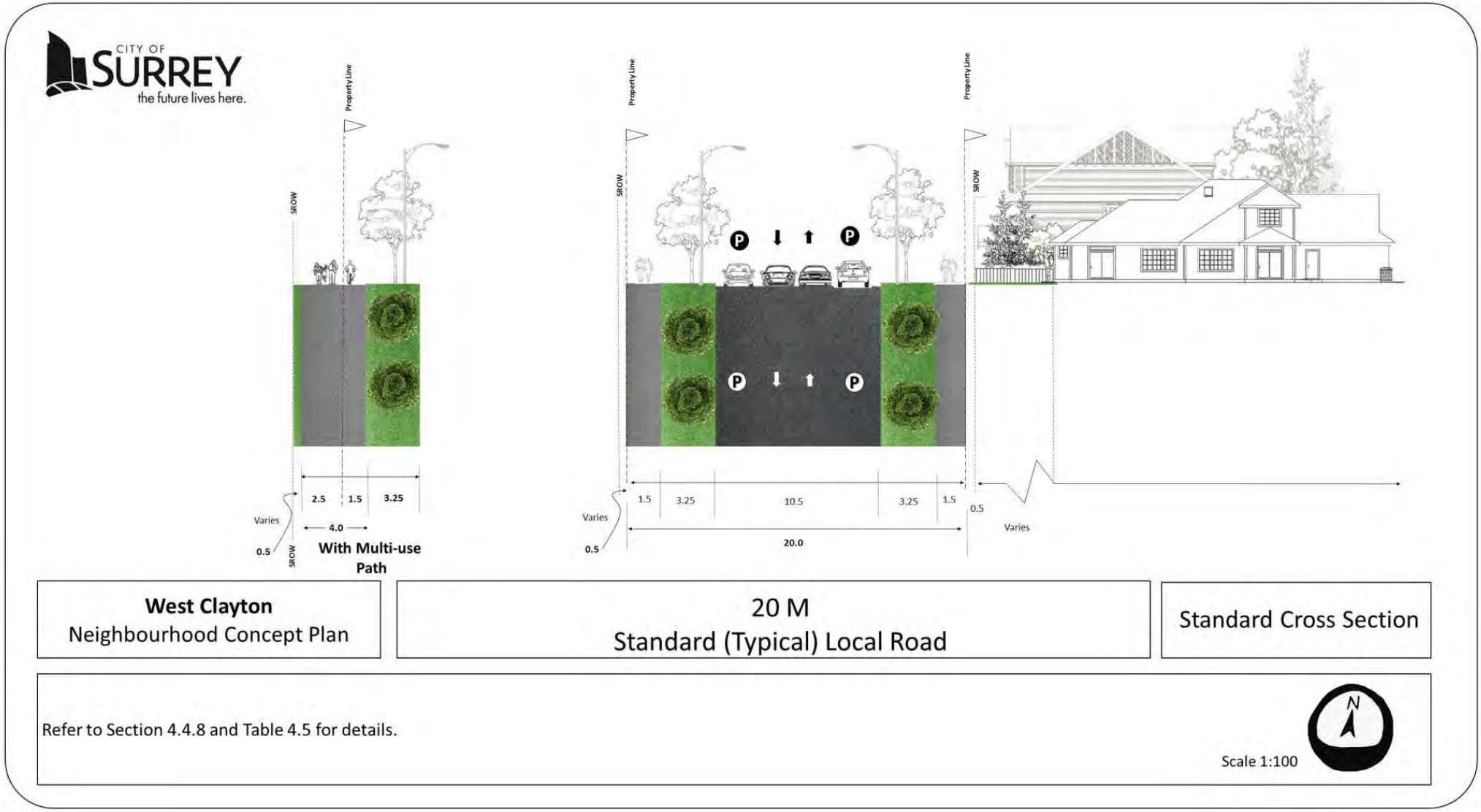


Figure 4.16- Standard Local Road Cross Section

Parking

Collector and local roads will all have parking on both sides of the street, with a few exceptions:

- No parking on collector roads where left-turn bays are planned
- No parking on local or collector roads where they cross the BCS corridor
- No parking along select park frontages
- No parking opposite elementary schools

Parking will not be permitted on arterial roads with the exception of a portion of 184 Street as described below.

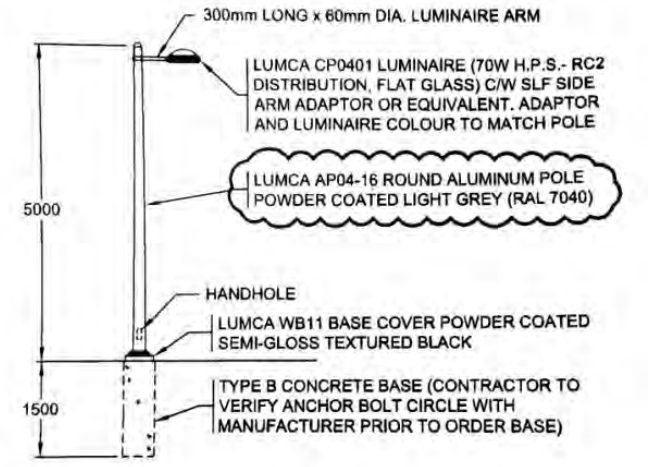
Within commercial areas and in the vicinity of the LRT station, on-street parking is expected to be in high demand. On roads in these areas, the use of parking management tools including time-limited parking and pay parking can be anticipated. These tools can help encourage parking turnover, which benefits commercial areas, and dissuades commuters from using these areas as all-day park-and-ride facilities.

Street lighting

As per Surrey's new standards, all street lighting in West Clayton will be LED, not high-pressure sodium. For roadway lighting, standard flat-glass cobra head fixtures will be used on powder-coated black octagonal poles.

Lighting will be provided for all multi-use pathways. Where multi-use pathways are adjacent to roads, pedestrian fixtures will be attached on the back of the poles. Where multi-use pathways are not adjacent to roads, pedestrian-scale poles (also powder-coated black) will be used with the same pedestrian fixtures. These fixtures are shown in Figure 4.17 (note that an LED fixture will be used and not HPS, and that the poles will be powder-coated black).

Figure 4.17: Pedestrian Light Fixture



TYPICAL PEDESTRIAN LIGHT POLE

Please see the Engineering Department's Design Criteria Manual for required lighting levels.

Green Lanes

A green lane is a type of back lane that also has a sidewalk and grass boulevard on one side. Within Surrey, they are typically used to provide access for multi-family developments when direct road access is not permitted. The cross-section is described in Table 4.6 and illustrated in Figure 4.18.

Table 4.6: Green Lane Features

Dedication	SROW	Pavement Width	Parking	Sidewalks	Boulevards	Streetlighting
12 m	0.5 m on sidewalk side	6.5 m	None	1.5 m on one side	2 m on both sides	On sidewalk side

184 Street, 70 Avenue to 71A Avenue

Within the commercial area on 184 Street near the LRT station, a certain amount of on-street parking will be permitted, which will require a 35 metre dedication width from 70 Avenue to 71A Avenue. Parking will not be permitted within the left-turn lane storage areas.

The multi-use pathway will be split in this segment (separate cycling and walking facilities), in order to allow cyclists free passage without having to navigate around window-shopping pedestrians.

This cross-section is described in Table 4.7 and illustrated in Figure 4.19.

Table 4.7: 184 Street (70 Avenue to 71A Avenue) Features

No. of Lanes	Road Allowance	Statutory Right-of-Way	Pavement Width + Median	Sidewalks	Bike Facilities
4 plus 2 parking lanes	35 m	1 @ 0.5 m, 1 @ 5.5 m on path side	25 m	2 @ 1.8 m	1.8 m bike lanes, 3 m path

Fraser Highway

As discussed in Sections 4.1.4 and 4.4.5, Fraser Highway will accommodate LRT in addition to arterial traffic. A conceptual cross-section is shown in Figure 4.21, with some details provided in Table 4.8.

Table 4.8: Fraser Highway Features

No. of Lanes	Road Allowance	Statutory Right-of-Way	Pavement Width + Median	Sidewalks	Bike Facilities
4 plus LRT	42 m	2 @ 2.5 m	31 m	0	1.8 m bike lanes
				2 @ 4 m multi-use path	

Figure 4.18

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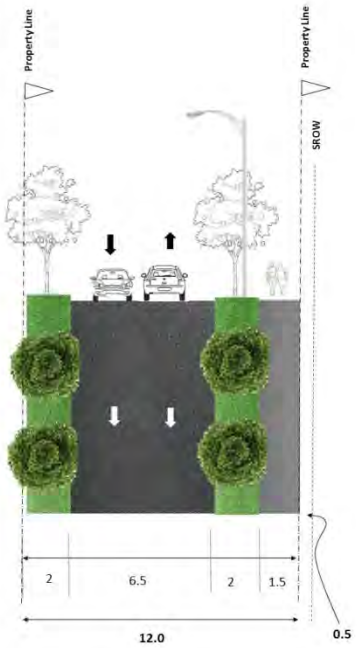


West Clayton Neighbourhood Concept Plan	12 M Residential Green Lane	Special Cross Section

Refer to Section 4.4.8 and Table 4.6 for details.

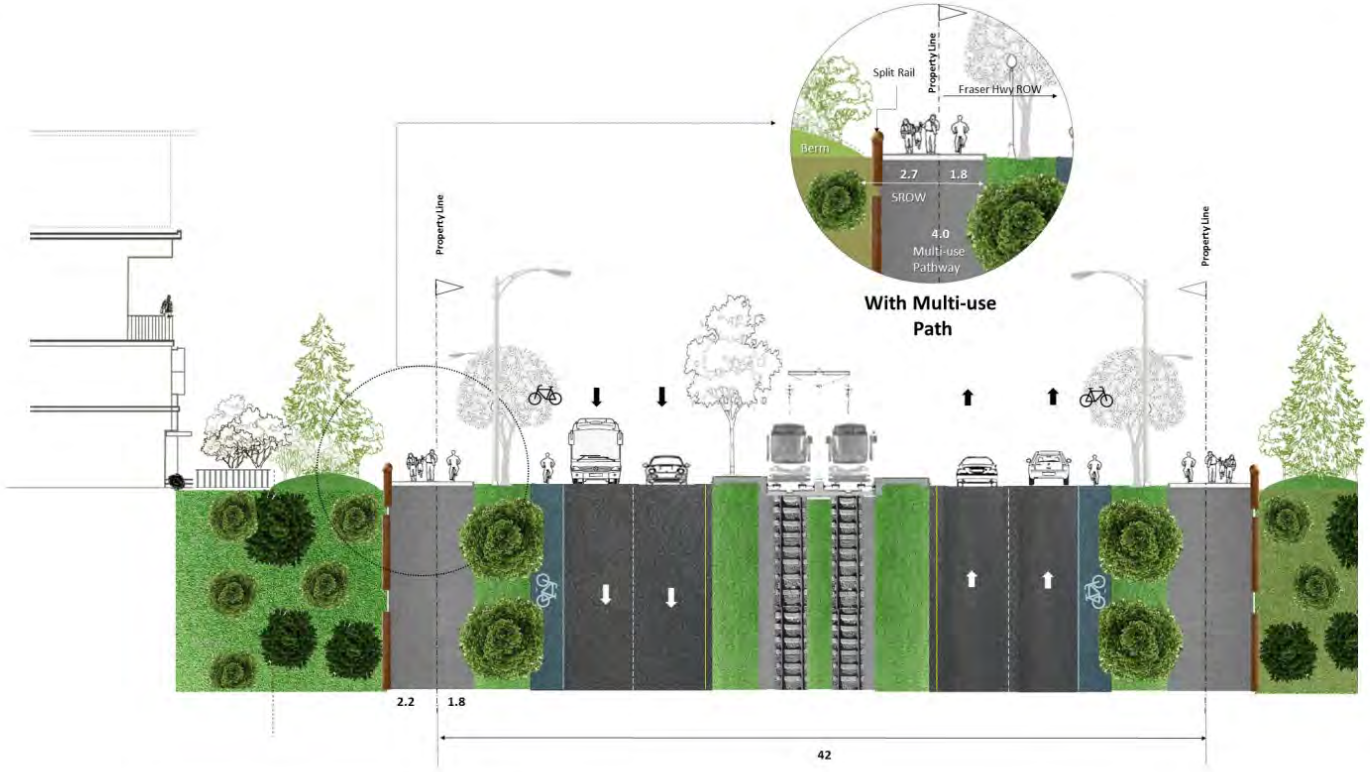
Scale 1:100

Figure 4.18: Residential Green Lane Cross Section

Figure 4.19

Figure 4.19 - 184 Street (70 Avenue to 71A Avenue Features

Figure 4.20



West Clayton Neighbourhood Concept Plan	Fraser Highway with Light Rail Transit	Standard Cross Section

Refer to Section 4.4.8 and Table 4.8 for details.

Scale 1:100

Figure 4.20: Conceptual Cross Section of Fraser Highway with future Light Rail Transit

Unique Local Roads

A number of unique scenarios have been identified in Figure 4.21, and special cross-sections have been developed to accommodate these locations, as shown in Figures 4.22 through 4.28. Information regarding the cross-sections is provided below and in Table 4.9 (note that cross-sections C and D are off-street multi-use pathways and are included in Section 4.4.4). Although some roads may have a lesser total road width than standard, if a development site includes one-half of any of these roads, a minimum 11.5 m dedication is required (and may be more in some cases).

Cross-Section A (Figure 4.23)

- This is a modification to a standard local road, to be used where it crosses a BCS corridor
- All boulevard features are to remain in the same alignment as for a 20 m road with 10.5 m pavement width

Cross-Section B (Figure 4.24)

- This cross-section is to be used in select locations adjacent to BCS corridors and/or parks
- Log-rail fence is to be installed along the property line on the BCS/park side
- The multi-use path (MUP) will be constructed within the BCS corridor and/or park, and may meander slightly within a maximum 9-metre-wide corridor adjacent to the road allowance.

Cross-Section E (Figure 4.25)

- This is a road that is generally supplemental to the base road network shown in Figure 4.6.
- This secondary road may be used to improve neighbourhood connectivity in locations with townhouses on both sides; it is not appropriate for other land uses.
- Townhouse driveways must be on the side of the road with parking, or else aligned exactly opposite another driveway.

Cross-Section F (Figure 4.26)

- This is a “main street” road in the commercial/mixed-use area around the LRT station.
- Curb bulges will be constructed through the parking lane at intersections and the pedestrian/cyclist street crossing.
- This road includes a landscaped median, which will be replaced with left-turn bays at 184 Street.
- The boulevard will be hard-surfaced adjacent to commercial land uses.

Cross-Section G (Figure 4.27)

- This is a local road that provides a green connection between BCS corridors.
- Lane access is required for the lots on the multi-use pathway (east) side of the road.
- The landscaping in the 6.75 m boulevard shall conform to Crime Prevention Through Environmental Design (CPTED) principles and ensure sightlines are maintained between the roadway and the multi-use path.

Cross-Section H (Figure 4.28)

- This is a local road that has been modified to include a multi-use pathway.

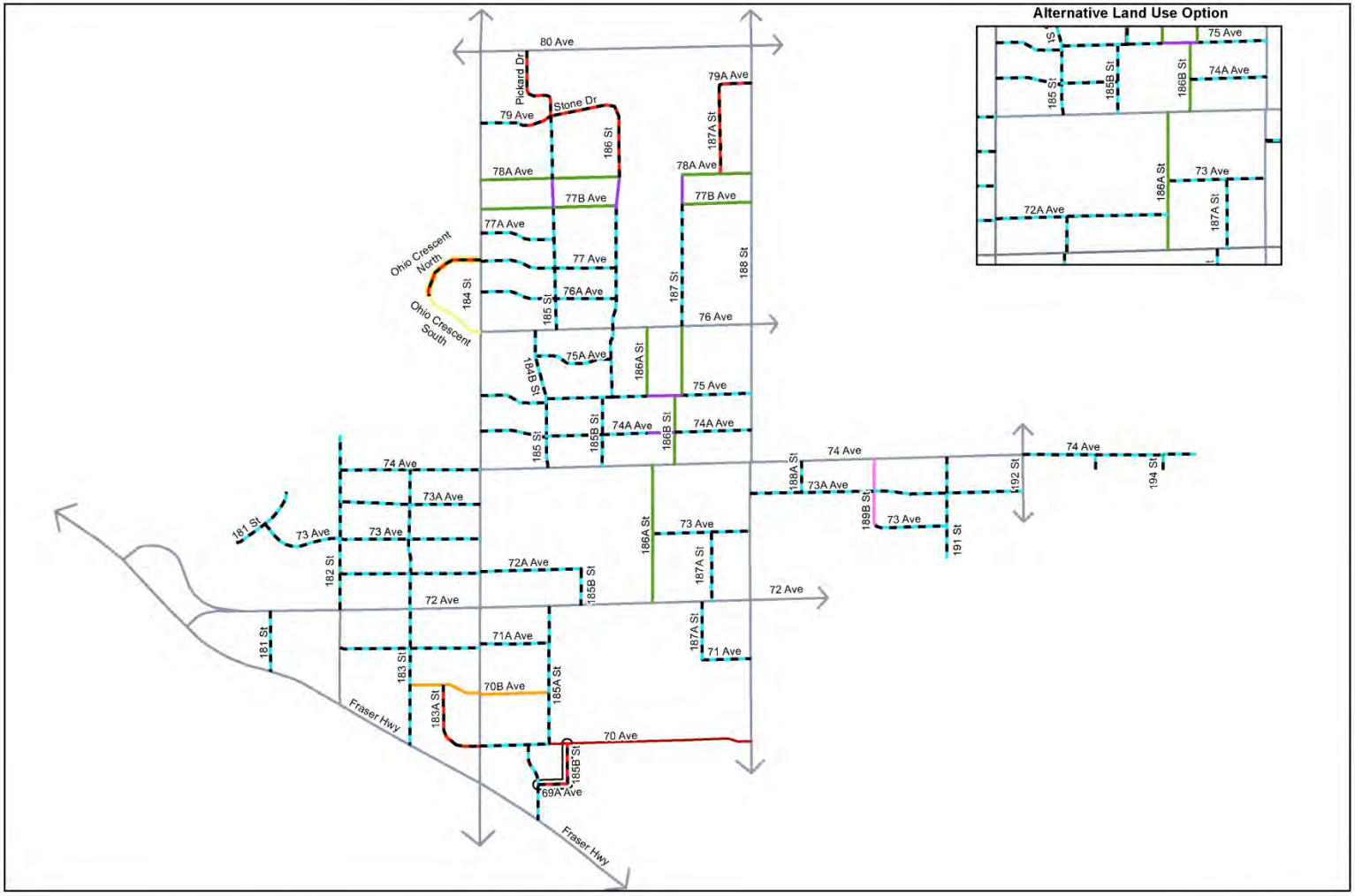
Cross-Section I (Figure 4.29)

- This is a series of cross-sections for 70 Avenue adjacent to Clayton Park.
- Parking is not permitted on the park side (north side) of the road, but will be provided where possible on the south side.
- The multi-use pathway can meander in and out of road allowance and into parkland as needed to preserve trees, with a minimum boulevard width of 2 metres and a maximum boulevard width of 7 metres.

- Adjacent to the Clayton Heights Secondary School building and parking lot, parking will not be permitted to allow a minimum pavement width (7 metres for two-way traffic and 11 metres where a left-turn bay is required), and the boulevard and sidewalk will be reduced in order to minimize impacts on the school property and parking lot.

Table 4.9: Unique Local Road Features

Cross-Section	Dedication	SROW	Pavement Width	Parking	Sidewalks	Boulevards		Streetlighting
A	20 m	0.5 m on both sides	6.6 m	None	1.5 m on both sides	5.2 m on both sides		Both sides
B	15.25 m	0.5 m on non-park side, variable on park side	8.5 m	On non-park side only	1.5 m on both sides OR 1.5 m on non-park side and 4 m MUP on park side	3.25 m on non-park side, 2 m on park side		Road and pedestrian lighting in boulevard on park side
E	14.5 m	0.5 m on both sides	7.5 m	One side	1.5 m on both sides	2 m on both sides		One side
F	24 m	3 m on MUP side, 0.5 m on non-MUP side	14 m	Both sides	1.5 m on one side and 4 m MUP on other side	3.25 m on both sides		Road lighting on both sides, with pedestrian lighting on MUP side
G	24 m	0.5 m on both sides	8.5 m	On non-MUP side only	1.5 m on one side and 4 m MUP on other side	3.25 m on non-MUP side and 6.75 m on MUP side		Road lighting on non-MUP side and pedestrian lighting adjacent to MUP
H	20 m	0.5 m on both sides	8.5 m	On non-MUP side only	1.5 m on one side and 4 m MUP on other side	3.25 m on non-MUP side and 2.75 m on MUP side		Road and pedestrian lighting on MUP side only
I	20 m	0.5 m on non-park side, variable on park side	8.5 m adjacent to residential	Adjacent to residential only	1.5 m on south side, 4 m MUP on park side	2-7 m adjacent to park	3.25 m adjacent to residential 1.5 m hard surface	Road and pedestrian lighting in boulevard on park side
	Variable, to be determined through design		7 m by school parking lot	None				
			11 m on 188 St approach					



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Legend

- Standard Local Road
- Flexible Alignment
- Cross-Section A
- Cross-Section B
- Cross-Section E
- Cross-Section F
- Cross-Section G
- Cross-Section H
- Cross-Section I
- Collector or Arterial Road

West Clayton NCP

Unique Local Roads

The accuracy and completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate and establish the precise location of all existing information, whether shown or not.

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Figure 4.21

Figure 4.21 – Unique Local Roads

Figure 4.22

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West Clayton Neighbourhood Concept Plan	20 m Local Road Crossing (BCS Corridor)	Special Cross Section **A**

Refer to Section 4.4.8 and Table 4.9 for details.

Scale 1:100

Figure 4.22 - Special Local Road Cross- Section A

Figure 4.23

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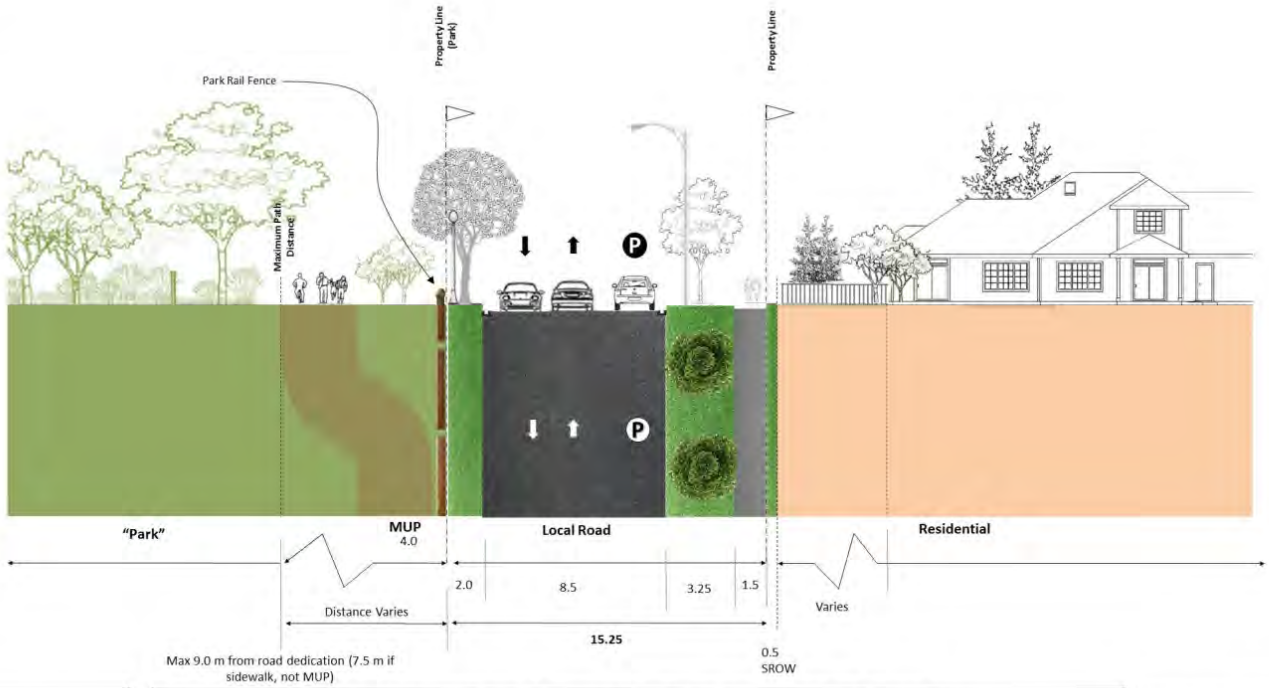

West Clayton Neighbourhood Concept Plan	15.25 m Local Road Adjacent to Parkland [with or without Multiuse Pathway (MUP)]	Special Cross Section **B**

Refer to Section 4.4.8 and Table 4.9 for details.

Scale 1:100

Figure 4.23 - Special Local Road Cross-Section B

Figure 4.24

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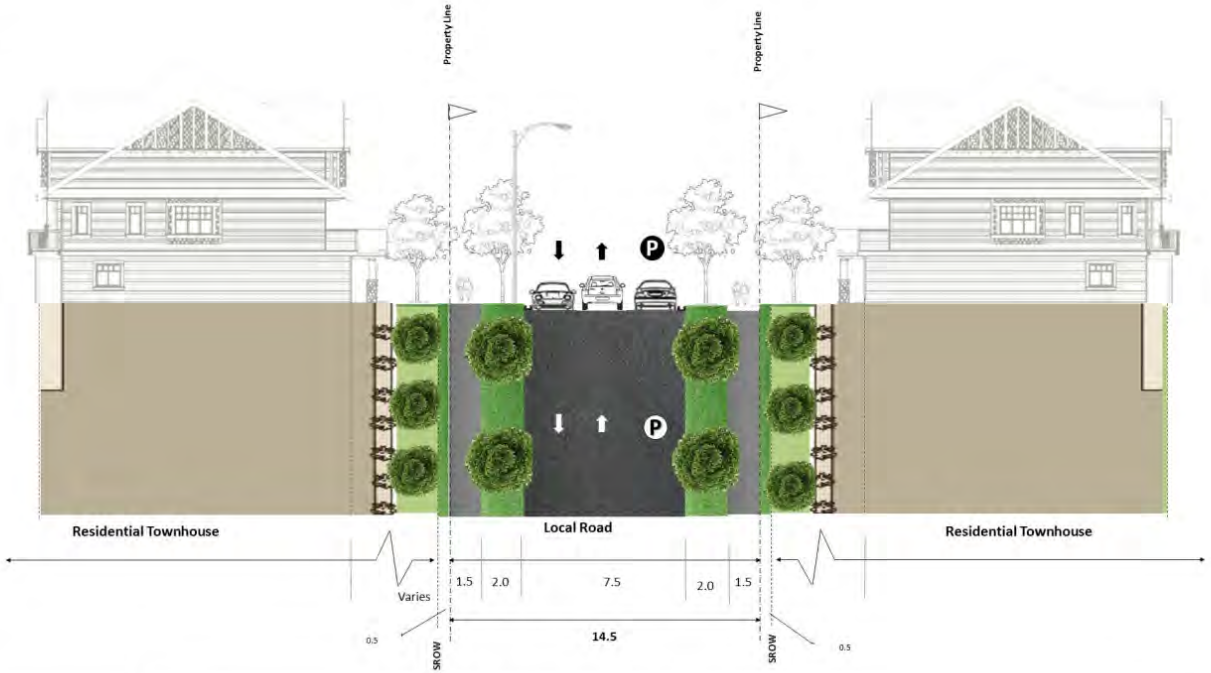

West Clayton Neighbourhood Concept Plan	14.5 m Secondary Road Townhouse Interface	Special Cross Section **E**

Refer to Section 4.4.8 and Table 4.9 for details.

Scale 1:100

Figure4.24 - Special Local Road Cross Section E

Figure 4.25

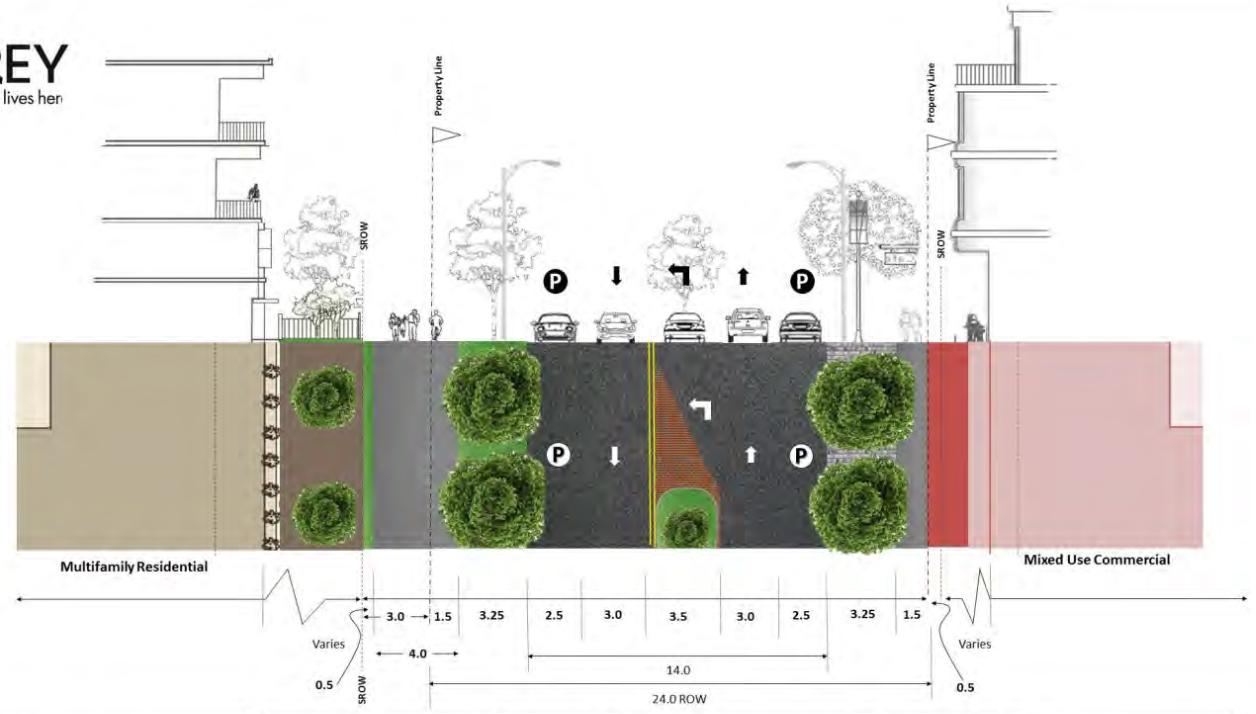

Figure 4.25- Special Local Cross-Section F

Figure 4.26

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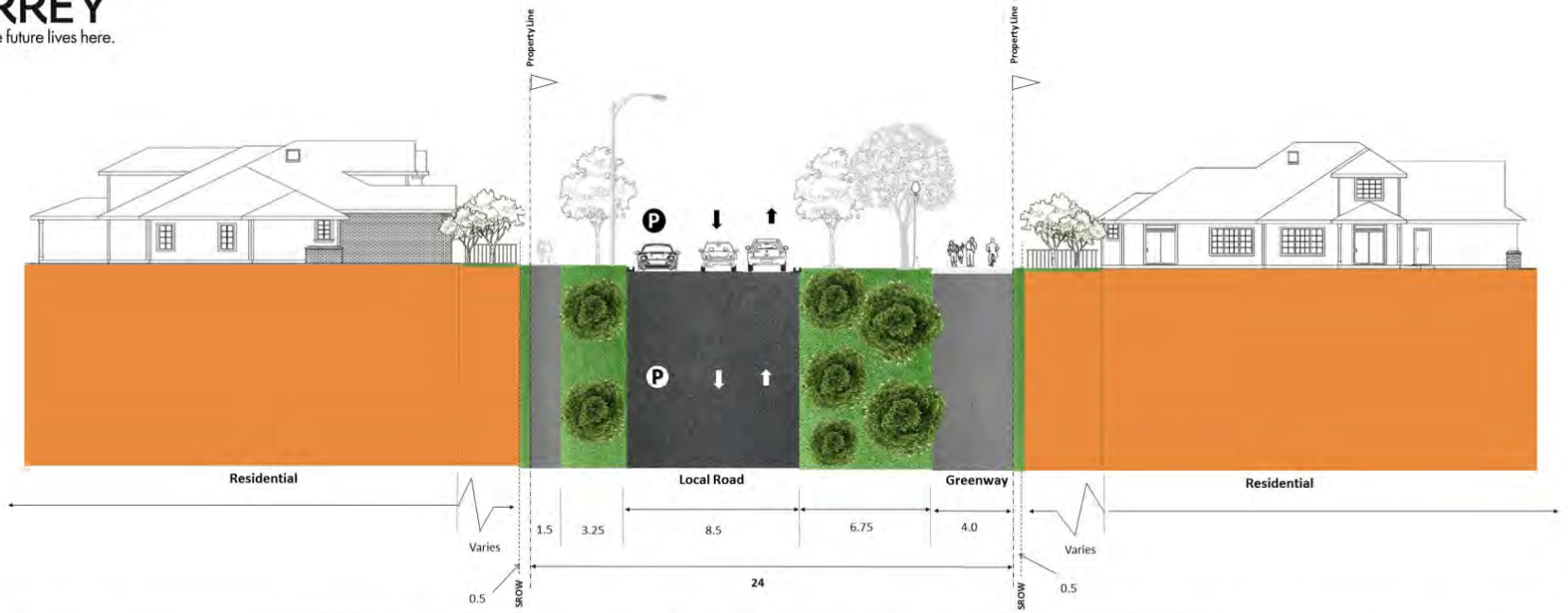


West Clayton Neighbourhood Concept Plan	24 m Local Road (**189B Street**) with Landscape Buffer Single Family Interface to Greenway and Landscape Buffer	Special Cross Section **G**

Refer to Section 4.4.8 and Table 4.9 for details.

Scale 1:100

Figure 4.26 - Special Local Cross-section G

Figure 4.27

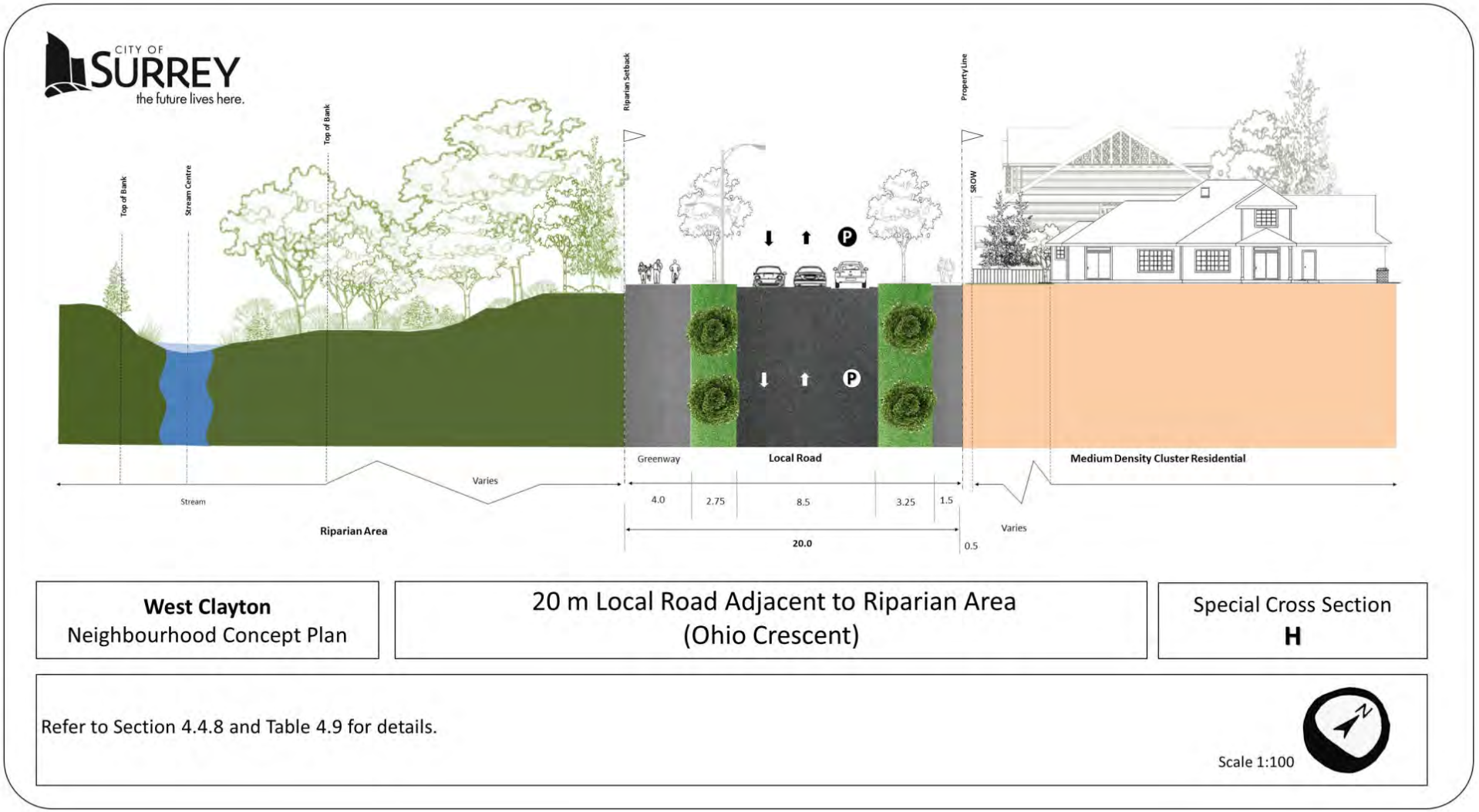


Figure 4.27- Special Local Cross-Section H

Figure 4.28

Figure 4.28 - Special Local Cross-Section I

4.4.9 Road and Greenway Names

In accordance with the Surrey Street Naming Policy, all roads within West Clayton have been numbered or named, as illustrated on Figure 4.6. In addition, the City-level greenways have also been named, as illustrated in Figure 4.8. The named roads and greenways generally honour notable historic figures within West Clayton, as described below:

Pickard Drive is named after John Wesley Pickard. The first Crown Grant in the Clayton area (then called the Serpentine Flats, Serpentine Valley, or Clover Valley) was issued to John Wesley Pickard in 1883. In the 1887 directory, the Pickard family makes several appearances: John Wesley Pickard and Elisha Pickard were listed as farmers, and Thomas W. Pickard listed as a dairyman. John Pickard was also one of Surrey's first councillors in 1880.

Stone Drive is named after the Stone family. William Stone was born in Ontario in 1850, and came to B.C. with his brother Edward in 1879. After a year of working in logging camps in Vancouver, they settled in Surrey in 1880 and each homesteaded 160 acres of land in the Clayton area, William at the corner of 88 Avenue and 176 Street, and Edward at the corner of 80 Avenue and 184 Street. In 1903, William married Elizabeth Ann Triggs, a daughter of Mr. and Mrs. George Triggs, also pioneer settlers in Surrey.

Ohio Crescent North and South are named in recognition of John George, who was the first postmaster in the Serpentine Flats area. In 1889, George renamed the area Clayton, after his hometown of Clayton, Ohio.

Great Northern Greenway is named after the old Great Northern Railway line, which was on the Harvie Road alignment. The Greenway runs parallel to the old tracks, approximately 800 metres to the east, and will provide views to the northwest, overlooking the railway alignment. The railway station at Fry's Corner (what's now the intersection of Fraser Highway, Harvie Road, and Pacific Highway) served Clayton.

Armstrong Greenway is named after the first mail carrier in Clayton, Johnny Armstrong, who began his route in 1915. Naming a greenway after him is a nod to another form of non-motorized transportation—Armstrong conducted his route by horse and buggy.

Hazelgrove Greenway in West Clayton is an extension of an existing greenway in East Clayton, and runs through Hazelgrove Park and by Hazelgrove Elementary School.

Serpentine Flats Greenway is named after one of the original names of the Clayton/Port Kells area, which recognizes the Serpentine River. The greenway runs along 80 Avenue, originally named Serpentine Road.

Fraser Greenway runs predominantly along the south side of Fraser Highway, with the exception that multi-use pathways are featured on both sides of Fraser Highway within the NCP boundary between but runs on both sides of Fraser Highway within the extents of the NCP. The Fraser Greenway is named after the road.

Siddons Greenway follows the alignment of the central BCS Corridors (GIN #s 141), connecting Clayton Park and the future community centre and library with the residential neighbourhoods to the north all the way to 80 Avenue.

4.5 TRANSPORTATION FINANCING

The transportation infrastructure required to service West Clayton will be funded in two ways:

- Directly by the developer of the adjacent lands, or
- By Development Cost Charges (DCCs) collected from new development throughout Surrey

Local roads are fully paid for and built by the developers of the adjacent land. As per the Surrey Subdivision and Development By-law, 1986, No. 8830, developers are required to build the road across their full frontage measured from the centreline of the road to their site, and the full road within their site. (Please note that there may be additional requirements.)

Collector roads are built with development. The local road component is paid for by developers, and DCCs pay for the "upsizing" (additional road features) to the collector standard.

The interim arterial road standard is built with development. DCCs pay for the ultimate works (through a DCC rebate, which has an upset limit) and developers directly pay for the interim works. The ultimate works include the sidewalk, streetlights, street trees, and ultimate boulevard. A road profile will be provided by the City. The interim works include minimal pavement widening to provide a road shoulder / bike lane, an interim curb, and sodded swale.

The ultimate arterial road standard is built according to City-wide priorities, as identified in the Engineering Department's 10-Year Servicing Plan, and paid for largely by DCCs. (Other funding sources, if applicable, are identified in the Servicing Plan.)

Traffic control treatments on arterial and collector roads, such as traffic signals, roundabouts, and crosswalks, are paid for by DCCs. Where possible, these treatments have been identified on Figure 4.12 and have been included in the transportation financing calculations for this NCP. However, not all of these treatments are foreseeable and therefore explicitly accounted for in this NCP, but, when warranted, they will be constructed by the City and are anticipated to be funded by DCCs.

Most forms of traffic control are constructed when warranted by an engineering study, and according to priority within the Servicing Plan. Roundabouts within West Clayton, however, are anticipated to be built in conjunction with the development of the fourth corner at the intersection.

On local roads, in common with other NCPs and general development practices, the cost of construction of traffic circles on local roads will be shared between the developers of the four corners at the intersection, and are anticipated to be built in conjunction with the development of the fourth corner at the intersection.

All multi-use pathways within road allowance will be constructed and funded by the fronting development.

Although DCCs received through redevelopment in West Clayton are pooled with DCCs received from redevelopment elsewhere in Surrey, and used to fund projects across the City, a certain number of DCC expenditures attributable to traffic generated by West Clayton were calculated, to ensure that West Clayton is "pulling its weight". As there is a slight surplus, no additional transportation fees will be required. Table 4.10 summarizes the anticipated transportation DCC revenues and expenditures, and Table 4.11 provides details of the DCC-eligible projects and estimated costs.

Table 4.10: Summary of Transportation DCC Revenues and Expenditures

DCC Type	Revenues	Expenditures
Arterial Roads	$58.9 million	$51.9 million
Non-Arterial Roads	$13.6 million	$7.6 million
Transportation Total	$72.5 million	$59.5 million

Table 4.11: DCC-Eligible Transportation Servicing Costs

Road	Unit Price	Quantity	Portion to West Clayton	Cost to West Clayton
Arterial Road Expenditures				
72 Avenue, Fraser Highway to 182 Street (interim)	$4,000,000	1	40%	$1,600,000
72 Avenue, Fraser Highway to 182 Street (ultimate)	$8,750,000	1	10%	$875,000
72 Avenue, 182 Street to 188 Street	$7000/metre	1200 metres	60%	$5,040,000
72 Avenue / 184 Street signal	$200,000	1	50%	$100,000
72 Avenue / Fraser Highway property	$3,500,000	1	40%	$1,400,000
80 Avenue, 168 Street to 172 Street	$3600/metre	800 metres	20%	$576,000
80 Avenue, 172 Street to Highway 15	$5400/metre	800 metres	20%	$864,000
80 Avenue, Highway 15 to 184 Street	$9600/metre	1650 metres	50%	$7,920,000
80 Avenue, 184 Street to 188 Street	$9600/metre	800 metres	80%	$6,144,000
80 Avenue, 188 Street to 196 Street	$7000/metre	1600 metres	20%	$2,240,000
80 Avenue / 184 Street signal	$200,000	1	10%	$20,000
184 Street, 70 Avenue to 80 Avenue	$7000/metre	2000 metres	100%	$14,000,000
184 Street, 80 Avenue to 90 Avenue	$9600/metre	2000 metres	25%	$4,800,000
Culverts	$325,000	7	100%	$2,275,000
LRT supportive improvements	$5,000,000	1	80%	$4,000,000
Total				**$51,854,000**
Non-Arterial Road Expenditures				
74 Avenue, 184 Street to 188 Street	$450/metre	800 metres	100%	$360,000
74 Avenue, 188 Street to 192 Street	$450/metre	800 metres	50%	$180,000
76 Avenue, 184 Street to 188 Street	$450/metre	800 metres	100%	$360,000
70 Avenue, 18500 block to 188 Street (south half)	$2000/metre	450 metres	100%	$900,000
182 Street, Fraser Highway to 72 Avenue	$450/metre	250 metres	100%	$112,500
188 Street, 70 Avenue to 73 Avenue	$450/metre	600 metres	50%	$135,000
188 Street, 73 Avenue to 74 Avenue	$450/metre	200 metres	100%	$90,000
188 Street, 74 Avenue to 80 Avenue	$450/metre	1200 metres	50%	$270,000
188 Street, 80 Avenue to 82 Avenue	$2925/metre	400 metres	40%	$468,000
188 Street, 82 Avenue to 84 Avenue	$5400/metre	400 metres	50%	$1,080,000
188 Street, 84 Avenue to 86 Avenue	$2925/metre	400 metres	40%	$468,000

74 Avenue / 188 Street roundabout	$500,000	1	50%	$250,000
76 Avenue / 188 Street roundabout	$500,000	1	50%	$250,000
70 Avenue / 188 Street signal	$100,000	1	100%	$100,000
70 Avenue / 188 Street civil works	$700,000	1	100%	$700,000
70 Avenue / 188 Street property	$600,000	1	100%	$600,000
72 Avenue/ 182 Street signal	$200,000	1	100%	$200,000
72 Avenue / 188 Street signal	$200,000	1	50%	$100,000
74 Avenue / 192 Street signal	$200,000	1	20%	$40,000
80 Avenue / 188 Street signal	$200,000	1	75%	$150,000
76 Avenue / 184 Street signal	$200,000	1	100%	$200,000
74 Avenue / 184 Street signal	$200,000	1	100%	$200,000
70B Avenue / 184 Street signal	$200,000	1	100%	$200,000
Fraser Highway / 182 Street signal	$200,000	1	80%	$160,000
Total				**$7,573,500**

SECTION 5

Design and Development Guidelines

SECTION 5 – DESIGN & DEVELOPMENT GUIDELINES

5.1 RIPARIAN AREA MANAGEMENT

With urban development comes increased pressure on natural watercourses and streams. Within the Land use Concept Plan Riparian Buffers have been identified to protect Riparian areas. The City of Surrey works with the federal Department of Fisheries and Oceans and the provincial Ministry of Environment to ensure that development respects these riparian resources and preserves and enhances them for all residents of Surrey.

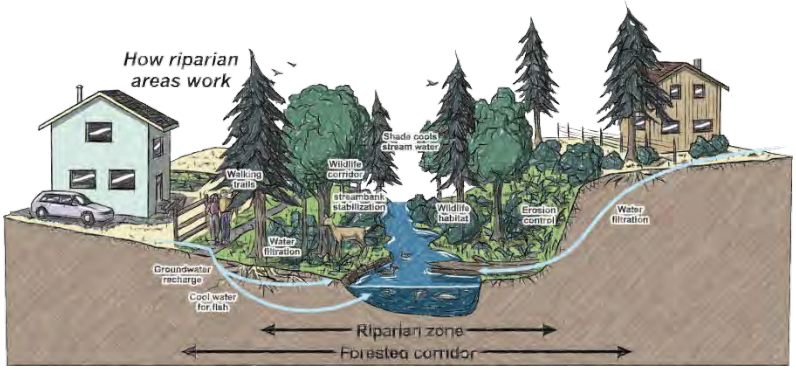
Depending on the type of development proposed land dedication (riparian setbacks), restrictive covenants, or landscaping may be required. Regulations and legislation to preserve riparian areas and prevent water pollution are identified the:

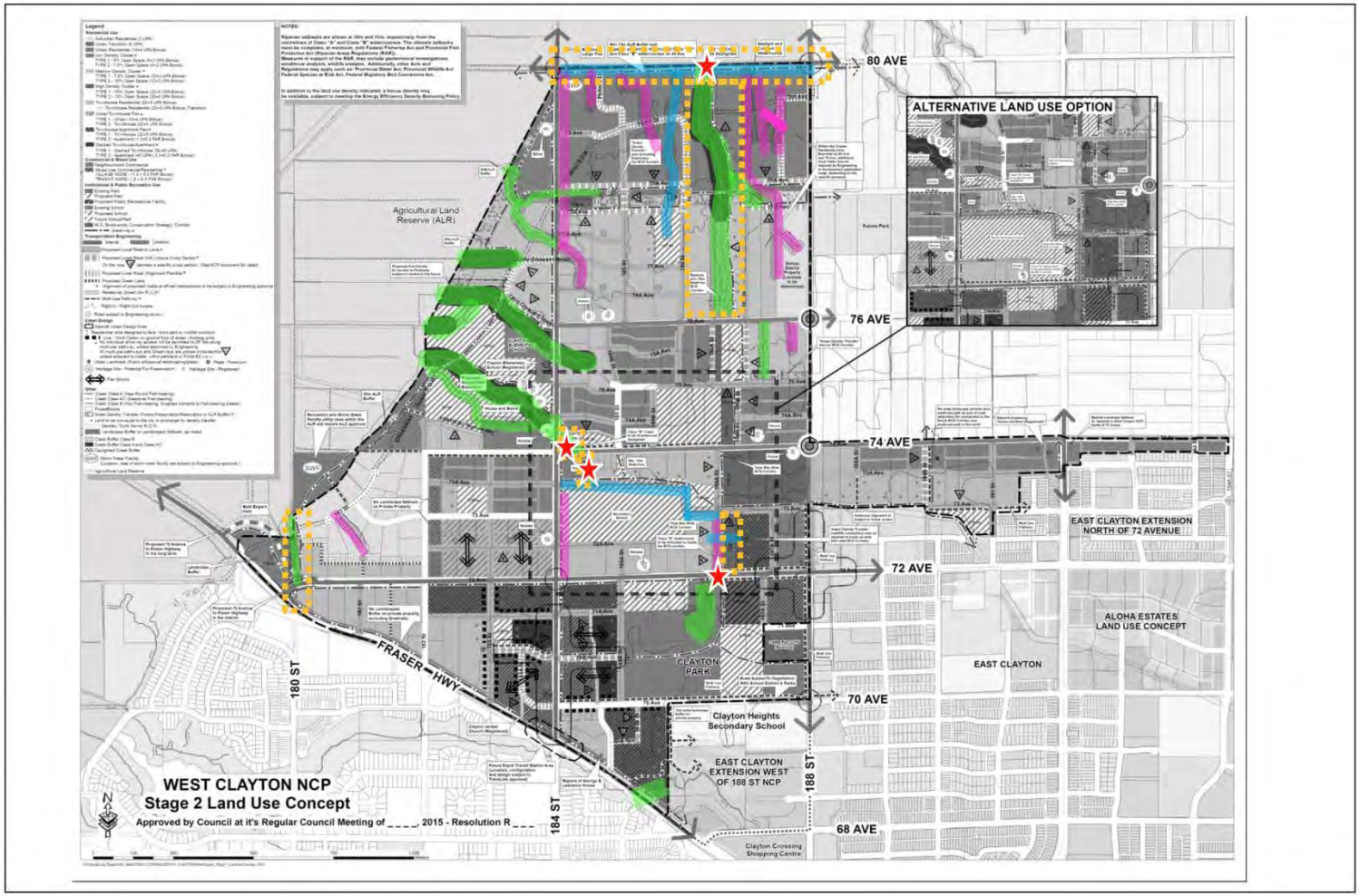
- Federal Fisheries Act;
- Provincial Water Act;
- Provincial Environmental Management Act;
- Stormwater Drainage Regulation and Charges By-Law; and
- Surrey Riparian Area Bylaw *(Development of this bylaw is currently underway).*
- *Surrey Environmental Development Permit Area (Development is currently underway)*

Please see Drainage and Environment Section 8, and West Clayton Environmental Study as well as contact Planning and Development Department for information on environmental management and riparian area setback requirements and regulations.

Riparian Management Areas

Within the West Clayton NCP, some riparian areas have been identified for riparian area management improvements. These riparian areas will be prioritized for stream enhancement through redevelopment of the NCP area. **Figure 5.1** identifies potential Riparian compensation and enhancement areas (pending environmental review and city approvals) within the West Clayton NCP. Compensation for stream movement or removal will be a requirement for any areas within the West Clayton are, and any proposed development must first be vetted by the Surrey Engineering and Drainage department.





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Legend

- Cluster Open Space / Restrictive Covenant
- Riparian Conveyance/ Dedication / Parkland
- Riparian Compensation required for removal (DFO) – Compensation to be provided within Drainage Catchment
- Potential Riparian Compensation Areas for watershed improvements
- Stream Daylighting or other Improvement

West Clayton NCP

Riparian Management Areas

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Figure 5.1

Figure 5.1 - Riparian Management Areas

5.2 GREEN DENSITY TRANSFER AREAS

Within the Land Use Concept Plan (Figure 3.1) CLUSTER Designations GREEN DENTISY TRASFER Areas have been identified. These areas allows for the development value (gross residential unit density) associated with one section of a property to be transferred and added to the amount of potential residential units available on another section of a property or development site. These GREEN DENSITY TRANSER Areas:

- Serve as a mechanism that permanently protects ecologically significant areas (Riparian areas, Significant Tree Patches, and Green Infrastructure) or agricultural buffer areas without the expenditure of public funds or long term enforcement of landscape maintenance;
- Are applied at a NCP level within prescribed Cluster Designation Areas;
- Provides a mechanism that restricts building on portions of land while providing equity to the private landowner in correlation with that restriction;
- Promote preservation of green areas while allowing development to occur in predefined designated areas and near service infrastructure.

5.2.1 Application

Cluster housing guidelines apply to the three "Cluster Residential" designation areas within West Clayton Neighbourhood. The three "Cluster Designation" areas (identified and summarized in Section 3) enable the transfer of development potential at rezoning from GREEN DENSITY TRANSFER Areas the City seeks to conserve/enhance or as Agricultural Buffer Areas, or are biologically significant to improve and protect, to areas specifically designated to be developed. These include the:

- LOW DENSITY CLUSTER Designation
- MEDIUM DENSITY CLUSTER Designation; and
- HIGH DENSITY CLUSTER Designation.

These designation areas are provided to enable the redistribution of development potential from one location to another in a way that is fair and equitable to landowners, while supporting community development, agricultural buffers, urban planning and environmental management goals.

5.2.2 Green Density Transfer Areas (GDT)

"Green Density Transfer" areas referred to in the Land Use Concept Plan (Figure 3.1) refer to the areas of a site where preservation of open space is to occur. The potential density from the green space transfer area is intended to be transferred to the "development area" of a site. A formal survey will be required to outline exact location and amount of Green space transfer Areas and they must be identified as such on any subdivision plans.

The following areas or land uses may not be counted as a part of designated green space transfer areas:

- Areas Covered by any Structures or Buildings;
- Road Rights-of-ways;
- Strata Lanes;
- Property Setbacks and private front or backyard areas;

The following areas shall be high priorities for inclusion as designated Green Space Transfer areas

- Riparian Dedication Setback Areas and Utility Corridors;
- Landscape Buffers separating uses;
- Agricultural Land Reserve Buffers;
- Ecologically Significant Vegetation Areas;
- Environmental Assessment);

- Passive Recreation and Trail Areas;
- Biodiversity Hub, Site, or Corridors areas as identified in Surrey BCS;
- Steep or unstable Slopes (Greater than 15%) as identified in the OCP Hazard Land Development Permit;

Portions of the Green Space Transfer areas may be "community space" and conveyed to the City, and may be used for public passive or active recreation, community gardens, or rainwater management facilities that meet all design, construction, maintenance, and public safety requirements set forth by the City of Surrey. At least 75% of designated open green space shall be contiguous, with no portion less than 20 meters wide.

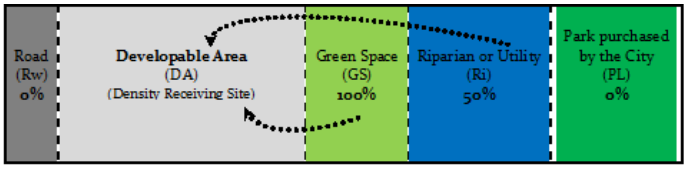
5.2.3 Development areas – Receiving Sites (DA)

Development Areas refer to the portion of the site where building and development should ideally be located. These areas are intended to be developed intensely, so that preservation can occur on other portions of the site. Individual Tree protection within Development Areas may still apply, as per the City of Surrey Tree Protection Bylaw.

5.2.4 Determining Cluster Housing Unit Yield

Density Transfer Values for sites with a "Cluster" Designation:

- 100% of site's density designation value from Green Space Transfer Areas
- 50% of site's density designation value from Riparian, Gas, or Hydro ROW Areas;
- 0% from Road Dedication Areas;
- 0% from land purchased for Park by the City



5.2.5 Density Allocation in Cluster Areas

The amount of Green Space preservation required should generally increase with increase in land use density, because of the feasibility of protecting open space and to offset the cost of development.

In lower density cluster designs (north of 78Avenue and along ALR edge), different techniques such as clustering homes into small groups may be used while in higher density urban areas small lot zoning and multiple family dwellings can be used to intensify development in specific locations such as near roads, on flatter slopes, and away from the Agricultural land reserve or environmentally sensitive features and stands of established trees.

The base and maximum densities in the Cluster designations should meet the requirements outlined in Section 3..

5.2.6 Green Space Area Management

The boundaries of designated green space areas, recreation areas, rainwater management facilities, and natural areas shall be clearly delineated on plans, including subdivision plans, rezoning plans, and marked in the field with signage during construction approved by the Surrey Planning and Development Department to distinguish these areas from private or common property.

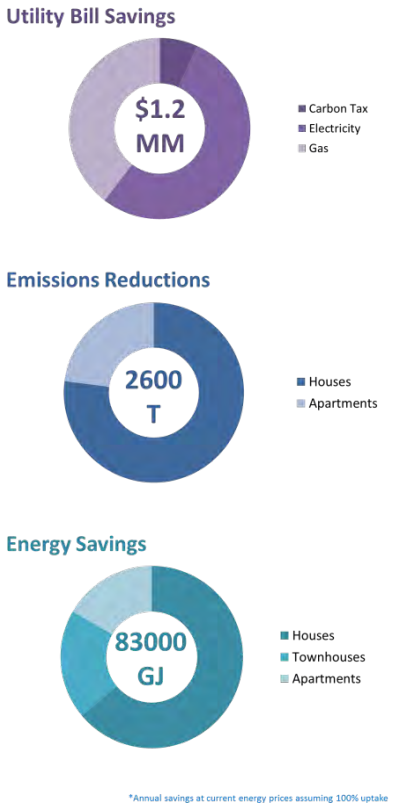
5.3 ENERGY DENSITY BONUS POLICY

This section describes the building energy standards required for developments seeking to exceed the base density as outlined in the West Clayton Neighbourhood Land Use Plan and establishes the additional density allowances.

5.3.1 Density Bonus Objectives

The following comprise the City of Surrey's objectives of the Energy Density Bonus.

1. to mitigate the emissions of greenhouse gases associated with the operation of buildings;
2. to minimize the demand for electricity and natural gas in buildings;
3. to reduce building operating costs for owners and occupants; and
4. to improve the comfort and indoor air quality of buildings.



5.3.2 Density Bonus Definitions

Airtightness Testing: The process of quantifying the air leakage of a building or suite. Airtightness shall be measured in accordance with the as-operated method based on CAN/CGSB 149.10-M86 "Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method."

Building Commissioning (Cx): The procedure used to verify and document that building systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the owner's project requirements. Building commissioning shall adhere to ASHRAE Standard 202-2013.

Compartmentalize: The design and installation of a continuously sealed air barrier system to fully enclose a suite, thereby separating it from adjacent indoor and outdoor areas.

ENERGY STAR: The version of Natural Resources Canada's ENERGY STAR® for New Homes Standard current at the time of building permit application.

Floor Area Ratio (FAR): The ratio of the area of all the floors of the buildings constructed or proposed to be constructed over the gross area of the lot.

Heat Recovery Ventilator (HRV): A mechanical system used to balance ventilation and recover heat from exhaust air. Eligible HRVs shall be at least 65% efficient at 0ºC and certified by the Home Ventilating Institute as an HRV or ERV, or be ENERGY STAR® qualified.

Units per Acre (UPA): A measure of the total number of dwelling units per acre of gross or net lot area depending on land use type.

5.3.3 Density Bonus Criteria

TYPE 1: PART 9 BUILDINGS

Residential developments with buildings less than four storeys and not more than 600m2 in building area (Part 9) shall be allowed to increase the Units per Acre beyond the base density stated in the Neighbourhood Community Plan according to Table 5.1 if:

I. all buildings proposed in the development application are certified to the ENERGY STAR standard.

TYPE 2: PART 3 BUILDINGS

Developments with buildings greater than or equal to four storeys or greater than 600m2 in building area (Part 3) shall be allowed to increase Floor Area Ratio above the base density stated in the Neighbourhood Community Plan according to Table 6.1 if all buildings proposed in the development application:

I. are constructed with compartmentalized suites,
II. are equipped with in-suite heat recovery ventilators,
III. undertake building commissioning (Cx), and
IV. conduct airtightness testing of the building envelope and a minimum of five selected suites to confirm air leakage less than or equal to 1.3 L/s/m2 at 50 Pa

Land Use Designation	Part 9 Additional Density (UPA)	Part 3 Additional Density (FAR)
Urban Residential	4	
Townhouse Residential	5	
Urban/Townhouse Flex Type 1 – Urban Residential Type 2 – Townhouse	 4 5	
Townhouse/Apartment Residential Flex Type 1 – Townhouse Type 2 – Apartment	 4	 0.2
Stacked Townhouse/Apartment Residential Flex Type 1 – Stacked Townhouse Type 2 – Apartment	 -	 0.2
Low Density Cluster	2	
Medium Density Cluster	2	
High Density Cluster Type 1 Type 2	 2 5	
Mixed Use Commercial/Residential Village Node Transit Node		 0.2 0.3

Table 5.1 West Clayton Land Use Designations and Density Allowances for Part 9 and Part 3 Developments

5.4 FLEX BLOCK AND FLEX DENSITY GUIDELINES

Flex Block and Flex Density designations are provided in selected locations within and in proximity of the two neighbourhood nodes as mentioned in the Land Use Section and identified on the Land Use Concept Plan (Figure 3.1).

5.4.1 Flex Block Areas

The intent of the Flex Block areas is to enable innovative site layouts, built forms and development options within the context of the urban blocks. In keeping with the intent of these flex designations, zoning variances may be permitted subject to achieving good urban design.

The locations of these designations are as follows:

- Fraser Highway, 183 Street, 71A Avenue and 184 Street;
- 70 Avenue, a84 Street, 71A Avenue and 185 street adjacent to the Clayton park;
- 71A avenue, 182 street, 72 Avenue and 185 Street adjacent to the Clayton park;
- 72 Avenue, 188 Street, 73 Avenue and the rear lane parallel to 182 Street; and
- 72 Avenue, 187 Street, 73 Avenue along the south side of the Fortis BC Gas Right-of-way and 187A street.

5.4.2 Flex Block Designation

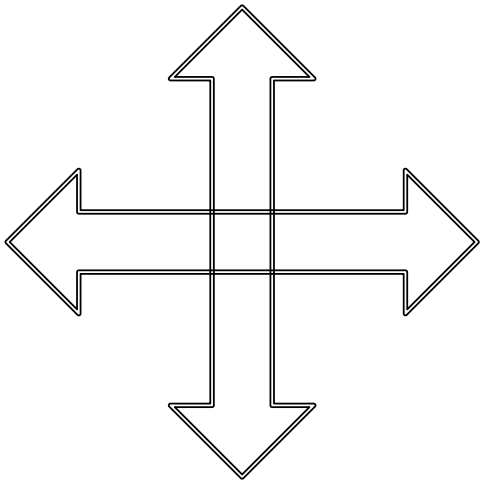
The Flex Block designation will allow flexibility in the distribution of densities and building forms between adjacent blocks as well as, subject to Engineering approval, alternatives to the street alignment and/or location. Replacing or substituting a street between blocks may be considered provided a pedestrian and/or vehicle connection (with a public right-of-way) through the development is maintained, subject to the requirement and approval of Engineering Department.

5.4.3 Flex Density Designation

The Flex Density designation will allow two different building forms at different densities within the same block subject to confirming to the maximum allowable overall density. There are two types of Flex Density designations.

Type 1: The TOWNHOUSE / APARTMENT FLEX Density designation will permit the options of developing townhouses or apartments or a combination of these two housing types.

Type 2: The URBAN / TOWNHOUSE FLEX designation will permit the development of ground-oriented units as single family detached on fee simple lots or within a strata development and/or townhouses or some combination of these building types.



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5.5 SPECIAL LAND USE INTERFACE AREA GUIDELINES

A number of unique urban interface areas have been identified in the West Clayton Land Use Concept Plan (Figure 3.1) and are identified in Figure 5.2.

The special interface cross-sections have been developed to accommodate special design consideration in these locations for areas adjacent to Riparian areas, agricultural edges, green space preservation corridors, landscape buffers, or along hillsides) as shown in Figures 5.3-5.8. Information regarding these special interface area cross-sections is provided in Table 5.2 below.

Table 5.2 - Special Land Use Interface Areas

Special Urban Use Interface Transition	Location	Description
Transition 1 – Figure 5.2	LOW DENSITY CLUSTER Areas South of 80 Avenue.	80Avenue ALR Edge Interface , (15 m Landscaped Buffer)
Transition 2 – Figure 5.3	MEDIUM DENSITY CLUSTER Areas Adjacent to ALR boundary west of 184 Street.	ALR Landscape Buffer Interface along western boundary. (50 m Landscaped Buffer)
Transition 3 – Figure 5.4	NEIGHBOURHOOD COMMERCIAL South east of 74 Avenue and 184 Street.	Landscaped buffer and day lighted stream interface.
Transition 4 - Figure 5.5	TOWNHOUSE RESIDENTIAL adjacent to Fraser Highway.	Fraser Highway interface. (5 m Landscaped Buffer)
Transition 5 - Figure 5.6	URBAN TRANSITION Area East of 182 Street.	Landscaped buffer Interface adjacent to 182 Street. (5 m Landscaped Buffer)
Transition 6 - Figure 5.7	MIXED USE COMMERCIAL/RESIDENTIAL Area with Transit Node along 184 Street.	184 Street Commercial and Street Interface adjacent to 184 Street (Additional dedication for On street Parking adjacent to Commercial areas).

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Legend

1. 80 Avenue ALR and Riparian Enhancement Area interface
2. Western ALR Edge Buffer Interface
3. Neighbourhood Commercial Residential Interface
4. 182 Street Transition Area Interface
5. Landscape Buffer adjacent to Fraser Hwy Interface
6. 184 Street Transit / Commercial Node Interface
7. Residential / School / Pathway Landscape buffer Interface

West Clayton NCP

Land Use Interface Transition Areas

The accuracy and completeness of infromation shown on this drawing is not guranteed. It will be the responsibility of the user of the information shown on this drawing to locate and establish the precise location of all existing information, whether shown or not.

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Figure 5.2

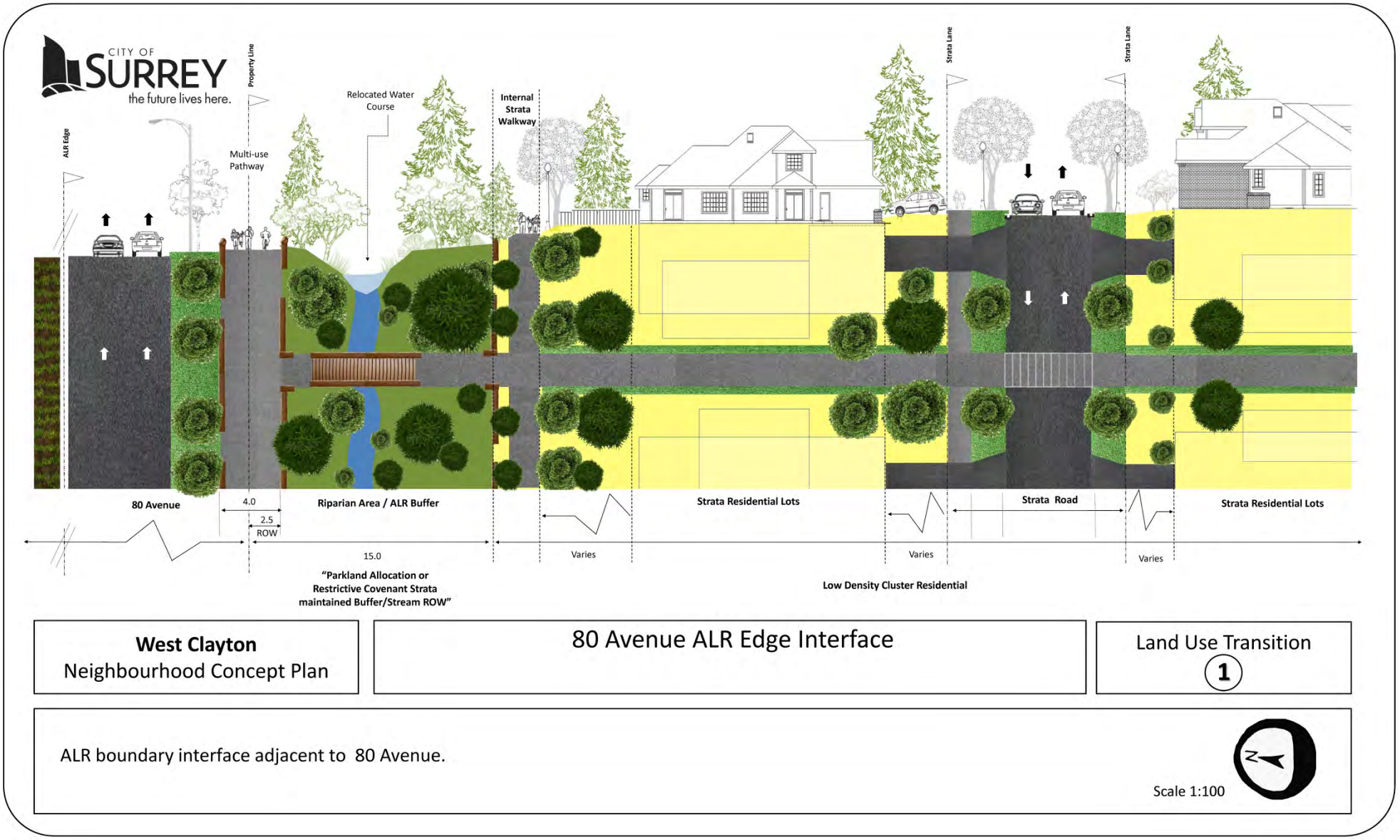


Figure 5.3 - 80 Avenue ALR Edge Interface

Figure 5.4 ALR Landscape Buffer Interface along western boundary

Figure 5.5 - Neighbourhood Commercial Interface to Day-lighted Stream with Landscaped Buffer

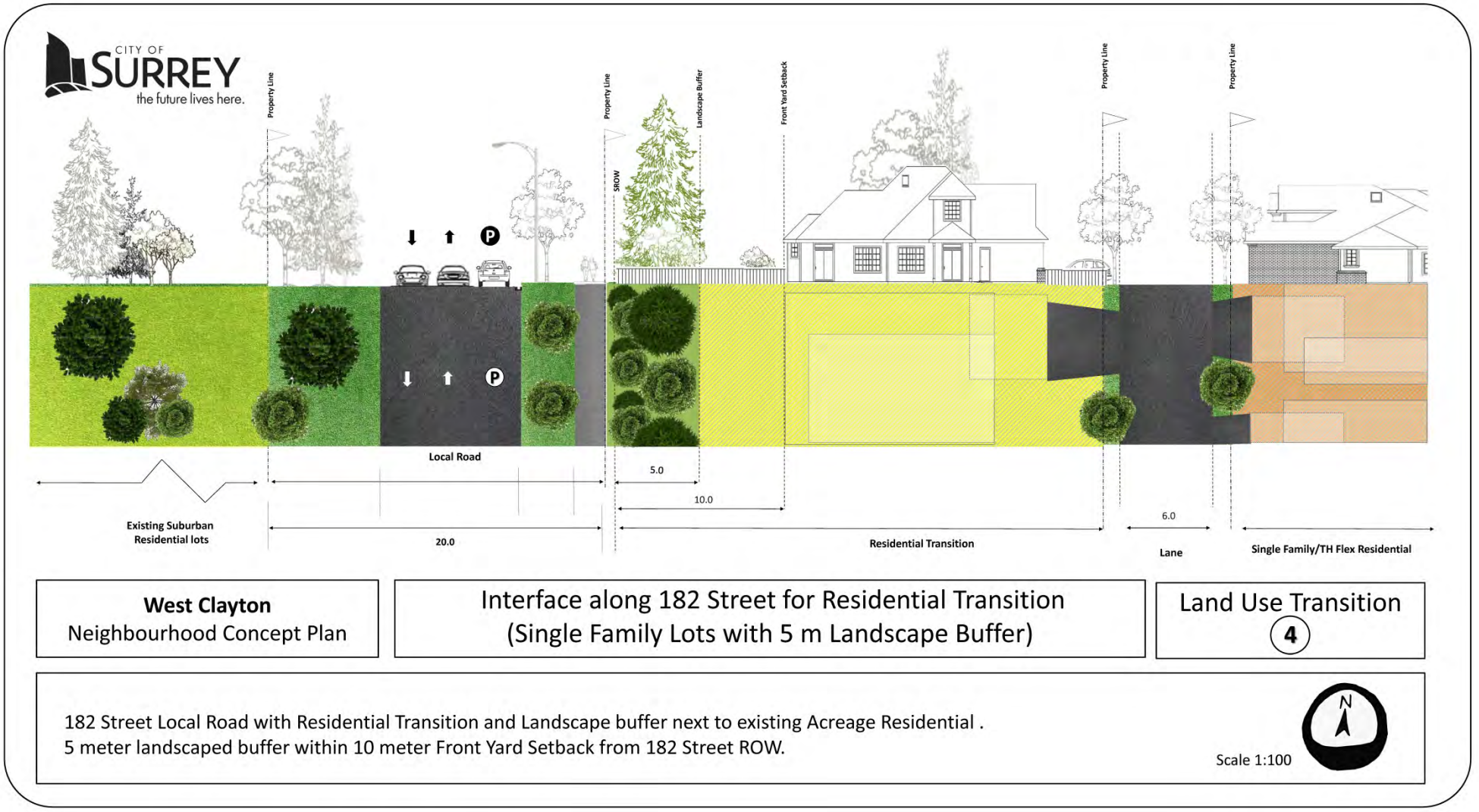


Figure 5.6 – Landscaped Buffer interface along 182 Street.

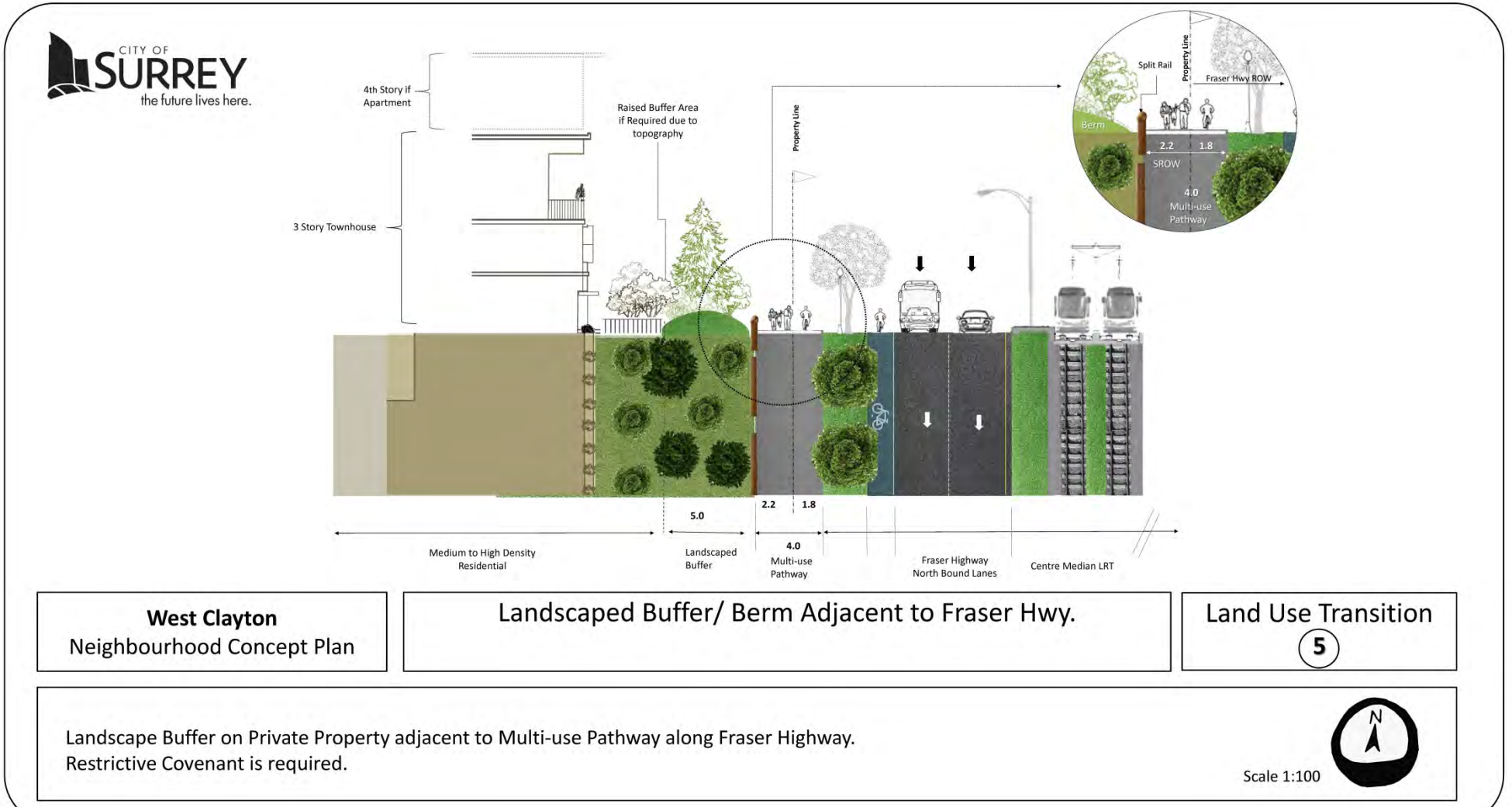


Figure 5.7– Landscaped Buffer interface along Fraser highway.

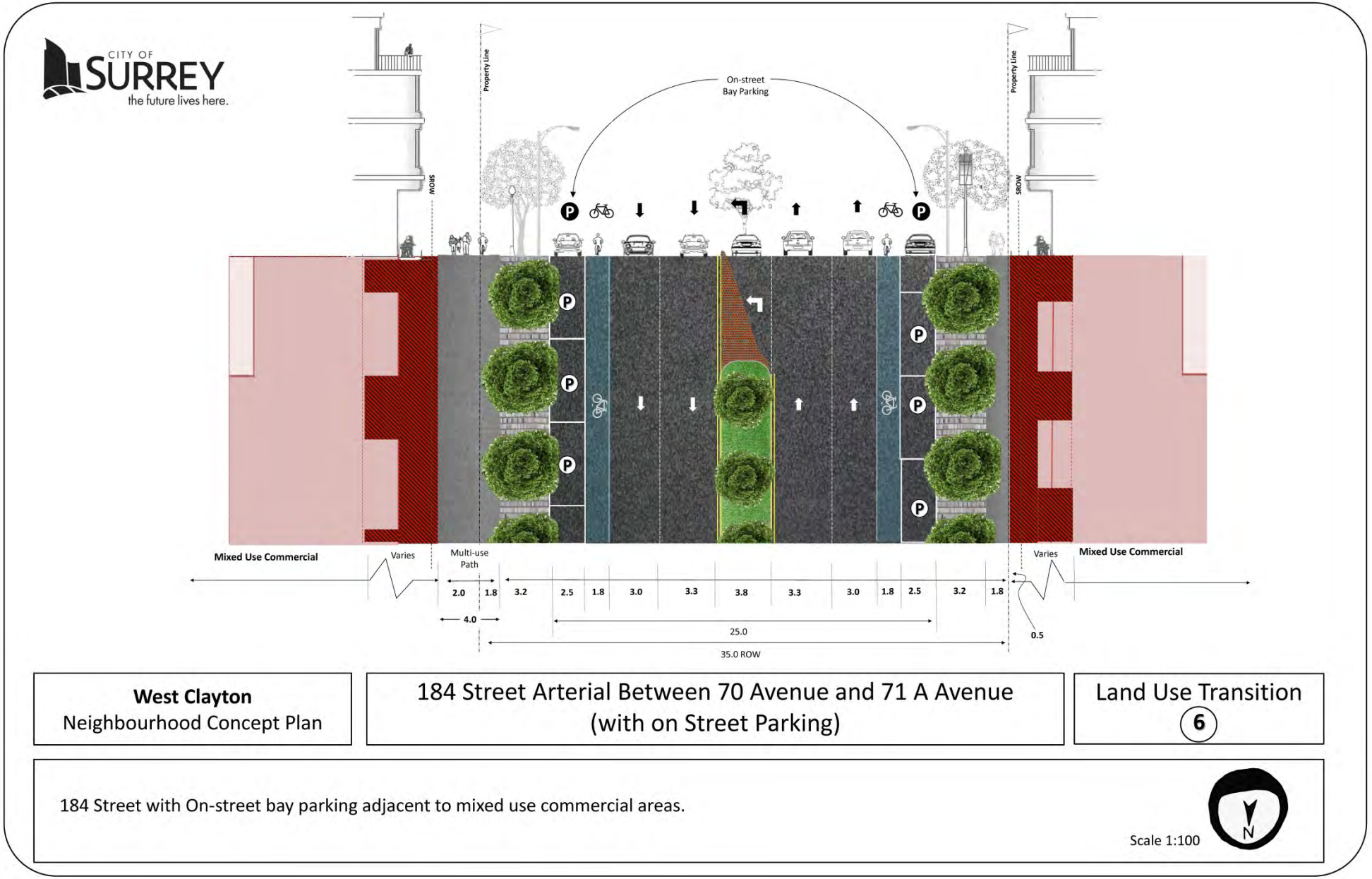


Figure 5.8 – Interface along 184 Street Transit Commercial Node with On-street Parking.

5.6 URBAN DESIGN ELEMENTS

Urban Design guidelines are to be used in the assessment of development applications in the COMMERCIAL/RESIDENTIAL MIXED USE and NEIGHBOURHOOD COMMERCIAL areas of West Clayton area where URBAN LANDMARKS, PLAZAS and/or FORECOURT areas identified in the Land Use Concept Plan in Figure 3.1 and in the Place making Elements Map in Figure 5.9.

The guidelines should assist developers and consultants to establish a design rationale and to create improved public open amenity spaces associated with new projects. While not intended for rigid application, the guidelines highlight important considerations which, when appropriately selected and interpreted, can result in safe and useful outdoor places which add economic and amenity value to a project.

Special urban design areas are designated at the village centre node area at 72 Avenue and 188 Street, the Transit Node area in the vicinity of the future rapid transit station on Fraser Highway at 184 Street, and the prominent intersections of 72 Avenue at 184 Street and Fraser Highway, 80 Avenue at 184 Street and 188 Street, and 70 Avenue.

Special urban design for these areas, will implemented through Form and Character Development Permits, and will look to create public spaces entrance features, visual markers, public art, pedestrian amenities, tree planting and special street design, public/private art opportunities and landscaping. View corridors, viewpoints and public seating areas could also be provided along the greenway running parallel to the ALR edge. Public parks and Pathway design guidelines area also intended to ensure connections to vibrant, safe spaces in the Plan area.

In addition, the redevelopment of the Transit Node are is required to exploring the opportunity to create a mini plaza or forecourt for the Surrey Little Theatre, which is a registered heritage building as described in Section 5.7, and illustrated conceptually in Figures 5.10.

5.6.1 Plazas and Forecourts

Plazas and Forecourts provide an urban open space area designed for public use and defined by surrounding buildings and/or streets. Its primary function is to encourage a diversity of opportunities for social interaction and activities, to provide relief and relaxation, to expand and reinforce the public realm and to contribute to the livability and general amenity of unique village and commercial areas of the West Clayton area.

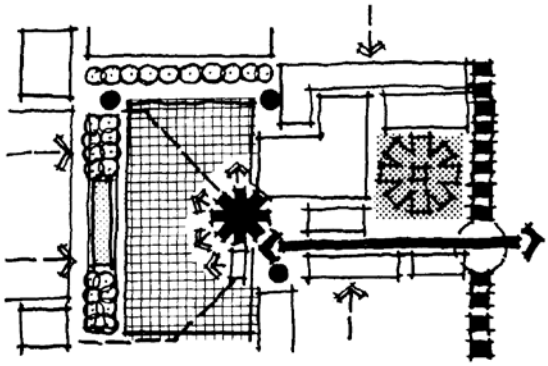
As the Neighbourhood grows, opportunities are presented through new development to provide open amenity spaces that offer delight, surprise, rest, enlightenment and amusement for a wide variety of users over the course of the day, week and year. Activities accommodated by public plazas such as socializing, resting, eating, bus waiting, exhibitions and open air markets add to the quality of city living and working, enhancing diversity and increasing the educational and cultural opportunities that define the positive experience of urban living.

Concept Design

Like a successful building, a plaza requires a program of use and a strong concept. Therefore, careful thought should be given to a plaza's principal functions and to its relationship with the adjacent public realm (i.e. streets, pedestrian routes, other open spaces), activities and architecture. While some plazas may act primarily as pedestrian nodes, others function best as important viewpoints or enhance the setting for a building.

A plaza should also reflect and reinforce the character of its location. Within the Clayton Neighbourhood, an individual plaza may function best as part of a hierarchy of open spaces, some small, others grand, still others as links within an open space network. Therefore, an understanding of area objectives, existing plazas and pedestrian movement, building and street scale, materials and circulation patterns are all essential in developing a use program and overall concept.

Plaza's and/or Forecourt areas should be planned comprehensively within identified site (including incorporation the United Church Heritage building), and mixed use areas to complement and extend public streets, pathways and parks. Plazas and open spaces should be designed to serve specific functions and activities for adjacent buildings and uses.

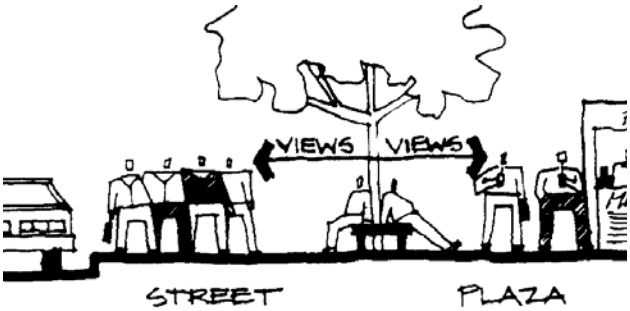


A Plaza's Proposed Uses, Functions and Linkages Should Be Determined as Part of the Overall Project Design Process

Visibility and Views

Good street-to-plaza visibility announces the plaza's internal attractions. It signifies that it is a public space, it permits users to watch street activity and it makes the space safer. Good visibility can be achieved by the following:

- arranging any walls and planting to not screen or block off the plaza from the street;
- locating the plaza at or as close as possible to street level, preferably no more than 1.0 m above or below street level.
- A plaza should also take advantage of distant views to the mountains, bluffs, valley bottoms, and other landmarks wherever possible.



Good Street-to-Plaza Visibility Should Announce the Plaza's Internal Attractions

Linkages

A plaza should be linked to other surrounding open spaces, as well as interior spaces such as lobbies, to create a dynamic pedestrian network. Such links will make the plaza more useful and provide a more dynamic, coherent urban environment. Linkages can be achieved or reinforced using the following devices:

- passages;
- bridges;
- steps/ramps;
- paving patterns;
- planting.

Seating

Good seating is important to plaza users. Without it, fewer people will stop to use a space. There are four major points to remember when planning seating:

1. Plentiful Seating
    a. maximize opportunities for sitting: walls, steps, planters, fountain edges, lawns.

2. Choice of Sitting Location
    a. locate seating toward street, oriented to a view, near building entrances, next to attractions/amenities, in shade, in sun.

3. Variety of Seating Types
    a. in groups/couples/alone;
    b. fixed and moveable;
    c. disabled accessible.

4. Comfortable Seating
    a. provide warmth: generally wood is preferable to stone, concrete or metal;
    b. provide contoured seating, preferably with a back and armrest.

Group Seating Example within a Plaza

Plaza Activity Generators

Successful plazas are generally characterized by several activity generators. Examples of such activity generators include food and retail outlets, as well as entertainment, which attract users and encourage socializing, relaxation and festivities. Good plaza management can include soliciting groups to activate the space, such as farmers markets, street theatre musicians and exhibitors. Providing the infrastructure for events (e.g. electrical outlets, water supply and lighting) will facilitate such activity.

Food and Retail Outlets and Entertainment Create a Social Atmosphere

Example of Open Air Café

Plaza Amenities

A plaza which is furnished with a variety of amenity features encourages general public usage and creates a sense of liveliness and excitement. Art work should provide a focal point for the plaza or become an integral component of the overall design of the plaza. Bike racks, drinking fountains and waste/recycling receptacles are practical, essential amenities. Some others are:

- game tables;
- kiosks for information and posters;
- open air cafes;
- children's play equipment (where appropriate).

Plazas Should Be Furnished With Open Air Cafes, Sculptures, Game Tables and Kiosks, etc.

Sculpture or Art pieces often provides a Focal Point in the Plaza

Natural Elements within Plaza

Natural elements which reflect seasonal change should be provided within plaza areas, such as water and trees, shrubs, ground covers, vines and flowers in a variety of colours and textures.

Whenever appropriate, lawn areas should be provided to visually "soften" the urban environment and as an effective dry weather seating area. Vegetation should never create substantial enclosures from the street.

Natural Elements such as trees and landscaping "Soften" a Plaza and attract users

5.6.3 Urban Landmarks

Urban landmarks and neighbourhood gateway features are identified in **Figure 3.1** and **Figure 5.9**, and are planned to announce entries into different areas of the west clayton neighbourhood, create civic focal points, and enhance the network of visual reference points throughout the community.

The cost of Urban Landmark features is not included in the estimated cost of the park and related amenities. It should therefore, be provided either through the City's capital construction program or through private sector sponsorship and development.

Public art should be incorporated into gateway features and/or at other locations in the Commercial and Mixed Used areas and as identified in the Land Use Concept Plan. Urban landmark features may incorporate special landscaping, signage, special design features and public art.

Possible example of Special Neighbourhood Entry Signage into West Clayton

Possible example of Neighbourhood Gateway Feature into West Clayton

Example of Landmark Feature area at Street Corner

CITY OF SURREY
the future lives here.

Legend

Public Art Opportunity

- Private Land (Art Opportunity)
- Public Land (Art Opportunity)
- Plaza / Forecourt
- Urban Architectural Landmark

Urban Design Elements

- Continues Retail Frontage Required
- Special Urban Design Area

West Clayton NCP
Urban Design Opportunities

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Figure #

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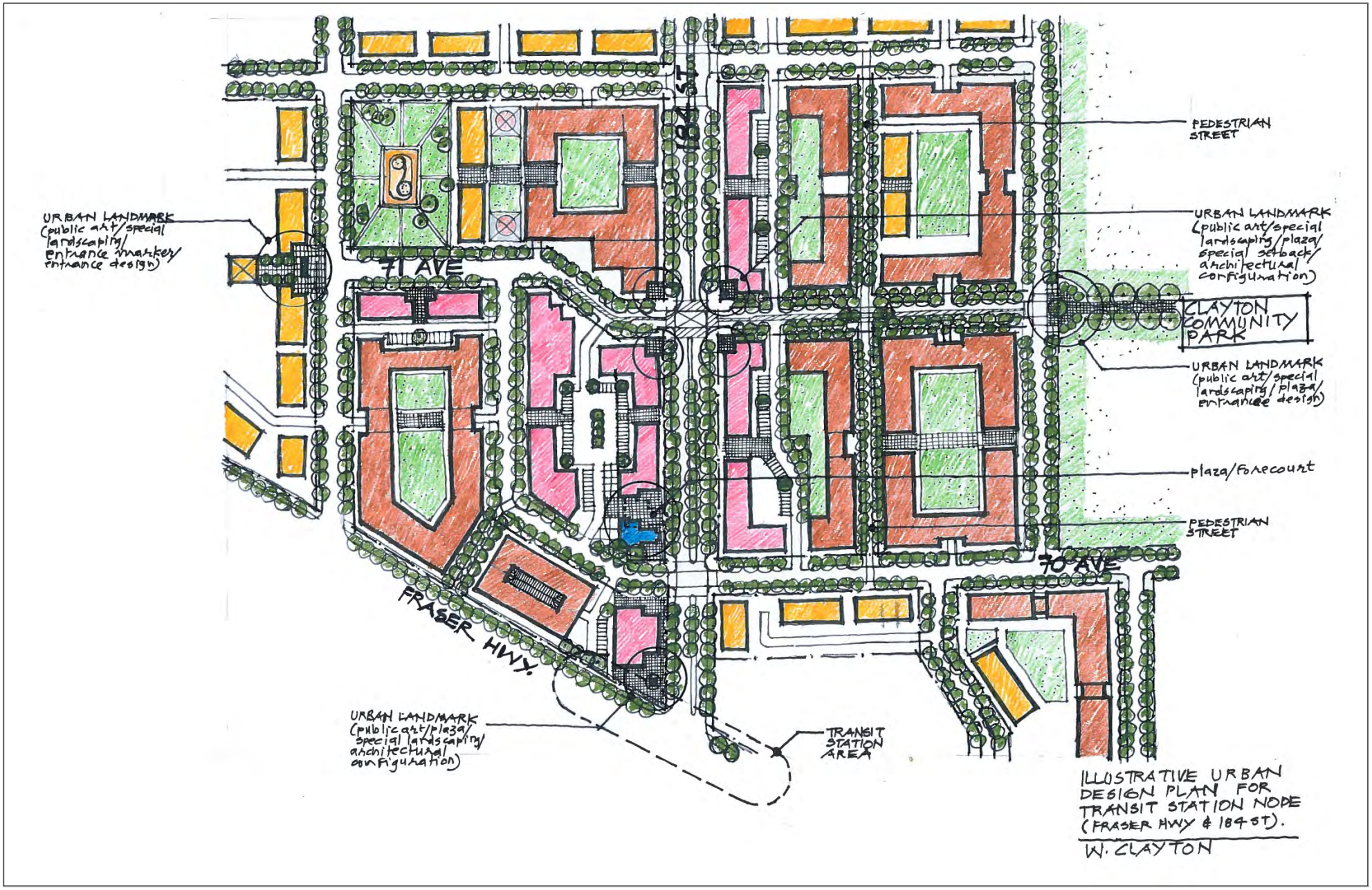


Figure 5.10 - Illustrated Urban Design Concept Plan for Transit Station Node

5.6.3 Parks and Pathway Design Guidelines

The intent of park, pathway and recreation area design guidelines are to encourage the development of public spaces that are connected and integrated into the broader community and provide a vibrant, safe and accessible place for community gathering and interaction. The following considerations are applicable for the design of all parks, pathways and public spaces in the plan area:

Guideline 1

Planning and design of all active park sites and public pathways will follow the intent and direction of the City of Surrey, Parks Design Guidelines. Detailed design will reference, wherever possible, the City of Surrey, Parks Standard Construction Documents.

Guideline 2

Parks will maintain community identity and character through the retention, wherever possible, of trees and native vegetation of environmental significance, integration of heritage features, acknowledgement of the ALR, and protection of key view corridors of mountains and the Serpentine Lowlands.

Guideline 3

Parks will provide spaces for gathering that are safe, accessible, provide amenities and promote social interaction

Guideline 4

Private development adjacent to, or across the street from all parks and public pathways should ensure CPTED design principles such as unit orientation, clear site lines, active rooms and windows facing public spaces be applied. Commercial development adjacent to parks and public pathways should provide an active commercial interface and avoid loading and other back-of-house functions adjacent to public space.

Guideline 5

Any private fencing adjacent to active parks or public pathways shall be permeable, located on the private property line and constructed no higher than 1.2 m to maintain site lines and public surveillance. Adjacent landscape materials at mature growth shall also not exceed this height to protect sight lines over time.

Clayton Park Design

Clayton Park will serve as an integrated community level park for the West Clayton NCP, serving the active amenity and athletic needs of the broader community. The park will also be the future home of the Clayton Recreation and Arts Centre and Library.

The park will be located adjacent to the NCP's highest density neighbourhoods and will be within walking distance of the village centre and transit station mixed-use nodes, as well as the two high schools. As such, the park's design will respond to the urban character and demographics of the surrounding land uses and institutions, and will focus on amenities for families and youth. Clayton Park amenities may include new athletic fields, a washroom building, new tennis courts, playground upgrades, a youth park, parking upgrades and new pathways and forest trails.

Park Site B Design

Park Site B is a large integrated neighbourhood park with a variety of natural features, including two fish bearing creeks, old field habitat and sloping views of the Serpentine Lowlands. The design of this park site will complement the natural character of the site and focus on the protection of the fish bearing creeks and the site's proximity to the ALR. Parks amenities may include trails and pathways, natural areas, viewing platforms, picnicking areas, a small washroom building and a children's play area. Park access should be anticipated from 184 Street and should include a small parking lot.

Park Site C Design

is a traditional suburban style neighbourhood park. The park will reflect the surrounding single family and multi-family residential neighbourhood with opportunities for passive open space, pathways, benches and a children's play area. This site is predominantly existing residential lawn, with opportunities to plant larger canopy park trees.

Park Site D Design

Park Site D is an urban mini-park within a high density mixed-use neighbourhood. This park will feature a contemporary design with opportunities for an urban plaza, horticultural display beds, seating areas and play. The design of the adjacent mixed-use development will be critical to the function of the park. Any adjacent commercial development should acknowledge the park with a storefront interface, with opportunities for patios and other active uses facing the park. This park may be suited for lighting

Park Site E Design

Park Site E is adjacent to the high school and will be located at the junction of the Siddons and Hazelgrove Greenways. As such, the site will be an active park site with amenities suited to joggers and other greenway users, as well as youth from the adjacent high school. The site is suited for a greenway amenity node, as well as active sport courts, such as sand or grass volleyball

Park Site F Design

Park Site F is a small passive park located along the Hazelgrove Greenway. It is predominantly suited as a passive open space with opportunities for a greenway amenity node, as well as daylighting an existing creek that is currently piped along the interface with 184 Street.

Park Site G Design

Park Site G is an existing forested natural area and is the headwaters to a yellow coded creek. The site is also adjacent to the northern BCS Corridor (GIN # 139). Given the site's natural features, the design will focus on natural area

improvements and naturalization. Passive park amenities may include forest trails, seating areas, passive open space and opportunities for nature play.

Park Site H Design

Park Site H will be amalgamated with existing parkland in the East Clayton NCP area. Combined, the site will serve residents of both East and West Clayton. The site will serve a predominantly multi-family and small lot single family residential neighbourhood, with opportunities to provide a larger passive open spaces, and amenities such as a community gardens, tyke bike tracks, pathways and seating areas.

Park Site I Design

Park Site I is located along the central BCS corridor (GIN #141), with an existing forested natural area. The surrounding neighbourhood is predominantly single family residential. The park offers opportunities for natural areas with complementary amenities such as forest trails, seating areas and a children's play area.

5.7 HERITAGE STRATEGY

5.7.1 Historic Buildings, Sites and Features

A number of historic buildings were identified as having heritage significance through the Heritage Register evaluation process identified in Figure 5.11. These sites are considered to have the greatest heritage value, and should be the primary focus for heritage conservation efforts.

1. Clayton United Church (7027 184 Street), Clayton Elementary School (7541 184 Street), and Edward Armstrong House and Barn (7381 192 Street) are listed on the Surrey Heritage Register but do not have formal heritage protection.

2. George Lawrence House (18431 Fraser Highway), a replica, is listed on the Surrey Heritage Register and is protected by Heritage Revitalization Agreement.

3. Additional buildings/ sites may or may not possess sufficient individual value to warrant addition to the Surrey Heritage Register; however, further evaluation is required. These include:
   - George Whitehead Farm (18717 74 Avenue)
   - House and Barn (7481 184 Street)
   - House (18477 76 Avenue)
   - Silos (7831 184 Street)

4. There are a number of natural features located throughout the area that have been identified as potential heritage resources. These include:
   - The West Clayton Ridge, “Clayton Hill”
   - The West Clayton Ravine
   - Large Tree, corner of 80 Ave and 184 Street (adjacent to West Clayton NCP planning

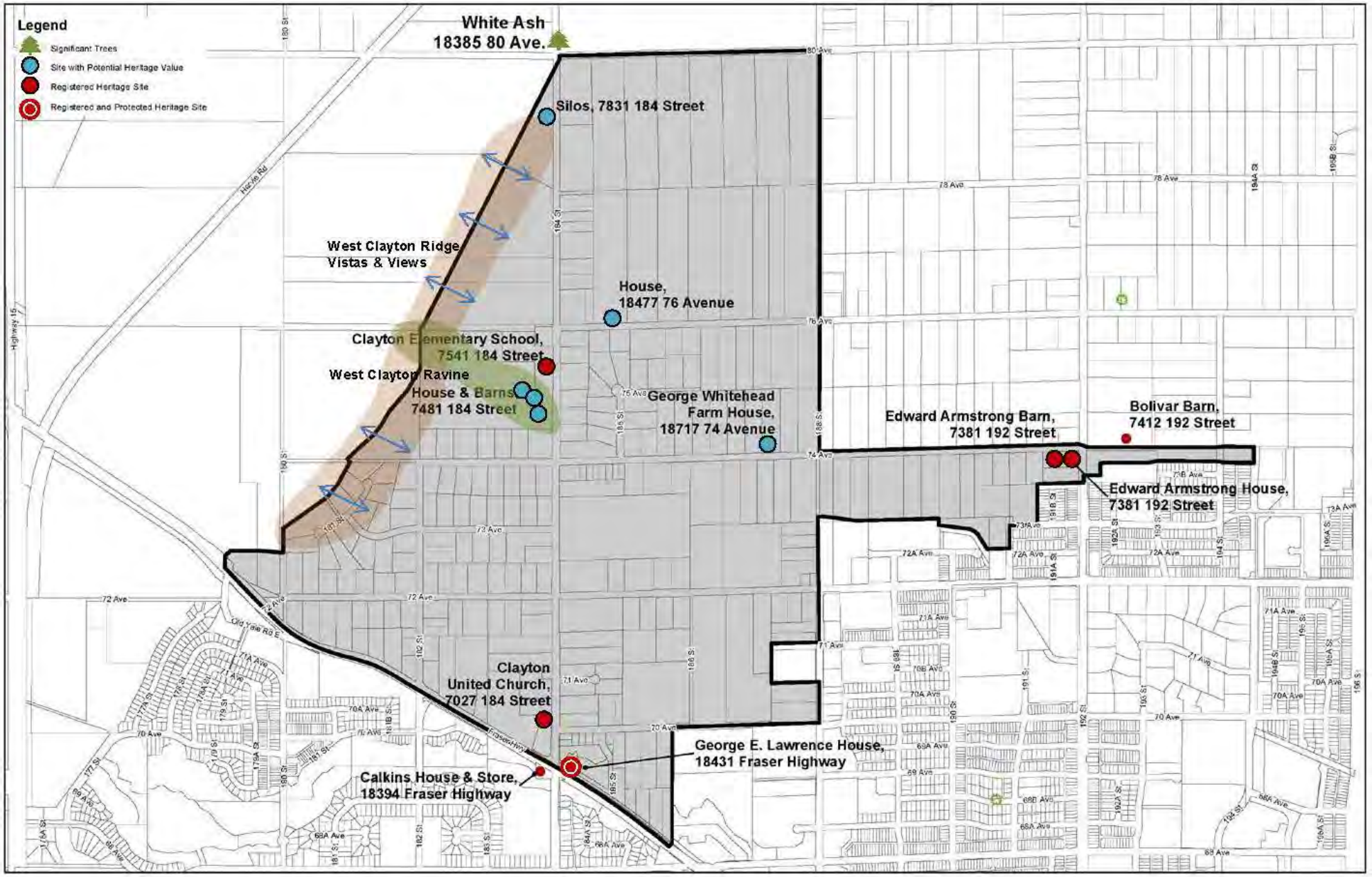


Figure 5.11 - West Clayton Heritage Sites and Areas

5.7.2 Heritage Policy Guidelines

The redevelopment of West Clayton will constitute major changes to the built heritage and agricultural character of the area. A programme of conservation, commemoration, documentation, and interpretation should be considered in conjunction with the preservation of historic buildings, sites and features. Heritage conservation, interpretation and commemoration strategies should include:

Objective 1

The preservation of registered heritage buildings/sites as well as buildings/sites recommended for addition to the Surrey Heritage Register. Development on these sites should not occur until the protection and restoration of each of the buildings is secured in a manner considered satisfactory to the City (e.g., heritage revitalization agreement). These buildings are intended to remain in private ownership with an adaptive use that respects the heritage value and encourages a viable future.

The registered Clayton United Church, and contiguous sites, should not be developed until the Church property and adjacent properties have been consolidated and the Church is protected in a manner considered satisfactory to the City (Figure 6.1 Consolidation Area Map). If possible the Church should be integrated into future development and upgraded to meet current standard with some conceptually illustrated examples provided in Figures 5.10, 5.12-5.13.

Objective 2

As opportunity permits, the preservation of additional buildings or sites that have not yet been proposed for addition to the Surrey Heritage Register.

Objective 3

Encouraging preservation of heritage buildings/ sites through variations in density, use, siting, and other regulations via heritage revitalization agreement, or other tools as provided in the Local Government Act.

Objective 4

Ensuring that new construction adjacent to heritage buildings/sites is sensitive to the historic context and design of existing heritage buildings;

Objective 5

Encouraging publicly accessible interpretation about the value associated with heritage resources in the area, First Nations history, pioneering families, and historic street names;

Objective 6

Requiring the documentation and interpretative commemoration of demolished heritage buildings; and

Objective 7

Retain the West Clayton Ravine as a walkable feature, negotiate for the retention of other identified natural features, and retain view corridors and topography that reflect the historic 'feel' of the neighbourhood.

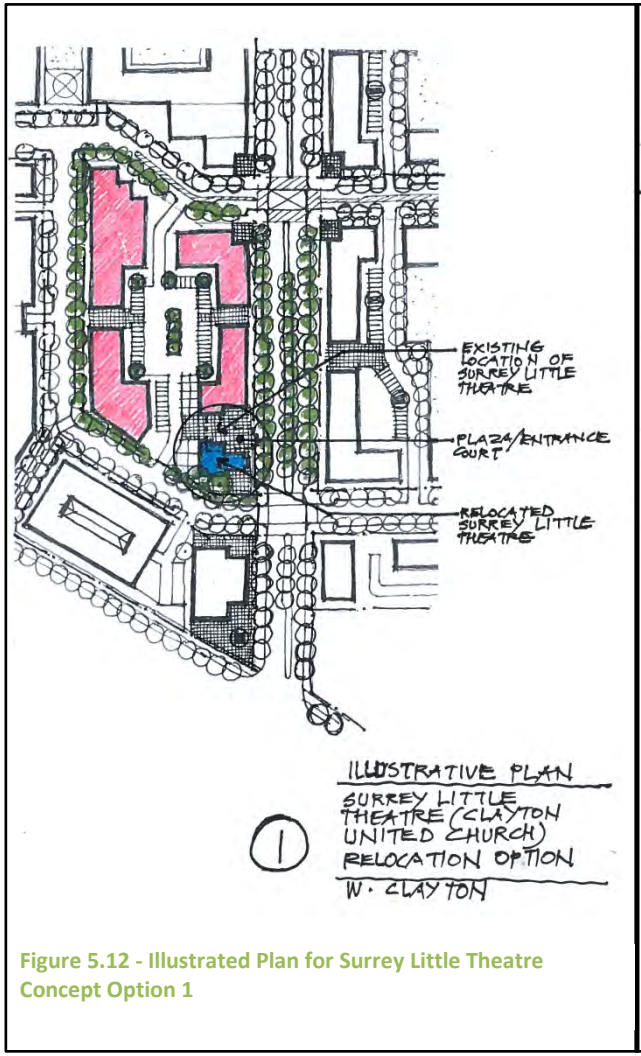


Figure 5.12 - Illustrated Plan for Surrey Little Theatre Concept Option 1

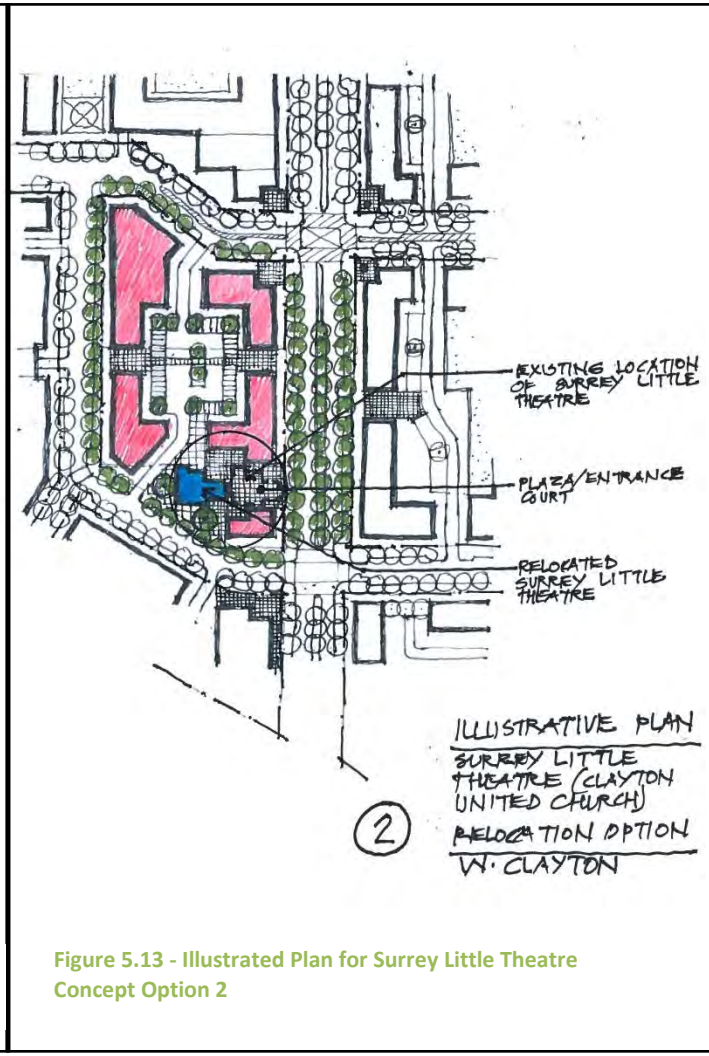


Figure 5.13 - Illustrated Plan for Surrey Little Theatre Concept Option 2

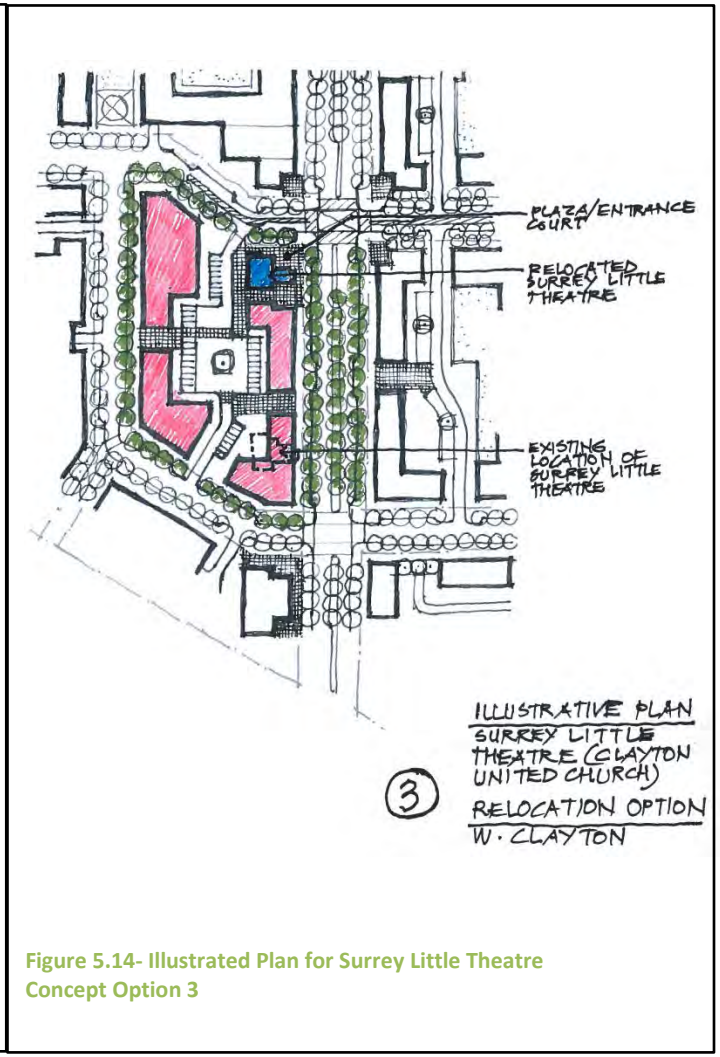


Figure 5.14- Illustrated Plan for Surrey Little Theatre Concept Option 3

5.8 LAND CONSOLIDATION STRATEGY

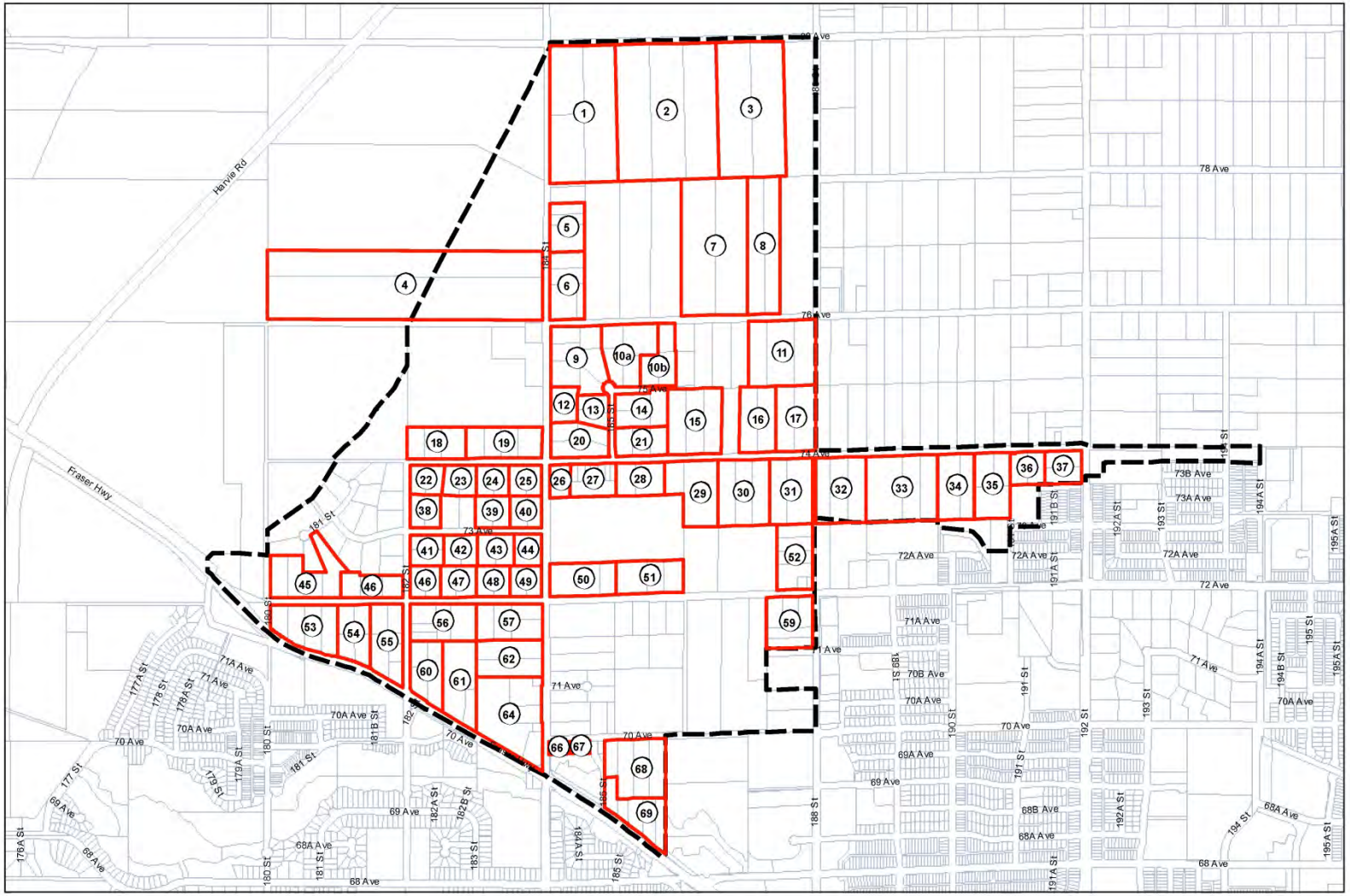
In several areas of the NCP, lot consolidation will be required to ensure efficient development of properties. These land consolidation opportunities will, in most circumstances, be determined on a case-by-case basis at development application stage.

In some cases, however, consolidation requirements have been identified in the Land Use Plan to avoid creating remnant pieces created by fragmented ownership that would not be developable on their own or limit the development potential of an adjoining lot.

Land consolidation areas have been generally identified in Figure 5.2 to inform developers and owners of the consolidation strategy guidelines, to ensure compatibility and feasible development areas, and to achieve an equitable distribution of road dedication and construction costs across properties.

If land consolidation is NOT proven to be possible or feasible during the development process, the developer must:

- Demonstrate that the development potential of the excluded property is not compromised to the satisfaction of the City; and
- Share any required road construction costs amongst properties shown in the land consolidation area.



Legend

- ConsolidationAreas
- WestClayton_Boundary
- Lots

West Clayton NCP

Condolidation Area Strategy

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Figure 5.15

V:\Policy&Long Range\GIS_ANALYSIS\CLOVERDALE\WEST_CLAYTON\WestClayton_Stage1_LandUseConcept_2014\West Clayton Stage1 Land USe Concept October2014 CONSOLIDATION AREA STRATEGY.mxd

Figure 5.15 - Consolidation Area Strategy

SECTION 6

Implementation Strategy

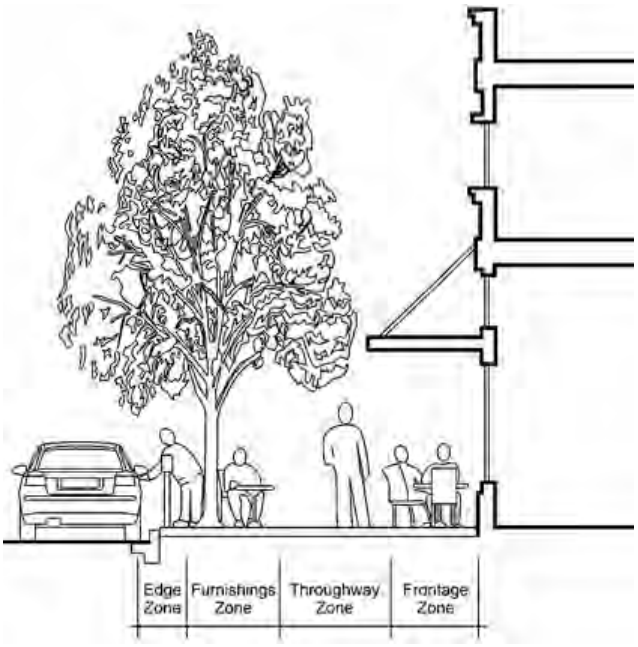
SECTION 6 – IMPLEMENTATION STRATEGY

6.1 OCP BYLAW AMENDMENTS

The majority of area covered by the West Clayton NCP is currently designated Suburban-Urban Reserve in the OCP. It is, therefore, recommended that the necessary bylaw amendment changes to the OCP land use designations related to the West Clayton NCP land use plan proceed following the approval of the West Clayton NCP to update the Surrey Official Community Plan as generally illustrated in **Figure 6.1.**

6.2 DESIGN AND DEVELOPMENT GUIDELINES

In the case of single-family residential development, the Design Guidelines will be implemented through the process of reviewing and approving subdivision plans and in developing and approving building schemes for each such subdivision.



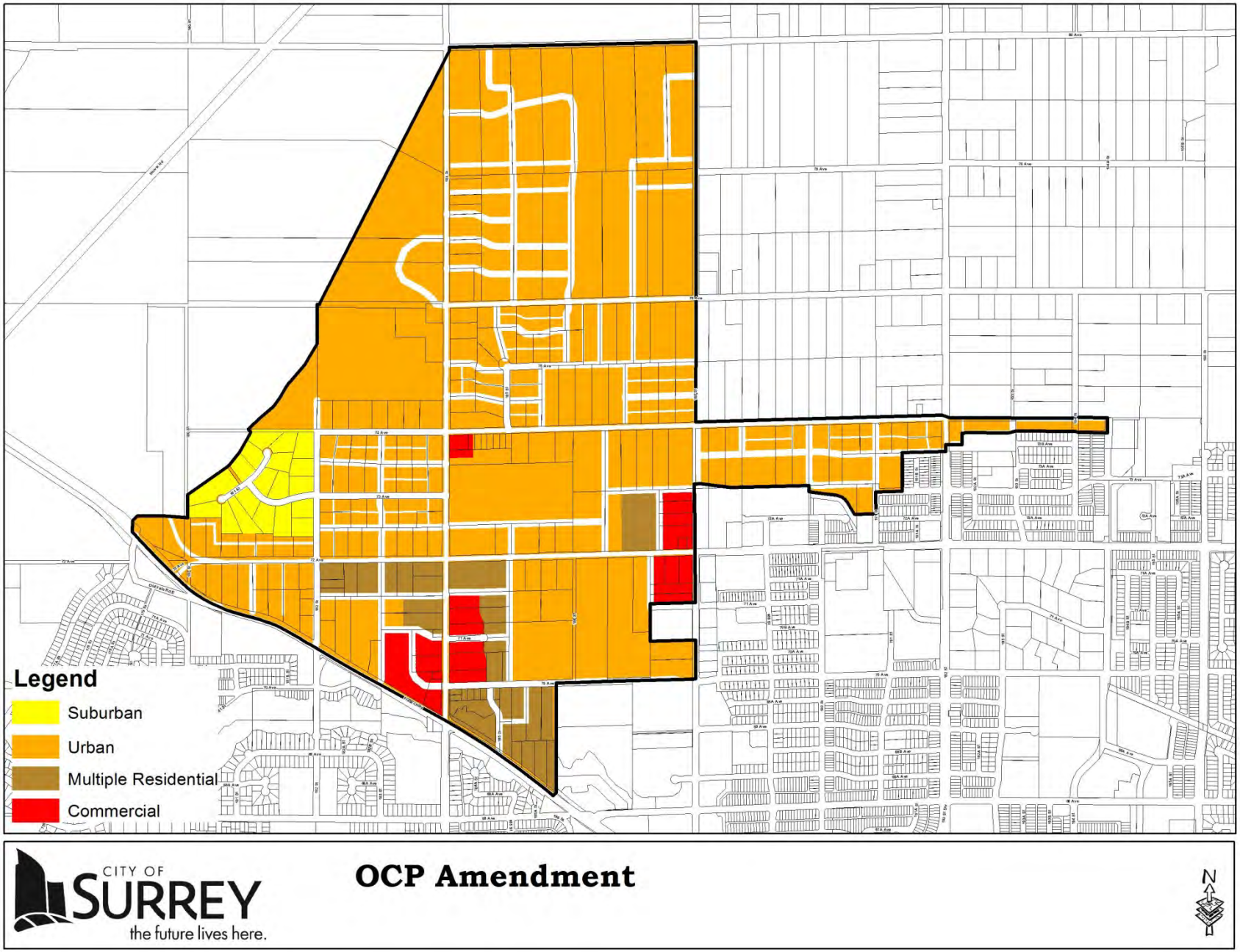


Figure 6.1 - Future West Clayton OCP Designations

6.3 ZONING BYLAW AMENDMENT (AMENITY CONTRIBUTIONS)

In accordance with City Council policy to address the amenity needs of the proposed new development in West Clayton, all development proposals at the time of rezoning or building permit issuance will be required to make a monetary contribution toward the provision of new police, fire protection and library services and toward the development of the parks, open spaces and pathways.

To enact amenity contribution requirements for development within the NCP as discussed above, the Zoning By-law will need to be amended to add West Clayton to the list of NCPs within which monetary contributions are required. The proposed amendments to Schedule G of the Zoning By-law to incorporate the amenity fees for the West Clayton NCP area are documented in **Table 6.1.**

The monetary contributions toward police, fire and library materials (described later in this section) will offset the capital costs of providing these services to the new development and are applied on a standardized basis in all of Surrey's Neighbourhood Concept Plan areas.

The monetary contributions toward parks, open spaces and pathway development (described later in this section) are based upon an estimate of the capital costs of these improvements for this particular NCP area.

The total cost is divided by the average anticipated number of dwelling units and acreages in the case of non-residential development to ensure an equitable contribution arrangement. The amenity contributions noted above are payable upon subdivision for single-family subdivisions or upon issuance of building permits for multiple development and other uses.

The Amenity Contributions rates are summarized in **Table 6.1**, and are derived from the average densities proposed in the residential designations of the West Clayton NCP and the number of dwelling units (excluding any secondary suites) that are anticipated.

The estimated costs of the various amenities are distributed evenly to each dwelling unit. Therefore, if the number of dwelling units in a proposed development is lower than that anticipated by the NCP, the applicant will be expected to "top up" the amenity fees based on the number of the dwelling units used to calculate the amenity charge to ensure that there is no shortfall in the funding for the proposed.

6.3.1 Parkland & Pathway Development

The scope of parkland development within the West Clayton NCP will include an expanded community level park (Clayton Park), eight (8) new neighbourhood level parks and three (3) Linear Park and BCS corridors. The estimated cost of developing park amenities is approximately $9,618,075, which results in a $1,544.08 (in 2015 dollars) per dwelling unit. This estimate includes the construction of on-site park amenities, such as playgrounds, washroom buildings, parking lots, sports courts, athletic fields, tree and horticultural plantings, park pathways and on-site plazas, seating areas, viewing platforms and passive open spaces. This also includes natural and riparian area management within land acquired by Parks.

Park amenity calculations do not include riparian area works on land conveyed to the City through the development process, such as invasive species removals, fence construction, replanting and naturalization, in-stream works and any other related riparian area costs, including planning and design costs, which are to be accounted for as part of the development process and subject to the Riparian Area By-Law.

6.3.2 Library Materials A study of library requirements in Surrey's new neighbourhoods has established that a contribution of $144.84 (in 2015 dollars) per dwelling unit (non-residential development is exempt) is necessary to cover the capital costs for library materials and services, which is sensitive to population growth. Consequently, a total of approximately $902,208.36 will be collected from West Clayton towards materials such as books, computers and CDs.

6.3.3 Fire Protection

Future development in this neighbourhood will drive the need to upgrade existing fire and police protection facilities. A study of fire protection requirements in Surrey's new neighbourhoods has established that a contribution of $278.12 per dwelling unit and $1112.48 per acre of non-residential development (in 2015 dollars) will cover the capital costs for fire protection. This will result in a total capital contribution from West Clayton of approximately $1,732,409.48 toward fire protection.

6.3.4 Police Protection

Similar to Fire Services, a contribution of $64.39 per dwelling unit and $257.56 per acre of non-residential development will cover the capital costs for police protection. This will result in a total capital contribution from West Clayton of approximately $401,085.31 toward police protection.

Table 6.1- Summary of Amenity Contributions for West Clayton NCP amenities

WEST CLAYTON NCP COMMUNITY AMENITY CONTRIBUTIONS			
	Per Unit Contribution All Residential (*Approx. 6,229 dwelling units @ average density)*	**Per Acre Contribution All Non-Residential Uses**	**Anticipated Total Revenue at Build Out**
Police Protection	$64.39 per dwelling	$257.56 per acre	$401,085.31
Fire Protection	$278.12 per dwelling	$1112.48 per acre	$1,732,409.48
Development of Parks& Pathways	$1,544.08 per dwelling	n/a	$9,618,075.00
Library Materials	$144.84 per dwelling	n/a	$902,208.36
Total Contribution (per unit or per acre)	**$2,031.43 per dwelling**	**$1370.04 per acre**	
Anticipated Total Revenue			**$12,653778.15**

6.4 DEVELOPMENT PERMIT AREAS

Where developments are located in designated Development Permit Areas as identified in the Surrey Official Community Plan (such as Steep Slopes, Farm Protection, Environmental Sensitive areas, etc.) as well as in the case of multiple unit residential developments or commercial developments, the Official Community Plan Design Guidelines will be implemented through the process of reviewing and approving the related Development Permit at the time of development application review and approval.

6.5 NCP CONSULTANT COST RECOVERY SURCHARGES

Several consultants were retained to assist with the preparation of the West Clayton NCP, including heritage, environmental, commercial, transportation, energy, and engineering service studies. The total cost of consultant services to the City was $461,642.82.

It was therefore recommended that the City amend the Fee Imposition By-law to provide for the recovery of these NCP preparation costs through the payment of application surcharge fees at time of development.

A per unit surcharge fee will be based on the anticipated 6,229 units at the mid-range density, and will result in a per unit fee of $74.11. Should the actual number of proposed units fall below the number anticipated on any particular site, the applicant will be required to make up the shortfall in the surcharge fee to ensure the City's NCP preparation costs are fully recovered. For non-residential development the equivalent application surcharge fee will be based on the lot area at a rate of 10 units per hectare (4 units per acre).

The proposed amendments the Fee Imposition By-law to require the payment of additional application "surcharge" fees to recover the costs of preparing the NCP for West Clayton NCP are documented in Table 6.2. The surcharge fees noted in Table 6.2 below are payable at time or rezoning application.

Cost Recovery of West Clayton NCP Preparation (Surcharge Fee)		
Consultant Study	**Cost**	**Per Unit Fee (Based on 6,229 units)**
Environmental Study	$21,770.28	$3.49
Heritage Study	$9,637.60	$1.55
Commercial Market Study	$24,360.00	$3.91
Land Economic Study	$16,744.00	$2.69
Building Energy Analysis	$1,732.50	$0.28
Transportation Study	$68,000	$10.92
Servicing Studies (Water, Sanitary, Drainage)	$319,398.44	$51.28
TOTAL STUDY COSTS:	$461,642.82	$74.11

Table 6.2- Cost Recovery Surcharge Fee Summary for West Clayton NCP

6.6 ENERGY EFFICIENCY DENSITY BONUS IMPLEMENTATION PROCESS

Developments seeking to build more units or floor area than the base density will be accepted within specified allowances if all buildings are constructed to meet the green building standard stated in West Clayton Energy Efficiency Density Bonus Policy identified in Figure 6.3, and as identified in Section 3 Land Uses.

The following steps outline the procedure to follow as part of the energy efficiency density bonusing process illustrated in Figure 6.1:

Step 1:

Those developments seeking density above the baseline are identified with the responsible Planner at the pre-application stage and details of the requirements are discussed.

Step 2:

A Restricted Covenant is registered at the time of rezoning indicating the requirement that buildings are constructed to the green building standard.

Step 3:

A bond is submitted to the City at the time of building permit application. The value of the bond is set at 1% of construction hard costs.

Step 4:

The builder engages with a third party Certified Energy Advisor (CEA) who is responsible for validating that all the buildings meet the green building standard. CEAs can also help secure for additional incentives.

Step 5:

The bond is released once all requirement documentation has been submitted to the City.

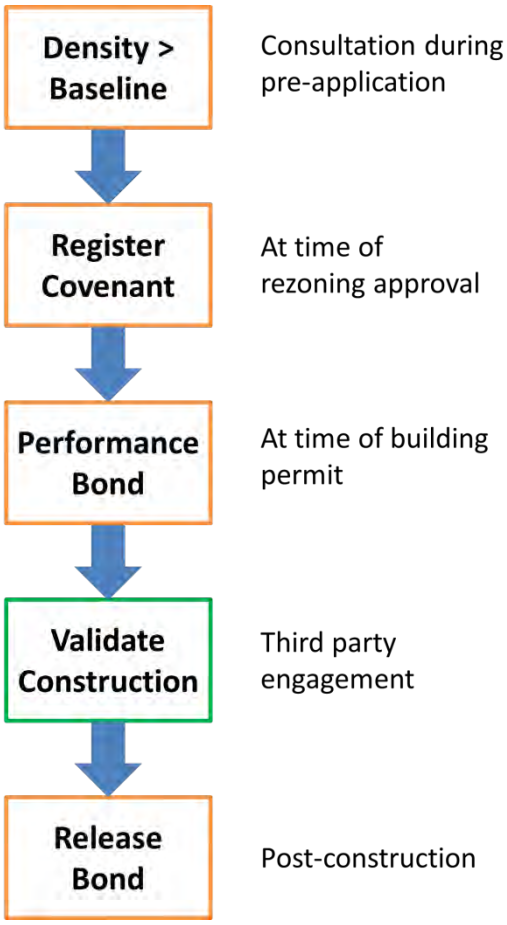


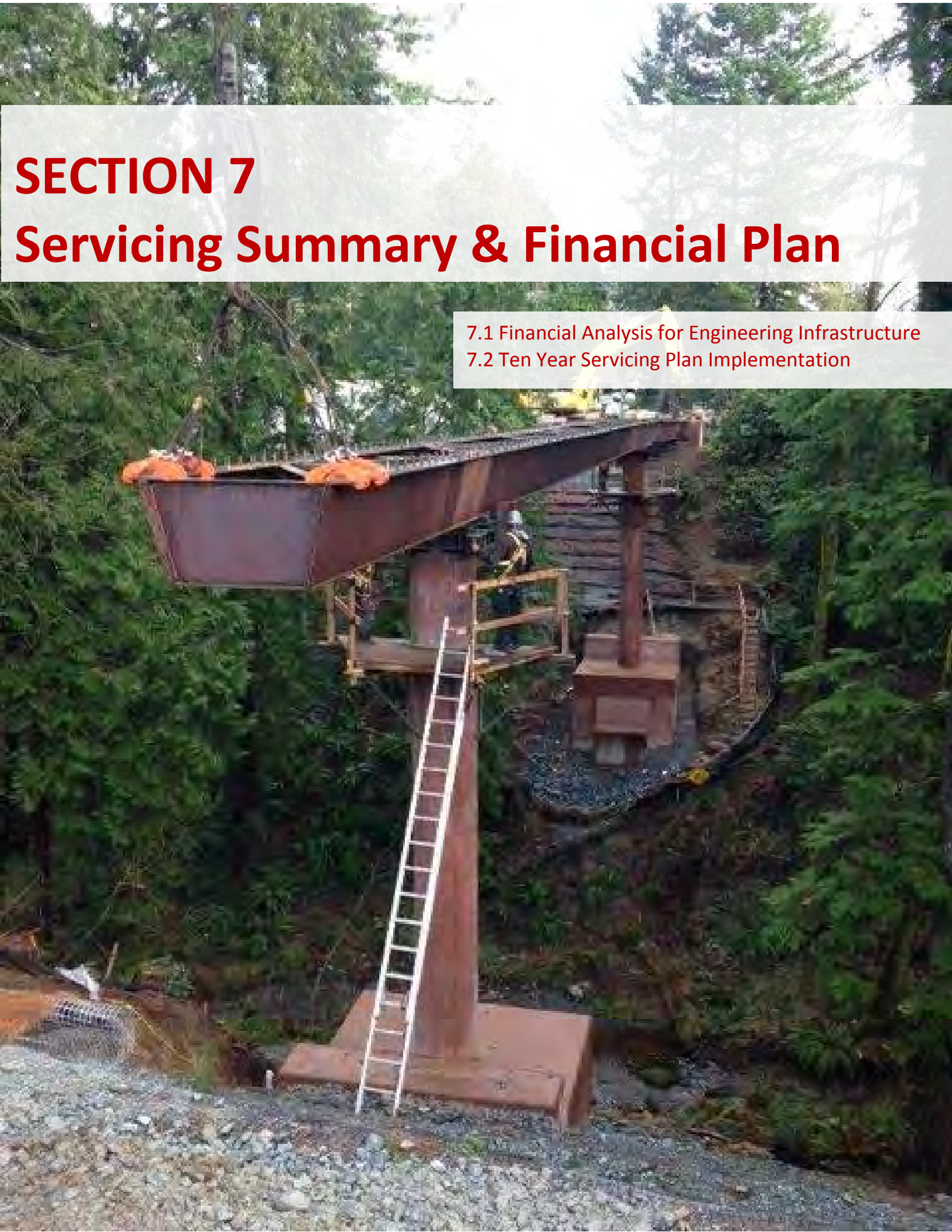
Figure 6.3 Density Bonus Process

PART B

Engineering Servicing

SECTION 7: Servicing Summary and Financial Plan
SECTION 8: Drainage and Environment
SECTION 9: Sanitary Sewer
SECTION 10: Water

SECTION 7
Servicing Summary & Financial Plan



7.1 Financial Analysis for Engineering Infrastructure
7.2 Ten Year Servicing Plan Implementation

SECTION 7: SERVICING SUMMARY AND FINANCIAL PLAN

7.1FINANCIAL ANALYSIS FOR ENGINEERING INFRASTRUCTURE

The water, sanitary sewer, storm sewer and transportation infrastructure required to support development in the NCP area is expensive. Table 7.1 summarizes the projected DCC revenues and construction costs for each of the major infrastructure systems that will be needed to support build-out of this NCP area. The revenues are based on the current DCC rates that came into effect on March 15, 2013, and include the DCC municipal assist factor for all DCC-Eligible Costs attributable to the NCP area for each utility as identified in Table 7.2.

Included in these costs are road improvements that will be necessary for the development of this NCP but that will also benefit development outside of this NCP area. In this regard, the NCP has only been burdened with a proportionate share of the total costs related to the road improvements.

Table 7.1 - Projected DCC Revenues and Construction Cost for West Clayton NCP

Service	Estimated DCC Revenues	DCC-Eligible Costs Attributable to the NCP Area	DCC Surplus/Shortfall
Water	$10,200,000	$7,500,000	$2,700,000
Sanitary Sewer	$12,800,000	$20,800,000	-$8,000,000
Drainage	$14,200,000	$19,300,000	-$5,100,000
Arterial Roads	$58,900,000	$51,900,000	$7,000,000
Non-Arterial Roads	$13,600,000	$7,600,000	$6,000,000

Table 7.2 – DCC Municipal Assist factor for DCC-Eligible Costs attributed to West Clayton NCP Utilities

Service	Municipal Assist Factor	Cost of the Municipal Assist Factor
Sanitary Sewer	10%	$750,000
Water	10%	$2,080,000
Drainage	10%	$1,930,000
Non-Arterial and Arterial Roads	5%	$3,275,000

7.1.1 Financing Options

As summarized in Table 7.1, the cost to provide the necessary sanitary sewer and storm water infrastructure to support development in the NCP area exceeds the expected DCC revenues from development in the area. The estimated DCC revenue shortfall as documented above will necessitate the introduction of additional levies to support development of this NCP area. There are four options available to address this shortfall:

- Establish an area specific DCC; or
- Authorize the developers in the NCP area to address the shortfall through the establishment of various development works agreements (DWAs); or
- Authorize the establishment of a Local Area Service charge to address the shortfall; or
- A combination of the two or more of the options above.

Financing Option 1 – Area Specific DCC

The use of an area specific DCC is not new in the City. They have been used in other NCP areas (Anniedale-Tynehead, Highway 99 Corridor and Campbell Heights) to assist in funding the costs of new infrastructure where the DCC revenues on their own are not sufficient to fund the necessary infrastructure.

Financing Option 2– Development Works Agreement

The use of a Development Works Agreement (DWA) to address a DCC funding shortfall is not new in the City. For this NCP area, DWAs could be established to address the funding shortfalls for the two stormwater detention ponds and various onsite and offsite sanitary sewer improvements.

The above approach is a common approach that has been completed numerous times. A recent example of this approach occurred at its Regular meeting on July 29, 2014, where Council adopted the recommendations of Corporate Report No. R157;2014 which authorized the use of a development cost charge front-ending agreement (DCCFEA) and a DWA to with the front-ending developer, for the construction of a community detention pond within the North Grandview Heights neighbourhood.

Financing Option 3– Local Area Service

The use of a Local Area Service (LAS) to address a DCC funding shortfall is relatively new in the City with Council only supporting this approach at its Regular meeting on February 2, 2015, where Council the recommendations of Corporate Report No. R018;2015 which authorized the use of a Local Area Service initiative for the southern portion of the Sunnyside Heights NCP Area as a means to finance a portion of the construction of the Fergus Pump Station and force main.

7.1.2 Recommended Financing Approach

Given that there is a DCC funding shortfall for both sewer and stormwater infrastructure and that there are a number of projects that make up this shortfall, it is recommended that an area specific DCC be established for sewer and stormwater for this NCP area.

Although both a DWA and LAS would be effective in addressing the shortfalls , given that there are a number of projects that make up the shortfall, a number of DWA and LAS petitions would need to take place. Administration of these various petitions will be onerous for both the City and the front-ending developer(s) and staff also believe that these various petitions would likely cause some confusion with land owners and developers in the respective benefiting areas. Establishing an area specific DCC will ensure a simple and clear financing approach as identified in Section 7.1.3.

7.1.3 Area Specific Development Cost Charge (DCC)

Table 7.3 below provides a comparison of current City-wide DCC rates and an estimate of the DCC rates that would be required to fully fund all of the sanitary sewer and drainage works in the West Clayton NCP area. These rates were developed in accordance with guidelines contained in the DCC Best Practices Guide as published by the Ministry of Community, Sport and Cultural Development.

Table 7.3 – Comparison of Current City-Wide DCC Rates and Estimated DCC Rates for West Clayton NCP.

Land Use	Existing City Wide DCC Rate	Estimated West Clayton DCC Rate	Proposed Rate as a % of Existing City Wide DCC Rate
SF (RF, RF-12)	$28,691 per lot	$31,200 per lot	109%
SF Small Lot (RF-10)	$24,950 per lot	$26,900 per lot	108%
RM-10, RM-15 & RM-30	$16.42 per sq.ft.	$17.75 per sq.ft.	108%
RM-45 and RM-70	$18.06 per sq.ft.	$19.25 per sq.ft.	107%
Commercial (ground floor)	$10.11 per sq.ft.	$11.25 per sq.ft.	111%

7.2 TEN YEAR SERVICING PLAN IMPLEMENTATION

The 10-Year Servicing Plan establishes the City's capital expenditure plan for the construction of engineering infrastructure to service existing neighbourhoods and to support new growth across the City. It also forms the basis for establishing the City's DCC rates. In December 2014, Council adopted an updated 10-Year (2014-2023) Servicing Plan and related DCC By-law. The Servicing Plan has been reviewed annually since 2006 and updates have occurred every two years since 2010.

The City is currently reviewing the 10-Year Servicing Plan and are intending to bring forward a new 10-Year (2016 – 2025) Servicing Plan and related DCC By-law to Council for their consideration this fall. As the introduction of any amendment or new DCC By-law is subject to consideration by Council in advance of being provided Provincial Ministry of Community, Sport and Cultural Development for approval prior to its final adoption by Council and so as not to burden staff at the City and the Province in addition to resulting in some confusion with land owners and developers as to which DCC By-law is applicable and when, it is also recommended that the proposed area specific DCC for the West Clayton NCP area only be introduced with the 10-Year (2016 – 2025) Servicing Plan and related DCC By-law review currently underway.

7.2.1 Operational and Maintenance Responsibilities

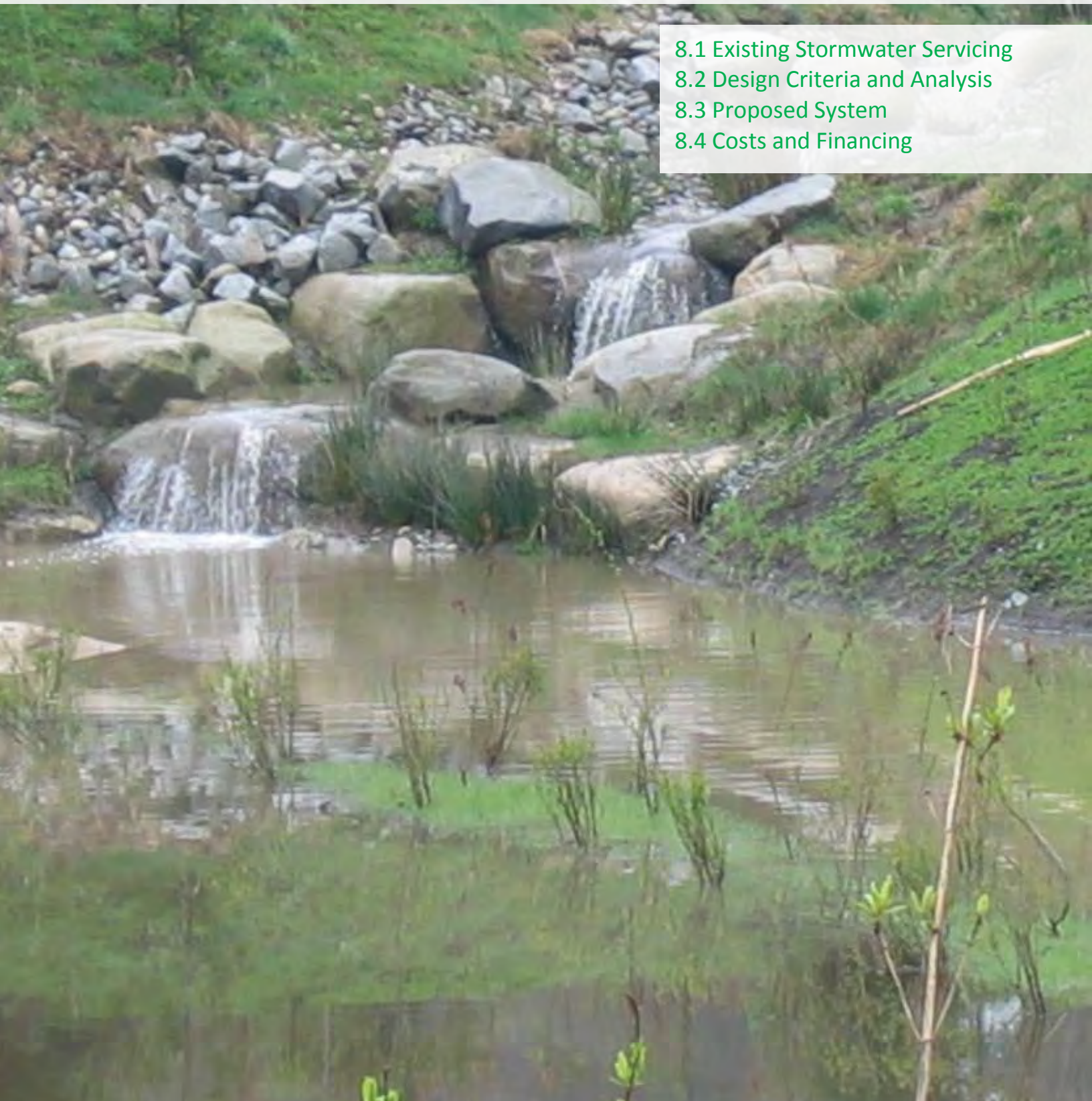
As indicated above, the sanitary servicing approach of expanding the existing pump station as opposed to replacing with a deep trunk will result in a higher ongoing operation and maintenance cost. In addition, the development of the NCP area will increase the total length of infrastructure that the City is required to operate, maintain and eventually replace. The increases to the City's major infrastructure categories are indicated in Table 7.4.

The midline build-out population estimate of 15,500 persons in the Plan area represents a 3.0% increase in the City's population. The infrastructure needed to support this increase in population results in the City's infrastructure inventory increasing by 1.0 to 1.9%. Therefore, the added infrastructure to support the development of the Plan area is positively balanced when compared against the increase in population.

Table 7.4 - Increase to City's Major Infrastructure Categories

Infrastructure Type	Existing Inventory	Increase to Inventory	Increase to Inventory (%)
Sewer mains	1,565 km	28.0 km	1.8
Water mains	1,840 km	27.5 km	1.5
Drainage mains	1,911 km	19.7 km	1.0
Local, Collector and Arterial Roads (centreline length)	1725.5 km	32.2 km	1.9%

SECTION 8
Drainage & Environment



SECTION 8: Drainage & Environment

8.1 EXISTING STORMWATER SERVICING

8.1.1 Study Area

The West Clayton NCP area is approximately 286 hectares (ha) in size. The overall flow regime for the area drains northwest through the Agricultural Land Reserve (ALR) to the Serpentine River. Based on 1m contours, the highest elevation in the study area is 83m, located at 74 Avenue and 192 Street. The terrain slopes northwest with 3-5% grade to the ALR, which is located at 1m elevation. Several Class A, AO, and B watercourses have been identified in the study area, and must be preserved and protected as development progresses within the Clayton watershed. **Figure 8.1** shows the study area boundaries.

8.1.2 Clayton ISMP

The stormwater servicing approach for the West Clayton NCP is governed by the *Clayton Integrated Stormwater Management Plan (ISMP)* completed by AECOM in August 2012. The ISMP provides long-term direction for local government and land owners to address community land use choices and determine the best options to manage growth while conserving the area's natural resources. The ISMP incorporates the requirements for drainage and flood control, terrestrial and aquatic ecosystems conservation, the existing community and future development, watershed health, as well as aesthetic, recreational and downstream functions.

At the time of the ISMP, the 1999 Clayton General Land Use Plan (GLUP) was used to establish the future land use of the area. This GLUP envisioned the West Clayton area to be predominantly sub-urban with the southeast corner near 72 Avenue and Fraser Highway to be urban.

The ISMP notes that overall current imperviousness of 12% increases to 40% under full build-out conditions based on the GLUP. This increase limits green space and environmentally valuable areas, and raises potential water quality issues. Therefore, the need to properly manage stormwater in terms of creek base flows, erosion concerns, flood mitigation, and no negative impacts to the downstream ALR is critical to the servicing strategy for West Clayton.

The approach to stormwater servicing for the West Clayton NCP was developed from the ISMP recommendations to ensure that a cohesive long-term vision for the area is achieved. The stormwater servicing strategy will be closely related to that of the ISMP, which, for reference purposes also reflects similarly to the approach implemented in East Clayton. The West Clayton NCP study area falls within the Fry's Corner watershed.

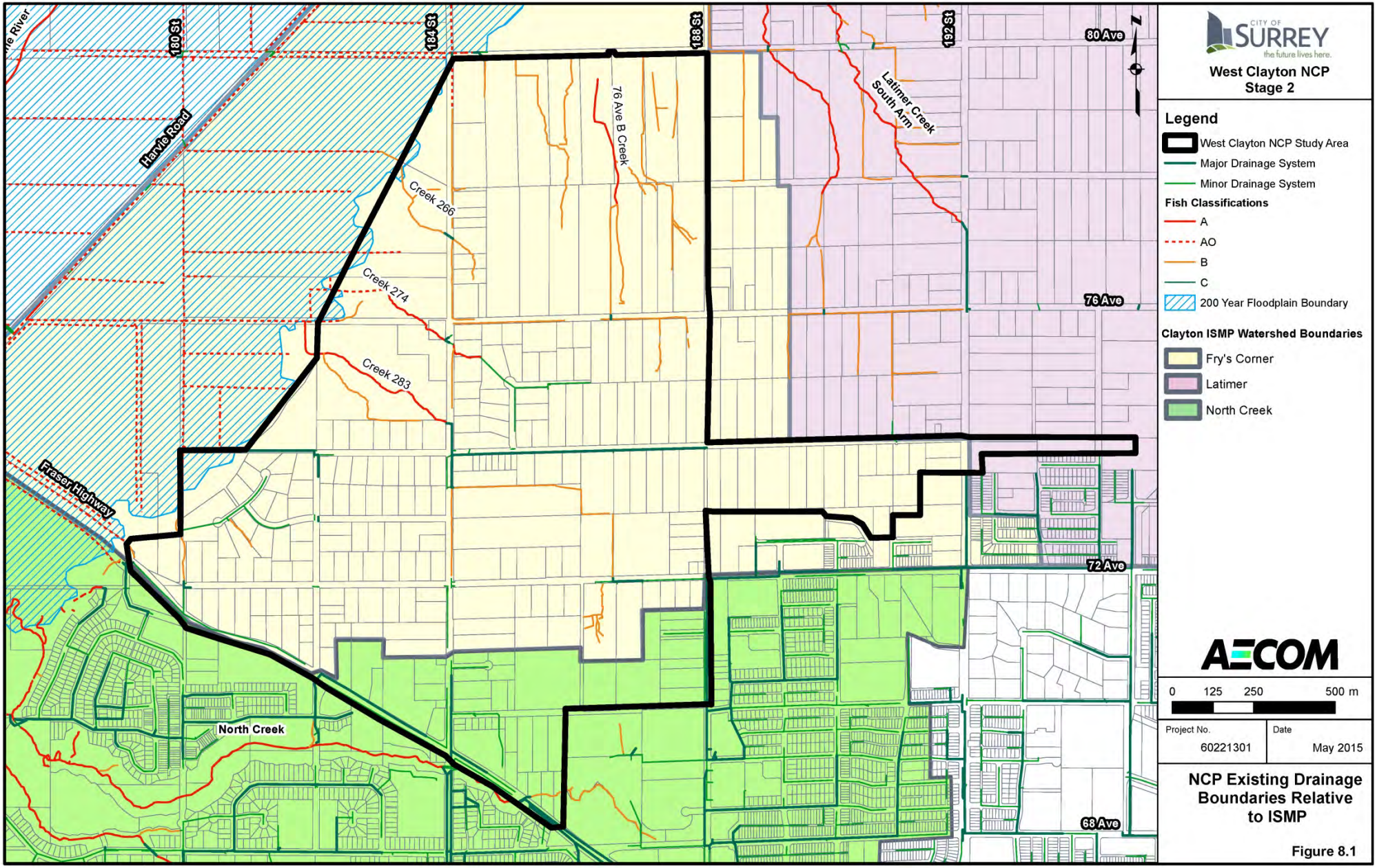


Figure 8.1 NCP Existing Drainage Boundaries Relative to ISMP

8.1.3 Existing Drainage System

Figure 8.1 shows the West Clayton NCP area in relation to the Clayton ISMP study area. Presently, the area consists of large acreages with contiguous forested areas. Latimer Creek lies northeast of 188 Street and 80 Avenue and North Creek is located south of Fraser Highway. There is minimal drainage infrastructure within the study area.

The majority of the study area drainage system consists of roadside ditches and culverts, which direct stormwater overland towards several creeks. The creeks drain the uplands to channels in the ALR, which ultimately discharge into the Serpentine River at the Fry's Corner Pump Station. Drainage is primarily discharged through flood boxes, and pumped only when the Serpentine River water level is high. The open channels within the ALR have been straightened along roads, property lines, farm fields, and right-of-way corridors. The channels are typical of the agricultural ditches throughout Surrey.

The land use within the ALR area is predominantly grasslands and agricultural crops. There are small patches of trees in wetland regions and areas that are not under cultivation. Typical roadside channels are 0.5 - 1 meter deep and 1-2 meters wide with homogenous channel cross sections.

8.1.4 Watershed Boundaries

As shown in **Figure 8.1**, West Clayton NCP is located within the Fry's Corner watershed, with the exception of two areas; a small area east of 192 Street that falls within the adjacent Latimer watershed, and the southern portion of the study area which drains to the Serpentine River via North Creek.

8.1.5 Existing Fish Classifications and Creek Buffers

The City has classified streams according to their value in supporting fish habitat. Developed in 1995, Surrey's Watercourse Classification Map is constantly updated through various resources and was initially used for City Engineering staff. Now it is widely used by City Planners, residents, and land developers to identify streams and setback requirements for new development.

Class A, AO, and B watercourses are regulated under the Federal Fisheries Act. This means that any modifications to in-stream or riparian habitat requires approval by Fisheries and Oceans Canada (DFO). DFO review and approval of any modifications to Class C watercourses is site specific. The stream classifications are divided into four classifications:

- **Class A (Red)** – watercourses support fish populations year round or have the potential to support fish populations year round if migration barriers are removed;
- **Class AO (Red-dashed)** – watercourses support fish populations generally only during the winter months; often roadside ditches that have very low flows and warm temperatures in the summer;
- **Class B (Orange)** – do not support fish populations, but provide food and nutrients to downstream fish habitats and often are supported year-round by groundwater; and,
- **Class C (Green)** – do not support fish populations and generally only convey flows associated with rainfall events; often roadside ditches in headwater areas.

Several Class A, AO, and B watercourses fall within the boundaries of the West Clayton NCP.

The proposed land use incorporates 30m creek buffers from top of bank for all Class A and AO watercourses, and 15m buffers for Class B watercourses; these setbacks should be reviewed for compliance upon Council approval of the upcoming Riparian Area By-Law. The majority of creeks in the study area drain northwest to the ALR, or north into existing roadside ditches along 80 Avenue. The three Class A watercourses that fall within the NCP study area are identified as 76 Avenue B Creek, Creek 274, and Creek 283. The tributary areas of the creeks are shown in **Figure 8.2**, and summarized in the following section in **Table 8.1.**

North Creek, located south of Fraser Highway, is also a Class A watercourse, and traverses east-west where it ultimately discharges into the Serpentine River. While this creek is outside of the study area, the southern portion of the NCP currently discharges to North Creek. Similarly, Latimer Creek South Arm is located outside the NCP; however stormwater from the area east of 192 Street flows into this creek. The future land use plan will manage runoff from development to maintain pre-development peak flows to these creeks. Where drainage area is rerouted by proposed storm sewers, base flows will be maintained in watercourses and creeks through low-flow diversion structures.

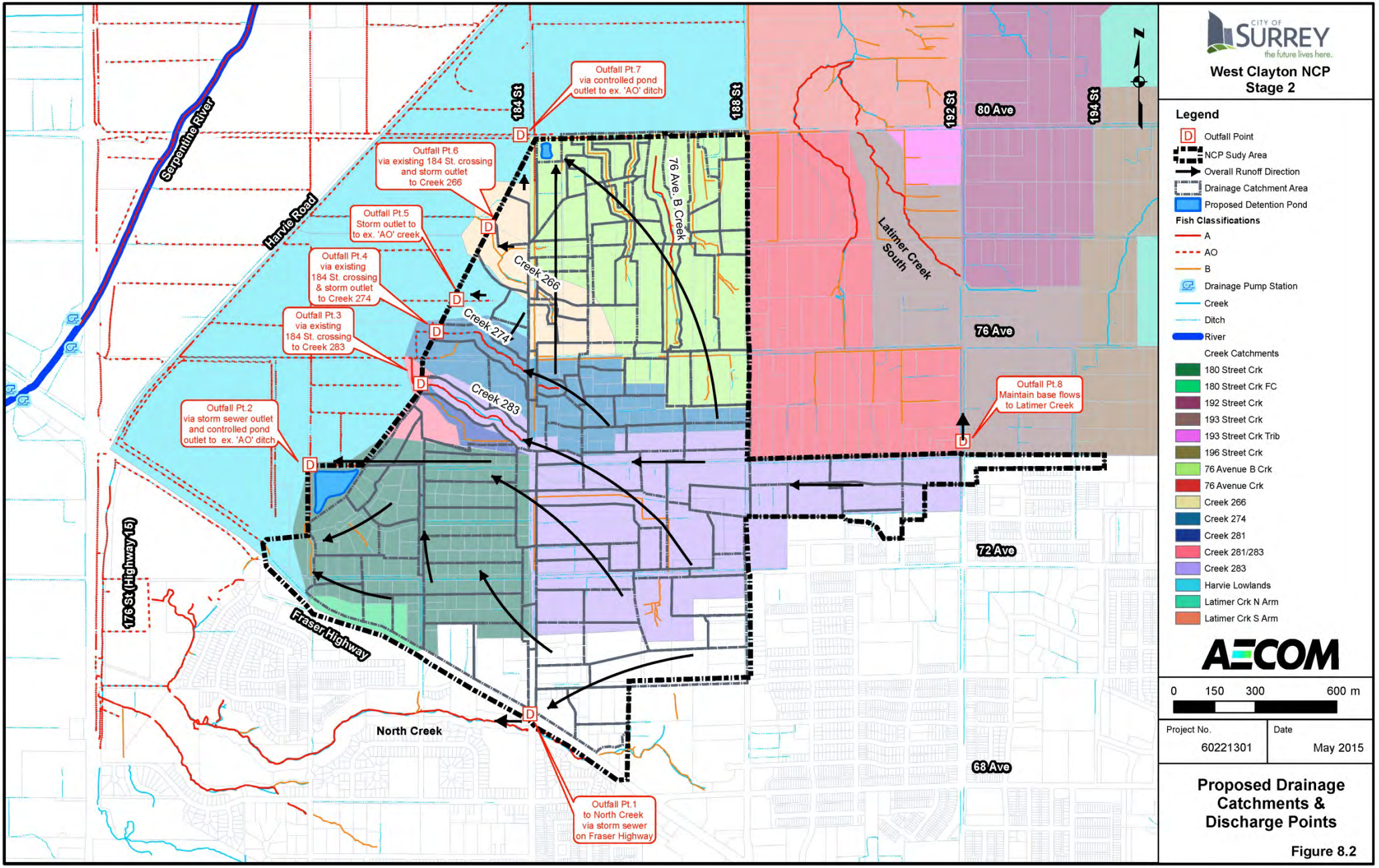


Figure 8.2 Proposed Drainage catchments and Discharge Points

8.1.6 Existing Soils and Hydrogeology

An understanding of the surficial soils is important to developing knowledge of the watershed and its operation under a range of conditions. A review of the surficial soils was undertaken to establish an understanding of the potential engineering constraints relating to drainage and possible infiltration as it relates to storm water best management practices (BMPs).

Historically, the upland area soils are of glaciomarine origin of moderately finely textured material; while the lowland area soils are of marine, floodplain, or deltaic origin with a large organic component. Upon these primary characteristics was imposed the effect of a humid and temperate climate. The large but unevenly distributed rainfall, together with moderately high temperatures and long growing season, combined to produce forest cover typical of the coastal western hemlock forest zone. The uplands supported a heavy forest of Douglas Fir and Western hemlock. In wetter soil locations and where seepage occurred, the Western red cedar was abundant. The lowlands were frequently inundated with salt and freshwater creating flood tolerant vegetation zones.

Since the onset of urban development there has been a pattern of removal of large contiguous portions of the organic soil horizon combined with the replacement of the native vegetation with species more desirable in a rural-residential setting. The lowlands have been altered by agriculture and flood management. The long term soil genesis under these conditions will ultimately result in soil types that are far different than those found during pre-development conditions.

Soil mapping of Surrey shows similar soil conditions for the West Clayton NCP area as those found in the East Clayton NCP area. The primary soil unit for both areas is the Bose soil unit; which when undisturbed and un-compacted, is typically able to absorb 1mm/hr in winter conditions and 1-2 mm/hr in summer conditions.

The Clayton ISMP study area includes an upland groundwater recharge area, a lowland discharge area, and at least three aquifers. These aquifers are known as the Upper Clayton Upland aquifer, the Lower Clayton Upland aquifer (also known as the Pre-Semiahmoo aquifer), and the Pre-Westlynn aquifer. Well records for the area show depths to range from 4-8m to as deep as 100m, while well yields ranged in capacity from 0.6 to 250gpm. Artesian (free flowing) wells are found throughout the lowland areas.

Figure 8.3 shows the schematic west-east hydrogeological profile of the upland area within the Clayton watershed. The existing soil makeup consists of four units:

1. Thin, relatively well drained sediment layer 1-2m thick, composed of geologic unit Ce (which is defined under the *Geological Survey of Canada Map No. 1484A* as Capilano sediments – mainly marine silt loam to clay loam with minor sand, silt, and stony glacial marine material up to 60+m thick), and Bose/Whatcom soils which form an unconfined, near-surface, aquifer in many of the upland areas. This unit supplies shallow wells in the area. Portions of this unit may dry out in summer; but near the toe of the slope east of the ALR boundary, above 20m elevation, the unit contributes base flows to streams on a year-round basis.

2. Thick, upper silty cap of geologic unit Ce sediments which thin towards the east. This is an aquitard layer that does permit some downwards percolation. It confines the aquifer below, generating artesian (free flowing) wells in the lowland area. Where this unit is thin or absent (eastern portions of the study area), important groundwater recharge areas are found. These are generally located in the Willoughby area of Langley. Aquitard – Low permeability saturated geologic unit that can transmit a small quantity of water to springs or other aquifers (a leaky aquifer).

3. A moderately extensive deep regional aquifer unit composed of hydraulically interconnected sand and gravel units. There is a high degree of variation in the substrate and definitive boundaries are not possible to delineate. It is possible to identify a consistent northwest gradient with a minor flow gradient to the southeast. The estimated travel time for groundwater entering the significant recharge areas in Langley and discharging to the west via the deep aquifer is 90-150 years.

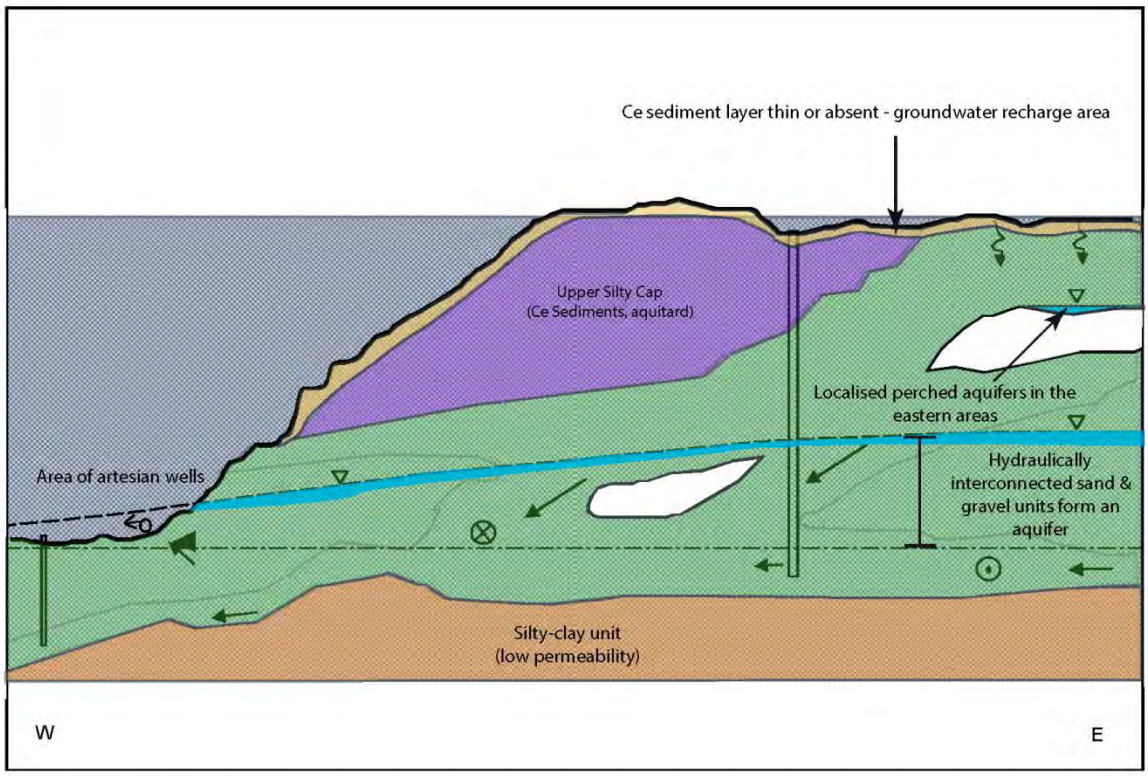
4. Silty clay aquitard unit.

The ISMP recommends identifying groundwater seepage areas in the upland area as these springs provide base flows for the numerous creeks. Development and drainage planning for these areas should ensure that these sources are maintained. It is estimated that developing within the Clayton area without infiltration compensation could reduce aquifer recharge by as much as 20-40%. It is estimated that this could result in a 40-60% reduction in creek base flows. As such, infiltration is a key component of the stormwater management for this area.

8.1.7 Key Drainage / Environmental Issues

The ISMP and other background information for the NCP identify the following key drainage / environmental issues:

- Minimize impacts on the downstream agricultural lowlands;
- Reduce erosion of ravine streams along the steep slopes and ravines that border between West Clayton and the lowlands;
- Maintain base flows in streams;
- Protect Class A, AO, and B streams. In some cases Class B streams are roadside ditches which will be impacted by future roadways in the area (i.e. 184 Street and 72 Avenue), in which case compensation will be needed; and
- Review and implement best management practices (BMPs), detention ponds and major storm trunk sewers as recommended by the Clayton ISMP.



LEGEND

- Aquifer piezometric surface
- Groundwater flow, in plane of section (Length of arrow indicates relative flow magnitude)
- Unsaturated groundwater flow
- Groundwater flow; in to plane of section
- Groundwater flow; out of plane of section
- Spring
- Thin, relatively well drained sediment layer 1 - 2 m thick, composed of geologic unit Ce, and Bose/Whatcon soils. This forms an unconfined aquifer in many upland areas that supplies shallow wells in the area.
- Ground surface; with 0.5 to 2m thick permeable sediements over low permeability sediments (see Fig. 6)

Note: Drawing not to scale

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HYDROGEOLOGICAL ASSESSMENT FOR CLAYTON MASTER DRAINAGE PLAN, SURREY, B.C.

SCHEMATIC WEST - EAST HYDROGEOLOGIC PROFILE OF CLAYTON UPLAND

Figure 8.3 Schematic West – East Hydrogeologic Profile of Clayton Upland

8.2 DESIGN CRITERIA AND ANALYSIS

8.2.1 Level of Service

The City's Design Criteria Manual provides the main source for drainage design criteria for the NCP. The recommendations from the Clayton ISMP have also been incorporated into the servicing strategy. The ISMP recommends the use of stormwater detention ponds, to be utilized in conjunction with the implementation of BMPs.

For the West Clayton NCP study area, the following specific requirements apply:

- Provide a storm sewer system with conveyance capacity to accommodate the 1:100-year return period storm, allowing for in-ground basements in single family residential homes; the maximum hydraulic gradeline (HGL) to be 300mm below minimum building elevation (MBE).
- Provide stormwater detention to attenuate post-development peak flow rates, and improve water quality. The 5-year peak flows will be controlled to pre-development rates as per the Design Criteria Manual.
- Where erosion is a concern, the 5-year post-development flow will be controlled to the more stringent of the following criteria; either 50% of the 2-year post-development, or the 5-year pre-development flow.
- The City's Design Criteria Manual also describes minimum pipe sizes, pond designs, etc. to be used.
- Implement the Clayton ISMP BMP Strategy for the purposes of improving water quality, runoff volume reduction, and to reduce erosion potential from small, frequent storms events by providing retention and infiltration BMPs sufficient to capture 46mm of rainfall in 24 hours.

8.2.2 Drainage Catchments & Outfall Points

Figure 8.2 shows the proposed drainage catchment areas and outfall points where stormwater runoff will leave the study area. A total of 137 sub-catchments were delineated based on the proposed land use plan, and eight outfall points were identified.

The proposed drainage network will alter the tributary area of several creeks in the study area. The plan therefore includes diversions to maintain creek base flows, and peak flow targets to match pre-development conditions.

8.2.3 Clayton ISMP Unit Rates

The Clayton ISMP stipulated that for future developments within this watershed the post-development condition must meet the pre-development condition so as to not have any negative impact on downstream creeks and agricultural lands. Predevelopment conditions are defined as those existing before 1978. To achieve this target, the ISMP identified that managing peak flows and stormwater volume is needed. Therefore, unit rates for both flow and storage were provided in the ISMP to meet this requirement, as summarized below.

- **Clayton ISMP Pre-Development Unit Flow Rates:**
  - 8.1 L/s/ha for 1:2 year pre-development flow unit rate;
  - 11.5 L/s/ha for a 1:5 year pre-development flow unit rate; and,
  - 21.0 L/s/ha for a 1:100 year pre-development flow unit rate.
- **Clayton ISMP Unit Storage Rates:**
  - Minimum of 34 m^3/ha for a 1:100 year storage unit rate with the implementation of BMP Strategy #4

These unit flow rates were based upon rainfall and runoff relationships within adjacent watersheds to the West Clayton study area and available historical flow monitoring data, as described in the Watercourse Hydrology (Section 5.5) of the Clayton ISMP. Stream gauges for the Salmon River at 72 Avenue and for West Creek near Fort Langley were used in establishing these unit runoff rates for existing conditions within the Clayton watershed. The unit storage rates are described in the Peak Flow Management (Section 7.7) of the ISMP.

8.2.4 Pre-Development Conditions

From the Clayton ISMP unit rates, pre-development flow rates were calculated at each creek outfall point and are summarized in **Table 8.1**.

Table 8.1 Pre-Development Flow Rates

Outfall point	Study Sub-Area	Watercourse	Contributing Area	1:2 Year	1:5 Year	1:100 Year
			(ha)	Pre-Development Flow (L/s)		
1	**North Creek**	North Creek	34.26	278	394	719
2	**Fry's Corner**	180th Street Creek	56.36	457	648	1,184
3		Creek 283	79.40	643	913	1,667
4		Creek 274	26.98	219	310	567
5		Harvie Lowlands	4.60	37	53	97
6		Creek 266	15.45	125	178	324
7		76th Avenue B Creek	65.80	533	757	1,382
8	**Latimer**	Latimer Creek South Arm	2.93	24	34	62
Total:			285.78			

8.2.5 Hydraulic Analysis

The hydraulic analysis for the study area was conducted using PCSWMM software. PCSWMM utilizes both runoff and hydraulic modules. The runoff module generates hydrographs based on rainfall (or hyetographs), soil characteristics, catchment widths, depression storage, impervious area, and infiltration rates. The hydraulic module routes these hydrographs through the drainage system, on a real time basis, from the start to the end of the rainfall event. The drainage system is represented as links (pipes or other conduits) and nodes (manholes or other junctions). Therefore, the hydro-dynamic model provides simulated results that emulate the real flow pattern and parameters such as flow rates, velocities, water depths, and volumes.

PCSWMM requires the input of various hydrologic parameters that define the catchment characteristics to be assigned to the nodes. These parameters include:

- catchment area, percent imperviousness, width, and overland slope;
- initial abstractions (impervious and pervious areas);
- soil infiltrations (Horton's infiltration); and
- rainfall hyetographs.

The West Clayton drainage model was developed based on the NCP land use plan. The model analyzed the future drainage system under the 2-year, 5-year, and 100-year design storm events. Future scenarios were assessed without modelling the best management practices (BMPs) in order to determine conservative estimates of peak flows. The purpose of the BMPs is to improve water quality within the watershed, and to improve creek base flows by infiltrating frequent, low-intensity surface runoff. They are not intended to attenuate large storms events such as the 1:5 or 1:100 year storm. The stormwater system will therefore be designed to convey the worst-case storm events without flow reductions from on-lot infiltration devices.

A total of 137 sub-catchments were delineated based on the proposed land use plan, and the eight outfall points. Modelling sub-catchment input parameters were matched to those applied in the Clayton ISMP, and are summarized in **Table 8.2.**

Table 8.2 Catchment Modelling Parameters

Impervious Manning's n	0.013
Pervious Manning's n	0.200
Impervious Depression Storage (mm)	2.5
Pervious Depression Storage (mm)	7
Horton's Maximum Infiltration Rate (mm/hr)	40
Horton's Minimum Infiltration Rate (mm/hr)	2.3
Horton's Infiltration Decay Constant (1/hr)	3.6

8.2.6 Post-Development Conditions

Area East of 188 Street Drainage Catchments

The area of 74 Avenue from 188 Street to 192 Street slopes westerly towards the center of the West Clayton NCP, draining to 283 Creek. However, the 2.9 ha area between 192 Street and 194 Street is flat and generally slopes north, draining to Latimer Creek; baseflows will need to be maintained to this watershed.

Upon a preliminary review of the topography along the 74 Avenue alignment, the potential exists to service the area east of 192 Street through the NCP via a deep storm sewer, with capacity to convey the 100-year flow west towards proposed drainage infrastructure. As per City Design Criteria the uppermost leg of any storm system must have a minimum slope 0.4%, and have an installation depth sufficient to service properties on both sides of the roadway. Pipe installations deeper than allowable for Class III pipes must be specially designed for the specific conditions.

The recommended strategy is to install a 300mm sewer at 1m depth east of 194 Street, sloping west at minimal grade, which will transition to a deep storm sewer (approximately 5m deep) near 192 Street. Servicing basements by gravity will not be a viable option for properties east of the 19450 block, subject to a review of topographic survey for confirmation. **Figure 8.4** illustrates the potential sewer profile along 74 Avenue between 188 and 194 Street. Where the sewer depth exceeds 3.5m depth for an extended length, a second sewer at a shallower depth ("header pipe") would reduce the depth of service connections to the lots fronting the deep sewer. The header pipe would also facilitate the low-flow diversion required at 192 Street (outfall point 8) to maintain base flows towards Latimer Creek.

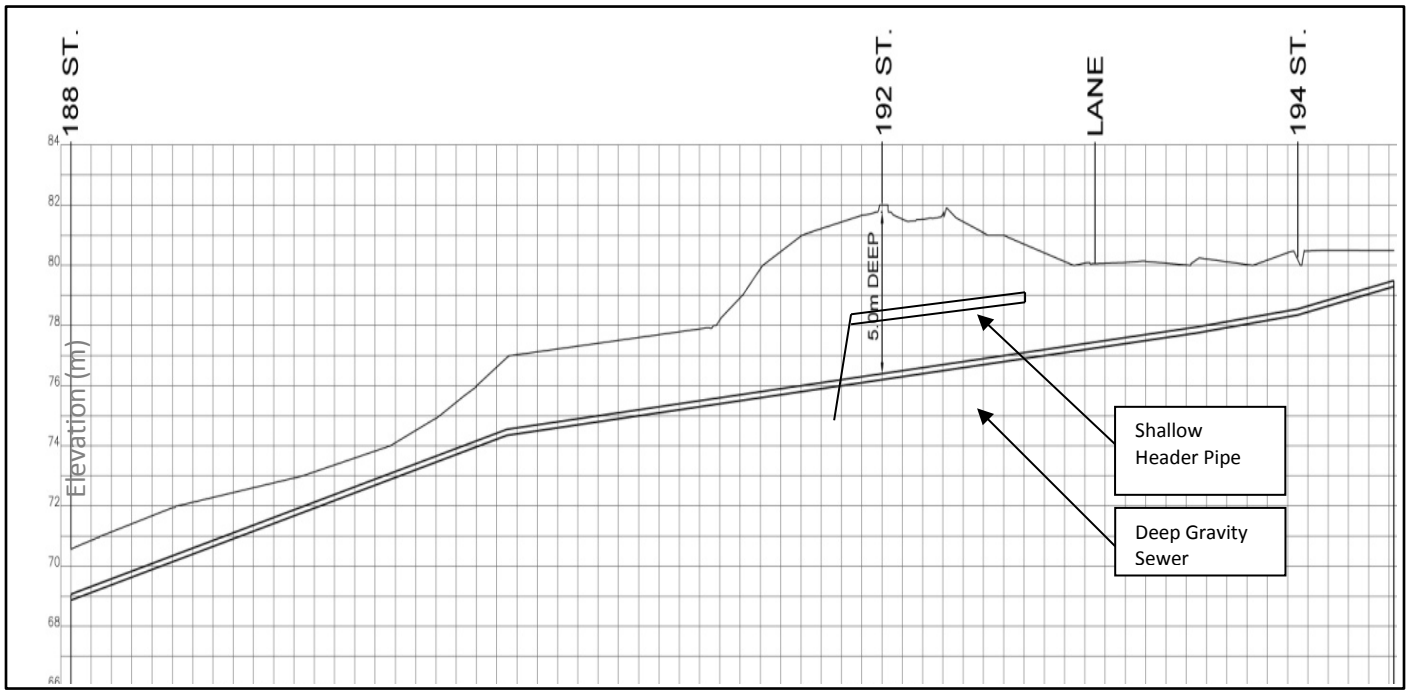


Figure 8.4 Storm Sewer Profile East of 188 Street at 74 Avenue

Creek 283

Creek 283 is a Class A watercourse located in the north-western portion of the study area, crossing 184 Street as shown in **Figure 8.2**. The creek has a large tributary area (79 ha), the majority of which will be developed be as part of the NCP. The increased impervious area from development will lead to higher peak runoff during storm events if unmitigated.

The existing crossing under 184 Street is a 750mm culvert which outlets to a concrete splash pad before draining to a deep ravine channel. The ravine area has numerous documented erosion points identified in the City's Biannual Ravine Assessment Project, making the creek especially vulnerable to increasing peak flows; therefore due to erosion concerns, more stringent City Design Criteria will apply to outfall point 3 to limit post-development flows. In this case limiting the 5-year post development flow to 50% of the 2-year post development flow was found to be the more stringent criteria.

To achieve the design criteria a diversion sewer will be required on 184 Street and 74 Avenue, which will convey all flows exceeding the target from the 36 ha upstream area to the detention pond (Pond#1). Additionally 19 ha of tributary area south of 74 Avenue will be rerouted from Creek 283 to the stormwater detention pond. Existing storm sewers on 184 Street and 74 Avenue will need to be upgraded to convey post-development peak flows. The existing culvert crossing was reviewed in the ISMP, and is estimated to have sufficient capacity to convey the 100-year storm.

Creek 274

Creek 274 is a Class A watercourse also located in the north-western portion of the study area, crossing 184 Street as shown in **Figure 8.2**. The residential area near 185 Street and 75 Avenue currently has storm sewers that drain to Creek 274. Drainage is conveyed across 184 Street by a 375mm culvert which discharges to a ravine. Developable area west of 184 Street, which is too low to drain to the proposed trunk sewer, will also outlet to the creek. Development of the tributary areas will result in higher peak flows if not mitigated. Erosion concerns have not been identified for Creek 274, therefore standard City Design Criteria will apply to outfall point 4.

To achieve the design criteria at the outfall, runoff from upstream areas will need to be reduced by rerouting enough flow to the 184 Street sewer system (Pond#2) to allow the downstream areas to drain uncontrolled. A diversion structure will be constructed for the 8 ha of area draining to the existing storm sewer on 185 Street and 75 Avenue. An orifice will limit the 5-year peak flow draining to the creek to 50% of the 2-year flow, and divert excess flows to the pond via a new storm sewer.

76 Avenue B Creek

76 Avenue B Creek is a Class A watercourse (and several Class B tributaries) draining 66 ha of the study area to a Class AO ditch on 80 Avenue (see **Figure 8.2**). The Ravine Assessment Project have identified one of the creek's channels as having numerous erosion points, and the Clayton ISMP noted the channel has insufficient capacity to convey existing 100-year peak flows. Due to the erosion concerns, all of the developable areas tributary to 76 Avenue B Creek will be routed to Pond#2. Baseflows will be maintained to the watercourses by low-flow diversions to be provided at 3 locations (76 Avenue, and two on 78 Avenue). The diversion flows will be regulated by an orifice to only convey base flows to the creeks, and divert all flows exceeding 50% of the 2-year post-development flows to Pond#2.

Creek 266 and Class B Watercourses

Creek 266 is a Class B watercourse crossing 184 Street, draining a total of 15 ha as shown in **Figure 8.2**. The area tributary to the creek is planned to develop as medium and low density cluster residential. Since the area slopes towards the ALR, the proposed lots west of 184 Street will be too low in elevation to be serviced by Pond#2. An outfall structure will be required at Creek 266 in order to provide gravity servicing for these lots. As part of the development process, developers will be required to secure any required right-of-ways to support the stormwater management system. To avoid any increase in flow to the creek, the 8 ha of upstream tributary area east of 184 Street will be rerouted to Pond#2. To help maintain baseflows within the upper portion of the creek, a low-flow diversion (peak outflow set to 50% of 2 year storm) will be installed on the proposed storm sewer on 184 Street.

Similarly, all remaining Class B streams within the study area that are adjacent to a storm sewer will have low-flow diversions regulated by an orifice. This will help to maintain creek baseflows while ensuring peak runoff greater than 50% of the 2-year peak flow will be conveyed to downstream storm sewers. Existing minor culvert crossings should be maintained to allow current surface runoff to contribute to baseflows.

8.2.7 Water Quality

Where flow diversions and storm outfalls discharge to a receiving water course, treatment to improve water quality will be required. The existing storm infrastructure consists mostly of roadside ditches, and creek channels collecting runoff from roads and forested areas. Under the ultimate conditions the source of the surface runoff will be urban, which may have lower water quality characteristics. Roadways accumulate hydrocarbons, sediments, and oils which are transported by runoff to receiving watercourses. The presence of these pollutants can negatively impact the health of the watershed, therefore water-quality improvements are recommended at all proposed flow diversions and outfalls. As a minimum, Oil-Grit Separators (OGS) should be installed where untreated runoff is entering a watercourse. OGS are in-ground structures usually designed to treat the "first-flush", the initial surface runoff, which typically contains the majority of contaminants from areas with large portions of impervious surfaces.

For the storm sewer discharging to Creek 283, a higher level of treatment may be required due to the size and proposed density of the contributing area. It is recommended that the water quality be further studied at this location to establish a baseline before development occurs. This will help to determine if an OGS will be sufficient to maintain water quality, or if a higher level of treatment is required at this location.

8.2.8 Hydraulic Model Analysis

The PCSWMM model was run using the West Clayton proposed land use conditions for the 2-year, 5-year, and 100-year design storm events. Various durations of the design storms were run to identify the most critical. It was found that the model produced the highest peak flows under the 100-year 1-hour event, while producing the largest runoff volumes under the 100-year 24-hour event. Storm pipe sizes and flow diversion rates were therefore determined using the 100-year 1-hour storm.

The model results indicate that peak flows at the 8 outfall points are at or below pre-development flow rates with the recommended drainage system improvements in place.

Outfall point 1 (to North Creek) flows to an existing 600mm storm sewer crossing Fraser Highway at 184 Street. Model results indicate the existing sewer is sufficiently sized to convey the 100year peak flow to North Creek.

Detention ponds are required to attenuate peak flows throughout the study area. The ponds have been sized sufficiently to control flows at outfall points 2 and 7 to pre-development levels and compensate for areas discharging uncontrolled to these outlets. The ponds also benefit areas discharging to outfall points1, 3, 4, 5 and 6 by reducing the overall contributing drainage area at each point, and accepting the flows that have been redirected. The ponds help mitigate the impact of development over the entire study area. Finally, outfall point 8 is a baseflow diversion installed to maintain flow to Latimer Creek. The peak flow is regulated by an orifice to allow low flows to drain to the creek while diverting remaining flows to the storm sewer.

Figure 8.5 shows the proposed drainage infrastructure network. The model results are summarized below for post development conditions, which includes active flow diversions and detention ponds. The peak flow at each outfall point is summarized in **Table 8.3** for the three design storms. A comparison of the pre-& post-development peak flows are also included.

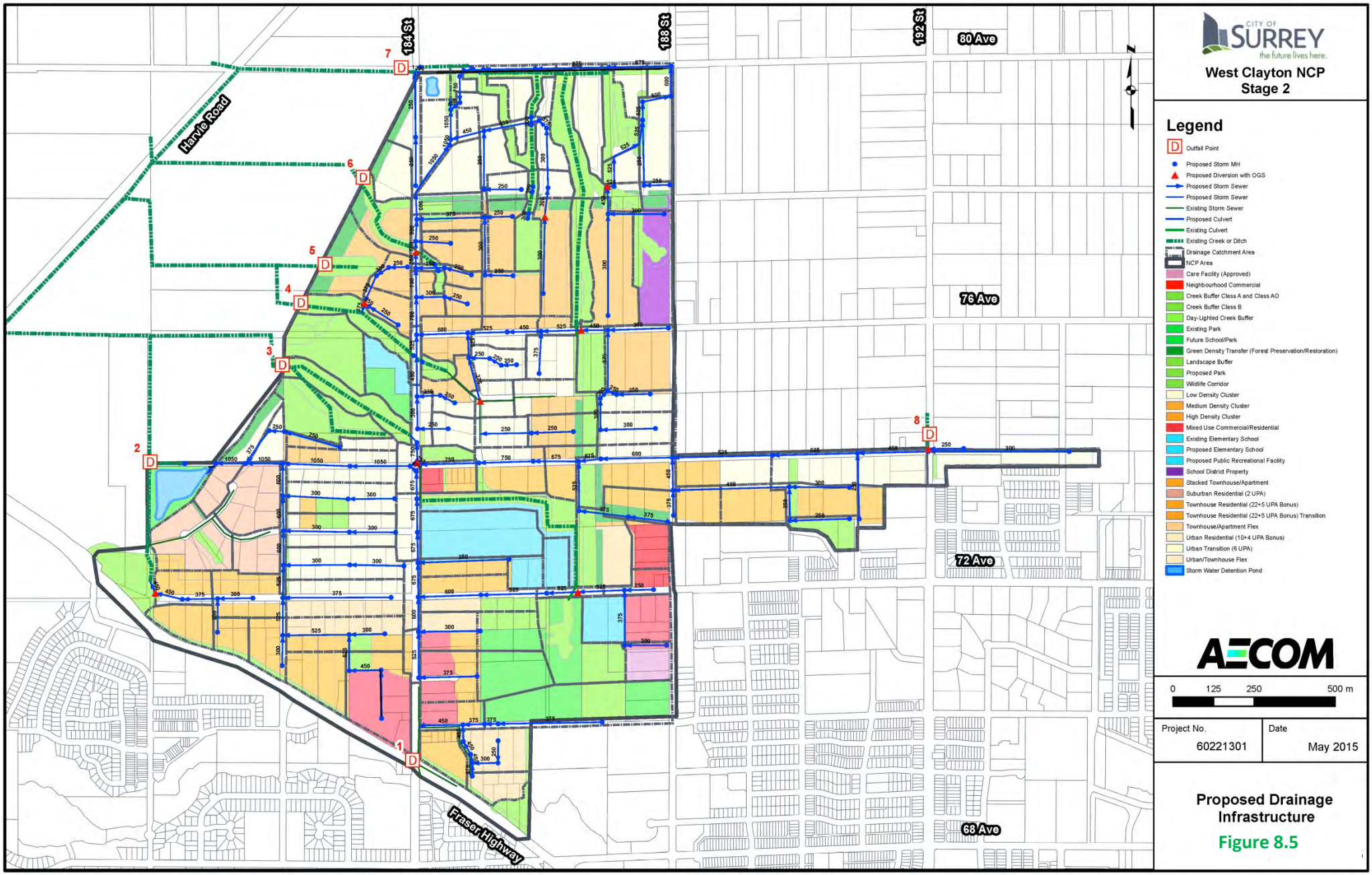


Figure 8.5 Proposed Drainage Infrastructure

Table 8.3 Model Results: Peak Flow Exiting the NCP Area

Outfall Point	Pre-Development			Post-Development			Design Criteria Achieved?
	1:2 Year	1:5 Year	1:100 Year	1:2 Year	1:5 Year	1:100 Year	
	Peak Flow (L/s)						
1 (North Creek)	*278*	*394*	*719*	214	289	527	Yes
2 (Pond#1)*	*457*	*648*	*1184*	477	636	955	Yes
3 (Creek 283)	*643*	*913*	*1667*	434	490	630	Yes
4 (Creek 274)	*219*	*310*	*567*	110	136	247	Yes
5	*37*	*53*	*97*	22	27	69	Yes
6 (Creek 266)	*125*	*178*	*324*	86	102	156	Yes
7 (Pond#2)*	*533*	*757*	*1382*	583	744	1056	Yes
8 (Latimer)	*24*	*34*	*62*	18	20	23	Yes

*Results shown from the 24-hour duration storm event, which was the critical design storm at these outlets

Table 8.4 Post Development Creek Base Flow Diversion Rates

Diversion Location	Diversion Type	Receiving Watercourse	Design Criteria 50% of 2-Year or 5-Year Pre-Dev	1:5 Year Post-Dev	1:100 Year Post-Dev	Orifice Size (mm)
			Peak Flow (L/s)			
74 Ave/184 St.	Peak Flow Management	Creek 283	497	494	622	615
75 Ave/185 St.	Peak Flow Management	Creek 274	67	62	76	275
76 Ave west of 188 St.	Baseflow	76 Ave B Creek	122	31	33	150
78 Ave west of 188 St.	Baseflow	76 Ave B Creek	72	33	37	150
78 Ave. east of 184 St.	Baseflow	76 Ave B Creek	52	20	23	150
74 Ave/192 St.	Baseflow	Class B Ditch to Latimer Creek	26	14	17	150
78 Ave./184 St.	Baseflow	Creek 266	90	30	36	150
72 Ave. west of 188 St.	Baseflow	Class B Ditch	19	11	14	100

Table 8.4 summarizes the peak flows that enter the creeks and ditches via the low-flow diversions that have been recommended to maintain baseflows. Since these diversions are only intended to provide low flow to the water courses, the outlets have been controlled by an orifice. In order to avoid concerns with erosion, the orifice at each diversion has been sized to limit the maximum allowable flow to the receiving watercourse's pre-development 5yr rates or 50% of the post-development 2-year rate. In most cases the baseflow rate well below the allowable flow.

8.3 PROPOSED SYSTEM

8.3.1 Stormwater Detention Ponds

The total NCP area is approximately 286 ha in size. Of this area, the detention ponds will directly service a total of 143 ha of developable land. It is important to note that as part of reviewing the proposed land use and Clayton ISMP detention pond locations, the recommended ponds C2 and C3 identified in the ISMP were combined into a consolidated "Pond#2" to reduce the land area required. The recommended pond C1's location was also modified as discussed below for "Pond#1".

Pond#1 has a tributary area of 71ha with and discharges to outfall point 2. An additional 36 ha of area can contribute flow to the pond through the flow diversion structure at 184 Street and 74 Avenue; the diversion is active for flows that exceed 50% of the 2 year storm. It is necessary to have a low release rate from this pond to compensate for peak flows from the 19 ha that are tributary to outfall point 2 but not serviced by the detention pond.

The previously recommended Pond#1 location on 72 Avenue east of 180 Street (Stage 1 Report, and Clayton ISMP) was modified upon review of the NCP land use plan. The 72 Avenue location posed several constraints, including limiting the drainage area served to areas adjacent to Fraser Highway, and limiting the size and type of facility to a dry pond, which does not provide water quality treatment. Since the receiving water course is a Class AO stream, which supports fish populations, maintaining high water quality from the pond is important. By relocating the site to the park at 74 Avenue and 180 Street, the area serviced by the pond can be increased, and the level of water quality treatment can be improved since there is enough space to provide a wet pond facility. Under the original Pond#1 location the majority of the NCP would be dependent on Pond#2, which would limit the amount of interim development before incurring significant capital costs.

The proposed Pond#1 site poses a challenge since it is located within the Agricultural Land Reserve (ALR). The City currently owns the parcel of land, and has zoned it as a park. In order to construct a stormwater facility on the parcel, the City will apply to the Agricultural Land Commission (ALC) on behalf of the development community for permission to use the land in the ALR for non-farm purposes, under Section 20(3) of the Agricultural Land Commission Act. If the application to the ALC is unsuccessful, the City should work with stakeholders to find an appropriate alternative.

Pond#2 has a tributary area of 72ha, and discharges to outfall point 7. An additional 8 ha of area can contribute flow to the pond through the diversion structure at 185 Street and 75 Avenue; the diversion is active for flows that exceed 50% of the 2 year storm. Pond#2 will outlet to a Class AO watercourse which is a roadway ditch on the south side of 80 Avenue. The ditch flows west to the ALR, crossing to the north side of 80 Avenue though an existing 600mm culvert east of the proposed pond, and a 450mm culvert crossing 184 Street. The pond will require a new road crossing as part of the outlet structure, with the alignment to be confirmed at the detailed design stage when the final siting has been selected.

Both ponds have been designed as wet pond facilities with a permanent pool depth of 1.5m to provide water quality treatment. They have been designed to attenuate the 2-year and 5-year peak flows to pre-development levels at outfall points 2 and 7, respectively. The model calculated the required active storage volume of 24,500 m^3 for Pond#1 and 14,200 m^3 for Pond#2 under the 5-year 24-hour design storm to meet the level of service required by the City's Design Guidelines. **Table 8.5** provides the details of each pond.

In meeting the requirements to attenuate the 5-year 24 hour design storm, the ponds have sufficient capacity to attenuate the 100-year 1-hour storm event, which the storm sewers have been sized to convey. An overflow spillway will be designed as part of the outlet structure in case of a blocked outlet, or overloading due to consecutive storms. The spillway will be sized to convey the peak inflow from the 1:100year storm.

The detention pond sizing provided below is based on City Design Criteria, using maximum side slopes of 1V:7H, and allowing for a minimum freeboard of 0.6m from the design high water level to the surrounding maintenance access path. The preliminary estimates are based on available site information, and will need to be confirmed at the detailed design stage.

Table 8.5 Proposed Pond Details

Detention Pond	Pond #1	Pond #2
Location	74 Avenue and 180 Street	80 Avenue and 184 Street
Catchment Area (ha)	70.8	72.2
Active Storage Volume, 5-year 24-hour (m^3)	24,500	14,200
Maximum Active Depth 5-year 24-hour (m)	2.0	2.0
Approximate Pond Footprint (ha)	1.6	1.1
Approximate Site Footprint (ha)	2.3	1.5
Peak Inflow, 5-year 1-hour (m^3/s)	2.019	1.786
Design Attenuation: Peak Outflow, 5-year 1-hour (m^3/s)	0.177	0.284
Outlet Orifice Size (mm)	360	420
Emergency Spillway Capacity (equals peak 100-year inflow) (m^3/s)	4.090	3.426

8.3.2 Stormwater Infrastructure Phasing

Although some areas of the NCP are not directly serviced (i.e. connected to) the proposed stormwater detention ponds, those that are seeking to develop in the NCP area will need to arrange for the construction of these ponds. The developments within the area of the NCP that drain to outfall points 1, 2, 3, and 8 will need to arrange for the construction of Pond #1, given that Pond #1 seeks to over detain stormwater runoff from areas that are connected to the pond so that stormwater runoff does not need to be controlled from areas that are not directly connected to the pond.

The developments within the area of the NCP that drain to outfall points 4, 5, 6, and 7 will need to arrange for the construction of Pond #2, given that Pond #2 seeks to over detain stormwater runoff from areas that are directly connected to the pond so that stormwater runoff does not need to be controlled from areas that are not directly connected to the pond.

Had the servicing strategy sought to ensure that all areas are directly connected to a pond, several new ponds would need to be added which would substantially increase the cost to service the NCP in addition to reducing the amount of land available for development. As such, the proposed approach is considered the most cost effective approach to service the NCP area.

Figure 8.6 shows the areas that are directly connected to each detention pond, and the areas that drain uncontrolled but are dependent on the ponds to over detain runoff.

The following list summarizes the required sequence for constructing drainage infrastructure as West Clayton develops:

1) Construct Pond#1 at 74 Avenue and 180 Street
2) Construct the trunk sewer on 74 Avenue from Pond#1 to 184 Street
3a) Construct flow diversion structure at 74 Avenue and 184 Street. Once completed, development can begin on 74 Avenue system between 184 Street and 192 Street.
3b) Construct trunk sewers on 182 Street, connecting with local drainage systems as development occurs.
3c) Construct trunk sewers on 184 Street, connecting with local drainage systems as development occurs.
4a) Construct outfall and low-flow diversion at 74 Avenue and 192 Street after 3a is completed.
4b) Construct outfall structure and local drainage system at 72 Avenue, east of 180 Street, after 3b is completed.
4c) Construct local drainage system and connect to existing sewers at 70 Avenue/185 Street after 3c is completed.
5) Construct Pond#2 at 80 Avenue and 184 Street.
6) Construct trunk sewers on 80 Avenue, connecting with local drainage systems as development occurs.
7) Construct trunk sewers on 184 Street, connecting with local drainage systems as development occurs.
8a) Construct outfall structure and local drainage system to Creek 266 (78 Avenue west of 184 Street).
8b) Construct diversion structure at 75 Avenue/185 Street and connect to Pond#2 system.
8c) Construct outfall structures and local drainage systems to Creek 274 (outfall point 4) and outfall point 5.

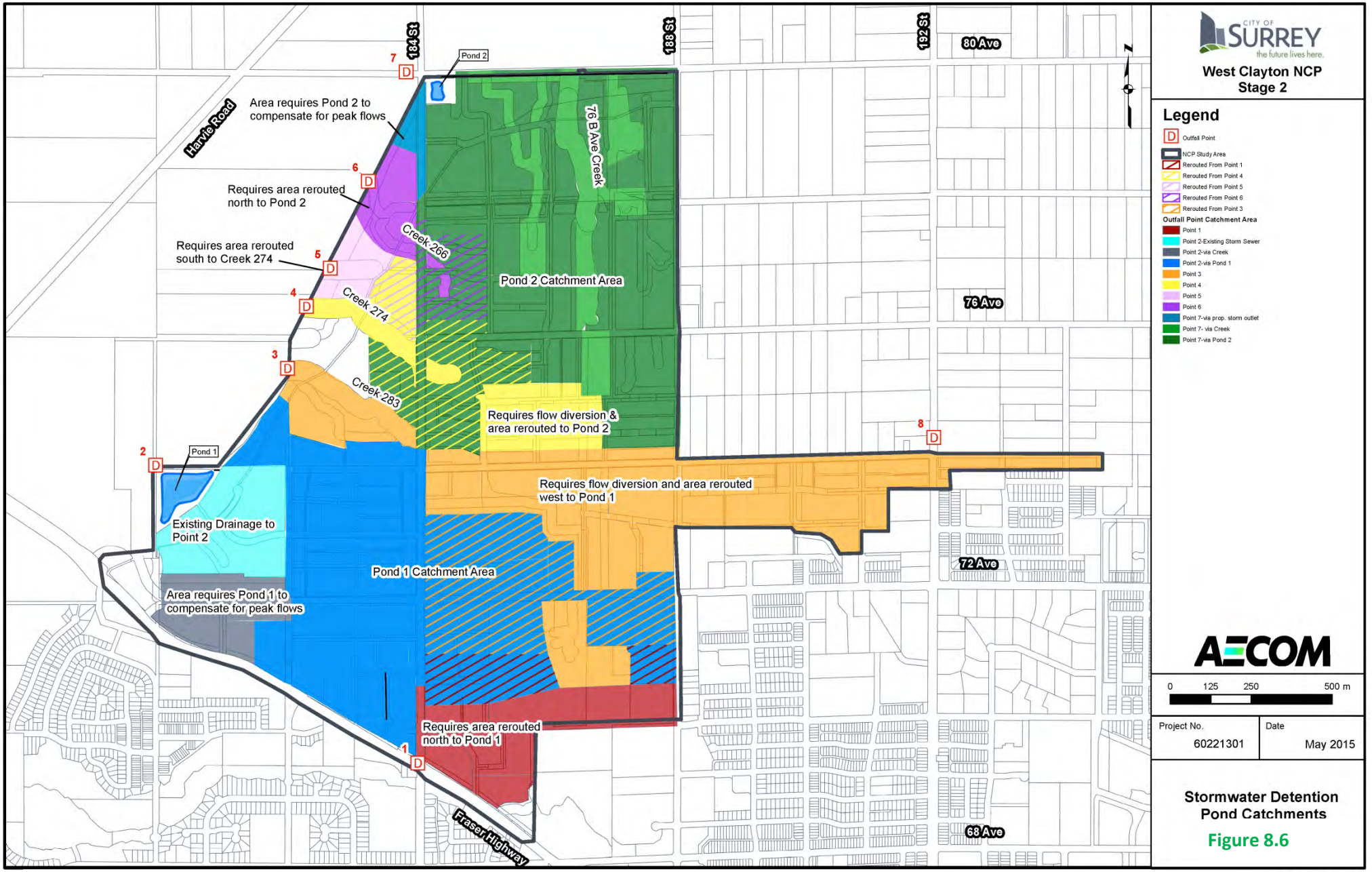


Figure 8.6 Stormwater Detention Pond Catchments

8.3.3 Best Management Practices (BMP) Strategy

The Clayton ISMP identifies that in order to manage stormwater within the watershed, a combination of on-lot BMPs for source control measures coupled with end-of-pipe detention ponds are necessary to mitigate negative impacts downstream from continued development.

Metro Vancouver's Source Control Design Guidelines are recommended to form the basis of the BMP strategy, with a target capture of 90% of the average annual rainfall. Site specific measures should be used to provide capacity to retain the 6-month 24-hour rainfall (equivalent to 72% of the 2-year 24-hour rainfall); for the Clayton area this means providing retention and infiltration sufficient to capture 46mm of rainfall in 24 hours.

There are many considerations that should be made when developing requirements for stormwater source controls, several of which are discussed below.

- All impermeable areas of the site should direct runoff over permeable areas to promote infiltration. Roof leaders should be disconnected from the storm sewer.
- On-lot infiltration devices will only work if they are maintained. It is particularly difficult for the City to monitor if residents are maintaining the on-lot infiltration devices within backyards. The City should require that infiltration devices be within the front yard building setback adjacent to the street right-of-way.
- Infiltration measures are site specific and require geotechnical investigations to verify soil conditions, infiltration capacity and local ground water table.
- The target percolation rate is a minimum of 1 mm/hr. Developers should provide an enhanced reservoir volume where percolation rates are found to be less than 1 mm/hr to prevent surface ponding while providing the necessary retention volume.
- Low-flow drains (very small diameter) are required from the infiltration system to the storm sewer for all sites where testing has shown the percolation rate to be less than 15 mm/hr to help prevent surface ponding from consecutive storms.
- All infiltration systems should have an overflow to the storm sewer (or ditch) system.
- Where inflow to a stormwater source control is a point discharge (as in a disconnected roof leader or curb cut), a transition area of clean crushed rock or rounded river rock should be used. This allows the flow to disperse and helps control erosion.
- Permeable utility trenches that intercept stormwater source controls should be sealed off with low permeability trench dams to prevent water from short-circuiting through the utility trench.
- Growing Medium (topsoil) should meet MMCD requirements for Topsoil and Finish Grading, with the following amendments to Table 2 of Section 32-91-21; the minimum saturated hydraulic conductivity should be 70 mm/hr; and the minimum organic matter content should be 8% for lawns, and 15% for planting areas.

- Native on-site topsoil can be used as a growing medium provided that it is amended to meet the standard set for imported topsoil.

- Parking lots shall have vegetated curb-less islands set below pavement grade to provide bio-retention and conveyance of parking lot run-off.

- Urban forestry should be encouraged by requiring a minimum of 35% of canopy coverage at maturity.

8.3.4 On-Lot Stormwater Source Controls

A combination of on-lot source controls are recommended to achieve the retention and infiltration target for all parcels in the West Clayton study area. Infiltration areas should be sized with a minimum area equal to 10% of the lot, and provided with vegetative (grass, shrubs, trees) or organic (mulch, straw, wood fiber) cover. For RF-10 zoning, the porous landscaping required in the bylaw can be counted towards the source control requirements.

The maximum ratio of impervious area draining to pervious area for absorbent landscaping is 2:1, as per MV Design Guidelines. Lots where the ratio is greater than 2:1 should use a rain garden, or similar device with a constructed reservoir, in place of absorbent landscaping.

To achieve the retention/infiltration target of 46mm of rain within 24hrs, the City should permit the following stormwater source controls as sufficient to meet the requirements:

- 450mm of growing medium (topsoil) covered with absorbent landscaping on all pervious areas to provide infiltration; and
- all lot drainage is directed over an infiltration area; and
- all infiltration areas are provided with an overflow (surface route or pipe) to a storm sewer.

If the total impervious area (roofs, patios, driveways, etc.) is less than 67% of the lot area (i.e., less than 2:1 impervious to pervious ratio), the on-lot source control requirement is met if the above requirements are implemented. If the ratio of impervious area is greater, additional source controls with sufficient capacity to meet the target will be required, as calculated using MV Source Control Design Guidelines.

Additional Source Controls are:

- Driveway constructed of Porous Paving or Pervious Pavers
- Infiltration Dry Well (Soak-away Manhole)
- Infiltration Swale
- Rain Garden (with reservoir and underdrain)
- Green Roof

Figure 8.7 illustrates a 10% infiltration footprint for a typical small lot in the study area.

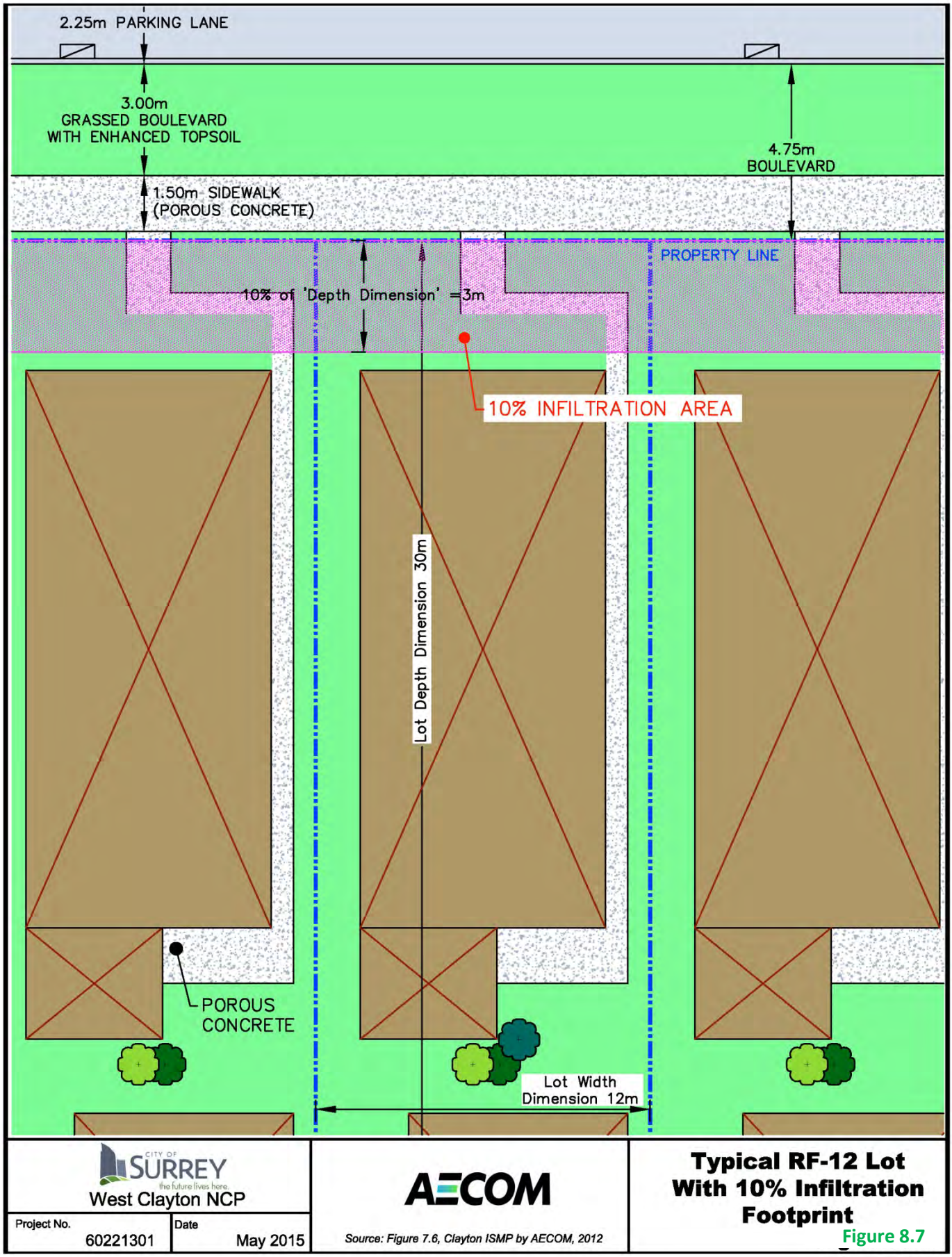
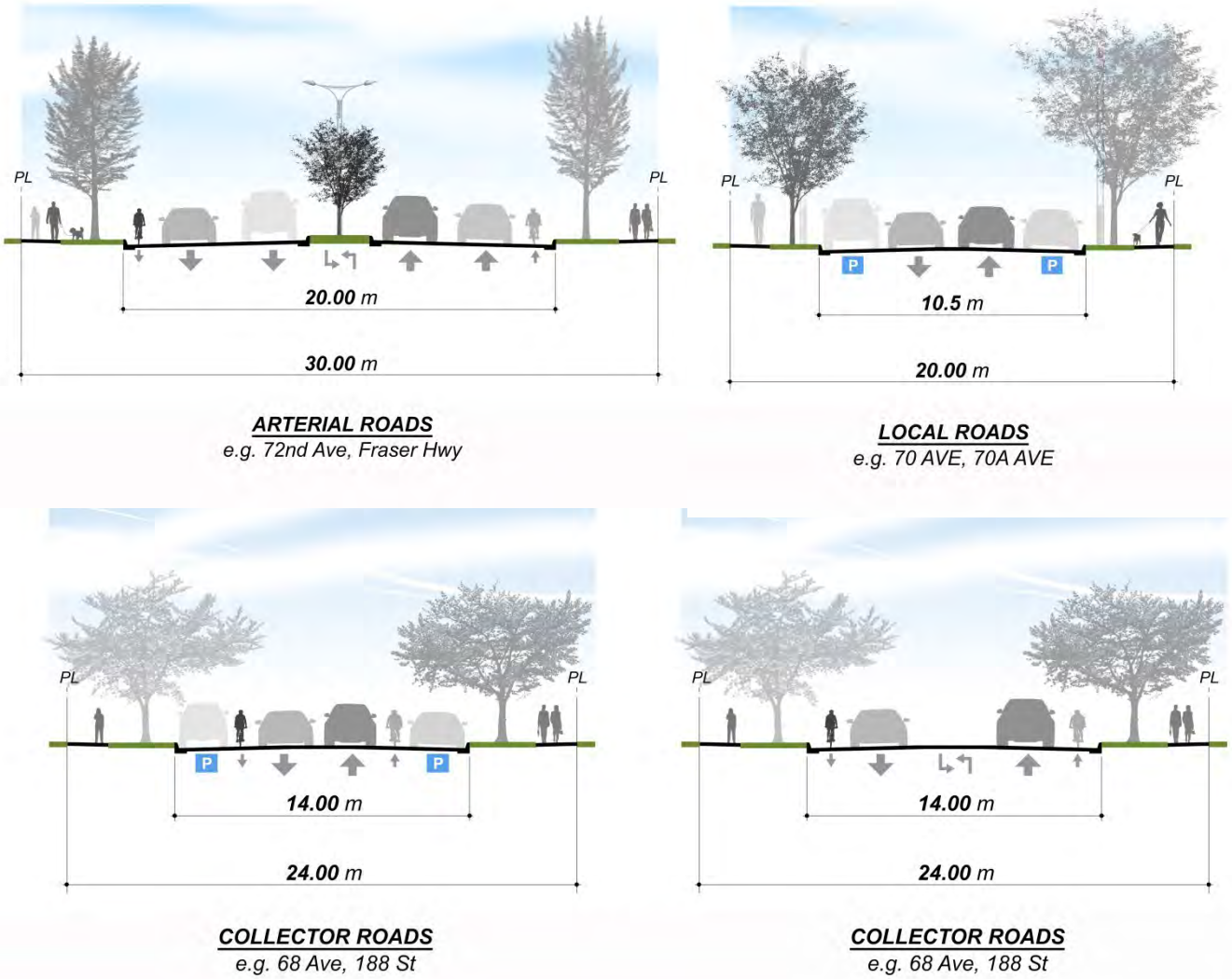


Figure 8.7 Typical RF-12 Lot with 10% Infiltration Footprint

8.3.5 Road Right-of-Way Stormwater Source Controls

The Clayton ISMP recommends the road right-of-ways have infiltration source controls with a contact area equal to 50% of the right-of-way. The City of Surrey should implement this requirement for arterial, collector, and local roads. Lanes should be exempt from the infiltration requirement due to the limited cross-sectional area. **Figure 8.8** shows the typical road cross sections in the NCP study area. BMPs are not shown on these figures; refer to **Figure 8.10** for a local road example with BMPs implemented.

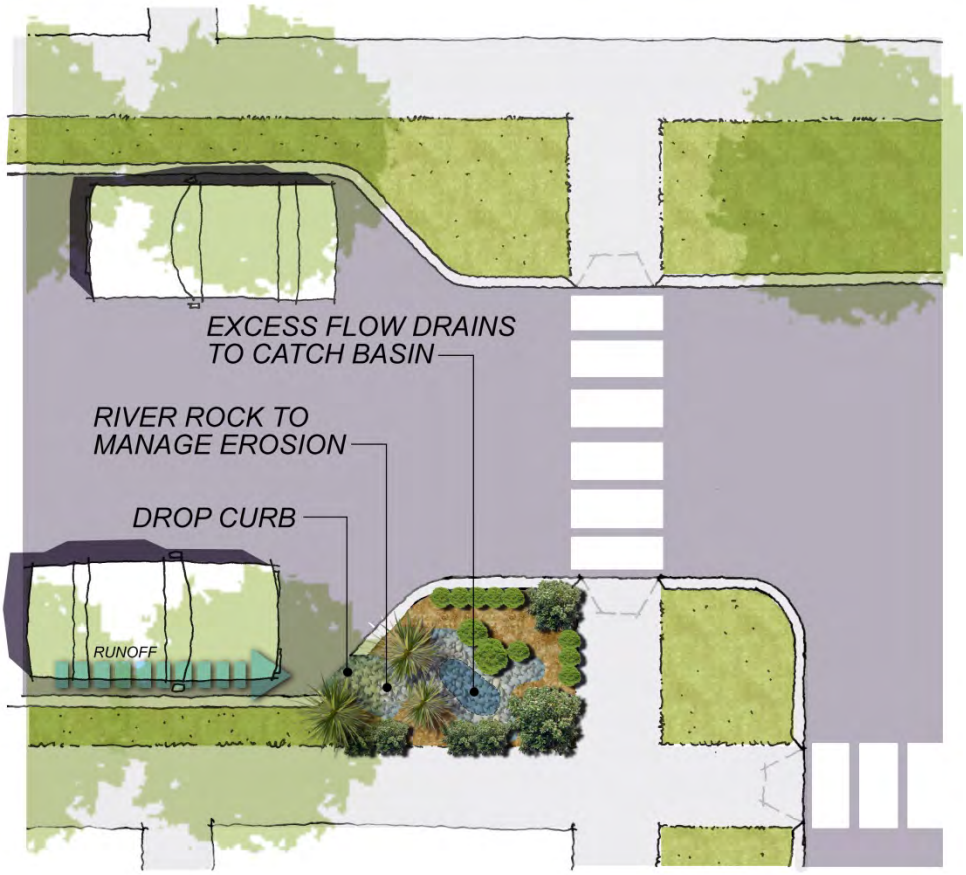
Figure 8.8 Typical West Clayton Road Cross Sections



With the implementation of porous sidewalks these road cross sections range from 33% pervious for an arterial road (with turning lane), to 48% pervious for a local road. To achieve the infiltration recommendation, some additional stormwater source controls will be required. The addition of a grassed boulevard with additional topsoil, or an infiltration swale would increase the pervious area sufficiently.

Where the cross section does not include a median, road surface drainage will need to be directed to a stormwater source control, such as a rain garden, tree planter, or catch basin draining to an infiltration trench. Where a parking lane ends, typically before an intersection, a bulge can be installed containing a rain garden with absorbent landscaping. Moving the road catch basin into the bulge would allow for road surface drainage to infiltrate, instead of draining to a storm sewer. Another strategy is to use parking lanes constructed of pervious pavers set above an infiltration trench.

Figure 8.9 Local Road Section with Rain Garden in Parking Lane Bulge



An example showing porous sidewalks and rain garden source control within a parking bulge is shown in **Figure 8.9** and a detailed figure showing the BMP cross section is shown in **Figure 8.10**.

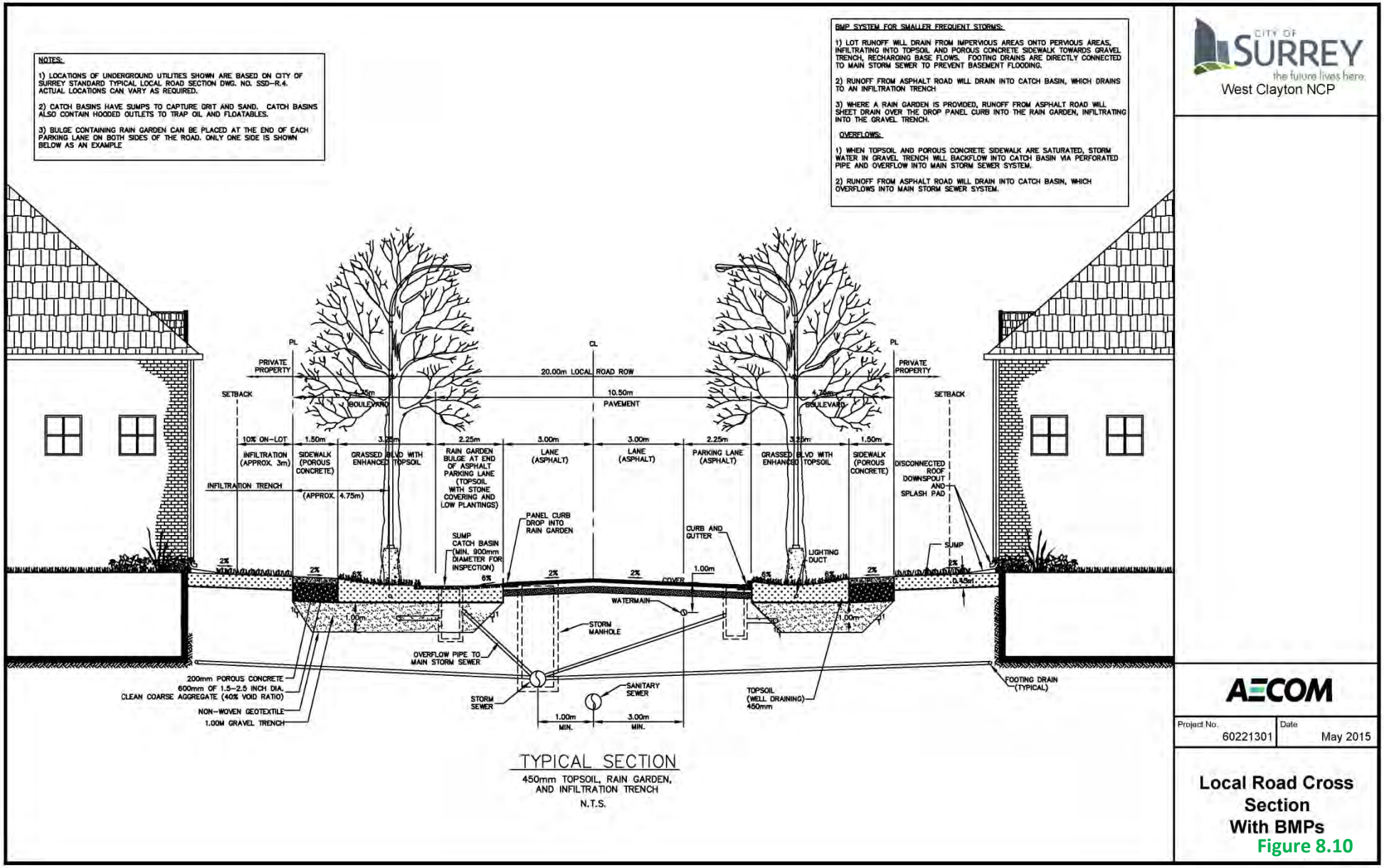


Figure 8.10 Local Road Cross Section with BMPs

Recommended Right-of-Way Source Controls

To achieve the recommended 50% infiltration area within the road right-of-way, the following stormwater source controls may be considered (subject to City approval):

- Grassed boulevards with additional topsoil and infiltration;
- Trees in boulevards;
- Catch basins draining to infiltration trenches;
- Rain gardens with panel curbs to accept road surface runoff (as required); and
- Porous sidewalks (pervious concrete or porous paving) (as required).

8.3.6 Source Control Operations & Maintenance

BMPs such as absorbent landscaping, infiltration trenches, porous sidewalks, and pervious pavement require specific operation and maintenance requirements in order to function properly. As such, it will be necessary to perform regular inspections and upkeep on BMPs. **Table 8.6** summarizes the key BMPs identified and the associated O & M plan for each.

Stormwater source controls rely on appropriate maintenance for performance and longevity. The lifespan of source controls will vary with the type, design, and maintenance provided. Absorbent landscaping and growing medium methods (topsoil) rely on living systems, which can be maintained indefinitely through proper care. This involves regular weeding, aeration, fertilizing of lawns and planters, and replacing dead plants. Infiltration systems must be kept clear of debris which can clog the system and reduce permeability. The primary sources of clogging are sediment and vegetative litter, the accumulation of which are site specific, therefore appropriate design will be crucial for longevity, followed by maintenance. Preventive maintenance involves regular inspection and clearing of debris, which has been shown to maintain and restore performance in many infiltration systems such as porous pavers and permeable concrete. Some loss of permeability can be expected but the proposed system will continue to function. Should the City determine that the permeability performance requires restoration in the future, US EPA studies suggest that rehabilitation costs can range from 15 to 20% of the initial cost.

Table 8.6 BMP Operation and Maintenance Schedule

BMP	Description	Maintenance Required When	Operation & Maintenance Action	Timeline
Infiltration Trench	Gravel-filled excavations that temporarily store stormwater and allow it to drain into underlying soil.	• Standing water is visible in the observation well for more than 48 hours after a rain event. • Insects and/or odour problems develop. • There is visible damage to the trench (e.g. sinkholes). • Trash, leaves, and other debris have collected on the surface. • Runoff is conveyed over and across the trench and not into the facility.	• Catch basins and inlets to be inspected and cleaned.	Annually
			• Ensure vehicles are not driven or parked on trench.	On-going
			• Avoid excessive compaction from equipment and mowers	On-going
			• Remove debris from surface to maintain proper function.	Quarterly
			• Repair any damages to trench.	As needed
			• Provide temporary diversions and ensure trench is protected from sediments during construction phase.	Construction Phase
			• Inspect cleanouts of perforated drains.	Quarterly
Pervious Pavers	Provide structure and stability while allowing runoff to infiltrate through to the ground surface.	• Significant amounts of sediment have accumulated between the pavers. • Ponding of water is visible on the surface 48 hours after a rain event.	• Surface sweeping to be completed with a commercial vacuum sweeping unit. Less frequent maintenance plan than porous paving due to application area (walk ways, parking lanes)	Annually
			• Inspection to check surface conditions to determine if any remedial work is needed.	Annually
Porous Paving	Diverts runoff through a porous asphalt or concrete layer and into an underground gravel trench, gradually infiltrating into the subsoil.	• Standing water is visible on the surface 48 hours after a rain event. • There is visible damage to the pavement (e.g. Sinkholes). • Dirt, debris, or vegetation is present on the surface.	• Avoid loading or placement of landscaping materials such as mulch, sand, or topsoil on porous paving.	On-going
			• Inspection of surface conditions to determine if there is uneven settling, water ponding, or potholes.	Bi-annually
			• Surface vacuuming with commercial vacuum sweeping unit or pressure washing of clogged surfaces.	Bi-annually
			• Restrict use of de-icing chemicals and sand on porous paving.	Winter periods
Absorbent Landscaping	Treats runoff by infiltration through soil. Provides detention, and reduces peak flows.	• Vegetation is wilting or dying. • Topsoil is exposed and/or being eroded.	• Inspections to ensure required depths have been constructed throughout the construction phase.	Construction Phase
			• Ensure areas of topsoil placement remain un-compacted during the construction phase.	Construction Phase
Detention Pond	Stormwater basins that include a permanent pool for water quality treatment and temporary runoff storage.	• Vegetation is wilting or dying. • Sediment accumulation is affecting hydraulic capacity. • Undesirable species of plants or insects are present.	• Inspect vegetation of pond to ensure healthy growth.	Quarterly
			• Inspection of any erosion, flow channelization, bank stability, or sediment/debris accumulation.	Quarterly
			• Pond to be drained and sediment to be removed from forebay.	Every 7 to 10 years

8.4 COSTS AND FINANCING

8.4.1 Stormwater Servicing Cost Estimate

The major drainage system encompasses creeks, ponds, collector ditches, culverts, and trunk sewers which service an area of 20 ha or larger. The minor drainage system includes minor ditches, water crossings, and storm sewers.

Table 8.7 summarizes Class 'D' cost estimates for the construction of the proposed stormwater trunk servicing strategy for the West Clayton NCP that are considered DCC eligible. This includes all drainage infrastructure (detention ponds, water quality upgrades, sewers, etc.) that serves an area equal to or greater than 20 ha in size.

The City of Surrey provided 2016 unit rates for storm sewers which are dependent on the existing road classification. To estimate cost of the detention pond costs, the City also provided land acquisition costs of $600,000 per acre ($1,482,600 per hectare) for Pond#1 and $465,000 per acre ($1,150,300 per hectare) for Pond#2.

8.4.2 BMP Cost Estimate

The Clayton ISMP established a BMP implementation plan to be carried out as part of the development process within the Clayton watershed. This BMP plan, in summary, includes:

- Each lot convey its runoff to infiltration devices with a minimum area equal to 10% of the lot area;
- The road right-of-way shall have infiltration devices with an area equal to 50% of the right-of-way;
- A minimum of 450mm of top soil is required on all pervious areas; and
- Stormwater detention facilities are to be constructed.

The Class 'D' cost estimate per unit lot (based on a standard small lot 12m x30m size) to construct these BMPs is estimated at $3,300 per lot. The cost was calculated as the difference between implementing BMPs and constructing traditional works. The estimate includes BMPs to be implemented within the road right-of-way as well as in the 10% lot frontage.

Figure 8.11 illustrates the proposed major drainage trunk system that is DCC eligible

Table 8.7 Stormwater Trunk Servicing Class 'D' Cost Estimate

Item No.	Description	Existing Road Class	Unit	Unit Price	Quantity	Cost
1	**Pond 1 Related Storm Sewers***					
1.01	Storm Sewer, 675mm dia.	Arterial	lin.m.	$2,475	411	$1,018,141
1.02	Storm Sewer, 750mm dia.	Arterial	lin.m.	$2,650	58	$152,773
1.03	Storm Sewer, 600mm dia.	Local	lin.m.	$1,611	534	$859,791
1.04	Storm Sewer, 675mm dia.	Local	lin.m.	$1,782	209	$372,046
1.05	Storm Sewer, 750mm dia.	Local	lin.m.	$1,908	360	$686,823
1.06	Storm Sewer, 1050mm dia.	Local	lin.m.	$2,439	623	$1,519,009
1.07	Storm Sewer, 1200mm dia.	Local	lin.m.	$2,925	42	$123,932
					Sub-Total =	**$4,732,514**
2	**Water Quality Infrastructure in Pond 1 Catchment Area**					
2.01	Diversion Structure c/w large Oil-Grit Separator		each	$92,000	1	$92,000
					12% Engineering and 15% Contingency	$24,840
					Sub-Total =	**$116,840**
3	**Detention Pond #1****					
3.01	Land Requirement		ha	$1,482,600	2.3	$3,409,980
3.02	Excavation Volume		cu.m.	$100	24,500	$2,450,000
					40% Engineering, Administration, and Contingency***	$980,000
					Sub-Total =	**$6,839,980**
4	**Pond 2 Related Storm Sewers***					
4.01	Storm Sewer, 675mm dia.	Arterial	lin.m.	$2,475	388	$960,201
4.02	Storm Sewer, 750mm dia.	Arterial	lin.m.	$2,650	347	$919,709
4.03	Storm Sewer, 900mm dia.	Arterial	lin.m.	$3,013	151	$455,159
4.04	Storm Sewer, 1200mm dia.	Arterial	lin.m.	$4,063	18	$71,500
4.05	Storm Sewer, 600mm dia.	Collector	lin.m.	$1,790	163	$291,233
4.06	Storm Sewer, 750mm dia.	Local	lin.m.	$1,908	117	$222,587
4.07	Storm Sewer, 900mm dia.	Local	lin.m.	$2,169	23	$48,954
4.08	Storm Sewer, 1050mm dia.	Local	lin.m.	$2,439	326	$794,846
					Sub-Total =	**$3,764,189**
5	**Water Quality Infrastructure in Pond 2 Catchment Area**					
5.01	Baseflow Diversion Structure c/w Oil-Grit Separator		each	$27,000	1	$27,000
					12% Engineering and 15% Contingency	$7,290
					Sub-Total =	**$34,290**
6	**Detention Pond #2****					
6.01	Land Requirement		ha	$1,150,300	1.5	$1,725,450
6.02	Excavation Volume		cu.m.	$100	14,200	$1,420,000
					40% Engineering, Administration, and Contingency***	$568,000
					Sub-Total =	**$3,713,450**
					TOTAL (excl. GST) =	**$19,201,263**

Notes:

*	= Unit prices for sewers based on the City's 2016 unit prices and include 12% engineering and 15% contingency allowances.
**	= Pipes are required for detention pond inlet and outlets.
***	= Higher engineering and contingency rate due to ponds having higher tender variation, landscaping and planting works.

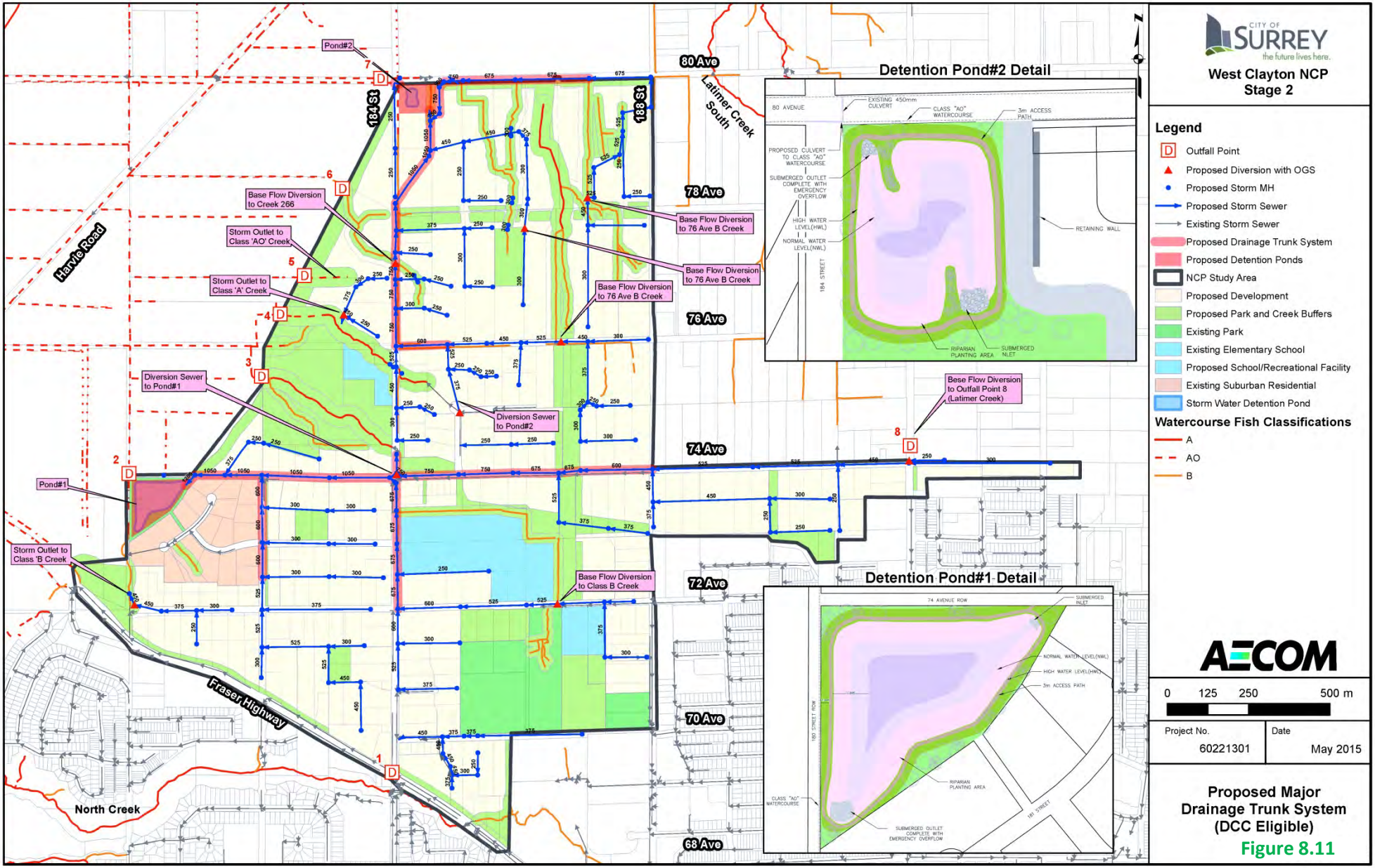


Figure 8.11 Proposed Major Drainage Trunk System (DCC Eligible)

SECTION 9
Sanitary Sewer

SECTION 9: Sanitary Sewer

9.1 EXISTING SEWER SERVICING

9.1.1 Existing Sewer System

The West Clayton neighbourhood area generally slopes to the northwest and there is no existing sanitary sewer infrastructure in this area to service the NCP. All of the existing lots are large / rural residential and are currently serviced by individual septic fields. The residential and commercial properties to the east (East Clayton) are serviced by the City's sewer system, but this system does not have the capacity to service the NCP area nor does the topography permit such a servicing strategy.

At present the City has limited sanitary sewer infrastructure in the adjacent area. The City's sanitary sewers closet to the NCP area are:

1. 1050mm diameter sanitary sewer on 177A Street alignment (south of Fraser Highway) at 72 Avenue;
2. 300mm sanitary sewer on 182 Street at south side of Fraser Highway; and
3. 300mm sanitary sewer on 184 Street, at 70 Avenue (north of Fraser Highway).

All of the City's existing sewer systems in this area drain into the City's North Cloverdale Lift Station at 176 Street (Highway 15) and 68A Avenue. The lift station pumps sewage south through 740m long - 350mm and 400mm diameter HDPE forcemains on 176 Street, which discharges to a City 600mm diameter PVC gravity trunk sewer at 65A Avenue and continues to flow south to Metro Vancouver's Cloverdale Trunk Sewer on 56 Avenue (Highway 10).

Figure 9.1 illustrates the City's existing sanitary sewer system in the West Clayton NCP area and downstream.

9.1.2 Previous Studies

Several background reports and studies on the City's sanitary sewer system have been completed for this area, and these studies have been reviewed to further understand the existing sewer system and potential servicing strategies that have already been evaluated. Background reports include:

- Dayton & Knight (2005) Cloverdale Trunk Sewer Conveyance Study
- Earth Tech (2007) 184 Street, North of Fraser Highway, Sanitary Servicing Study
- RF Binnie (2011) Preliminary Design of the City's North Cloverdale Trunk Sewer (178 Street / 72 Avenue to 188 Street).

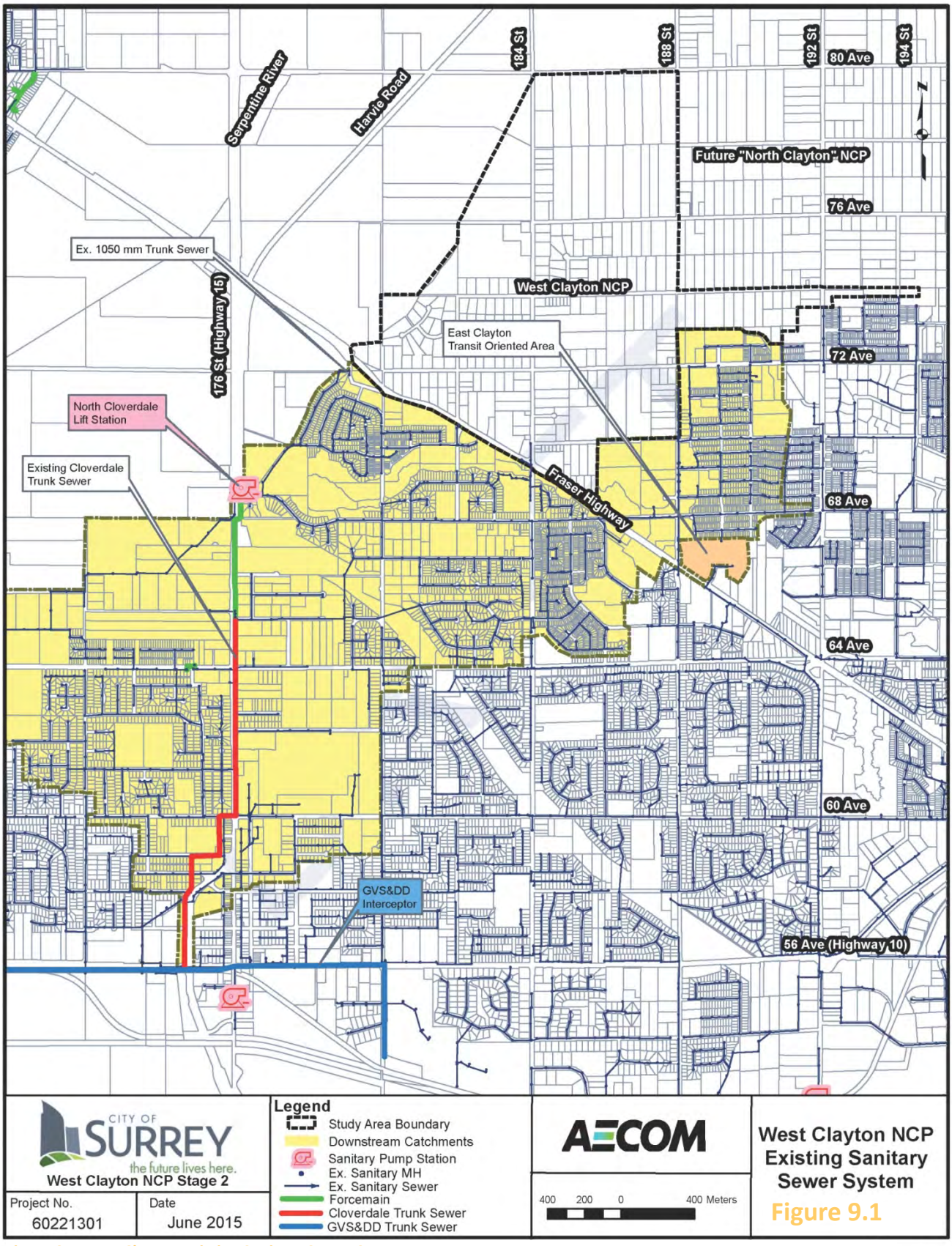


Figure 9.1 West Clayton Existing Sanitary Sewer System

Key recommendations from the previous studies are summarized below.

North Cloverdale Trunk Sewer – Cloverdale Trunk Sewer Conveyance Study, June 2005

The City had previously commissioned Dayton and Knight (D&K) to complete a sanitary servicing strategy for the North Cloverdale area, which encompasses West Clayton NCP and areas to the northeast. D&K evaluated potential servicing strategies for the area, including the assessment of the City's downstream North Cloverdale Lift Station and subsequent discharge infrastructure up to Metro Vancouver's Cloverdale Trunk Sewer (CTS).

The key recommendation from the D&K study was a North Cloverdale Trunk Sewer (NCTS) to service the Clayton / Cloverdale area. The sewer will extend from the existing 1050 mm diameter trunk sewer on 72 Avenue and 177A Street, across Fraser Highway and run along the toe of slope to the intersection of 188 Street and 80 Avenue. From there, lateral trunk sewers would extend to the upper reaches of the West Clayton NCP and future "Northern Clayton NCP" area. The previous D&K study also evaluated downstream servicing options as to whether the North Cloverdale Lift Station (NCLS) will require upsizing and forcemain twinning, or if the station could be removed and a deep trunk sewer installed on 176th Street from 69 Avenue to the Metro Vancouver's CTS on 56 Avenue.

In 2011 RF Binnie completed preliminary design of the City's NCTS (from 72 Avenue and 177A Street) to 188 Street and 80 Avenue. The primary objectives of the design were to: confirm trunk sewer alignment, sewer flows, trunk sizing based on topography, property requirements, environmental permits, risks and a more accurate cost estimate.

Fraser Highway and 184 Street Pocket

In 2007 the City had previously commissioned Earth Tech (now AECOM) to complete a sanitary servicing study of the area around 184 Street, north of Fraser Highway. Findings from the study concluded that the area around 184 Street and north of Fraser Highway (within the West Clayton NCP) could be serviced by either:

1. Gravity flow through lateral sewers in the NCP which will ultimately drain into the future North Cloverdale Trunk Sewer; OR
2. Gravity flow through the local sewer system that drains south across Fraser Highway and into the existing sewer system in Cloverdale.

The former servicing option was deemed more cost effective; however the latter approach (more costly) may be more favourable from a development timing approach, subject to the time of other pending developments in approved NCP's (i.e. East Clayton).

9.1.3 Future Servicing

To develop the sewer servicing strategy for the NCP area it is important to assess the NCP requirements as well as consider the long-term servicing plan for the existing surrounding area and future developments or NCP's that will contribute to the same downstream infrastructure, namely the North Cloverdale Lift Station and the City's Cloverdale Trunk Sewer. The overall servicing strategy prepared for the NCP takes into consideration the entire contributing area.

West Clayton NCP Area

The West Clayton NCP land use plan forms the basis of the engineering servicing analysis.

Future "North Clayton" NCP

The future North Clayton NCP is the 263 hectare area located east of 188 Street and north of 74 Avenue. The topography of the future NCP area ranges from 28m to 62m, and slopes downward in a northern direction. Most of the future NCP can be serviced, by gravity, by extending the NCTS east of 188 Street; while the remainder of the future NCP may require a small lift station to convey sewage up to the trunk sewer.

Population and catchment area estimates from the future "North Clayton" NCP should be incorporated into the peak flow estimates for the NCTS. Population estimates, sewage flow projections and the respective allocation of flows from the future NCP are discussed in further detail in Section 9.2.2.

Surrounding Cloverdale Area

As shown in **Figure 9.1**, the sewer infrastructure downstream of the NCP also conveys flows from existing areas of Cloverdale. As the existing area develops, re-develops and adds secondary suites to single-family properties there will be an increase in peak sewage flows and as such the capacity of the North Cloverdale Lift Station, forcemain, and downstream trunk sewer needs to service the ultimate demand conditions from the West Clayton NCP + future "North Clayton" NCP + build-out of the surrounding area. The future sanitary sewer flow projections for the surrounding Cloverdale area are discussed in Section 9.2.2.

9.2 DESIGN CRITERIA AND ANALYSIS

9.2.1 Design Criteria

The City of Surrey Design Criteria Manual has been used as the servicing criteria for the preparation of this NCP. Summarized below are the key sewer design criteria applicable to the NCP:

Sewage Flow Rates

- Average daily sanitary flows of 350 L/cap/day
- Peaking factor as per Harmon's formula
- Inflow and Infiltration (I&I) allowance rate of 11,200 L/ha/day

Sewer Capacity / Sizing

- Manning's "n" of 0.013 for all pipes (local and trunk);
- Sewers designed to convey Peak Wet Weather Flow (PWWF);
- Local Sewers are those with a PWWF ≤ 40 L/s, and peak flow depth shall not exceed 50% of internal diameter ($d_{peak}/d_{full} \leq 0.50$) which translates to a peak flow versus pipe capacity ratio of 50% ($Q_{peak}/Q_{full} < 0.50$)
- Trunk Sewers are those with a PWWF > 40 L/s, and peak flow depth shall not exceed 70% of internal diameter ($d_{peak}/d_{full} \leq 0.70$) which translates to a peak flow versus pipe capacity ratio of 83.5% ($Q_{peak}/Q_{full} \leq 0.835$)
- Pipe slopes should be greater than 0.5%, with exception to uppermost pipes which may require 0.6% to 1.0% slope;
- Pipe slopes may be less than 0.5% if a minimum velocity of 0.6 m/s at 70% of PDWF is achieved.

Low Pressure Sewers

- Q = 0.008xP + 2.10 where Q (flow) is expressed in L/s and P is population (per lot);
- Minimum velocity in LPS = 0.6 m/s
- Maximum Total Dynamic Head in LPS = 35 m

Lift Stations

- Pumps sized to convey PWWF at Total Dynamic Head (TDH) with a standby pump;
- Minimum pump efficiency of 70%
- Discharge forcemain Hazen Williams friction coefficient C=120, as well as design to ensure no pump over-runs with a C=140;
- Minimum forcemain velocity of 1.0 m/s and maximum of 2.4 m/s for short forcemains. Preferred maximum velocity is in the range of 1.5 – 1.8 m/s;

9.2.2 Population Projections

The West Clayton NCP will impact the downstream sewer system, and so will flows from the future "North Clayton" NCP and portions of Clayton-Cloverdale that are already serviced by the downstream sewer system. Three land-use horizon / population scenarios have been identified for further engineering analysis in order to determine the impact of the development of the West Clayton NCP on the downstream system, and develop a long-range servicing strategy that allows for future development plans. The three conditions can be summarized as:

1. **Committed Condition**: Existing Clayton – Cloverdale Area, downstream to 56 Avenue
2. **Interim Condition**: Existing Clayton – Cloverdale Area + West Clayton NCP.
3. **Long-Range Condition**: Existing Clayton – Cloverdale Area (including densification) + West Clayton NCP + North Clayton NCP

Described below are the assumptions used to estimate populations and peak sewage flows from the various areas, for these three (3) land-use horizons / conditions.

#1 Committed Condition: Existing Clayton – Cloverdale Area

The first condition represents the existing population scenario and was used to verify the capacity of the existing sewer system and potential excess capacity to service the NCP. The existing sewer system downstream of the NCP services areas of Cloverdale, between 74 Avenue and 56 Avenue, from 164 Street to 192 Street. The sewer system and catchment area downstream of the NCP is shown on **Figure 9.1**.

Populations for the existing serviced areas were generated based on the current zoning designations for parcels that have an existing sewer service. The City's *2004 Engineering Design Criteria Manual* has an estimated rate of 2.8 residents for single-family houses in Cloverdale, which has become an underestimate due to changing household demographics and the addition of secondary suites. From the City's Sanitary Sewer Model (AECOM 2010), actual densities for Single Family residences in Cloverdale were 3.44 people / unit, of which 12.5% had secondary suites with an additional unit rate of 1.76 people/suite. By the time the West Clayton NCP develops, it is predicted the population density will be 3 to 4% higher than existing; therefore a combined density of 3.77 people per single-family residence was used in the analysis of the committed condition. This density was derived through discussions with City Engineering and Planning and Development staff.

#2 Interim Condition: Existing Clayton – Cloverdale Area + West Clayton NCP

For this land-use condition / scenario, the population estimates for the existing serviced areas remained unchanged from Condition #1 noted above. However, sewage flows as the result of development of the West Clayton NCP area was included in this condition.

Peak sanitary flows for the West Clayton NCP land-use were generated using parcel size and zoning densities, with equivalent populations for commercial and institutional (IC) land uses, as outlined in *"Table 2.6 (b) of the City's Engineering Design Criteria Manual*".

The following summarizes the population densities used to estimate the populations within the West Clayton NCP:

- Single Family with Secondary Suite Density of 5.33 people per lot (3.56 people in main dwelling + 1.77 people in Suite);
- Single Family Household Size of 3.56 people per dwelling;
- Townhouse Household Size of 2.69 people per unit;
- Apartment Household Size of 1.43 people per unit;
- Commercial: 60 people / ha;
- Mixed use Commercial / Residential: 196 people / ha;
- Institutional (school and child care facilities): 50 people / ha; and,
- Recreational: 50 people / ha

The total population including secondary suites and institutional/commercial equivalent is 21,792 for the NCP area. This population and the NCP area is summarized in Table 9.1. The values shown in the table are rounded to the nearest whole number.

Table 9.1 – West Clayton NCP Population Summary

Area	Land-Use	Population Equiv.	Gross Land-Area (ha)	Average Density (people/gross area)
West Clayton NCP	Residential	20,379	125	163
	Institutional, Commercial	1,413	20	69
	Creeks, Parks, ALR buffers, Wildlife Corridors, Forest Preservation, and SWM Ponds	0	74	0
	Road ROWs (Approx.)	0	66	0
Total		**21,792**	**286**	**76**

#3 Long Range Condition: Existing Area + West Clayton NCP + North Clayton NCP + OCP

The long-range condition represents the build out of the OCP, or full saturation, condition, which includes development of the West Clayton and future "North Clayton" NCP areas. In addition, the OCP condition includes infill, re-development, densification and secondary suites for all single-family parcels amongst the existing service areas throughout Clayton-Cloverdale.

Future "North Clayton" NCP

It is anticipated that the land-use within the future "North Clayton" NCP will be very similar to that proposed for West Clayton NCP, and likewise similar to the East Clayton NCP area. To estimate the potential future population, and sewage flows, for the future "North Clayton" NCP the average population density of 100 people equivalents per gross land hectare was used (derived from West Clayton NCP with a 15% growth factor).

This approach is reasonable if the future "North Clayton" NCP has a similar percentage of land-area designated for parks, creeks, riparian areas and road right-of-ways. This approach also ensures that the future "North Clayton" NCP population allowance incorporates secondary suites for all single-family lots, with the assumption that the ratio of single family to multi-family population remains relatively similar to the West Clayton NCP.

The future "North Clayton" NCP was divided into three large catchment areas, for ease of assigning the sewage flow allowances into the West Clayton NCP servicing strategy at specific locations based on topography and probable servicing strategy. The locations of these three (3) "discharge points" from North Clayton into the West Clayton sewer network are shown graphically on Figure 9.2. Population estimates / allowances and the contributing catchment area(s) for the future "North Clayton" NCP, divided into each of the three large catchments, are summarized in Table 9.2.

Table 9.2 – Future "North Clayton" NCP Population Allowance

	Catchment Area Drains To "Node"	Average Density (people/gross area)	Gross Land-Area (ha)	Population Equivalent
Future "North Clayton" NCP	E06	100 people/ha	45.4	4,540
	J06	100 people/ha	13.4	1,340
	T50	100 people/ha	202.2	20,227
Total		100 people/ha	**261**	**26,107**

OCP Infill / Re-Development of Existing Areas

In the long-range, the existing serviced areas outside the NCP designated areas will likely re-develop to a slightly higher density, up to the maximum density permitted by the zoning bylaw. In addition, over the next 50+ years it is expected that all single-family dwellings will have secondary suites. Under this condition, the population and sewage flows from the existing serviced areas outside the NCP's was increased to account for secondary suites, development of vacant parcels and subdivision of residential parcels to the City's Zoning Bylaw.

9.2.3 Sanitary Servicing Strategy and Options

The preliminary design alignment (RF Binnie, 2011) for the City's NCTS was used as the base for the overall strategy to service the West Clayton NCP area by gravity flow for the majority of the area. The alignment was adjusted, based on the latest land use and road network layout layer provided by the City (December 2014), to follow the rights-of-way in areas that were not serviced by a road. Provision for future development northeast of the NCP area (east of 188 Street and north of 74 Avenue) was included in the servicing strategy for the NCP because once this area develops it will ultimately be serviced by the NCTS. For the area around Fraser Highway, from 184 Street to 186 Street, the potential exists to service portions of the NCP via existing sewers on the south side of Fraser Highway.

Figure 9.2 outlines the conceptual layout of the future NCTS along with the proposed sanitary sewer network through the NCP. This figure also shows the future "North Clayton" NCP area and how it can be serviced by the sewers within West Clayton, including where the allowance of additional flows from the future "North Clayton" NCP were allocated into the sanitary sewer analysis.

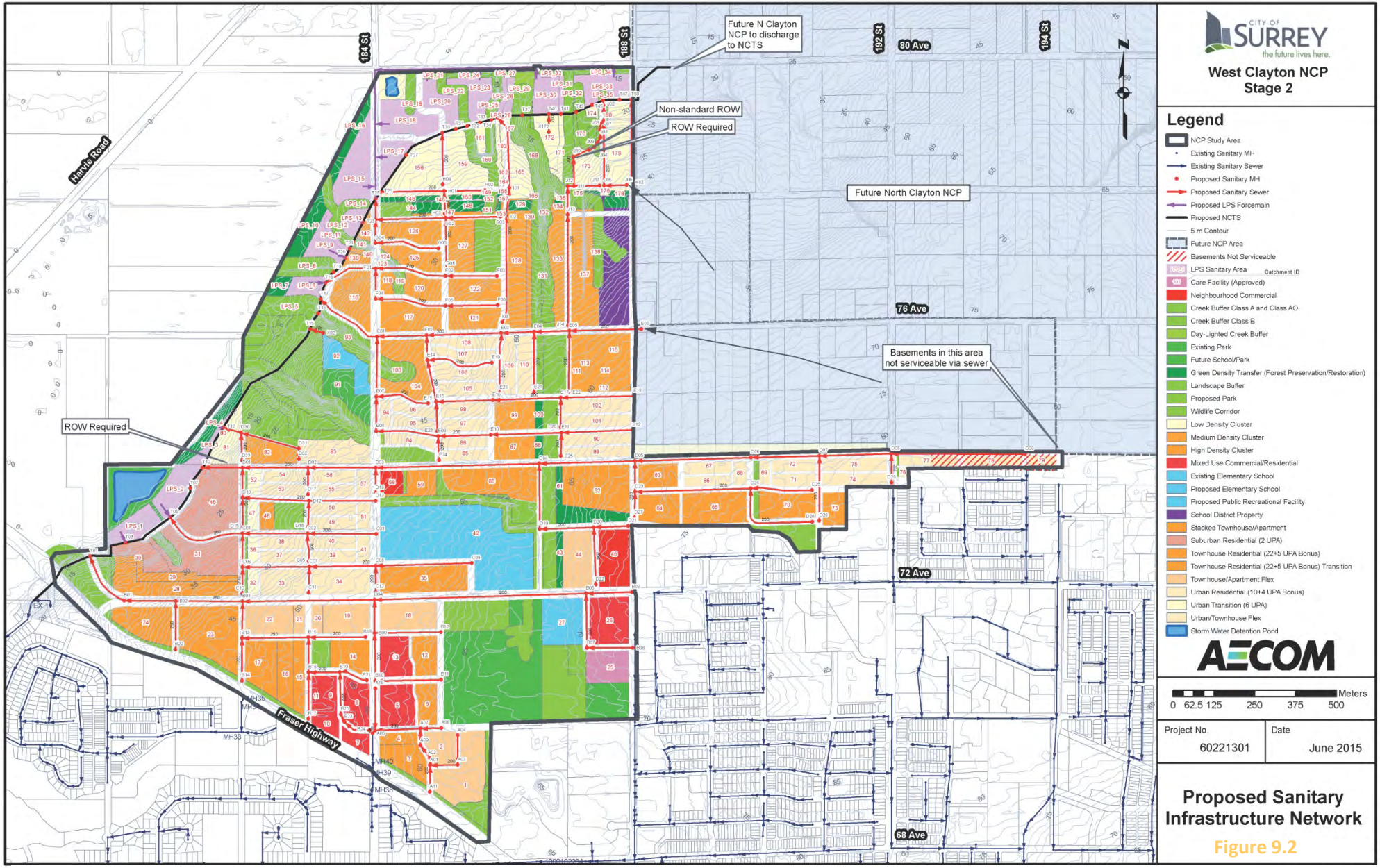


Figure 9.2 Proposed Sanitary Infrastructure Network

The elevation of the NCTS, and hence gravity servicing for the most of NCP, is governed by the invert elevation (6.15m geodetic) of the existing 1050mm diameter sanitary sewer near 177A Street and 72 Avenue alignment. From this invert the NCTS slopes upwards in a northeastern direction and the sewer alignment follows the 11m contour, eventually reaching an invert of 10m +/- at 184 Street and approximately 12m at 188 Street (NE edge of the NCP). In general, this means all properties above the 10 to 12m contour can be serviced by gravity whereas properties below the 10 to 12m contour will require a low-pressure sewer (pumped service).

NCP Area (Gravity Catchments)

For the NCP, the sewer connections from the development to the NCTS have been concentrated at a number of locations to minimize the number of direct connections into the trunk sewer. The location of each connection is determined based on the topography and proposed road network, and the goal of maximizing the extent of the upstream catchment area that can be serviced by a gravity sewer without any right-of-way being required. However, there are a few catchment areas (161, 171, 172 and 174) located north of 78 Avenue as shown on **Figure 9.2** that do not have a right-of-way or road/lane access. These areas adjacent to the NCTS can drain by gravity to the trunk sewer area assuming that a right-of-way is established or a private tie-in is allowed.

These local sewers follow the road network developed as part of the land use plan. In the vicinity of 72 Avenue the NCTS crosses the existing residential parcels and as such a right-of-way will be required before the NCTS can be extended east to service the NCP.

NCP Area (Non-Gravity Catchments)

Properties north/northwest of the NCTS alignment are below the invert of the proposed trunk sewer and will require pumping into the NCTS for servicing. As shown on the NCP land use plan, the northwestern portion of the NCP, at the toe of the slope / lowlands, is identified as low-density residential parcels transected by a series of creeks and riparian setbacks – this land-use establishes a buffer between the NCP and ALR. Because of the low density and segregated nature of the parcels due to creeks, the most cost effective servicing strategy for these low lying areas would be a low pressure sewer (LPS) where each property has their own private sewage pump rather than multiple larger, municipal pump stations.

The LPS system operates with individual private pumps discharging into a common City forcemain, which then connects into the NCTS. The servicing objective includes minimizing the number of LPS forcemains and direct connections to the trunk sewer, for odour control and operation/maintenance reasons.

Figure 9.2 also illustrates the areas that are identified to be serviced via a LPS system. The area around 80 Avenue and 184 Street can be serviced by a common forcemain on these fronting roads, whereas the other small LPS pockets may require a few different, short length, municipal forcemains.

182 Street – 186 Street and Fraser Highway Pocket

For the NCP pocket area north of Fraser Highway, between 182 Street and 186 Street, the previous Earth Tech strategy was re-evaluated in consultation with City Engineering Staff and with consideration of pending development applications in approved NCP's. The long term strategy for this area is recommended to flow westerly to the NCTS trunk sewer (as shown on **Figure 9.2**) except for a portion (sanitary catchments 1 to 5) between 184 Street and 186 Street that will flow south via gravity flow in the sanitary sewer along 184 Street.

74 Avenue, between 188 Street and 194 Street

The area along 74 Avenue, west of 192 Street, slopes westerly towards the center of the West Clayton NCP. However, the segment of 74 Avenue between 192 Street and 194 Street is flat and generally slopes north and northwest towards the future "North Clayton" NCP area.

At the present time, the NCP area includes the fronting properties along the south side of 74 Avenue but not those on the north side that are also fronting 74 Avenue. For the purposes of the servicing strategy, the catchment area contributing to a future sewer on 74 Avenue will likely include the properties fronting 74 Avenue, from the south, and a small portion of those on the north side which would be the immediate fronting parcels once the properties subdivide. Refer to **Figure 9.2** for an illustration of the catchment area extents for the portion of the lots on the north side of 74 Avenue that were assumed will be ultimately connected to the 74 Avenue sewer.

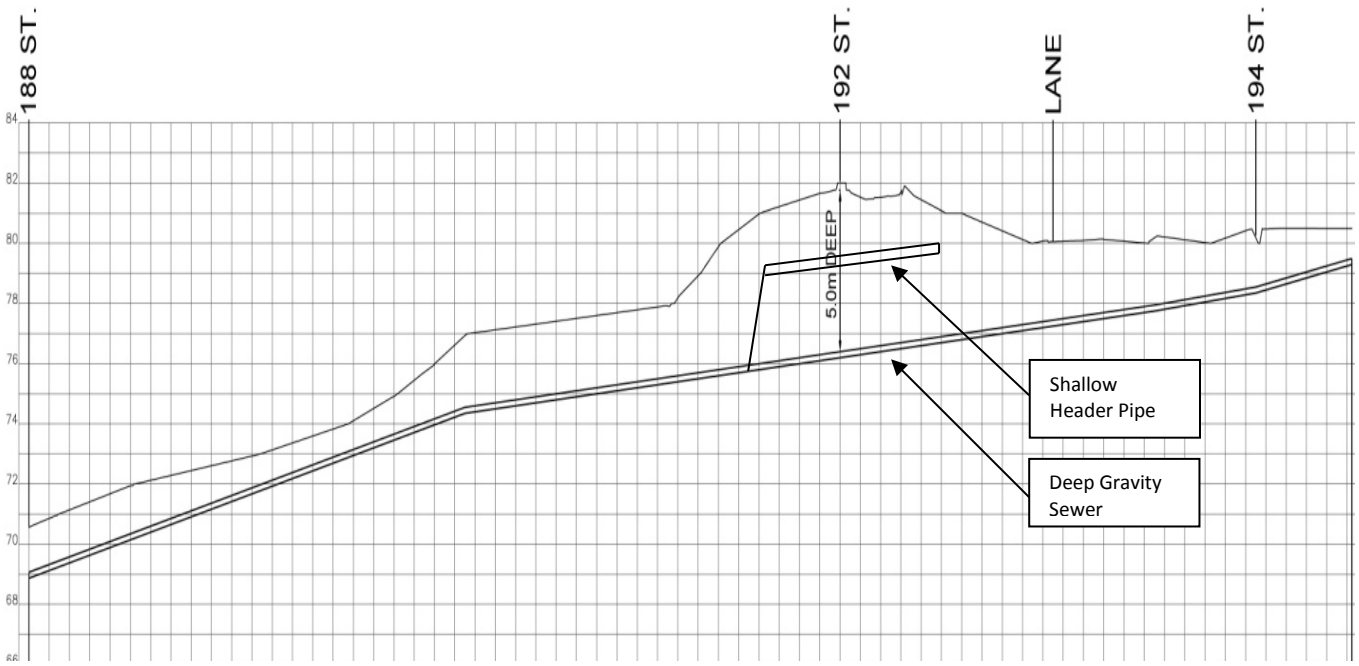
Upon a preliminary review of the topography along the 74 Avenue alignment, the potential exists to service the area east of 192 Street through the NCP via a deep sanitary sewer. A 250mm gravity sewer draining west along 74 Avenue, starting east of 194 Street and sloping at minimal grade until west of 192 Street. As per the City's Engineering Design Criteria:

- The terminal section of sewer servicing 6 houses or less shall be at 1.0%;
- The sewer between the 7th and 12th house connection can be at 0.6%;
- Minimum slope, for sewers with more than 12 connections, shall be 0.5%;

If the area east of 19350 block is developed for "slab on grade" houses, the sanitary sewer would start at a depth of 1m and result in maximum depths of 4 – 5m over a 300m length. This is still above the City's design criteria however local re-grading around 192 Street at the time of development could result in this depth being reduced further to 3.5 to 4m range.

Figure 9.3 illustrates the potential sewer profile along 74 Avenue, between 188 Street and the 19450 block, for this recommended strategy. Upon review of a detailed topographic survey of the area, if the sewer segment along 74 Avenue does exceed the 3.5m depth for an extended length, a second sewer at a shallower depth ("header pipe") may be required to reduce the depth of service connections to the lots fronting the deep sewer segment.

Figure 9.3 – Potential Sewer Profile along 74 Avenue



If the area east of 19350 block desired below-grade basement suites it would require a sewer depth of 2.4m at 194 Street which translates to a depth of 6 to 7m (using the above design criteria) along 74 Avenue, for a 300m long segment. Even with local re-grading, within maximum limits authorized by the City, the sewer depth would be well beyond the City's design criteria maximum depth of 3.5m and over a considerable length; as a result servicing basements by gravity is not a viable option for the properties east of 19350 block. **Figure 9.2** highlights those properties along 74 Avenue which below-ground basements cannot be achieved, subject to confirmation with a detailed topographic survey.

As an alternate approach, if the extension area east of 19350 block prefers to develop with below-grade basement suites then it would require servicing to the north through the future "North Clayton" NCP.

Future "North Clayton NCP"

For the future "North Clayton NCP" (north of 74 Avenue and east of 188 Street), it is unknown at this time when the area will develop. The NCTS sizing and preliminary design is based on flow contribution from this future NCP. **Figure 9.2** illustrates the anticipated servicing locations for the future "North Clayton" NCP, as discussed previously in Section 9.2.2.

East Clayton Transit Oriented Area

A part of East Clayton along the north side of Fraser Highway between 188 Street and proposed 192 Street Diversion is planned as a transit oriented area with land uses allowing for higher densities; a total population of 2,626 is estimated for this area. The sanitary catchment area is divided into three outlets: west to188 Street, southeast to 192 Street and east to 65 Avenue. Only the catchment area (estimated

population of 1,110) with the outlet to the west along the sanitary sewer on 188 Street will contribute flow the NCLS. A sanitary flow of 17.85 L/s, estimated by others were provided by the City for inclusion into the model. Due to the location of this area with respect to the NCLS, the peaking factor would be lower than the value of 3.77 as calculated for the local sewer; the peaking factor is calculated at 2.17. The peak wet weather flow from this area expected at the NCLS is 10.7 L/s. The portion of the transit oriented area that contributes flow into the NCLS is shown in Figure 9.1.

9.2.4 Hydraulic Analysis within the NCP

Peak flow rates from the West Clayton NCP were generated using the Harmon Peaking Factor and spreadsheet based approach, and then used to size the sewer infrastructure. Lengths for the sewer system were estimated using GIS and the latest land-use plan. The City's 1m contours of the ground elevations were used to estimate pipe invert elevations, and subsequently the pipe slopes. For the NCTS, the pipe diameters and slopes from the RF Binnie preliminary design drawings were used and confirmed through the hydraulic analysis.

Table 9.3 summarizes the estimated populations, peak wet weather flows (PWWF's) and proposed sewer sizes for the proposed servicing strategy for the sewers within the NCP. Flow rate calculations for LPS properties are based on the City's design criteria, which represents a constant peak pumping rate that incorporates I&I allowance.

Table 9.4 summarizes the estimated peak wet weather flows (PWWF's) and sewer sizes for the proposed North Cloverdale Trunk Sewer as it parallels the NCP.

9.2.5 Analysis of Downstream Sewer System

As shown in Figure 9.2, sewage flows from the NCP Areas will enter the City's existing sewer system at the 1050mm diameter trunk sanitary sewer on 72 Avenue alignment (south of Fraser Highway) at 177A Street. From this location, sewage flows will be conveyed through the City's existing sewer system to the City's NCLS, from where the sewage is pumped via twin 350mm and 400mm diameter forcemains into a 600 mm diameter, gravity trunk sewer near 65A Avenue and continues to Metro Vancouver's Cloverdale Trunk Sewer (refer to Figure 9.1). A pocket of catchments (1 to 5) north of Fraser Highway between 184 Street and 188 Street will be conveyed through the existing sewer on 184 Street to the NCLS.

The West Clayton NCP will increase peak flows through the City's sewer system. An analysis of the downstream sewer system (refer to Figure 9.1) was completed utilizing peak flows generated from the NCP (Tables 9.3 and 9.4) coupled with the City's recently developed InfoSWMM hydraulic computer model of the downstream sewer system and flows from Clayton-Cloverdale. The InfoSWMM sewer model includes a pipe-by-pipe computer model of the City's sewer system and it includes flows rates from all properties, on a lot-by-lot basis / allocation.

Figure 9.4 illustrates the estimated PWWF's in the downstream sewer system for the "Committed Condition". This figures depicts the peak flow and pipe capacity, and is colour coded based on the d/D ratio. As shown on this figure, there is only 96m of downstream sewer segments which do not currently achieve the desired d/D ratio. The sewer segments are mainly a short section of 750mm sewer on 60 Avenue, immediately west of 176 Street. The NCLS will need to be upgraded to convey a design flow of 202 L/s.

Figure 9.5 illustrates the estimated PWWF's in the downstream sewer system for the "Interim Condition" with the – which represents peak flows from current service parcels plus the addition of the West Clayton NCP. As shown on this figure, there is 1.6 km of sewer segments that do not meet the City's design criteria for peak flows / depths. The NCLS will also need to be upgraded to convey a design flow of 460 L/s for this scenario.

Figure 9.6 illustrates the estimated PWWF's in the downstream sewer system for the "Long Range Condition" – which represents peak flows from OCP build-out plus the addition of the West Clayton and future "North Clayton" NCP's. As shown on this figure, there is 2.1 km of sewer segments that do not meet the City's design criteria for peak flows / depths – all of which are on the Cloverdale Trunk Sewer downstream of the lift station forcemain discharge. The NCLS will need to be upgraded to convey the ultimate design flow of 735 L/s.

Table 9.5 summarizes the downstream sewers that have been identified as not being able to achieve the City's design criteria for any of the above three land-use horizons/conditions.

Table 9.3 West Clayton Sewer Flows and Sizing Range for Long Range Condition

Locations			Subcatchments										Pipe Parameters					
Node No.		Pipe	Branch	Eq. Pop. Density	Area	Accum. Area	Popln	Accum. Popln	Average Flow	Peak Factor	Peak dry Weather Flow	Inflow & Infiltration	Peak Wet Weather Flow	Length	Diameter	Slope	Pipe Capacity	Flow Ratio	Actual Flow Velocity
From	To	ID	Branch	PopDens	A	A	Pop	Pop	ADWF	F_p	PDWF	$Q_{I\&I}$	Q_{WWF}	L	D	S	Q_{cap}	Q_{WWF}/Q_{cap}	V_{act}
MH	MH	ID		(pop/ha)	(Ha)				(L/s)		(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(L/s)	%	(m/s)
A04	A03	117		299.1	1.95	1.9	583	583	2.4	3.9	9.3	0.3	9.6	90	200	1.02%	33	29%	0.9
A03	A01	118				1.9		583	2.4	3.9	9.3	0.3	9.6	85	200	5.05%	74	13%	1.7
A11	A01	144		299.1	0.50	2.4	150	150	0.6	4.2	2.5	0.3	2.9	81	200	1.23%	36	8%	0.7
A01	A02	143		166.2	1.12	3.6	186	919	3.7	3.8	14.2	0.5	14.7	22	200	1.35%	38	39%	1.1
A02	A09	119				3.6		919	3.7	3.8	14.2	0.5	14.7	49	200	1.03%	33	44%	1.0
A09	A07	122		299.1	0.86	4.4	257	1,175	4.8	3.8	17.9	0.6	18.4	52	200	1.35%	38	48%	1.2
A08	A07	121				0.0		0	0.0	4.5	0.0	0.0	0.0	64	200	8.38%	95	0%	0.7
A07	A06	41		166.2	0.43	4.9	71	1,246	5.0	3.7	18.9	0.6	19.5	139	200	2.01%	47	42%	1.4
A10	A06	44		294.0	1.37	1.4	402	402	1.6	4.0	6.5	0.2	6.7	128	200	1.17%	35	19%	0.9
A06	A05	43				6.2		1,648	6.7	3.6	24.4	0.8	25.2	11	200	4.02%	66	38%	1.9
B06	B05	59		50.4	0.13	0.1	7	7	0.0	4.4	0.1	0.0	0.1	141	200	4.68%	71	0%	0.6
B08	B07	61		50.0	1.17	1.2	58	58	0.2	4.3	1.0	0.2	1.2	141	200	1.93%	46	3%	0.6
B07	B05	62		254.8	1.75	2.9	446	504	2.0	4.0	8.1	0.4	8.5	167	200	1.14%	35	24%	0.9
B05	B04	60		50.0	1.80	4.8	90	600	2.4	3.9	9.6	0.6	10.2	649	200	2.07%	47	22%	1.2
B11	B10	40		206.7	0.79	0.8	163	163	0.7	4.2	2.8	0.1	2.9	201	200	3.16%	58	5%	0.9
B10	B09	42		294.0	1.16	1.9	341	504	2.0	4.0	8.1	0.3	8.4	148	200	0.61%	26	33%	0.7
B12	B09	36		206.7	0.91	0.9	187	187	0.8	4.2	3.2	0.1	3.3	203	200	2.44%	51	6%	0.9
B09	B04	35		299.1	1.45	4.3	435	1,126	4.6	3.8	17.2	0.6	17.7	101	250	0.59%	46	39%	0.9
B04	B03	7		299.1	1.32	10.5	394	2,121	8.6	3.6	30.6	1.4	32.0	405	250	2.85%	100	32%	1.8
B21	B19	45		294.0	1.09	1.1	321	321	1.3	4.1	5.3	0.1	5.4	89	200	3.06%	57	9%	1.2
B24	B23	114		294.0	0.44	0.4	129	129	0.5	4.2	2.2	0.1	2.3	86	200	1.00%	33	7%	0.6
B23	B20	142				0.4		129	0.5	4.2	2.2	0.1	2.3	26	200	1.36%	38	6%	0.7
B20	B19	116		294.0	0.53	1.0	155	284	1.2	4.1	4.7	0.1	4.8	129	200	1.09%	34	14%	0.8
B19	B16	46				2.1		605	2.5	3.9	9.6	0.3	9.9	96	200	1.41%	39	25%	1.0
B17	B16	38		294.0	0.84	0.8	247	247	1.0	4.1	4.1	0.1	4.2	143	200	0.80%	29	14%	0.7
B16	B15	39				2.9		852	3.5	3.8	13.3	0.4	13.6	107	250	0.51%	43	32%	0.8
B18	B15	37		206.7	1.14	1.1	235	235	1.0	4.1	3.9	0.1	4.1	175	200	1.68%	43	10%	0.9
B15	B13	34		200.5	2.41	6.4	483	1,570	6.4	3.7	23.3	0.8	24.2	204	250	2.24%	89	27%	1.5
B14	B13	32		166.2	1.47	1.5	245	245	1.0	4.1	4.1	0.2	4.3	130	200	2.14%	48	9%	1.0
B13	B03	33		299.1	1.31	9.2	393	2,208	8.9	3.6	31.8	1.2	33.0	113	250	2.73%	98	34%	1.8
B03	B02	30		166.2	2.62	13.3	435	4,764	19.3	3.3	63.0	1.7	64.7	205	250	4.17%	121	53%	2.5
B22	B02	31		166.2	3.03	3.0	503	503	2.0	4.0	8.1	0.4	8.5	149	200	3.42%	61	14%	1.4
B02	B01	29		166.2	1.62	18.0	269	5,536	22.4	3.2	71.8	2.3	74.2	158	250	5.32%	137	54%	2.8
B01	T01	28	B			18.0		5,536	22.4	3.2	71.8	2.3	74.2	178	250	9.53%	184	40%	3.5
C03	C02	12		184.4	0.83	0.8	153	153	0.6	4.2	2.6	0.1	2.7	210	200	3.59%	62	4%	1.0
C05	C02	127		184.4	0.49	0.5	91	91	0.4	4.3	1.6	0.1	1.6	86	200	3.16%	58	3%	0.8
C02	C01	13		184.4	1.03	2.4	189	434	1.8	4.0	7.0	0.3	7.3	200	200	4.82%	72	10%	1.5
C09	C08	8		50.0	8.61	8.6	431	431	1.7	4.0	7.0	1.1	8.1	295	200	2.37%	50	16%	1.2
C12	C08	126		166.2	2.17	2.2	361	361	1.5	4.0	5.9	0.3	6.2	81	200	2.11%	48	13%	1.1
C08	C07	9				10.8		792	3.2	3.9	12.4	1.4	13.8	203	200	3.62%	62	22%	1.6
C11	C07	125		184.4	1.38	1.4	254	254	1.0	4.1	4.2	0.2	4.4	80	200	5.42%	76	6%	1.3
C07	C06	10		184.4	1.09	13.2	200	1,246	5.0	3.7	18.9	1.7	20.6	205	250	4.44%	125	16%	1.9
C10	C06	124		49.1	0.27	0.3	13	13	0.1	4.4	0.2	0.0	0.3	81	200	5.34%	76	0%	0.6
C06	C01	11		49.1	0.27	13.8	13	1,272	5.2	3.7	19.2	1.8	21.0	103	250	4.19%	122	17%	1.9
C01	T05	27	C	26.3	2.39	18.5	63	1,769	7.2	3.6	26.0	2.4	28.4	255	250	8.18%	170	17%	2.6
D32	D31	138		93.1	1.55	1.6	144	144	0.6	4.2	2.5	0.2	2.7	32	200	8.69%	97	3%	1.2
D31	D30	139				1.6		144	0.6	4.2	2.5	0.2	2.7	184	200	7.06%	87	3%	1.2
D33	D30	140		158.0	1.07	1.1	170	170	0.7	4.2	2.9	0.1	3.0	86	200	8.21%	94	3%	1.3
D30	T12	141	D2			2.6		314	1.3	4.1	5.2	0.3	5.5	57	200	11.21%	110	5%	1.8

Table 9.3 West Clayton Sewer Flows and Sizing Range for Long Range Condition

Locations			Subcatchments										Pipe Parameters					
Node No.		Pipe	Branch	Eq. Pop. Density	Area	Accum. Area	Popl'n	Accum. Popl'n	Average Flow	Peak Factor	Peak dry Weather Flow	Inflow & Infiltration	Peak Wet Weather Flow	Length	Diameter	Slope	Pipe Capacity	Flow Ratio	Actual Flow Velocity
From	To	ID	Branch	PopDens	A	ΣA	Pop	ΣPop	ADWF	F_p	PDWF	$Q_{I\&I}$	Q_{DF}	L	D	S	Q_{cap}	Q_{DF}/Q_{cap}	V_{act}
MH	MH	ID		(pop/ha)	(Ha)				(L/s)		(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(L/s)	%	(m/s)
D09	D08	1		93.1	1.29	1.3	121	121	0.5	4.2	2.1	0.2	2.2	411	200	1.00%	33	7%	0.6
D29	D08	102		93.1	0.12	0.1	11	11	0.0	4.4	0.2	0.0	0.2	88	200	5.16%	74	0%	0.6
D08	D07	2		93.1	0.81	2.2	75	206	0.8	4.1	3.5	0.3	3.8	221	200	0.60%	25	15%	0.6
D28	D07	50		130.1	1.47	1.5	191	191	0.8	4.2	3.2	0.2	3.4	199	200	2.37%	51	7%	0.9
D07	D06	3		93.1	0.74	4.4	69	466	1.9	4.0	7.5	0.6	8.1	210	200	0.56%	25	33%	0.7
D06	D05	4		93.1	1.26	5.7	117	583	2.4	3.9	9.3	0.7	10.0	356	200	0.97%	32	31%	0.9
D25	D24	51		93.1	0.54	0.5	50	50	0.2	4.3	0.9	0.1	0.9	189	200	2.73%	54	2%	0.6
D26	D24	101		166.2	1.38	1.4	229	229	0.9	4.1	3.8	0.2	4.0	287	200	1.64%	42	10%	0.9
D24	D23	52		166.2	1.90	3.8	316	595	2.4	3.9	9.5	0.5	10.0	355	200	0.85%	30	33%	0.8
D27	D23	58		166.2	1.13	1.1	188	188	0.8	4.2	3.2	0.1	3.3	79	200	0.72%	28	12%	0.6
D23	D05	53		166.2	0.89	5.8	148	931	3.8	3.8	14.4	0.8	15.2	94	200	1.10%	34	44%	1.1
D05	D04	5		166.2	3.45	15.0	573	2,087	8.5	3.6	30.2	1.9	32.1	294	200	3.84%	64	50%	2.0
D22	D20	54		60.0	1.89	1.9	113	113	0.5	4.2	1.9	0.2	2.2	211	200	1.30%	37	6%	0.6
D20	D19	56		266.5	2.27	4.2	604	717	2.9	3.9	11.3	0.5	11.8	150	200	4.42%	69	17%	1.7
D19	D04	57				4.2		717	2.9	3.9	11.3	0.5	11.8	148	200	1.19%	36	33%	1.0
D04	D03	6		166.2	3.19	22.3	531	3,336	13.5	3.4	46.0	2.9	48.9	502	200	3.88%	65	76%	2.2
D18	D03	17		60.0	0.50	0.5	30	30	0.1	4.4	0.5	0.1	0.6	77	200	6.49%	84	1%	0.7
D03	D02	19		93.1	0.82	23.6	77	3,442	13.9	3.4	47.3	3.1	50.4	207	250	2.67%	97	52%	2.0
D17	D02	132		93.1	0.50	0.5	47	47	0.2	4.3	0.8	0.1	0.9	82	200	3.24%	59	1%	0.6
D02	D01	18		93.1	0.94	25.1	88	3,577	14.5	3.4	48.9	3.3	52.2	201	250	5.81%	143	36%	2.6
D15	D10	131		49.1	0.27	0.3	13	13	0.1	4.4	0.2	0.0	0.3	89	200	4.44%	69	0%	0.6
D13	D12	14		93.1	0.80	0.8	75	75	0.3	4.3	1.3	0.1	1.4	205	200	4.00%	66	2%	0.8
D16	D12	129		93.1	0.54	0.5	50	50	0.2	4.3	0.9	0.1	0.9	79	200	4.04%	66	1%	0.7
D12	D10	15		166.2	0.41	1.7	67	192	0.8	4.2	3.2	0.2	3.5	203	200	5.40%	76	5%	1.2
D10	D01	16		49.1	0.29	2.3	14	219	0.9	4.1	3.7	0.3	4.0	92	200	4.62%	70	6%	1.2
D01	T10	26	D1			27.4		3,797	15.4	3.4	51.6	3.6	55.1	123	250	10.82%	196	28%	3.4
			N Clayton	100.0	45.40	45.4	4,540	4,540	18.4	3.3	60.4	5.9	66.3						
E06	E05	47		131.5	2.42	47.8	319	4,859	19.7	3.3	64.1	6.2	70.3	220	250	3.44%	110	64%	2.4
E22	E05	70		158.0	0.82	0.8	130	130	0.5	4.2	2.2	0.1	2.3	187	200	3.66%	63	4%	0.9
E05	E04	68				48.6		4,988	20.2	3.2	65.6	6.3	71.9	108	300	2.01%	137	53%	2.0
E21	E04	69		93.1	0.77	0.8	72	72	0.3	4.3	1.2	0.1	1.3	185	200	3.70%	63	2%	0.7
E04	E03	67				49.4		5,060	20.5	3.2	66.4	6.4	72.8	101	300	1.37%	113	64%	1.7
E20	E03	66		93.1	0.70	0.7	65	65	0.3	4.3	1.1	0.1	1.2	184	200	1.87%	45	3%	0.6
E03	E02	48		93.1	0.61	50.7	57	5,182	21.0	3.2	67.8	6.6	74.4	229	300	5.53%	227	33%	2.8
E18	E17	63		93.1	0.89	0.9	83	83	0.3	4.3	1.4	0.1	1.5	224	200	2.94%	56	3%	0.7
E26	E17	136		93.1	0.77	0.8	72	72	0.3	4.3	1.2	0.1	1.3	91	200	1.75%	43	3%	0.6
E17	E16	64		158.0	1.30	3.0	206	360	1.5	4.0	5.9	0.4	6.3	209	200	4.23%	67	9%	1.4
E16	E15	65		93.1	0.64	3.6	60	420	1.7	4.0	6.8	0.5	7.3	173	200	3.23%	59	12%	1.3
E23	E15	135		93.1	0.54	0.5	50	50	0.2	4.3	0.9	0.1	0.9	91	200	3.76%	64	1%	0.7
E15	E14	98		93.1	0.74	4.9	69	538	2.2	4.0	8.6	0.6	9.3	130	200	5.24%	75	12%	1.7
E19	E14	100		93.1	0.79	0.8	74	74	0.3	4.3	1.3	0.1	1.4	203	200	4.93%	73	2%	0.8
E14	E02	99		93.1	0.62	6.3	58	670	2.7	3.9	10.6	0.8	11.4	77	200	2.05%	47	24%	1.2
E02	E01	49		158.0	1.86	58.9	294	6,146	24.9	3.2	78.7	7.6	86.3	152	300	4.50%	205	42%	2.8
E12	E11	20		93.1	0.72	0.7	67	67	0.3	4.3	1.2	0.1	1.3	218	200	3.09%	58	2%	0.7
E25	E11	137		93.1	0.66	0.7	61	61	0.2	4.3	1.1	0.1	1.2	72	200	2.02%	47	2%	0.6
E11	E10	21		158.0	1.04	2.4	164	292	1.2	4.1	4.8	0.3	5.1	216	200	2.94%	56	9%	1.1
E10	E09	22		93.1	0.44	2.9	41	333	1.3	4.1	5.5	0.4	5.8	162	200	4.11%	67	9%	1.3
E24	E09	134		93.1	0.48	0.5	45	45	0.2	4.3	0.8	0.1	0.9	74	200	2.92%	56	2%	0.6
E09	E08	23		93.1	0.92	4.3	86	464	1.9	4.0	7.5	0.6	8.0	191	200	5.16%	75	11%	1.6
E08	E07	24		93.1	0.27	4.5	25	489	2.0	4.0	7.9	0.6	8.5	106	200	3.63%	62	14%	1.4

Table 9.3 West Clayton Sewer Flows and Sizing Range for Long Range Condition

Locations			Subcatchments										Pipe Parameters					
Node No.		Pipe	Branch	Ex. Pop. Density	Area	Accum. Area	Popl'n	Accum. Popl'n	Average Flow	Peak Factor	Peak dry Weather Flow	Inflow & Infiltration	Peak Wet Weather Flow	Length	Diameter	Slope	Pipe Capacity	Flow Ratio	Actual Flow Velocity
From	To	ID	Branch	PopDens	A	A	Pop	Pop	ADWF	P_f	PDWF	Q_{INF}	Q_{DES}	L	D	S	Q_{CAP}	Q_{DES}/Q_{CAP}	V_{ACT}
MH	MH	ID		(pop/ha)	(Ha)				(L/s)		(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(L/s)	%	(m/s)
E13	E07	123		93.1	0.44	0.4	41	41	0.2	4.3	0.7	0.1	0.8	166	200	5.50%	77	1%	0.7
E07	E01	25		79.0	0.65	5.6	51	581	2.4	3.9	9.3	0.7	10.0	184	200	2.80%	55	18%	1.3
E01	T17	71	E			64.5		6,727	27.3	3.1	85.1	8.4	93.5	215	300	7.65%	268	35%	3.4
F03	F02	76		158.0	1.11	1.1	176	176	0.7	4.2	3.0	0.1	3.1	158	200	3.97%	65	5%	1.0
F02	F01	77		140.9	1.03	2.1	145	321	1.3	4.1	5.3	0.3	5.6	218	200	4.76%	72	8%	1.4
F06	F05	74		158.0	1.05	1.0	166	166	0.7	4.2	2.8	0.1	2.9	160	200	4.26%	68	4%	1.0
F05	F04	75		158.0	1.55	2.6	245	410	1.7	4.0	6.7	0.3	7.0	217	200	4.07%	66	11%	1.4
F04	F01	73		158.0	0.29	2.9	46	456	1.8	4.0	7.4	0.4	7.8	93	200	5.48%	77	10%	1.6
F01	T18	72	F	158.0	1.66	6.7	263	1,040	4.2	3.8	16.0	0.9	16.8	168	200	7.24%	88	19%	2.2
G03	G02	79		113.8	0.26	0.3	29	29	0.1	4.4	0.5	0.0	0.5	168	200	3.44%	61	1%	0.6
G06	G02	82		158.0	1.31	1.3	206	206	0.8	4.1	3.5	0.2	3.6	156	200	5.33%	76	5%	1.2
G02	G01	80		158.0	2.03	3.6	321	556	2.3	3.9	8.9	0.5	9.4	215	200	3.21%	59	16%	1.4
G05	G04	83		147.3	1.14	1.1	167	167	0.7	4.2	2.8	0.1	3.0	196	200	4.96%	73	4%	1.1
G04	G01	81				1.1		167	0.7	4.2	2.8	0.1	3.0	72	200	1.46%	40	8%	0.7
G01	T25	84	G			4.7		723	2.9	3.9	11.4	0.6	12.0	65	200	6.01%	80	15%	1.9
H02	H01	86		95.9	0.44	0.4	42	42	0.2	4.3	0.7	0.1	0.8	125	200	3.16%	58	1%	0.6
H03	H01	88		158.0	0.53	0.5	83	83	0.3	4.3	1.4	0.1	1.5	70	200	4.57%	70	2%	0.8
H01	T26	85	H1	105.4	0.48	1.4	51	176	0.7	4.2	3.0	0.2	3.2	196	200	5.03%	74	4%	1.1
H04	T30	89	H2	84.8	2.52	2.5	212	212	0.9	4.1	3.6	0.3	3.9	159	200	5.04%	74	5%	1.2
I03	I02	78		126.3	4.52	4.5	571	571	2.3	3.9	9.1	0.6	9.7	329	200	5.07%	74	13%	1.7
I02	I01	87		158.0	0.21	4.7	33	604	2.4	3.9	9.6	0.6	10.2	85	200	4.21%	67	15%	1.6
I01	T35	90	I	76.8	3.16	7.9	242	847	3.4	3.8	13.2	1.0	14.2	227	200	4.69%	71	20%	1.8
J14	J13	91		151.3	4.45	4.4	673	673	2.7	3.9	10.6	0.6	11.2	340	200	6.40%	83	14%	1.9
J13	J12	93		88.5	0.67	5.1	59	732	3.0	3.9	11.5	0.7	12.2	88	200	2.61%	53	23%	1.4
J12	J11	104				5.1		732	3.0	3.9	11.5	0.7	12.2	20	200	2.50%	52	23%	1.3
J17	J11	105		105.4	0.21	0.2	23	23	0.1	4.4	0.4	0.0	0.4	78	200	6.81%	86	1%	0.7
J11	J10	108		52.7	0.14	5.5	7	762	3.1	3.9	12.0	0.7	12.7	91	200	5.67%	78	16%	1.9
J10	J09	109		105.4	0.90	6.4	95	857	3.5	3.8	13.3	0.8	14.2	70	200	1.00%	33	43%	1.0
J09	J08	110				6.4		857	3.5	3.8	13.3	0.8	14.2	35	200	1.01%	33	43%	1.0
J08	J07	111				6.4		857	3.5	3.8	13.3	0.8	14.2	43	200	5.21%	75	19%	1.8
J07	J03	113				6.4		857	3.5	3.8	13.3	0.8	14.2	13	200	13.96%	123	12%	2.7
			N Clayton	100.0	13.40	13.4	1,340	1,340	5.4	3.7	20.2	1.7	21.9						
J06	J05	96		105.4	0.10	13.5	10	1,350	5.5	3.7	20.3	1.7	22.1	69	200	5.45%	77	29%	2.1
J05	J04	106				13.5		1,350	5.5	3.7	20.3	1.7	22.1	111	200	5.93%	80	28%	2.1
J04	J03	95				13.5		1,350	5.5	3.7	20.3	1.7	22.1	86	200	10.69%	107	21%	2.7
J03	J02	112		52.7	0.04	19.9	2	2,209	8.9	3.6	31.8	2.6	34.4	50	200	4.77%	72	48%	2.3
J02	T45	103	J			19.9		2,209	8.9	3.6	31.8	2.6	34.4	15	200	4.87%	72	47%	2.3
K02	T50	94	K	105.4	1.67	1.7	176	176	0.7	4.2	3.0	0.2	3.2	248	200	9.02%	98	3%	1.3

Table 9.4 North Cloverdale Trunk Sewer Flows and Sizing for Long Range Condition

Locations			Subcatchments										Pipe Parameters					
Node No.		Pipe	Branch/Sub-catch ID	Eq. Pop. Density	Area	Accum. Area	Popl'n	Accum. Popl'n	Average Flow	Peak Factor	Peak dry Weather Flow	Inflow & Infiltration	Peak Wet Weather Flow	Length	Diameter	Slope	Pipe Capacity	Flow Ratio	Actual Flow Velocity
From MH	To MH	ID		(pop/ha)	A (Ha)	A	Pop	Pop	ADWF (L/s)	F_p	PDWF (L/s)	$Q_{I\&I}$ (L/s)	Q_{PWWF} (L/s)	L (m)	D (mm)	S (%)	Q_{full} (L/s)	Q_{PWWF}/Q_{full} %	V_{full} (m/s)
			North Clayton	100.0	202.20	202.2	20,227	20,227	81.9	2.65	216.9	26.2	243.1						
T50	T47	3	K	105.4	1.7	203.9	176.2	20,403	82.7	2.64	218.5	26.4	244.9	35.89	703	0.23%	449	55%	1.2
T47	T45	4				203.9		20,403	82.7	2.64	218.5	26.4	244.9	51.77	703	0.23%	449	55%	1.2
T45	T43	5	J	0.0	19.9	223.8	2208.9	22,612	91.6	2.60	238.1	29.0	267.1	35.76	703	0.23%	449	59%	1.2
T43	T42	6		105.4	0.14	223.9	14	22,626	91.7	2.60	238.2	29.0	267.2	54.47	703	0.23%	449	59%	1.2
T42	T41	7		52.7	1.70	225.6	90	22,716	92.0	2.60	239.0	29.2	268.2	46.82	703	0.23%	449	60%	1.2
T41	T40	8		105.4	0.35	226.0	37	22,753	92.2	2.60	239.3	29.3	268.6	37.64	703	0.23%	449	60%	1.2
T40	T37	9		105.4	0.86	226.8	90	22,843	92.5	2.59	240.1	29.4	269.5	81.16	703	0.23%	449	60%	1.2
T37	T36	10				226.8		22,843	92.5	2.59	240.1	29.4	269.5	47.02	703	0.23%	449	60%	1.2
T36	T35	11				226.8		22,843	92.5	2.59	240.1	29.4	269.5	30.74	703	0.23%	449	60%	1.2
T35	T34	12	I	76.8	7.9	234.7	846.6	23,690	96.0	2.58	247.5	30.4	277.9	18.92	703	0.23%	449	62%	1.2
T34	T33	13				234.7		23,690	96.0	2.58	247.5	30.4	277.9	36.95	703	0.23%	449	62%	1.2
T33	T32	14		105.4	0.25	235.0	26	23,716	96.1	2.58	247.7	30.5	278.2	38.70	703	0.23%	449	62%	1.2
T32	T31	15				235.0		23,716	96.1	2.58	247.7	30.5	278.2	37.09	703	0.23%	449	62%	1.2
T31	T30	16				235.0		23,716	96.1	2.58	247.7	30.5	278.2	42.95	703	0.23%	449	62%	1.2
T30	T27	17	H2	84.3	2.5	237.5	212.3	23,928	96.9	2.57	249.6	30.8	280.3	133.75	703	0.23%	449	62%	1.2
T27	T26	18		105.4	1.77	239.2	186	24,114	97.7	2.57	251.2	31.0	282.2	137.88	703	0.23%	449	63%	1.2
T26	T25	19	H1	105.4	1.4	240.7	176.2	24,290	98.4	2.57	252.7	31.2	283.9	25.18	703	0.23%	449	63%	1.2
	T25		LPS FM	61.2	13.19	13.2	806	25,097	101.7	2.55	259.6	31.2	290.8						
T25	T23	20	G		4.7	245.4	723.5	25,820	104.6	2.54	265.8	31.8	297.7	82.97	703	0.24%	462	64%	1.2
	T23		LPS_13	122.1	0.47	0.5	57	25,877	104.8	2.54	266.3	31.8	298.1						
T23	T22	21		158.0	0.23	245.6	36	25,914	105.0	2.54	266.6	31.8	298.5	66.89	703	0.24%	462	65%	1.2
	T22		LPS_12	52.8	0.34	0.3	18	25,932	105.0	2.54	266.8	31.8	298.6						
T22	T21	22		61.3	0.51	246.2	31	25,963	105.2	2.54	267.1	31.9	299.0	22.80	703	0.24%	462	65%	1.2
	T21		LPS_11	105.6	0.23	0.2	24	25,988	105.3	2.54	267.3	31.9	299.2						
T21	T20	23		158.0	0.10	246.3	16	26,003	105.3	2.54	267.4	31.9	299.3	31.13	703	0.24%	462	65%	1.2
	T20		LPS_10	105.6	1.01	1.0	106	26,110	105.8	2.54	268.3	31.9	300.2						
	T20		LPS_9	105.6	0.82	0.8	87	26,196	106.1	2.54	269.1	31.9	301.0						
	T20		LPS_8	52.8	1.01	1.0	53	26,250	106.3	2.53	269.5	31.9	301.4						
T20	T19	24		158.0	0.27	246.5	43	26,293	106.5	2.53	269.9	32.0	301.8	57.79	703	0.24%	462	65%	1.2
T19	T18	25				246.5		26,293	106.5	2.53	269.9	32.0	301.8	43.90	841	0.24%	745	41%	1.3
	T18		LPS_7	105.6	0.36	0.4	38	26,331	106.7	2.53	270.2	32.0	302.2						
	T18		LPS_6	105.6	0.60	0.6	64	26,394	106.9	2.53	270.7	32.0	302.7						
	T18		LPS_5	79.0	1.13	1.1	89	26,484	107.3	2.53	271.5	32.0	303.5						
T18	T17	26	F	158.0	6.7	253.2	1040.2	27,524	111.5	2.51	280.3	32.8	313.1	52.47	841	0.24%	745	42%	1.3
T17	T16	27	E		64.5	317.7	6727.1	34,251	138.7	2.42	335.9	41.2	377.1	45.07	841	0.24%	745	51%	1.3
T16	T15	28		79.0	1.32	319.0	105	34,356	139.2	2.42	336.8	41.4	378.1	54.28	841	0.24%	745	51%	1.3
T15	T12	29		50.0	2.55	321.6	127	34,483	139.7	2.42	337.8	41.7	379.5	411.96	841	0.24%	745	51%	1.3
	T12		LPS_4	70.4	1.00	1.0	70	34,553	140.0	2.42	338.4	41.7	380.0						
	T12		LPS_3	70.4	0.36	0.4	25	34,579	140.1	2.42	338.6	41.7	380.2						
	T12			91.0	1.08	322.7	99	34,677	140.5	2.42	339.4	41.7	381.0						
T12	T10	30	D2		2.6	325.3	314.3	34,991	141.7	2.41	341.9	42.2	384.1	139.13	841	0.24%	745	52%	1.4
T10	T07	31	D1		27.4	352.7	3796.6	38,788	157.1	2.37	372.2	45.7	417.9	75.37	841	0.24%	745	56%	1.4
T07	T05	32		26.3	3.15	355.9	83	38,871	157.5	2.37	372.9	46.1	419.0	111.05	841	0.24%	745	56%	1.4
	T05		LPS_2	17.6	1.23	1.2	22	38,893	157.6	2.37	373.0	46.1	419.2						
T05	T03	33	C	26.3	18.5	374.4	1768.6	40,661	164.7	2.35	386.9	48.5	435.5	162.09	841	0.24%	745	58%	1.4
			LPS_1	17.6	1.04	1.0	18	40,679	164.8	2.35	387.1	48.5	435.6						
T03	T01	34		26.3	1.37	375.8	36	40,716	164.9	2.35	387.4	48.7	436.1	141.71	841	0.24%	745	59%	1.4
T01	OUT	1	B		18.0	393.7	5536.0	46,252	187.4	2.30	430.2	51.0	481.3	141.85	981	0.20%	1019	47%	1.3

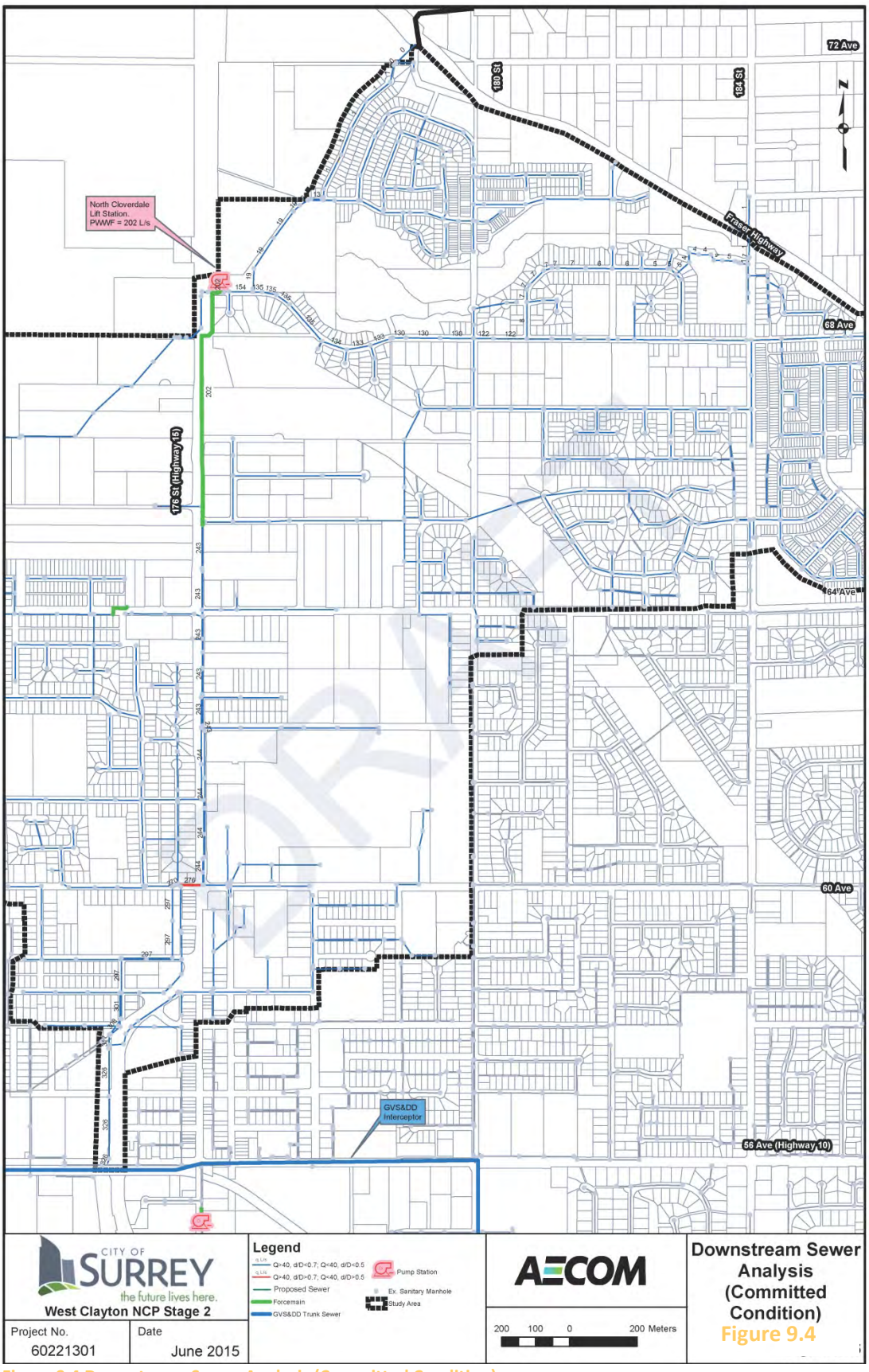


Figure 9.4 Downstream Sewer Analysis (Committed Condition)

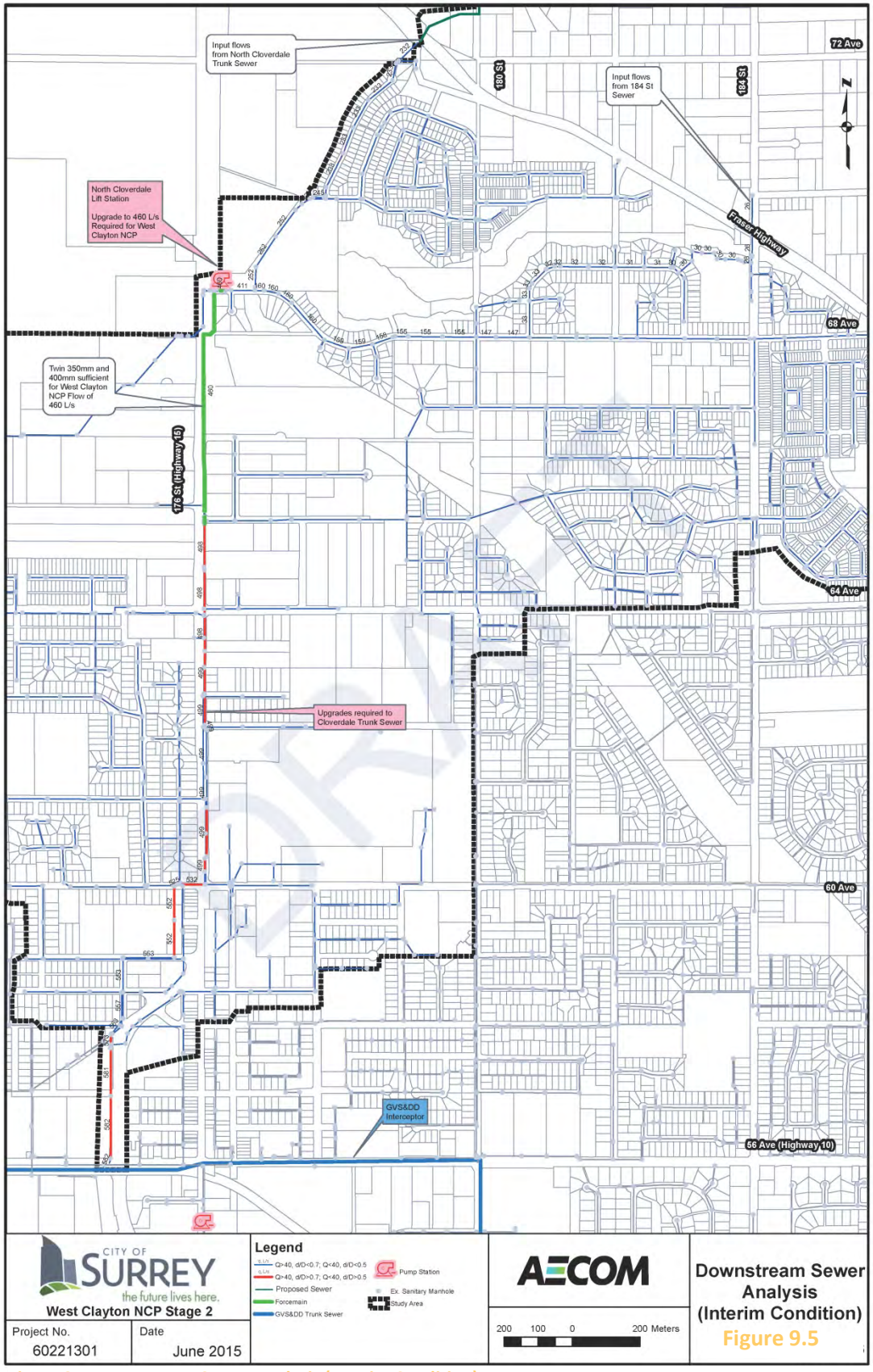


Figure 9.5 Downstream Sewer Analysis (Interim Condition)

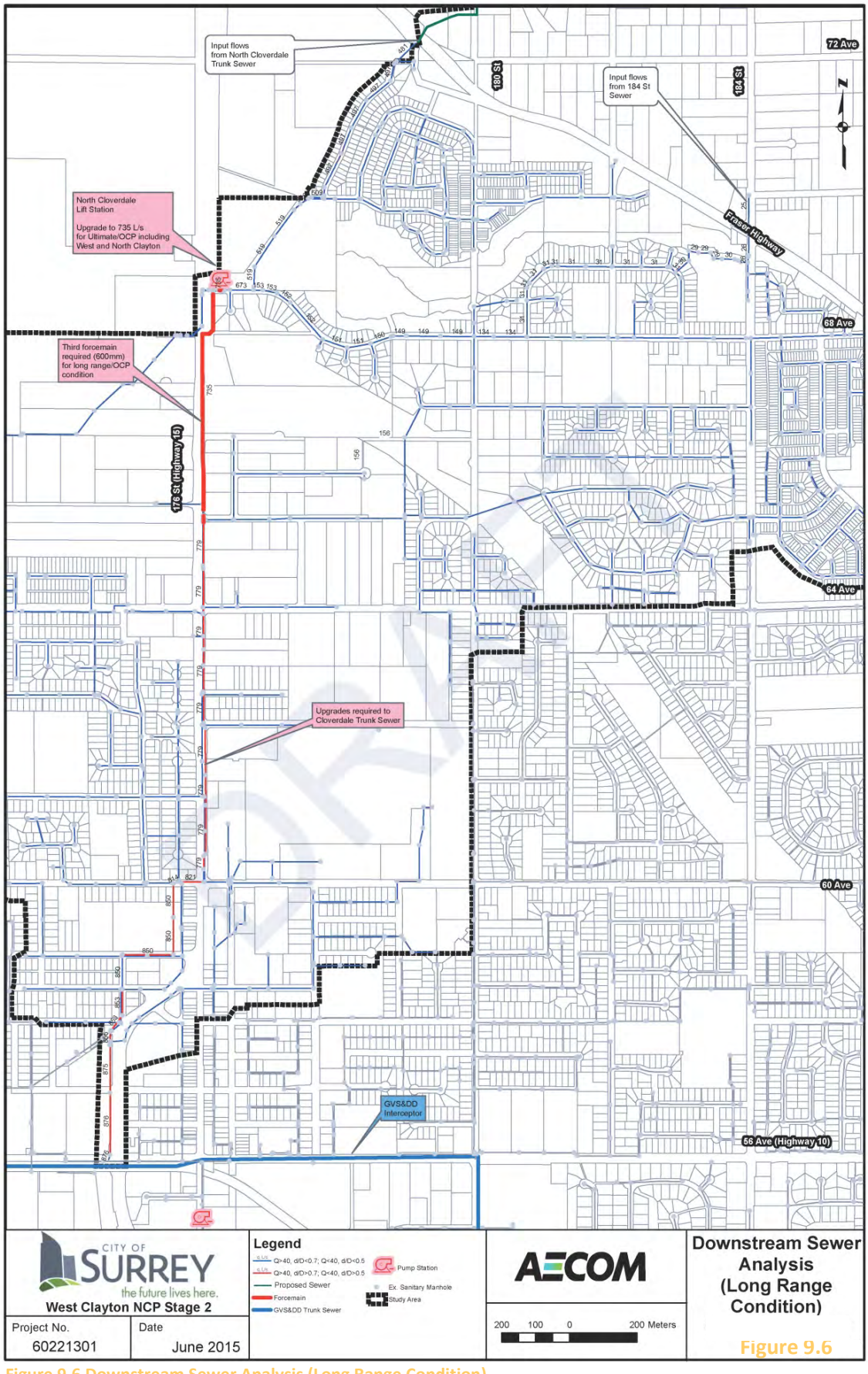


Figure 9.6 Downstream Sewer Analysis (Long Range Condition)

Table 9.5 Undersized Sewer Downstream of West Clayton NCP

Location	Between	Ex. Diameter (mm)	Length (m)	Existing Capacity (Q_{cap})	Current Condition			Interim Condition			Long Range Condition			Prop. Diameter (mm)
					Q_{des} (L/s)	Q_{des}/Q_{cap}	d/D	Q_{des} (L/s)	Q_{des}/Q_{cap}	d/D	Q_{des} (L/s)	Q_{des}/Q_{cap}	d/D	
Highway 15	65A Ave. and 64 Ave.	600	136	483	250	0.52	0.51	502	1.04	> 1.0	779	1.61	> 1.0	900
Highway 15	65A Ave. and 64 Ave.	600	133	467	250	0.53	0.52	502	1.07	> 1.0	801	1.71	> 1.0	900
Highway 15	64 Ave. and 62A Ave.	600	107	456	250	0.55	0.52	502	1.10	> 1.0	801	1.75	> 1.0	900
Highway 15	64 Ave. and 62A Ave.	600	126	455	250	0.55	0.52	502	1.10	> 1.0	801	1.76	> 1.0	900
Highway 15	62A Ave. and 62 Ave.	600	91	460	250	0.54	0.52	502	1.09	> 1.0	801	1.74	> 1.0	900
Highway 15	62A Ave. and 62 Ave.	600	14	660	250	0.38	0.42	502	0.76	0.68	801	1.21	> 1.0	900
Highway 15	62 Ave. and 61A Ave.	600	140	670	251	0.37	0.42	503	0.75	0.67	801	1.19	> 1.0	900
Highway 15	62 Ave. and 61A Ave.	600	89	916	251	0.27	0.35	503	0.55	0.55	801	0.87	0.72	900
Highway 15	61A Ave. and 60 Ave.	600	144	549	251	0.46	0.47	503	0.92	0.80	801	1.46	> 1.0	900
Highway 15	61A Ave. and 60 Ave.	600	9	878	251	0.29	0.36	503	0.57	0.56	801	0.91	0.74	900
Highway 15	61A Ave. and 60 Ave.	600	39	645	251	0.39	0.43	503	0.78	0.69	801	1.24	> 1.0	900
Highway 15[1]	61A Ave. and 60 Ave.	600	37	1043	251	0.24	0.33	510	0.49	0.51	801	0.77	0.65	900
60 Avenue	Highway 15 and 175A Street	750	78	236	284	1.20	> 1.0	536	2.27	> 1.0	843	3.57	> 1.0	1350
60 Avenue	Highway 15 and 175A Street	750	14	213	284	1.33	> 1.0	529	2.48	> 1.0	843	3.95	> 1.0	1350
Property north of 59 Ave. and west of Hwy. 15	60 Ave. to 59A Ave.	750	100	370	304	0.82	0.68	556	1.50	> 1.0	872	2.35	> 1.0	1350
Property south of 60 Ave. and west of Hwy. 15	59A Ave. and 59 Ave.	750	110	352	264	0.75	0.64	556	1.58	> 1.0	872	2.48	> 1.0	1350
59 Avenue	Highway 15 and 175A Street	750	150	798	304	0.38	0.42	556	0.70	0.64	872	1.09	> 1.0	1350
175 Street[1]	59 Ave. and 58A Ave.	750	102	1102	304	0.28	0.35	556	0.50	0.52	872	0.79	0.67	1350
175 Street[1]	59 Ave. and 58A Ave.	750	78	1033	309	0.30	0.37	560	0.54	0.54	875	0.85	0.7	1350
175 Street	58A Ave. and 58 Ave.	900	56	871	315	0.36	0.41	567	0.65	0.61	875	1.00	0.82	1350
175 Street	58 Avenue and 57 Avenue	900	4	159	315	1.97	> 1.0	576	3.61	> 1.0	877	5.50	> 1.0	1350
175 Street	58 Avenue and 57 Avenue	900	31	458	325	0.71	0.62	576	1.26	> 1.0	877	1.92	> 1.0	1350
175 Street	58 Avenue and 57 Avenue	900	8	646	325	0.50	0.50	598	0.93	0.78	897	1.39	> 1.0	1350
175 Street	58 Avenue and 57 Avenue	900	142	559	333	0.60	0.55	585	1.05	> 1.0	897	1.60	> 1.0	1350
175 Street	57 Ave. and Highway 10 (56 Ave.)	900	184	526	334	0.63	0.57	585	1.11	> 1.0	898	1.71	> 1.0	1350
				Sub-Total =	0.1 km undersized			1.6 km undersized			2.1 km undersized			

Note: [1]The flow capacity just meets the criteria for this section. However, since pipe size should not be smaller than the section upstream, this section is to be upsized to a larger diameter sewer.

North Cloverdale Lift Station

Sewage from the entire West Clayton NCP area (and future "Northern Clayton NCP") will drain into the City's existing North Cloverdale Lift Station. The lift station is currently a triplex station with three (3) – 50 hp pumps that currently discharge through a 350mm diameter forcemain with additional twin 400mm forcemain, then into the City's gravity trunk sewer and eventually to Metro Vancouver's Cloverdale Trunk Sewer.

In 2005 Dayton and Knight (D&K) completed the "Cloverdale Trunk Sewer Conveyance Study", in which they assessed the future flows expected in the area, the capacity of the lift station and trunk sewer, and recommended a future servicing strategy.

Table 9.6 – North Cloverdale Lift Station Capacity

* Capacity is based on 85% of theoretical maximum capacity.

Scenario	350mm forcemain operating	400mm forcemain operating	Ex. Capacity * (L/s)
One 50 hp Pump	✓		77 L/s
One 50 hp Pump		✓	98 L/s
Two 50 hp Pumps		✓	115 L/s
Two 50 hp Pumps	✓	✓	170 L/s

As shown in Table 9.6, the lift station currently has a maximum capacity of 170 L/s whilst having one pump for standby. A further evaluation of the existing lift station structure and site plan needs to be completed in order to confirm if the station can be retrofitted to a higher capacity or if a completely new station, including property acquisition, is required. Regardless of which option, it is anticipated that 3 – 100 Hp pumps, a larger wet-well, emergency storage tank and electrical upgrades will be required to service the West Clayton NCP.

Like sanitary sewers, the City's Design Criteria is to size a sanitary lift station to convey the peak wet weather flows, which is based on a 5year: 24hr event. Since trunk sewers are sized to operate no more than 70% full (d/D ratio), there is some flexibility to convey higher peak flows and mitigate impacts of higher levels of I&I before surcharging. However, lift stations have a finite capacity (which reduces with wear and tear) and do not have flexibility in managing sudden increases in peak instantaneous flows that may result from higher levels of I&I.

It is good engineering practice to size lift stations to convey peak wet weather flows, with design storm events higher than a 1 in 5-year return period, and/or provide allowance for overflow storage facilities to attenuate the increases in peak flows that are attributed to higher levels of I&I. This is particularly the case for the City of Surrey in Cloverdale where the City has completed flow monitoring to determine the average 5 year:24 hour I&I rates in Clayton-Cloverdale is 17,100 L/ha/day, which is 50% higher than the City's Design Criteria. This is only further amplified by the fact that I&I has been proven to increase as the sewer system ages.

Table 9.7 summarizes the estimated peak flows into the North Cloverdale Lift station for the "committed", "interim' and "long range" conditions. In addition to the three land-use conditions / horizons, an "existing actual" scenario was simulated in the model – this represents the existing peak sewage flows based on measured flow data from 2010, it does not account for increases in secondary suites, and should be considered under-conservative and only used for references purposes to assist in timing the pump upgrades. Peak flows were also estimated for various rainfall events to estimate the increase in I&I, and assess the impact on the lift station relative to its theoretical capacity.

Table 9.7 – North Cloverdale Lift Station Peak Inflows

Land-Use Condition / Scenario	Ex. Capacity* (L/s)	Peak Wet Weather Inflow (L/s)		
		5yr : 24hr Event	*25yr : 24hr Event*	*100yr : 24hr Event*
Existing Actual (2010)	170	110	120	128
Full Zoning Actual	170	185	197	207
#1 – Committed Condition (Zoning Regulatory)	170	202	na	na
#2 – Interim Condition (with West Clayton NCP)	170	460	na	na
#3 – Long Range Condition (OCP + West + North Clayton NCP)	170	735	834	877

As shown in Table 9.7, the existing NCLS is presently operating below its peak capacity however, the committed peak flow of 202 L/s is above the stations current maximum capacity of 170 L/s.

In order to service the West Clayton NCP, the station will need to be upgraded to a capacity of 460 L/s, with consideration to an ultimate capacity of 735 L/s when the future North Clayton NCP develops. Coinciding with the OCP / long range lift station upgrade, the existing forcemains will require a 3rd twin forcemain of diameter 600mm.

180 Street Diversion Sewer

Currently sewer flows from the residential area between 184 St to 180 St and from 66 Avenue to 69 Avenue are conveyed by a 450 mm sewer along 68 Avenue to the North Cloverdale Lift Station (NCLS) at 176 Street and 69 Avenue. Instead of continuing to convey sanitary flow from this area to NCLS, an option is to construct a diversion sewer on 180 Street (or other local options to be reviewed during the detailed design stage) and divert flows to the trunk sewer on 176 St at 65A Avenue. The diversion sewer would mainly reduce flows to the NCLS and the capacity analysis of infrastructure downstream of the forcemain would remain the same. The alignment of the proposed diversion sewer is shown on Figure 9.7, Figure 9.8 and Figure 9.9.

Figure 9.7 illustrates the estimated PWWF's in the downstream sewer system for the "Committed Condition" with the 180 Street Diversion Sewer taking flows in Cloverdale from tributary sanitary catchments along 67 Avenue and 68 Avenue east of 180 Street. By diverting the sanitary flows from the NCLS, the design flow at the NCLS is reduced to 77 L/s for this scenario.

Figure 9.8 illustrates the estimated PWWF's in the downstream sewer system for the "Interim Condition" with the 180 Street Diversion Sewer – which represents peak flows from current service parcels plus the addition of the West Clayton NCP. As shown on this figure, there is 1.6 km of sewer segments that do not meet the City's design criteria for peak flows / depths.

The NCLS will also need to be upgraded to convey a design flow of 305 L/s for this scenario.

Figure 9.9 illustrates the estimated PWWF's in the downstream sewer system for the "Long Range Condition" with the 180 Street Diversion Sewer – which represents peak flows from OCP build-out plus the addition of the West Clayton and future "North Clayton" NCP's. As shown on this figure, there is 2.1 km of sewer segments that do not meet the City's design criteria for peak flows / depths – all of which are on the Cloverdale Trunk Sewer downstream of the lift station forcemain discharge. The NCLS will need to be upgraded to convey the ultimate design flow of 585 L/s.

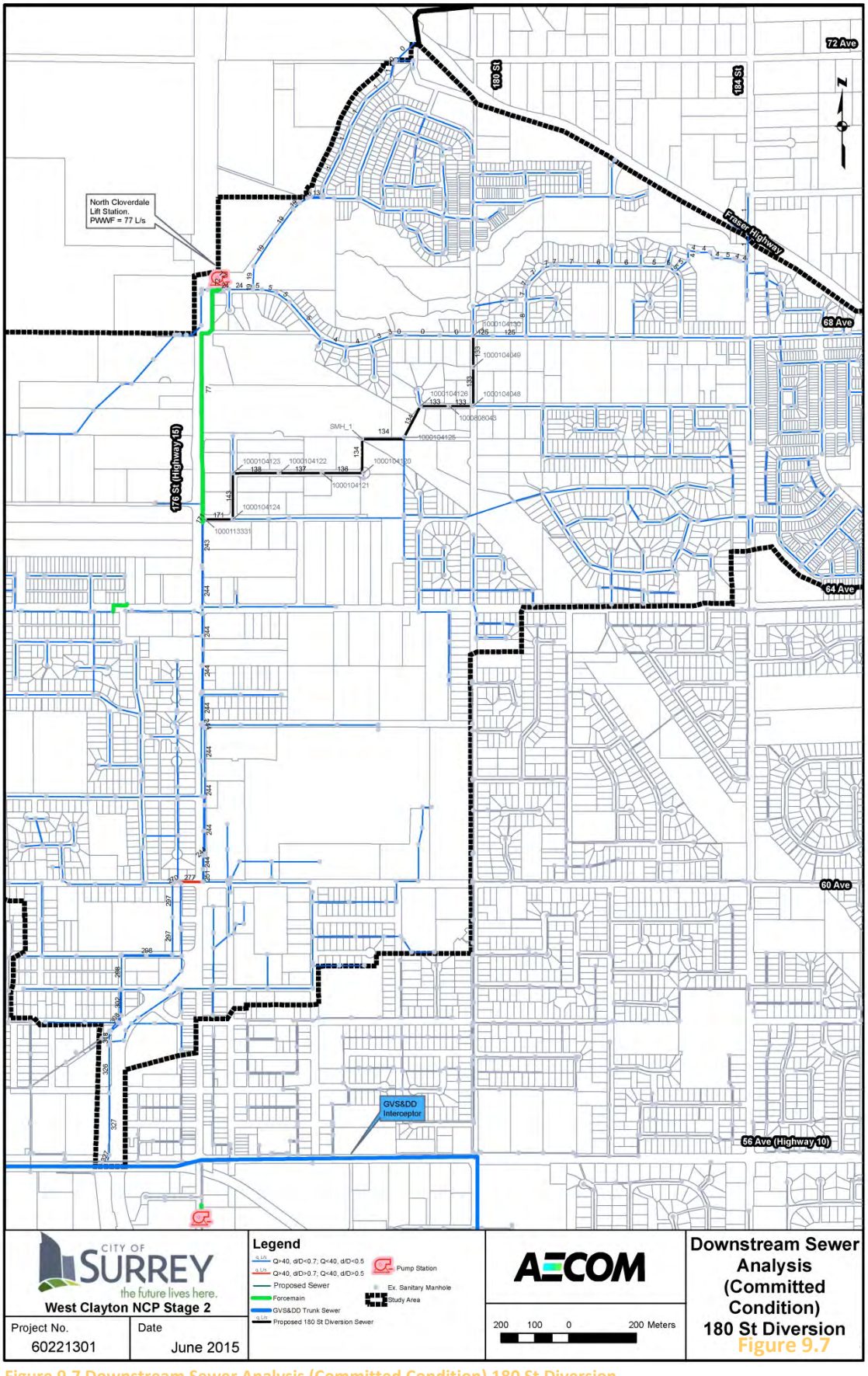


Figure 9.7 Downstream Sewer Analysis (Committed Condition) 180 St Diversion

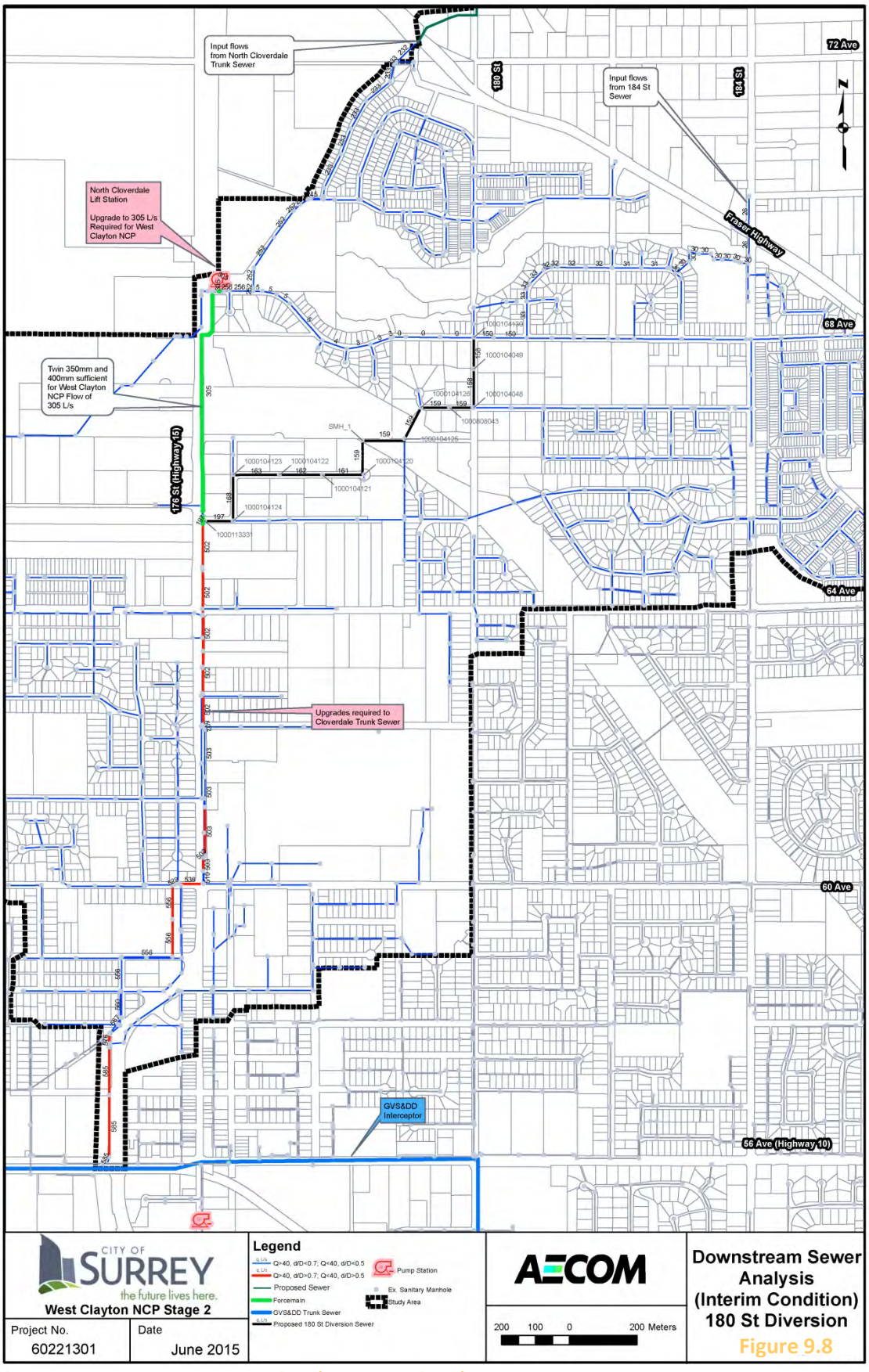


Figure 9.8 Downstream Sewer Analysis (Interim Condition) 180 St Diversion

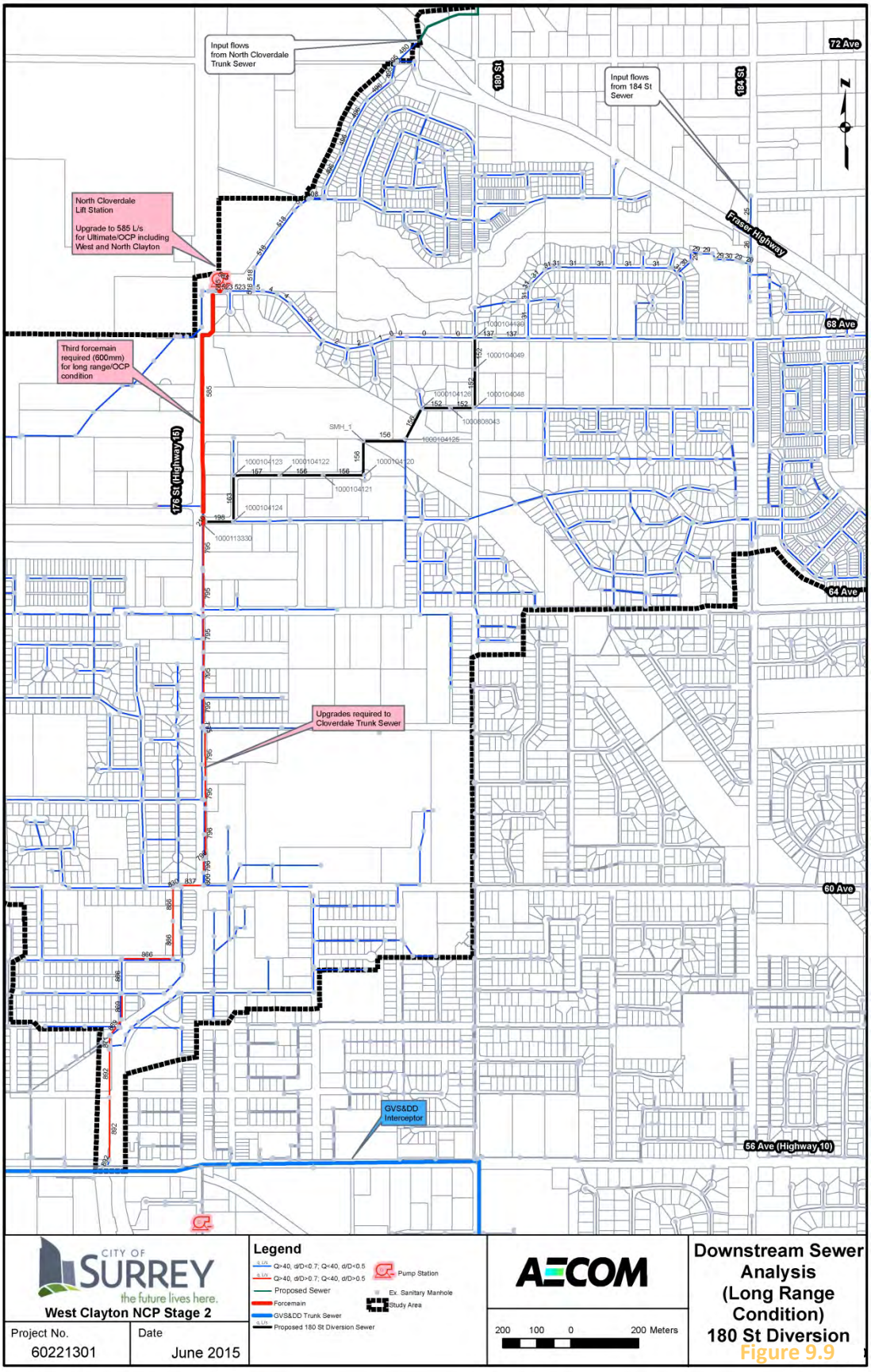


Figure 9.9 Downstream Sewer Analysis (Long Range Condition 180 St Diversion

The sanitary flows from the East Clayton Transit Oriented Area are included in this analysis; the peaking factor for the contributing flow from this area is calculated at 2.88. The peak wet weather flow from this area expected at the upstream end of the 180 Street Diversion at 68 Avenue is 13.9 L/s.

The reduction in flows (PWWF flows for the 5-year, 24-hour event) conveyed to the NCLS when the diversion sewer is in place, is summarized in Table 9.8.

Table 9.8 – North Cloverdale Lift Station Peak Inflows with 180 Street Diversion Sewer

Land-Use Condition / Scenario	Ex. Capacity* (L/s)	PWWF (L/s) 5yr : 24hr Event
Existing Actual (2010)[1]	170	110
Full Zoning Actual[1]	170	185
#1 – Committed Condition (Zoning Regulatory)	170	77
#2 – Interim Condition (with West Clayton NCP)	170	305
#3 – Long Range Condition (OCP + West + North Clayton NCP)	170	585

[1]Before 180 Street Diversion Scenario

The alignment for the diversion sewer mostly follows the existing roads and rights-of-way except for where it crosses the Cloverdale Greenway; a right-of-way will need to be acquired through the greenway. The sewer will also need to cross St. Gelais Brook, similar to a nearby right-of-way for an existing 200 mm diameter sanitary sewer. A connection from the existing sanitary sewer would need to be constructed at 17926 – 67 Avenue to convey the flow from the local 67 Avenue sewer to the 180 Street Diversion and to decommission the local sewer immediate downstream of the tie-in.

Downstream of the greenway, at 17926 – 67 Avenue, the diversion sewer will continue south along an existing pathway just west of 17855 65A Avenue and connect to the sanitary sewer along 65A Avenue and west on 66 Avenue to 176A Street, south on 176A Street to 65A Street and west on 65A Avenue to 176 Street to connect to the existing 600 mm diameter sewer. Additional right-of-ways will be required along the walkway as the existing 3 meter width is not sufficient. Table 9.9 summarizes the proposed size for the diversion sewer to convey flows from Scenario #3: Long Range Condition.

Table 9.9 – Proposed 180 Street Diversion Sewer

Location	Upstream MH	Downstream MH	Length (m)	Proposed Diameter (mm)	Design Flow (Scenario #3) (L/s)
180 Street between 68 and 67 Avenue	1000104130	1000104049	92	525	152
180 Street between 68 and 67 Avenue	1000104049	1000807851	115	525	152
67 Avenue at 180 Street	1000104048	1000807851	2	200	12.5
67 Avenue between 180 Street and Cloverdale Greenway	1000807851	1000808043	69	525	152
67 Avenue between 180 Street and Cloverdale Greenway	1000808043	1000104126	84	525	152
Cloverdale Greenway ROW (existing)	1000104126	1000104125	104	525	156
Cloverdale Greenway ROW (proposed)	1000104125	SMH_01	124	525	156
Pathway ROW north of 66 Avenue	SMH_01	1000104120	106	525	156
66 Avenue Cul-de-Sac to 176A Street	1000104120	1000104121	122	525	156
66 Avenue Cul-de-Sac to 176A Street	1000104121	1000104122	127	525	156
66 Avenue Cul-de-Sac to 176A Street	1000104122	1000104123	137	600	157
176A Street between 66 and 65A Avenue	1000104123	1000104124	135	600	163
65A Avenue between 176A Street and 176 Street	1000104124	1000113331	83	600	198
65A Avenue at 176 Street	1000113331	1000113330	11	600	198

Deep Gravity Sewer Tunnel Alternative to Upgrading NCLS

A deep gravity sewer tunnel, as an alternative to upgrading the NCLS, was explored in the 2005 *Cloverdale Trunk Sewer Conveyance Study* by Dayton & Knight. The concept was to construct a deep (10m to 13m) gravity sewer from 68 Avenue to 60th Avenue, primarily along the 176A Street alignment through the Cloverdale Fair Grounds. The design flows used for the conceptual design was estimated as 718 L/s at the NCLS. Based on the analysis of flows completed for the NCP, the ultimate design flow is currently estimated higher at 734 L/s under the long range scenario.

The proposed alignment is constrained by the invert elevation of the existing 750 mm diameter gravity trunk sewer on 60 Avenue; the estimated grade for the deep trunk sewer is 0.06%. The proposed size of 1200 mm diameter has a conveyance capacity of 800 L/s at 70% depth of flow and is sufficient to convey the design flow of 734 L/s. If the 180 Street Diversion Sewer is constructed, the design flow for the deep gravity sewer tunnel would be lower at 585 L/s. The reduction in flow does not affect the pipe size, as a smaller 1050 mm diameter pipe is only able to convey a flow of 560 L/s at 70% depth.

The D&K report highlights some of the challenges of the construction of a deep gravity sewer tunnel. Installation options summarized in the report include pipe jacking, directional drilling, micro-tunnelling and conventional tunnelling. Pipe jacking and directional drilling is typically suitable for relatively short installations such as road, creek or rail crossings and in competent glaciated soils. The length of

the proposed sewer is over 1,500m and the soils are a mixture of silt (clayey) and till. Micro-tunnelling and conventional tunnelling is used for longer installations and uses a tunnel boring machine (TBM). For micro-tunnelling, the pipe is simultaneously jacked in segments into the tunnel and the annulus is filled with grout. A disadvantage to micro-tunnelling is its vulnerability to encountering obstructions; a rescue shaft is required if an obstruction is encountered. This is an unknown risk and can add considerable expense and construction delay. Based on the inferred till-silt/clay interface from a geotechnical report completed (*Figure 4-3, Cloverdale Trunk Sewer Conveyance Study*) there is a high likelihood of encountering cobbles and boulders that will hamper micro-tunnelling efforts. Based on the available information at this stage, it is recommended that conventional tunnelling be used to construct the deep gravity sewer. Instead of a 1.5m diameter tunnel, a 2.0m diameter or larger is recommended as small diameter TBMs for conventional tunnelling to allow for easier installation of the 1,200 mm diameter sewer.

The construction cost in the 2005 report was estimated at ***$11 million***, a detailed breakdown is summarized in **Table 9.10.**

Table 9.10 – Deep Gravity Sewer Tunnel Estimated Costs (2005, Dayton & Knight)

Item	Quantity	Unit Cost	Cost
1.5 m diameter tunnelling (1,200 mm pipe)	1,550 m	$4,500/m	$6,975,000
1,200 mm PVC open cut	300 m	$2,000/m	$600,000
Jacking Shaft	1 ea	$60,000	$60,000
Receiving Shaft	1 ea	$40,000	$40,000
911 Shaft	2 ea	$150,000	$300,000
		Subtotal	$7,975,000
		30% Contingency	$2,392,500
		Subtotal	$10,367,500
		Add 7% GST	$725,725
		Total	$11,093,225

The preferred proposed alignment by D&K assumes that an entry shaft can be located on an existing private, single-family residential property, 6838 176A Street. The property would need to be acquired by the City; 2015 assessed value is $918,000. Other construction management issues would need to be considered as there are other private properties around the 176A Street cul-de-sac. The other proposed option would require deflecting around the property and aligning the deep sewer to be directly beneath an existing Class A creek. The tunnel at this end would be less than 3m deep and would be constructed using the cut-and-cover method, creating significant construction challenges in the creek riparian area. Environmental approvals and habitat compensation would be required as considerable damage may be caused to the Class A creek during construction. Additional, geotechnical and hydrogeological issues may make this option unfeasible.

A similar study and preliminary design for a deep gravity sewer tunnel for Robson Creek in 2011, unit costs for tunneling (1.5 to 2.0 m diameter tunnel boring) were estimated at $9,000 per lineal metre. 2011 costs were adjusted for inflation at 2% per annum to $10,000 per lineal metre. Due to the length of the tunnel, a number of entry and exit tunnel shafts may be required at intervals along the route or where there is significant change in direction. The costs allowed for one jacking and one receiving shaft appear to be on the low end in the D&K report and are adjusted to reflect a more reasonable expected cost.

The construction costs are estimated at ***$25.3 million*** (rounded cost); a detailed breakdown is summarized in Table 9.11**.** Based on the construction challenges and costs, it is not recommended to construct a deep gravity sewer to replace the NCLS.

Table 9.11 – Updated Deep Gravity Sewer Tunnel Estimated Costs

Item	Quantity	Unit Cost	Cost
2.0 m diameter tunnelling (1,200 mm pipe)	1,550 m	$10,000/m	$15,500,000
1,200 mm PVC open cut	300 m	$2,500/m	$600,000
Jacking Shaft	1 ea	$275,000	$275,000
Receiving Shaft	1 ea	$275,000	$275,000
911 Shaft	2 ea	$275,000	$550,000
Property Purchase	1 ea	$1,000,000	$1,000,000
		Subtotal	$18,200,000
		30% Contingency	$5,460,000
		Subtotal	$23,660,000
		Add 7% GST	$1,656,200
		Total	$25,316,200

9.3 PROPOSED SYSTEM

9.3.1 Recommended Option

The long-term sanitary sewer servicing strategy for the West Clayton NCP is to construct the NCTS, from the intersection of 72 Avenue and 177A Street, and extend along the contour line to the intersection of 80 Avenue and 188 Street. This trunk sewer would service the NCP as well as provide a long-term servicing plan for the future "North Clayton" NCP.

At this time the City's North Cloverdale Lift Station and forcemain has been identified as requiring upgrades as part of the overall strategy, as well as portions of the City's downstream Cloverdale Trunk Sewer to Metro Vancouver. One alternative to upgrading these infrastructure components would be a deep gravity sewer tunnel from the lift station, downstream towards Metro Vancouver. The recommendation from the Dayton and Knight report took into account the capital costs and operations and maintenance costs for both the pump station upgrades and the construction of a deep trunk gravity sewer. The findings indicated that the upgrading of the pump station was more cost effective, AECOM's review confirms these conclusions and therefore, it is the recommended option.

9.3.2 Interim Phasing

Currently the downstream portion of the NCTS has been constructed up to 72 Avenue and 177A Street. This sewer would require extension across Fraser Highway and property dedication before it reaches an existing road right-of-way at 181 Street and 73 Avenue – at which point it could continue east to service the NCP. Development within the NCP cannot occur until the NCTS has been extended across Fraser Highway and until the North Cloverdale Lift Station is upgraded or the 180 Street Diversion Sewer is constructed. The 184 Street Pocket area within the NCP area by Fraser Highway can be conveyed through the existing sanitary sewer on 184 Street to the NCLS until the inflow to the station reaches 170 L/s. The flows from this area will bypass the NCLS when the 180 Street Diversion Sewer is constructed.

The construction of the 180 Street Diversion Sewer will alleviate capacity concerns at the NCLS and delay the construction of the required third forcemain. However, the pump station wet well will still need to be upgraded to house the three 100 hp pumps as peak flows at the station reach 170 L/s. To service the West Clayton NCP, the North Cloverdale Lift Station will need to be upgraded to a capacity of 305 L/s, which would require: (i) the replacement of all 3 x 50 hp pumps with 3 x 100 hp pumps (ii) modifications to the wet well (iii) emergency storage tank and (iv) generator and electrical modifications. The ultimate lift station capacity should be 585 L/s in order to service the future North Clayton NCP and OCP conditions, at which time a fourth 100 hp pump and a 3rd forcemain of diameter 600mm will be required. In this scenario, a new pump station will be required.

As the lift station is upgraded, the flows in the downstream trunk sewer will increase respectively. Because of the increase in flows, the offsite trunk downstream will need to be upgraded accordingly.

The following list summarizes the required sequence of upgrades as West Clayton develops:

1) Construct 180 Street diversion sewer (lowers NCLS flow from 210 L/s to 77 L/s);
1a) Construct two (2) downstream sections of the Cloverdale Trunk sewer upgrades, between 59 and 60 Avenue west of 176 Street, when flows to the NCLS reach 98 L/s;
2) Construct NCTS;
2b) Construct one (1) downstream section of the Cloverdale Trunk sewer upgrades, 35m immediately south of the Cloverdale Canal, when flows to the NCLS reach 115 L/s;
3) Replace three (3) 50 hp pumps with two (2) 100 hp pumps when West Clayton develops and flows to the NCLS reach 170 L/s;
3a) Construct emergency overflow storage tank (Stage 1), when flows to the NCLS reach 170 L/s;
3b) Construct three (3) downstream sections of the Cloverdale Trunk sewer upgrades, 334m immediately north of Highway 10, when flows to the NCLS reach 170 L/s;
4) Construct new NCLS control building, upgrade power service acoustic and emergency genset;
5) Add third 100 hp pump when flows to the NCLS reach 230 L/s; and,
6) Construct the remaining downstream sections of the Cloverdale Trunk sewer upgrades as shown in Figure 9.8 when flows to the NCLS reach 230 L/s.

The remaining upgrades can be deferred until North Clayton develops:

7) Construct 600 mm forcemain when flows reach 370 L/s with new discharge chamber at 65A Avenue;
8) Upgrade discharge piping and forcemain discharge chamber;
9) Construct larger wet well and odour control bed;
9a) Construct the remaining downstream sections of the Cloverdale Trunk sewer upgrades as shown in Figure 9.9;
10) Add fourth 100 hp pump when flows reach 490 L/s; and,
11) Construct emergency overflow storage tank (Stage 2), when the lift station is upgraded with an ultimate capacity of 585 L/s.

It is assumed that the ultimate pump station will be a quadplex pump setting arrangement. The upgrade triggers will change if the number of pumps setting arrangement is changed during the detailed design stage.

9.4 COSTS AND FINANCING

For local sewers within the NCP that are required to be 250mm diameter or larger, the DCC eligible cost is only the upsize cost portion in excess of the base cost for a 200mm sewer if flows are less than or equal to 40 L/s. However for trunk sewers conveying flows in excess of 40 L/s from the upstream catchment, the DCC eligible costs are for the entire sewer costs.

The capital costs for sanitary infrastructure improvements required to service West Clayton NCP is estimated at ***$20.8 million*** as shown in **Table 9.12.**

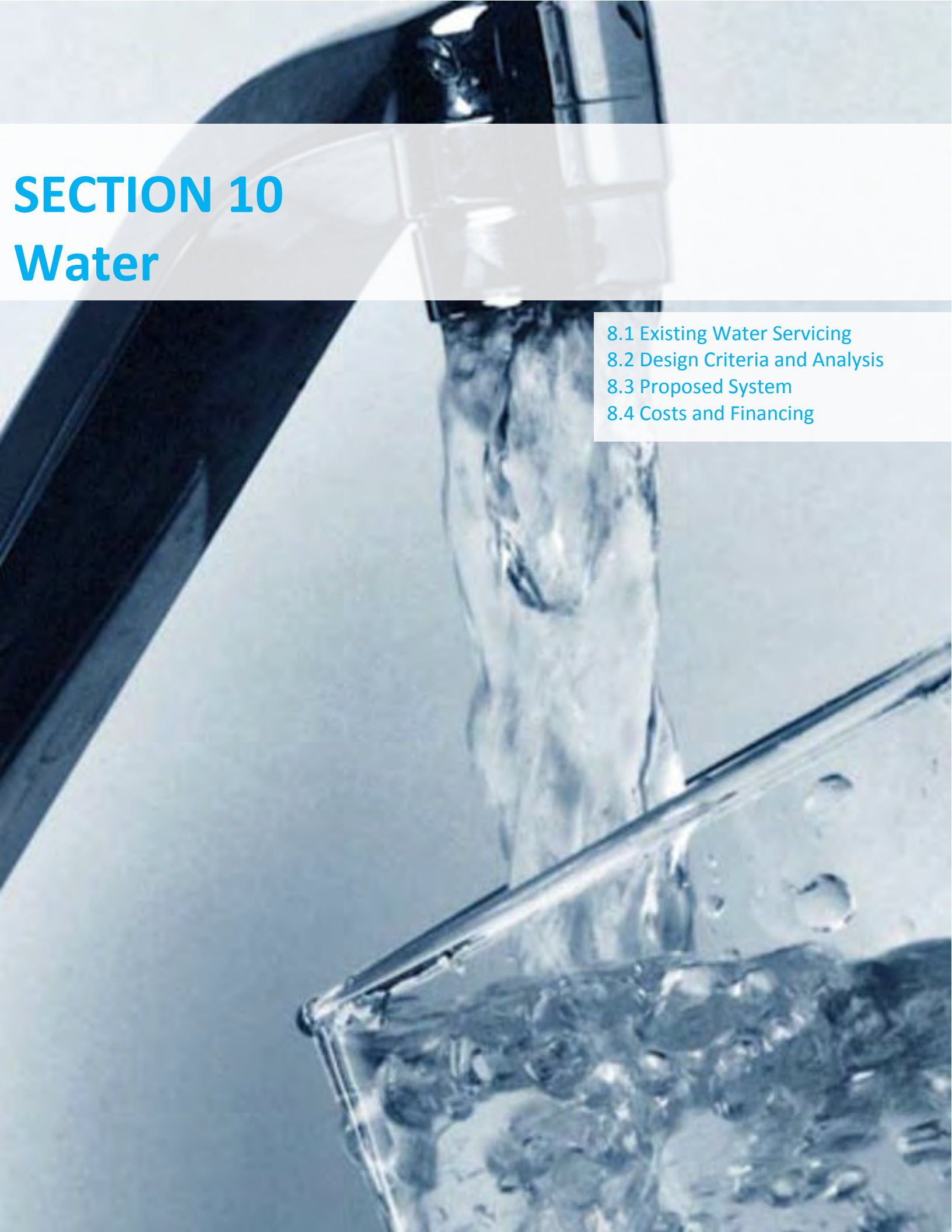
The capital costs to upgrade the NCLS to provide sufficient level of service for North Clayton are estimated to be ***$7.4 million.*** As described in the analysis, the construction of the third forcemain and fourth 100 hp pump can be deferred till North Clayton develops, provided that the 180 Street Diversion Sewer is constructed.

The total sanitary infrastructure improvements required to service the West and North Clayton NCP areas is ***$28.2 million***.

Table 9.12 Eligible Sewer Infrastructure Servicing Cost Estimates

Ref No.	Description	Unit	Unit Price[1]	Quantity	Estimate Eligible DCC Cost	DCC Split Inside vs Outside NCP	
						Eligible DCC Expenditures Inside the NCP Area	Eligible DCC Expenditures Outside the NCP Area
1	**Sewer Mains Within NCP (Upsize Cost Only)[2]**						
1.1	250mm sewer (currently vacant areas)	lin.m.	$75	613	$45,975	$45,975	
1.2	250mm sewer (currently local road)	lin.m.	$90	1,085	$97,650	$97,650	
1.3	250mm sewer (currently collector road)	lin.m.	$100	220	$22,000	$22,000	
1.4	250mm sewer (currently arterial road)	lin.m.	$125	869	$108,625	$108,625	
1.5	300mm sewer (currently vacant areas)	lin.m.	$143	215	$30,745	$30,745	
1.6	300mm sewer (currently collector road)	lin.m.	$190	590	$112,100	$112,100	
				Sub-Total =	**$417,095**	**$417,095**	
2	**North Cloverdale Trunk Sewer[3,4,5]**						
2.1	750mm sewer (currently vacant areas)	lin.m.	$1,887	1,130	$2,132,310	$2,132,310	
2.2	750mm sewer (currently collector road)	lin.m.	$2,120	15	$31,800	$31,800	
2.3	750mm sewer (currently arterial road)	lin.m.	$2,650	20	$53,000	$53,000	
2.4	900mm sewer (currently vacant areas)	lin.m.	$2,105	1,102	$2,319,710	$2,319,710	
2.5	900mm sewer (currently arterial road)	lin.m.	$3,013	20	$60,260	$60,260	
2.6	900mm sewer (currently local road)	lin.m.	$2,169	115	$249,435	$249,435	
2.7	1050mm sewer (currently vacant area)	lin.m.	$2,330	142	$330,860	$330,860	
2.8	1050mm sewer (currently local road)	lin.m.	$2,439	46	$112,194	$112,194	
2.9	1050mm sewer (currently arterial road)	lin.m.	$3,388	40	$135,520	$135,520	
2.10	1350mm Casing Pipe Across Fraser Highway	each	$265,000	1	$265,000	$265,000	
2.11	1050mm GVWD watermain & utility conflicts on Fraser Highway	each	$210,000	1	$210,000	$210,000	
2.12	Gravity Sewer Crossings of Existing Creeks / Watercourses	each	$160,000	6	$960,000	$960,000	
				Sub-Total =	**$6,860,089**	**$6,860,089**	**$0**
3	**180 Street Diversion Sewer**						
3.1	200mm sewer (local road)	lin.m.	$909	5	$4,545		$4,545
3.2	525mm sewer (local road)	lin.m.	$1,476	624	$921,024		$921,024
3.3	525mm sewer (park land/side walk)	lin.m.	$1,230	315	$387,450		$387,450
3.4	600mm sewer (local road)	lin.m.	$1,611	366	$589,626		$589,626
3.5	Boulevard/Sidewalk/Landscape Restoration	allow	$90,000	1	$90,000		$90,000
3.6	ROW Land Acquisition (6 m width)	acre	$200,000	0.31	$62,400		$62,400
				Sub-Total =	**$2,055,045**	**$0**	**$2,055,045**
4	**North Cloverdale Lift Station/Forcemain Upgrade**						
4.1	Pump Station Upgrade (305 L/s Capacity)	LS	$2,300,000	1	$2,300,000		$2,300,000
4.2	Emergency Overflow Storage Tank Stage 1	LS	$1,300,000	1	$1,300,000		$1,300,000
				Sub-Total =	**$3,600,000**	**$0**	**$3,600,000**
5	**Cloverdale Trunk Sewer (56 Ave. to 68 Ave.)[3]**						
5.1	900mm sewer (arterial road)	lin.m.	$3,013	1,064	$3,205,832		$3,205,832
5.2	1350mm sewer (arterial road)	lin.m.	$4,413	1,056	$4,660,128		$4,660,128
				Sub-Total =	**$7,865,960**	**$0**	**$7,865,960**
				TOTAL (excl. GST) =	**$20,798,189**	**$7,277,184**	**$13,521,005**

1. Unit Prices were provided by the City of Surrey Engineering Department and represent their 2016 10-year Capital Planning Unit Costs and include 12% engineering and 15% contingency allowance
2. Costs for sewer mains inside the NCP are for upsize amount only, which is the amount above the minimum required 200mm diameter cost and flows < 40 L/s
3. Base sewer costs for North Cloverdale Trunk Sewer and upgrades to Cloverdale Trunk Sewer are charged to West Clayton, and upsize contribution is allocated to future North Clayton NCP
4. North Cloverdale Trunk sewer unit rates through vacant areas include right-of-way costs at $1,000,000 / acre x 20% factor and based on a 6m ROW width
5. Nominal sizes for HDPE, actual internal diameters used for analysis.



SECTION 10
Water

SECTION 10: Water

10.1 EXISTING WATER SERVICING

10.1.1 Study Area

The majority of the West Clayton area is located within the 115m Clayton Pressure Zone with some agricultural/rural properties along the northwest boundary falling within the Cloverdale 90m HGL zone. The NCP area is served from a number of sources including the Clayton Reservoir and Pump Station, the PRV at the old Clayton Pump Station, as well as a PRV from the Metro Vancouver supply main on 72 Avenue and 184 Street. There is a Metro Vancouver PRV located at Fraser Highway and Harvie Road, however it does not have capacity to service the NCP.

There are several key issues that will need to be reviewed and analyzed in order to properly service the NCP:

- Determine if the City's 184 Street / 72 Avenue PRV and existing connection to Metro Vancouver can supply the 90m pressure zone or does the NCP require servicing off Metro's Clayton Reservoir (90m HGL).
- Maximize the limits of the 90m HGL pressure zone to reduce the pumping requirements for the City's Clayton Booster Station and maximize its usage for the 115m zone.
- Adjust the existing pressure zone boundary between the 115m and the 90m zones.
- Tie-in the City's major grid network south of Fraser Highway (90m zone) to the West Clayton 90m zone, which will provide system redundancy.
- Consider a future interconnection between the Cloverdale 90m zone and the Anniedale – Tynehead 90m zone.
- Address poor fire flow results both in the West Clayton area and to the east, especially north of 72 Avenue.

10.1.2 Existing Water Distribution System

Within the West Clayton NCP boundary there is currently very limited water infrastructure servicing the existing large, rural lots and agricultural land reserve (ALR). In general, the area is either serviced by small 150mm and 200mm watermains that dead-end at the ALR, or by private wells. The NCP area falls within the 115m HGL pressure zone, while the properties along the southwest boundary are situated along the 90-115m pressure zone boundary. **Figure 10.1** shows the existing water distribution system and pressure zone boundaries for the West Clayton NCP area.

Water supply to the area is provided by the Metro Vancouver 900mm Whalley/Clayton and 900mm Jericho/Clayton feeder mains that supply the Clayton Reservoir (90m HGL) at 72 Avenue and 190 Street. In winter months the HGL in Metro's main can exceed 115m, but during peak demand in summer months the feeder main's HGL can drop below 90m. This fluctuation in supply HGL impacts how the City operates their distribution system and how the NCP area can be serviced. For instance, when the feeder main operates above 90m HGL the water level in the Clayton Reservoir can drop to 85m due to volumes required to provide balancing storage.

The City operates a booster station (Clayton Booster Station) that pumps water from the 90m reservoir to a 115m HGL, and distributes this HGL to the City's system. The City's PRV at the old Clayton Pump Station services the 115m pressure zone regularly in the winter. The City also has a 150mm PRV at 72 Avenue and 184 Street that operates directly off Metro Vancouver's feeder main. With a PRV setting of 112.7m HGL, coupled with the significant seasonal fluctuations in Metro's HGL, this 72 Avenue PRV rarely operates.

10.1.3 Previous Studies

Several background reports and studies utilizing WaterCAD modelling software have been reviewed to further understand the existing water distribution system and identify opportunities and constraints. Background reports include:

- Earth Tech (2005) Clayton and Cloverdale Water Supply Planning.
- CH2M Hill (2006) Clayton Water Pumping Station Pre-Design Report.
- AECOM (2010) Clayton Cloverdale Water Model Upgrade Report.

The previous extensive modelling work for the City using the WaterCAD model and development of the 2010 Clayton Cloverdale Water Model Upgrade will be used as the basis of understanding the current conditions for the study area as well as determining how the NCP area will be serviced.

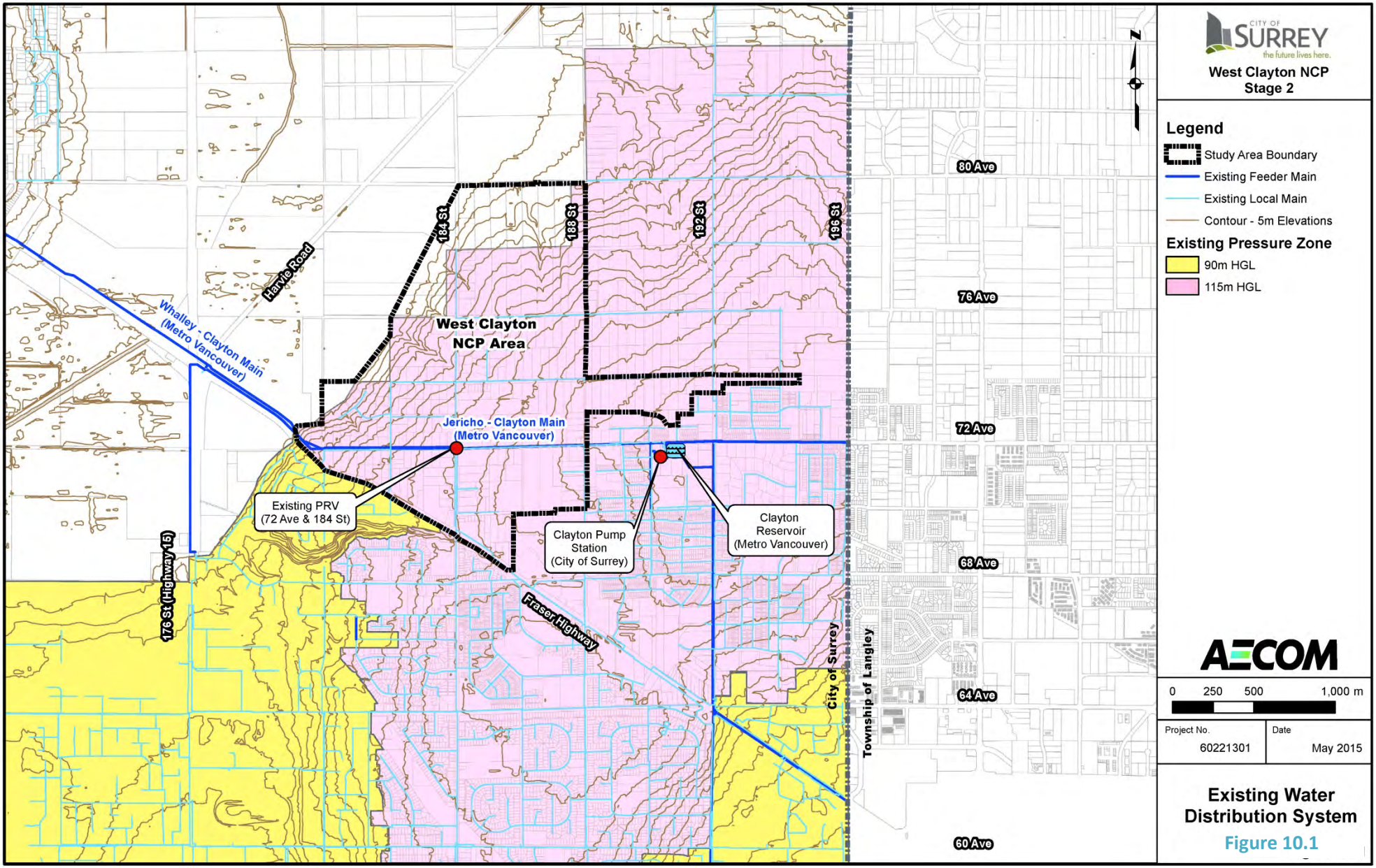


Figure 10.1 Existing Water Distribution System

10.1.4 Clayton Booster Station Capacity

The 2010 Clayton Cloverdale Water Model Upgrade Report by AECOM completed a review of existing flows and capacity of the Clayton Pump Station. This station is currently designed to have a capacity of 67 ML/d (or 775 L/s) and CH2M Hill's 2006 report envisions an ultimate capacity of 120 ML/d (1,389 L/s) will be required for peak hour periods. The station has been designed to accommodate installation of two new additional pumps to increase the ultimate capacity to 1,389 L/s without the need for significant improvements to the building, discharge piping or additional property.

Bulk meter data for Clayton and Cloverdale were reviewed in the 2010 AECOM report which is summarized in Table 10.1. Bulk data for the Clayton zone was based on connections from the Clayton Reservoir, Clayton Pump Station, and the 72 Avenue & 184 Street PRV, while bulk data for the Cloverdale zone was based on connections at 68A Avenue & 176 Street, 54 Avenue & 192 Street, and the PRV at 194 Street & Fraser Highway. The highest demand recorded in recent years occurred in the summer of 2006, followed by the summer of 2009.

Table 10.1 Bulk Meter Flow Data

	Year	MDD (L/s)	PHD (L/s)
Clayton - 115m Zone	2006	261	417
	2009	190	360
Cloverdale 90m Zone	2006	275	439
	2009	186	383

10.1.5 Future Servicing

For providing water servicing to the NCP area, it is important to assess both the NCP requirements as well as the long-term servicing plan for the surrounding area as development continues; plus any future development or NCP's such as the "Future North Clayton NCP". The overall servicing strategy prepared for the NCP takes into consideration the entire Clayton area.

West Clayton NCP Area

The West Clayton NCP land use plan forms the basis of the engineering servicing analysis.

In general, it is proposed that the northern and western portions of the NCP be serviced by the 90m pressure zone, which is either from the Clayton Reservoir or the PRV directly connected to Metro's feeder mains. The anticipated top servicing elevation for the 90m pressure zone is based on the residual pressure requirements outlined in the City's Engineering Design Criteria. Accounting for some headloss in the watermains and considering the head in the Clayton Reservoir can drop as low as 85m in the summer, the 55m contour elevation was identified as the approximate pressure zone boundary.

For system redundancy, the 90m pressure zone in West Clayton should be interconnected to the existing 90m zone south of Fraser Highway. Provisions should be made for a future interconnection to the Anniedale – Tynehead 90m zone via a future watermain north on 184 Street or 188 Street. The southern and eastern portions of the NCP should be serviced by the existing 115m pressure zone, supplied by the Clayton Booster Station.

Future "North Clayton" NCP

The future North Clayton NCP is the 261 hectare area located east of 188 Street and north of 74 Avenue. The topography of the future NCP area ranges from 28m to 62m, meaning it would also span the 90m and 115m pressure zones. The portion of the future North Clayton NCP below the 55m contour can therefore be serviced by the 90m pressure zone.

The pressure zone boundary will add a total area of 115 hectares to the 90m HGL zone, while the remaining 146 hectares will be serviced by the 115m HGL zone. These estimates will be used to generate population and water demand projections for the future North Clayton NCP area (refer to Section 10.2 for more details).

Surrounding Clayton – Cloverdale Area

Presently the Clayton-Cloverdale area (including East Clayton) adjacent to the West Clayton NCP is located within the 115m pressure zone, which is serviced by the Clayton Booster Station. As this area continues to develop there will be increasing water demands and pumping requirements for the Clayton Booster Station. As such, the capacity assessment of the Clayton Booster Station needs to consider the ultimate demand conditions from the West Clayton NCP + future "North Clayton" NCP + build-out of surrounding area. Water demand projections for the surrounding Clayton – Cloverdale area are discussed in Section 10.2.

10.2 DESIGN CRITERIA AND ANALYSIS

10.2.1 Design Criteria

The City of Surrey Design Criteria Manual has been used for servicing criteria for this NCP, and provisions for future development. This includes water demand rates, minimum pressure, and fire flow requirements. Parameters to be used for the assessment of the water distribution system for this NCP:

- Average Day Water Demand per Person (ADD): A demand factor of 500 L/d/capita.
- Maximum Day Water Demand per Person (MDD): A demand factor of 1,000 L/d/capita.
- Peak Day Water Demand per Person (PDD): A demand factor of 2,000 L/d/capita.
- Maximum Day Demand plus Fire Flow (MDD+FF): A minimum pressure of 14m (20psi) is required.
- Peak Hour Demand condition (PHD): A minimum pressure of 28m (40 psi) is required.
- Design Populations by Zoning / Land-Use Designation: Values as per *"Table 3.2 (b) of the City's Engineering Design Criteria Manual".*
- Fire Flow Design Requirements: Values as per *"Table 3.2 (b) of the City's Engineering Design Criteria Manual".*
- Hazen-Williams coefficient is equal to 125 for all new watermains 250mm dia. or larger.
- Hazen-Williams coefficient is equal to 100 for all new watermains 200mm dia. or smaller.
- Headloss in the watermains shall not exceed 5 m/km, and is preferred to be less than 2.5 m/km.
- Flow velocity within pipes shall not exceed 2 m/s for ultimate design flows, and where interim fire flow is permitted, the velocity of flow shall not exceed 3.25 m/s.
- All watermains shall be looped except for short length (<100m) for cul-de-sacs.
- Clayton Reservoir has a Top Water Level of 85.0m during Max Day + Fire and Peak Hour Scenarios.

10.2.2 Water Demand Projections

Peak demands for the NCP land-use were generated using parcel size and zoning densities, with equivalent populations for commercial and institutional demands. There are currently no industrial areas proposed in the NCP. In addition to using zoning densities as outlined in *"Table 2.6 (b) of the City's Engineering Design Criteria Manual"*, allowances for secondary suites were included in the population projections.

The following list summarizes the population densities used to estimate the populations within the West Clayton NCP:

- Single Family with Secondary Suite Density of 5.33 people per lot (3.56 people in main dwelling + 1.77 people in Suite)
- Single Family Household Size of 3.56 people per dwelling
- Townhouse Household Size of 2.69 people per unit
- Apartment Household Size of 1.43 people per unit
- Commercial: 60 people / ha;
- Mixed use Commercial / Residential: 196 people / ha; and,
- Institutional (school and child care facilities): 50 people / ha.
- Recreational: 50 people / ha

For land uses with a Floor Area Ratio (FAR) greater than 1, the FAR factor was applied to the estimated population over the gross lot area. FARs less than 1 were not applied in order to maintain conservative estimates; this relates to the commercial area at 184 Street and 74 Avenue, and the commercial area north of 72 Avenue at 188 Street.

The total estimated population NCP is 21,792, which includes secondary suites and institutional/commercial equivalent population. Allocating the population distribution using the proposed land use plan, the population of the 90m zone is estimated to be 12,403 and the population of the 115m zone is estimated to be 9,389.

Future "North Clayton" NCP

It is anticipated that the land-use within the future "North Clayton" NCP will be very similar to that proposed for West Clayton NCP, and likewise similar to the East Clayton NCP area. To estimate the potential future population, and water demands, for the future "North Clayton" NCP the average population density of 100 people equivalents per gross land hectare was used (derived from West Clayton NCP with a 15% growth factor).

This approach is reasonable if the future "North Clayton" NCP has a similar percentage of land-area designated for parks, creeks, riparian areas and road right-of-ways. This approach also ensures that the future "North Clayton" NCP population allowance incorporates secondary suites at all single-family lots, with the assumption that the ratio of single family to multi-family population remains relatively similar to the West Clayton NCP.

Referring to *"Table 3.2 (b) of the City's Engineering Design Criteria Manual"* for design fire flow requirements, the highest required fire flow is 120 L/s for institutional and community commercial zoning. **Table 10.2** summarizes the population and flow demands for the West Clayton NCP and future "North Clayton NCP".

Table 10.2 Population and Water Demands (West Clayton & "North Clayton" NCP)

Area	Pressure Zone	Residential Population	IC Eq. Population	Total Population	ADD (L/s)	MDD (L/s)	MDD+FF (L/s)	PHD (L/s)
West Clayton NCP	90m	12,019	384	12,403	72	144	144 + 120 = 264	287
	115m	8,360	1,029	9,389	54	109	109 + 120 = 229	217
Total		**20,379**	**1,413**	**21,792**	**126**	**252**	**252 + 120 = 372**	**504**
Future North Clayton NCP	90m	10,744	745 [1]	11,489 [2]	66	134	134 + 120 = 254	266
	115m	13,670	948 [1]	14,618 [2]	85	169	169 + 120 = 289	338
Total	**90m zone**	**24,414**	**1,693**	**26,107**	**151**	**303**	**303 + 120 = 423**	**604**

1. *IC Population estimate is based on the ratio from West Clayton NCP*
2. *Population based on equivalent population estimate of 100 people per hectare.*

The City of Surrey estimates the current residential population of the Clayton – Cloverdale area is 69,980 residents. With the addition of the West Clayton and North Clayton NCP's, the residential population would increase to approximately 115,000. City Planning Staff envision the area will develop to 129,770 residents by 2046 – meaning approximately 15,000 residents are expected in the form of infill / densification in Cloverdale. This amount represents a 21% increase over the current residential population, which can be considered a reasonable estimate for infill in relation to other areas that have densified in the City.

To proceed with the analysis, three conditions were identified that would logically take into account the areas that the proposed water distribution strategy would service:

1. **Current Condition**: Existing Clayton - Cloverdale
2. **Interim Condition**: Existing Area + West Clayton NCP.
3. **Long-Range Condition**: Existing Area + Infill + West Clayton NCP + North Clayton NCP

For all three land-use conditions identified above, flow demands for each area were calculated. Flows for both the West Clayton NCP and future "North Clayton NCP" were summarized above in **Table 10.2**.

Table 10.3 below summarizes the estimated flows for each of the three land-use conditions. These flows are summarized by pressure zone to assist in determining overall supply requirements to the zones, which assists in confirming the required supply for the 90m zone as well as the booster station capacity for 115m zone. Infill estimates were spread evenly over both pressure zones. The existing 90m zone demands are supplied by current PRV's and connections therefore the feeder main from Clayton Reservoir and/or the PRV at 184 St and 72 Avenue only needs to convey 90m zone demands for West and North Clayton and not necessarily the "long range" flows for the entire 90m zone for Clayton-Cloverdale.

Table 10.3 90m and 115m Pressure Zone Water Demands

Pressure Zone	1. Current Condition (Existing)			2. Interim Condition (Existing + West Clayton)			3. Long-Range Condition (Existing + Infill + West & North NCP)		
	ADD (L/s)	MDD+FF (L/s)	PHD (L/s)	ADD (L/s)	MDD+FF (L/s)	PHD (L/s)	ADD (L/s)	MDD+FF (L/s)	PHD (L/s)
90m Zone (All Clayton-Cloverdale)	100	275+120=395	439	172	419+120=539	726	282	693+120=759	1166
115m Zone (Clayton PS)	130 +/-	261+120=381	417	184	370+120=490	634	312	626+120=746	1146

10.2.3 Servicing Strategy and Options

A key objective for the water servicing strategy for the NCP is to effectively maximize the use of the existing Metro Vancouver HGL to service the area by residual pressure in the mains, therefore minimizing pumping requirements from the Clayton Pump Station. In other words, the goal is to have as much of the NCP area within the 90m pressure zone as possible, where distribution can be supplied by gravity mains.

The study area ranges in elevation from 0m to 75m (+/-). Properties located below the 55m contour can be serviced by the 90m HGL Zone, with a supply HGL minimum of 85m, while maintaining minimum residual pressures. Minimizing the area supplied by the 115m HGL zone helps to reduce energy costs and reliance on water supplied through the Clayton Booster Station. Servicing the portions of the West Clayton NCP that are within the 115m pressure zone will be via the Clayton Booster Station. The portions of the NCP within the 90m zone can be serviced through the following two options:

Option 1: Clayton Reservoir (90m HGL)

This option would require a new dedicated (90m zone) feeder main along 72 Avenue, from the Clayton Reservoir to 184 Street, where it would service the proposed 90m zone in West Clayton and subsequently the future North Clayton NCP. A disadvantage of this option is that the Clayton Reservoir can operate at levels as low as 85m during summer months meaning under Max Day demands. While the reservoir is being upgraded to include additional storage volume, it would still operate as low as 85m resulting in pressure limitations.

Option 2: PRV at 72 Avenue and 184Street

Currently the City has a PRV and connection to Metro Vancouver's feeder main at 72 Avenue and 184 Street. The PRV is currently set at a HGL of 112.7m, but with the seasonally fluctuating HGL's in Metro's main this PRV rarely operates. This PRV could be replaced with a larger PRV and the setting changed to a 90m HGL, such that it would be the primary supply for the West Clayton NCP's 90m pressure zone. Under max day demands, Metro's Feeder main (and therefore this PRV) operates above 90m HGL therefore this option would ensure the City's 90m zone remains a 90m zone year-round.

Based on initial discussions with Metro Vancouver, all new direct connections to Metro Vancouver watermains are discouraged because of the impact on hydraulics, balancing demands and turn-over in reservoirs. This also applies to significantly increasing demands through existing direct connections.

Since it is unclear if Metro Vancouver's feeder main has adequate capacity to meet the peak demands of the NCP while also meeting existing demands, Option 1 is recommended to form the primary water supply for the NCP. When the future "North Clayton NCP" develops, it is anticipated that its 90m pressure zone will be interconnected to West Clayton; therefore the supply to North Clayton will also be via Option 1, depending on the timing of development.

Figure 10.2 shows the proposed pressure zone boundary for the West Clayton NCP (which is consistent for both servicing options) and the two supply options for the 90m HGL pressure zone.

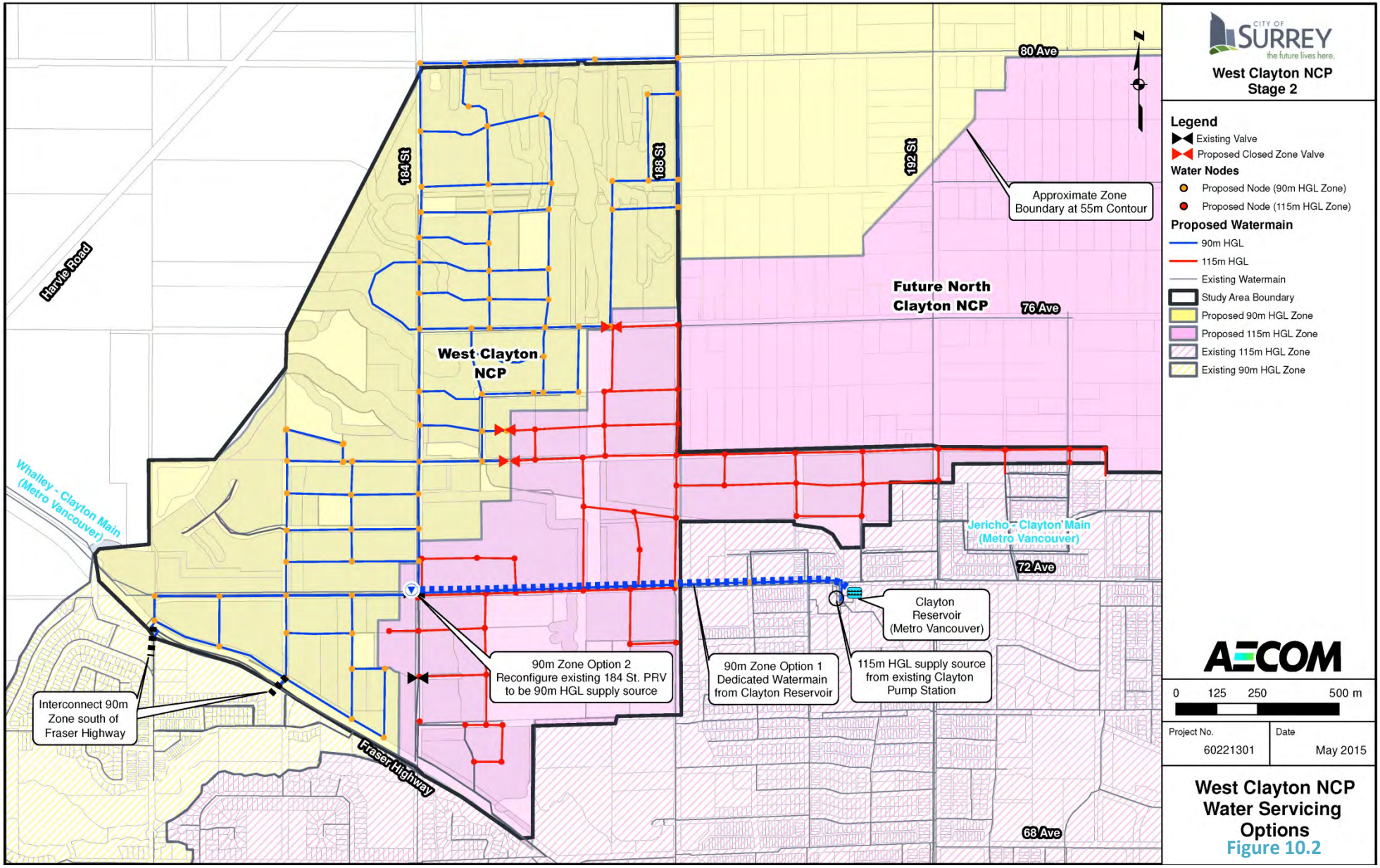


Figure 10.2 Proposed Pressure Zone Boundary

10.2.4 Water Supply Source Analysis by Pressure Zone

115m Pressure Zone

The south and eastern portions of the NCP are located in the 115m pressure zone and will be serviced by the existing Clayton Booster Station. The station has a current design capacity of 775 L/s (as identified in the *2006 CH2M Hill* report) which includes capacity reserved for development in East Clayton and other portions of Clayton – Cloverdale. Thus, the capacity of 775 L/s cannot be relied upon to solely service existing properties plus the West Clayton NCP.

From **Table 10.3**, under the interim land-use condition (Existing demands + West Clayton NCP) the governing demand condition for the 115m zone is Peak Hour Demand of which the PHD is predicted to be 634 L/s. This PHD rate of 634 L/s is based on the current PHD of 417 L/s + 217 L/s for West Clayton PHD (as per **Table 10.2**).

In the long-range, it is estimated that the capacity of the Clayton Booster Station should be 1,146 L/s, which would include servicing portions of the West Clayton NCP and future "North Clayton NCP". The station has a capacity of 775 L/s and overall the building and discharge piping is designed for a capacity of 1,389 L/s with the intention that two (2) additional pumps would be required (each of capacity 300 L/s +/-). Therefore in order to service West Clayton NCP at least one (1) – 300 L/s pump would be required for the booster station. When the "North Clayton NCP" develops, it will likely require the additional pump and a 450mm feeder main from the Clayton Booster Station.

90m Pressure Zone

The existing Clayton-Cloverdale zone has a Peak Hour Demand of 439 L/s, which is supplied by existing PRV connections to Metro Vancouver. With the addition of the West Clayton NCP, the Peak Hour Demand for the 90m zone (existing + West Clayton) is predicted to increase to 726 L/s as noted previously in **Table 10.3**. This 287 L/s increase is solely for the West Clayton NCP.

Referring again to **Table 10.3**, if the future "North Clayton NCP" develops as well, the combined West + North Clayton 90m zone peak demand is 553 L/s and the entire Clayton-Cloverdale 90m pressure zone is estimated to be 1,166 L/s. Servicing the West + North Clayton 90m zone will require a large feeder main to the Clayton Reservoir, as well as interconnections to the existing 90m zone south of Fraser Highway to balance pressure and provide redundancy (as described in Option 1).

In summary, the servicing strategy for the 90m zone is as follows:

- Utilize existing PRV connections to Metro and the Clayton Reservoir to supply existing 90m zone demands;
- The Clayton Reservoir's inlet/outlet piping should be upgraded to meet the servicing requirements of the West + North Clayton 90m Zone;
- A proposed feeder main on 72 Avenue, from the Clayton Reservoir to 188 Street, should be sized to convey the long-range Peak Hour Demand for the West + North Clayton 90m zone.

10.2.5 Hydraulic Analysis

The hydraulic analysis for the study area was conducted using WaterCAD software. This takes advantage of the water model AECOM previously created for the Clayton Cloverdale Water Model Upgrade Report (2010). WaterCAD models hydraulics, operations, and fire flows of pipe networks. The water distribution system is represented as links (water mains) and nodes (junctions, hydrants, and valves). Pipe hydraulics are calculated using parameters of pipe diameter, roughness, elevation and length. Demands, including fire flow requirements, are applied at nodes.

To analyze the servicing strategy both Maximum Day Demand + Fire Flow, and Peak Hour Demand scenarios were created with the proposed pipe network.

Results from the WaterCAD model for residual pressure (psi) in each node with velocities, and headloss gradient (m/km) for each pipe are shown in the following figures:

- **Figure 10.3**: Proposed Water System MDD + FF;
- **Figure 10.4**: Proposed Water System PHD (Pressures and Velocities); and,
- **Figure 10.5**: Proposed Water System PHD (Headloss Gradient).

Figure 10.3 indicates that the flows for each node under MDD+FF are well above the fire flow requirement of 120 L/s. As well, all distribution node pressures are above 40 psi. **Figure 10.4** shows that all proposed watermain velocities are less than 2.0 m/s under peak hour conditions, which is the governing flow condition for the area. **Figure 10.5** shows that within the proposed water distribution system, there are no watermains that experience a headloss greater than 5 m/km.

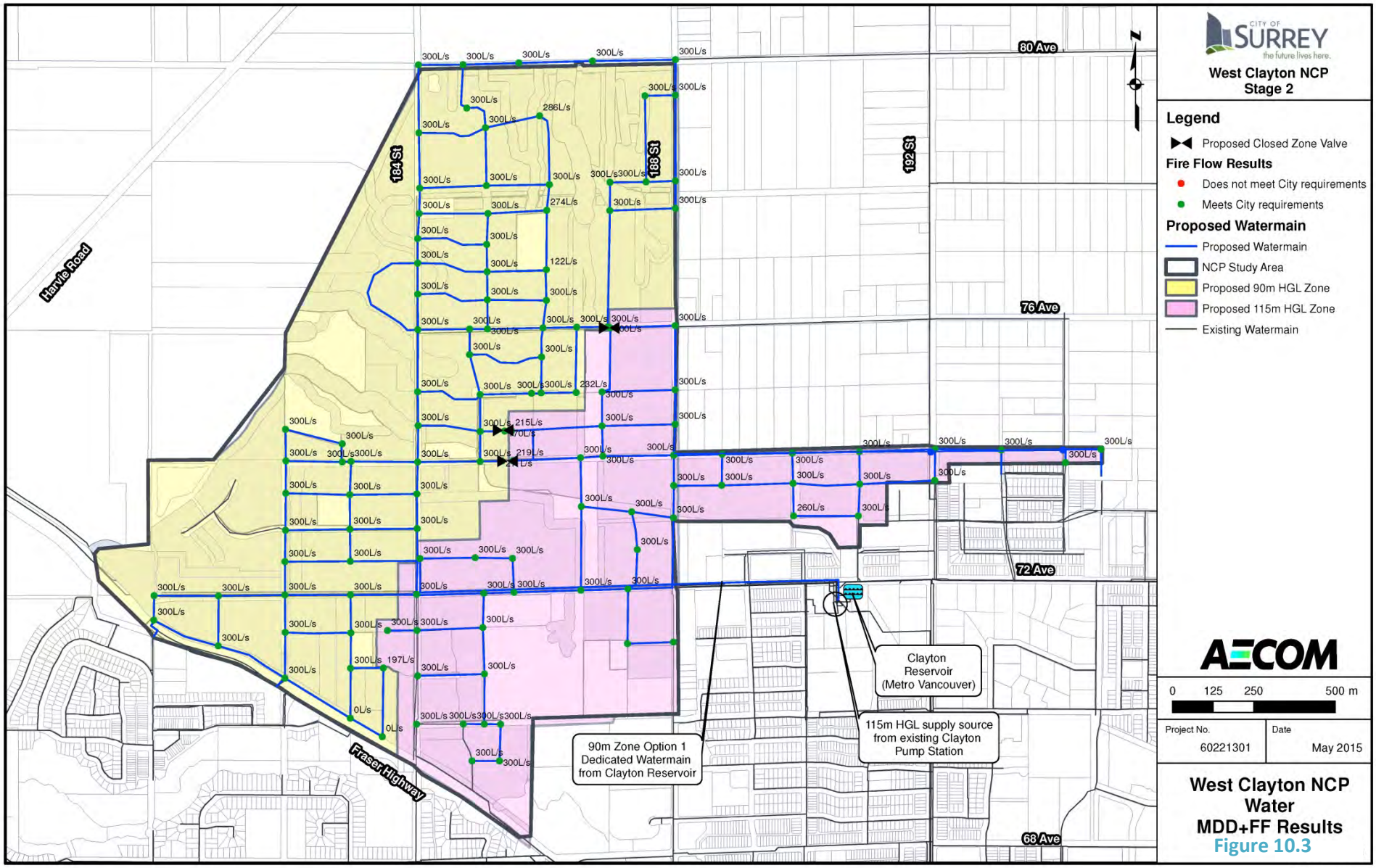


Figure 10.3 West Clayton NCP Water MDD+FF Results

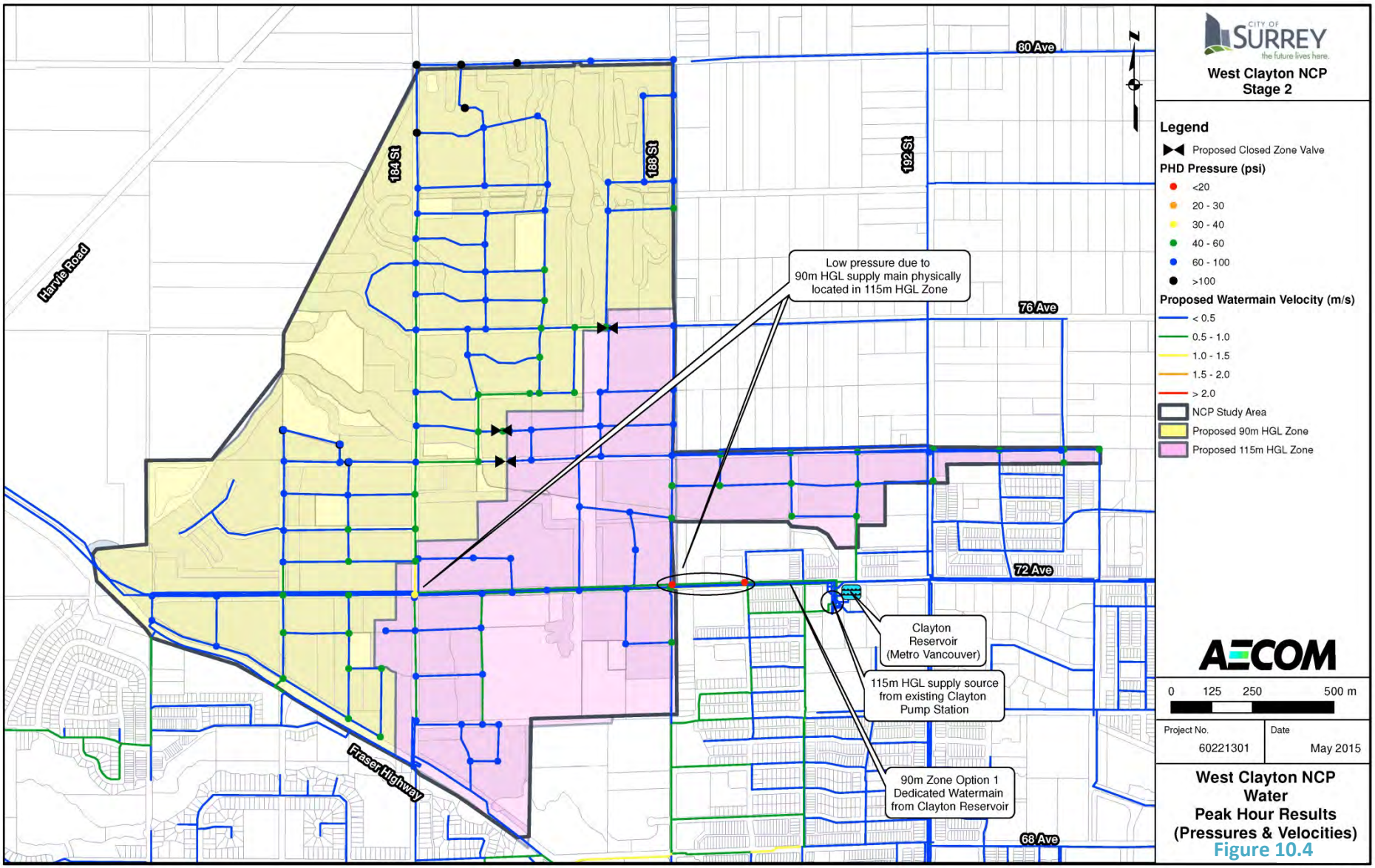


Figure 10.4 West Clayton NCP Water Peak Hour Results (Pressure and Velocity)

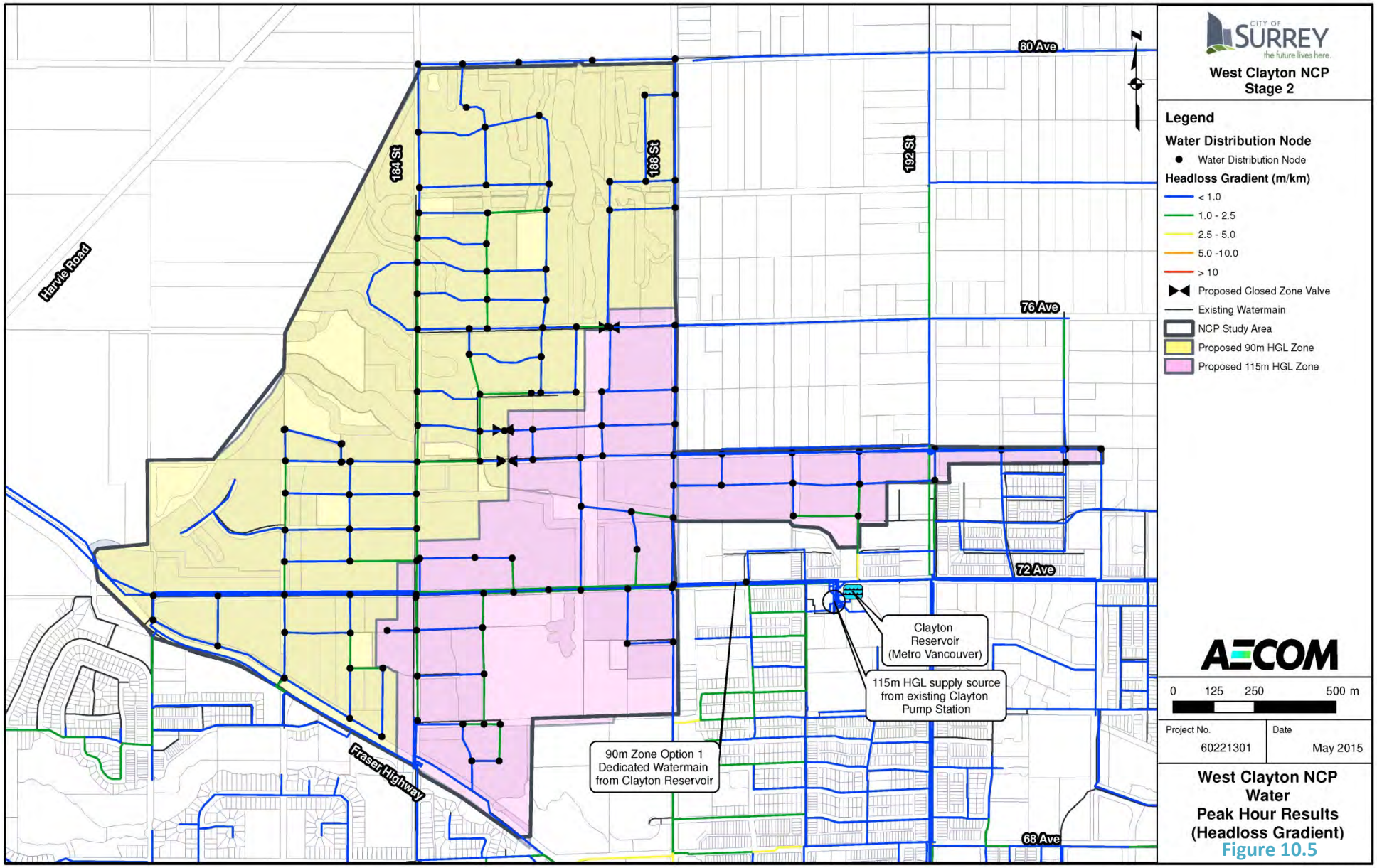


Figure 10.5 West Clayton NCP Water Peak Hour Results (Headloss Gradient)

10.3 PROPOSED SYSTEM

10.3.1 Recommended Option

The long-term servicing strategy for the West Clayton NCP is to:

(i) service the 115m pressure zone via the existing Clayton Booster Station, which will require an upgrade to service the build-out of the NCP; and,
(ii) service the 90m pressure zone by constructing a 750mm feeder main on 72 Avenue from the Clayton Reservoir to 188 Street, and a 600mm feeder main from 188 Street to 184 Street.

For the future "North Clayton NCP" the long-term strategy would be to extend a large diameter main north on 188 Street to 76 Avenue. Depending on the timing of development in North Clayton versus Anniedale – Tynehead, a subsequent supply option could be to interconnect the Anniedale – Tynehead 90m zone to the North Clayton NCP. A minimum 300mm watermain will be installed on 184 Street to 80 Avenue to allow for a future 90m zone connection to the Anniedale-Tynehead.

The recommended long-term strategy and capital upgrades required to service the West Clayton NCP are summarized on **Figure 10.6**. This includes the recommended supply sources and watermain diameters. It is important to note that the watermain diameters recommended are based on the interim network. Because development does not all occur simultaneously, the water network will be constructed in segments which may result in temporary dead-ends. Under these interim conditions a larger diameter watermain (i.e. 300mm vs 200mm) may be required to satisfy the fire protection or peak hour requirements, where a fully looped network of smaller mains may be sufficient. For this reason mains on arterial and major collector roads have been sized at a minimum 300mm diameter. In addition to the proposed water network through the NCP area, there are a few significant "off-site" capital upgrades that are required by the NCP and these are summarized below for each pressure zone:

90m Zone

- Construct a 750mm watermain on 72 Avenue, from Clayton Reservoir to 188 Street. A 600mm watermain would be required for the West Clayton NCP but it is recommended to be upsized to a 750mm watermain to also service the future "North Clayton" NCP;
- Construct a 600mm watermain on 72 Avenue, from 184 St to 188 St, for West Clayton's 90m zone. This will provide the primary water supply to the zone as its source will be from supplied by the Clayton Reservoir.
- Interconnect to existing 300mm watermain on 180 Street and Fraser Highway (proposed 90m zone interconnection).
- Interconnect to existing 300mm watermain on north side of Fraser Highway at 182 Street (proposed 90m zone interconnection).
- A dedicated 600mm watermain will be required on 188 Street, from 72 Avenue to 78 Avenue, to service the future "North Clayton NCP".

115m Zone

- Add one (1) additional pump to the Clayton Booster Station, with a capacity of approximately 300 L/s.
- Upgrade watermains on 72 Avenue, from 184 Street to 188 Street to 450mm diameter to meet PHD criteria in the 115m zone.

- Utilize the existing 400mm watermains on 188 Street, south of 72 Avenue, to supply the 115m zone.
- Utilize existing 300mm watermains on 184 Street, from 72 Avenue to Fraser Highway to supply 115m zone.
- A dedicated 450mm watermain will be required from the Clayton Booster Station to service the future "North Clayton NCP" 115m zone.

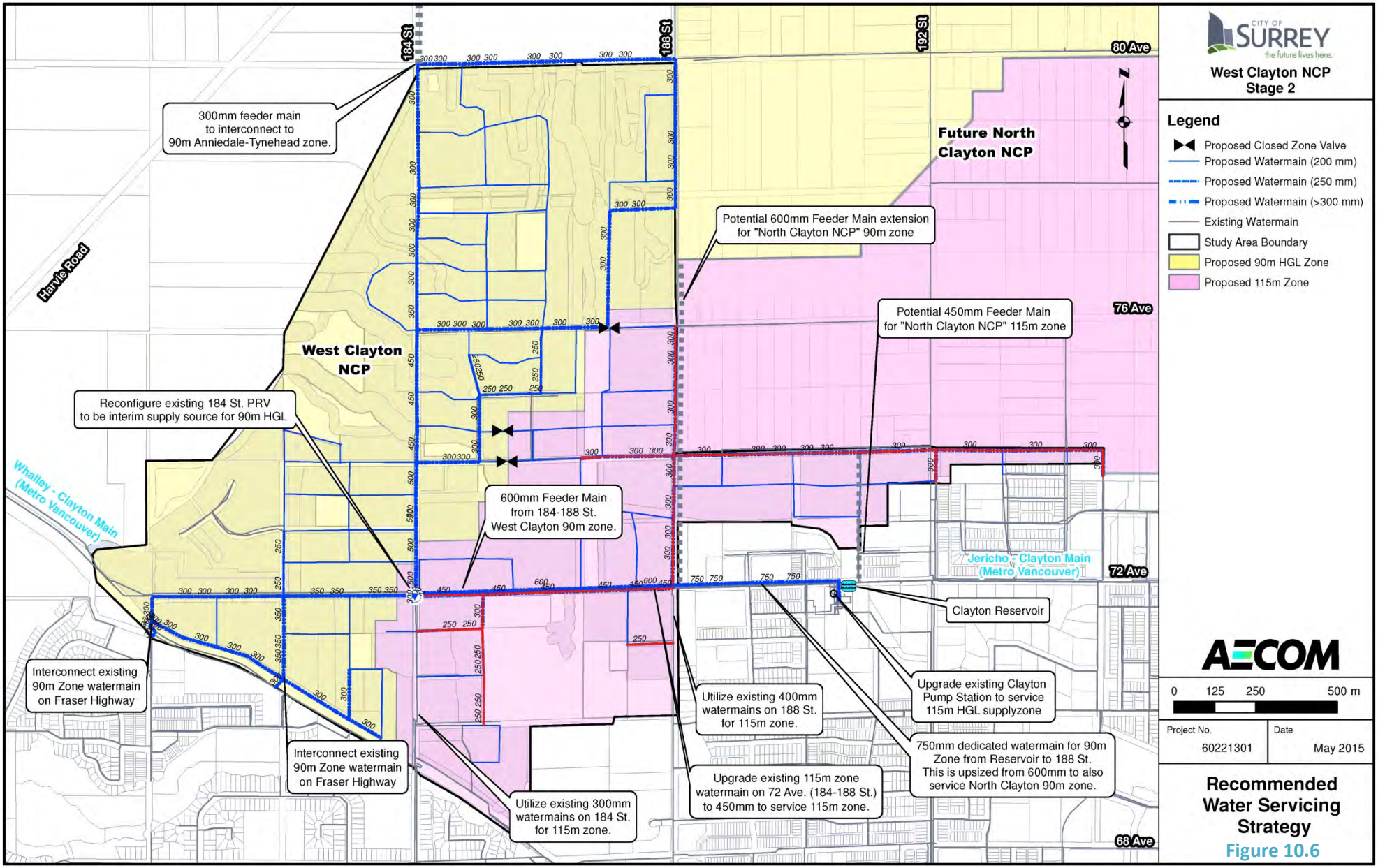


Figure 10.6 Recommended Water Servicing Strategy

10.3.2 Interim Phasing

90m Zone

At this time there is no 90m Zone servicing within the NCP area. For development to proceed, a 90m Zone water supply needs to be constructed. The primary supply for the NCP will be the proposed feeder main from the Clayton Reservoir to be constructed from 190 Street to 184 Street.

The City currently has a 150mm PRV at the intersection of 184 Street and 72 Avenue. The 150mm PRV has an existing capacity of 106 L/s, based on the manufacture's recommendation of a maximum velocity of 6 m/s. The PRV could be reconfigured to serve as the interim supply for the proposed 90m Zone. The existing population in the area is approximately 500 residents, which equates to a Max Day demand of 5.8 L/s (500 people x 1000 L/capita/day). This results in the existing 150mm PRV having a spare capacity of 100 L/s.

This PRV would be required to provide fire protection to the West Clayton 90m zone, and the City's interim fire flow requirements range from 45 L/s for single-family to 90 L/s for multi-family and commercial land-use. The following summarizes the available capacity of the 150mm PRV based on the potential land-uses proposed for development:

- PRV capacity 106 L/s = Fire Flow 45 L/s (single family) + 6 L/s (current MDD) +55 L/s (excess)
- PRV capacity 106 L/s = Fire Flow 90 L/s (multi-family/commercial) + 6 L/s (current MDD) + 10 L/s (excess)
- PRV capacity 106 L/s = no spare capacity for design fire flow of 120 L/s (Commercial and Multifamily)

The PRV could be used to service the initial stages of development before construction of the 72 Avenue feeder main is complete. The proposed land use in the 90m pressure zone between 74 Avenue and Fraser Highway is predominantly townhouses, medium density clusters, and mixed use commercial developments; therefore, the existing PRV station would have 10 L/s of capacity provided interim fire flow criteria are used. To provide redundancy, the mains interconnecting with the existing 90m Zone south of Fraser Highway should be constructed in the early stages of development.

115m Zone

At this time, the existing Clayton Booster Station and watermain network in the 115m zone has spare capacity for development within West Clayton as well as continued development in East Clayton – Cloverdale areas. The booster stations current capacity of 775 L/s is significant higher than the 2006 Peak Hour Demands of 417 L/s. While development has occurred in the 115m zone and water demands have increased since 2006, it is anticipated there is likely on the order of 200 L/s of spare capacity in the existing booster station.

10.4 COSTS AND FINANCING

To satisfy anticipated fire flow and peak hour demand requirements, the West Clayton NCP will require a looped watermain network supplied by a feeder main from the Clayton Reservoir for the 90m zone, and an upgrade to the existing Clayton Booster Station (115m zone).

The total cost of infrastructure improvements required to service the NCP area is estimated at ***$8.1 million*** and the eligible DCC expenditures for the West Clayton NCP area are ***$7.5 million***, and the eligible DCC expenditures for the future "North Clayton NCP" area are ***$0.6 million***, as shown in **Table 10.4**.

Table 10.4 Water Infrastructure Servicing Cost Estimate

Ref No.	Description	Unit	Unit Price[1]	Quantity	DCC Cost	DCC Split Between West Clayton & North Clayton NCP	
						West Clayton NCP	North Clayton NCP
1	Water Distribution System - 115m HGL Zone						
1.1	250mm Distribution Main[2]	lin.m.	$200	640	$128,000	$128,000	
1.2	300mm Distribution Main[2]	lin.m.	$250	2,696	$674,000	$674,000	
1.3	450mm Feeder Main	lin.m.	$1,350	788	$1,063,800	$1,063,800	
				Sub-Total =	**$1,865,800**	**$1,865,800**	**$0**
2	Water Distribution System - 90m HGL Zone						
2.1	250mm Distribution Main[2]	lin.m.	$200	713	$142,600	$142,600	
2.2	300mm Distribution Main[2]	lin.m.	$250	5,022	$1,255,500	$1,255,500	
2.3	350mm Feeder Main[2]	lin.m.	$350	784	$274,400	$274,400	
2.4	450mm Feeder Main	lin.m.	$1,350	407	$549,450	$549,450	
2.5	500mm Feeder Main	lin.m.	$1,450	407	$590,150	$590,150	
2.6	600mm Feeder Main	lin.m.	$1,600	795	$1,272,000	$1,272,000	
2.7	750mm Feeder Main	lin.m.	$2,100	567	$1,190,700	$619,164	$571,536
				Sub-Total =	**$5,274,800**	**$4,703,264**	**$571,536**
3	PRV Upgrade						
3.1	1 - 150mm PRV	each	$220,000	1	$220,000	$220,000	
				Sub-Total =	**$220,000**	**$220,000**	**$0**
4	Clayton Booster Station Upgrade						
4.1	1 - 300 L/s Additional Pump	each	$750,000	1	$750,000	$750,000	
				Sub-Total =	**$750,000**	**$750,000**	**$0**
				TOTAL (excl. GST)	$8,110,600	$7,539,064	$571,536

1. Unit Prices were provided by the City of Surrey Engineering Department and represent their 2016 unit rates and include 12% engineering and 15% contingency allowances.
2. Costs are for upsize amount only, which is the amount above the minimum required 200mm diameter cost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PART C

Appendices and Acknowledgements

A-1 Corporate Reports (Stage I and Stage 2)

A-2 Background Studies

- i. Environmental Study
- ii. Energy Efficiency Study
- iii. Transportation Study
- iv. Commercial Viability Study
- v. Engineering Servicing Studies

A-3 Summary of Public Consultation Feedback and Results

A-4 Sustainability Charter Objective Tables

ACKNOWLEDGMENTS

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Neighbourhood Concept Plan

Planning and Development &
Engineering Departments

City of Surrey
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Approved by Council July 2015

CITY OF SURREY