A COMMUNITY CORRIDOR

Community Contributions

There are a number of community gardens, art projects, and grassroots activities that continue to emerge on and around the Arbutus Corridor since its temporary paving, including cycling, dance parties, yoga, picnics and Tai Chi. This enhanced activity demonstrates that the Corridor is not just a linear pathway, but a series of gems cherished by the community.

Community expressions along the Corridor are varied in style and location, with specific “hot spots” of activity observed in 2017, as shown on the adjacent map.

An important consideration for future planning of the Greenway will be how it’s managed, including opportunities to involve more volunteers and local stewardship.

These regularly occurring community expressions are undertaken both in partnership with and independently of the City.

Stewardship

Community and Victory Gardens

Works of Art

COMMUNITY ART

There have been a number of artistic efforts made by members of the local community to add some aesthetic enhancements to the Arbutus Corridor. Currently, these are the only artistic presence of any kind that can be experienced while on the corridor itself. These projects are primarily ephemeral in nature.

For example, Rainbow Rocks is a linear installation of multi-coloured rocks along the edges of the corridor near Nanton Street. Artist Toni Latour worked with Grade 2 students from York House as they painted the rocks and wrote messages on them.

Near 16th Avenue, a bright blue wooden box was converted into a sign that reads "Artbutus" under a painter's palette covered with paint splotches of many different colours.

Other examples of community art include:

- Tree house perched in Quilchena Park
- Pollinator Park painting - a brightly coloured painted mural of flowers, lady bugs, bees and butterflies that embellishes the asphalt near the southern terminus of the greenway and calls to mind the pollinator strategy being implemented by the City
- Recreations of historic rail signage at street crossings near Broadway Street

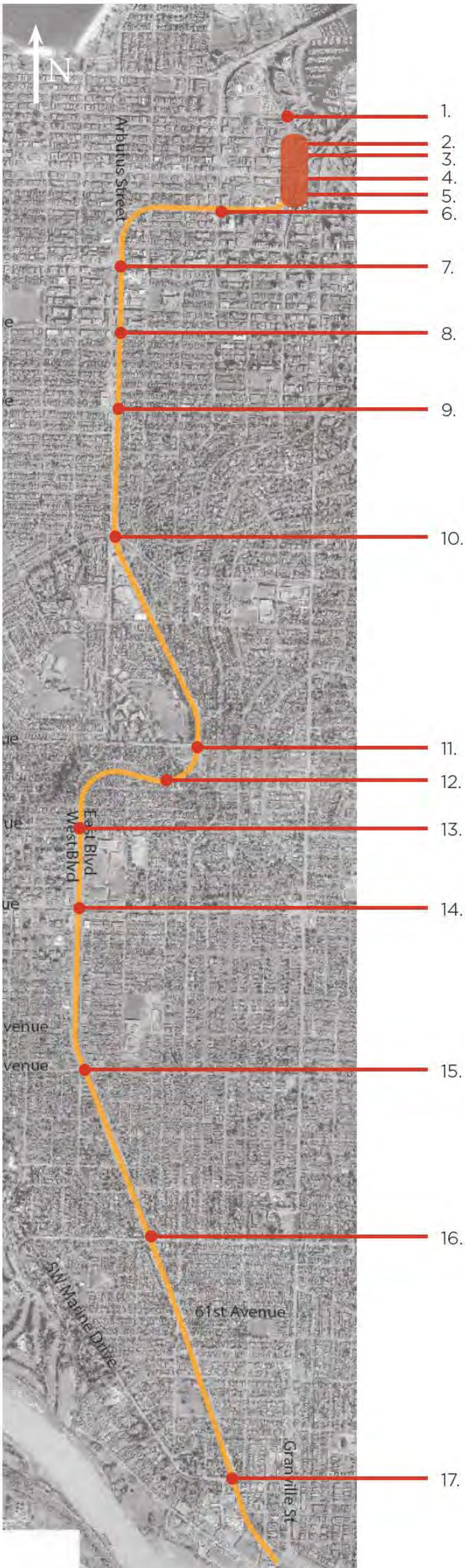
These flourishes and embellishments seem to have arisen out of a lovely sense of appreciation by local residents and students for this new civic asset.

The future Arbutus Greenway will offer significant opportunities for a varied, robust, context-sensitive collection of public art throughout the Greenway. Opportunities for public art will be investigated through the development of the Arbutus Greenway Project Public Art Master Plan.


Thank you for mak
the Arbutus corridor
more beautiful!

SIGNAL BOX GUERRILLA ART

A local resident has been painting the leftover railway signal boxes all along the greenway in brightly coloured harlequin patterns that evoke minimalist colour field painting, as documented on the following page. Colour choices seem to be made carefully and take queues from the immediate surroundings.




1. 1st Avenue: Before and After


2. 2nd Avenue - Currently unaltered


3. 3rd Avenue


4. 4th Avenue


5. Fir Street


6. Burrard Street


7. West Broadway


8. 12th Avenue


9. 16th Avenue


10. King Edward


11. 33rd Avenue - Currently unaltered


12. Cypress Street


13. 37th Avenue - Before Removal


14. 41st Avenue


15. 49th Avenue - Currently unaltered


16. 57th Avenue


17. South West Marine Drive

Community Gardens

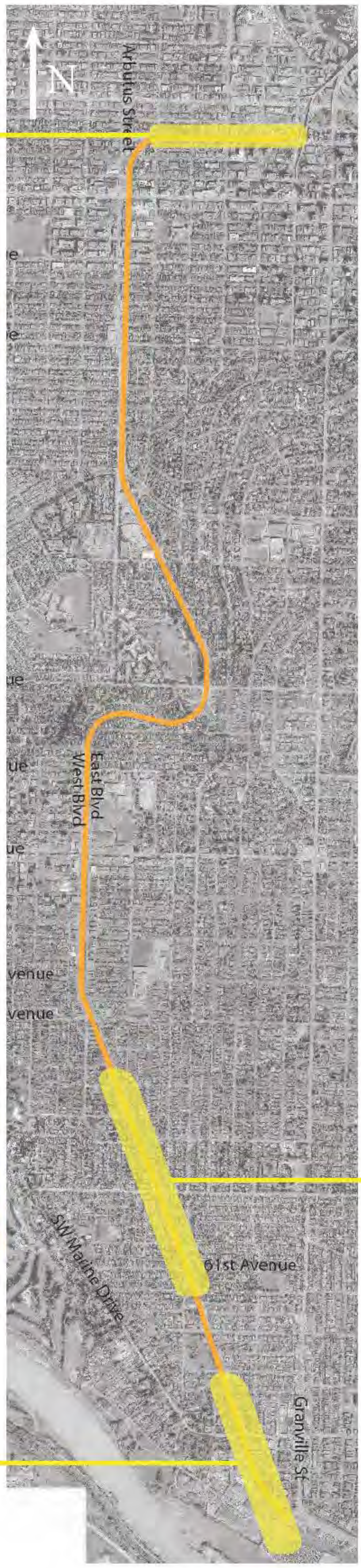
Dr. Donald Flather established the Arbutus Victory Gardens, located between 65th Avenue and South West Marine Drive in 1942 in response to the government's call to action for food production to support Britain during World War II. When the war ended, Dr. Flather and several of his neighbours continued the gardens.

In Vancouver, community gardens are formalized when they are located on City-owned land, with membership and plot allotments that are managed by Community Garden Associations.

There are four community gardens along 6th Avenue, between Fir Street and Maple Street. Pine Street Gardens was most recently established in the early 2000s, while other gardens date back to the 1980s. The World in a Garden and the Kerrisdale Community Garden span seven blocks along the east side of the Corridor between 50th Avenue and 57th Avenue.

There are also a number of community gardens on private property, which has created a park-like setting along the Corridor and demonstrates the strong community investment in the area.

6th Avenue Gardens



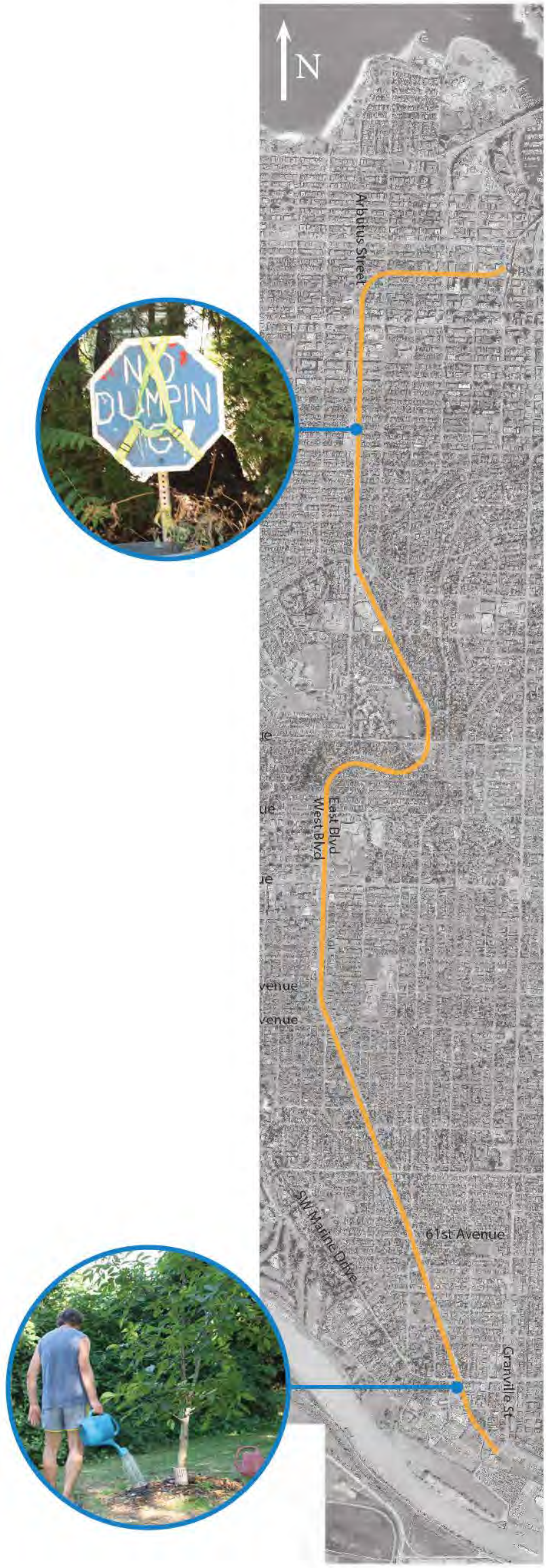
50th to 57th

65th to South West Marine Drive

STEWARDSHIP

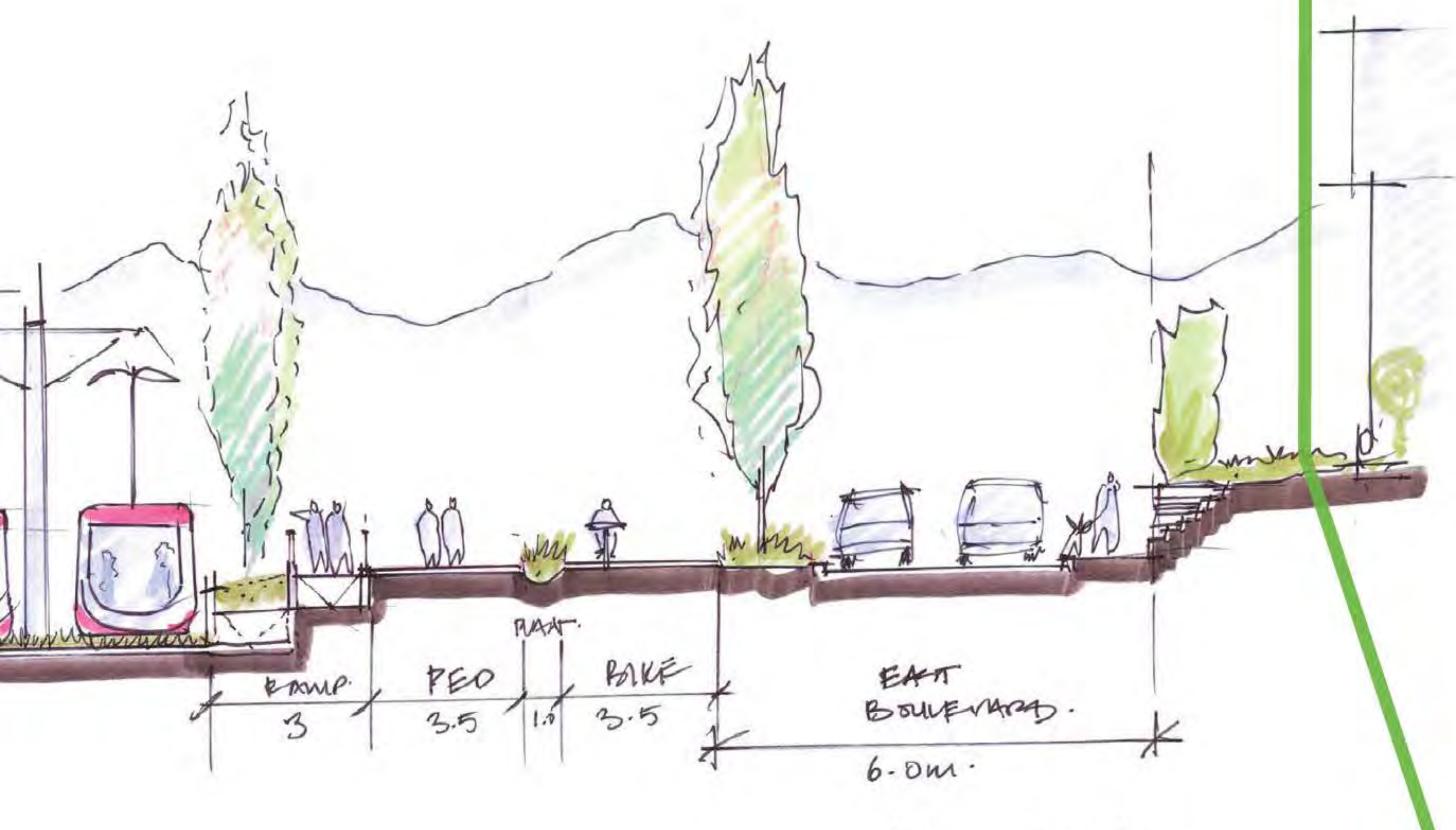
In addition to the artistic and community expressions, there are several community members who act as stewards for the Corridor and surrounding areas, including working to ensure the Corridor is kept clean for all users to enjoy.

Near the south entrance to the corridor, William Mackie Park signifies a significant gesture of local stewardship by residents. The Park, named after William Mackie who was a prominent Vancouver pioneer, gold miner and lumberman, and whose family owned the property in the early 1900s, was established by community efforts. Today, nestled within the trees and shrubs that were planted by the City of Vancouver, are several new trees and shrubs that have been planted by and are tended to and by local residents.




ARBUTUS ST.
13.0

LOOKING AHEAD



Looking Ahead

This comprehensive, integrated assessment of the Arbutus Corridor today lays the foundation for the development of the Arbutus Greenway Master Plan. As the Master Plan and design of the Greenway and its various elements progress, we can reflect on this interdisciplinary overview of this valued space.

TECHNICAL APPENDIX

APPENDIX A - UTILITIES

This appendix provides further detail from the review of City of Vancouver Utility infrastructure that is currently available from VanMap together with review of background documents that were provided specific to the AGP project. The appendix also provides a series of drawings that illustrate the approximate locations of the City owned utility infrastructure as it relates to the Arbutus Greenway Corridor.

AGP Utility Chapter (Sanitary, Combined Sewer, Water, Drainage)

At this time of this writing, a complete composite base plan, including all third party utilities, was not yet available. Topographic survey and compilation of utility information for the project corridor is still underway by the City of Vancouver (City). Therefore, the understanding of utilities will be enhanced as new information becomes available and concepts of the corridor are developed.

The following content is based on a review of City infrastructure information available from VanMap, a review of background documents provided by the City specific to this AGP assignment, and a site reconnaissance on conducted in July 18, 2017.

The City has provided its 10 year capital plan for sewer separation that will influence the corridor to some degree from 53rd Avenue to 33rd Avenue. In addition, the City has also notified their plan to complete both transmission and distribution watermain upgrades on West Boulevard from 37th Avenue to 33rd Avenue.

Generally speaking, there is very little piping infrastructure directly within the legal boundary of the AGP corridor, but there are significant piping infrastructure at all municipal roadway crossings and along parallel streets; West Boulevard and East Boulevard. Based on best available information at this time, the following infrastructure exists directly within the legal boundary of the AGP corridor (excluding City Street crossings). In the table below, the diameter of the piping is reported.

An item of note is that according to information obtained from VanMap, there are 16 combined sewers (CS) crossing the AGP corridor, excluding those in public roadways. An additional 11 CS appear to cross the AGP at public roads, for a total of 27 CS crossings between Milton Street and Fir Street. The City map provided for the 10 year combined sewer separation program only notes 2 crossings that are to be separated – one at 53rd Avenue and one north of 36th Avenue. This raises question to 1) the inventory and status of combines sewers, and 2) whether further consideration needs to be given to the sewer program.

Within established roadway and laneway corridors there are numerous utilities; City is third party, of various sizes and ages. The proposed services to be provided within the AGP corridor are not expected to be a driver for requiring changes to buried utilities. The primary drivers for changes to buried infrastructure associated with the AGP project are:

1. The existing utility has reached, or has nearly reached, the end of its service life; therefore, the AGP provides an opportunity to coordinate replacement to prevent near impact to the AGP resurfacing after the fact. The City would need to decide how much service life remains in the existing utility and what the acceptable time frame would be to defer utility upgrade beyond the AGP construction. If the City elects to replace or repair utilities within the disturbed corridor as part of the AGP construction, the City will also need to decide the limits of those works (eg, just within the disturbed footprint of the AGP?).
2. Existing utilities need to be moved to make way for undergrounding of electrical systems, should the City elect to pursue that.
3. Existing utilities need to be relocated or upgraded due to the loading of the future street car. Loading information needs to be determined and compared to highway traffic loading and the former railway loading. Only if and where street car loading is higher that highway and rail might utilities need to be checked for adequacy.
4. It is unlikely to occur, but earth cuts should be limited in the location of existing utilities. If the surface grade is proposed to be lower. Significant earth cuts may reduce cover, or expose existing buried utilities.
5. A service lateral is required into the AGP corridor to provide connection to water fountains, concessions, washrooms, etc. Similar is true for electrical and telecommunication systems. Opportunities for such service connections are not heavily restricted, however siting of facilities requiring service should be done in proximity to existing utilities to allow easy connection. The flow demands from the AGP corridor are expected to be relatively low;

Crossing Location	Water Main	Sanitary Sewer	Storm Sewer	Combined Sewer
Avery Avenue		150 mm	200 mm	
66th Avenue				300 mm
62nd Avenue				375 mm
61st Avenue	1,500 mm (transmission main - TM)			375 mm and 900 mm
58th Avenue				450 mm
53rd Avenue				450 mm
52nd Avenue	200 mm			
39th Avenue				450 mm
38th Avenue				375 mm
North of 36th Avenue				250 mm
Quilchena Crescent				150 mm[1]
Maple Street				200 mm
Cypress Street				200 mm and 600 mm[2]
29th Avenue				675 mm
Nanton Avenue				600 mm
Maple Crescent				300 mm
20th Avenue	200 mm[3]			
18th Avenue		250 mm	750 mm	
South of 16th Avenue	150 mm 1,050 mm (TM)			

[1]A combined sewer located at the intersection of Quilchena Crescent and Arbutus Street is shown in VanMap as running between two residential properties and extending a short distance into the Arbutus Corridor (not crossing). This pipe may be abandoned and its status should be confirmed.

[2]At Cypress Street, a 200 mm combined sewer running parallel to the legal boundary of the corridor (and running partially within the corridor) appears to provide service to four residential properties. A 600 mm trunk line then crosses the corridor.

[3]This watermain crosses the corridor, but does not appear to be looped; therefore appearing as a dead-end service, but to what is unclear. Its status should be determined.

however a question to the City is whether there are any systems with a history of problems to which additional flow demands should not be placed by the AGP project.

Existing drainage infrastructure within the AGP corridor is minimal. In many parts of the corridor a small V-ditch exists on either side of the paved surface, while in many other parts no drainage system exits at all. Rainfall that falls is either absorbed by the site soils, or runoff that is generated sheds of in a disbursed manner to adjacent lands. From the July 2017 site reconnaissance, there are no apparent signs of erosion or slope instability. The site reconnaissance was conducted during a period of try weather, yet the southern bank of the AGP corridor paralleling 35th Avenue was discharging significant seepage that collects and flows with the v-ditch parallel to the pathway on the south side. The corridor design will need to ensure that seepage collection is sufficiently maintained in this zone.

Significant vegetation growth currently hampers the ability to visually inspect where this collected seepage water flows to; vegetation clearing will be required to enhance the view. One possibility is that flow eventually finds a suitable soil that allows it to seep back into the ground at the base of the slope, or flow is intercepted by an existing 200 mm storm sewer within the 34th Avenue alignment that appears to extent into AGP corridor from the east.

At approximately 18th Avenue the surface topography of the corridor forms a sag depression. Outside of the public road crossings, this is one of only two locations where a storm sewer exists within the AGP corridor. There is the potential at this location for appreciable drainage to collect from the AGP corridor. Likely done as part of the temporary surfacing, there is a new catch basin installed in this vicinity. Drainage provisions, particularly at this location, are expected to remain. Along the rest of the corridor, there appear to be little signs of formal drainage infrastructure, yet with no obvious signs of erosion or impact. The City has not raised any awareness to flooding complaints or problems.

The "Preliminary Geotechnical Assessment and Scope of Work for Geotechnical Investigations" (Advisian, May 25, 2017) describes the soils in the corridor largely being Capilano Sediments (Cb) and Vashon Drift and Capilano Sediments (VCa,b). The drainage characteristics of these soils are not specifically noted in the report, but Capilano sediments are typically well drained. Those of Vashion Drift and Capilano sediments are expected to be moderate, but may be high variable. In general, the anticipated drainage characteristics are that most of the precipitation that falls on the corridor infiltrates, and when runoff is generated, its runs off the corridor in a highly distributed manner as to not create an impact. The addition of paved surfaces, even the temporary pathways, will increase rainwater runoff. The infiltration capacity of the adjacent soils is critical to assessing whether or not the increase in runoff will exceed the available capacity of the soils. A program to test soil infiltration has been separately recommended to the City.

The City's Integrated Rainwater Management Plan (IRMP) provides a long-term Green Infrastructure Strategy to protect and improve water quality in waterbodies surrounding Vancouver. As described in the IRMP Volume 1 – Vision, Principles and Actions (Final Draft, 2016), the IRMP sets forth the following vision, goal, and targets:

Vision: Vancouver's abundant rainwater is celebrated as a resource:

- To maintain clean water from watersheds to receiving environments;
- To reduce potable water demand; and
- To connect people to urban and natural ecosystem functions.

Goal: Vancouver is surrounded by clean water. This goal is achieved by:

- Reducing combined sewer overflows (CSOs);
- Replacing combined sewers with separated storm and sanitary sewage systems;
- Redirecting rainwater into natural pathways;
- Allowing the piped drainage system to be resilient to climate change;
- Protecting water quality in our beaches, bays, rivers and groundwater;
- Providing healthier landscapes and water conservation/drought tolerance; and
- Adding to the biodiversity, environmental health and urban design diversity.

City wide IRMP overall target: Capture and treat 90% of Vancouver's average annual rainfall by implementing green infrastructure tools and design guidelines on public and private property throughout the City.

Specific rainwater management targets

Normal Rainfall: "Soak it in"	Soak it in	Soak up the first 24 mm (1") in a day (24hrs) Includes the common "drizzle" up to small storms	Objective is to infiltrate these rainfalls near where they land, providing benefits to water quality and reduced runoff
Large Storms: "Clean it up"	Clean it up	Clean up the next 24 mm (1"), when combined with the small storms, adding up to 48 mm (2") in a day (24hrs) Includes large storms that occur once per year in a typical year	Objective is to treat for water quality in the runoff from these rainfalls near where they land, as well as to maximize the time available for rainfall to soak into the subsoils.
Extreme Storms: "Convey it safely"	3. Convey it safely	Addresses storm events that are over 48 mm (2") in 24 hrs, up to extreme events Extreme storms (1 in 10 year, 1 in 100 year return period) can occur at any time, but on average do not happen every year.	Objective is to safely convey to outlets the excess runoff through both pipes and in extreme cases by the "major drainage" system of surface gutters along street edges, channels, and overflows.

The specific technical criteria are as follows:

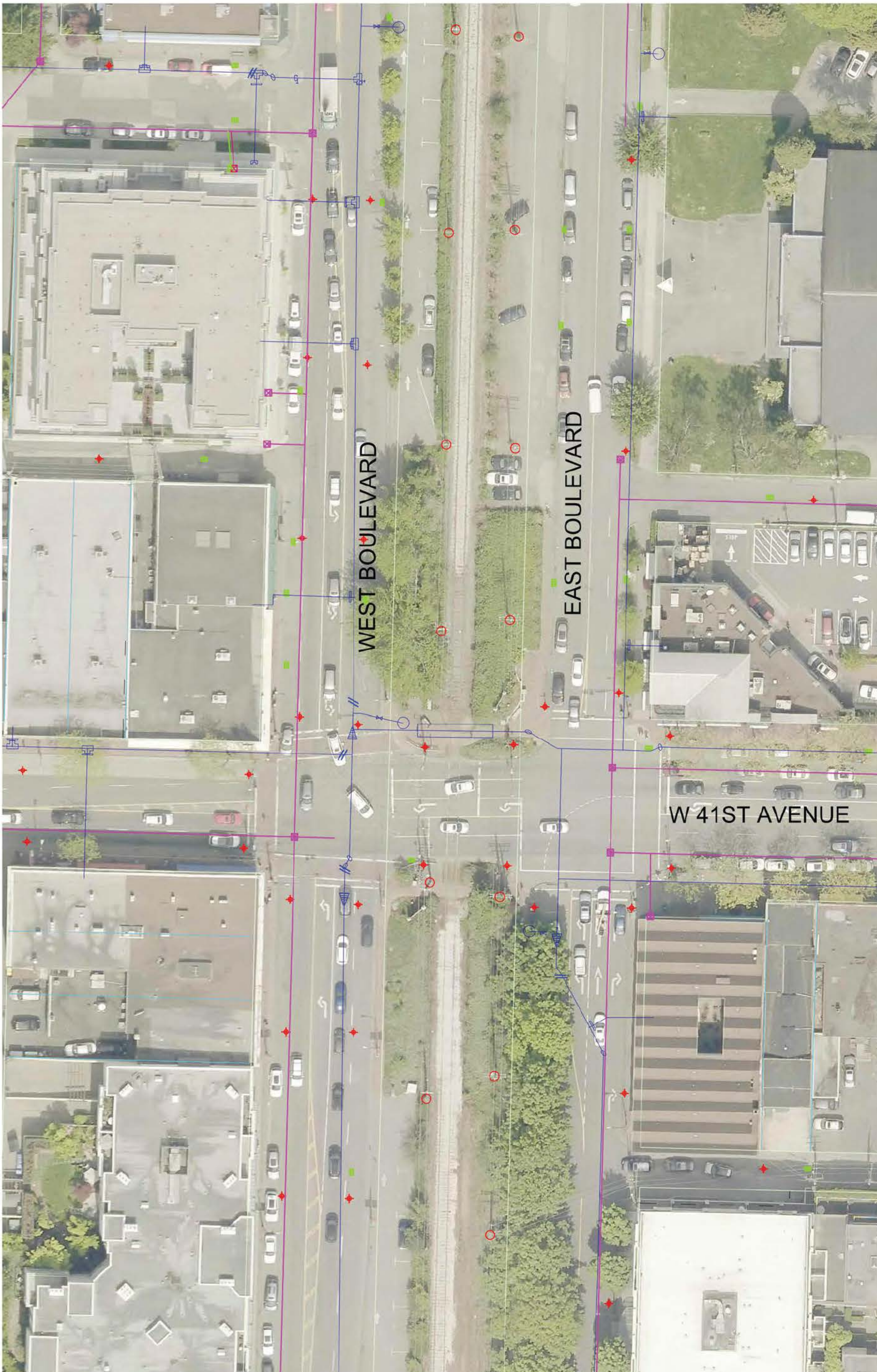
Water Quality Target: "Treat 90% of the volume of runoff from effective impervious areas, other than roof in low density residential land uses, to the water quality standards – yellow or green – for piped drainage set out in the Monitoring and Adaptive Management Framework (AMF), Metro Vancouver, 2014."

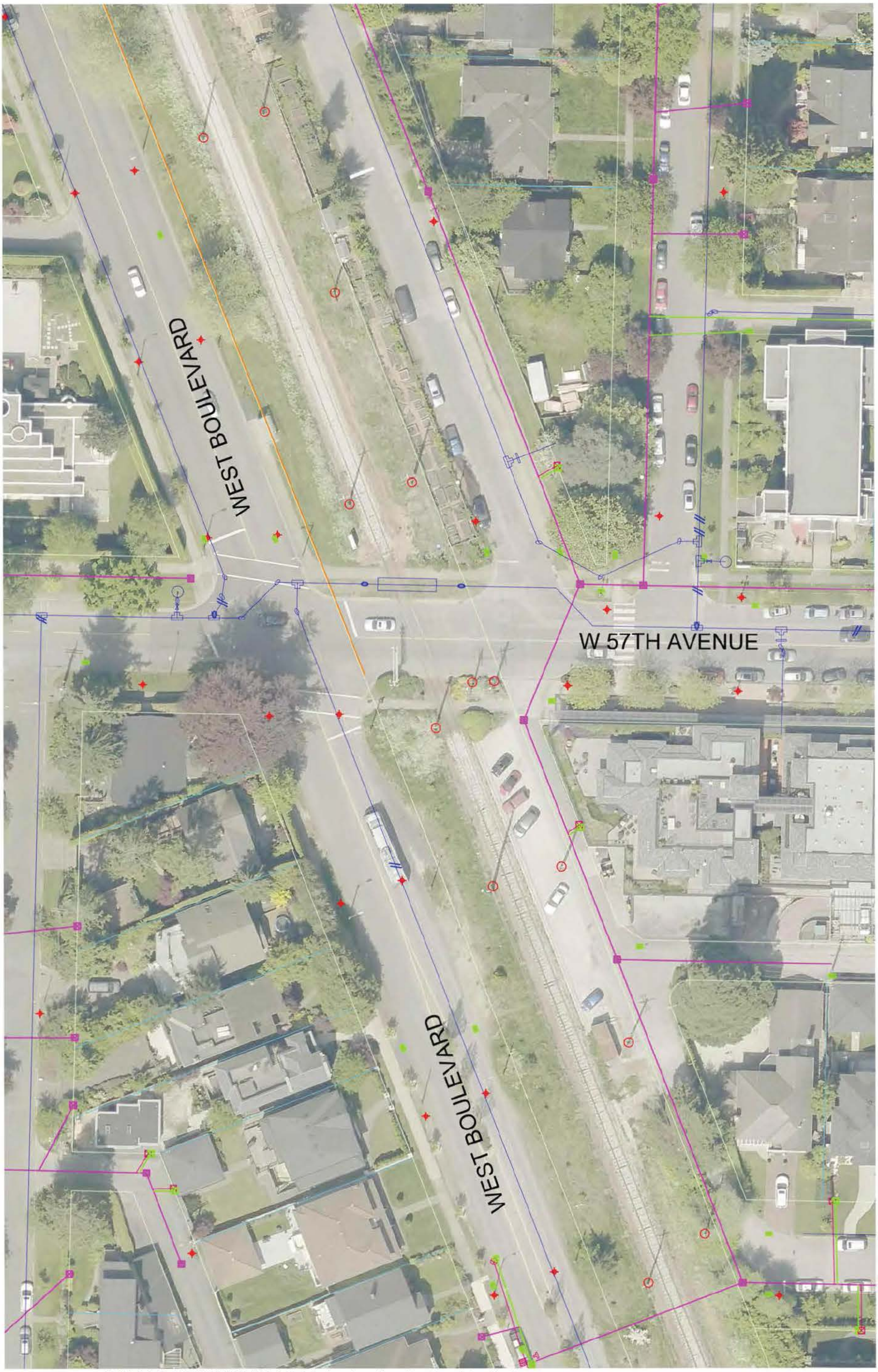
Water Volume Reduction Target: "Capture a minimum of 50% of the 6-month, 24-hour post-development volume from effective impervious areas, other than collector/arterial roads in all land uses and either infiltrate to ground, evapotranspirate, or reuse the captured rainfall."

Detention or Rate Control Target: "For development defined as "large scale developments", reduce post-development rate and volume to at or below pre-development levels for the 2-year, 24-hour precipitation events. Pre-development equals the site's immediate preceding use. Large scale developments should be defined using the same criteria as in the Rezoning Policy for Sustainable Large Developments, City of Vancouver, 2013, which current has similar requirements."

For other major projects across the City (the Flats and NEFC), the City has recognized the unique characteristics across the City that warrant tailored application of these global criteria. It is anticipated to be the same for the AGP corridor. Particularly through Kerridale where West Boulevard and East Boulevard exist, there is likelihood for significant reconfiguration of existing paved surfaces, yet potentially without increasing the paved surface. A question for the City is whether this reconfiguration should present an opportunity to improve on current conditions, or whether the City elects, as a baseline, ensure current conditions are not worsened.


These plans show the above and below-ground utilities found at key intersections along the Corridor.
ARBUTUS STREET
W 16TH AVENUE


WEST BOULEVARD
EAST BOULEVARD
W 41ST AVENUE


WEST BOULEVARD
W 57TH AVENUE
WEST BOULEVARD


ARBUTUS STREET
W BROADWAY
ARBUTUS STREET

APPENDIX B - EXISTING TREE INVENTORY

This appendix sets out the methodology used to conduct a preliminary tree survey and inventory within the Arbutus corridor. The appendix also includes two spreadsheets; the first provides and inventory of
the Tree Stands (i.e. trees with crowns growing into adjacent trees with similar basic attributes) while the second spreadsheet provides an inventory of trees growing as individuals.

The following is a brief description of the methods used to conduct a preliminary tree inventory within the Arbutus Corridor. The purpose of this preliminary inventory data is to aid the decision-making process while planning upgrades to the site. A subsequent site visit is recommended once plans have reached a preliminary phase and the trees have been legally surveyed to determine their exact attributes. This will be used to produce a detailed tree retention/removal plan for the Arbutus Corridor.

Arborists walked the Arbutus Greenway collecting general tree attributes for trees in and directly adjacent to the corridor. Each tree or group of trees was assess visually for general size, condition and other obvious structural or other notable characteristics. Trees with crowns growing into adjacent trees that had similar, basic attributes were collected as a group or 'stand' and the four most common tree species were identified in this group. An average diameter at breast height (dbh) and height of the stands were collected so that a person interested in knowing what was present within these groupings could get an idea of the forest cover. Trees growing as individuals were collected with a single point on the maps. A tree condition rating, diameter at breast height (dbh), height and brief descriptions of the growing conditions were collected. The stands and trees have been labeled numerically on the accompanying maps. At this stage, no tags were placed on the trees. The air photo was utilized with a GPS device that would place the individual trees within a couple of meters of their location. Stand polygons were broadly applied across the canopy of trees to indicate the area of the trees assessed.

This information will be useful to the designers in the initial stages of the design in that it will provide:

1. The approximate location of the trees
2. The general attributes of these trees including their diameter (which is used to determine the required root protection zone) their height and spread (with individual trees) which can be used to determine potential overhead conflicts and their condition which will give an idea of whether the tree is worth planning around and/or whether it will be a future risk.
3. The maps will provide a quick determination of whether the trees are located within the right of way or whether they are close to property lines and will require surveying. Please note that offsite trees will require protection unless the owner provides permission to remove the tree(s).

Once the design team has had a chance to work with these files to determine the preferred concept the next steps would be to survey those trees that had the potential to be retained as well as those trees located just off site. The survey file would then be used to provide detailed recommendations for tree retention, mitigation, enhancement and removal.

Arbutus Greenway

Tree Inventory *(Page 1 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

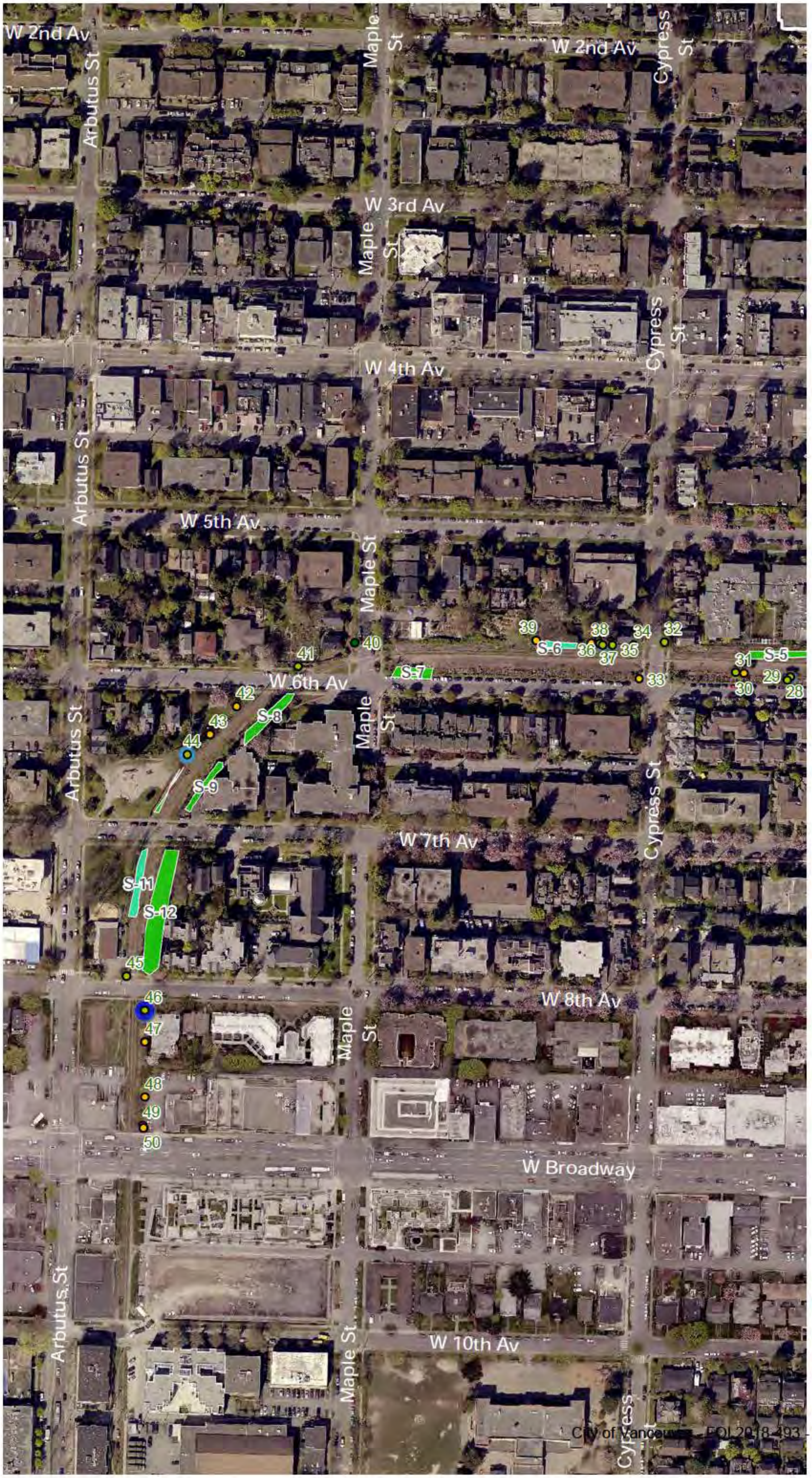
DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 25 50 100 m

Tree locations are approximate

DIAMOND HEAD



Arbutus Greenway

Tree Inventory *(Page 2 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 25 50 100 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 3 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 4 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

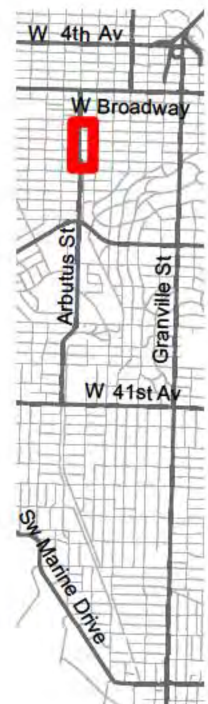
Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150



0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 5 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 6 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 7 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 20 40 80 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 8 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

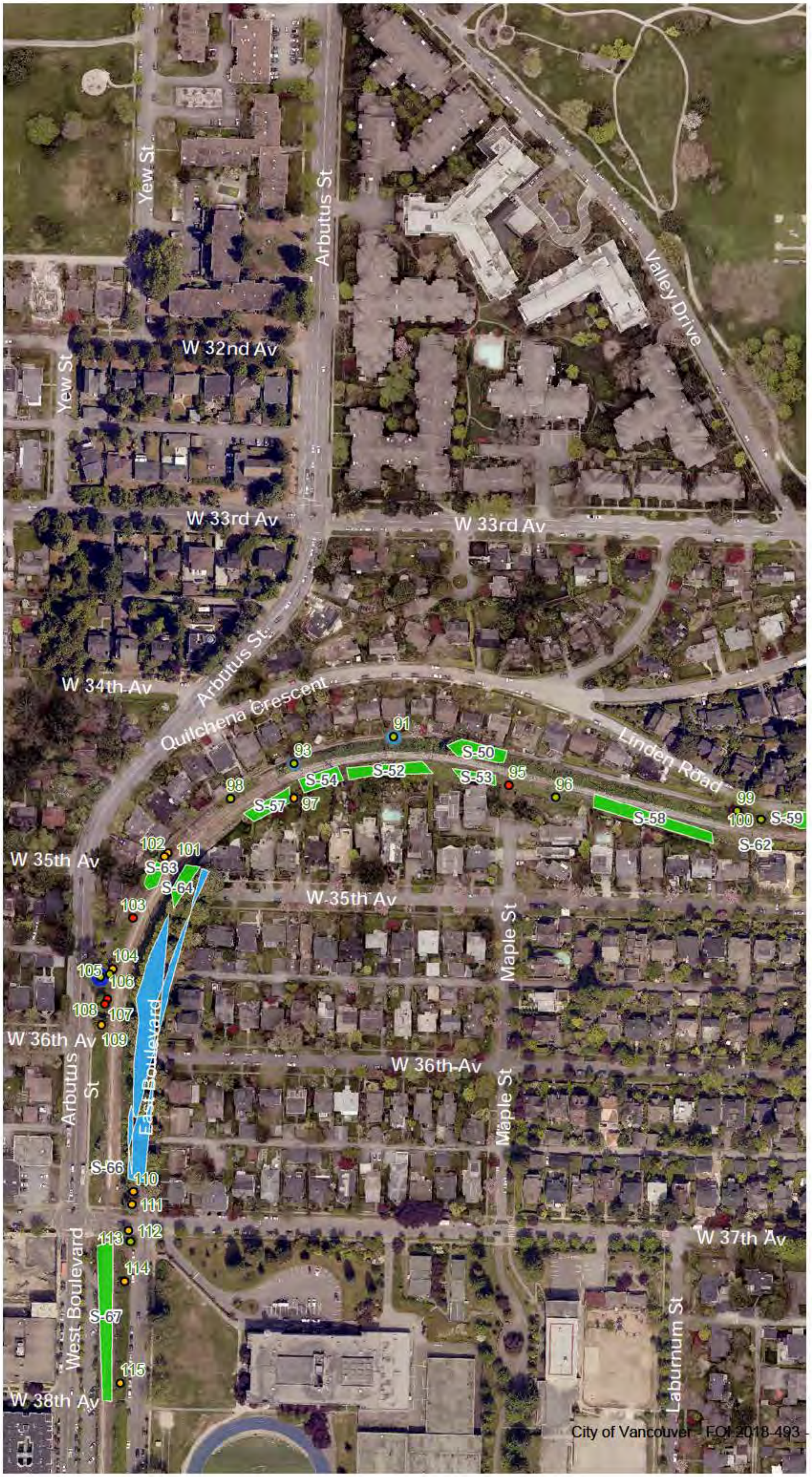
0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 9 of 18)*



Tree Inventory

Condition

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- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 25 50 100 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 10 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 11 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

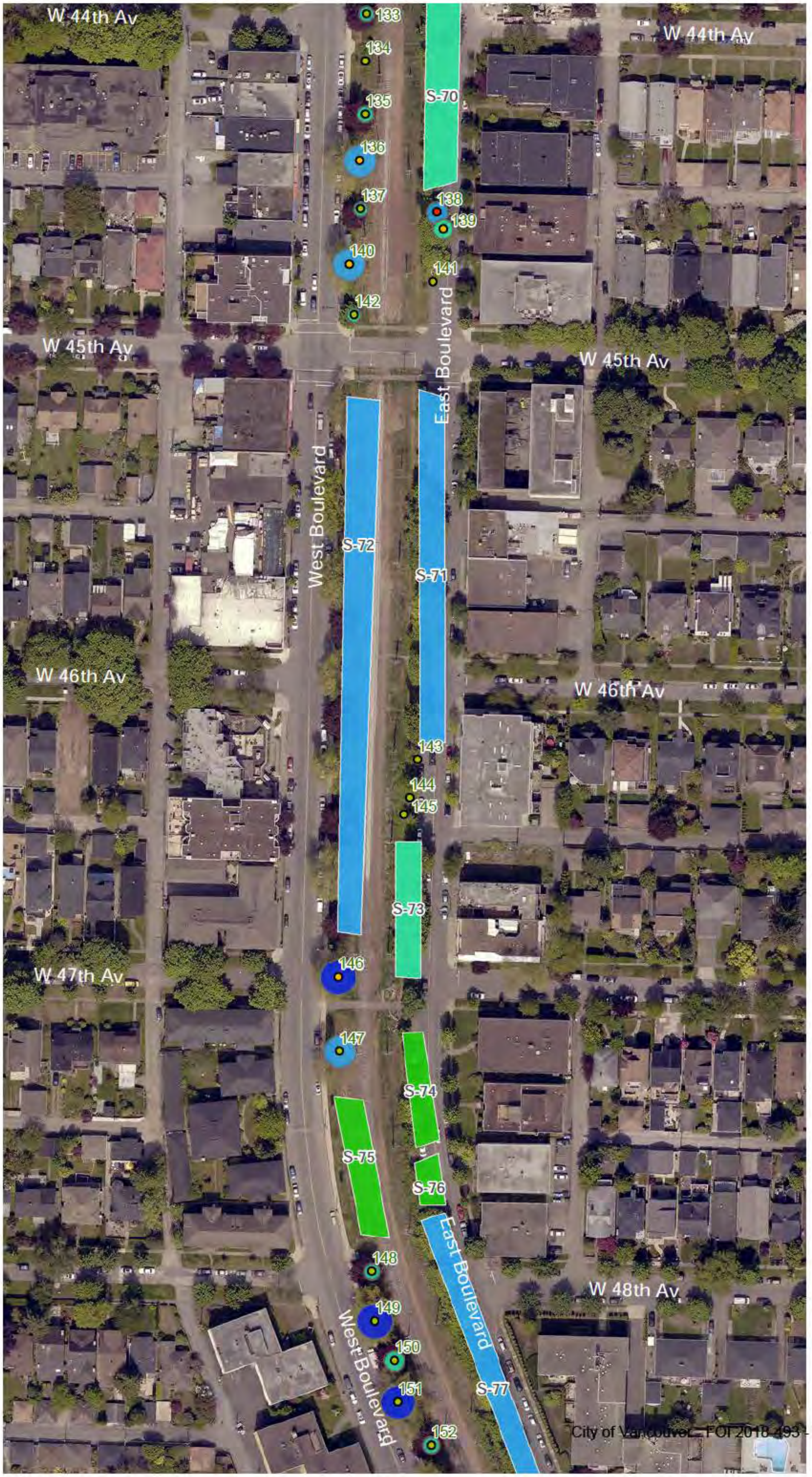
0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Arbutus Greenway

Tree Inventory *(Page 12 of 18)*



Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

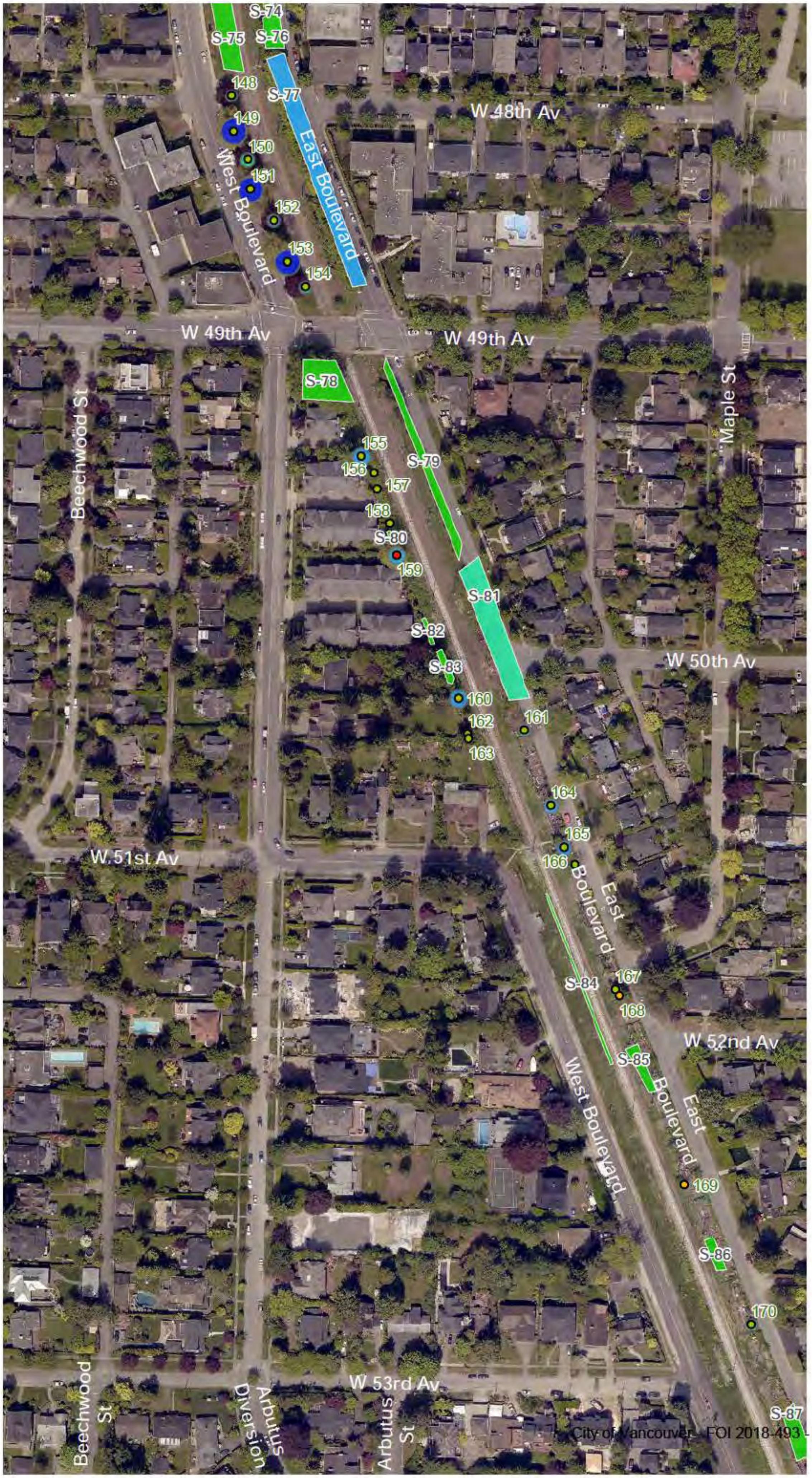
- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 15 30 60 m

Tree locations are approximate

DIAMOND HEAD

Vancouver, BC 604.733.4886



Arbutus Greenway

Tree Inventory *(Page 13 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 20 40 80 m

Tree locations are approximate

DIAMOND HEAD

Vancouver, BC 604.733.4886

Arbutus Greenway

Tree Inventory *(Page 14 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

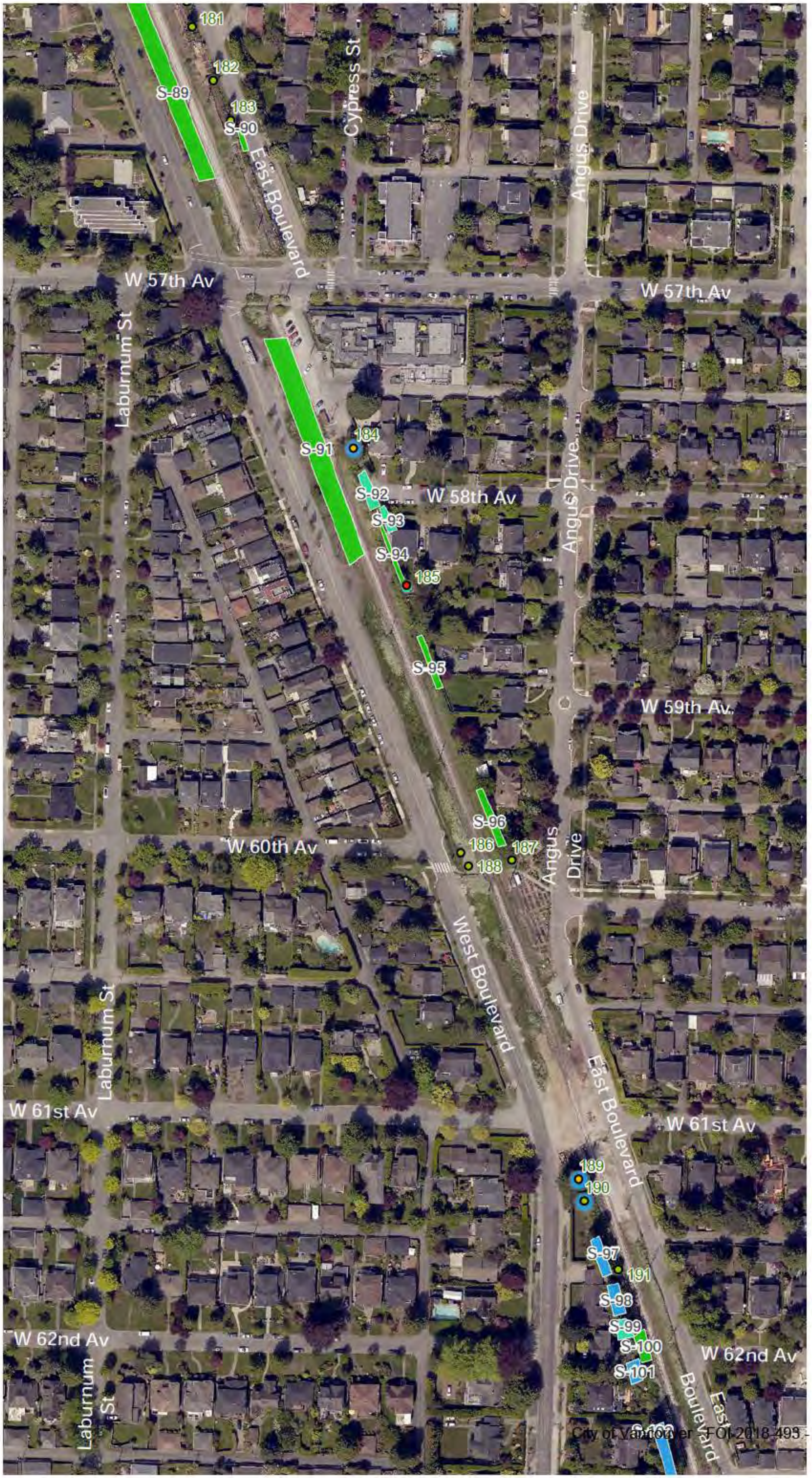
- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 20 40 80 m

Tree locations are approximate

DIAMOND HEAD

Vancouver, BC 604.733.4886



Arbutus Greenway

Tree Inventory *(Page 15 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 20 40 80 m

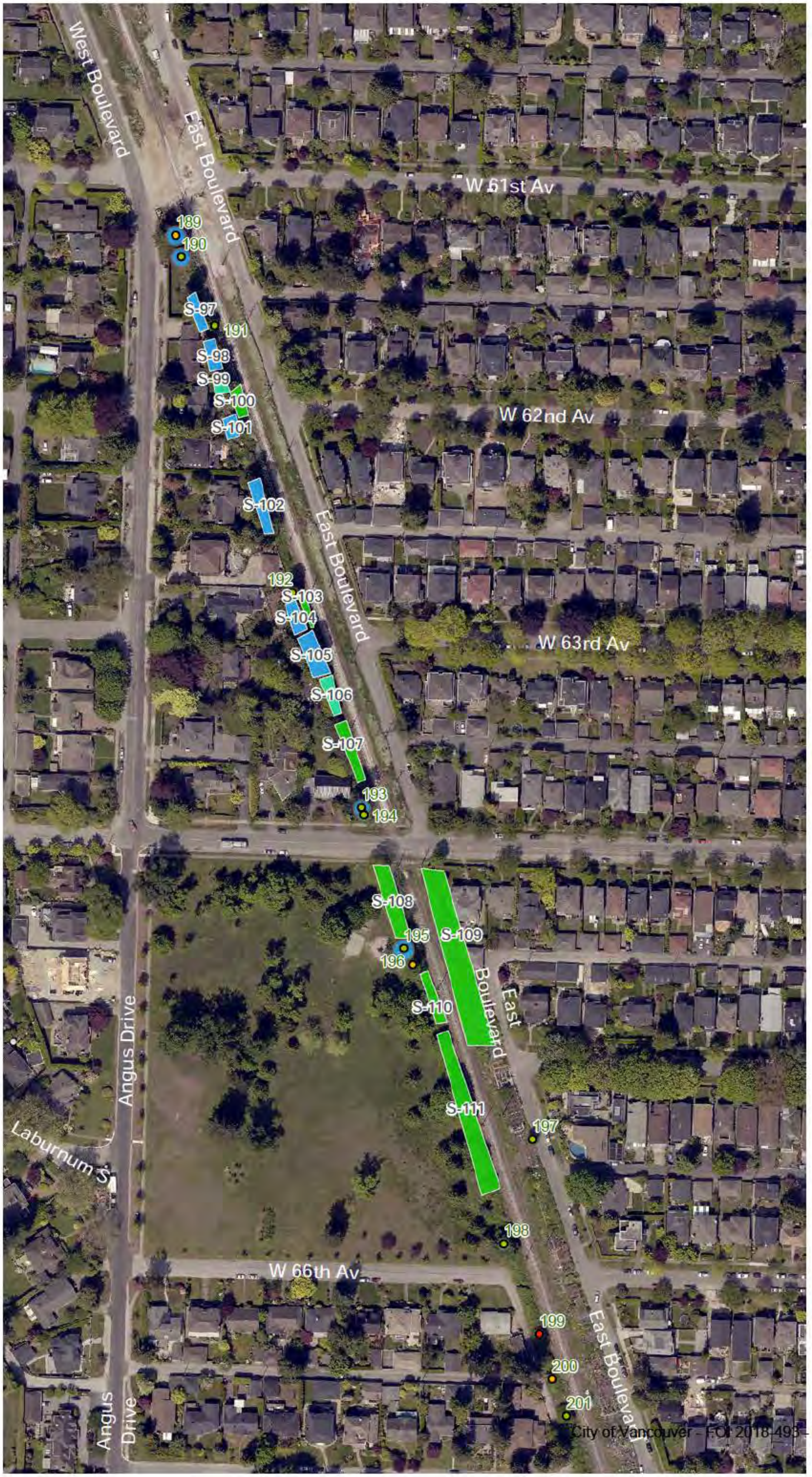
Tree locations are approximate

DIAMOND HEAD

Vancouver, BC 604.733.4886

Arbutus Greenway

Tree Inventory *(Page 16 of 18)*



Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

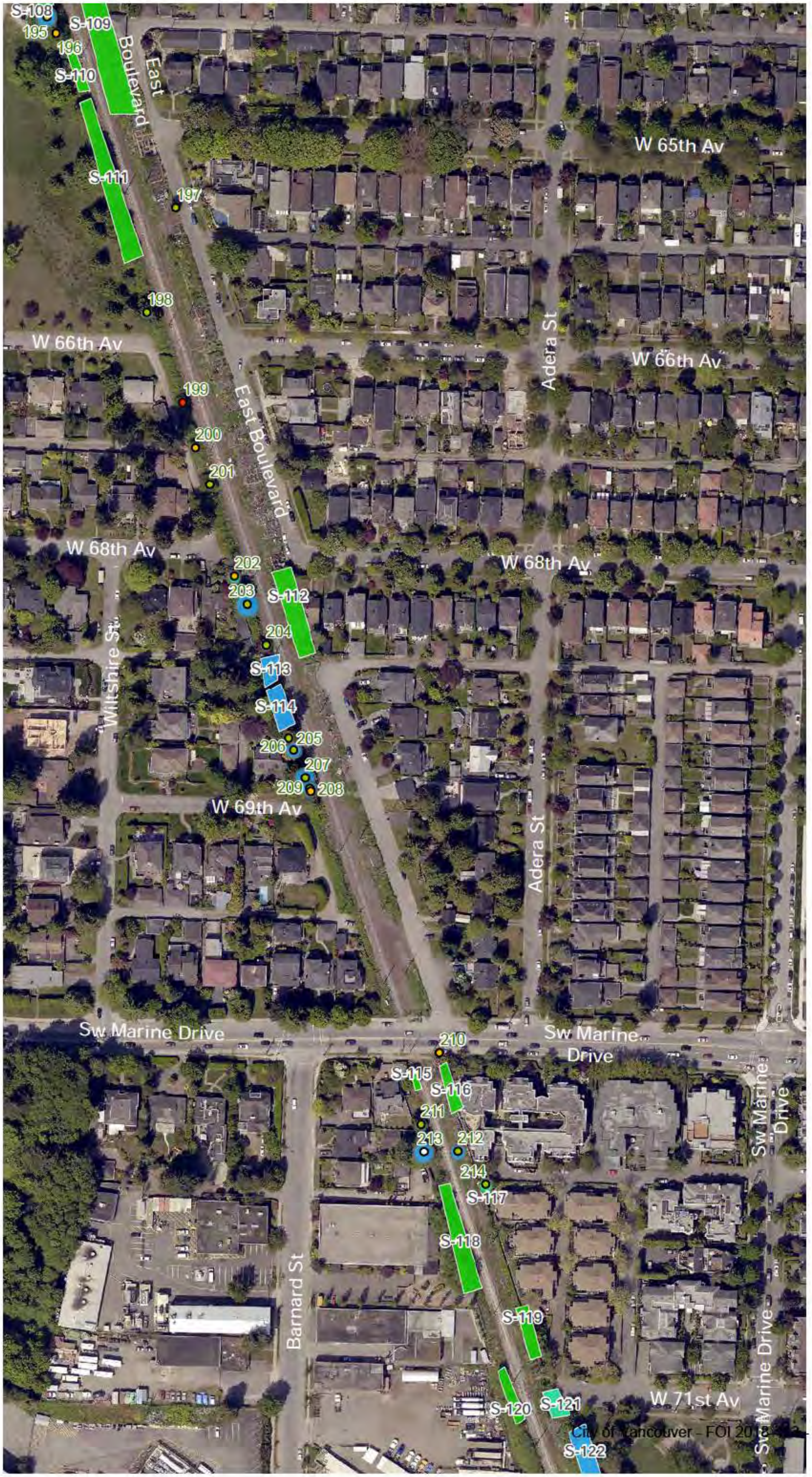
DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 20 40 80 m

Tree locations are approximate

DIAMOND HEAD



Arbutus Greenway

Tree Inventory *(Page 17 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 20 40 80 m

Tree locations are approximate

DIAMOND HEAD

Vancouver, BC 604.733.4886

Arbutus Greenway

Tree Inventory *(Page 18 of 18)*

Tree Inventory

Condition

- Excellent
- Normal
- Moderate
- Poor
- N/A

Root Protection Zone, by DBH (cm)

- 06 - 30
- 31 - 59
- 60 - 90
- 91 - 150

Tree Stands

DBH (cm)

- 0 - 30
- 31 - 55
- 56 - 90
- 91 - 150

0 20 40 80 m

Tree locations are approximate

DIAMOND HEAD

APPENDIX C - EXISTING ROAD TRAFFIC INTERSECTIONS

This appendix sets out the location and type of road traffic intersections that cross the Arbutus Greenway corridor. The information provided includes a summary of the current modelled Level of Service for each intersection in both the AM and PM Peak hours. Further detail is also provided for each traffic movement associated with each intersection in terms length of delay in seconds, Level of Service for each movement and queue lengths.

Intersection LOS Summary

Location	Type	AM	PM
Fir St & W 4 Ave	Signalized	B	B
Burrard St & W 4 Ave	Signalized	C	C
Fir St & W 7 Ave	Unsignalized	A	A
Burrard St & W 7 Ave	Unsignalized	A	A
Arbutus St & W Broadway	Signalized	B	B
Arbutus St & W 10 Ave	Unsignalized	A	A
Arbutus St & W 12 Ave	Signalized	B	C
Arbutus St & W 16 Ave	Signalized	C	C
Arbutus St & W King Edward Ave	Signalized	D	D
Arbutus St & W 33 Ave	Signalized	C	B
Arbutus St & W 37 Ave	Signalized	B	B
West Blvd & W 41 Ave	Signalized	D	D
East Blvd & W 41 Ave	Signalized	B	B
West Blvd & W 49 Ave	Signalized	F	F
East Blvd & W 41 Ave	Signalized	A	A
SE Marine Dr & Cornish St	Signalized	B	B

Detailed Synchro Summary Table - AM Peak Hour

Base Network - AM Peak Hour

Location	Synchro INT ID	Type	Intersection LOS	Approach	Movement	Control Type	Delay (sec/veh)	LOS	v/c	95th Queue (m)
Fir St & W 4 Ave	4000	Signalized	B	EB	L	Signalized	5.7	A	0.13	1 6
					Thru, R	Signalized	5.5	A	0.39	19.5
				WB	L	Signalized	19 3	B	0.5	26.5
					Thru, R	Signalized	10.1	B	0.5	54.7
				NB	L, Thru, R	Signalized	17	B	0.35	24.9
				SB	L	Signalized	23 8	C	0.28	20.3
					Thru, R	Signalized	17 5	B	0.15	14.6
Burrard St & W 4 Ave	3000	Signalized	C	EB	L, Thru, R	Signalized	19.4	B	0.99	56
				WB	Thru	Signalized	36	D	0.76	89.8
					R	Signalized	9.4	A	0.16	12
				NB	L	Signalized	36.7	D	0.53	28.7
					Thru, R	Signalized	27 6	C	0.76	69.4
				SB	L	Signalized	36 2	D	0.76	41.3
					Thru, R	Signalized	15.1	B	0.43	42.1
Fir St & W 7 Ave	4010	Unsignalized	A	EB	L, Thru, R	Stop	10 6	B	0.04	1.1
				WB	L, Thru, R	Stop	10.4	B	0.04	1
				NB	L, Thru, R	Free	0.7	A	0.01	0 2
				SB	L, Thru, R	Free	0.7	A	0	0.1
Burrard St & W 7 Ave	3010	Unsignalized	A	EB	L, Thru, R	Stop	28 5	D	0.24	7.4
				WB	L, Thru, R	Stop	13 9	B	0.06	1 5
				NB	L, Thru, R	Free	0.1	A	0.22	0.1
				SB	L, Thru, R	Free	0	A	0.18	0
Arbutus St & W Broadway	1020	Signalized	B	EB	L	Signalized	21.1	C	0.25	14.6
					Thru, R	Signalized	19 3	B	0.44	33
				WB	L	Signalized	12 2	B	0.27	14.6
					Thru	Signalized	12 8	B	0.37	34.2
					R	Signalized	4.3	A	0.05	4 3
				NB	L, Thru, R	Signalized	15 8	B	0.7	65.6
				SB	L, Thru, R	Signalized	15 9	B	0.49	38.3
Arbutus St & W 10 Ave	1030	Unsignalized	A	EB	L, Thru, R	Stop	11.1	B	0.13	3 5
				WB	L, Thru, R	Stop	16 6	C	0.08	2.1
				NB	Thru, R	Free	0	A	0.29	0
				SB	L, Thru, R	Free	0.5	A	0.18	0 6
Arbutus St & W 12 Ave	1040	Signalized	B	EB	L, Thru, R	Signalized	15	B	0.48	42.5
				WB	L, Thru, R	Signalized	17 5	B	0.61	48.5
				NB	L	Signalized	15.1	B	0.29	18.4
					Thru, R	Signalized	15 9	B	0.6	60
				SB	L	Signalized	28 6	C	0.61	26.2
					Thru, R	Signalized	8.9	A	0.34	26.3
Arbutus St & W 16 Ave	1050	Signalized	C	EB	L, Thru, R	Signalized	20	C	0.63	60
				WB	L, Thru, R	Signalized	21.1	C	0.66	51.1
				NB	L	Signalized	12.1	B	0.27	14.7
					Thru, R	Signalized	39 9	D	0.96	116
				SB	L	Signalized	11 3	B	0.18	8.1
					Thru, R	Signalized	20.7	C	0.52	49.1
Arbutus St & W King Edward Ave	1060	Signalized	D	EB	L	Signalized	77 5	E	0.98	95.3
					Thru	Signalized	66 6	E	0.96	217.2
					R	Signalized	6.4	A	0.18	12.6
				WB	L	Signalized	29 9	C	0.57	30.2
					Thru	Signalized	47.7	D	0.81	161.9
					R	Signalized	5.7	A	0.34	17.2
				NB	L	Signalized	19 6	B	0.35	25.5
					Thru, R	Signalized	41.4	D	0.79	117.6
				SB	L	Signalized	39.4	D	0.77	63.4
					Thru, R	Signalized	31.7	C	0.55	82.7
Arbutus St & W 33 Ave	1070	Signalized	C	EB	L	Signalized	25 6	C	0.55	31.8
					Thru, R	Signalized	19	B	0.58	67.4
				WB	L, Thru, R	Signalized	57	E	0.99	138.1
				NB	L, Thru, R	Signalized	15 8	B	0.61	57.6
				SB	L, Thru	Signalized	19 3	B	0.72	60.7
					R	Signalized	3.3	A	0.13	6 9
Arbutus St & W 37 Ave	1080	Signalized	B	EB	L, Thru, R	Signalized	26	C	0.78	61.6
				WB	L, Thru, R	Signalized	16.4	B	0.63	45.3
				NB	L, Thru, R	Signalized	19 5	B	0.71	113.5
				SB	L, Thru, R	Signalized	15 3	B	0.65	58.8
West Blvd & W 41 Ave	1090	Signalized	D	EB	L, Thru, R	Signalized	21 8	C	0.46	54.2
				WB	L	Signalized	21 3	C	0.19	15.2
					Thru, R	Signalized	24.7	C	0.69	96.6
				NB	L	Signalized	584.1	F	2.17	80.7
					Thru, R	Signalized	16 6	B	0.46	37.2
				SB	L	Signalized	33 6	C	0.63	34.2
					Thru, R	Signalized	13 8	B	0.33	41.7

Detailed Synchro Summary Table - AM Peak Hour

Base Network - AM Peak Hour

Location	Synchro INT ID	Type	Intersection LOS	Approach	Movement	Control Type	Delay (sec/veh)	LOS	v/c	95th Queue (m)
East Blvd & W 41 Ave	2090	Signalized	B	EB	L, Thru, R	Signalized	5.1	A	0.38	15.5
				WB	L	Signalized	6	A	0.02	2
					Thru, R	Signalized	8.4	A	0.39	47.1
				NB	L	Signalized	30 5	C	0.18	17.2
					Thru	Signalized	32 3	C	0.44	51.2
					R	Signalized	0.9	A	0.17	0
				SB	L, Thru, R	Signalized	33 9	C	0.39	35.8
West Blvd & W 49 Ave	1100	Signalized	F	EB	L, Thru, R	Signalized	24 5	C	0.68	51
				WB	L, Thru, R	Signalized	15	B	0.5	47.6
				NB	L, Thru, R	Signalized	Err*	F	5.57	200.6
				SB	L	Signalized	19 6	B	0.43	17.7
					Thru, R	Signalized	12 8	B	0.39	49.8
East Blvd & W 41 Ave	2100	Signalized	A	EB	L, Thru, R	Signalized	5.2	A	0.25	12.4
				WB	Thru, R	Signalized	6.7	A	0.29	26.5
				NB	L, Thru, R	Signalized	25 3	C	0.34	31.9
				SB	L, Thru, R	Signalized	17 9	B	0.18	16.2
SE Marine Dr & Cornish St	4110	Signalized	B	EB	Thru	Signalized	14 8	B	0.39	51.8
					R	Signalized	2.6	A	0.36	13.3
				WB	L	Signalized	11 6	B	0.02	2 3
					Thru, R	Signalized	14.1	B	0.33	42.9
				NB	L	Signalized	29 9	C	0.7	110
					R	Signalized	7.2	A	0.04	4 9

*Err: traffic demand significantly exceeds capacity. Long delays and queue lengths are expected

Detailed Synchro Summary Table - PM Peak Hour

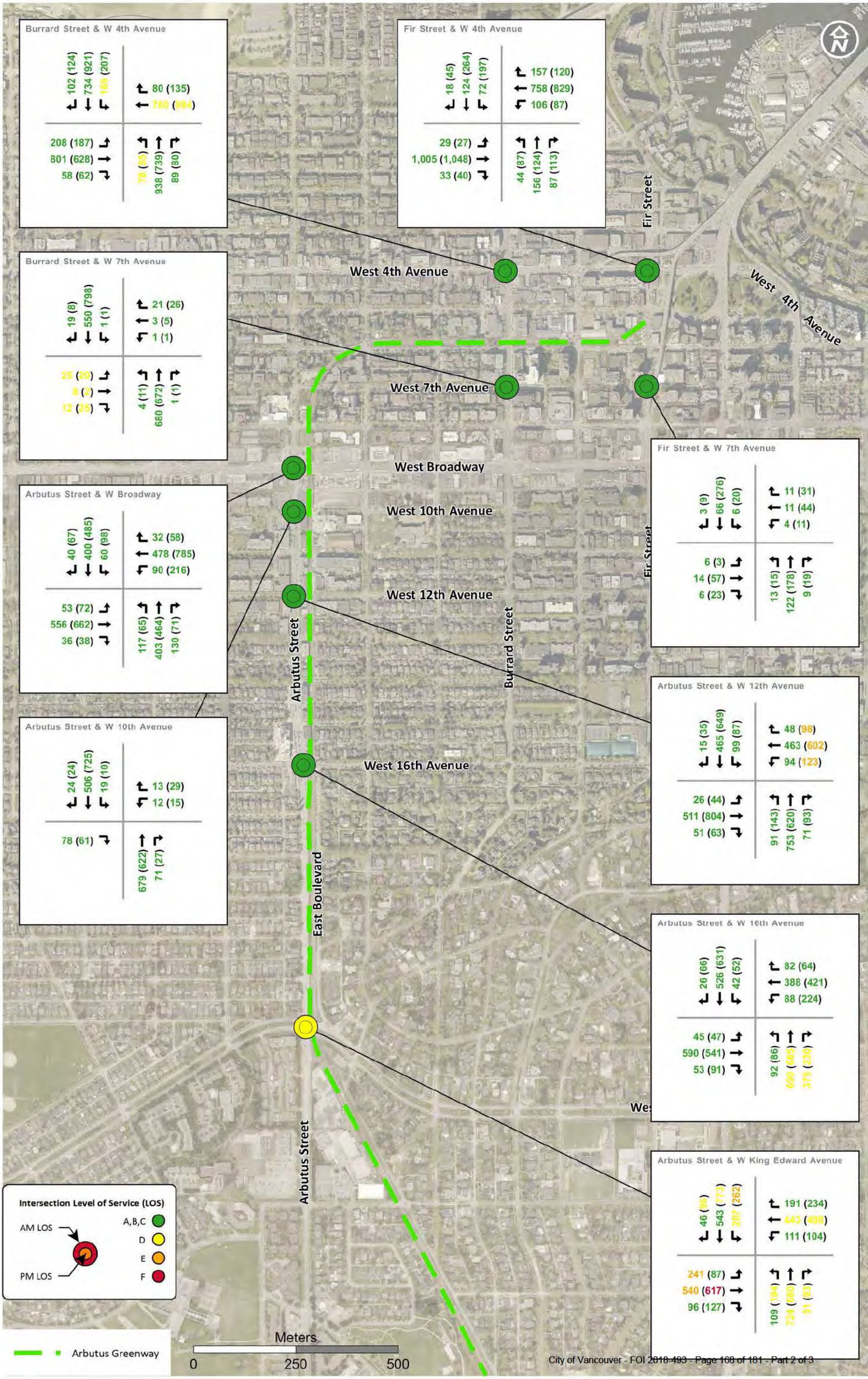
Base Network - PM Peak Hour

Location	Synchro INT ID	Type	Intersection LOS	Approach	Movement	Control Type	Delay (sec/veh)	LOS	v/c	95th Queue (m)
Fir St & W 4 Ave	4000	Signalized	B	EB	L	Signalized	12	B	0.16	6 8
					Thru, R	Signalized	11 6	B	0.47	43.9
				WB	L	Signalized	27 8	C	0.56	29.1
					Thru, R	Signalized	13 3	B	0.6	62.4
				NB	L, Thru, R	Signalized	15 5	B	0.4	25.5
				SB	L	Signalized	28 8	C	0.64	51
					Thru, R	Signalized	14 2	B	0.27	23
Burrard St & W 4 Ave	3000	Signalized	C	EB	L, Thru, R	Signalized	19 6	B	0.94	50
				WB	Thru	Signalized	48 9	D	0.96	120.1
					R	Signalized	5.8	A	0.29	13
				NB	L	Signalized	49	D	0.66	36.4
					Thru, R	Signalized	23.1	C	0.55	53.7
				SB	L	Signalized	33 2	C	0.77	46.4
					Thru, R	Signalized	15 3	B	0.49	54.5
Fir St & W 7 Ave	4010	Unsignalized	A	EB	L, Thru, R	Stop	15	C	0.2	5 9
				WB	L, Thru, R	Stop	14 8	B	0.2	6
				NB	L, Thru, R	Free	0.7	A	0.01	0 3
				SB	L, Thru, R	Free	0.7	A	0.02	0.4
Burrard St & W 7 Ave	3010	Unsignalized	A	EB	L, Thru, R	Stop	26 5	D	0.23	7
				WB	L, Thru, R	Stop	17 2	C	0.1	2.7
				NB	L, Thru, R	Free	0.2	A	0.21	0.4
				SB	L, Thru, R	Free	0	A	0.26	0
Arbutus St & W Broadway	1020	Signalized	B	EB	L	Signalized	32.7	C	0.48	23
					Thru, R	Signalized	22 3	C	0.53	42.8
				WB	L	Signalized	16 8	B	0.57	31
					Thru	Signalized	14 3	B	0.56	60
					R	Signalized	3.4	A	0.09	5 6
				NB	L, Thru, R	Signalized	17 9	B	0.66	61.5
				SB	L, Thru, R	Signalized	26.7	C	0.78	67.1
Arbutus St & W 10 Ave	1030	Unsignalized	A	EB	L, Thru, R	Stop	12	B	0.12	3 3
				WB	L, Thru, R	Stop	15.7	C	0.13	3.4
				NB	Thru, R	Free	0	A	0.27	0
				SB	L, Thru, R	Free	0.2	A	0.25	0 3
Arbutus St & W 12 Ave	1040	Signalized	C	EB	L, Thru, R	Signalized	22	C	0.77	81.9
				WB	L, Thru, R	Signalized	65 6	E	1.05	107.3
				NB	L	Signalized	34	C	0.67	45
					Thru, R	Signalized	15.7	B	0.52	53.6
				SB	L	Signalized	17.4	B	0.44	15.1
					Thru, R	Signalized	12 5	B	0.49	50.7
Arbutus St & W 16 Ave	1050	Signalized	C	EB	L, Thru, R	Signalized	32.4	C	0.8	78.4
				WB	L, Thru, R	Signalized	21.7	C	0.76	57.3
				NB	L	Signalized	19 3	B	0.39	17.7
					Thru, R	Signalized	51	D	0.98	121.3
				SB	L	Signalized	16 6	B	0.25	12.1
					Thru, R	Signalized	30 9	C	0.75	77.3
Arbutus St & W King Edward Ave	1060	Signalized	D	EB	L	Signalized	25 5	C	0.44	23.8
					Thru	Signalized	121.3	F	1.15	260.7
					R	Signalized	7.4	A	0.24	16.4
				WB	L	Signalized	30 2	C	0.54	28.6
					Thru	Signalized	51.4	D	0.86	192.7
					R	Signalized	5.4	A	0.38	18.7
				NB	L	Signalized	40 5	D	0.75	60.5
					Thru, R	Signalized	40 8	D	0.78	117
				SB	L	Signalized	57.4	E	0.9	97.4
					Thru, R	Signalized	44 5	D	0.86	144.4
Arbutus St & W 33 Ave	1070	Signalized	B	EB	L	Signalized	20.1	C	0.46	29.1
					Thru, R	Signalized	17 8	B	0.53	60
				WB	L, Thru, R	Signalized	19.7	B	0.62	68.1
				NB	L, Thru, R	Signalized	15	B	0.56	53.7
				SB	L, Thru	Signalized	28 2	C	0.87	89.9
					R	Signalized	2.8	A	0.28	10.6
Arbutus St & W 37 Ave	1080	Signalized	B	EB	L, Thru, R	Signalized	24 3	C	0.71	40.7
				WB	L, Thru, R	Signalized	18 2	B	0.73	44.9
				NB	L, Thru, R	Signalized	14.1	B	0.61	82.5
				SB	L, Thru, R	Signalized	9.3	A	0.36	29.2
West Blvd & W 41 Ave	1090	Signalized	D	EB	L, Thru, R	Signalized	23	C	0.54	61.5
				WB	L	Signalized	19.7	B	0.22	14.6
					Thru, R	Signalized	22 6	C	0.75	102.8
				NB	L	Signalized	268.8	F	1.41	62.6
					Thru, R	Signalized	16 3	B	0.46	35.8
				SB	L	Signalized	91.7	F	0.76	51.2
					Thru, R	Signalized	13.1	B	0.27	33.8

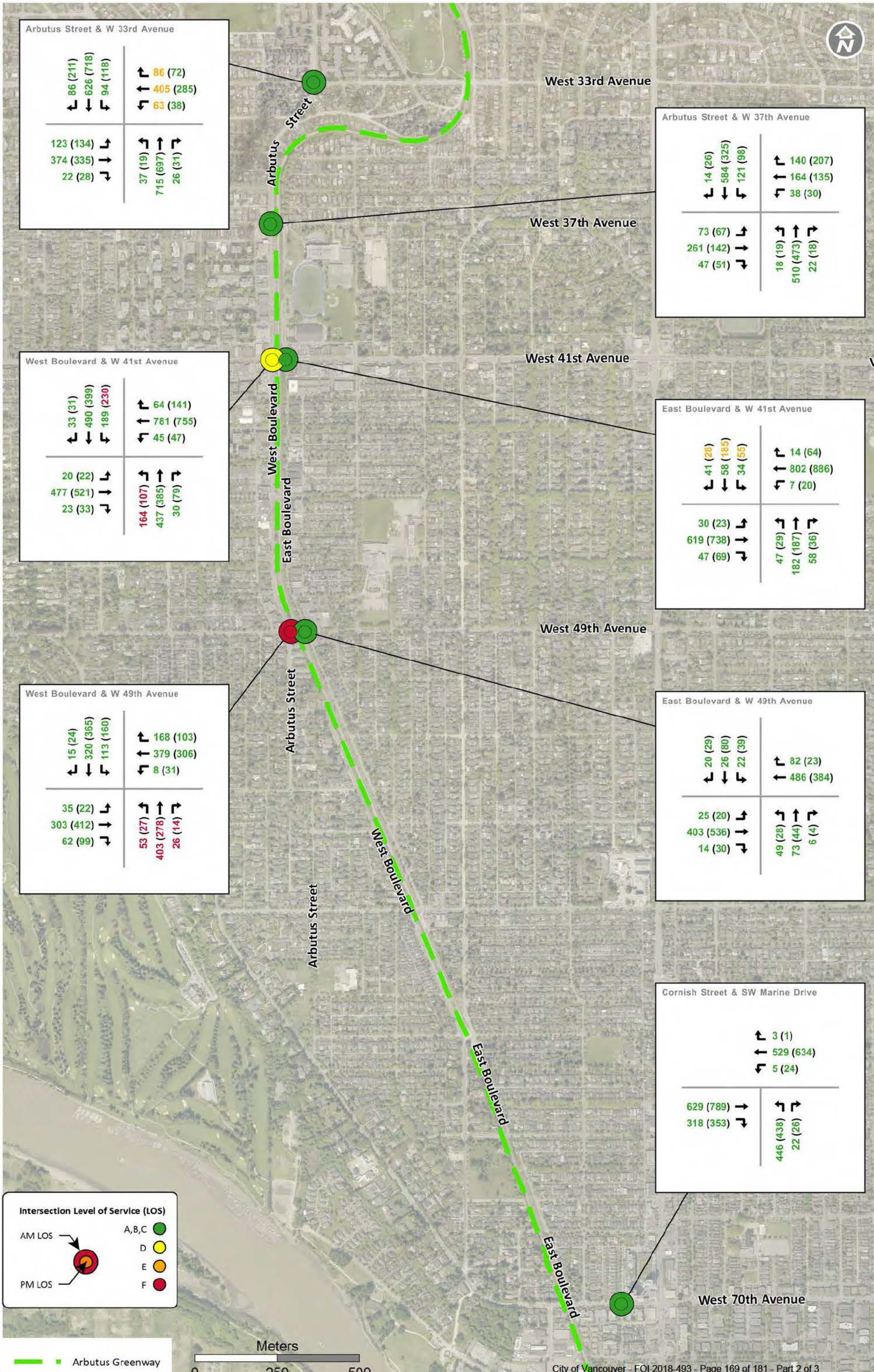
Detailed Synchro Summary Table - PM Peak Hour

Base Network - PM Peak Hour

Location	Synchro INT ID	Type	Intersection LOS	Approach	Movement	Control Type	Delay (sec/veh)	LOS	v/c	95th Queue (m)
East Blvd & W 41 Ave	2090	Signalized	B	EB	L, Thru, R	Signalized	6.2	A	0.44	23
				WB	L	Signalized	6.6	A	0.07	4 2
					Thru, R	Signalized	9.2	A	0.47	57.8
				NB	L	Signalized	29 8	C	0.17	12.6
					Thru	Signalized	32 6	C	0.45	52.4
					R	Signalized	0.5	A	0.1	0
				SB	L, Thru, R	Signalized	62 8	E	0.81	91.9
West Blvd & W 49 Ave	1100	Signalized	F	EB	L, Thru, R	Signalized	22 3	C	0.62	58.7
				WB	L, Thru, R	Signalized	16 8	B	0.42	41.3
				NB	L, Thru, R	Signalized	422.3	F	1.85	138.6
				SB	L	Signalized	20.1	C	0.49	26
					Thru, R	Signalized	14 8	B	0.46	64
East Blvd & W 41 Ave	2100	Signalized	A	EB	L, Thru, R	Signalized	4.4	A	0.3	13.5
				WB	Thru, R	Signalized	5.4	A	0.19	17.9
				NB	L, Thru, R	Signalized	26 8	C	0.23	22.5
				SB	L, Thru, R	Signalized	29.1	C	0.44	38.5
SE Marine Dr & Cornish St	4110	Signalized	B	EB	Thru	Signalized	16	B	0.49	67.8
					R	Signalized	3.1	A	0.39	15.9
				WB	L	Signalized	13 5	B	0.11	7 2
					Thru, R	Signalized	14 8	B	0.39	52.4
				NB	L	Signalized	29.4	C	0.69	107.4
					R	Signalized	6.3	A	0.04	5 3



Burrard Street & W 4th Avenue
102 (124)
734 (921)
(207)
80 (135)
208 (187)
801 (628)
58 (62)
938 (739)
89 (80)
Fir Street & W 4th Avenue
18 (45)
124 (264)
72 (197)
157 (120)
758 (829)
106 (87)
29 (27)
1,005 (1,048)
33 (40)
44 (87)
156 (124)
87 (113)
Burrard Street & W 7th Avenue
19 (8)
550 (798)
1 (1)
21 (26)
3 (5)
1 (1)
25 (20)
4 (11)
680 (672)
1 (1)
Fir Street & W 7th Avenue
3 (9)
66 (276)
6 (20)
11 (31)
11 (44)
4 (11)
6 (3)
14 (57)
6 (23)
13 (15)
122 (178)
9 (19)
Arbutus Street & W Broadway
40 (67)
400 (485)
60 (98)
32 (58)
478 (785)
90 (216)
53 (72)
556 (662)
36 (38)
117 (65)
403 (464)
130 (71)
Arbutus Street & W 12th Avenue
15 (35)
465 (649)
99 (87)
48 (98)
463 (602)
94 (123)
26 (44)
511 (804)
51 (63)
91 (143)
753 (620)
71 (93)
Arbutus Street & W 10th Avenue
24 (24)
506 (725)
19 (10)
13 (29)
12 (15)
78 (61)
679 (622)
71 (27)
Arbutus Street & W 16th Avenue
26 (66)
526 (631)
42 (52)
82 (64)
388 (421)
88 (224)
45 (47)
590 (541)
53 (91)
92 (86)
Arbutus Street & W King Edward Avenue
46
543
(262)
191 (234)
111 (104)
241 (87)
540 (617)
96 (127)
109
West 4th Avenue
West 4th Avenue
West 7th Avenue
West Broadway
West 10th Avenue
West 12th Avenue
West 16th Avenue
Fir Street
Fir Street
Burrard Street
Arbutus Street
East Boulevard
Arbutus Street
Intersection Level of Service (LOS)
AM LOS
PM LOS
A,B,C
D
E
F
Arbutus Greenway
Meters
0
250
500


Arbutus Street & W 33rd Avenue
86 (211) 626 (718) 94 (118)
86 (72)
405 (285)
63 (38)
123 (134)
374 (335)
22 (28)
37 (19) 715 (697) 26 (31)
Arbutus Street & W 37th Avenue
14 (26) 584 (325) 121 (98)
140 (207)
164 (135)
38 (30)
73 (67)
261 (142)
47 (51)
18 (19) 510 (473) 22 (18)
West Boulevard & W 41st Avenue
33 (31) 490 (399) 189 (230)
64 (141)
781 (755)
45 (47)
20 (22)
477 (521)
23 (33)
164 (107) 437 (385) 30 (79)
East Boulevard & W 41st Avenue
41 (28) 58 (185) 34 (55)
14 (64)
802 (886)
7 (20)
30 (23)
619 (738)
47 (69)
47 (29) 182 (187) 58 (36)
West Boulevard & W 49th Avenue
15 (24) 320 (365) 113 (160)
168 (103)
379 (306)
8 (31)
35 (22)
303 (412)
62 (99)
53 (27) 403 (278) 26 (14)
East Boulevard & W 49th Avenue
20 (29) 26 (80) 22 (39)
82 (23)
486 (384)
25 (20)
403 (536)
14 (30)
49 (28) 73 (44) 6 (4)
Cornish Street & SW Marine Drive
3 (1)
529 (634)
5 (24)
629 (789)
318 (353)
446 (438) 22 (26)
West 33rd Avenue
West 37th Avenue
West 41st Avenue
West 49th Avenue
West 70th Avenue
Arbutus Street
West Boulevard
East Boulevard
Intersection Level of Service (LOS)
AM LOS
PM LOS
A,B,C
D
E
F
Arbutus Greenway
Meters
0
250
500

APPENDIX D - ENVIRONMENTAL AND URBAN ECOLOGY

This appendix sets out the findings of the review of the Stage 1 Environmental Assessment previously undertaken for the corridor prior to this study. While further environment assessment is not required at this stage, the appendix sets out the pertinent information related to site location, historic streams, birds and wildlife and land use which is important background information to aid the understanding of the Arbutus Corridor Today.

Background Environmental Review

In 2016, PGL Environmental Consultants (PGL) was retained by the City of Vancouver (COV) to conduct an Environmental Site Assessment (ESA) along the Arbutus Rail Corridor ("the Corridor"). The Corridor, as defined by PGL, is 9.46 km in length and extends from West 2nd Avenue and Fir Street to 160 m west of Hudson Street at Mile 6.26. PGL reviewed several previous environmental reports, but primarily relied on the Phase 1 ESA completed on the Corridor by Teranis in 2008; the following areas of potential environmental concern (APECs) were identified: on-site rail operations (e.g., use of lubricants, and presence of 'treated' rail ties and ballast material), herbicide use along the Corridor, off-site operations of concern adjacent to the Corridor (e.g., auto repair shops, gas stations and drycleaners), and potential poor-quality fill at stream courses. The historical reports reviewed by PGL, including the Phase 1 ESA were not made available to Hemmera for review. Through discussions with the COV, PGL identified twelve locations along the Corridor that posed the highest risk and selected/prioritized those for further investigation. One additional area (1500 block of West 75th Avenue) was noted to potentially contain slag rail ballast but additional investigation was not completed by PGL due to difficulties in obtaining the required archeological permits.

The investigation program assessed soil and groundwater quality through a combined drilling and shallow soil sampling program; soil vapour quality was not assessed. Assessment of the twelve locations involved advancement of nine boreholes completed as monitoring wells, and 15 shallow soil sample locations. Shallow soil samples were generally collected from areas of visible petroleum hydrocarbon staining or likely related to an historical lubrication release. Soil analytical results were compared to the BC Contaminated Site Regulation (CSR) commercial (CL) and residential land use (RL) standards, and groundwater analytical results were compared to the CSR drinking water (DW) and aquatic life (AW, marine and fresh water) standards.

The findings of the investigation can be summarized as follows:

- Soil concentrations exceeded the RL standards for one or more parameters at six of the twelve sites investigated, while only one soil sample concentration (collected from W 44th Avenue & West Boulevard) of copper exceeded the CL standard.
- Soil contamination that was identified and considered by PGL to be the result of on-site operations included heavy extractable petroleum hydrocarbons (HEPH), polycyclic aromatic hydrocarbons (PAHs), and several metals (barium, copper and zinc). Contamination was primarily identified in the shallow soil, and is expected to be limited to this zone, based on PGL's opinion; however, contaminant concentrations were not vertically or laterally delineated.
- Groundwater concentrations of several PAH parameters exceeded one or more of the DW and AW standards in two samples from deep nested wells at West 2nd Avenue, and West 4th Avenue and Fir Street. Historical off-site operations in this area included a former drycleaner, and current and historical auto repair shops. It was PGLs opinion that the PAH groundwater in this area was likely sourced off-site and that PAH groundwater contamination along the corridor related to on-site activities was not likely.

- Soil and groundwater exceedances of volatile organic compounds (VOCs) were identified at one site (West Broadway and Arbutus) that likely migrated from an off-site dry cleaner. PGL noted that while the contamination was likely significant, it was too deep to affect current users, but the contamination could limit future redevelopment.

PGL concluded that shallow soil concentrations of copper, HEPH and PAHs greater than the RL standards were likely related to on-site railway operations, and could be present at other locations within the Corridor. A source for the soil concentrations of barium and zinc greater than the RL standards was not identified, but it was PGL's opinion that they were likely related to an unidentified on-site source. The soil concentrations encountered were less than the CL standards, with one exception, indicating that the soil quality within the corridor is likely suitable for a CL use.

Hemmera screened the analytical results from the PGL investigation against the park land (PL) use standards, and the future Stage 10 Amendment CSR standards that come into effect on November 1, 2017. All of the soil concentrations identified by PGL to be greater than the current CSR RL standard, also exceed the future RL and PL standards. Furthermore, the concentration of naphthalene in one sample exceeded the future PL and RL standards, and arsenic and lead in three samples exceeded the future CSR standards for all land uses.

Based on the review of the PGL investigation, Hemmera identified the following environmental recommendations for consideration during planning and redevelopment:

- Additional investigation should be completed in any areas of the ARC where an agricultural, park or residential land uses are considered, to determine if contaminants are present at levels of concern.
- For development in areas where shallow soil contamination as been identified, physical remediation or risk assessment should be completed based on the planned future use of each area, if required.
- Any shallow (<1 m depth) soil requiring off-site disposal or identified for reuse during redevelopment should be appropriately characterized for the presence of HEPH, PAHs and metals.
- Development in the vicinity of West Broadway and Arbutus should consider the VOC contamination present in this area, including additional investigation to assess soil vapour.
- The 1500 block of West 75th Avenue should be assessed for metals contamination, due to the reported slag rail ballast used in this area.

Ecological/Biophysical History

A desktop assessment to characterize historic and existing natural areas and environmental values along the Arbutus Corridor was completed (**Figure 1**, **Figure 3A-V**). A desktop review of existing vegetation and wildlife (including species of conservation concern and invasive species) included a review of publicly available sources, such as:

- Zoning, including legal boundaries and ownership of adjacent parcels, environmentally sensitive areas;

- Urban Forestry Strategy (City of Vancouver 2014), Biodiversity Strategy (Vancouver Board of Parks and Recreation 2016), and Greenest City Action Plan (City of Vancouver 2011);
- Government databases (i.e., BC Conservation Data Centre) (BC CDC 2017);
- eBird (eBird 2017);
- Environmental reports in the Project area; and
- Engineering design plans, drawings and reports.

Vegetation

Vegetation Cover

Historically, the City of Vancouver was covered by coastal western hemlock (CWH) forest (Pojar et al. 1991, Er et al. 2005); the Arbutus Corridor runs through the CWHxm (very dry maritime) subzone (UBC Faculty of Forestry 2017).

The forest canopy was mainly composed of coniferous tree species, especially western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*). Douglas-fir (*Pseudotsuga menziesii*) also occurred, but on drier sites. Broad-leaved deciduous trees, such as red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*) and bitter cherry (*Prunus emarginata*), were more prevalent along coastal and water-associated habitats (Pojar et al. 1991, Er et al. 2005). Salal (*Gaultheria shallon*), vine maple (*Acer circinatum*), and salmonberry (*Rubus spectabilis*) dominated the shrub layer, while bracken fern (*Pteridium aquilinum*), lady fern (*Athyrium filix-femina*), sweet-scented bedstraw (*Galium triflorum*), sword fern (*Polystichum munitum*), and three-leaved foamflower (*Tiarella trifoliata*) were the most common herb species (Pojar et al. 1991).

Invasive Plant Species

As European settlers began colonizing the area, many imported goods became staples of the Canadian agriculture sector, including crops such as corn and wheat. However, along with the benefit of exotic plant species also came invasive plants (ISCBC n.d.).

Invasive plants (commonly referred to as “alien,” “non-native,” or “introduced” plant species) are those which were brought from other areas into ecosystems without their predators to keep populations in check (ISCBC n.d.). They aggressively out-compete native plants, permanently altering ecosystems, destroying wildlife habitat, potentially harming human health and safety, and costing natural resource industries and taxpayers millions of dollars every year in management and control. As invasive plants capitalize on disturbed sites, any newly formed trail, roadway, tilled farmland, or railway can become a vector for their introduction and establishment.

The progression of invasive plants in Vancouver advanced with the fur trade in the early 1800s. As invasive plants began to be recognized as potentially detrimental to native ecosystems, legislation was introduced to keep them under control, with the *Thistle Prevention Act* introduced in 1877, the *Noxious Weeds Act* in 1888, and eventually, the BC *Weed Control Act* in 1996. Additional provincial legislation that governs the management of invasive plants includes the *Community Charter Act*, *Forest and Range Practices Act*, and the *Integrated Pest Management Act*.

With the completion of CPR's Arbutus Corridor line in 1902 and a rapidly expanding city, many of the historic western hemlock and western redcedar were cut down to accommodate for new development and infrastructure. The rail line running from the north arm of the Fraser River to False Creek allowed for invasive plant species to spread and become established, outcompeting native plants. Historic shrub occurrences of salal, vine maple, salmonberry, dull Oregon-grape (*Berberis nervosa*), and red huckleberry (*Vaccinium parvifolium*) were replaced with invasive plants such as Himalayan blackberry (*Rubus armeniacus*), hedge bindweed (*Calystegia sepium*), and wild chervil (*Anthriscus sylvestris*) (Diamondhead 2016).

Current Vegetation Condition

Today, approximately one third of the Arbutus Corridor is covered with invasive plant species (**Figures 3A-V**) (Diamondhead 2016). Himalayan blackberry, hedge bindweed, wild chervil, common hops (*Humulus lupulus*), Japanese knotweed (*Fallopia japonica*), and cherry-laurel (*Prunus laurocerasus*) each cover > 1,000 m^2 of the corridor, with an additional 10 invasive species also documented in lower occurrences. Coverage of the corridor in well-developed native plant species is low (< 1%), approximately 850 m^2, most of which is fragmented in small sections. The largest stretches of native vegetation occur between West 18th and West 20th Avenues, and between West 35th and West 38th Avenues.

Current native vegetation includes salmonberry, thimbleberry (*Rubus parviflorus*), harhack (*Spirea douglasii*), snowberry (*Symphoricarpos albus*), and bracken fern. The City of Vancouver maintains a record of trees planted on city property, with Kobus magnolia (*Magnolia kobus*), pin oak (*Quercus palustris*), crimson king Norway maple (*Acer platanoides*), London plane tree (*Platanus acerifolia*), and purple leaf sycamore maple (*Acer pseudoplatanus*) making up the majority of occurrences along the Arbutus Corridor (City of Vancouver 2017). A complete list of all trees occurring within the Arbutus Corridor during the tree survey is presented in **Section XX**.

Potential for ecological restoration is greatest in the southern portion of the Arbutus Corridor. From Milton St. north to 49th Ave., there is a good mix of trees at varying stages of structural development. There are a number of parks with good connecting habitat in close proximity (i.e., a mixture of young trees, mature trees and shrubby vegetation) in this southern reach. Between 49th and 41st Avenues, trees are less abundant and there are fewer nearby parks. From 41st Ave north to King Edward Ave. the vegetation is well suited for many species of wildlife as there is a diverse community of native trees and shrubs, and several parks are connected by young and mature trees that line the streets. North of King Edward Ave. there are very few trees along the edge of the corridor, and very little connecting habitat to suitable areas nearby.

Aquatics

Numerous streams were once found in proximity to the Arbutus Corridor, with those occurring north of 40th Ave running into False Creek, and those occurring south of 40th Ave running into the north arm of the Fraser River (Lesack and Proctor 2011) (**Figure 2**). In the Fraser Lowlands of Metro Vancouver, 86% of wetlands were lost between 1827 and 1990 (David Suzuki Foundation et al. 2013).

Wildlife

Wildlife composition in the area has also changed since the construction Arbutus Corridor. Species that would have once been common in the area are now in decline or absent altogether, while others that have no historic occurrence in the area now flourish.

Invertebrates

With the loss of native vegetation and the proliferation of invasive plant species, many invertebrates no longer have suitable habitat to meet various life requisites. Perhaps one of the most noticeable declines, both locally in Vancouver and globally, are the decline of pollinators (e.g., bees, butterflies) (Ahrné et al. 2009, Potts et al. 2010, Elle 2015). Replacement of native plants that pollinators rely on, including members of the *Rubus* genus (City of Vancouver 2015), with invasive species has resulted in conditions that are not conducive to recovery of this group in decline.

Amphibians

Many amphibians that breed in streams and slow-moving water, including long-toed salamander (*Ambystoma macrodactylum*), northwestern salamander (*Ambystoma gracile*), and western toad (*Anaxyrus boreas*), likely occurred in the area historically. With the elimination of historic surface water streams, suitable breeding habitat for these species has also disappeared. Some amphibians that breed in standing water, such as Pacific tree frogs (*Pseudacris regilla*), are still relatively abundant in Vancouver, while others, such as red-legged frogs (*Rana aurora*), are not (Vancouver Board of Parks and Recreation 2016).

Birds

Common native birds that have been documented within two kilometres of the Arbutus Corridor over the last 25 years include a mix of water and terrestrial associated birds. Common water associated birds include American wigeon (*Anas americana*), snow goose (*Chen caerulescens*), black scoter (*Melanitta americana*), Canada goose (*Branta canadensis*), Bonaparte's gull (*Chroicocephalus philadelphia*), mew gull (*Larus canus*), white-winged scoter (*Melanitta fusca*), American coot (*Fulica americana*), mallard (*Anas platyrhynchos*), brant (*Branta bernicla*), and ring-billed gull (*Larus delawarensis*) (eBird 2017). Common birds associated with terrestrial habitats include Wilson's warbler (*Cardellina pusilla*), golden-crowned kinglet (*Regulus satrapa*), northwestern crow (*Corvus caurinus*), bushtit (*Psaltriparus minimus*), golden-crowned sparrow (*Zonotrichia atricapilla*), pine siskin (*Spinus pinus*), fox sparrow (*Passerella iliaca*), barn swallow (*Hirundo rustica*), cedar waxwing (*Bombycilla cedrorum*), yellow-rumped warbler (*Setophaga coronata*), common redpoll (*Acanthis flammea*), house finch (*Haemorhous mexicanus*), purple finch (*Haemorhous purpureus*), black-capped chickadee (*Poecile atricapillus*), and ruby-crowned kinglet (*Regulus calendula*) (eBird 2017). A complete list of all birds observed within 2 km of the Arbutus Corridor, is available in **Appendix A**.

Mammals

The composition of mammals in Vancouver has also undergone changes. While some individuals occasionally are observed within city limits, large native mammals such as black-tailed deer

(*Odocoileus hemionus*), elk (*Cervus elaphus*), black bear (*Ursus americanus*), grizzly bear (*Ursus arctos*), grey wolf (*Canis lupus*), and cougar (*Puma concolor*) have been extirpated from the area (Raincoast Applied Ecology 2012, Vancouver Board of Parks and Recreation 2016); coyote (*Canis latrans*) are now the top predator in Vancouver.

Smaller native mammals are more abundant within city limits, and include such species as big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), little brown myotis (*Myotis lucifugus*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), coast mole (*Scapanus orarius*), common muskrat (*Ondatra zibethicus*), Douglas squirrel (*Tamiasciurus douglasii*), northern flying squirrel (*Glaucomys sabrinus*), deer mouse (*Peromyscus maniculatus*), and Keen's mouse (*Peromyscus keeni*) (Raincoast Applied Ecology 2012, Vancouver Board of Parks and Recreation 2016).

Invasive Wildlife

There are also a number of invasive wildlife species found along the Arbutus Corridor. European fire ants (*Myrmica rubra*) are an invertebrate that can cause impacts to native ant species, as well as human health, was first recorded in BC in 2010 (BC Inter-Ministry Invasive Species Working Group n.d., Diamondhead 2016). Colonies of European fire ants occur between 65th and 68th Avenues along the Arbutus Corridor (**Figure 3A-V**).

Invasive amphibians in the area include green frog (*Lithobates clamitans*) and American bull frog (*Lithobates catesbeiana*) are two frog species that are not native to Vancouver, but are occasionally found in the area. Neither of these species likely occur along the Arbutus Corridor.

The composition of birds in Vancouver has also changed since the construction of the Arbutus Corridor. A number of invasive bird species have been introduced as Vancouver and BC have become more developed and more people arrive from around the world:

- European starlings (*Sturnus vulgaris*) were introduced to North America in 1890 and arrived in BC in 1945 (Davidson 2015);
- House sparrows (*Passer domesticus*) were introduced to North America in 1851 and had arrived in BC by the early 1900s (Cornell Lab of Ornithology 2015);
- Eurasian collared-doves (*Streptopelia decaocto*) were introduced to BC around 2005 (The Vancouver Sun 2009);
- Mute swans (*Cygnus olor*) were introduced to North America in the 1870s, with populations increasing in BC since the late 1990s (Environment Canada 2013);
- Rock doves/domestic pigeons (*Columba livia*) were introduced to North America in the early 1600s (Clifford and Guiguet 1958), and have been in BC as far back as records go; and
- Crested mynas (*Acridotheres cristatellus*) were introduced to BC around 1890, and flourished in Vancouver until the early 2000s; they were eventually outcompeted by another invasive bird species, the European starling, with the last known occurrence in Vancouver in 2003 (Mickleburgh 2002, Grady 2008).

Mammals that have been introduced to the area include Virginia opossum (*Didelphis virginiana*), house mouse (*Mus musculus*), European rabbit (*Oryctolagus cuniculus*), brown rat (*Rattus norvegicus*), roof rat (*Rattus rattus*), and eastern grey squirrel (*Sciurus carolinensis*) (BC CDC 2017). Additionally, while not necessarily considered wild, domestic cats (*Felis catus*) are also an introduced species in Vancouver, one which arguably has a disproportionate effect on native species (specifically birds) when compared with other introduced species of wildlife (Calvert et al. 2013, Loss et al. 2013, Nuwer 2013). Feral cats make up a large portion of coyote diet (Quinn 1997), but more action can be taken to reduce the impacts of cats on local native wildlife (Stewardship Centre for British Columbia (SCBC) 2016).

List of birds observed within 2 kilometres of the Arbutus Corridor

Common Name	Scientific Name	Sum of Count	Habitat
American Coot	Aegolius acadicus brooksi	46	Water
American Goldfinch	Archilochus colubris	11	Terrestrial
American Robin	Aquila chrysaetos	12	Terrestrial
American Wigeon	Acanthis flammea	278	Water
Anna's Hummingbird	Aythya americana	8	Terrestrial
Bald Eagle	Archilochus alexandri	12	Terrestrial
Band-tailed Pigeon	Calidris acuminata	4	Terrestrial
Barn Swallow	Ammodramus bairdii	23	Terrestrial
Barred Owl	Calidris temminckii	2	Terrestrial
Barrow's Goldeneye	Antigone canadensis	13	Water
Belted Kingfisher	Buteo regalis	5	Shore
Bewick's Wren	Arenaria melanocephala	9	Terrestrial
Black Scoter	Accipiter cooperii	216	Water
Black Swift	Ardea alba	11	Terrestrial
Black-capped Chickadee	Anas clypeata	19	Terrestrial
Black-headed Grosbeak	Calidris alba	4	Terrestrial
Black-throated Gray Warbler	Cepphus columba	1	Terrestrial
Blue-gray Gnatcatcher	Cerorhinca monocerata	1	Terrestrial
Blue-winged Teal	Certhia americana	1	Water
Bohemian Waxwing	Ardenna creatopus	10	Terrestrial
Bonaparte's Gull	Actitis macularius	55	Water
Brambling	Chaetura vauxi	1	Terrestrial
Brant	Aix sponsa	30	Water
Brewer's Blackbird	Anas formosa	16	Terrestrial
Brown Creeper	Bartramia longicauda	7	Terrestrial
Brown-headed Cowbird	Branta hutchinsii	6	Terrestrial
Bufflehead	Anas cyanoptera	18	Water
Bushtit	Aethia psittacula	37	Terrestrial
Cackling Goose	Accipiter gentilis	155	Water
California Gull	Buteo swainsoni	5	Water
Canada Goose	Accipiter gentilis atricapillus	124	Water
Canvasback	Charadrius melodus	1	Water
Caspian Tern	Artemisiospiza nevadensis	9	Water
Cedar Waxwing	Ammodramus nelsoni	22	Terrestrial
Chestnut-backed Chickadee	Calidris alpina	4	Terrestrial
Chipping Sparrow	Calidris tenuirostris	2	Terrestrial
Cinnamon Teal	Calidris virgata	2	Water
Cliff Swallow	Calidris bairdii	4	Terrestrial
Common Goldeneye	Bubo scandiacus	6	Water
Common Merganser	Ardea herodias	11	Water
Common Nighthawk	Callipepla californica	2	Terrestrial
Common Raven	Aythya collaris	8	Terrestrial
Common Redpoll	Amphispiza bilineata	21	Terrestrial
Common Yellowthroat	Calidris mauri	3	Shore
Cooper's Hawk	Bombycilla cedrorum	7	Terrestrial
Crested Myna	Asio flammeus	9	Terrestrial
Dark-eyed Junco	Anthus cervinus	14	Terrestrial
Double-crested Cormorant	Bombycilla garrulus	7	Water
Downy Woodpecker	Asio otus	9	Terrestrial
Eurasian Collared-Dove	Calidris melanotos	3	Terrestrial
Eurasian Wigeon	Calidris minuta	3	Water
European Starling	Accipiter gentilis laingi	103	Terrestrial
Evening Grosbeak	Calidris canutus	4	Terrestrial
Fox Sparrow	Alauda arvensis arvensis	29	Terrestrial
Gadwall	Ardenna gravis	10	Water
Glaucous-winged Gull	Anas crecca	19	Water
Golden-crowned Kinglet	Aegolius acadicus	48	Terrestrial

Common Name	Scientific Name	Sum of Count	Habitat
Golden-crowned Sparrow	Agelaius phoeniceus	33	Terrestrial
Great Blue Heron	Butorides virescens	5	Shore
Great Horned Owl	Calypte anna	2	Terrestrial
Greater Scaup	Calidris minutilla	3	Water
Greater White-fronted Goose	Charadrius mongolus	1	Water
Green Heron	Calypte costae	2	Shore
Green-winged Teal	Anas penelope	16	Water
Hairy Woodpecker	Caracara cheriway	2	Terrestrial
Hammond's Flycatcher	Cardellina canadensis	2	Terrestrial
Harris's Sparrow	Charadrius montanus	1	Terrestrial
Hermit Thrush	Bubo virginianus	6	Terrestrial
Herring Gull	Charadrius nivosus	1	Water
Hooded Merganser	Bubulcus ibis	6	Water
Horned Grebe	Charadrius semipalmatus	1	Water
House Finch	Anas acuta	21	Terrestrial
House Sparrow	Alle alle	26	Terrestrial
Hutton's Vireo	Calidris ferruginea	4	Terrestrial
Killdeer	Ammodramus leconteii	23	Shore
Lesser Scaup	Anas discors	17	Water
Lincoln's Sparrow	Bonasa umbellus	7	Terrestrial
Long-billed Dowitcher	Charadrius vociferus	1	Shore
Long-tailed Duck	Columba livia		Water
MacGillivray's Warbler	Calidris fuscicollis	4	Terrestrial
Mallard	Aeronautes saxatalis	42	Water
Marsh Wren	Cardellina pusilla	2	Shore
Merlin	Calidris himantopus	4	Terrestrial
Mew Gull	Aechmophorus clarkii	55	Water
Mute Swan	Chen caerulescens	1	Water
Northern Flicker	Aythya fuligula	8	Terrestrial
Northern Harrier	Chen canagica	1	Terrestrial
Northern Pintail	Chen rossii	1	Water
Northern Rough-winged Swallow	Contopus cooperi		Shore
Northern Shoveler	Ardenna grisea	10	Water
Northern Shrike	Chlidonias niger	1	Terrestrial
Northwestern Crow	Aethia cristatella	41	Terrestrial
Olive-sided Flycatcher	Cathartes aura	2	Terrestrial
Orange-crowned Warbler	Antrostomus arizonae	13	Terrestrial
Osprey	Calidris ptilocnemis	3	Terrestrial
Pacific Loon	Calidris pugnax	3	Water
Pacific Wren	Aythya marila	8	Terrestrial
Pacific-slope Flycatcher	Calidris pusilla	3	Terrestrial
Pelagic Cormorant	Ardea herodias fannini	11	Water
Peregrine Falcon	Bucephala albeola	6	Terrestrial
Pied-billed Grebe	Bucephala clangula	6	Water
Pigeon Guillemot	Contopus sordidulus		Water
Pileated Woodpecker	Calidris pygmea	3	Terrestrial
Pine Siskin	Alauda arvensis	30	Terrestrial
Purple Finch	Anas americana	21	Terrestrial
Purple Martin	Calidris ruficollis	3	Terrestrial
Red Crossbill	Catharus fuscescens	2	Terrestrial
Red-breasted Merganser	Anthus rubescens	14	Water
Red-breasted Nuthatch	Botaurus lentiginosus	7	Terrestrial
Red-breasted Sapsucker	Calidris maritima	4	Terrestrial
Red-eyed Vireo	Chondestes grammacus	1	Terrestrial
Redhead	Chordeiles acutipennis	1	Water
Red-tailed Hawk	Bucephala islandica	6	Terrestrial
Red-throated Loon	Aythya valisineria	8	Water
Red-winged Blackbird	Ardea herodias herodias	11	Shore
Ring-billed Gull	Alectoris chukar	27	Water
Ring-necked Duck	Anas platyrhynchos	16	Water

Common Name	Scientific Name	Sum of Count	Habitat
Ring-necked Pheasant	Chordeiles minor	1	Terrestrial
Rock Pigeon	Aegolius funereus	46	Terrestrial
Rough-legged Hawk	Catharus guttatus	2	Terrestrial
Ruby-crowned Kinglet	Anas querquedula	16	Terrestrial
Ruddy Duck	Chroicocephalus philadelphia	1	Water
Rufous Hummingbird	Athene cunicularia	9	Terrestrial
Sanderling	Coragyps atratus		Shore
Savannah Sparrow	Ardenna tenuirostris	10	Terrestrial
Sharp-shinned Hawk	Buteo jamaicensis	6	Terrestrial
Snow Goose	Acanthis hornemanni	250	Water
Snowy Owl	Chroicocephalus ridibundus	1	Terrestrial
Song Sparrow	Anas rubripes	16	Terrestrial
Sora	Cinclus mexicanus	1	Shore
Spotted Sandpiper	Aythya affinis	9	Shore
Spotted Towhee	Brachyramphus brevirostris	7	Terrestrial
Steller's Jay	Brachyramphus marmoratus	7	Terrestrial
Surf Scoter	Circus cyaneus	1	Water
Swainson's Thrush	Calidris subruficollis	3	Terrestrial
Swamp Sparrow	Cistothorus palustris	1	Shore
Thayer's Gull	Catharus minimus	2	Water
Townsend's Solitaire	Cistothorus platensis	1	Terrestrial
Townsend's Warbler	Clangula hyemalis	1	Terrestrial
Tree Swallow	Anthus spragueii	14	Shore
Trumpeter Swan	Anas falcata	17	Water
Tundra Swan	Buteo lagopus	6	Water
Turkey Vulture	Anas strepera	15	Terrestrial
Varied Thrush	Branta bernicla	7	Terrestrial
Vaux's Swift	Arenaria interpres	10	Terrestrial
Violet-green Swallow	Branta canadensis	7	Shore
Virginia Rail	Coccothraustes vespertinus	1	Shore
Warbling Vireo	Ardenna carneipes	11	Terrestrial
Western Grebe	Anser albifrons	15	Water
Western Gull	Coccyzus americanus	1	Water
Western Meadowlark	Aphelocoma californica	13	Terrestrial
Western Sandpiper	Coccyzus erythropthalmus	1	Shore
Western Tanager	Branta canadensis occidentalis	7	Terrestrial
Western Wood-Pewee	Calamospiza melanocorys	5	Terrestrial
White-crowned Sparrow	Anthropoides virgo	15	Terrestrial
White-throated Sparrow	Catharus ustulatus	2	Terrestrial
White-winged Crossbill	Calcarius lapponicus	5	Terrestrial
White-winged Scoter	Aechmophorus occidentalis	51	Water
Willow Flycatcher	Catherpes mexicanus	2	Terrestrial
Wilson's Snipe	Calcarius ornatus	5	Shore
Wilson's Warbler	Accipiter striatus	68	Terrestrial
Wood Duck	Calcarius pictus	5	Water
Yellow Warbler	Buteo platypterus	6	Terrestrial
Yellow-bellied Sapsucker	Centrocercus urophasianus	2	Terrestrial
Yellow-headed Blackbird	Colaptes auratus	1	Shore
Yellow-rumped Warbler	Ammodramus savannarum	22	Terrestrial

Source: eBird 2017

ARBUTUS GREENWAY PLAN
UNDERSTANDING THE CORRIDOR TODAY

SEPTEMBER 2017

Arbutus Greenway Project

Streetcar Planning & Design Context Memo

September 8, 2017

City of Vancouver

Mott MacDonald
Suite 1888
Bentall 5
550 Burrard Street
Vancouver, BC V6C 2B5
Canada

T + 1 604 681 4400
mottmac.com

City of Vancouver
453 West 12th Avenue
Vancouver, BC
V5Y 1V4

Arbutus Greenway Project

Streetcar Planning & Design Context Memo

September 8, 2017

City of Vancouver

Mott MacDonald Canada Limited is registered in Canada No. 2232292. Suite 301, 30 Duncan Street, Toronto, ON M5V 2C3

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Executive Summary

The Arbutus Greenway Project is the concept planning and engagement assignment dedicated to transforming a disused freight rail corridor in Vancouver, British Columbia into a world class multimodal greenway, accommodating cyclists, pedestrians, people participating in a myriad of activities, and a future streetcar transit system feeding into a city-wide streetcar network.

The Streetcar Planning & Design Context Memo contextualizes considerations for planning and design of streetcar within this wider interdisciplinary process. The Context Memo includes:

- A brief orientation to streetcar as a modern transit technology
- An overview of modern streetcar considerations taken to-date in the Metro Vancouver context
- A discussion of general design principles, including philosophical and technical considerations
- Design considerations for later stages of design, including:
  - Streetcar design guidelines
  - Recommended geometric design parameters for streetcar and stops/stations, futureproofing
- Planning assumptions taken in generating schematic concepts.

The memo also discusses the integration of the north and south ends of the corridor into wider Vancouver and the regional transit system.

Ascertaining the City of Vancouver’s preferred approach to some of the overarching philosophical design assumptions and challenges described here will inform the development of a preferred concept, the Master Plan, and later stages of design.

1 Introduction

The Arbutus Corridor, located parallel to Arbutus Street in south-central Vancouver, is approximately 9 kilometres long and 15-20 metres wide between Fir Street in the north and Milton Street in the south, and represents approximately 42 acres of open space. It has always been, and remains an important north-south corridor that links False Creek to the Fraser River, and connects neighbourhoods like Marpole, Kerrisdale, and Kitsilano. The area surrounding the Corridor is one of diverse land uses, neighbourhoods, communities, and natural features.

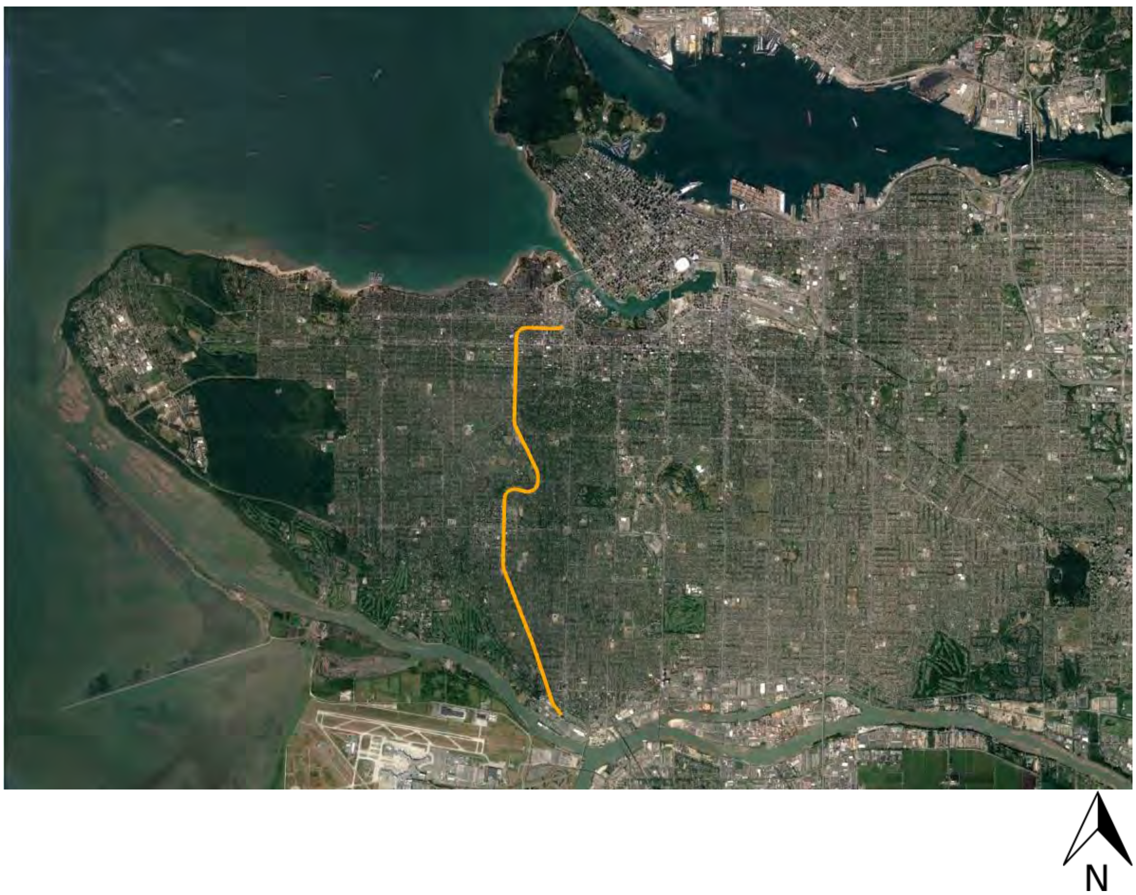


Figure 1-1 Arbutus Corridor within Vancouver

The City of Vancouver purchased the disused freight rail corridor from Canadian Pacific Rail in 2016, with the view in the long term to create a thoroughfare and public space for use by all. In the short term, temporary paving has been laid and today it is used by myriad outdoor recreation and ecology enthusiasts as a place to visit, gather, and travel by foot, bike, skateboard, and other modes.

The Arbutus Greenway Project (AGP) is a master planning and engagement assignment led by the City of Vancouver, dedicated to transforming the Arbutus Corridor into a world-class active transportation and green space. The vision for the Greenway is to be a series of new beautiful, recreational, ecological, and educational destinations in Vancouver but also to function as a safe and efficient part of Vancouver's wider multimodal transportation network including cycling, walking, and streetcar infrastructure.

The purchase of the corridor by the City was on the basis that it will be used as a transportation corridor that features light rail transit. Aspirations of the City go on to mandate multimodal functionality for the greenway and its vicinity, dictating some of our planning approach and imagined multimodal operational characteristics. Additionally, while allocating space for future streetcar (enabling its relatively easy and affordable implementation in future) is a key component of our design process, the AGP is not simply a transportation project, but a city-shaping one, as captured in the Vision statement:

"The Arbutus Greenway will be a defining element of Vancouver's urban landscape as a vibrant and beautiful public space for walking, cycling, and streetcar. It will be a destination which fosters both movement and rich social interaction - inspired by nature and the stories of the places it connects."

1.1 Streetcar Planning and Design

Two dominating factors influence the conceptual planning of any number of streetcar alignments within or near the Arbutus Corridor;

- Streetcar is not anticipated to be constructed in or near the Arbutus Corridor in the near term. Therefore, recommendations regarding physical space allocations and even overarching philosophical design considerations are subject to change (possibly becoming less conservative) as technologies and transportation operations in cities evolve.
- The purchased area ("Corridor") is constrained, with some challenging geometry, utility interfaces, multimodal conflicts at accesses and intersections, and streetcar vehicles and infrastructure have relatively inflexible space requirements.

With these considerations taken into account, the conceptual planning of the future Arbutus greenway begins with investigating feasibility for streetcar alignments. These initial alignments will form the basis for defining other greenway elements and can evolve through the master planning process.

2 What is Streetcar?

While the concept of "streetcar" tends to evoke images of small heritage vehicles trundling through mixed traffic, or Toronto's classic red high-floor streetcars, modern streetcar systems in North America can best be described within the class of Light Rail Transit (LRT); sleek, multi-car trains that typically have higher capacity, with possibly increased travel speed, and frequency than buses, with fewer stops and more definitive physical segregation from other road users, providing a high level of service reliability.

Figure 2-1 Portland Streetcar

Figure 2-2 Atlanta Streetcar

Figure 2-3 Salt Lake City S-Line

The American Public Transit Association (APTA) defines streetcars as:

Lightweight passenger rail cars operating singly (or in short, usually two-car, trains) on fixed rails in right-of-way that is not separated from other traffic for much of the way. Light rail vehicles are typically driven electrically with power being drawn from an overhead electric line via a trolley or a pantograph.

The Transportation Research Board's Transit Cooperative Research Program (TRB TCRP)'s report *Synthesis 86: Relationships Between Streetcars and the Built Environment* quotes:

Streetcars are for local transportation. A Light Rail line may operate ten or 20 miles out beyond the downtown, running at high speeds between suburban stations spaced a mile or more apart. Streetcars operate in the downtown and perhaps a bit beyond it, picking people up and letting them off at almost every street corner. Often, people will use Light Rail to come into town, then use a streetcar to get around town.

Streetcar can further be defined by a list of characteristics:

- is customizable, modern-looking and can feature branding;
- is operated by humans on a line of sight basis so can be responsive to changing conditions and surroundings;
- will stop to allow passengers to board and alight at stops/stations that are typically placed between 300 – 800 m apart;
- can operate at different speeds depending on the operating context;
- requires its own operations and maintenance facilities;
- features seated and standing capacity, as well as accessible areas for mobility aids and strollers;
- can include on-board areas for bicycles and luggage if required;
- can operate on a variety of track types, including:

  - tracks that are on tie and ballast;
  - tracks that can be embedded into hard- or green-surfaced areas; and
  - tracks that are directly fixed to hard surfaced areas, but are not embedded
- is typically propelled by electricity transmitted by wires, but is also capable of wireless propulsion;
- typically, does not exceed posted road speed limits when running integrated with or adjacent to traffic;
- can adapt to a variety of urban and suburban environments using speed, stop spacing and varying degrees of signalized prioritization; and
- can adapt to a range of operating scenarios - full segregation to shared right-of-way on-street with other vehicles.

Figure 2-4 Platform interface ‑ CAF Urbos 3 in Birmingham

Figure 2-5 Integrated platforms and sidewalk in Birmingham, UK

3 Why Streetcar for AGP?

3.1 Policy Context

The City of Vancouver has had long-standing goals to redevelop a city-wide streetcar network, first documented in 2000 in the Arbutus Corridor Official Development Plan, which identified rail transit for the future Greenway.

In 2012, Vancouver City Council approved Transportation 2040, a long-term vision for the City of Vancouver that will help guide transportation and land use decisions and public investments. The plan is focused on promoting walking, cycling and transit, with the target to have at least two-thirds of all trips made by foot, bike, or transit by 2040.

The Arbutus Corridor is identified as one of the “emerging areas of focus” in Transportation 2040, with the objective to develop the Corridor as an active transportation greenway with high quality walking and cycling routes and a future streetcar or light rail line.

For decades, aspirations of implementing streetcar (or rail transit in general) appear in numerous policy documents through to 2016 when the City purchased the Corridor.

3.2 Legal Context

In March 2016, the City of Vancouver purchased the Arbutus Corridor from Canadian Pacific Railway (CPR). The City’s agreement with CP was intended to ensure that residents could continue to use the Arbutus Corridor as a sustainable greenway and transportation corridor, including walking, cycling and future streetcar – a clear link to the planning and policy foundation that had been laid to enable its revitalization. The Purchase Agreement specifies that portions of the corridor are to be dedicated for light rail use.

3.3 City-Shaping Context

The opportunity to reclaim, redevelop, and revitalize a disused freight rail corridor in the middle of Vancouver into a world-class Greenway is unique and important, not only from a multimodal transportation perspective, but in terms of its catalytic city-shaping potential.

Implementing integrated, context-responsive light rail transit in communities that are observed to be growing or ready to grow can enhance the aesthetic and function of public space, and can encourage mixed-use, sustainable development on a variety of scales. The relevant, sensitive infill development potential around the Arbutus Corridor can increase significantly with the introduction of light rail transit or modern streetcar, and can encourage improvements for cycling, walking, and placemaking.

Although the origins, destinations, and neighbourhoods surrounding the Arbutus Corridor today are well-served by the Frequent Transit (bus) Network, enhancing transit passenger experience through the implementation of streetcar in the Arbutus Greenway’s redevelopment could incent transit ridership across Vancouver and within the neighbourhoods around the Greenway.

3.4 City of Vancouver's Vision for Streetcar

Streetcar can elegantly respond to the context of its surroundings and can operate in varied ways to suit the projects objectives.

As the City is looking to update its City-Wide Streetcar Strategy in the near future, the AGP work is being developed without the ability to refer to a defined set of guidelines and principles.

On this basis, planning assumptions made here and that inform the schematic concepts are designed to show various options as to how the streetcar can be laid out; some options will provide moderately higher speeds and better reliability through more segregation with the trade-off that they occupy a large portion of the purchased corridor, while others would provide more corridor space for the other transportation modes and for placemaking by taking opportunities to integrate the streetcar either partially or fully into the street network.

Through the MAE process, and as parallel City investigation of streetcar expansion continues, it will be necessary to assess these different options to define the City's vision and appetite for the various trade-offs they require.

4 Streetcar at Home & Abroad

While Metro Vancouver (and indeed most of Canada) was home to streetcar historically, most heritage systems have been decommissioned almost completely, or are in tourism-based operation separate to public transit networks. Modern streetcar systems have recently been reintroduced to cities across North America as public transit networks diversify to include a wider range of transit services, and as the link between land use and transportation planning has grown. Modern streetcar systems or light rail transit schemes can integrate seamlessly with the communities they serve, requiring minimal infrastructure capable of being delivered elegantly and responsively to their contexts.

4.1 Streetcar at Home

4.1.1 Heritage Streetcar

The Streetcar was a common fixture in Metro Vancouver and the City of Vancouver between 1897 and the 1950s. The Vancouver-Richmond Interurban Line run by the BC Electric Company (BCER) travelled along what is now the Arbutus Corridor, established in 1905 when BCER leased the line from the Canadian Pacific Railway (CPR).

Figure 4-1 Arbutus Interurban near 37th Ave (Credit: Railforthevalley.com)

The line began at the north end of the Granville Bridge and stopped at various locations along the route, including the streets now referred to as 4th Avenue, Broadway, 41st Avenue, and others. The development of the line led to the establishment of neighbourhoods on the west side of the city and neighbourhood centres such as Kerrisdale. Trains ran along the line every half hour and the travel time between downtown Vancouver and Kerrisdale was just over 15 minutes. As the prominence of the private automobile became more pronounced in the 1950s through the *Rails to Rubber* conversion program, this marked the end of streetcar throughout Metro Vancouver and along the Arbutus Corridor. The Lower Mainland interurban trains ended operation in 1952.

4.1.2 Olympic Streetcar Demonstration Project

As a showcase for the 2010 Olympic Winter Games and Paralympic Games, the City of Vancouver's Olympic Line Streetcar project involved the redesign and rehabilitation of approximately 2 km of the Downtown Historic Streetcar line, linking the Olympic Village Canada Line Station to Granville Island. Two modern streetcars operated 18 hours per day, seven days per week over 60 days, traveling over 30,000 km and transporting over 550,000 passengers. To-date, this project is the sole modern streetcar system that has operated in Western Canada, although only for a short period of time.

Figure 4-2 Vancouver Olympic Demonstration Project

4.2 Streetcar Abroad

There are many modern streetcar systems in operation across the globe. In Europe, these are classified as Tramways and combine elements of both LRT and streetcar, featuring wider stop spacings and higher speeds in suburban areas where segregation can be achieved, and slowing and serving a more granular network of stops, possibly shared with traffic, in more urban areas.

Bearing in mind similarities in development context and operational cultures, there may be more applicability in assessing US streetcar systems for Vancouver's consideration. Portland was the first city in the USA to build a modern system, with its first lines opening in 2001. The last decade, however, has seen a significant increase in the number of systems entering operation in the USA.

These include new systems in Atlanta and Salt Lake City, where with the Beltline and the Sugar House Greenway respectively, parallels can be drawn to the Arbutus Project. Both are operational streetcar systems today but whereas Atlanta's is planned to extend into the Beltline in the future, in Salt Lake the Greenway has been developed around the streetcar line. This development incorporates planting and hardscaping elements to act as buffers and directional cues to other corridor users in a way which may become relevant to this project.

Lessons learned and major successes realized on these and other projects will help guide the design development of AGP.

5 Streetcar Intelligence

The development of a preferred concept for the Arbutus Greenway streetcar will be informed by a variety of local studies, expertise garnered from a legacy of streetcar planning, design, and operations expertise in the United States and Europe, and regulatory and industry standards / best practices.

5.1 Local Studies

As a part of delivering on Transportation 2040 and numerous other policy documents that support implementation of light rail, various streetcar explorations have been undertaken. Four pertinent streetcar reports / memoranda developed by the City of Vancouver provide context for the Arbutus Greenway Project, as summarized below. The first two documents are now somewhat outdated and are no longer necessarily appropriate as references. With the recent adoption of European-style / urban low-floor LRT systems across Canada, parameters from those documents pertaining to vehicle dimensions require careful consideration.

The latter two documents were written as guidance for the North East False Creek Project where the streetcar is planned to operate on urban streets. While these memos are recent and acknowledge advances in streetcar and LRT technology, the recommendations are specific to the local urban environment and don't necessary translate directly to the more natural, potentially off-street AGP context.

5.1.1 Downtown Streetcar – Design, Layout, and Ridership Study (IBI Group, 2005)

This report discussed the City of Vancouver's overall vision of the Downtown Streetcar, defining its alignment, stations, projected ridership, revenue, and cost estimates. Although this report did not consider the Arbutus Greenway, it detailed ridership and streetcar design information that can help characterize the parameters for the AGP. While the technical parameters for vehicle design included in this report are now considered outdated due to advancements in technology, it does provide some useful context, highlighting the City of Vancouver's vision for streetcar, where streetcar service is "intended to provide an attractive transit service in developing areas, linking destinations, and serving combined usage by residents, workers, and tourists". Overall, this document provides some defined parameters which will be used in the basis of planning the AGP.

5.1.2 Downtown Streetcar – Preliminary Design Report (Hatch Mott MacDonald, 2008)

This 2008 report examined a streetcar design along the Southeast False Creek (SEFC) area from Granville Island to Science World. This report details comparisons between heritage and modern heritage vehicles, particularly geometric envelopes.

5.1.3 Northeast False Creek (NEFC) – Streetcar Considerations Memo (Mott MacDonald, 2016)

The NEFC Streetcar Considerations Memo highlights important streetcar geometric parameters recommended by Mott MacDonald, with reference to TCRP 155: Track Design Handbook for Light Rail Design. This memo provides high-level guidance on streetcar design for the Northeast False Creek Project. Although this memo is written for a geographic context different to the Arbutus Greenway, the parameters discussed are applicable in developing and confirming the AGP's streetcar geometric design considerations, particularly for in-street streetcar concepts.

s.13(1), s.17(1)

[redacted]

5.2 Industry Best Practice

Industry best practices and design guidelines for modern streetcars are well-established across the globe, and vary in applicability based on geography and operating characteristics. Technical documents which are well-suited to inform planning and design work for the Arbutus Greenway Project include but are not limited to:

- Transit Cooperative Research Program (TCRP) Report 155: Track Design Handbook for Light Rail Transit – is based upon historic and current practices for many light rail projects across North America. It sets out principles and parameters which are adopted as industry standards by designers when developing rail based transit systems.
- Guidance on Tramways, Railway Safety Publication 2 (RSP2), Office of Rail Regulation – is a guideline published by the UK's regulatory body for railways which has oversight for safety on tramways. It provides useful additional guidance over what is included in the TCRP report, particularly around how these types of systems interact with road traffic, pedestrians, and cyclists.
- APTA RT-ST-GL-001-13: Modern Streetcar Vehicle Guideline – provided typical parameters and capabilities for streetcars and some discussion about how they interact with and influence other aspects of a system's design.

5.3 Regulations

Given the absence of in-operation, at-grade modern streetcar systems in Canada and in British Columbia, there is a shortage of definitive design parameters or regulatory literature regarding operations. Although streetcar design parameters are not significantly varied throughout the world, there are unique regulatory considerations dependent on location and operating context; for instance, regulatory requirements may differ between highly urbanized and more natural environments.

The only regulatory literature for at-grade rail systems currently applied in British Columbia are for freight rail or commuter rail (West Coast Express) – both technologies whose operating characteristics are markedly different from streetcar.

However, there are several Canadian modern at-grade light rail systems that are in the design and construction phases or are moving towards operation. One such project is TransLink's South of Fraser Rapid Transit Project, which will be the province's first modern at-grade light rail system. TransLink are currently involved in discussions with the British Columbia Safety Authority (BCSA), so the outcomes for the Surrey LRT project may be applicable to the Arbutus Greenway streetcar in future.

6 Streetcar Design Philosophy

Future streetcar in the Arbutus Greenway has been identified as needing to be a key component of the city's wider transportation network; meant to have transit functionality, serving passengers effectively and safely, with minimal physical and operational impacts to its surroundings. While these aspirations will philosophically inform the design approach, more specificity about streetcar infrastructure will need to be achieved as planning advances to design.

6.1 A Greenway featuring many Modes

The City of Vancouver's Transportation 2040 identifies its mode hierarchy as:

1. Walking
2. Cycling
3. Transit
4. Taxi / Commercial Transit / Shared Vehicles
5. Private Automobiles

Additionally, the City of Vancouver has purchased the Arbutus Corridor "for light rail use and walking and cycling use". With this in mind, in determining the more specific operational aspirations for the streetcar – how it is expected to operate and interact with Greenway and ambient users - it is important to agree on an operational hierarchy; one that may or may not need to differ from the one defined above. In establishing this, it can be determined what the streetcar – and other corridor elements – will be enabled to achieve operationally, informing vehicle type, track type, frequency and span of service, and coverage of service (number of stops/stations). Streetcar planning considerations are discussed below to this effect.

6.2 Vehicle

There is a wide variety of streetcar vehicles available today. Manufacturers can create a streetcar vehicle to nearly any specification for overall look and feel, size, level of universal accessibility into and within the vehicle, propulsion, and myriad other operational and physical features. As cities retrofit to expand their transit networks and densify their urban areas, there is an increasing appetite for and supply of urban-style, low-floor light rail transit or streetcar vehicles that integrate with minimal ancillary infrastructure such as stop platforms. Additionally, manufacturers have a growing ability to deliver vehicles that are responsive to constrained urban contexts; a wide variety of widths, lengths, and maneuvering capabilities can be supplied.

In the USA, the supply of streetcar and light rail vehicles (LRVs) is restricted by "buy America" rules and stringent design requirements. In Canada, these restrictions don't exist and therefore the options for the procurement of streetcar vehicles and the number of potential suppliers available is much greater.

Figure 6-1 European style LRVs from Birmingham (CAF) and Nottingham (Bombardier)

Figure 6-2 US Streetcars from Salt Lake City (Siemens) and Portland (Skoda Inekon)

In the case of the Arbutus Greenway, urban-style, low-floor streetcar is most appropriate to achieve the City's universal accessibility objectives as well as its vision of an integrated, world-class multimodal greenway that is not simply a transit thoroughfare. This is not to say that the overall look and feel of the streetcar must be modern; a heritage design that offers these benefits can be procured.

Given that the Arbutus Greenway streetcar is not envisaged to be implemented in the near term, it is likely that light rail / streetcar vehicle technology will continue to advance, increasing vehicle type options.

Planning Assumption: Generic design vehicle with dimensions of 2.65m wide x 35m long.

6.3 Propulsion

Historically, streetcars have used pantographs or trolley poles to collect electric power from overhead lines. Traction Power Substations (TPSS) are typically located every kilometre or two depending on the number of vehicles operating on the tracks. These facilities will vary in size, also depending on the operational requirements of the system, but the maximum size anticipated would be similar to a 40ft shipping container. TPSS need to be located in reasonably close proximity to the tracks with around 100m typically being the furthest away that is acceptable. They need to be accessible at all times but can be located inside buildings or compounds to disguise them. If necessary, and if there is a tolerance for significant ventilation, they can be placed in chambers underground.

The power is accessed by the streetcar via a system of overhead wires and a pantograph. Overhead lines are familiar in Vancouver from the network of trolley buses which operate across the city. Streetcar Overhead Catenary Systems (OCS) can be designed to be relatively unobtrusive, generally with only a single wire supported above each track. The poles required to support the OCS are often decorative and can become a signature element of a system. In many European applications, wires are supported by building fixings but it is unclear whether the legislative powers to require this would exist for the project. However, it may be possible to reach agreement, particularly with new developments, to facilitate these fixings and therefore reduce ground level infrastructure.

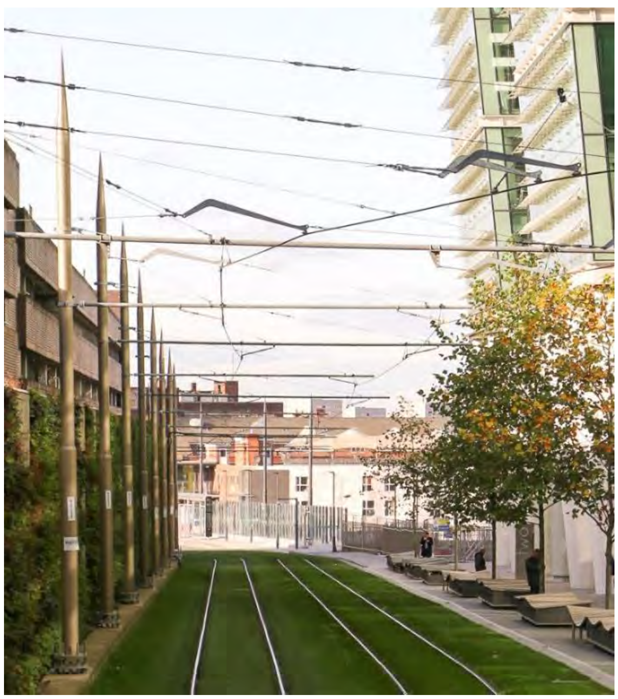


Figure 6-3 Decorative poles with cantilever supports in Birmingham

Figure 6-4 Single wire OCS in Barcelona

Figure 6-5 Dublin Luas with single wire OCS

Figure 6-6 Span OCS wires affixed to buildings, Sheffield, UK

In more recent times, alternate options have become more common. There are several proprietary systems which allow the power to be collected from ground-based infrastructure while not posing the safety issues that a traditional third rails system would. Some systems are now moving, at least partially, to on-board energy storage systems, such as supercapacitors and batteries, to provide power in locations where overhead wires and the poles which support them are not desirable. These systems will have different requirements for TPSS facilities, potentially requiring smaller but more frequent provision, most likely in close proximity to stops, where charging will take place.

Figure 6-7 Charging point at a stop – Seville, Spain

Currently, that technology is in its relative infancy and the distances which can be traveled, particularly when in shared traffic where there is a risk of delay, may limit operational flexibility. Given the likely timelines before streetcar is implemented, the technology will have moved on and may be a commonly-adopted solution at the time of Arbutus Greenway streetcar implementation.

Planning Assumption: Propulsion by overhead catenary system with Traction Power Substations.

6.4 Operation

If transit priority is defined as one of the key project objectives, then at this initial planning stage it is considered appropriate that two tracks should be provided along the length of the corridor with as much segregation from adjacent users as possible. This would provide the fastest and most reliable streetcar operation and journey times and could be the basis against which other concepts are measured.

However, there are many competing demands over the space available along the corridor and in some places, it may be necessary to compromise the streetcar slightly in order to achieve the wider vision for the corridor. This could include single-track operations or placing tracks in alternate locations within or near the corridor, as described below.

Full Street Running – Streetcar can integrate with road traffic to make use of available space. There are several considerations which should be acknowledged when deciding where this is appropriate.

1. The streetcar will possibly be subject to delays caused by road traffic. To minimise the risk to transit operations two interventions should be considered:
   a. Limiting shared areas to local roads where traffic congestion is low and delays are unlikely to be frequent or sustained.
   b. Where necessary to operate within busier streets, make adjustments to road networks and intersections to prioritise the movements which are shared by the streetcar.
2. Tracks placed within active streets are more disruptive, difficult, and expensive to maintain. Limiting the extent of the sections in street can lessen the impact.
3. Maintaining one track segregated from traffic while the other is shared would potentially allow limited single-track operations when the street running track is blocked by an accident or road works. Appropriate special trackwork and control mechanisms would be required.

Figure 6-8 Street running - Portland

In-street Segregated trackways – It is possible to construct the streetcar tracks outside of the purchased corridor, either in the median of a road or adjacent to one, but segregated from road traffic. This is a common approach for LRT systems and is being proposed in the Vancouver region for the South of Fraser Rapid Transit project. The following are relevant considerations:

1. Centre running is often used to minimise impact to accesses. Widening is often required at intersections as turning movements across the tracks need to be controlled and require dedicated lanes.
2. Side running alignments can be used where there are few or no access requirements on one side of the street. As with median running, it is often necessary to widen the road at intersections as turning movements across the tracks must be controlled. The layout needs to be consider carefully to ensure that it is legible to all users.
3. While the streetcar will not necessarily be afforded full priority at all intersections, as it is in a segregated lane on it’s approach, it will not get caught in queuing traffic.

Figure 6-9 In-street Segregated Trackway, Seattle

Grade Separated Trackway – where significant traffic interactions are anticipated, it is sometimes considered necessary to grade separate by building elevated guideways or underpasses, although this is more common for LRT systems than for streetcar.

1. Both elevating above and intersection and tunneling below one will result in significant additional costs.
2. Speeds and reliability of the streetcar are likely to be increased over at-grade crossings of intersections.

Figure 6-10 Edmonton Valley Line – Elevated trackway rendering

Figure 6-11 Underpass grade separation, Sheffield, UK

Planning Assumption: Each of these operational scenarios has been depicted in the Arbutus Greenway schematic concepts. The preferred concept may include more than one operating scenario over the length of the Greenway.

6.5 Track

There are generally four types of streetcar track finishes – embedded, ballast, direct-fixation, and green-track. Track types can change along an alignment and can be tailored to the environment and desired aesthetic.

Design considerations that should be taken into account for later stages of the project include but are not necessarily limited to:

1. Aesthetics – should the rails be visible, obvious, or concealed?
2. Segregation – will people, vehicles, cyclists, and other road / greenway users be permitted to cross the tracks or enter the trackway? Will the tracks be physically inaccessible at certain locations (i.e. switches), or for the length of the trackway, and by whom? Do emergency vehicles need to be physically able to cross or enter the trackway? Is it important to provide a clear delineation for where people are and are not permitted to be?
3. Maintenance – Ease of access and maintenance
4. Cost – capital and operating

6.5.1 Embedded track

With embedded track, the streetcar rails and track bed are embedded in concrete, asphalt, pavers, or other material used in roadways. The top of the rail is flush with the top of the surface it is embedded in. It is typical for urban light-rail projects where the streetcar crosses or is integrated with traffic and/or plazas.

The finished surface can vary significantly depending the use or the context it is situated in. If integrated with the road then it will need to be suitable for road traffic whereas tracks through a plaza space could have a surface which is complementary to the surroundings. Finishes can range from simple concreate or asphalt, through coloured or textured concrete to setts or pavers. All uses will need to allow for adequate drainage of the surface although that can involve shedding water onto adjacent landscaped areas if possible in order to provide a more sustainable solution.

This type of finish can provide an aesthetically pleasing solution which can integrate with surrounding surface finishes. However, that can also be problematic as changes of surface type will often act as an indicator to show where people are and are not permitted to be.

Once constructed, embedded track requires minimal maintenance until the rail becomes overly worn and needs to be replaced. Doing so can be time consuming and expensive as it is necessary to break out and then restore the surrounding surface finishes.

Figure 6-12 Embedded track from Dublin Luas and Midland Metro

6.5.2 Ballast track

With a ballast solution, the track bed consists of ties (concrete or wooden) sitting on top of ballast (gravel), which is in turn supported by a compacted foundation. Ballast track is often used for heavy rail and was the type of track which previously was in place for the majority of the Arbutus Corridor. Typically, it is used in more segregated areas with minimal interaction or intersection with other modes of transportation. It provides clear indication to the areas occupied by the streetcar.

Ballast track is economical to construct but often requires that more space is allocated to the streetcar, as construction and maintenance tolerances mean a wide envelope must be prescribed. It requires more frequent maintenance than other types of track form as it can move and shift over time, and is repaired by a process called tamping. Tamping can be noisy so may not be desirable in some of the residential areas within which the AGP is situated.

While ballast track will allow rainwater to permeate through the top layers which surround the ties, it must be laid on a compacted foundation which will not permit infiltration. These foundation layers will require sub-drains which may be able to permit infiltration if the ground conditions permit.

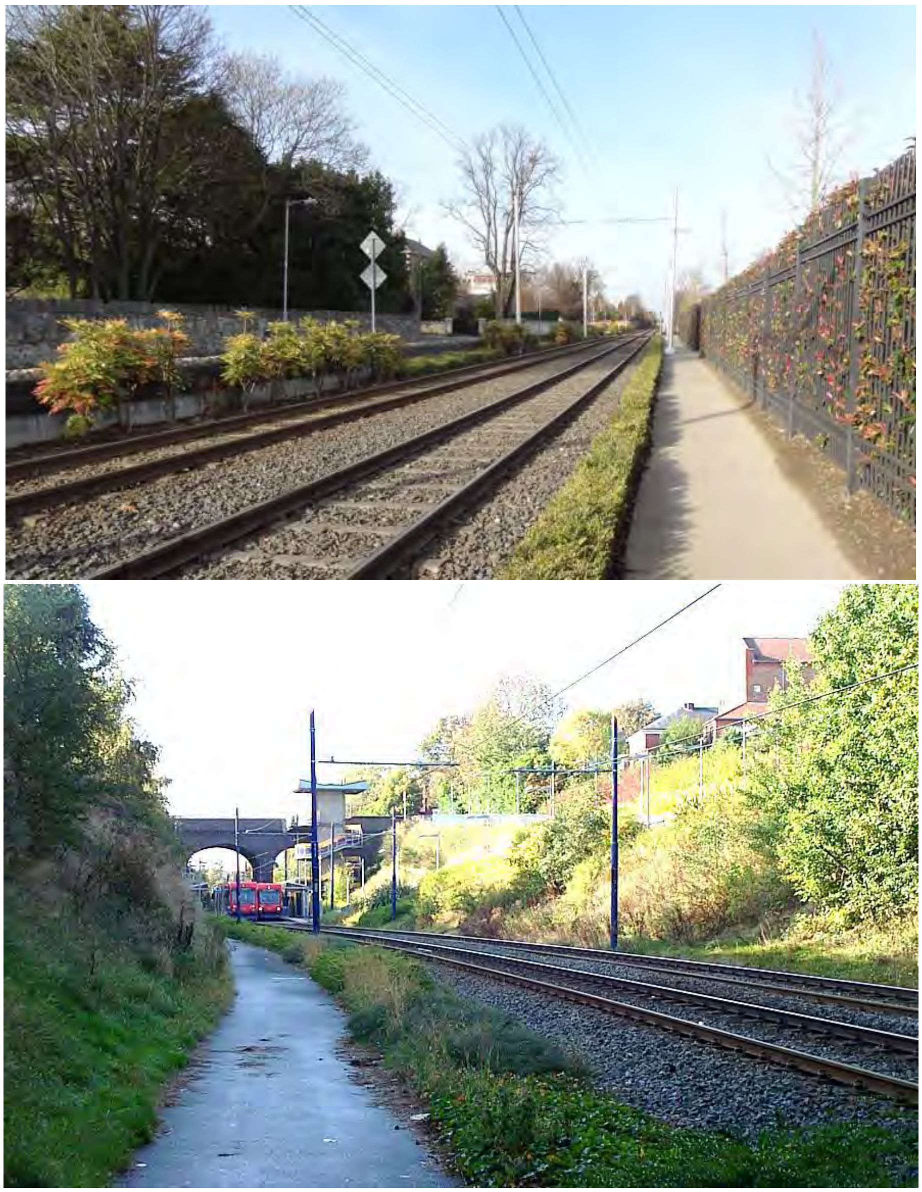


Figure 6-13 Ballast track from Dublin Green Line and Birmingham

6.5.3 Direct fixation track

Direct fixation (DF) track consists of rail and fasteners mounted on concrete plinths or track slabs, as shown in Figure 6-14. The top of the rail is typically 350-400mm above the top of concrete slab. It is most typically used on structures (such as bridges or tunnels) in areas where the streetcar is not required to share the trackway with pedestrian or vehicular traffic

This type of track form is probably the most desirable from an operations and maintenance perspective. The concrete rail support means that like embedded track, the rail is held securely in place. However, as the rail is not encased in concrete, it is easy to inspect and replace when it is necessary.

With the rails standing proud of the surrounding surface, DF track provides clear indications that the area is reserved for the rail system and could be used where there is clear separation between streetcar and the other adjacent modes.

As with embedded track, it may be possible to shed water from the support slabs to adjacent landscaping.

Figure 6-14 Direct Fixation track from Dublin Luas

6.5.4 Green track

Green (or grass) track is really a subset of the other types of track as each of the embedded, ballast and DF track solutions can be modified to incorporate a green finish. While ballast track can be overlaid with grass or other plants, doing so limits the ability to maintain the ballast, so it is not frequently used.

More commonly, a similar track bed to embedded or direct fixation is used with vegetation (grass, sedum, wildflowers) in between and adjacent to the rails. There are many different types of construction which can be considered; some provide a full concrete slab below the trackway, while others utilise a series of beams and plinths to support the rails, allowing at least some areas around the tracks which may permit infiltration of rainwater. It should be noted that grass track is not always green (drought conditions, drainage issues or winter), and is not suited to every operating environment. If the City wishes not to have people entering the trackway, clear delineation between the green track and other landscaped areas of the future Greenway will be critical.

Figure 6-15 Green track from Berlin, Birmingham, Freiburg, and Munich

Planning Assumption: No planning assumption has been or needs to be made for technical reasons at this stage of the Arbutus Greenway Project. Images used in the City of Vancouver's public engagement features embedded track, so a decision from the City may be required now in order to manage aesthetic and segregation expectations of stakeholders and the public. This decision can accompany a streetcar education campaign at any time.

6.6 Stops

6.6.1 Stop Features

Streetcar stops are best likened to bus stops with improved amenities. Stops can be scaled to integrate with their operating context, often blending in with a sidewalk or plaza.

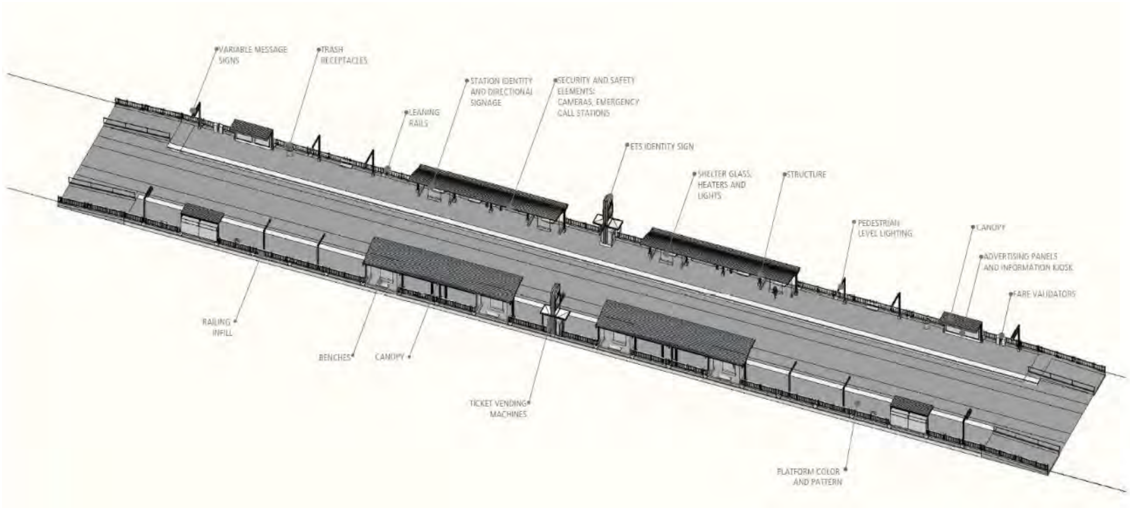


Figure 6-16 Typical Stop Components, Edmonton Valley Line (credit: City of Edmonton)

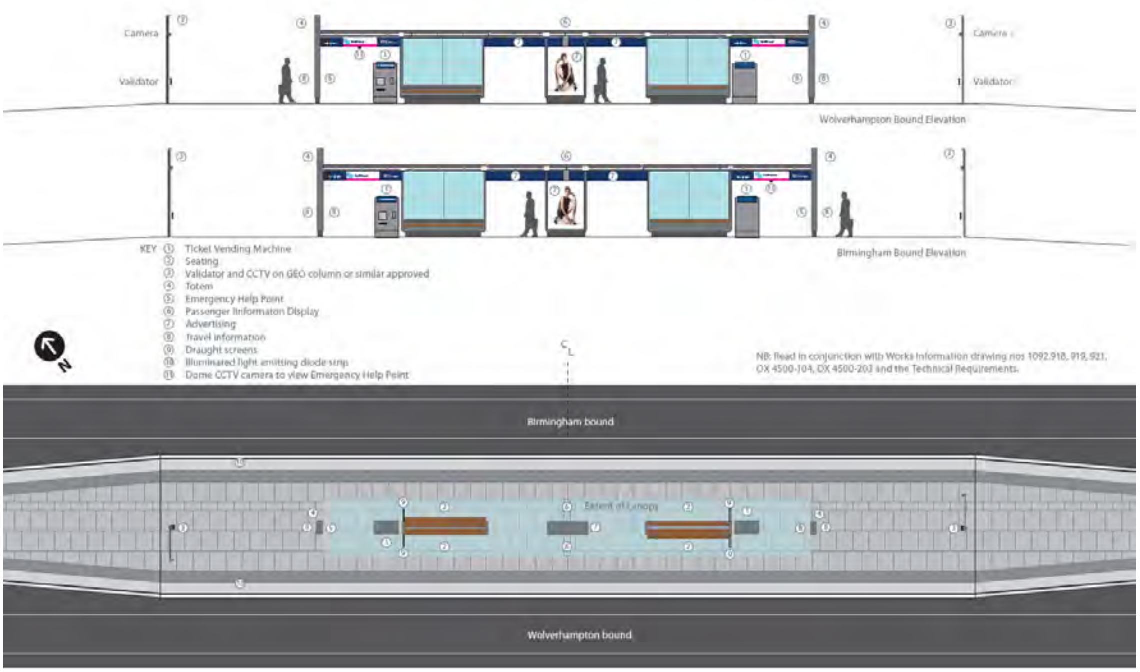


Figure 6-17 Typical Stop Component – Birmingham, UK

While contemporary streetcar stops are commonly understated and minimalist in order to blend into their surroundings, “statement” stops that vary in size and aesthetic can be curated / procured if desired.

If the Arbutus Greenway streetcar is planned to be an urban-style, low-floor light rail project that is integrated with the urban and natural contexts of the Greenway, stop platform heights will need to be around twice the height of a standard curb. This will allow step-free boarding so that the system is universally accessible.

Planning Assumption: at this stage in the AGP, it is not necessary to identify platform heights.

Figure 6-18 Accessible stop platform in Barcelona

6.6.2 Stop Configurations

There are two typical stop configurations that are applicable for the Arbutus Greenway Project:

Centre-Loading – At a centre-loading stop, tracks pass on each side of the platform and passengers board and alight to the middle of the tracks before crossing one to reach their destinations. Some transit authorities prefer this configuration, particularly where the trackway is in the middle of a road as it keeps waiting passengers further away from traffic.

Centre platforms can be slightly more efficient, both in terms of total width requirements and due to the fact that the infrastructure such as ticket machines and shelters can be shared. However, they generally require the tracks to separate apart, adding curves into the alignments.

Figure 6-20 shows two examples of centre platforms from Birmingham, UK and Zaragoza, Spain as well as an approach to a centre platform where the tracks separate and the potential treatments which can be applied to these areas.

Side-Loading - At a side-loading platform, streetcar passengers board to a platform at one side of the tracks in a similar way to how buses unload passengers the curb of a road. This configuration can permit the two platforms to be separated slightly, for instance once can be placed south of an intersection and the other to the north.

Figure 6-18 above shows a side loading platform with a roadway at the rear while figure 6-6 below, shows two different side loading platforms from Nottingham in the UK. One is within the city centre where the LRT is shared with road traffic and the platform is integrated with the sidewalk behind. The second shows a more suburban location where the LRT is in its own right-of-way and the platforms link into a park area.

Figure 6-19 Side platforms in Nottingham, UK

Figure 6-20 Centre Platforms

Planning Assumption: the schematic concepts show variations on these stop types in order to assess their use in the context of the greenway.

6.6.3 Stop locations

Typically, streetcar stop spacing is similar to bus stop spacing. The closer the stops are together, the longer will the streetcar's runtime be, due to the cumulative deceleration, dwell, and acceleration time at each stop. Therefore, stop spacing is a factor in operating speed and therefore overall performance.

Planning Assumption: In the case of the Arbutus Greenway Project, potential streetcar stops have been identified based on route 16 bus stop locations, as well as on known areas of development/redevelopment potential, and a notional assessment of population and employment characteristics.

Figure 6-21 identifies preliminary stop locations based on existing bus transit service.

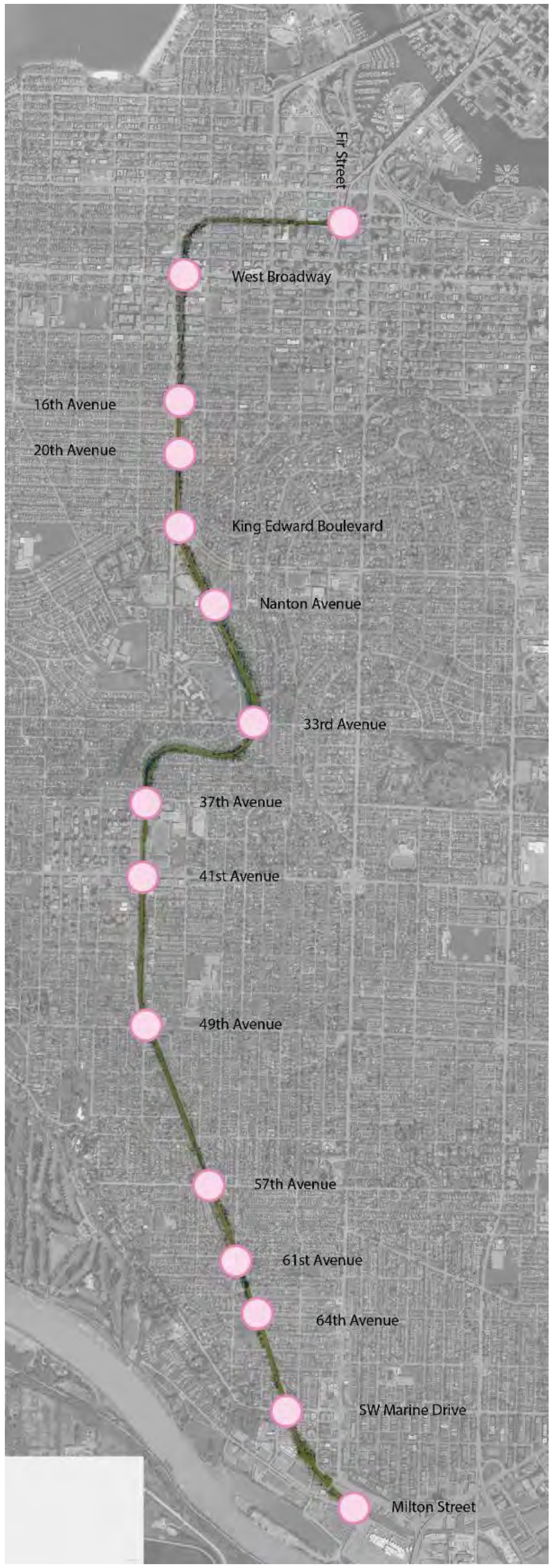


Figure 6-21 Potential Streetcar Stop Locations

Additional potential stop locations could be considered at the following locations if ridership demand related to intensified development warrants it in the long term:

1. Burrard Street or Maple Street
2. W 12th Avenue
3. W 45th Avenue

If the streetcar follows Arbutus Street between W King Edward Boulevard to W 33rd Avenue, the proposed stops at Nanton Avenue and W 33rd Avenue would be located on Arbutus Street. They could be integrated into transit-oriented development sites.

These stop locations are generally around 800m apart, with some spacings around the Broadway and Kerrisdale precincts down as low as 400m.

6.7 Frequency, Span of Service, and Journey Times

How frequently the streetcar will operate, and within which hours each day, are important operational characteristics to determine later in the Arbutus Greenway streetcar's development. The previous downtown streetcar studies and subsequent report to council discussed the use of 8-minute headways. The City's upcoming streetcar network study may provide further guidance when it is undertaken.

Considering the context of the greenway, an indicative journey time assessment shows that a likely journey time for the 9km length of the system would be in the range of 24 minutes to 29 minutes. This equates to an average speed between 18kph and 21kph including time stopped at stops and at intersections.

6.8 Operations and Maintenance Facility

Streetcar vehicles will require a facility in which to be stored and maintained. Space requirements for such a facility are determined by LRV fleet size and the required maintenance intervals. At this stage of the Arbutus Greenway Project, identifying the full requirements and a site is not necessary. General considerations for facility planning at later stages include the size and type of vehicle, the requirements for staff facilities and whether an operations control centre is required.

Based upon an 8-minute headway and the indicative journey times from Section 6.7, it is estimated that a fleet of 9 streetcars would be required to serve the Arbutus Greenway streetcar route. However, as this is anticipated to form part of a wider streetcar network it is likely that a larger fleet will be required.

On the basis of a fleet of 9-15 streetcars, it is recommended that a site of approximately 1-1.5 hectares could be required to accommodate the operations and maintenance facility.

7 Streetcar Design Parameters

While the wider philosophical aspirations for streetcar will affect the ultimate Greenway design, some specific streetcar infrastructure parameters can be set at this planning stage. In this section are the key design parameters which have been used to guide the development of the Schematic Concepts. A full design guide for a Streetcar or LRT project would go into more depth – and will need to be developed in a future design stage, typically functional planning or reference concept – but these criteria are sufficient for the current stage.

The design parameters outlined in Table 7-1 have been developed through consideration of best practices and key reference documents outlined in Section 5.2, and precedent study parameters. These parameters include minimum clearances required from the streetcar to structures and property lines, as well as buffer space to traffic lanes, pedestrian walkways, and bicycle pathways.

While the streetcar parameters set out are reasonably conservative, there are only minor adjustments that may be made as the design is refined. The major space requirements are all set and must be accommodated by compromising other more flexible elements of the greenway if necessary.

Table 7-1 Streetcar Design Parameters

Parameter	Proposed Criteria	Comments
Geometry		
Minimum Radius – Horizontal	25 m	Although it maybe possible to acquire vehicles capable of tighter radii, 25m is consider achievable by most modern streetcars.
Minimum Radius – Vertical	250 m (crest) 250 - 350 m (sag)	Typical parameters adopted by other systems
Maximum Gradient	6% preferred 10% absolute	6% is what is recommended in TCRP 155 but previous market research and project experience has shown that many manufacturers will supply vehicles capable of 8% gradients. APTAs Modern Streetcar identified that sustained gradient over 9% are problematic but there are many systems which currently operate on 10% gradients.
Streetcar Length	35 m	Consistent with NEFC assumptions
Streetcar Width	2.65 m	Standard width for vehicles supplied by most manufacturers. 2.4m vehicles are also common but impose capacity constraints
Dynamic Envelope (DE) Width – Straight Track	3.4 m	Considered a conservative assumption which allows for a range of vehicles and will allow for some shallower curves without additional widening
Dynamic Envelope (DE) Width – Curved Track	Varies	Depending on the radius of curve a minimum in-swing and out-swing will need to be accounted for. The effect of superelevation will need to be considered on the inside of curves. For simplicity, the effects can be assumed to add twice the applied superelevation to the in-swing of the vehicle.
Platform Length	35 m	Consistent with NEFC assumptions and allows for a wide range of vehicles which are nominally categorised as 30m but can be slightly longer. Would also allow 40m LRVs to be used as long as the doors are set greater than 2.5m from each end and other infrastructure is sufficiently distant from the end of the platform.
Clear space on loading edge of platform	1.5 m	Sufficient to allow for a wheelchair passenger movement.
Platform Width – Side	3 m preferred	Consistent with NEFC. Sufficient to accommodate necessary equipment and allow passenger movement.

Parameter	Proposed Criteria	Comments
		Could potentially be combined with adjacent sidewalk as long as sufficient clear space is maintained and platform sized to accommodate ridership and pedestrian flows.
Platform Width - Centre	5m preferred 4m absolute	4m is the minimum required in order to accommodate items such as ticket machines and shelters and allow circulation on each side.
Platform Height	300-350 mm	Typical height above top of rail for modern streetcars
Platform Gradient	2%	Derived from ADA regulations and consistent with TransLink requirements for platforms on rail based systems
Typical Design Speed	30 – 50 km/h	Design speed of the streetcar will generally depend on the road classification, adjacent parking lanes, proximity to parks and school, and sightline issues. This will be further analyzed as the project progresses.
Maximum Design Speed	80 km/h	Many manufacturers will supply vehicles capable 80 km/h or higher
Clearances		
Between two streetcars DEs without centre OCS poles	200 mm	TCRP 155
Between two streetcars DEs with centre OCS poles	800mm With at least 150 mm to the face of the pole	Most poles will typically be less than 500mm but occasional ones may need to be larger
Centreline track to edge of platform	1415mm	
Isolated Obstruction – Clearance to Dynamic Profile (Applies to Tangent and Curved Track)	600 mm preferred 100 mm absolute	The absolute minimum should only be considered in locations where streetcar is segregated and pedestrian are unlikely to be
Continuous Obstruction – Clearance to Dynamic Profile (Applies to Tangent and Curved Track)	1000 mm preferred 600 mm absolute	This will be further analyzed as the alignment adjacencies and conflicts are investigated.
Edge of pedestrian walkway or bicycle pathway – Clearance to Dynamic Profile (Applies to Tangent and Curved Track)	600 mm preferred 400 mm absolute	This will be further analyzed as the alignment adjacencies and conflicts are investigated.

8 Schematic Concepts

The City of Vancouver's vision for the Arbutus Greenway includes accommodating streetcar, cycling, and walking infrastructure, as well as public spaces for ecological, community, public art, educational, and programmatic use. The corridor ranges from x to x m wide over its x km length, so accommodating this variety of uses can be challenging. Recognizing the allowable space, future development in adjacencies, and feasible configuration, three conceptual designs have been generated – where streetcar is within the purchased area, to the east, and to the west.

The three conceptual designs for streetcar which are set out in Section 8, were chosen and developed to express a variety of layout opportunities in different parts of the corridor. The primary track configurations and their relationships to adjacent infrastructure, roads, pedestrian areas, bicycle paths, parks, and other open spaces, have been laid out to test and communicate these different ideas. They will evolve as the project progresses, and portions of each schematic concept could be selected and merged into hybrid designs. The preferred concept will be determined after stakeholder and public engagement, a Multiple Account Evaluation (MAE), and ongoing technical analysis. Schematic Concepts are detailed in the Schematic Concepts Report, generated in September 2017.

It should be noted that at this time, the streetcar options have only considered using land which is already owned by (or available to) the City of Vancouver; namely the purchased corridor, road rights of way and in a few areas, some park land. No private property has been considered.

8.1 Concept A: Streetcar within the Purchased Area

This concept is focused on a streetcar alignment that is, for its majority, within the purchased area. Throughout the entire Arbutus Greenway, the alignment and configuration of streetcar, pedestrian walkway, and bike path remain consistent. The streetcar runs on the west side of the corridor, while the pedestrian walkway and bike paths are abutted on the east. A snapshot of the configuration along Arbutus Street at W King Edward Boulevard is shown in Figure 8-1 and Figure 8-2.

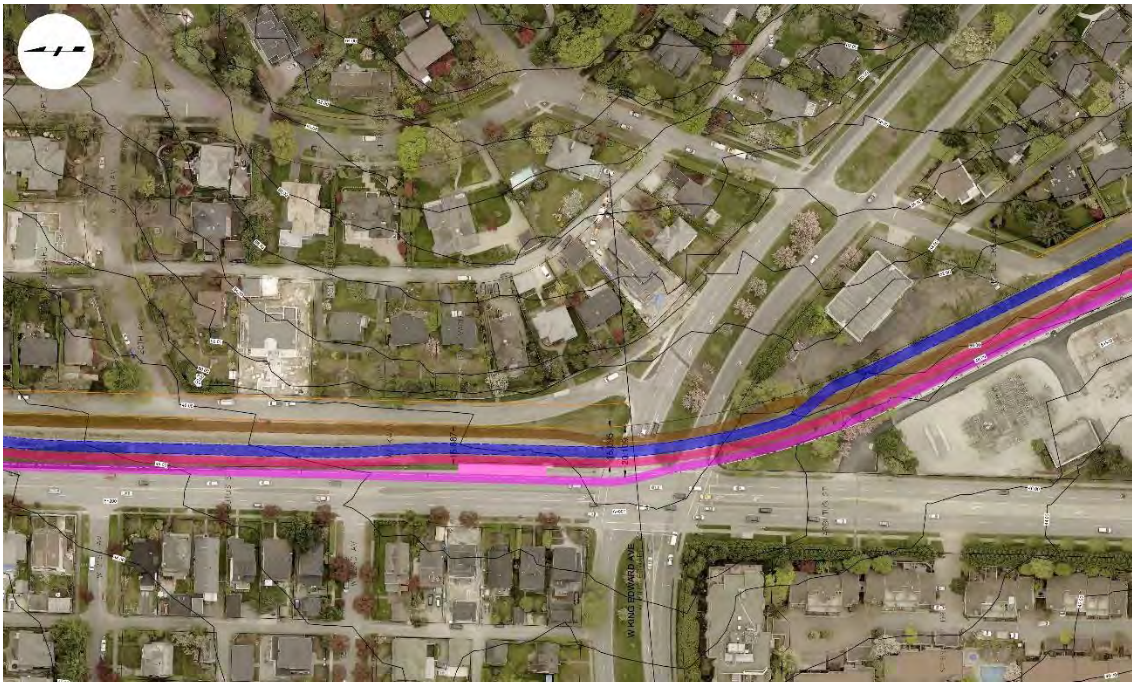


Figure 8-1 Concept A at W King Edward Boulevard

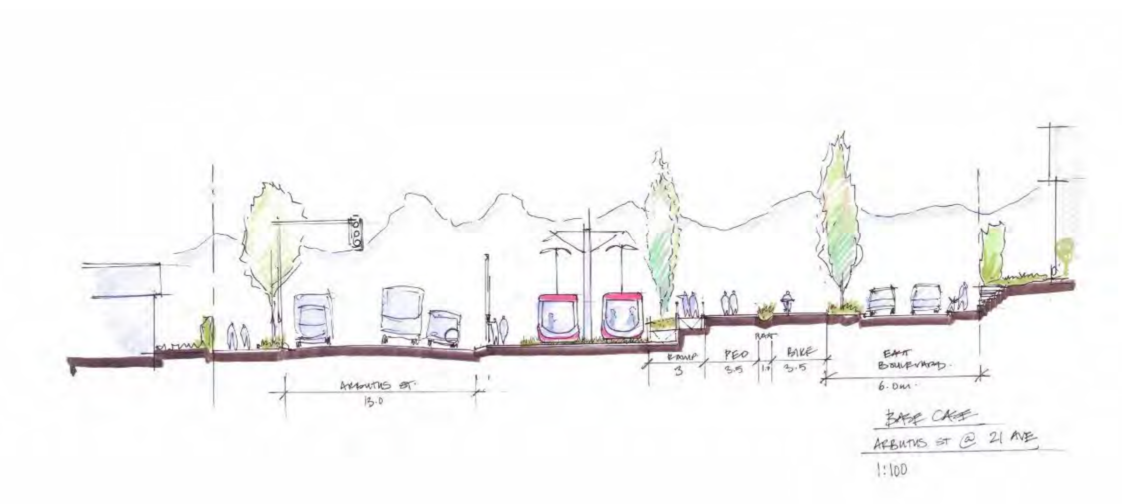


Figure 8-2 Concept A cross section at W King Edward Boulevard

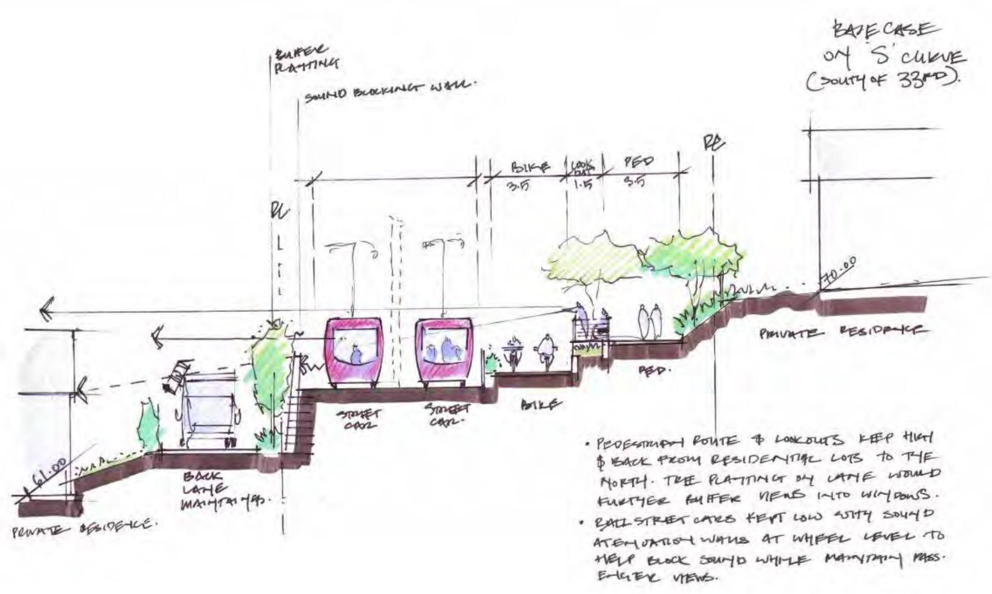
This approach generally does not impact any existing adjacent properties, developments, and only roadways in some small areas as the streetcar, pedestrian walkway, and bike path are constrained within the purchased area. This increases the opportunity for development outside of the purchased area.

It is likely that this concept would provide the best overall speed and reliability of the three concepts as the tracks will be segregated from road traffic. The only interactions will be at the points where the corridor crosses roads. Depending on how many opportunities to close crossings towards the northern end there will be around 12-15 intersections of this nature. With the streetcar, totally segregated techniques could be employed to give it as mush priority at intersections as possible. What will be achieved will depend on the level of disruption which is considered acceptable which in turn will be a function of the frequency of streetcar services.

As with all LRT type systems which operate in their own segregated right of way, this option will have challenges related to the signal phasing at intersections. In order to provide the necessary degree of priority to streetcar, additional phases will be required at many of the intersections where interactions occur. The changes required will have to be analyses closely during further design developments to ensure that the traffic impacts are balanced with transit priority and that the active transportation modes are also properly incorporated with conflicts clearly demarcated and managed.

With this concept, the constrained width of the purchased corridor and the requirement to accommodate all the transportation infrastructure within it, limits the opportunity to increase ecological biodiversity and recreational space. In order to provide some additional opportunities this option was shown to deviate slightly from within the purchased area. Between 57th Ave and 61st Ave, West Blvd is quite wide relative to the traffic volumes observed. Therefore, it was considered a feasible option to utilise some redundant space and repurpose it for the tracks, moving the southbound one to the west, outside of the land boundary of the corridor. There may be other locations where such opportunities can be realised.

With the active transportation modes being in close proximity the degree of segregation between the streetcar and those modes, including how much separation is provided and what is in that space, will be key to avoid it becoming necessary to operate at slower speeds.



s.13(1), s.17(1)

[redacted]

Figure 8-5 Concept A – North of 41st

8.2 Concept B: Streetcar Aligned to the East

Concept B is focused on an eastern streetcar alignment, in some locations located in the corridor and in others taking advantage of the adjacent road rights-of-way. It also shows how the streetcar could make a turn eastbound onto SW Marine Drive with the aim to continue east and connect with the Marine Drive Canada Line Station. This option generally keeps the pedestrian walkways and bike paths within the corridor, with the streetcar occupying local roads east of the purchased area where possible as shown in Figure 8-6 and Figure 8-7.

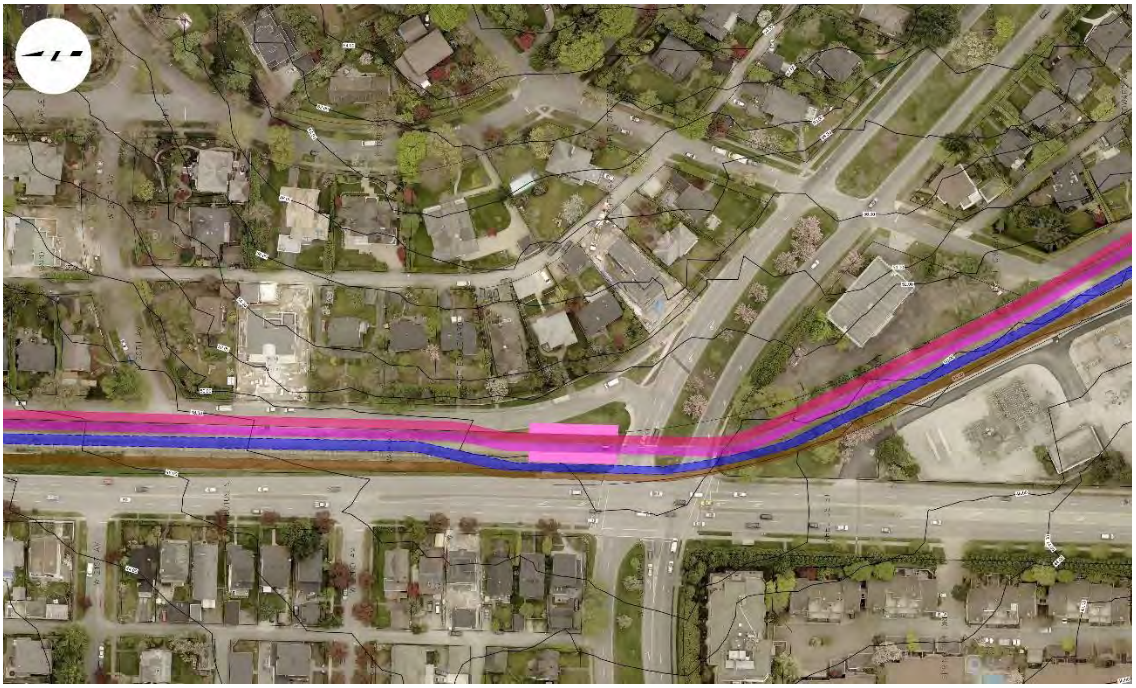


Figure 8-6 Concept B at W King Edward Boulevard

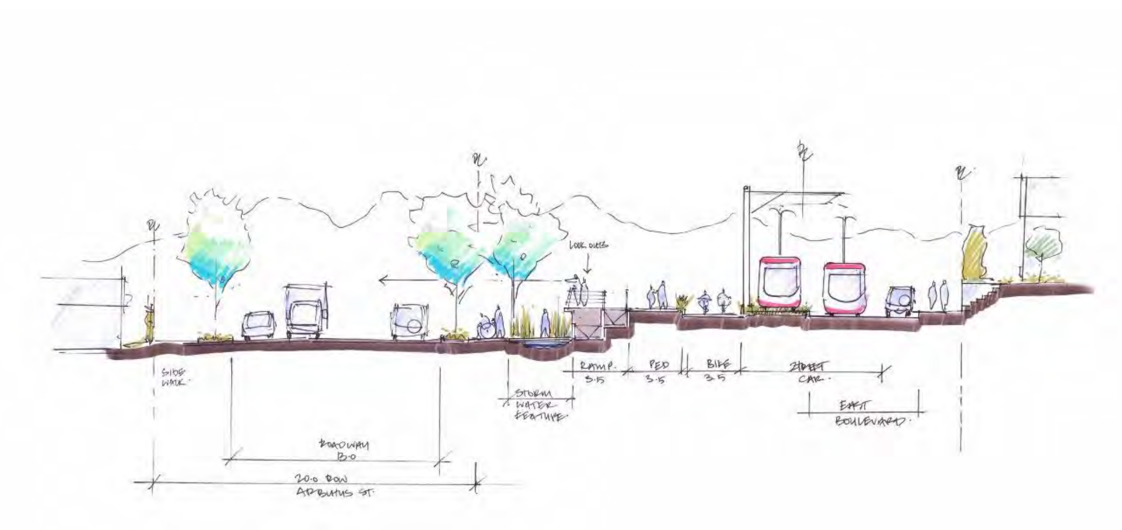


Figure 8-7 Concept B cross section at W King Edward Boulevard

As the roads to the east of the purchased corridor are generally local roads, this concept envisages them becoming rationalised to be one way only with parking in front of properties. Generally, the northbound streetcar track would be in a shared lane with the southbound one operating segregated.

Between W 41st Avenue and W 37th Avenue, the streetcar alignment deviates from the overall concept and is placed to west of the corridor, using part of the West Boulevard road ROW, side running segregated from traffic. Employing this option allows East Blvd to be utilized to accommodate for future development or a large public open space. This is shown in Figure 8-8.

Figure 8-8 Concept B at W 41st Avenue

Similarly, between W 16th Avenue and W Broadway, the concept is altered. In this instance, as the purchased narrows to 15m, the northbound streetcar alignment transitions west onto Arbutus Street, while the southbound streetcar remains within the Arbutus corridor. This solution requires the two streetcar tracks to cross each other at the north and the south of the segment. This approach was taken so that the stops at Broadway could closely integrate with the future Millennium Line SkyTrain Station at Arbutus.

s.13(1), s.17(1)

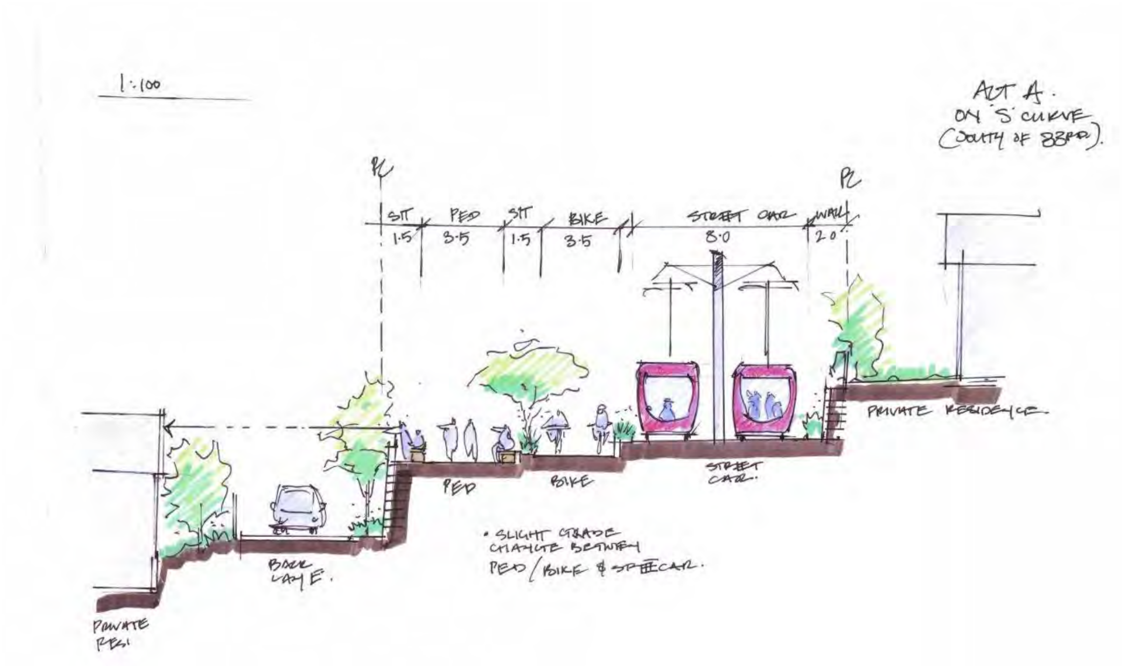


Figure 8-10 Concept B at S Curve

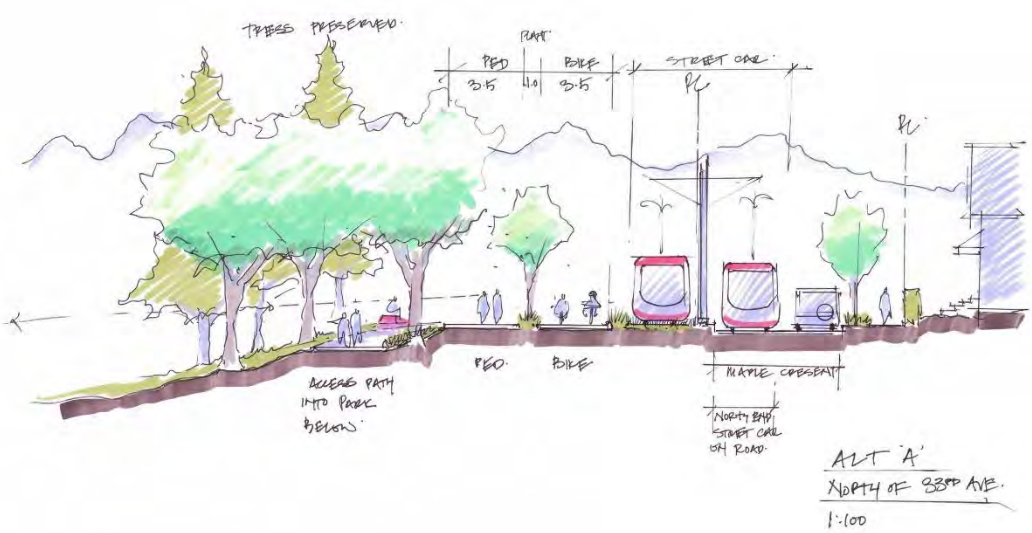


Figure 8-11 Concept B at 33 Ave

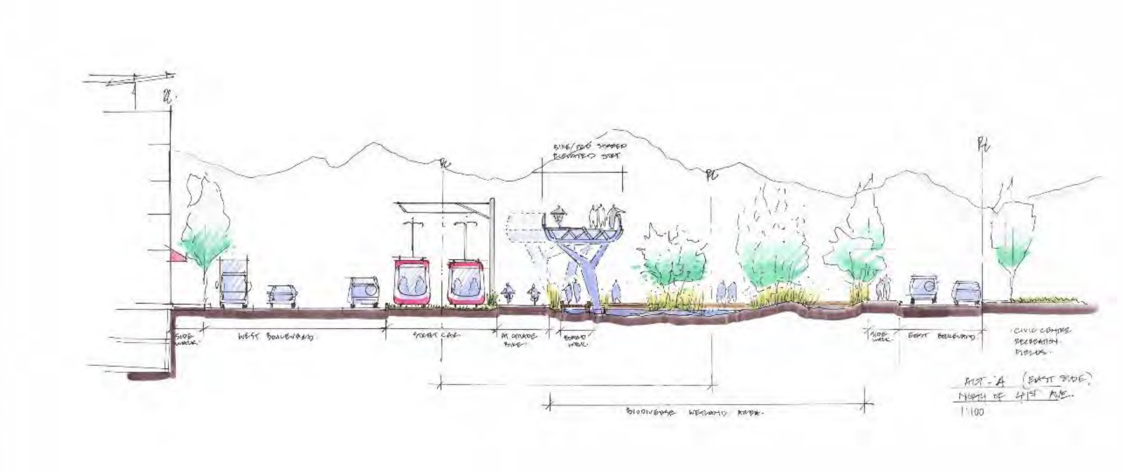


Figure 8-12 Concept B – North of 41st

8.3 Concept C: Streetcar Aligned to the West

This concept is focused on a western streetcar alignment, located in both the corridor and adjacent street rights-of-way. This option generally keeps the pedestrian walkways and bike paths within the corridor, with the streetcar occupying roads west of the purchased area where possible south of W 49th Avenue.

This concept takes the opportunity to share with traffic on streets which generally run parallel to the purchased corridor. While this will potentially compromise the operational speeds and reliability it does provide opportunity free up space within the corridor for other uses.

Through Kerrisdale, Shaughnessy, Arbutus Ridge and Kitsilano, the streetcar is in-street running along West Boulevard, Arbutus Street and W 6th Avenue while the pedestrian walkway and bike path remain within the Arbutus Corridor, as shown in Figure 8-13 and Figure 8-14.

Figure 8-13 Concept C at W Broadway

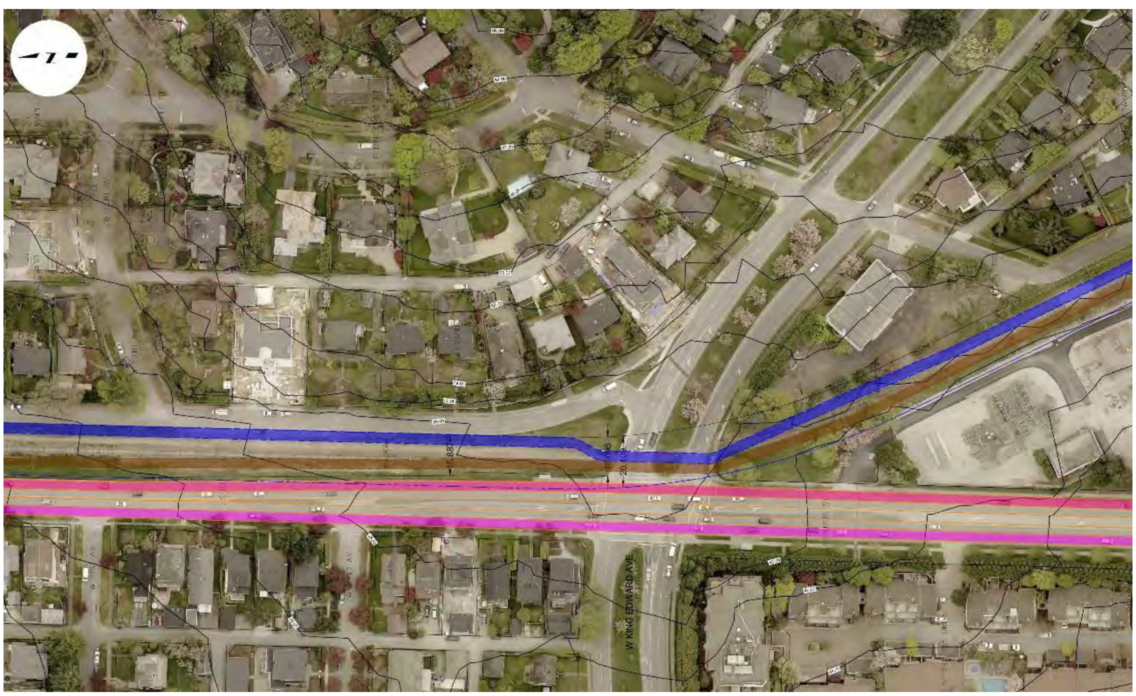


Figure 8-14 Concept C at W King Edward Boulevard

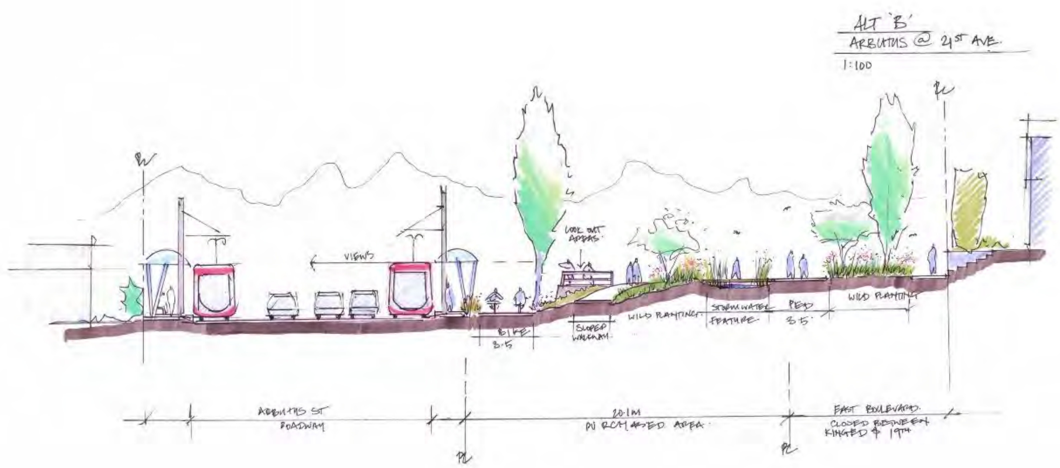


Figure 8-15 Concept C cross section at W King Edward Boulevard

North of Kerrisdale, it is assumed that the streetcar would stay on Arbutus street rather than stay in the corridor through the "s-curves". Some parts of this section are very steep with gradients today identified as being in excess of 10%. If this route is part of the preferred concept then it will be a key study area to ensure the technical feasibility.

Overall, this approach separates the streetcar with the pedestrian and cycling pathways. With the alignment's adjacency to roadways and buildings, this concept allows transit-oriented developments to occur in many precincts along the Arbutus Corridor. This allocates more space for recreational features, active transportation, and ecological biodiversity components on the purchased area. In addition, this alignment prevents pedestrians and cyclists to conflict with the streetcar and vehicles. Although this concept permits more space and flexibility, this option will potentially impact existing traffic and parking conditions.

It should be noted that although the streetcar is shown within certain lanes when on street, if this option becomes part of the preferred concept then it is likely that the layouts will be refined based upon the City's requirements for the use of the roadway infrastructure.

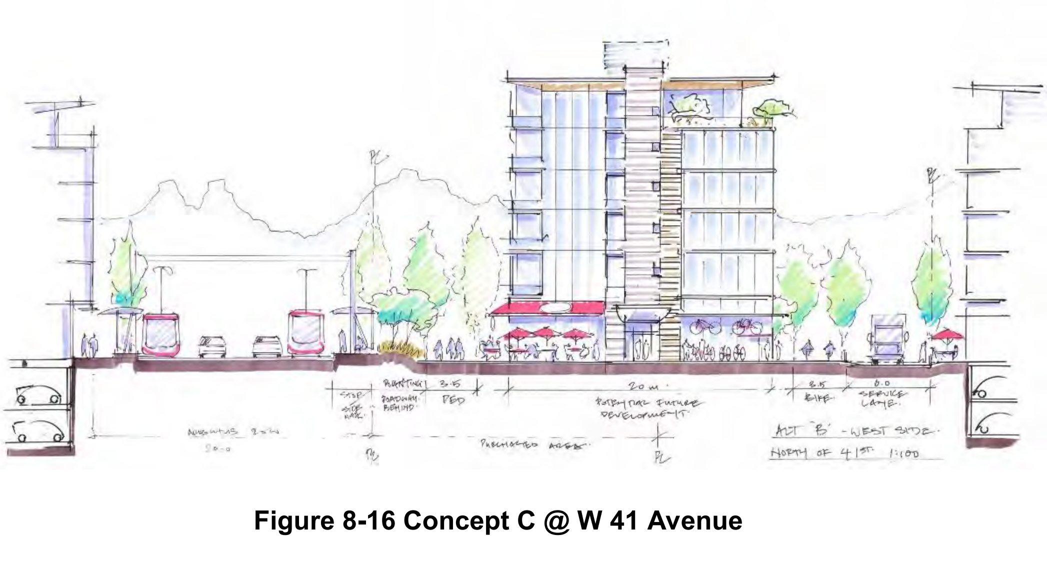


Figure 8-16 Concept C @ W 41 Avenue

8.4 North and South Connections

As part of the development of the Arbutus Greenway, consideration is being given for how the streetcar alignment, pedestrian walkway and bicycle pathway will connect into the wider network. These considerations are being looked at in the northern and southern study areas.

For the streetcar, options for a northern connection onto the Granville Street Bridge or Phase 1 portion of the Downtown Streetcar network (as shown in Figure 8-18), as well as for a southern connection to the Marine Canada Line Station (as shown in Figure 8-17) are being considered. They are being developed in consultation with the CoV APT and CoV Transportation Planning Team.

Figure 8-17 Southern Study Area

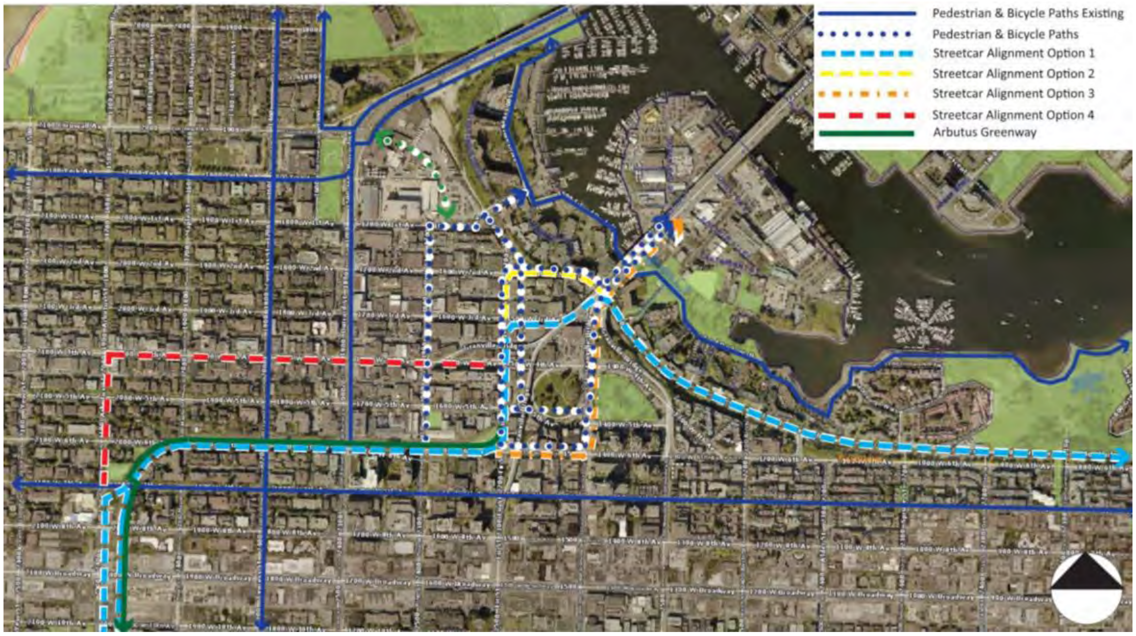


Figure 8-18 Northern Study Area

As the Arbutus Greenway project progresses this work will focus on identifying the potential options at a planning level and will identify the risks and technical issues that should be considered by the future design work that will be undertaken by the future City-Wide Streetcar planning study. At this stage, the objective is to identify the options that could potentially be feasible so as to seek to ensure that the streetcar design for the Arbutus Greenway does not preclude options for future North and South connections.

Should any more detailed conceptual design for these connections be required as part of the Arbutus Greenway Project, this will be undertaken at the direction of the Arbutus Project Team and in close collaboration with the consultant undertaking the City-Wide Streetcar Network update study.

9 Next Steps

The schematic designs are an integral part of the development of a preferred concept and an Arbutus Greenway Master Plan, all which imagine the Greenway of tomorrow. This process is developed after identifying project objectives, collecting relevant information, and collaborating inspiration from the team. The schematic designs evolved by recognizing the entire allowable space, feasible configuration for alignment options, and potential development in adjacencies and its wider network.

Further interactive collaboration between the different disciplines, CoV APT and the streetcar design team will continue to progress the schematic concept designs. The three conceptual designs proposed may evolve as the project progresses, and have portions that could be selected and merged into hybrid designs. The optimal alignment will be determined after multiple stakeholder engagement, a Multiple Accounts Evaluation (MAE), and general discussion with the team.

The City's upcoming city-wide streetcar study is likely to run in parallel with future stages of the AGP and that study may build upon and refine some of the context provided in this report.

Additionally, further discussions are needed with the CoV APT and CoV senior leadership to better envisage the streetcar, and how it is to influence the City's development, growth and ultimately become a city shaping project. This will need to take place as a preferred concept is selected.

As these other influences emerge it may be necessary to revisit and update this report to reflect the latest understanding of how streetcar will be realised in Vancouver.

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