CITY OF NANAIMO
THE HARBOUR CITY

Wakesiah Corridor Improvements Project| Concept Design Report

September 23, 2019

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Executive Summary

Parsons Inc. (Parsons) was retained by the City of Nanaimo (City) for Engineering Consulting Services for the Engineering Design associated with the ***Wakesiah Corridor Improvements Project*** (Project) - Phase I, per the '***Request for Statement of Qualifications No. 2117***' (RFSQ No. 2117) Phase I of the Project.

The objective of the Project is to commence pedestrian, cycling, transit, and vehicle infrastructure while completing the identified underground utility upgrades along the Project corridor that are scheduled for construction within the Wakesiah Avenue corridor in 2020 and 2021. The vision of the community for Wakesiah Avenue is to become a well-balanced, multi-modal green corridor.

The Project stretches along Wakesiah Avenue from First Street to Sixth Street and on Fifth Street from Wakesiah Avenue to Highway 19, the Nanaimo Parkway. Wakesiah Avenue is a north-south road corridor in the University District and is classified as a major collector, connecting Bowen Road to Sixth Street at Colliery Dam Park. The corridor is flanked by a mix of single-family, multiple-family, commercial and institutional uses with typical driveway access exiting directly onto the street. Wakesiah Avenue sees significant traffic volumes of 12,000 vehicles per day and connects with both Fifth Street and Third Street that are major gateway connections to and from Highway 19. The area also boasts some of the highest levels of walking, cycling, and transit use in the City given the presence of the Vancouver Island University (VIU), Nanaimo District Secondary School (NDSS), the Nanaimo Aquatic Centre (NAC), Nanaimo Ice Centre (NIC), Colliery Dam Park, and Jingle Pot Marsh in the area.

There are currently no formal cycling facilities along the corridor and pedestrian sidewalks are generally in poor condition and limited in width. Congested traffic conditions exist during commuting hours and parking is very challenging in the neighbourhood, filling the side streets with lines of vehicles and encroaching on shared shoulders used by pedestrians.

The Project will also include the replacement of aging underground utilities, namely the replacement of an existing 200mm and 150mm Asbestos Cement watermains between South of Third Street and First Street, and a structurally deficient storm drain between Fourth Street and Cat Stream on Wakesiah Avenue.

The project will include, among others, the following infrastructure upgrades on Wakesiah Avenue:

- Addition of 1.5m bicycle lanes between First Street and Fifth Street (both directions) north-bound from Harewood Road to Sixth Street.
- 3.0m multi-use Path between Third Street and Harewood Road connecting to the existing trail network at Colliery Dam Park including improvement to the Park's entrance.
- Wakesiah Avenue sidewalk upgrades on the west side between Second Street and Third Street.
- The addition of 2 pedestrian activated half signal crossings at First Street and Foster Street. Pre-ducting will also be included for a development driven pedestrian activated signal at the Queen Street intersection.
- Pedestrian and cyclist roadway improvements including reduction of curb return radius, removal of three (3) channelized right-turn lanes and crossing-lane marking improvements.
- Existing pavement rehabilitation on Wakesiah Avenue between Second Street and Fifth Street and on Fifth Street between Wakesiah Avenue and Highway 19.
- Corridor greenspace improvement including landscaping upgrades as well as the installation of softscape swales where feasible to implement best management practices in terms of stormwater management.
- Opportunity of environmental enhancement in the Cat Stream crossing area of the Project corridor.

The design process takes into account input from the City of Nanaimo Engineering Department as well as stakeholders, which includes VIU, NDSS, Harewood Neighbourhood Association, the Greater Nanaimo Cycling Coalition as well as the input from local residents via a public engagement which will include an on-

line survey. ***Appendix A*** includes Conceptual Drawings of the proposed works including plan and typical sections for the corridor.

1 Vision

The community envisions that Wakesiah Avenue will be a highly utilized and well-balanced, multi-modal green corridor. One with a consistent urban cross-section that supports surrounding land uses and functions as a connector route for commercial services, schools, public facilities, and City parks. Improved transit features along with safe and enhanced cycling and pedestrian facilities along every block will encourage these modes of travel and be shared with calm motor vehicle traffic. Landscaped medians, boulevards, and swales with setback multi-use pathways will open up the streetscape, embedded in the institutional frontage of VIU and NDSS.

The ***Wakesiah Avenue Corridor Improvements Concept Plan (the Plan***) will reflect the objective of higher-level planning documents including the Official Community Plan and the Harewood Neighbourhood Plan. Key goals from the Official Community Plan will be met and include creating corridors that increase mobility and opportunity for safe and convenient movements for motorists, cyclists, pedestrians, and transit users. For vulnerable users such as pedestrians and bicyclists, the Plan will serve to not only reduce the potential for collisions and increase visibility, but ultimately increase usage of these sustainable transportation modes.

The Plan will utilize the "Complete Street" approach to design of urban roadway cross-sections and will address the context of the corridor while providing safe access for all intended users. Pedestrians, bicyclists, motorists and transit riders of all ages and abilities will be able to safely and effectively move along and across Wakesiah Avenue.

The Plan provides a comprehensive basis for design that will:

- Improve on and expand transportation choice. Visibility of attractive and comfortable pedestrian, bicycling and transit facilities will serve to create greater awareness of the transportation options available. In turn, increased use of these facilities will motivate people to consider opportunities that can contribute toward personal and community goals.
- Increase overall safety. Shorter pedestrian crossings and separated sidewalks open up the road cross section and reduce unsafe interactions. Slower vehicle speeds can be realized by reduced lane widths and centre medians, further increasing the level of safety in active multi-modal corridors.
- Enhance connection to community. Complete streets are complementary to the surrounding land uses. They provide space for people to move around, within, and between communities, as well as places for people to live, work, shop and play. They can also support the development and creation of a vibrant public realm, extending businesses into the street space with patios, parklets or simply with better access.
- Enhance the environment. Explore opportunities to improve environmental areas and integrate sustainable design, such as drought-resistant landscaping and rainwater management. Look at all greenspace options and low maintenance streetscape features.

The Plan will address the desired future character, development frontages, and urban design considerations along Wakesiah Avenue and in the surrounding area. The complexity of land uses within the corridor area is acknowledged and will connect these with environmental/recreational facilities via wayfinding signage to ensure the ongoing success of the area. The Plan will help to guide future development in the area so that it may fully contribute to community building, while supporting positive renewal of land to maintain the desired look, feel, and function of the corridor.

2 Background

Wakesiah Avenue is a north-south road corridor in the University District and is classified as a major collector, connecting Bowen Road to Colliery Dam Park at Sixth Street. The corridor is flanked by a mix of single-family, multiple-family, commercial and institutional uses with typical driveway access exiting directly onto the street. Signalized intersections are in place at Second Street to Fifth Street, and a four-way stop intersection is located at Harewood Road. The street has one traffic lane in each direction, with dedicated right and left turn bays present at most intersections. Third and Fifth Streets act as major gateways to the corridor given their connection to the Nanaimo Parkway (Highway 19).

There are currently no formal cycling facilities along the corridor and pedestrian sidewalks are generally in poor condition and limited in width. Congested traffic conditions exist during commuting hours and parking is very challenging in the neighbourhood, filling the side streets with lines of vehicles and encroaching on shared shoulders used by pedestrians. The existing street lighting is provided by BCH pole lease lights that leave several areas poorly lit.

Several existing land parcels in the Project area are either currently under development or have the potential for future development. In addition to VIU and NDSS amenities in the Project area that would benefit from the corridor improvement project and its pedestrian and cyclist connections, it includes Colliery Dam Park, the Rotary Bowl, Serauxmen Stadium and sports fields, Third Street Park and the City's Ice and Aquatic Centres.

2.1 Design Guiding Principals

2.1.1 Strategic Context

Each year the City undertakes capital improvement projects driven by growth, development, asset management, and other priority-based frameworks. As part of the City's strategic planning process, the 5-year Capital Plan identifies these projects and where possible combines those of similar scope and proximity to achieve economy of scale and a comprehensive product. There are several infrastructure improvements scheduled for construction within the Wakesiah Avenue corridor in 2020 and 2021 and as a result, these projects have been combined to create the Plan. Subsurface utility upgrades, including watermain and storm sewer replacements, would be completed in 2020, with the balance of the surface works constructed the following year in 2021.

Wakesiah Avenue area also boasts some of the highest levels of walking, cycling, and transit use in the City given VIU, NDSS, the Nanaimo Aquatic Centre, Nanaimo Ice Centre, Colliery Dam Park, and Jingle Pot Marsh. The potential for this corridor to support a further increase in sustainable modes of transportation is significant, and the Plan is a crucial element to direct future buildout of the corridor, including major campus changes at VIU and NDSS that are currently, or soon to be, underway.

2.1.2 Planning Context

The definition of a complete street is dependent on the surrounding land use, vehicle-cyclist-pedestrian interactions, user demographics, roadway classification and connectivity, and other predominantly local components. Considerations relating to a corridor feel, form, and function should be taken into account when pursuing the ultimate corridor plan and objectives, recognizing the importance of implementing the prescribed corridor characteristics via any future development planning. To include the community vision for the corridor, specific public consultation topics were presented with the intention of identifying major themes or preferences from people that will utilize the corridor and call it home.

Instead of primarily focusing on the physical elements (e.g., the built forms, roadway infrastructure) of a complete street project, the planning approach for the concept stage included public input on how the corridor is "envisioned", as opposed to providing a mostly technical product. By incorporating how the

community conceptualizes an improved corridor for Wakesiah Avenue, there is a greater chance of enhancing their connections and receiving higher support and use from the overall public.

The Harewood Neighbourhood Plan (HNP) identifies Wakesiah Avenue as one of four major corridors that requires strong character and identity. Key strategies from the HNP will be applied to where possible to provide a high-quality pedestrian environment, implement safer and more effective transit and cycling modalities, identify future gateways, and support mixed use developments along Wakesiah Avenue. While extensive public streetscapes, art installations, parkettes/plazas are not within the scope of the improvements under this project, the HNP identifies and suggests how and where these features may be constructed in the future.

Once finalized, the Plan will serve as a directive for infill land development along Wakesiah Avenue to ensure consistent frontage works and street concepts, while supporting long-term buildout of the envisioned corridor plan.

2.1.2.1 Key Principles

In cities and towns across the Canada, forward-thinking transportation planners and policy makers are transforming their communities with a simple shift in design focus: complete the street by considering all potential users. This simple shift in focus, this slight broadening of scope, has almost unlimited capacity for improving the livability of a community. When all possible users are considered, streets are safe for children to walk to school, parents can bike and walk to neighborhood parks and neighbours of all ages and physical ability can safely navigate sidewalks and public transit as they make their way around the community. Complete Streets are a profound policy change from how designers and engineers typically approach the public roads in their communities. Adoption of a Complete Streets policy does far more than just accommodate additional users of a road or street. When transportation planners broaden their design focus to include all potential users of the road, they begin to view streets as places. The endorsement of a Complete Streets policy by the City is an acknowledgment that the role of streets is to build communities, not simply to move cars.

3 Geotechnical Assessment and Investigation

The City retained Tetra Tech Canada Inc. (Tetra Tech) c/o Parsons to undertake pavement evaluation and geotechnical exploration for the Project. The scope of the geotechnical evaluation included a visual condition inspection, a drilling exploration program, asphalt coring and Benklemen Beam testing to assess the existing pavement structure and subsurface conditions within the Project area. Existing asphalt thickness ranged from 40mm to 180mm. All areas tested by Benkelman Beam passed the maximum allowable deflection. In general, some localized pavement repairs will be required prior to overlay paving. Detailed information from the geotechnical evaluation conducted in June 2018 can be found in ***Appendix B.***

Roadway Rehabilitation

It is anticipated that the roadway rehabilitation will include milling and asphalt overlay of 75 mm thickness. Some areas of the existing pavement (estimated at 5-10% of total area) are showing high severity fatigue cracking and should be treated with deep patch repairs prior to overlay paving. Deep patch repairs should include removal and replacement of the entire existing asphalt layer. Once the existing asphalt is removed, evaluation of the exposed base should be conducted and replacement of a gravel road structure to the City of Nanaimo standards.

Underground Utility Construction

Typical open trench utility construction is anticipated to depths of 1.5m to 5m. Temporary shoring should be used for trenches constructed within the road alignment, and a maximum temporary slope of 1H:1V should be used for short-duration trenching in granular soils. It is recommended that underground utility construction is undertaken during the summer to minimize the impacts of groundwater seepage. To mitigate the impacts of settlement in the backfill on the pavement structure, it is recommended that City considers delaying paving for one winter season to minimize the reflection of trench settlement on the final pavement surface.

4 Environmental Considerations

The Project alignment exists along an established road corridor that includes major and minor collector and neighbourhood roads that will limit risks of environmental impact. A crossing of Cat Stream, a known salmon-bearing watercourse, is the primary environmentally sensitive area (ESA) within the Project area. In general, historical land clearing, road and residential/commercial development, and other infrastructure-related disturbances have resulted in impacts to the stream's ecological integrity and habitat function. Because of its impaired condition, opportunities exist to restore and enhance Cat Stream and its riparian area, as well as provide a site for public education to share concepts of stream health and stewardship. In addition to Cat Stream, other sensitive areas that have varying risks of exposure to impacts from proposed construction include the Chase River, with potential for limited exposure to drainage from the southern end of the project footprint, and possible interactions with seasonal avian nesting sites along the project alignment.

Challenges

Design

Cat Stream is a tributary to the Chase River that crosses under Wakesiah Avenue between 2nd and 3rd Street and is known to support chum and coho salmon, and cutthroat and rainbow/steelhead trout. The Chase River flows east between 6th and 7th Street and although the channel is outside the immediate boundaries of the Project, drainage from the southern end of the project footprint may be conveyed downstream into this ESA making it relevant to the Project.

According to Section 5.3 of the City's OCP, floodplain development is discouraged and includes those reaches of Cat Stream near the project area.

Opportunities for stormwater detention and water quality improvements should be maximized for drainage infrastructure leading into Cat Stream and Chase River to reduce cumulative hydrologic impacts of urban development.

Timing

Depending on location, design, implementation methods, and timing of works there may be a need to precede work with bird nest survey and/or fish isolation/salvage operations.

Permitting

The primary regulatory jurisdictions over environmentally related aspects of the Project may include the Department of Fisheries and Oceans (DFO), and the BC Ministry of Forest Lands and Natural Resource Operations (MFLNRO) agencies.

Avoiding impacts to ESAs and the minimization/mitigation of environmental impacts are to be of primary importance during construction of the Project. There are several regulators that govern construction activities in proximity to ESAs. These include:

1. City of Nanaimo Official Community Plan (OCP)
2. Federal Fisheries Act
3. Federal Species at Risk Act (SARA)
4. Federal Migratory Bird Convention Act
5. BC Wildlife Act
6. BC Water Sustainability Act

An Environmental Assessment and Protection Plan (EAPP) will ensure the protection of ESAs and compliance with the abovementioned regulations that will be implemented during construction, and detail specific permits that will be required for work to proceed. The EAPP will also address specific requirements detailed in the City's OCP and Guidelines for Municipal Works and Services within ESAs.

Opportunities & Recommendations

The City's OCP requires identification, protection, and enhancement of "ecological health of significant natural features and systems". Opportunities exist to protect and enhance the aquatic and riparian areas of Cat Stream surrounding the Wakesiah Avenue crossing. During ground-level assessment it was observed that the riparian canopy at the crossing has been partially removed and has an understory dominated by invasive plant species that can be restored by removing invasives and planting a suitable assemblage of native vegetation species. The aquatic area is lacking in cover for rearing juvenile salmonids that can be enhanced by creating deeper pool habitat, installing woody debris structures, and boulder cover. Spawning potential for coho salmon may also be enhanced by building a riffle/pool complex using boulders and spawning grade gravel.

Any habitat restoration or enhancement projects can be relayed to the public via media release, on-site signage, and local mailouts. A small information board or kiosk may be installed near the Cat Stream crossing to inform pedestrians of the habitat values and sensitivities of the creek, and how their actions can influence the ecological function and health of the stream.

5 Subsurface Utilities

The Project will strategically upgrade aging existing subsurface utilities and will include the replacement of an existing Asbestos Cement watermain as well as the existing storm drain system as outlined in the following sections. Upgrading utilities prior to completing permanent surface works is the standard approach for asset management applied by the City.

5.1 Watermain Upgrades

The section of Wakesiah Avenue between First Street and Third Street contains approximately 862m of existing 150mm and 200mm CL 150 Asbestos Cement watermain that is required to be upgraded to 250mm PVC watermain. The upgrade is capacity-based, and the larger diameter pipe is needed to service growth and provide minimum operating pressures/fire flows of 300 L/s for the corridor land use per the 2015 City Wide Water Distribution Development Cost Charge review. The remaining section from Third Street to 308 Wakesiah Avenue is 109m of new pipe and is being extended to provide water services to adjacent properties from the roadway. This upgrade is a precursor to the abandonment of a poor condition AC watermain in a rear yard easement that has a significant break history. All watermains to be upgraded along this section are in City pressure zone 6 (HGL = 121m).

The proposed alignment for the new 250mm water main upgrade will be constructed off-line of the existing watermain at a standard offset of 2.0m +/-. Given the future cross section of Wakesiah Avenue, installing the new pipe to the west of the existing watermain will keep the utility within the travelled roadway, and result in less expensive future replacement given the high cost surface restoration of concrete curb, sidewalk, and boulevards. Outside of tie-in locations, the existing AC watermains will be capped and abandoned in place. There are no upgrades required to the existing steel transmission main connections to increase their size. The conceptual alignment including details for the proposed tie-in points are shown in ***Appendix A.***

5.2 Storm Sewer Upgrade

The existing 600mm concrete and corrugated metal pipe storm sewer constructed in the early 80s between Fourth Street and its outlet at Cat stream has structural deficiencies, root intrusions and is corroding as identified by the CCTV condition assessment. The condition of this pipe causes operational and maintenance issues and is intended to be replaced as part of this Project. A Technical memorandum is included in ***Appendix C*** providing the conceptual sizing of the drain to be upgraded with the final size to be confirmed during detail design. The pipe size will vary between 675 and 900mm to handle 5-year and 100-year event including the climate stage impacts.

The proposed alignment will likely be replaced in place of the existing stormdrain within Wakesiah Avenue, except between Third Street and its outlet at Cat Stream. The current location of the stormdrain in that section is within a heavily treed boulevard area (see photo) and the alignment should be relocated within the road to facilitate and future upgrades or maintenance. Crossing the treed boulevard will need to be reviewed during the design phase to limit removal of existing trees. To limit disturbance within Cat Stream, we are proposing to connect into the manhole located 1.0m upstream of the cast-in-place outlet structure and connected via a 750mm PVC pipe (see photo). Hydraulic constraints of this proposed connection will be confirmed during detailed design as the proposed 900mm pipe would discharge into a 750mm PVC pipe. If required, the outlet structure could also be modified. Conceptual plan is provided in ***Appendix A.***

Existing storm drain outlet at Cat Stream

Treed boulevard

6 Road Works

To meet the project objectives previously outlined, the following section showcase proposed upgrades to the roadway corridor.

6.1 Cycling infrastructure

The cycling infrastructure along the corridor is inclusive of dedicated cycling lanes along with a multi-use pathway between Harewood Road and Third Street.

The following highlights cycling infrastructure upgrades proposed to meet the Project's objectives:

Bicycle Lane

Bicycle lanes designate an exclusive space on the roadway for people riding bicycles, distinct from motor vehicle lanes. Bicycle lanes are marked with a solid white line between the vehicle lane and the bicycle lane and include a bicycle symbol and diamond. Bike Lane or bicycle wayfinding signs may be used to further identify the route. Located adjacent to motor vehicle travel lanes, bicycle lanes follow the same direction of travel. Parking or stopping is not allowed in bicycle lanes.

Bike lanes are proposed southbound on Wakesiah Avenue from First Street at the north end of the project to Fifth Street. Northbound bike lanes start at Harewood Road and continue to First Street. Where there is opportunity add a painted buffer, one will be installed.

Bicycle lane

Multi-use path

Multi-use paths are located in the boulevard of the roadway or follow an independent right-of- way. They are generally paved and provide sufficient width and supporting facilities to be used by cyclists, pedestrians and other non-motorized users. Best practice in multi-use paths is to encourage all users to stay right except when passing.

Upgrades and relocation of the multi-use path is proposed on the west side of Wakesiah Avenue from Harewood Road to Third Street. This will permit the connection to the existing Colliery Dam Park Trail. The multi-use path will target a 4.0m width with a minimum of 3.0m to allow safe cycling/pedestrian use and will be separated from the roadway.

Multi-use path.

Shared Lane Markings

Shared lane markings, or 'sharrows', are used to indicate a shared road environment for people riding bicycles and people driving on roadways with lower traffic speeds and volumes. They can also be used to guide where in the lane people should ride to avoid hazards such as doors opening on parked cars or navigating into and across vehicle lanes where bike lanes are not continuous. In addition to alerting motorists to expect to encounter people riding bicycles, shared lane markings serve as a form of wayfinding for cyclists. A shared lane marking consists of two white chevron markings placed above a white bicycle marking.

Shared lane markings are proposed for the northbound travel lane on Wakesiah Avenue south of Harewood Rd to be used to transition the cycling facility at the south project limit.

Shared lane markings.

Paved Shoulder

A shoulder is a paved area outside the general-purpose travel lanes delineated by a continuous white line. Located on rural roadways, shoulders suitable for active transportation should be at least 1.5m wide and may include bicycle and/or pedestrian-oriented signage and lane marking. Paved shoulders may accommodate two-way pedestrian travel but should not be intended for two-way bicycle travel. Shoulders marked for bicycle and pedestrian use should not be used for parking.

A paved shoulder on the west side of Wakesiah Avenue extends south from Harewood Road to Sixth Street.

Paved Shoulder example.

Two-stage bicycle turn box

A two-stage turn box provides an alternative method for cyclists to turn left at an intersection with less exposure to traffic. Cyclists complete the first phase of the turn by crossing the intersection on the through movement, then wait in a two-stage turn box for a green signal to proceed through on the cross street. Two-stage turn boxes are typically painted green for higher visibility and are paired with a right-turn-on-red restriction for the conflicting right-turn movement from the side street.

Two-stage turn boxes are proposed at the intersections of Wakesiah Avenue and Second Street, Third Street, Fourth Street and Fifth Street.

Two stage bicycle turn box.

No right-turn on red

The installation of Bike Boxes for two-staged left turns has often included the prohibition of right turn on red at the signalized intersection. This can reduce the capacity for right turning vehicles at intersections in some cases. However, if the through traffic is significant, stopped-through traffic at a red light in a single-approach lane will also impede right-turning traffic at the intersection. Some municipalities in Canada, where turning right on red is legal, have implemented these Bike Boxes without the turn prohibitions. The implementation of no- right-turn-on-red signal will be confirmed during detailed design.

No right turn on red.

Combined Cross-ride

A cross-ride is a roadway crossing designed specifically for bicycles. Cross-rides can also accommodate pedestrians, such as when a multi-use path crosses a roadway.

Combined crosswalks and cross-rides are proposed for roadway and driveway crossings of the multi-use trail between Third Street and Harewood Road.

Opportunity to have the combined cross-ride raised are possible at 4 entrances locations to VIU and NDSS between Third Street and Fifth Street.

Currently this is proposed on the NDSS access south of Foster Street.

Combined crosswalks and cross-rides.

Bike Lane Extensions

Bike lane extensions connect bike lanes across intersections helping direct people riding bicycles through long crossings and alerting people driving to expect to see cyclists.

Bike lane extensions are used through intersections on Wakesiah Avenue between Harewood Road and First Street.

Bike lane extensions.

6.2 Pedestrian Improvements

Pedestrian Crossings Traffic Signal

To provide safer pedestrian crossings on Wakesiah, three additional traffic signals upgrades are proposed at the following locations:

Foster Street - The existing special crosswalk (pedestrian activated flashing signal) is to be replaced with a pedestrian activated half signal to provide a safer full stop crossing in front of NDSS due to the nature and volume of pedestrians crossing. As an additional benefit the signal will improve traffic flow for vehicles on Wakesiah Avenue before and after school opening.

Upgrading this pedestrian crossing to pedestrian signals would provide clear guidance to pedestrians when to cross the road and when to wait and provide sufficient time for the pedestrians to cross the road. The signals would also provide amber and all-red clearance intervals for motorists to ensure they can bring their vehicles to a stop before the pedestrians start to cross the road.

First Street. - A pedestrian activated half-signal is proposed at the Wakesiah Avenue/First Street. intersection to improve crossing safety at this location.

Queens Street. - A future pedestrian activated half-signal is expected to be required at the Wakesiah Avenue/Queens Street intersection as VIU continues to expand their campus and construct facilities closer to Wakesiah Avenue with additional pedestrian volumes driving the warrant for the crossing. This will be exacerbated by the future development of mixed commercial/residential build outs on the east side of Wakesiah Avenue. At this time pre-ducting for the future crossing will be the extent of the work.

Traffic Signal Timing Improvements

In addition of new proposed pedestrian signals at Queen Street, Foster Street, and First Street, the existing signals at Fifth Street, Fourth Street, Third Street, and Second Street are affected by this project. This presents an opportunity to review and adjust the signal timings and phasing throughout the project. Changes to the timing and phasing can help to improve pedestrian and cyclist conditions and safety, improve traffic flow and reduce conflicts. Specific changes can be reviewed in detailed design but could include changes to green times, dedicated cyclist signal heads with leading or separated phases, leading or lagging pedestrian phase and extended pedestrian walk times, among others.

Removing channelized right turn lane configuration

The removal of existing channelized right turn lane configuration reduces the intersection curb returns radius which reduces the speeds of right turning vehicles and makes pedestrians and cyclists more visible to approaching motorists, as they are positioned closer to the parallel through travel lanes when waiting to cross the intersecting road. This improves the safety for pedestrians and cyclists at the intersections.

To reduce pedestrian crossing distance at intersections, the plan proposes to remove the existing channelized south bound right turn lane on Wakesiah Avenue at the following intersections:

- Second Street
- Fourth Street
- Fifth Street

As outlined in the Technical Memorandum in ***Appendix D***, the removal of channelized right turn lane will have minor impact on existing traffic and will provide similar existing traffic conditions as per the current laning scheme.

Curb Ramp and Curb Return Improvements

Walking using a wheelchair or scooter is a method of transportation for many people is their only means of transportation outside of transit. Too often a lack of accessibility provides road blocks to convenient routes for people with mobility challenges or people with disabilities. Providing a network of accessible sidewalk connections from neighbourhoods to amenities is critical to encouraging short distance transportation and is part of a complete street.

Curb ramps are to be provided at all four quadrants of each intersection along the Wakesiah Avenue corridor. The curb ramps will be installed as per the City of Nanaimo Manual of Engineering Standards and Specifications (MOESS).

Opportunities

With the replacement of curb ramps at intersections, reductions to the curb return radii will be considered to reduce the speed of turning vehicles, provide a shorter crossing distance for pedestrians, and increased sidewalk space behind the curb at each corner. Additional road right of way located at the south west corner of Wakesiah Avenue and Third Street provides for a plaza area to connect the crosswalk to the proposed multi-use trail.

Challenges

With the buildout timeline of the east side of the corridor not directly tied to the upcoming corridor improvements a portion of the east side curb ramp improvements will connect existing sub-standard asphalt sidewalks with extruded curbs. Limiting the pedestrian improvements to the wheel chair letdowns will need to consider the condition of existing approach sidewalks, existing curb grades, intersection grading, and utility box adjustments.

Sidewalks Improvements

Walking is part of a healthy lifestyle and makes up a part of each trip. Constructing an accessible, connected and comfortable sidewalk provides for a convenient alternative for short trips and makes walking more enjoyable. There are many major destinations for pedestrians along and in close-proximity to the corridor that includes the VIU, NDSS, Nanaimo Aquatics Center, commercial nodes, and transit facilities. Linking these destinations together with pedestrian infrastructure reflects the complete street model employed along the corridor.

In addition to the proposed Multi-use path along the west side of Wakesiah Avenue from Third Street to Harewood Rd, additional sidewalks upgrades are proposed on the west side of Wakesiah Avenue between Second Street and Third Street to have a minimum 2.0m sidewalk to meet the future MOESS. It is noted that existing trees between Third Street and Cat Stream could be impacted as part of the sidewalk upgrades.

Opportunities

Where possible a buffer area could be provided to separate pedestrian from traffic and cyclists. Provide pathway connections for destinations along the corridor to improve the connection points within the right of way.

Challenges

Between Second Street and Third Street the existing vegetation and trees line the back of sidewalk. In addition, the existing topography of the corridor slopes away from the existing back of sidewalk providing limitations for providing the desired separation for a new sidewalk.

Mitigating the speed differential between pedestrians and cyclists along the multi-use pathway between Third Street and Harewood Road will need to be considered particularly northbound when the grade of the pathway increases that could provide for an uncomfortable pedestrian environment.

Pedestrian Plaza Opportunities

The access to the Colliery Dam Park and NDSS provide an inviting, safe and aesthetically pleasing shared pedestrian and cycling gateway to both sites. A pedestrian plaza at these locations will permit the installation of appurtenances such as benches, wayfinding signage, garbage cans, public art and will be developed during detailed design, to enhance these areas.

Example of multi-modal plaza

6.3 Transit

The Official Community Plan states that a principal objective is to increase transit use by making it a more economical, convenient and practical means to move around the city. Improvements to the corridor need to consider the mobility requirements of all transit users including those with physical and mental disabilities along with safe and convenient access to stop locations located along the corridor.

The Harewood Neighborhood Plan (HNP) outlines that bus stops are typically best located at the 'far side' of intersections for operational and safety reasons. In addition, the plan outlines that bus stop curb extensions or bus bulges should be considered in pedestrian priority zones at busier stops to avoid buses having to merge back into traffic and to provide more pedestrian queuing space even if this creates delays for regular vehicles.

The transit stops along the corridor are generally spaced within the desired 150-400m metrics outlined in the Harewood Neighbourhood Plan. The corridor contains a mix of transit stop locations at both near-side and far-side of intersections due to the existing layout NSDD Recreational facilities along the corridor. Two bus stops are proposed to be relocated along the corridor. Bus stop ID:110068 originally located on Fifth Street and Hillcrest Avenue has been relocated to the north side of Wakesiah Avenue and Fifth Street. In addition, Bus stop ID:110482 originally located 120m south of the Fourth Street along Wakesiah Avenue has been relocated 100m south to the far-side of the Queens St/VIU access intersection. Concrete bus stop pads will be added to existing bus stop locations where existing sidewalks exist street NDSS southbound bus bay will remain and will be upgraded as part of the project.

Opportunities

Improvement to bus stop accessibility and amenities such as shelters, furniture, garbage cans, and lighting can be enhanced at stop locations along the corridor. Adjacent wheel chair ramps at approached to transit stops will be upgraded to improve accessibility to stops.

The northbound bus stop north of Foster Street services the NDSS and NAC providing considerable ridership at pedestrian ques at peak times. This location has the potential of a bus bay to provide a short pull-over zone, adjacent to the main travel lanes, where buses can stop and pick up passengers without interfering with the regular flow of traffic. An existing bus bay exists for the southbound ridership fronting the NDSS that will be maintained. Typically bus bays are considered when:

- The roadway has high traffic volumes
- Where the roadway is a high-speed facility, denied as having posted or prevailing speed of 70 kilometers per hour or higher, bus bays should be provided.
- The roadway has a single travel lane in each direction where passing sight distance is not available for vehicles approaching a stopped bus.
- The bus is scheduled to layover at the stop for an extended period of time.
- Bus service frequency is high such that buses occupying the curb lane would impede traffic flow or increase the risks of rear-end and sideswipe collisions associated with approaching vehicles trying to bypass the bus.
- Where a center median is adjacent creating an impediment for emergency vehicle access.

While the installation of a bus bay is not directly in line with the HNP consideration will be given based on the stakeholder feedback received and internal discussions with the CoN.

6.4 Landscaping/Aesthetics/Stormwater Improvements

The corridor improvements will enable landscaping and aesthetic improvements (in addition to the plaza areas outlined in the previous section) in greenspaces along the corridor as well as the implementation of best management practice in terms of stormwater management by the incorporation of bio-swales.

Landscaping and Aesthetic Opportunities

Landscaping Median Islands

Landscaped median island is proposed between Third Street and Fifth Street which will permit the following:

- improve the aesthetics of the corridor
- permit the planting of vegetation to help limit unregulated pedestrian crossings in front of NDSS and VIU
- add shading to the asphalted road to reduce heat refraction

Boulevard Landscaping

The proposed separated multi-use path upgrades along Wakesiah will create a significant boulevard with greenspace and landscaping opportunities. Respondents are supportive of eliminating street parking in order to install boulevards and greenspace to allow for a greener corridor and improve cyclist and pedestrian safety. Hardscaping/drought resistant landscaping vs. shrubbery and flower type landscaping was preferred. Landscaped boulevard can be modified as rain-garden or bio-swales to improve stormwater management as discussed in the following section.

Decorative Crosswalks

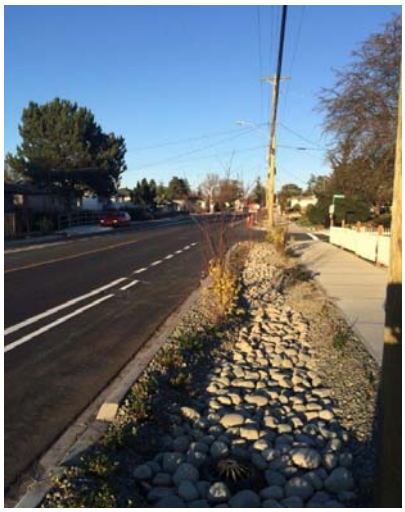
A decorative crosswalk with an artistic design could be installed at the Wakesiah Avenue and Foster Street intersection pedestrian activated signal to provide a sense of community and identity along the corridor. This opportunity was supported by the public respondents of the online survey. Internal discussion within the CoN will be required to determine if the application is supported considering that the crossings are not supported from a transportation engineering perspective, ICBC along with maintenance operations.

Streetlighting

The project intends to remove all streetlighting currently on BC Hydro poles onto standalone lighting poles which will improve the aesthetics of the corridor. The replacement poles will provide opportunity for an improved aesthetic with the use of decorative light poles with optional banner arm mounts.

Stormwater Management Opportunities

During detailed design, suitable highlighted greenspace areas will be reviewed if they can accommodate a bio-swale to reduce roadway run-off to the pipe storm system by infiltrating the soil and assist with the quality improvement of the run-off as well.



Roadside bio-swale Example

For a suitable bioswale design for our integrated stormwater management application, our design will take into consideration the following:

- Aesthetically-pleasing design and functional design for inflow of surface roadway stormwater runoff that requires low-maintenance of clearing debris;
- Proper design of engineered soil medium that provides stormwater runoff storage and biofiltration;
- Selection of low-maintenance draught resistant vegetation and planting scheme, specifically the use of native species that have been proven to work in the system and have the characteristics of a root system that enhances infiltration, soil permeability, moisture distribution, and biofiltration; and,
- Appropriate sizing of subsurface storm drain system which will be connected to the storm sewer system.

6.5 Road Rehabilitation

Overall the pavement surface of Wakesiah Avenue and Fifth Street is in fair condition with respect to surface distresses. Intermittent low to moderate severity longitudinal cracking, meandering cracking, and alligator cracking were observed on both road sections being considered for rehabilitation. Localized areas of poor condition with moderate to high severity alligator cracking were observed on Wakesiah Avenue, particularly near the NDSS School crossing (near Foster St) and 384 Wakesiah Avenue. Existing utility trenches also appear to have created some depressions on the southbound lane of Wakesiah Avenue.

The pavement appears to be somewhat maintained through the use of crack sealant and patching.

The Project provides the opportunity of improving the existing paved area and repaving of the existing Wakesiah Avenue is proposed to be repaved between Second and Fifth Street and Fifth Street between Wakesiah Avenue and Highway 19. Our cost estimate assumes that 5% of the existing roadway will require structural rehabilitation in addition to the new asphalt pavement.

Additional existing pavement condition information is included in the Geotechnical Report included in ***Appendix B***.

6.6 Electrical Works - Streetlighting and Traffic Signal

Parsons retained PBX Engineering to provide input on streetlighting and traffic signal upgrades based on Parsons conceptual plans for the proposed improvements to the Wakesiah Avenue corridor in Nanaimo, British Columbia.

The following is the conceptual design approach which includes traffic signal works and roadway and pathway lighting throughout the corridor.

In general, the ultimate configuration of the corridor includes two lanes of traffic with left-turn lanes, roadside bike lanes, and a multi-use pathway. Also included are several signalized intersections. The

illumination design will be undertaken in accordance with the MoESS. The roadway classifications per the MoESS will be confirmed by the CoN for this corridor.

Proposed civil works along Wakesiah Avenue will require signal poles to be relocated along the west side of the corridor. Impacted intersections include Second Street, Third Street, Fourth Street, and Fifth Street. The relocations will include installation of new signal pole concrete bases, re-installation of existing poles, modification of signal arms as required, upgrade of light fixtures, and installation of new junction boxes. Underground trenching and conduit works will be required to accommodate these modifications, along with the removal of all redundant equipment and materials.

The corridor improvements include three pedestrian-controlled traffic signals, at Queens Street, Foster Street, and First Street. The Foster Street and First Street signal installations will include new poles, concrete bases, junction boxes, wiring, and conduit road crossings. The Queens Street location will include pre-ducting of the intersection to accommodate the future installation of a pedestrian half signal. Light fixtures will be installed on new signal poles as required to integrate with corridor lighting. It is assumed that new electrical services will be required at each location.

In regard to street lighting, luminaires will be LED type with colour temperature of 4000K and will be from manufacturers appearing on the Ministry of Transportation and Infrastructure Recognized Products listing street lighting, which includes bike lanes, will typically be provided by 9m luminaire poles with 135W fixtures, spaced at approximately 45-50m. Intersections will be illuminated by fixtures mounted on signal poles, while illumination of the multi-use pathway may require the addition of 4m or 6m pedestrian scale luminaire poles.

It is understood that the CoN has requested that street lighting be provided from the west side of Wakesiah Avenue. While this constraint will place limits on the flexibility of the design, a cursory review suggests that it is generally feasible. Conflicts between luminaire poles and existing overhead Hydro conductors are anticipated where they share the west side of the road between Fourth Street and Sixth Street. Shorter luminaire poles or poles with adjustable heights may be deployed in this area along with tighter pole spacing, in order to achieve standards.

Conceptual locations of the proposed streetlights are included in ***Appendix A.***

7 Stakeholder Consultation

A stakeholder Management Plan (SMP) was prepared to identify and engage key stakeholders at the early stages of project planning. The SMP ensures that public and private interests are informed of the Project scope and provided the opportunity to give input on both current issues and challenges in the corridor as well as future development plans affecting the overall design. Approaching the consultation component in this way produces a better understanding of specific corridor issues from the user perspective early on in the design process, minimizes potential for adverse impacts, and strengthens partnerships for future initiatives and growth.

The SMP included the following objectives:

- Acknowledge that the corridor design will be a combination of technical infrastructure upgrades, site specific considerations, and overall community vision;
- Provide a focused engagement with each individual stakeholder to identify and understand comments and concerns pertinent to corridor design;
- Identify major and minor issues from an end-user or organizational perspective; and
- Strengthen City-Community partnerships for the design/construction phases of the project, including future initiatives.

The stakeholders identified below were consulted and the salient points of each discussion summarized. Individual SMPs are provided in ***Appendix E***.

7.1 Vancouver Island University (VIU)

VIU is a major stakeholder in the area, and specifically Wakesiah Avenue given the frontage and connections to the corridor. Discussing the 2017 update to the VIU Master Campus Plan helped begin the conversation about future campus development and potential connections to be considered.

As the Third Street connector and Fourth Street gateway to VIU are focused initiatives, resurfacing of Fifth Street from Wakesiah Avenue to the Parkway would potentially allow for the closure of under-utilized accesses including 5C (Lot F access) and possibly 5E (Lot H access). The addition of cycling facilities to Fifth Street was not identified as a high priority based on their observations. VIU voiced interest in improvements to the main entrance at Oppgard Drive, with the possible addition of a roundabout intersection. It was noted that this is not within the scope of the Project and would ideally be constructed in conjunction with development of the DND lands to the south.

A conceptual plan for the future Fourth Street entrance to VIU was provided, allowing the intersection here to be designed with the future cross-section considered for a seamless future buildout. Significant and increasing pedestrian volumes were flagged for Wakesiah Avenue at Queen Street given the existing and future commercial service infill potential along here. Pre-ducting for a future half-signal here (similar to Foster) was agreed to be appropriate. The potential removal of southbound dedicated right-turn lanes approaching Fourth and Fifth streets was identified as part of the corridor plan to shorten pedestrian crossing distances and improve safety at major intersections. The addition of a southbound transit stop just past Fourth Street was requested.

7.2 Nanaimo District Secondary School (NDSS)

Students attending NDSS commute from a variety of locations in the City and as a result, are heavily reliant on chartered buses and public transit. Ongoing challenges and safety concerns were noted about student-vehicle conflict potential internally, and also in and around the transit stops for the northbound bus routes and students running across the street at unmarked locations. Of specific concern is the congestion and

confusion around multiple route stops at the same location (i.e. Route 40, 15, 15A) and the unsafe product of large groups of students gathering on sidewalks directly adjacent to vehicle travel lanes.

It was noted that centre medians are being proposed as a traffic calming and greenspace initiative, and the location and treatment type (bushes, fencing, etc.) could discourage or limit the potential for this unsafe crossing. Barrier fencing along the sidewalks at bus stop locations was also suggested. A pedestrian conflict was noted at the laneway entrance/exit to the SD68 office off Wakesiah Avenue.

The future seismic building upgrade of NDSS is a high priority for the school district and has the potential to alter current pedestrian and transit movements. The preferred option is to construct a new high school in the open green space are fronting on Wakesiah Avenue opposite Foster Street. This would further support the double crosswalks at Foster Street as the main pedestrian crossing route and could be supported with a half signal. This major future upgrade highlighted that the west side boulevard area along this section requires future congruency with the new institutional building and space should be left to accommodate a pedestrian focused frontage.

7.3 Greater Nanaimo Cycling Coalition

The discussion with representatives from the cycling community were appropriately centred on the proposed cycling infrastructure in the Project area, safety issues, and connectivity/opportunity with other trail systems. The concept presented showed dedicated cycling lanes on both sides of the road from First Street to Sixth Street, with the exception of a shared multi-use path along the NDSS/VIU frontage between Fifth Street and Third Street. The alternate to the multi-use path would be to share the road for this southbound section and the feedback noted that a significant demographic of cyclists would be lost without a dedicated bike lane, as most advanced riders would avoid the shared multi-use path. It would also provide a consistent cross-section and sense of continuity through the corridor despite the additional capital cost.

Speed reduction strategies such as speed humps were requested to facilitate traffic calming; however, Wakesiah Ave is a major collector road therefore it would not be appropriate here. Connectivity of trails was deemed to be paramount and improving the safety for cyclists at intersections was requested, specifically at Third, Fourth, and Fifth Streets. The connectivity of cycling lanes from First Street to facilities on Bowen Road was discussed, and while not part of this Project scope, is a known issue and under review.

7.4 Harewood Neighbourhood Association (HNA)

An initial meeting was held with a staff member from the Harewood Neighbourhood Association (HNA), with a subsequent presentation of the concept plan to a larger contingent of the HNA. As previously noted, the design of the corridor is seen as a combination of technical infrastructure upgrades, site specific considerations, and overall community vision. The latter two components were largely expected to be a function of input from the Harewood Neighborhood Plan, HNA, and general public. High level comments received from the HNA regarding issues in the neighbourhood and Project area included:

- Traffic volumes/speeds increasing, specifically between Fifth Street and Sixth Street;
- Parking is very challenging in the neighbourhood, largely along the side streets to Wakesiah Avenue;
- Advancing development with parking variances only exacerbates the parking issue; and,
- Locations of poor street lighting exist.

Parking challenges on Wakesiah Avenue and its side streets are well documented and viewed by some as getting worse, with increased students, reduced VIU parking, and increasing parking rates. One of the fundamental objectives of the Plan is to provide viable alternatives to vehicle travel to and throughout the corridor by improved pedestrian, cycling, and transit infrastructure. Opportunities may also exist for additional parking with future development of the DND lands at 901 Fifth Street and the continued buildout

of the VIU Campus. Traffic volumes and congestion in the corridor between Third and Fifth Streets was noted as a prominent issue.

Some participants commented on the importance of providing streetscapes that are green and pedestrian friendly. Any efforts to improve the quality of runoff into Cat Stream and improve the riparian areas would be welcomed as this watercourse is one environmental asset the HNA endeavors to improve where possible. Streetlighting improvements were identified as another area of concern/interest as low-lit areas make motorist/pedestrian conflicts a safety issue outside of daylight hours; installation of dedicated City streetlighting (on a priority basis) was acknowledged to be within the scope of the Project.

7.5 City Departments

In addition to the external stakeholders shown, projects of this nature have internal stakeholders vested in the product from an operational and functional interest. The Project scope was reviewed with the following departments below, with the summary of discussion as provided.

Development Services – Once finalized, the Corridor Plan will be a valuable tool to provide direction on frontage works for infill development, specifically along the east side of Wakesiah Avenue from Third Street to Fifth Street where it is suggested that landscaped boulevards will be the requirement with no allowance for parking. Outside of this area, parking or boulevard can be constructed as required by the development and with approval by the City. The intersection of First and Wakesiah will be improved during Phase 6of the adjacent development and will include a consolidated access to Stonewater Dr, as well as a half signal for pedestrians and cyclists crossing Wakesiah Avenue (similar to Foster St).

Parks, Recreation, and Environment – High level discussions surrounded future maintenance of landscaping within the road allowance (specifically centre medians), a possible gateway to Colliery Dam Park, and wayfinding signage to highlight the many park and facility destinations in the area. Additional consultation will occur during the detailed design phase, after the concept has been further refined based on public input.

Roads – Outside of the transportation engineering aspect of the corridor design, a significant area of road pavement rehabilitation will be completed including Wakesiah Avenue from Second to Fifth Streets, and Fifth Street from Wakesiah Avenue to the Parkway. The function of the Roads Department is to operate and manage City road assets to maximize their life and prioritize replacement and rehabilitation. Including their technical feedback during detailed design of the road resurfacing, components of the Project will ensure the final product meets the expectation of the stakeholders.

7.6 Public Engagement

In order to ensure local knowledge was considered and informed the final design, area residents and the broader Nanaimo community were asked to provide their feedback with respect to components of the Project design. Public engagement produces a better understanding of corridor issues from a local perspective and helps builds long-lasting relationships, communication channels and overall trust with the community.

Residents of the area were asked to weigh in with their opinion on components of the Project design, including transportation, parking and community features. Feedback will help ensure that local knowledge is considered and informs the final design. An online survey tool (Survey Monkey) was posted on the City's website from March 18 - April 8, 2019 and promoted on social media in addition to a flyer distributed to area residents. A total of 342 individuals responded to the survey. The common themes of feedback were:

- Intersection and crosswalk safety;
- Improved pedestrian cyclist options;
- Traffic conditions and congestion concerns;
- Boulevards, green spaces and landscaped medians over parking;
- A desire for consistent approach to corridor design.

Pedestrian-controlled crossing lights at the NDSS and separation of pedestrian and cycling infrastructure from vehicle traffic were some of the highest priority for respondents. Elimination of parking for installation of boulevards and green spaces was supported as well.

The Public Engagement Summary Report completed by Zinc is provided in ***Appendix F.***

8 Conceptual Design Summary

8.1 Design Process

The conceptual design has been developed while utilizing the City of Nanaimo Official Community Plan, Harewood Neighbourhood Plan (HNP), National Association of City Transportation Officials, City of Nanaimo Manual of Engineering Standards and Specifications, input from the City of Nanaimo Engineering Department as well as stakeholder input outlined in the Section 8 which includes the VIU, NDSS, HNA, the Greater Nanaimo Cycling Coalition as well as the input from the local residents via a public engagement process outlined previously.

The objective of the concept design is to create a balanced transportation corridor that is safe, enjoyable, and connected for all modes and users. The criteria utilized to develop the geometry for the cross sections along the corridor within the existing road Right-of-way which will include:

- 3.4m wide travel lanes, 3.2m wide turning lanes, 1.5m wide bike lanes, 1.5m boulevards minimum, 2.0m wide sidewalks, and 2.4m parking lanes as per the City of Nanaimo, City of Nanaimo Manual of Engineering Standards and Specifications drawing number R3-XS2.
- The cross-section criteria was utilized to develop a minimum baseline cross section for the corridor.
- A 3.0m multi-use trail is proposed to provide connectivity to Colliery Dam Park starting at Third Street providing horizontal and vertical separation from road traffic.
- Design elements and opportunities outlined in the Section 7 were incorporated to develop a safe, multi-modal transportation corridor including streetlighting improvements, the opportunity for additional landscaped area and implementation of best management practice stormwater management in terms of run-off quality and quantity by implementing rain-gardens and bio swales, where feasible.
- Upgrade existing aging water and storm drain infrastructure within the Project corridor to avoid duplication of road reinstatement cost and limit future road disturbance.
- Asphalt rehabilitation between Second Street and Fifth Street on Wakesiah Avenue and on Fifth Street between Wakesiah and Highway 19.
- The control alignment for the corridor avoids horizontal lane deflections through intersections.

8.2 Conceptual Design Outline

The following section outlines a block by block proposed works, highlight any opportunities as well as provide any challenges related to the proposed upgrades. See conceptual drawings in ***Appendix A***.

8.2.1 Sixth Street to Harewood Road

Connecting the Colliery Dam Park entrance and Sixth St, a painted 1.5m asphalt shared shoulder along the west side connecting pedestrians and cyclists to a reconfigured park access will provide formalized turning movements in and out of the park and delineate pedestrian and cycling access points. A combined cross ride crosswalk will be provided across the west leg of the Harewood Road intersection that will allow cyclists to cross with pedestrians providing access to the both the existing park trail and the proposed shared shoulder. An extension of the Colliery Dam trail head will connect users to the Wakesiah corridor via a 3.0m asphalt multi-use pathway. The north-bound travel lane will accommodate a 4.0m lane with the ultimate build out of the east side pedestrian facilities tied to future development of the corridor.

<u>Opportunities</u>

With the crossing of the multi-use pathway across Harewood Rd, a formal pathway connection can be accommodated to connect pedestrians and cyclists to both Wakesiah Avenue and Colliery Dam Park.

Challenges

Existing trees and steep fill slope along the west side of the right-of-way creates limitations to the build out of the desired cross section.

8.2.2 Harewood Road to Fifth Street

A 3.0m multi-use path is proposed on the west side that will be separated by a landscaped boulevard. North and southbound vehicle travel lanes will be maintained with the addition of a 1.5m painted bike lane along the east side (northbound). Left turn bike boxes will be provided at the Fifth Street intersection allowing cyclists to complete two -stage left turn movements.

Opportunities

The proposed landscape area along the west side could serve as a stormwater management opportunity in the form of a bio-swale. The closure of Dundas Street at Wakesiah Avenue could enhance the pedestrian environment once the future build out of the east side is completed.

Challenges

The existing crossfall of the road right-of-way transitions from the high side on the west to the low side on the east. The geometry and build out of the east side will require retaining walls and driveway grading onto private property.

8.2.3 Fifth Street to Fourth Street

The 80m right turn lane on the south approach to the Fifth Street intersection will be removed in favour of a bike lane and formalized curb return for the north west quadrant of the intersection. A 3.0m multi-use path is proposed on the west side that will be separated by a landscaped boulevard. North and south bound vehicle travel lanes will be maintained with the addition of a 1.5m painted bike lane along the east side (north bound). Landscaped medians will be introduced to provide an aesthetic feature and aid in traffic calming the corridor. A future pedestrian activated half signal will be pre-ducted for the Queens Street intersection and will provide enhanced pedestrian connectivity to transit stops and amenities when warranted. Left turn bike boxes will be provided at the Fourth Street intersection.

The existing BC hydro lease lights will be removed from the hydro poles with new LED Street lighting provided on freestanding davit poles.

Opportunities

The proposed landscape area along the west side could serve as a stormwater management opportunity in the form of a bio-swale.

Challenges

A truck driver training facility is located at the VIU. The access geometry will need to accommodate the associated truck traffic.

8.2.4 Fourth Street to Third Street

The 80m right turn lane on the south approach to the Fourth Str intersection will be removed in favour of a bike lane and formalized curb return for the northwest quadrant of the intersection. A 3.0m multi-use path is proposed on the west side that will be separated by a landscaped boulevard. North and south bound vehicle travel lanes will be maintained with the addition of a 1.5m painted bike lane along the east side (north bound). Landscaped medians will be introduced to provide an aesthetic feature and aid in traffic calming the corridor. A pedestrian activated half signal will replace pedestrian activated flashing beacons at the Foster Street intersection. Left turn bike boxes will be provided at the Third Street intersection

The existing BC hydro lease lights will be removed from the hydro poles with new LED Street lighting provided on freestanding davit poles.

Opportunities

The proposed landscape area along the west side could serve as a stormwater management opportunity in the form of a bio-swale. A raised crossing at the Elementary School entrance would enhance the visibility of the crossing for pedestrians and cyclists.

8.2.5 Third Street to Second Street

A 2.0m concrete sidewalk is proposed on the west side. North and south bound vehicle travel lanes will be maintained with the addition of a 1.5m painted bike lane in both directions with bike boxes proposed at the Second Street intersection.

The existing BC hydro lease lights will be removed from the hydro poles with new LED Street lighting provided on free standing davit poles.

Opportunities

Cat stream enhancement and education adjacent to the sidewalk. A boulevard buffered sidewalk can be accommodated for approximately 100m within the existing asphalt sidewalk alignment.

8.2.6 Second Street to First Street

The existing right turn lane on the south approach to the Jingle Pot Road intersection will be removed in favour of a bike lane and formalized curb return for the northwest quadrant of the intersection. North and southbound vehicle travel lanes will be maintained with the addition of a 1.5m painted bike lane in both directions. The existing BC hydro lease lights will be removed from the hydro poles with new LED Street lighting provided on free standing davit poles. A pedestrian activated half signal is proposed on First Street. to assist crossing to link the corridor to the First Street. bikeway and future off-Bowen bikeway.

Opportunities

Providing concrete bus stop pads where existing sidewalk is present will enhance the transit experience along this section.

8.3 Future Works

In the future, proposed upgrades to the east side of the Wakesiah Corridor will include the upgrades and separation of the sidewalk from the roadway which will permit the addition of a landscape boulevard enhancing the appeal and pedestrian safety of the corridor as outlined in the Harewood Neighborhood Plan.

9 Cost Estimate

The following table outlines the Class "C" Cost estimate for the project including construction cost, Engineering and Environmental services (5% of construction cost) and Level of Class Estimate Contingency (30%).

ROAD WORKS		
Wakesiah Road	$	3,415,915.00
Fifth Street	$	630,160.00
UTILITIES		
Storm	$	751,950.00
Water	$	795,000.00
Miscellaneous	$	30,000.00
Power/Communications	$	120,000.00
ELECTRICAL		
Street Lighting and Traffic Signals	$	1,018,000.00
SUBTOTAL	**$**	**6,761,025.00**
Engineering and Environmental Services (5%)	$	338,051.25
Contingencies (30%)	$	2,028,307.50
TOTAL	**$**	**9,127,383.75**

The detailed cost estimate is included in ***Appendix G.***

No provision is included in the cost estimate for the following:

- Land acquisition cost
- Contaminated soils remediation
- City of Nanaimo internal cost
- Financing Cost

10Next Steps

The following outlines next steps for the implementation of the project:

- Update this draft report with final input from the City, the stakeholders and public input based on available budget including updating conceptual design drawings accordingly.
    - This will permit to confirm opportunities to be implement as part of the project such as bio-swale locations, environmental enhancement of Cat Stream, proposed upgrades to transit facilities, confirm landscaping scheme, NDSS plaza and Collier Park entrance plaza amenities and upgrades, confirmation of traffic signal timing upgrades, confirmation of aesthetics improvements along the corridor, etc.
    - Mitigate during design challenges including tie in to existing grades and strategic use of retaining walls, work around significant trees, works with environmentally sensitive Cat Stream, tailor proposed upgrades based on available budget, etc.
- Complete the detailed design of the works including construction tender documents by end of year 2019;
- Public tender of the construction contract for the project in the first quarter of 2020;
- Construction starting spring of 2020 with completion in early 2021.

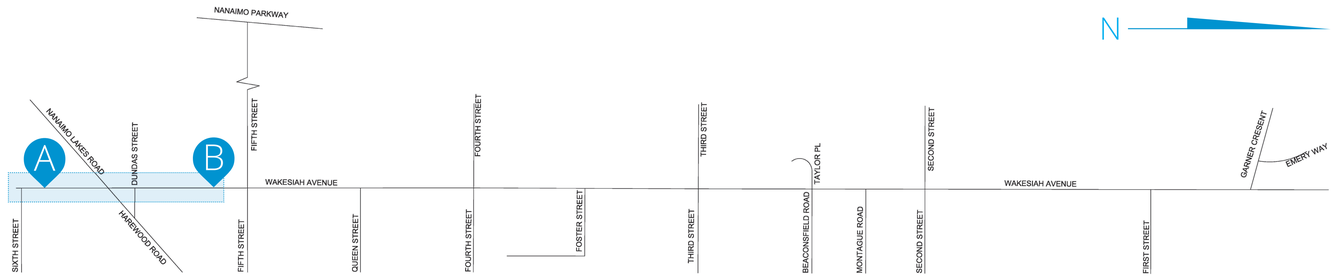
Appendix A Conceptual Design Drawings

- Roadway Conceptual Design
- Subsurface Utilities Conceptual Design
- Electrical Works Conceptual Design

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Sixth Street (Colliery Dam Park Entrance) to Fifth Street



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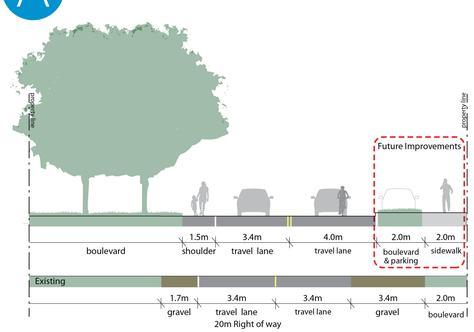

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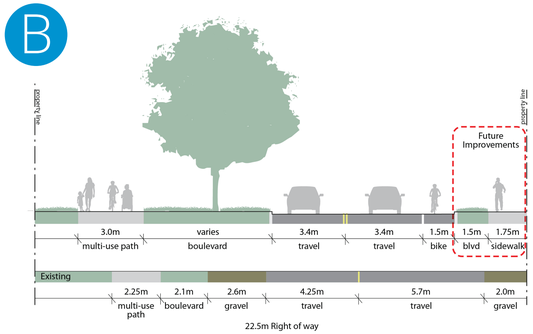

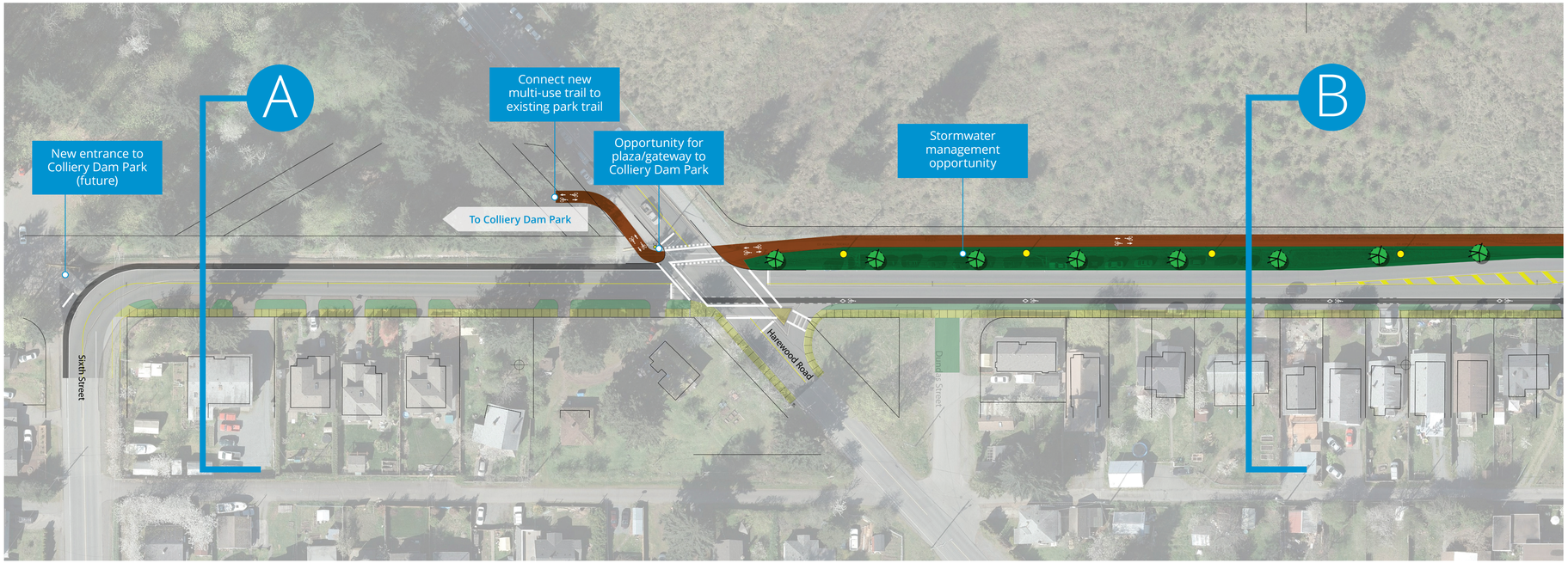

LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)

PARSONS

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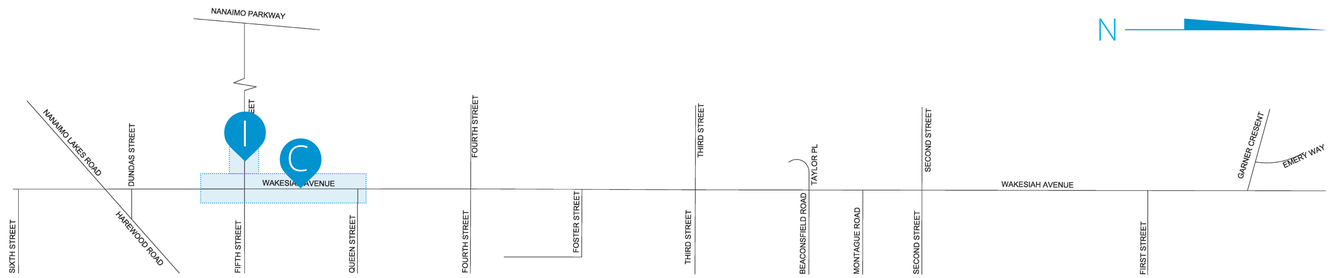
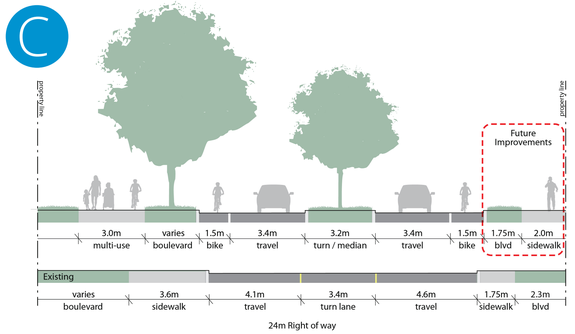
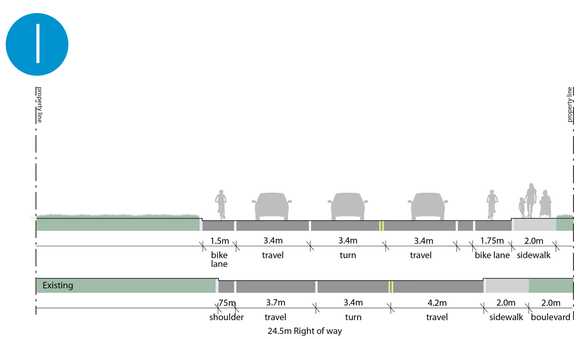
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

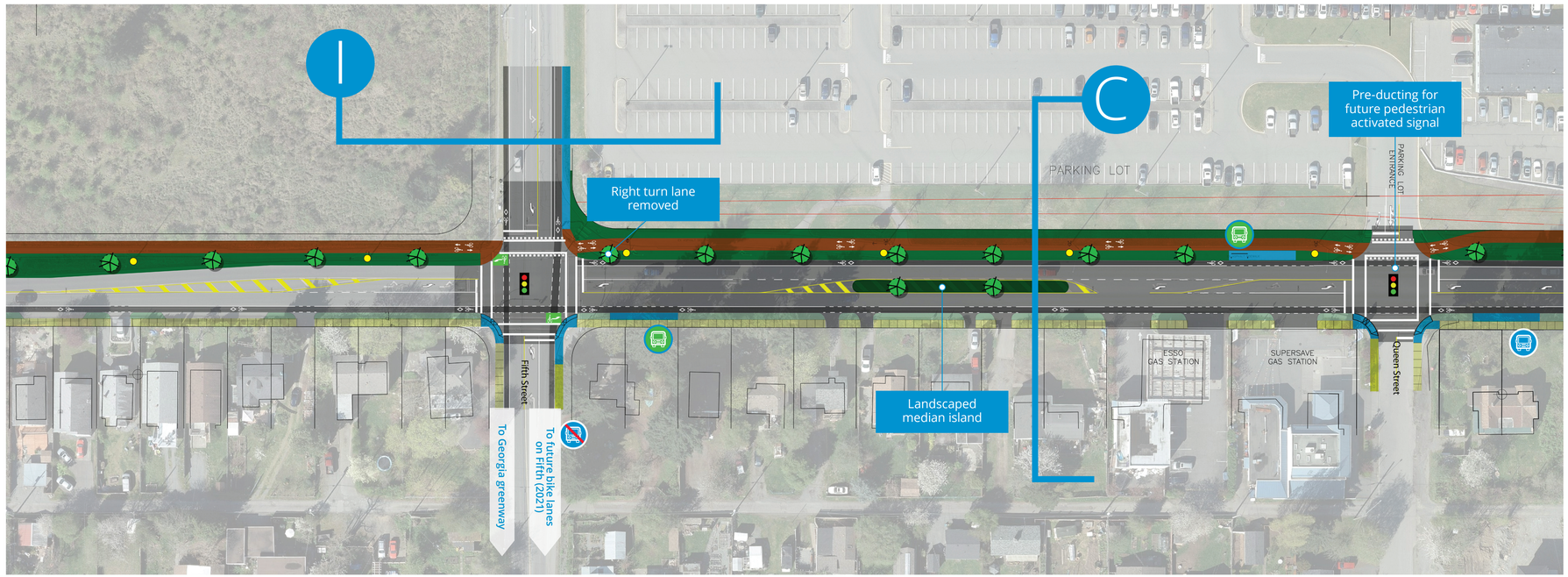
Wakesiah Avenue

Fifth Street to Queen Street









LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)

PARSONS

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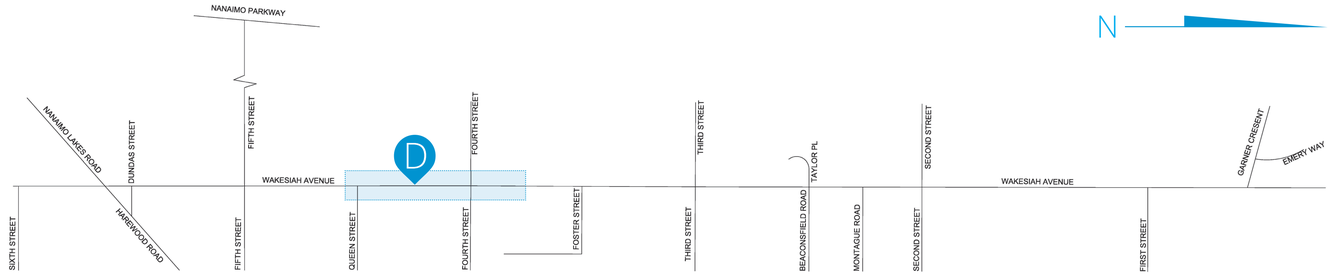
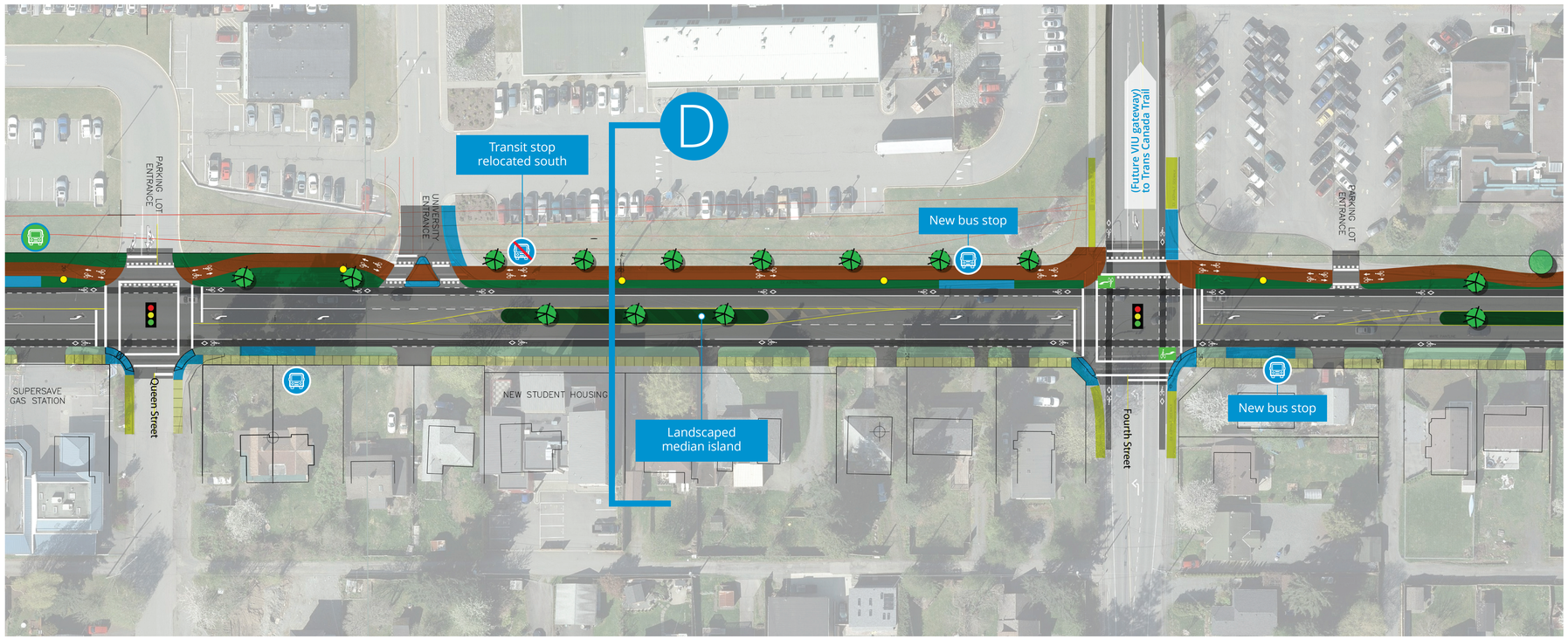
CITY OF NANAIMO THE HARBOUR CITY

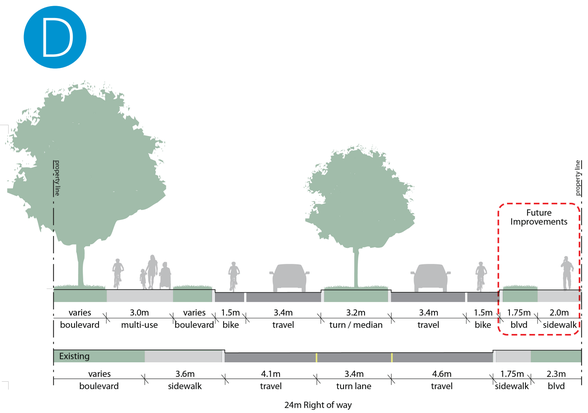
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Queen Street to Fourth Street







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)

PARSONS

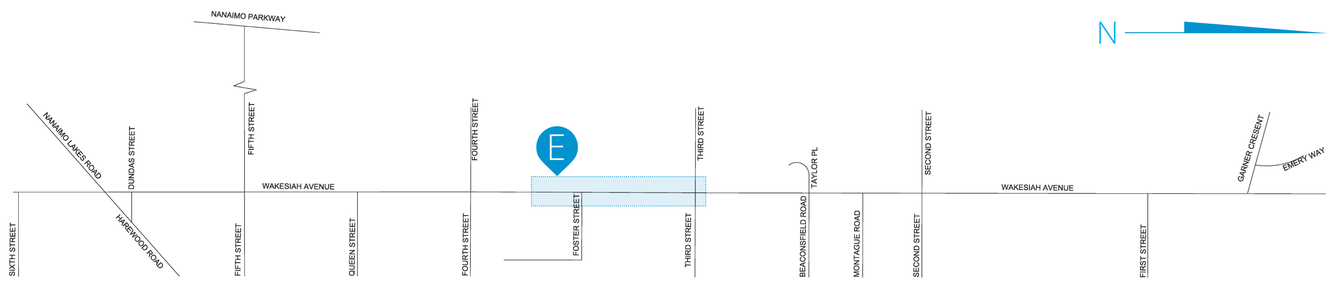
alta PLANNING + DESIGN

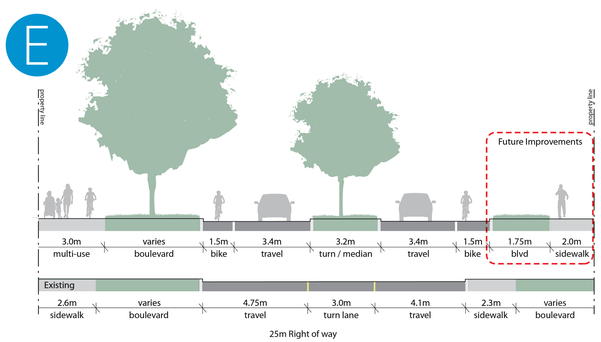
CITY OF NANAIMO THE HARBOUR CITY

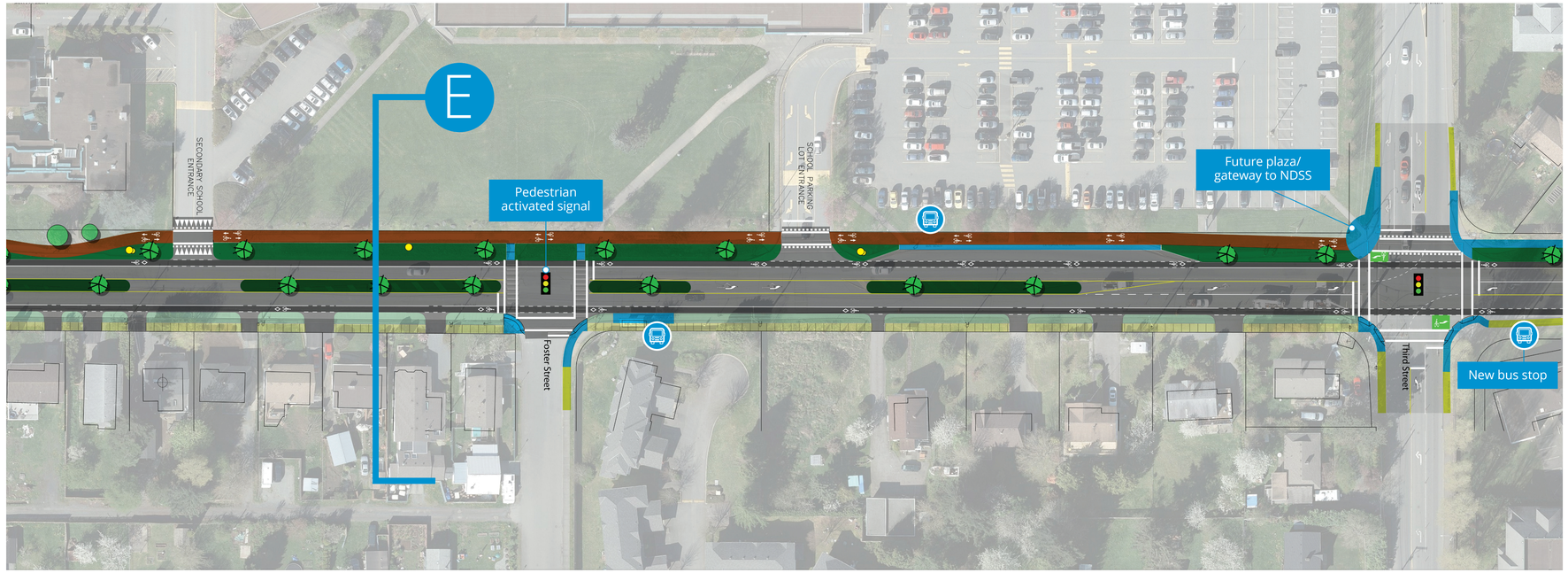
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Fourth Street to Third Street







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)

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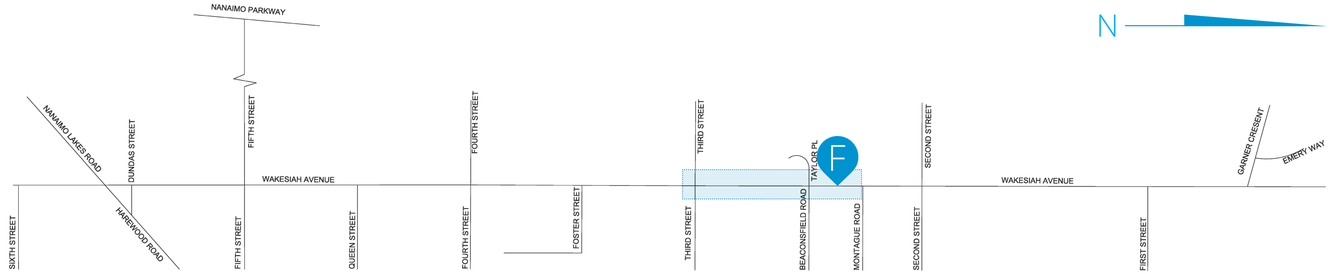
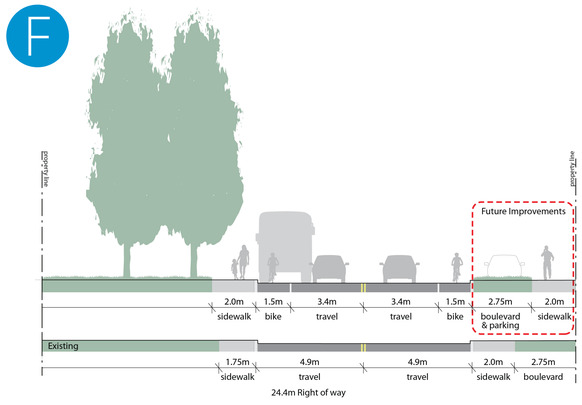
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Third Street to Beaconsfield Road





LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)

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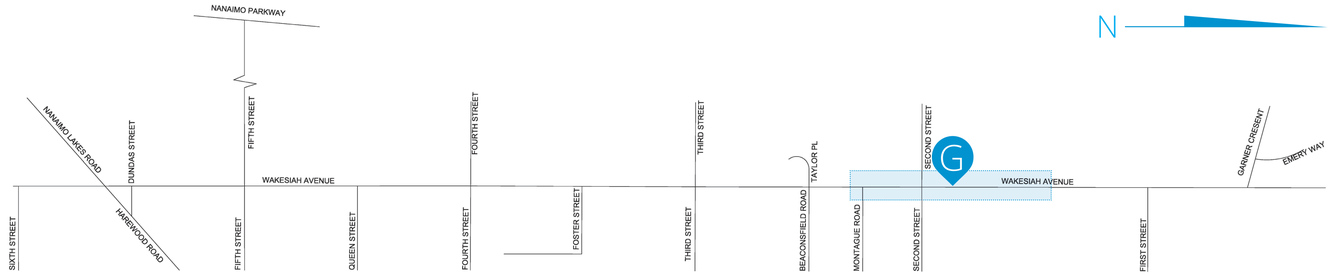
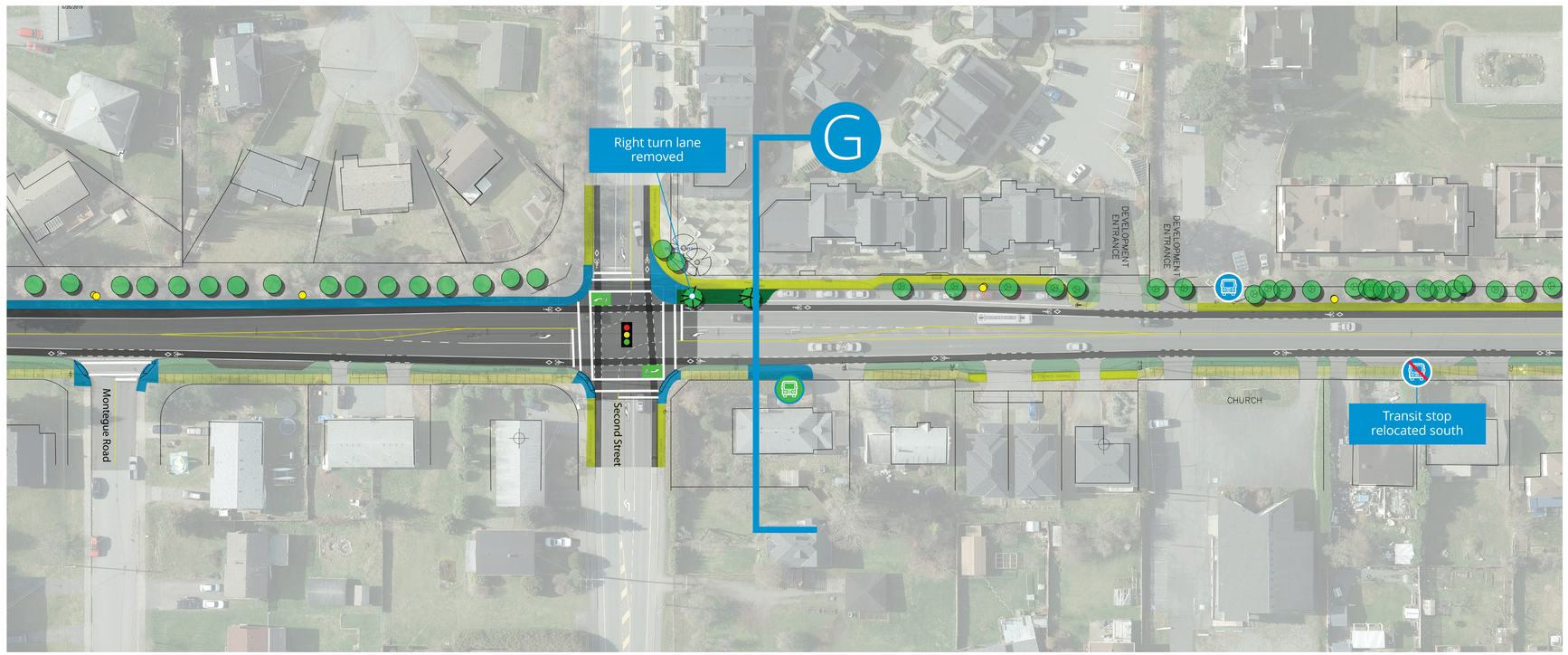
CITY OF NANAIMO THE HARBOUR CITY

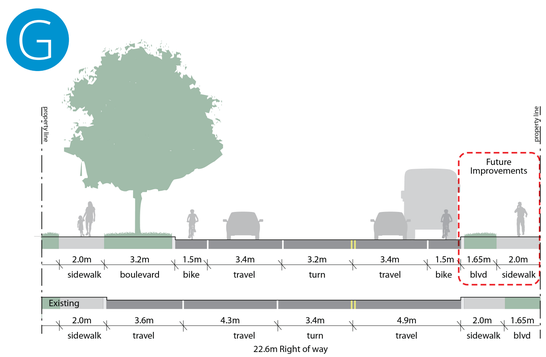
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Beaconsfield Road to Second Street







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
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- Multi-Use Pathway
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- Significant Tree (proposed)

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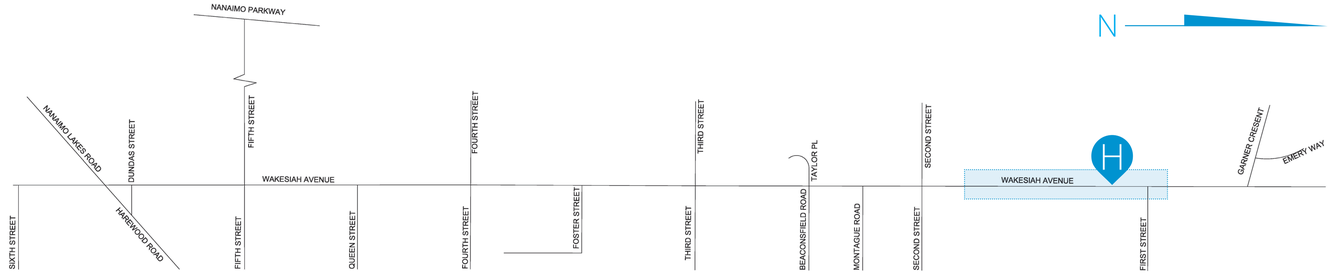
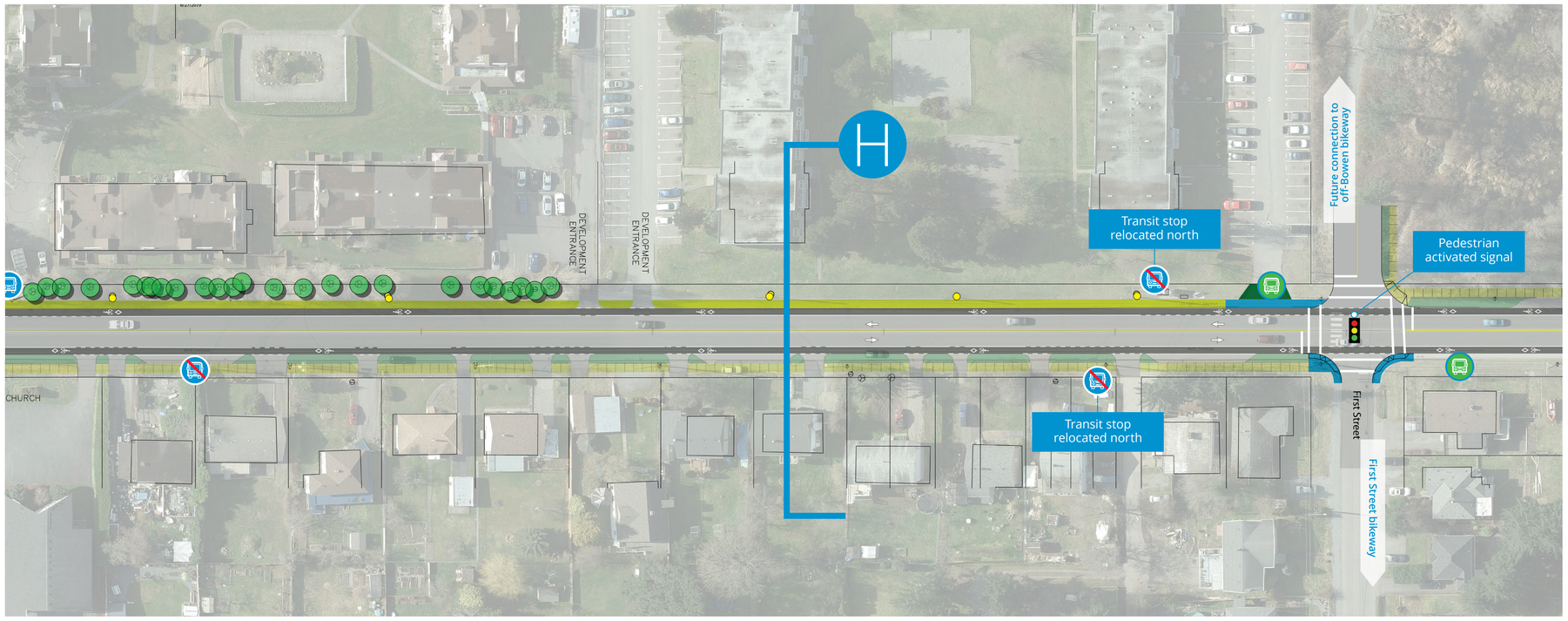
CITY OF NANAIMO THE HARBOUR CITY

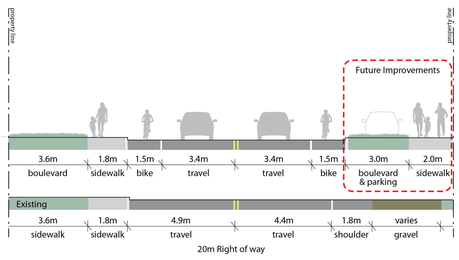
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Second Street to First Street







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
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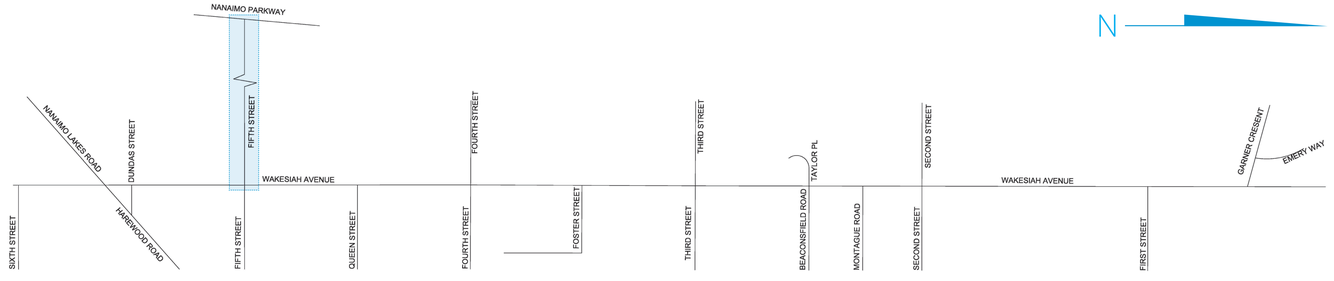
CITY OF NANAIMO THE HARBOUR CITY

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Fifth Street

Wakesiah to Nanaimo Parkway



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PROPOSED 400Ø STORM
(REMOVE AND REPLACE)

PROPOSED 675Ø STORM
(REMOVE AND REPLACE)

PROPOSED 900Ø STORM
(REMOVE AND REPLACE)

WAKESIAH AVE

EX 500ø PVC
EX 800ø ST
EX 200ø AC
EX 250ø PVC
EX 400ø CONC
EX 700ø ST
EX 675ø CMP
EX 200ø AC
EX 675ø CMP
EX 200ø AC
EX 450ø UNK
EX 600ø CMP
EX 600ø CONC
EX 700ø ST
EX 200ø AC
EX 200ø AC

625 396 390 396 384 380 376 370 366 364 623 375 309 326 355 308 306

FOURTH ST

FOSTER ST

END OF PROPOSED 250Ø PVC MAIN

PROPOSED 900Ø STORM
(REMOVE AND REPLACE)

PROPOSED 900Ø STORM (OPTION B)
(REMOVE AND REPLACE)

PROPOSED STORM 900Ø

WAKESIAH AVE

EX 600ø CSP
EX 250ø PVC
EX 250ø PVC
EX 600ø CONC
EX 600ø CMP
EX 600ø CMP
EX 700ø ST
EX 700ø ST
EX 150ø AC
EX 200ø AC
EX 200ø AC
EX 525ø CSP
EX 525ø
EX 150ø PVC
EX 200ø AC
EX 150ø PVC
EX 250ø PVC
EX 200ø AC
EX 150ø PVC
EX 200ø PVC
EX 150ø PVC
EX 1050ø CONC
EX 300ø PVC

715 711 712 716 273 266 262 304 302 290 270 230 228 226 697 695 303 5

THIRD ST

CONNECT TO E□ISTING

PROPOSED 250Ø PVC MAIN

LEGEND

PRO	E□	
	D	STORM
	W	WATERMAIN
	S	SANITARY
●	⊙	STORM MANHOLE
	⊙	SANITARY MANHOLE
	▨	CATCH BASIN
	•	SANITARY CLEANOUT
	•	STORM CLEANOUT
⋈	⋈	WATER VALVE
	⊙	HYDRANT

P:\476764 - CON-WAKESIAH CORRIDOR PLAN\DWGS\476764 CONCEPTUAL DESIGN

4:30:201□

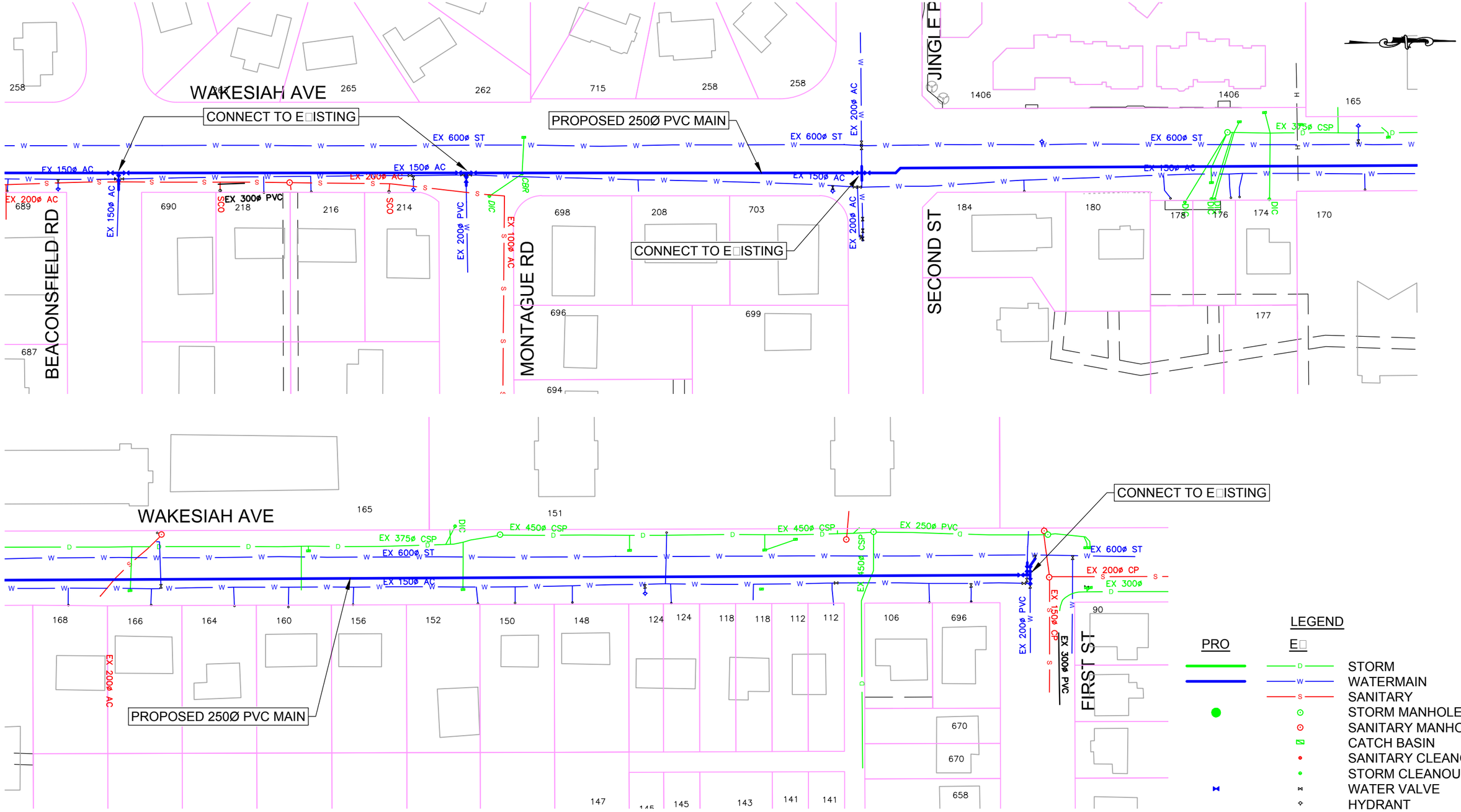
PROPOSED PIPE LENGTHS
950m OF 250Ø PVC WATERMAIN
277m OF 900Ø PVC STORM MAIN
137m OF 675Ø PVC STORM MAIN
93m OF 400Ø PVC STORM MAIN

Design □y	Date
MH	30:04:201□
Drawn □y	
PB	30:04:201□
Checked □y	
Approved □y	

CITY OF NANAIMO
THE HARBOUR CITY

Scale
Hori□ 1:1000 Vert.
Cost Center
Sheet 1 o□2
Eng File No.
Dwg No.

Pro□ect
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS
Title
UTILITY UPGRADES CONCEPTUAL DESIGN



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4.30.201□

Design □y MH Date 30/04/201□

Drawn □y PB 30/04/201□

Checked □y

Approved □y

CITY OF NANAIMO
THE HARBOUR CITY

Scale
Hori□ 1:1000 Vert.

Cost Center

Sheet 2 o□2

Eng File No.

Dwg No.

Pro□ect
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Title
UTILITY UPGRADES CONCEPTUAL DESIGN

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Sixth Street (Colliery Dam Park Entrance) to Fifth Street

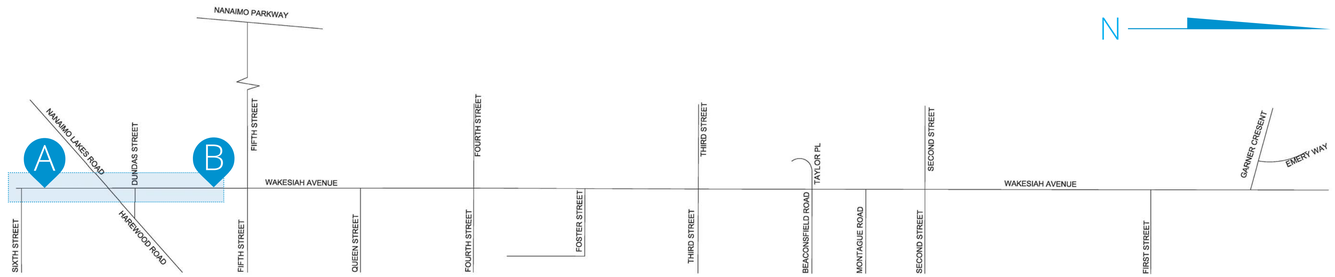
PBX ENGINEERING

18073 -
WAKESIAH CORRIDOR IMPROVEMENTS

DATE: 04/29/2019

SHEET 1 OF 7

LIGHTING CONCEPT



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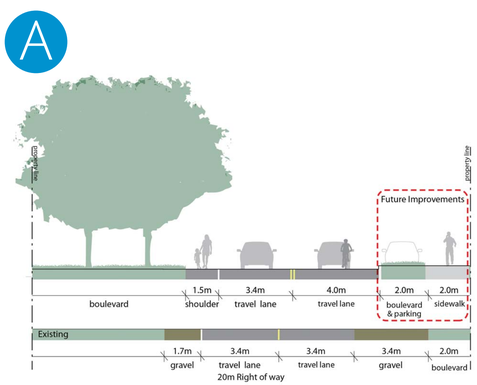

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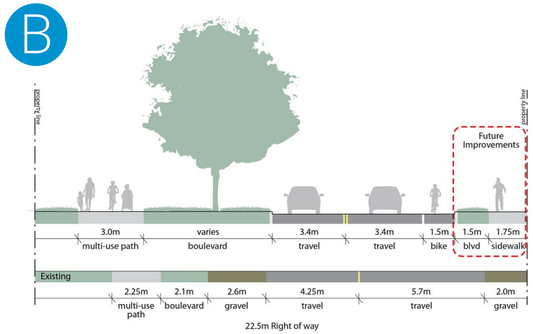

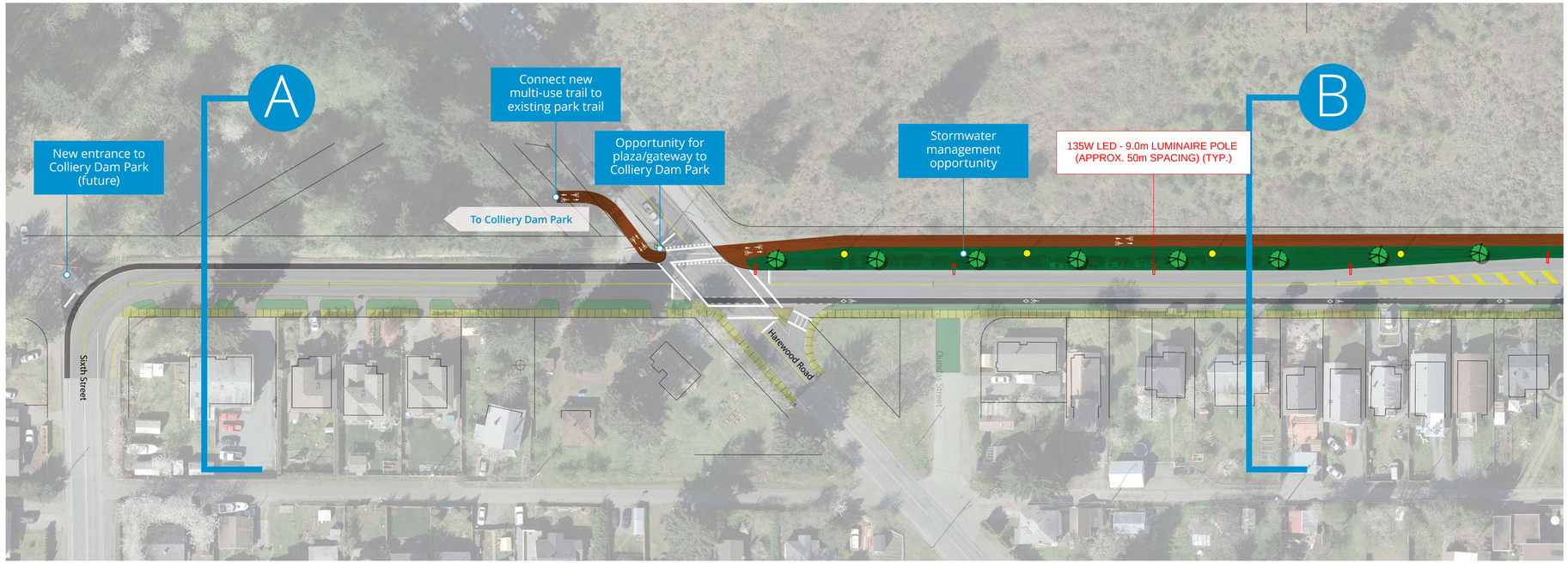

LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)

LUMINAIRE POLE
(STREET LIGHTING - PBX CONCEPT)

PARSONS

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CITY OF NANAIMO THE HARBOUR CITY

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Fifth Street to Queen Street

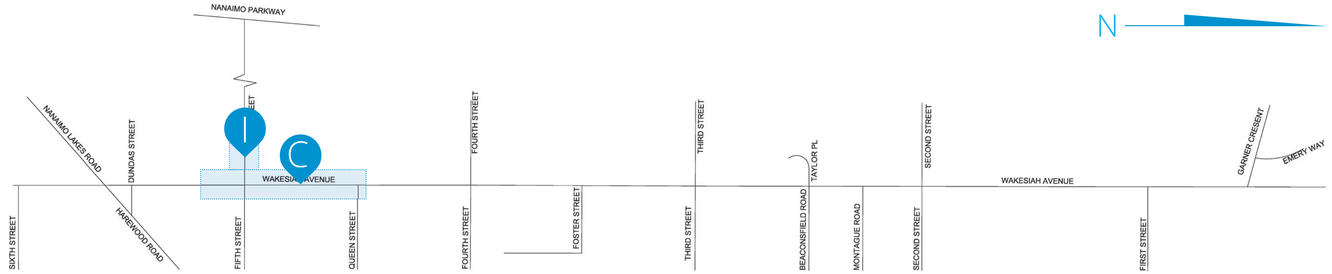
PBX ENGINEERING

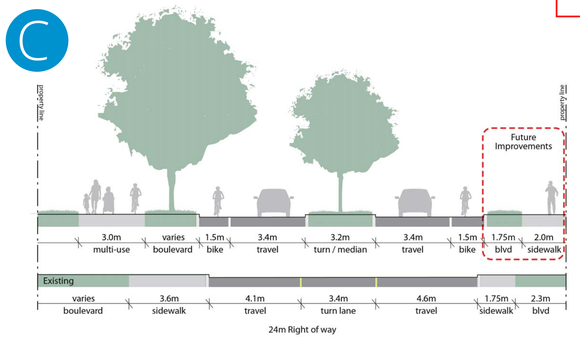
18073 -
WAKESIAH CORRIDOR IMPROVEMENTS

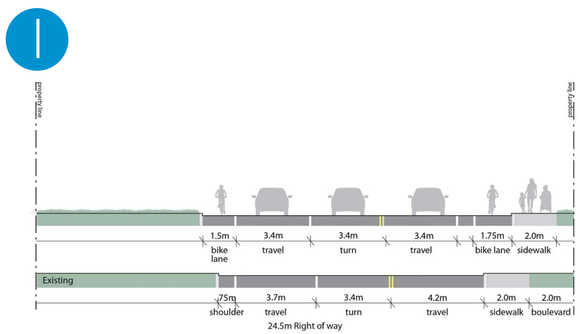
DATE: 04/29/2019

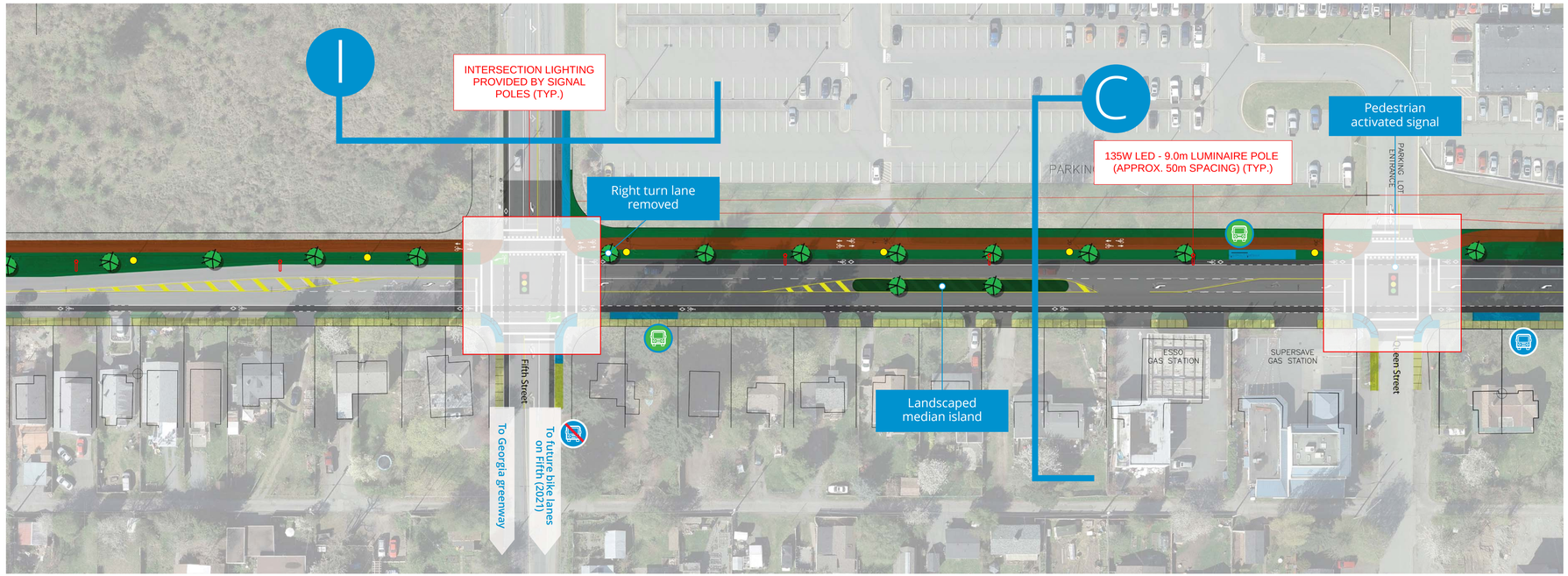
SHEET 2 OF 7

LIGHTING CONCEPT









LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
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- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)
- LUMINAIRE POLE (STREET LIGHTING - PBX CONCEPT)

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CITY OF NANAIMO THE HARBOUR CITY

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Queen Street to Fourth Street

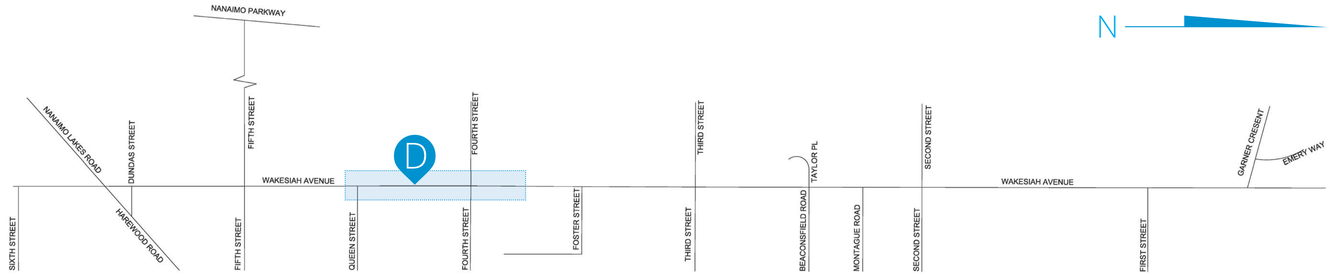
PBX ENGINEERING

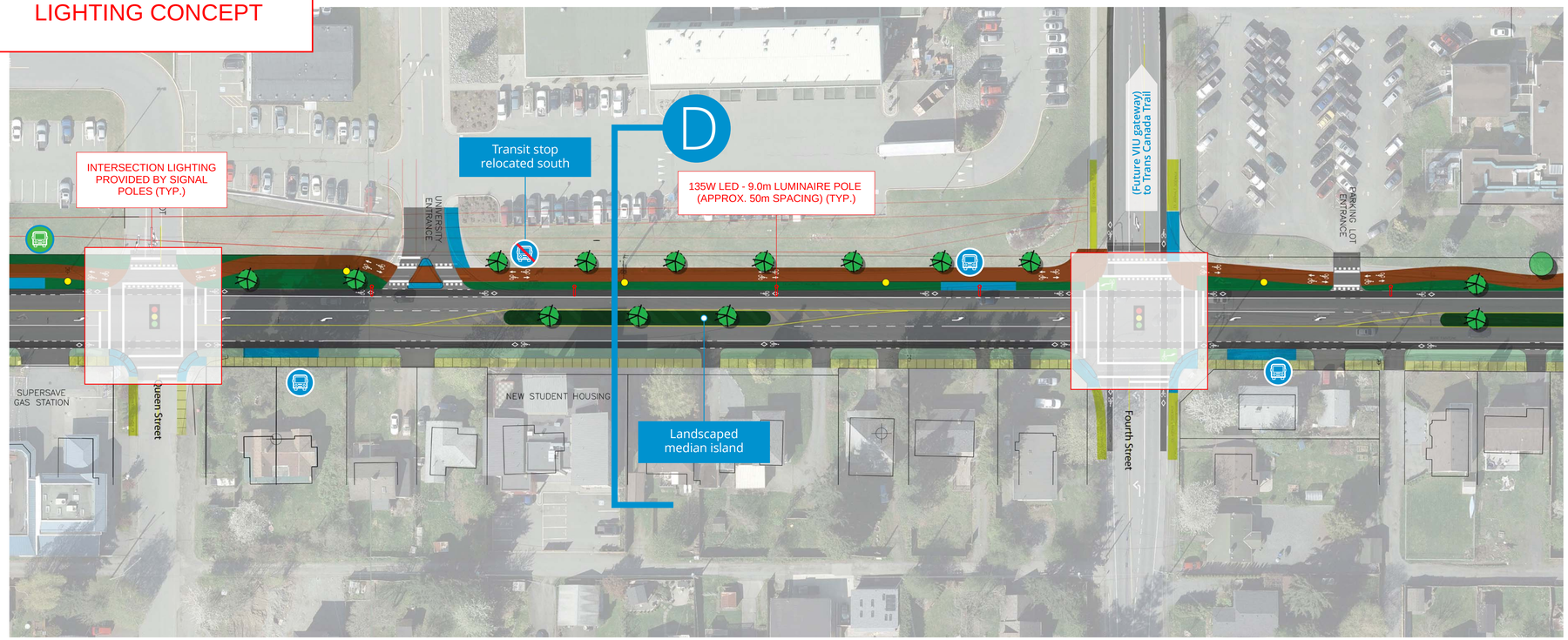
18073 -
WAKESIAH CORRIDOR
IMPROVEMENTS

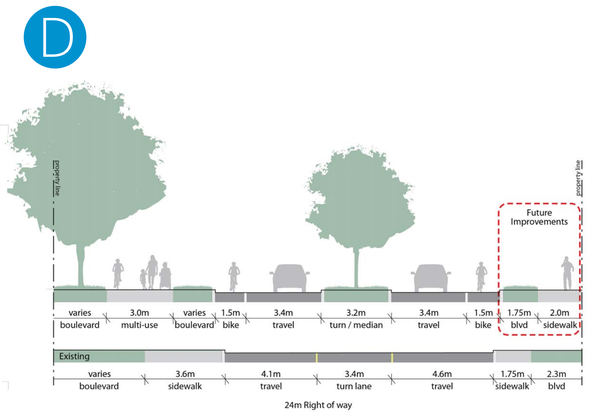
DATE: 04/29/2019

SHEET 3 OF 7

LIGHTING CONCEPT







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
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LUMINAIRE POLE
(STREET LIGHTING - PBX CONCEPT)

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CITY OF NANAIMO THE HARBOUR CITY

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Fourth Street to Third Street

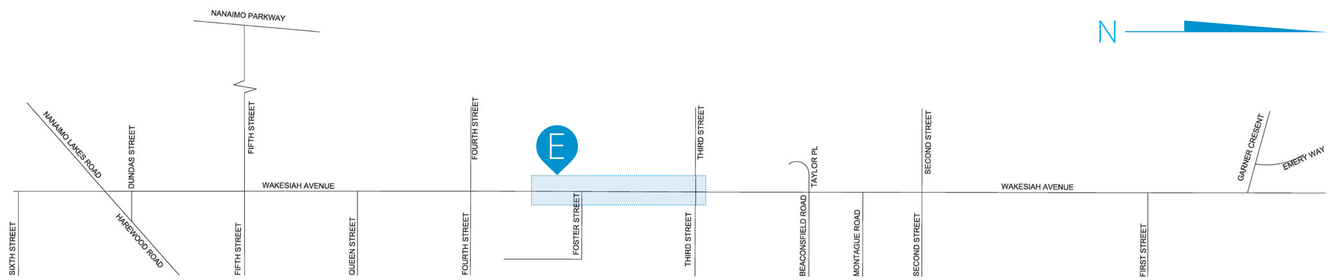
PBX ENGINEERING

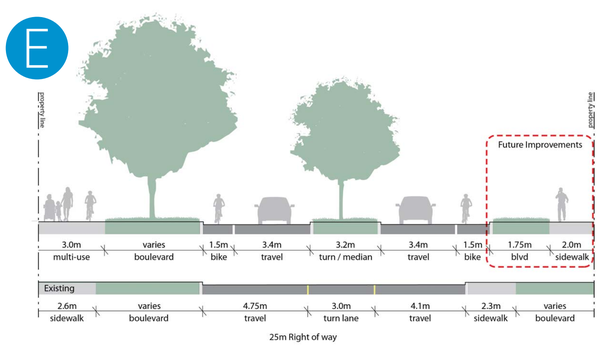
18073 -
WAKESIAH CORRIDOR
IMPROVEMENTS

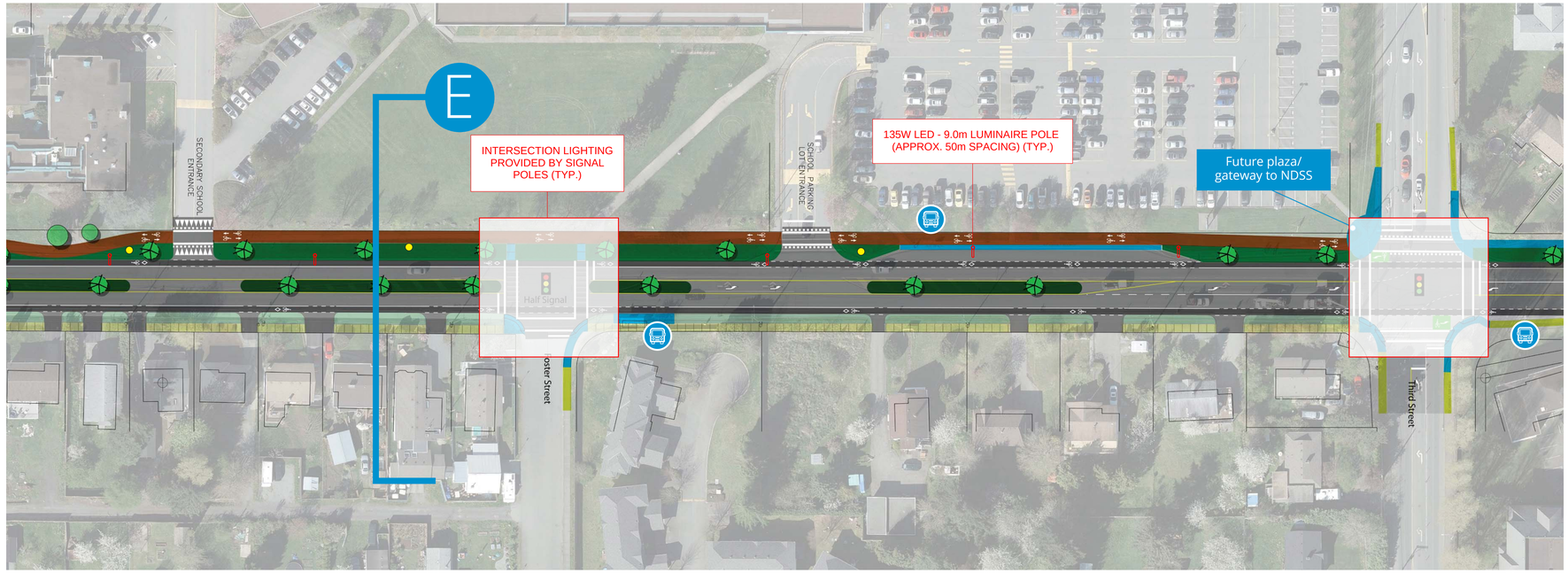
DATE: 04/29/2019

SHEET 4 OF 7

LIGHTING CONCEPT







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
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- Significant Tree (proposed)

LUMINAIRE POLE
(STREET LIGHTING - PBX CONCEPT)

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CITY OF NANAIMO THE HARBOUR CITY

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Third Street to Beaconsfield Road

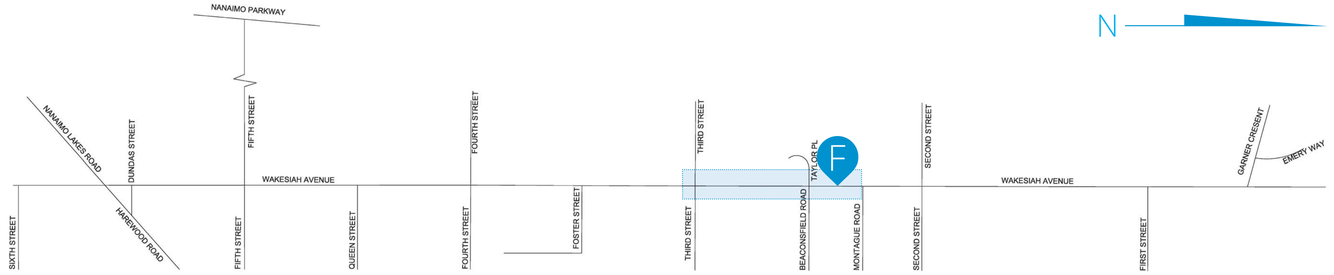
PBX ENGINEERING

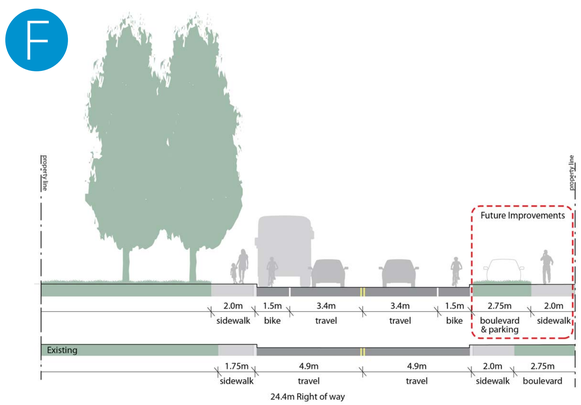
18073 -
WAKESIAH CORRIDOR IMPROVEMENTS

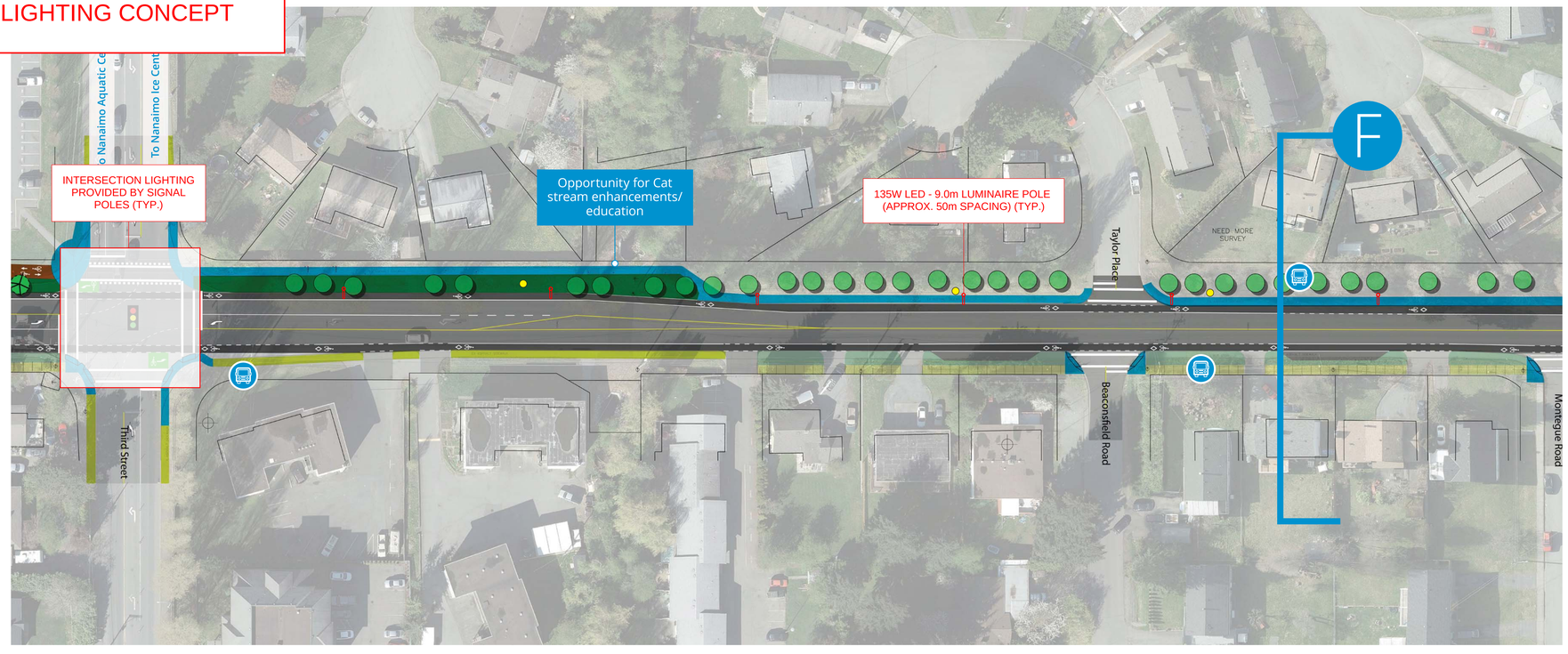
DATE: 04/29/2019

SHEET 5 OF 7

LIGHTING CONCEPT







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
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LUMINAIRE POLE
(STREET LIGHTING - PBX CONCEPT)

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CITY OF NANAIMO
THE HARBOUR CITY

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Beaconsfield Road to Second Street

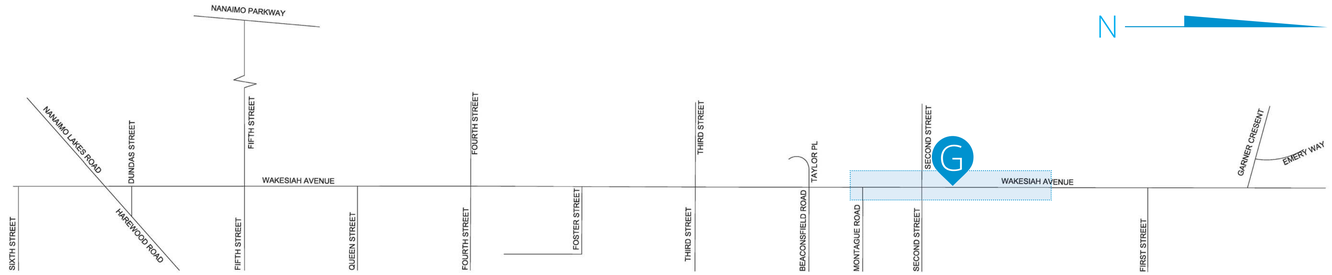
PBX ENGINEERING

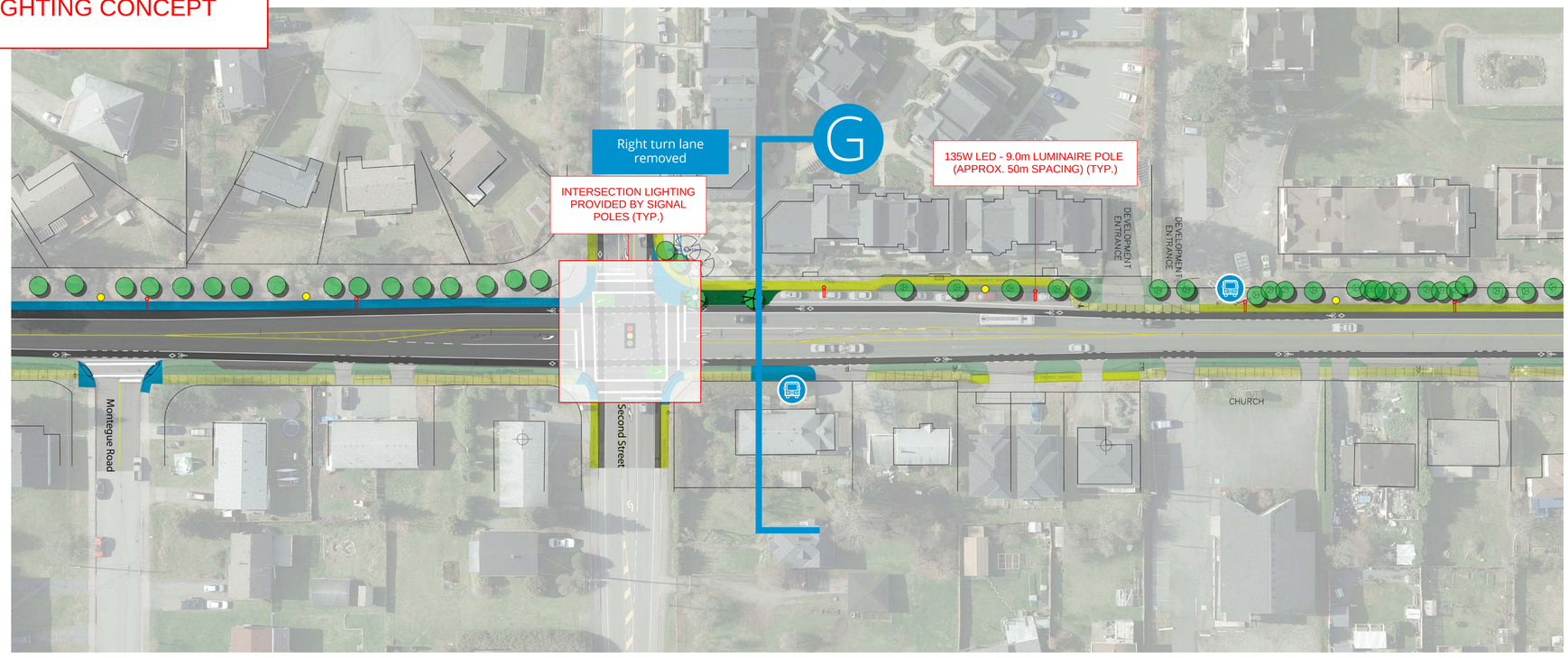
18073 -
WAKESIAH CORRIDOR
IMPROVEMENTS

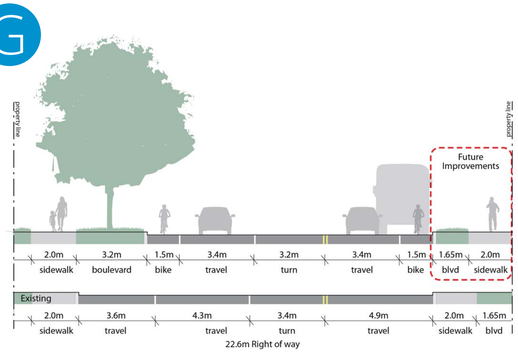
DATE: 04/29/2019

SHEET 6 OF 7

LIGHTING CONCEPT







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
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- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
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LUMINAIRE POLE
(STREET LIGHTING - PBX CONCEPT)

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CITY OF NANAIMO THE HARBOUR CITY

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Wakesiah Avenue

Second Street to First Street

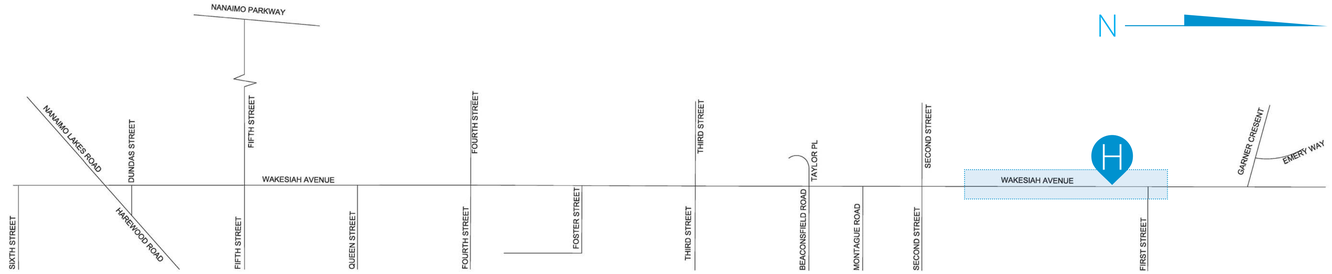
PBX ENGINEERING

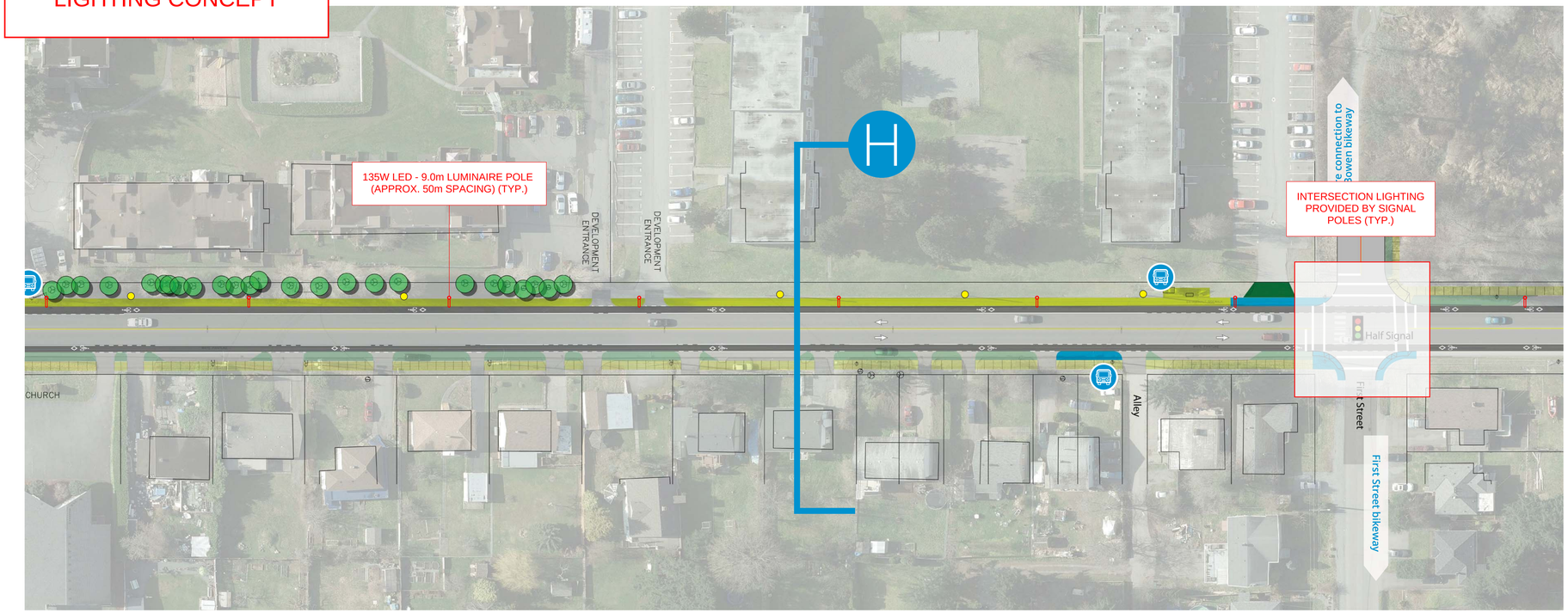
18073 -
WAKESIAH CORRIDOR
IMPROVEMENTS

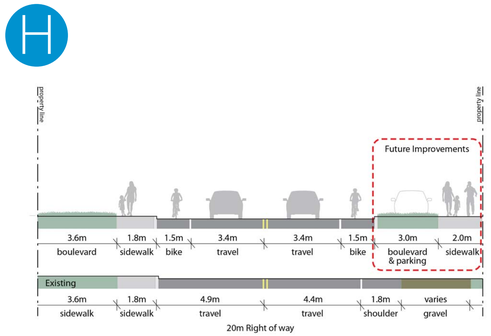
DATE: 04/29/2019

SHEET 7 OF 7

LIGHTING CONCEPT







LEGEND

- Pavement Resurfacing
- Dedicated Bicycle Lane
- Bicycle Turn Box
- Street Light
- Existing Bus Stop
- Relocated Bus Stop
- Concrete Sidewalk (current/future)
- Existing Sidewalk to Remain
- Multi-Use Pathway
- Greenspace (current/future)
- Significant Tree (existing)
- Significant Tree (proposed)
- LUMINAIRE POLE (STREET LIGHTING - PBX CONCEPT)

PARSONS

alta PLANNING + DESIGN

CITY OF NANAIMO THE HARBOUR CITY

Appendix B Geotechnical Report

Wakesiah Avenue and Fifth Street Corridor Improvements Nanaimo, BC

PRESENTED TO

The City of Nanaimo c/o Parsons Corporation

JULY 31, 2018
ISSUED FOR REVIEW
FILE: 704-ENG.VGEO03461-01

This document has been “Issued for Review” to allow the client/design team to review and provide comments back to Tetra Tech Canada Inc. This document is subject to revision based on input received and therefore any decisions based on this unsigned document should be reviewed in relation to the subsequent “Issued for Use” document.

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the City of Nanaimo, Parsons Corporation and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the City of Nanaimo and Parsons Corporation or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the City of Nanaimo (the City) c/o Parsons Corporation (Parsons) to undertake pavement evaluation and geotechnical exploration for the proposed corridor improvements of Wakesiah Avenue (from Sixth Street to First Street) and Fifth Street (from Highway 19 to Wakesiah Avenue) in Nanaimo, BC. The scope of work included a drilling exploration program, asphalt coring and Benklemen Beam testing to assess the pavement structure and subsurface conditions of the subject areas of Wakesiah Avenue and Fifth Street.

The project site subject areas of Wakesiah Avenue and Fifth Street are shown in Figure 1.

2.0 PROJECT DESCRIPTION

The Wakesiah Avenue and Fifth Street Corridor Improvements include utility upgrades and road rehabilitation.

The utility upgrades include:

- The replacement of approximately 417 m of storm sewer along Wakesiah Avenue between Fourth Street and the outlet at Cat Stream; and
- The replacement of the existing watermain between Third Street and Montague Road.

Road rehabilitation will follow the City's Manual of Engineering Standards and Specifications (MOESS) and be limited to 75 mm of asphalt overlay on:

- Fifth Street from Wakesiah Avenue to Highway 19;
- Wakesiah Avenue from Second Street to Fourth Street; and
- Other related transportation improvements for pedestrian and cycling lanes from Sixth Street to First Street.

3.0 EXPLORATION PROGRAM

The exploration program consisted of drilling, asphalt coring and Benkelman Beam testing. All Power Traffic Control were engaged to provide traffic control services during the exploration program. Each of the tasks were completed on separate days due to the differing requirements for lane closure and traffic control.

3.1 Drilling Program

The drilling exploration was conducted on June 21, 2018. Twelve boreholes ranging from depths of 0.6 m to 3.1 m were advanced using a truck-mounted, auger rig owned and operated by Drillwell Enterprises Ltd. of Duncan, BC. Borehole locations were generally spaced at 125 m centres, alternating lanes along the subject areas of road rehabilitation and utility upgrades of Wakesiah Avenue and Fifth Street. Final locations were modified based on feedback from the project team and clearance from existing underground utility conflict.

The target depths of the boreholes were 3.0 m for the purpose of reviewing pavement construction and subsurface conditions for typical trench excavations of 1.5 m to 2.5 m. Some boreholes that encountered refusal on possible bedrock, boulders or very dense soils were terminated at shallower depths. Grab samples of select soils were collected for further characterisation and index testing.

Boreholes were backfilled with cuttings upon completion and capped with cold asphalt mix. A handheld GPS was used to measure borehole locations with an estimated accuracy of +/- 5 m. Northings and Eastings for each borehole are shown on the borehole logs in Appendix B.

A summary of the boreholes completed is presented in Table 1 below.

Table 1: Borehole Summary

Borehole	Road	Lane	Asphalt Thickness (mm)	Completion Depth (m)	Comments
BH18-01	Fifth Street	EBL	50	1.5	Completed within the shoulder
BH18-02	Fifth Street	EBL	100	1.5	
BH18-03	Fifth Street	EBL	90	1.5	
BH18-04	Fifth Street	EBL	90	1.2	
BH18-05	Wakesiah Ave	NBL	60+50*	2.5	Slight hydrocarbon odour at ~0.8 m
BH18-06	Wakesiah Ave	NBL	30+150*	1.6	2nd asphalt layer (40 mm thick) at 0.25 m depth
BH18-07	Wakesiah Ave	NBL	75+30*	3.1	2nd asphalt layer (50 mm thick) at 0.25 m depth
BH18-08	Wakesiah Ave	NBL	40	3.1	
BH18-09	Wakesiah Ave	SBL	120	0.6	2nd asphalt layer (100 mm thick) at 0.3 m depth
BH18-9A	Wakesiah Ave	NBL	120	3.1	2nd asphalt layer (100 mm thick) at 0.3 m depth
BH18-10	Wakesiah Ave	NBL	65	3.1	
BH18-11	Wakesiah Ave	NBL	70	3.1	

*Indicates immediate underlying asphalt layer

3.2 General Visual Condition Assessment

Overall the pavement surface was in fair condition with respect to surface distresses. Intermittent low to moderate severity longitudinal cracking, meandering cracking, and alligator cracking was observed on both road sections being considered for rehabilitation. Localized areas of poor condition with moderate to high severity alligator cracking were observed on Wakesiah Avenue, particularly near the NDSS School crossing (near Foster Street) and 384 Wakesiah Avenue. Existing utility trenches also appear to have created some depressions on the southbound lane of Wakesiah Avenue.

The pavement appears to be somewhat maintained through the use of crack sealant and patching.

3.3 Benkelman Beam Testing

Pavement testing using a Benkelman Beam was completed on July 3, 2018 on both Wakesiah Avenue (from First Street to Sixth Street) and Fifth Street (from Highway 19 to Wakesiah Avenue). Tests were alternated from inside to outside wheel path locations at approximately 60 m intervals. A weighted truck with an 80 kN single axle load was used to complete the testing. The results of the Benkelman Beam testing were corrected for seasonal temperature and are summarized in Table 2 below. Detailed results are included in Appendix D.

Table 2: Benkelman Beam Testing Summary

Road	Lane	Classification	Allowable Max Deflection	Tested Rebound Deflection
Wakesiah Avenue	NBL	Major Collector	1.25 mm	0.74 mm
Wakesiah Avenue	SBL	Major Collector	1.25 mm	0.83 mm
Fifth Street	EBL	Arterial	0.75 mm	0.37 mm
Fifth Street	WBL	Arterial	0.75 mm	0.71 mm

The tested rebound deflections were below the allowable deflections for the classifications outlined in the City of Nanaimo Manual of Engineering Standards and Specifications, Section 9.06 Minimum Base and Pavement Strengths.

3.4 Asphalt Coring

Asphalt coring was completed at 25 locations along Wakesiah Avenue and Fifth Street. Locations were typically at 100 m centres on alternate lanes. The coring was completed using a coring rig with a 4" (10 cm) coring barrel advanced between wheel paths in each lane. Core samples were retrieved and collected for future reference or testing, if required. Core samples and cored hole depths were then measured for confirmed asphalt thickness. Holes were then patched and levelled with cold mix asphalt patch repair.

Tables 3 and 4 summarize the asphalt coring completed for this exploration.

Table 3: Asphalt Coring Summary – Wakesiah Avenue

Core No.	Lane	Location	Thickness (mm)	Core No.	Lane	Location	Thickness (mm)
1	NBL	10 m South off Dundas Street	101	**11**	SBL	Adjacent to Entrance to 149-155 Wakesiah Ave.	93
2	NBL	15 m South of Fifth Street	88	**12**	SBL	Across from 164 Wakesiah Ave.	76
3	NBL	38 m South of Queen Street	57	**13**	SBL	10 m South of Second Street	80
4	NBL	15 m South of Fourth Street	95	**14**	SBL	3 m North of Taylor Place	77
5	NBL	18 m South of Entrance to NDSS	112	**15**	SBL	10 m South of Third Street	139
6	NBL	8m North of Driveway at 290 Wakesiah Ave.	113	**16**	SBL	Adjacent to Entrance to School Board	106
7	NBL	216 Wakesiah Ave.	92	**17**	SBL	Across from 442 Wakesiah Ave.	114
8	NBL	25 m North of Second Street	123	**18**	SBL	Across from 520 Wakesiah Ave.	95

Core No.	Lane	Location	Thickness (mm)	Core No.	Lane	Location	Thickness (mm)
9	NBL	156 Wakesiah Ave.	72	**19**	SBL	13 m North of Nanaimo River Road	79
10	NBL	112 Wakesiah Ave.	123	**20**	SBL	Centreline at Sixth Street	90

Table 4: Asphalt Coring Summary – Fifth Street

Core No.	Lane	Location	Thickness (mm)
21	WBL	30 m East of Entrance to Navy League	81
22	WBL	27 m East of Entrance to Lot 5C	91
23	WBL	27 m West of west end of Island at top of hill	55
24	EBL	Across from Arts and Humanities Building	111
25	EBL	Across from SW Corner of Navy League Building	92

3.5 Laboratory Testing

Selected soil samples collected were tested at Tetra Tech's laboratory in Nanaimo for further characterization. The results of this testing have been included in the borehole logs and are attached as Appendix C.

Laboratory testing was focused on sieve analysis of select base course material to confirm gradations and fines contents. Samples generally confirmed well graded gravel and sand with trace (less than 10% by weight) fines. A sample tested from BH18-10 indicated a fines content of 11.9 % which could indicate additional fines have migrated into the base course, which could be a contributing factor to the pavement distress observed at surface.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

More detailed descriptions of the soils are given in the borehole logs included in Appendix B. A brief summary of the encountered soil conditions for Wakesiah Avenue and Fifth Street is described below.

4.1.1 Wakesiah Avenue

Subsurface conditions generally comprised of asphalt with varying thickness overlaying well graded gravel and sand crush. A secondary asphalt layer was encountered below the pavement basecourse, in several boreholes (BH18-06, BH18-07, BH18-09 and BH18-09A), about 0.3 m below road surface.

Below the secondary asphalt layer or the well graded gravel and sand crush base course material, the subgrade conditions generally varied from sand and gravel to silty sand. An anomaly was BH18-10 which encountered sand and silt from 0.8 m to 0.9 m below road surface, underlain with organic silt from 0.9 m to 1.2 m depth. Varying sands and silts continued to be encountered through to end of borehole depth at 3.1 m.

4.1.2 Fifth Street

Subsurface conditions along Fifth street generally comprised of asphalt with varying thickness overlying a well graded gravel and sand base course, overlying sand with some silt or gravelly sand subgrade stratums. The granular soils below the asphalt surface were generally inferred to be dry to damp and compact to dense.

Due to time constraints, two borehole locations proposed on the WBL of Fifth Street were not able to be completed.

4.2 Groundwater Conditions

During the June 2018 drilling exploration, no groundwater seepage was encountered at any testhole location through to completed depths. Wet sand and moist silts were encountered in BH18-10 where some seepage would be expected if left exposed for a longer period of time than that of a borehole exploration.

5.0 RECOMMENDATIONS

5.1 Utility Construction

5.1.1 Temporary Slopes and Excavation

Open trench excavations extending to depths of 1.5 m to 2.5 m are anticipated for utility construction. All excavation slopes must comply with Work Safe BC requirements. The following recommendations notwithstanding, the responsibility of trench and all excavation cut slopes resides with the contractor and should take into consideration site-specific conditions concerning soil stratigraphy and groundwater.

With regards to temporary excavations in relation to service installation, the following comments regarding temporary slopes and excavations are provided below:

- For utility trenches located within the road alignment, trench shoring is recommended to maintain the stability of granular soil layers and prevent sloughing from undermining existing pavement sections. We also recommend that the edge of the trenches be saw cut to ensure a clean vertical edge for the new pavement to butt against;
- Without trench shoring, typical temporary slopes in granular soils can be as flat as 1H:1V. Slopes for excavations should be based on site conditions at the time of excavation with inspection and approval being required by a geotechnical engineer (if required);
- Excavations of approximately 1.5 m to 2.5 m in-depth are expected to be relatively dry if completed during summer months. However, some groundwater seepage could be encountered in the lower depths of the trench excavations in some areas depending on seasonal weather;
- Refusal on a potential boulder was encountered in BH18-09 at a depth of 0.6 m. In BH18-06, refusal was met at a depth of 1.6 m which could indicate a possible boulder or bedrock; and
- Any shoring carried out must be in good practice and done in accordance with WorkSafe BC.

5.1.2 Trench Bottom

Boreholes completed along proposed utility alignments general indicate compact to dense granular soils will be encountered at trench bottom elevations between 1.5 m to 3.0 m. The exception is BH18-10 which will likely encounter silt and silty sands, depending on the required trench depth. The silts encountered were generally firm to stiff and would provide a suitable trench subgrade, however, these soils are indicative of fluvial deposits in the area and some potential soft spots could be encountered.

If areas of soft soils are encountered, the trench foundation should be assessed by a geotechnical engineer, and, if necessary, sub-excavated to the depth determined by the geotechnical engineer and backfilled with 19 mm clear crush.

If 19 mm clear crush is used in the sub-excavation, we recommend that the clear crush should be wrapped in geotextile. A non-woven geotextile with a tensile strength of 750 N and an “Apparent Opening Size” of 0.212 mm would be recommended (geotextile #4551 as supplied by Nilex would be satisfactory).

5.1.3 Dewatering During Excavation

During the June 2018 drilling exploration, no groundwater seepage was encountered at any testhole location through to completed depths. The wet sands and moist silts could indicate a conduit of groundwater movement which, if left open during trench like excavations, could experience some seepage.

If excavations extend beyond anticipated depths of 1.5 m to 3.0 m, some groundwater seepage could also be encountered.

Tetra Tech recommends that construction be completed during summer to minimize impacts that groundwater could create during construction and working with open excavations.

If seepage is encountered, it may be appropriate to deal with this using proper construction techniques and local sump pumps. Completing the excavation and utility installation quickly and using coarser bedding sand could be considered as a method to reduce difficulties where seepage is encountered.

5.1.4 Backfill

All trench backfill must be approved and placed in layers in accordance with good industry-standard construction practices and must meet the City’s specifications, including pipe bedding. Compaction must be confirmed by field density testing. In accordance with the City’s specifications, trench backfill maybe either; approved native material, imported granular fill or controlled density fill.

As per the City’s specifications, the minimum compaction level is 95% of Modified Proctor Maximum Dry Density (MMDD). In areas that will be paved, the compacted thickness of each lift of backfill should not exceed 250 mm; however, an acceptable lift thickness should be determined by the field compaction tests.

Some settlement of the backfill should be expected, even in areas where backfill compaction meets the specification and where the trench bottom is on competent material. Such settlement is typically in the order of 0.5% to 1% of backfill thickness, based on Tetra Tech’s previous experience. Considerations such as to delay paving can help avoid trench settlement affecting the final pavement surface. The ultimate performance of the trench backfill and overlying pavement is directly related to the uniformity of the backfill compaction. In order to achieve uniformity and minimise settlement, the lift thickness and compaction criteria should be strictly enforced.

If the gradation of the backfill material is not compatible with the native soils, to prevent the migration of fines, a nonwoven geotextile (Nilex 4551 or similar approved) should be placed around the trench fill material. This should be assessed during construction.

5.1.4.1 Native Material

Because conditions of actual trench excavations are variable from the locations drilled during the exploration, any excavated material considered for reuse as backfill should be confirmed by the geotechnical engineer prior to placement and compaction.

5.1.4.2 Imported Granular Fill

Where the material excavated from the trench is unsuitable, imported granular fill should be used. Imported granular fill should consist of well graded granular material, with not more than 8% passing the 0.075 mm sieve, which contains no particle larger than 150 mm in diameter and contains no deleterious material, per the City's specification.

5.2 Road Rehabilitation

Based on the Benkelman Beam deflection testing completed on July 3, 2018, Wakesiah Avenue and Fifth Street currently met their designated rebound deflection performance criteria as indicated in Table 2.

It is understood the road rehabilitation will follow the City MOESS and include up to 75 mm of asphalt overlay.

It is recommended that areas exhibiting high severity fatigue cracking be treated by deep patch repair. Areas of note include (but not limited to) depressions observed in existing utility trenches, alligator cracking near the NDSS crossing, and near 384 Wakesiah Avenue. Depressions in some of the existing utility trenches are anticipated to be remedied during the upgrades. If the upgrades are to be completed offline of the existing utility trenches, some patch repairs for areas exhibiting distress should be considered.

At a minimum, the deep patch repairs should include the removal of the entire existing asphalt. The exposed granular base should be evaluated for signs of softening or contamination with fines. If the exposed granular material is determined to be unsatisfactory, it is recommended that the existing poor quality material be sub-excavated to a minimum depth of 300 mm and replaced with new imported crushed granular base course material on top of a non-woven geotextile. The asphalt pavement should then be replaced to the same thickness as the adjacent asphalt. The localized repair sites should be pre-marked in the field and repairs completed prior to rehabilitating the roadway.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

ISSUED FOR REVIEW

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FIGURES

LEGEND

Borehole Location

0 250m

Scale: 1:5,000 @ 11"x17"

CLIENT

CITY OF NANAIMO
THE HARBOUR CITY

TETRA TECH

WAKESIAH AVENUE AND FIFTH STREET CORRIDOR PLAN NANAIMO, BC

Testhole Location Plan

PROJECT NO.	DWN	CKD	REV
VGEO03461-01	IK	AW	0

OFFICE	DATE
Nanaimo	July 28, 2018

Figure 1

Q:\Nanaimo\Engineering\704-ENG.VGEO03461-01 Wakesiah Avenue Corridor Plan\ENG.VGEO03641-01.dwg [FIGURE 1] July 31, 2018 - 12:12:15 pm (BY: KITCHINGMAN, ISAAC)

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

APPENDIX B

BOREHOLE LOGS

Borehole No: **BH18-01**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429222 E; 5445067 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (50 mm)					0
	Solid stem auger	GRAVEL and SAND (FILL), trace silt, well graded, angular gravel, damp, dense (inferred), brown		G1	1.6	●	
		SAND, some silt, some gravel, damp, compact to dense (inferred), brown; cobble inclusions		G2	4.7	●	1
1							2
							3
							4
		End of borehole at 1.5 m - dry at completion - backfilled with cuttings and patched with cold mix asphalt					5
2							6
							7
							8
							9
3							10
							11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 1.5 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-02**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429497 E; 5445167 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (100 mm)					0
	Solid stem auger	SAND and GRAVEL (FILL) trace silt, well graded, damp, dense(inferred), brown		G1	2.5	●	1
		- gravelly; trace cobbles to 75 mm					2
1		SAND, some silt, trace gravel, damp, compact to dense (inferred), brown		G2	13.6	●	3
		- trace to some silt, damp, dense to very dense (inferred), brown					4
		End of borehole at 1.5 m - dry at completion - backfilled with cuttings and patched with cold mix asphalt					5
2							6
							7
							8
							9
3							10
							11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 1.5 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-03**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429643 E; 5445155 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0							0
	Solid stem auger	ASPHALT (90 mm)					
		GRAVEL and SAND (FILL), trace silt, angular gravel, damp, dense (inferred) grey					
		- gravelly		G1	2.5	●	1
				G2	2.6	●	2
1		SAND. gravelly, trace to some silt, damp, dense (inferred), brown					3
							4
		End of borehole at 1.5 m - dry at completion - backfilled with cuttings and patched with cold mix asphalt					5
2							6
							7
							8
							9
3							10
							11
							12
4							13
							14
							15
							16
5							

TETRA TECH

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 1.5 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-04**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429853 E; 5445148 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0							0
	Solid stem auger	ASPHALT (90 mm)					
		SAND (FILL), gravelly, trace silt, damp very dense (inferred), brown; cemented structure					
		SAND and GRAVEL (FILL), trace silt, well graded, damp, dense (inferred) dark brown		G1	4.1	●	
		SAND, some gravel trace to some silt, damp, dense to very dense (inferred), brown		G2	4.6	●	
1							1
							2
							3
		End of borehole at 1.2 m - dry at completion - backfilled with cuttings and patched with cold mix asphalt					4
							5
2							6
							7
							8
							9
3							10
							11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 1.2 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-05**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429929 E; 5445648 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (60 mm + 50 m)					0
		GRAVEL and SAND (FILL), trace silt, well graded, subrounded gravel, damp, compact to dense (inferred), brown		G1	3.7		1
		SAND (FILL), silty, some gravel, damp to moist, compact (inferred), mottled grey and brown		G2	14.9		2
1	Solid stem auger	- light brown; slight hydrocarbon odour		G3	17		3
		SAND, some silt, trace gravel, damp, dense (inferred), grey					4
		- very dense (inferred)					5
2							6
							7
							8
		End of borehole at 2.5 m - dry at completion - backfilled with cuttings and patched with cold mix asphalt					9
3							10
							11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 2.5 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-06**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429935 E; 5445902 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (30 mm + 150 mm)					0
	Solid stem auger	GRAVEL and SAND (FILL), trace silt, well graded, angular, damp, compact to dense (inferred), grey					
		ASPHALT (40 mm)					
		SAND (FILL) silty, some gravel, damp, loose to compact (inferred), mottled brown, black and grey		G1	1.7	●	
				G2	12.4	●	
1		SAND, silty, trace gravel, damp, compact to dense (inferred), greyish brown					1
							2
							3
							4
							5
2		End of borehole on possible boulder or bedrock at 1.6 m - smooth drilling with no advancement - sandstone powder observed on drill bit - dry at completion - backfilled with cuttings and patched with coldmix asphalt					6
							7
							8
							9
3							10
							11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 1.6 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-07**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429943 E; 5446349 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (75 mm + 30 mm)					0
		SAND and GRAVEL (FILL), trace silt, well graded, rounded to sub rounded gravel, damp, compact to dense (inferred), grey		G1	5		1
		ASPHALT (50 mm)					
		SAND (FILL), silty, trace gravel, trace organics, damp, loose to compact (inferred), mottled grey, brown and black		G2	21.5		2
		SAND, silty, trace gravel, damp, compact to dense (inferred), brown					3
1	Solid stem auger	- dense (inferred)					4
		- some silt, moist lenses, dense to very dense					5
							6
2							7
							8
							9
3							10
		End of borehole at 3.1 m - dry at completion - backfilled with cuttings and patched with coldmix asphalt					11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 3.1 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-08**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429940 E; 5446177 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (40 mm)					0
		SAND (FILL), gravelly, trace silt, well graded, damp, compact (inferred), brown		G1	3.9	●	1
		SAND (FILL) silty, trace organics, trace gravel, damp to moist, loose to compact (inferred), grey; rootlet inclusions					2
1		- gravelly, some silt; trace hydrocarbon odour; inclusions of asphalt pieces					3
	Solid stem auger	- silty, orange brown					4
							5
2		SAND, some silt, some gravel, damp, dense to very dense (inferred), light brown					6
							7
							8
							9
3							10
		End of borehole at 3.1 m - dry at completion - backfilled with cuttings and patched with coldmix asphalt					11
							12
							13
4							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 3.1 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-09**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429930 E; 5446048 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0	Solid stem auger	ASPHALT (120 mm)					0
		GRAVEL and SAND (FILL), trace silt, well graded, damp, dense (inferred) brown		G1	2.2	●	1
		ASPHALT (100 mm)					
		SAND and GRAVEL (FILL), trace silt, trace cobbles, well graded, damp, dense (inferred) brown					2
		End on probable boulder 0.6 m - dry at completion - backfilled with cuttings and patched with coldmix asphalt - BH18-09A advanced 1.5 m north					3
1							4
							5
							6
2							7
							8
							9
3							10
							11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 0.6 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-09A**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429930 E; 5446050 N; Z

Depth (m)	Method	Soil Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (120 mm)			0
		SAND and GRAVEL (FILL), trace silt, well graded, damp, dense (inferred) brown			
		ASPHALT (100 mm)			
		SAND and GRAVEL (FILL), trace silt, trace cobbles, well graded, damp, dense (inferred) brown			1
1	Solid stem auger				2
					3
		SILT, sandy, damp, firm (inferred), mottled grey and brown			4
		SAND, silty, trace gravel damp, dense (inferred) brown			5
		- some gravel			6
2		- very dense, grey			7
					8
					9
3					10
		End on borehole at 3.1 m - dry at completion - backfilled with cuttings and patched with coldmix asphalt			11
					12
4					13
					14
					15
					16
5					

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Contractor: Drillwell Enterprises Ltd.	Completion Depth: 3.1 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-10**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429924 E; 5445764 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (65 mm)					0
		SAND and GRAVEL (FILL), trace silt, well graded, damp, compact to dense (inferred), brown		G1	4.9	●	
		- trace cobbles					1
							2
		- some silt					
		SAND and SILT, trace gravel, trace organics, damp, to moist, loose to compact (inferred), grey					
1		SILT (ORGANIC), some sand, moist, firm, dark brownish black		G2	58.5	●	3
	Solid stem auger	SAND, some silt, fine to medium, wet, loose (inferred), grey					4
							5
		- silty					6
2							7
		SILT, some sand, trace clay, damp, stiff, low plastic, grey with brown mottling					8
							9
		SAND, silty, trace gravel, damp, very dense (inferred), brown					10
3							11
		End of borehole at 3.1 m - dry at completion - backfilled with cuttings and patched with coldmix asphalt					12
							13
4							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 3.1 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

Borehole No: **BH18-11**

Project: Wakesiah Avenue and Fifth Street Corridor	Project No: 704-ENG.VGEO03461-01
Location: Wakesiah and Fifth Street	
Nanaimo, BC	UTM: 429923 E; 5445682 N; Z

Depth (m)	Method	Soil Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		ASPHALT (50 mm)					0
		SAND and GRAVEL (FILL), trace silt, well graded, damp, compact to dense (inferred), brown		G1	2	●	
		SAND (FILL), silty, trace gravel, damp to moist, loose (inferred), brown		G2	13.9	●	1
							2
		- some gravel, damp, compact to dense (inferred)					
1		- trace silt, dense (inferred)					3
	Solid stem auger	SAND, silty, trace gravel, damp, compact to dense (inferred), brown					4
							5
							6
2		- dense to very dense					7
							8
							9
3							10
		End of borehole at 3.1 m - dry at completion - backfilled with cuttings and patched with coldmix asphalt					11
							12
4							13
							14
							15
							16
5							

Contractor: Drillwell Enterprises Ltd.	Completion Depth: 3.1 m
Drilling Rig Type: Gus Pech GP1300	Start Date: 2018 June 21
Logged By: IK	Completion Date: 2018 June 21
Reviewed By: AW	Page 1 of 1

APPENDIX C

LABORATORY RESULTS

PARTICLE SIZE ANALYSIS REPORT

ASTM C136 & C117

Project: Wakesiah Avenue Corridor Plan

Project Number: 704-ENG.VGEO03461-01

Date Tested: July 26 2018

Borehole Number: BH18-01

Depth: 0.1m

Soil Description: GRAVEL and SAND, trace silt, damp, grey

Cu: 62.7

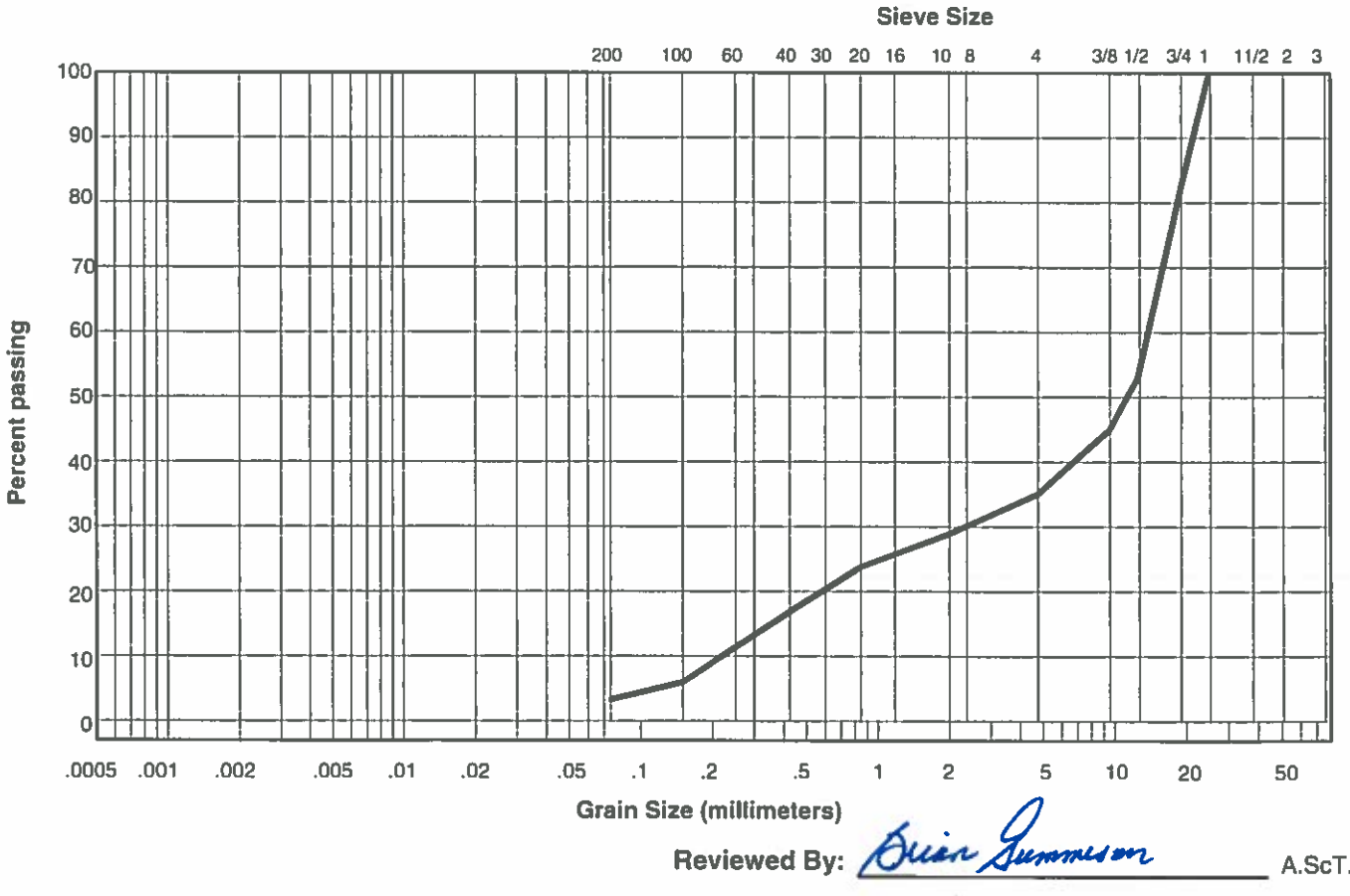
Cc: 1.8

Natural Moisture Content: 2.2%

Remarks:

Sieve Size (mm)	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	100
19.000	82
12.500	53
9.500	45
4.750	35
2.000	29
0.850	24
0.425	17
0.250	11
0.150	6
0.075	3.3

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: Brian Summerson A.ScT.

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PARTICLE SIZE ANALYSIS REPORT

ASTM C136 & C117

Project: Wakesiah Avenue Corridor Plan

Project Number: 704-ENG.VGEO03461-01

Date Tested: July 26 2018

Borehole Number: BH18-03

Depth: 0.2m

Soil Description: GRAVEL and SAND, trace silt, damp, dark grey

Cu: 38.5

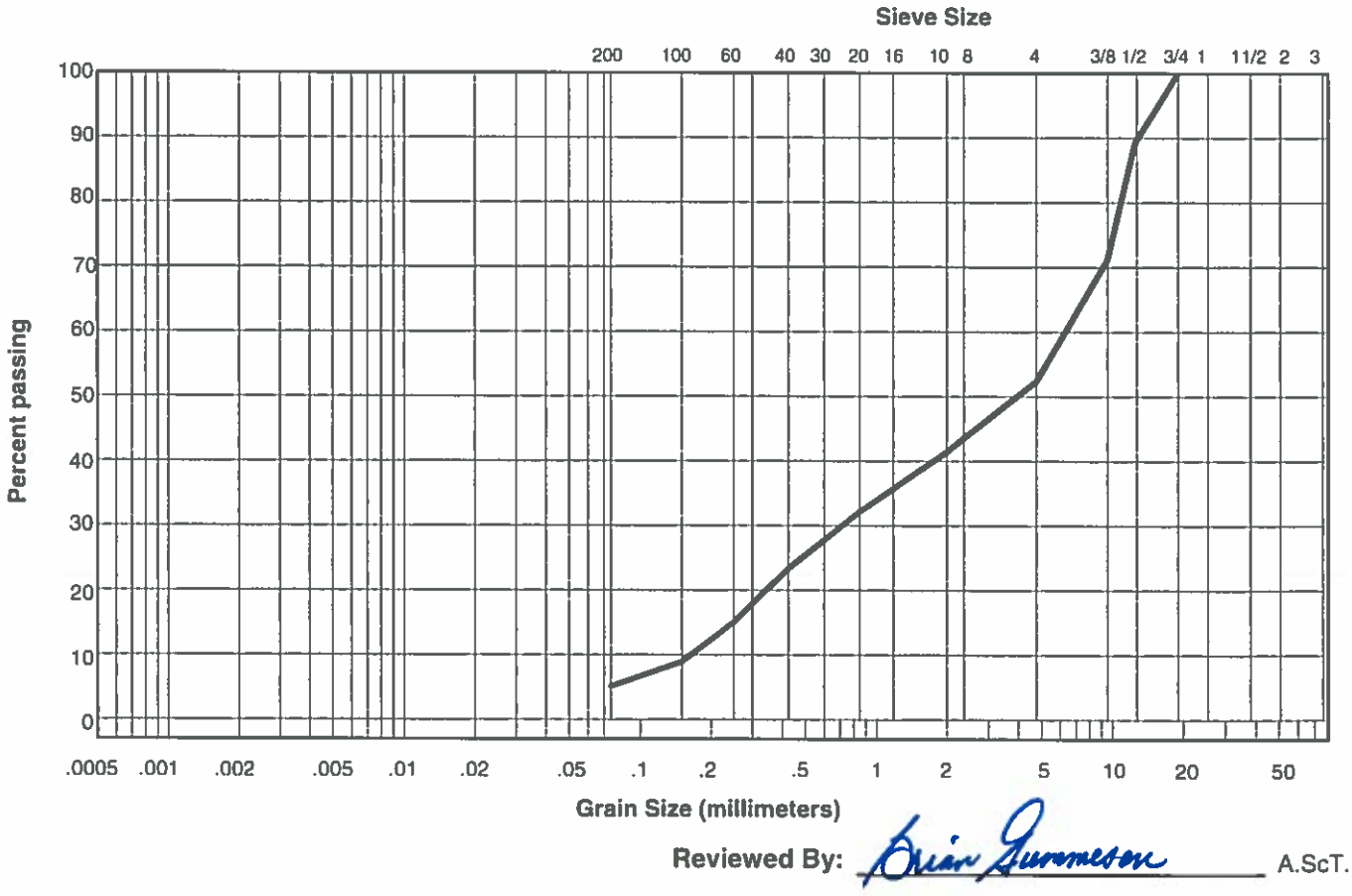
Cc: 0.5

Natural Moisture Content: 2.5%

Remarks:

Sieve Size (mm)	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	#N/A
19.000	100
12.500	89
9.500	71
4.750	52
2.000	41
0.850	32
0.425	23
0.250	15
0.150	9
0.075	5.1

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: Brian Summerson A.ScT.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM C136 & C117

Project: Wakesiah Avenue Corridor Plan

Project Number: 704-ENG.VGEO03461-01

Date Tested: July 26 2018

Borehole Number: BH18-05

Depth: 0.2m

Soil Description: GRAVEL and SAND, trace silt, dry, grey

Cu: 47.5

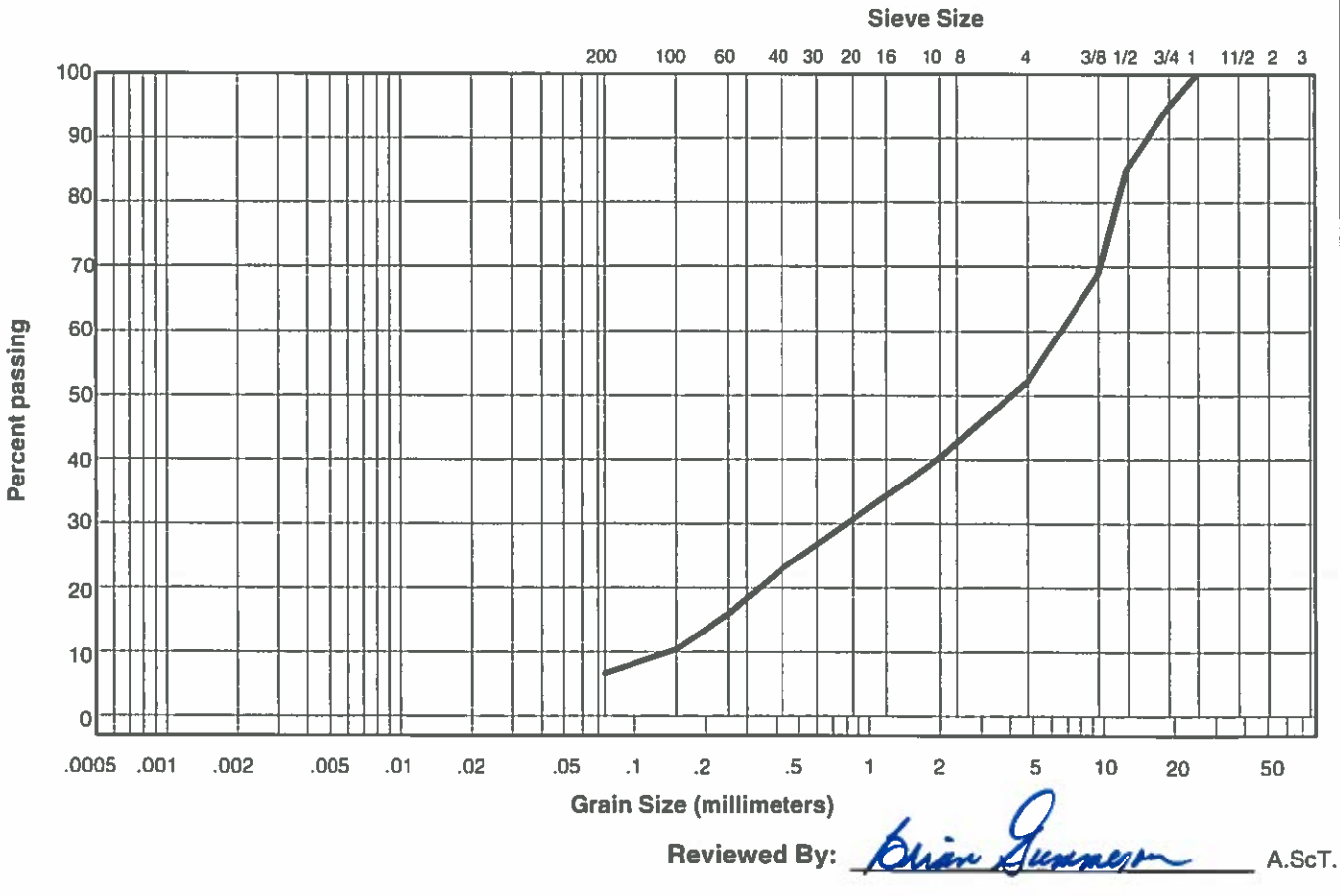
Cc: 0.7

Natural Moisture Content: 3.7%

Remarks:

Sieve Size (mm)	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	100
19.000	95
12.500	85
9.500	69
4.750	52
2.000	40
0.850	31
0.425	23
0.250	16
0.150	10
0.075	6.7

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: Brian Guenzler A.Sc.T.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM C136 & C117

Project: Wakesiah Avenue Corridor Plan

Project Number: 704-ENG.VGEO03461-01

Date Tested: July 26 2018

Borehole Number: BH18-07

Depth: 0.3m

Soil Description: SAND and GRAVEL, trace silt, damp, grey

Cu: 47.4

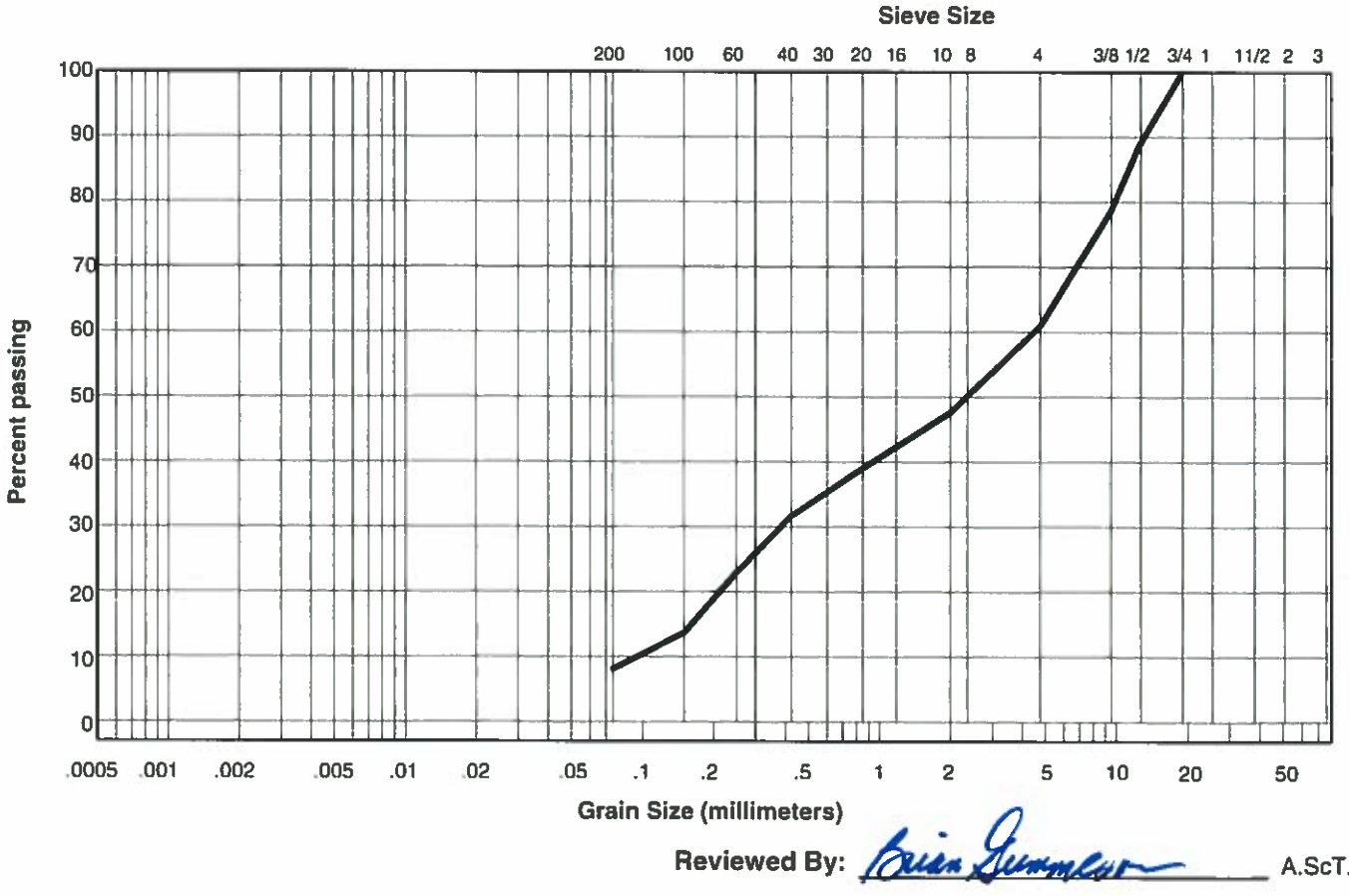
Cc: 0.3

Natural Moisture Content: 5.0%

Remarks:

Sieve Size (mm)	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	#N/A
19.000	100
12.500	89
9.500	79
4.750	61
2.000	48
0.850	39
0.425	32
0.250	23
0.150	14
0.075	8.1

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: Brian Gunnerson A.ScT.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM C136 & C117

Project: Wakesiah Avenue Corridor Plan

Project Number: 704-ENG.VGEO03461-01

Date Tested: July 26 2018

Borehole Number: BH18-10

Depth: 0.1m

Soil Description: SAND and GRAVEL, some silt, damp, grey

Cu:

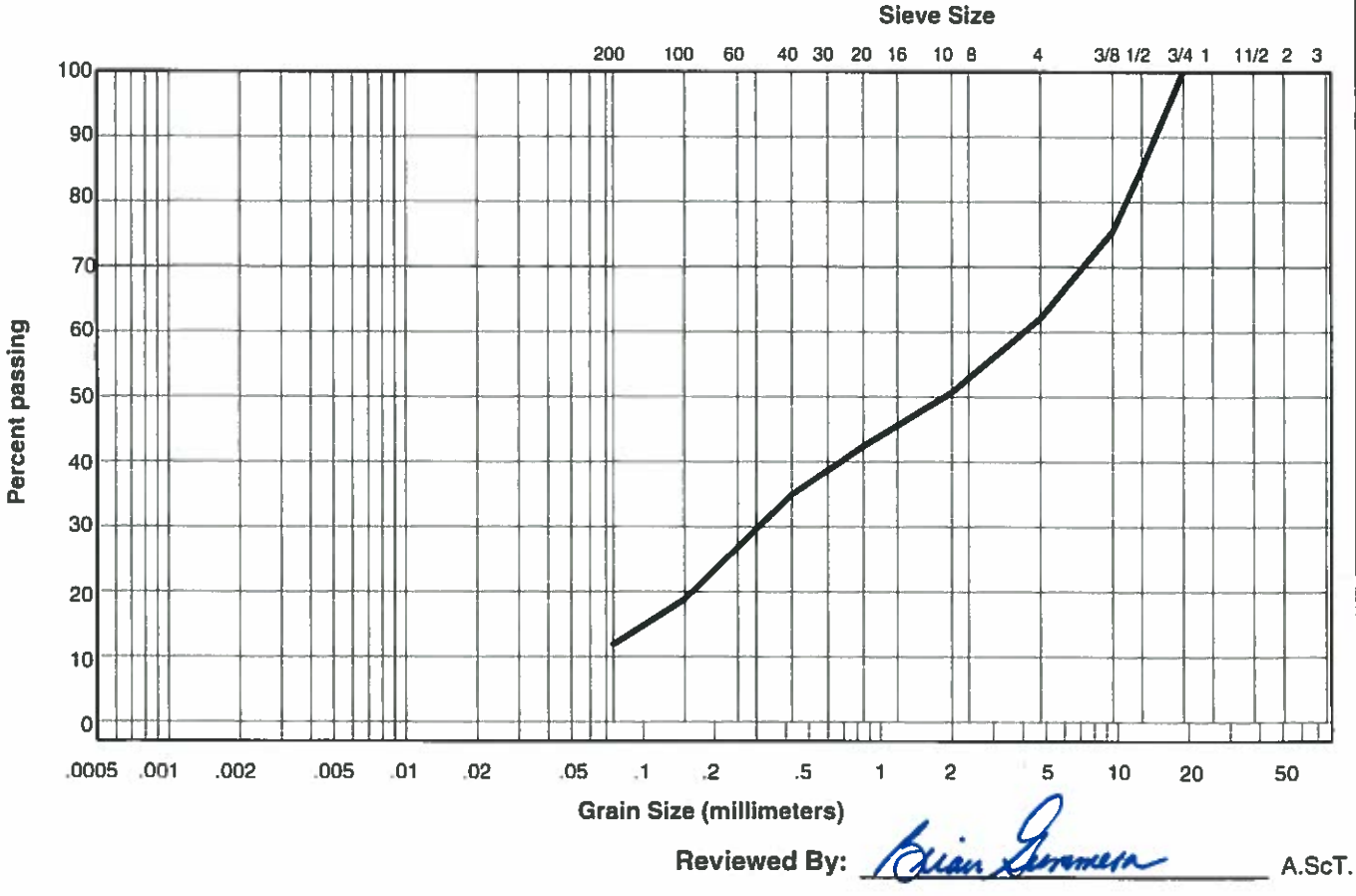
Cc:

Natural Moisture Content: 4.9%

Remarks:

Sieve Size (mm)	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	#N/A
19.000	100
12.500	85
9.500	75
4.750	62
2.000	51
0.850	42
0.425	35
0.250	27
0.150	19
0.075	11.9

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: Brian Grammen A.ScT.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM C136 & C117

Project: Wakesiah Avenue Corridor Plan

Project Number: 704-ENG.VGEO03461-01

Date Tested: July 26 2018

Borehole Number: BH18-09

Depth: 0.2m

Soil Description: GRAVEL and SAND, trace silt, damp, grey

Cu: 44.7

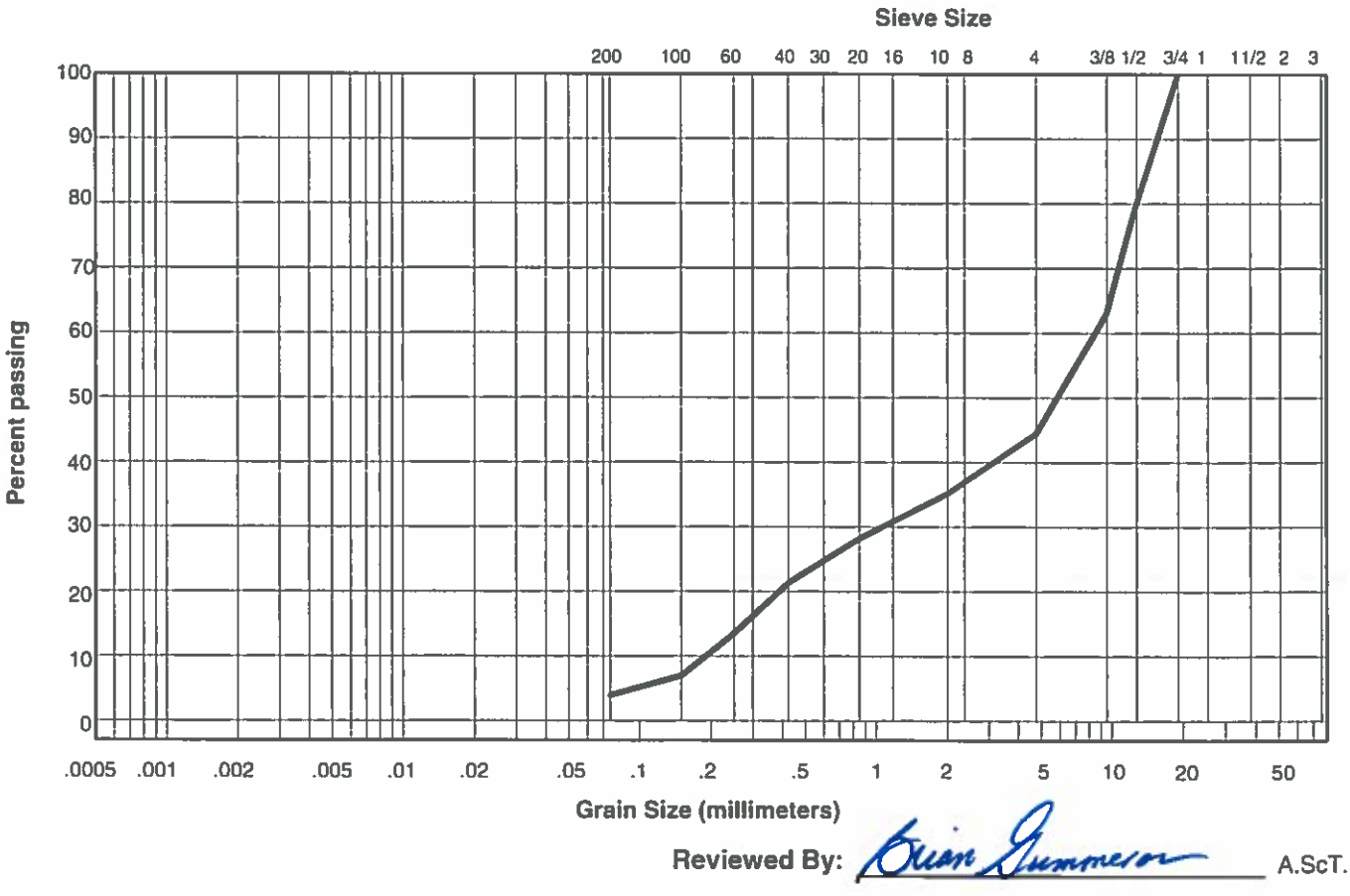
Cc: 0.7

Natural Moisture Content: 2.2%

Remarks:

Sieve Size (mm)	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	#N/A
19.000	100
12.500	79
9.500	63
4.750	44
2.000	35
0.850	28
0.425	21
0.250	14
0.150	7
0.075	3.9

Clay	Silt	Sand			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



Reviewed By: Brian Summerson A.ScT.

TETRA TECH

APPENDIX D

BENKELMAN BEAM RESULTS

Beam Results		Fifth Street from Highway 19 to Wakesiah Avenue						
		ENG.VGEO03461-01						
Station	**Lane**	**Offset from curbline (m)**	**Gauge Reading**	**2X Gauge**	**GPS Readings**		**Surface**	
0+00	EBL	1	0.01	0.02			ASPHALT	
0+30	EBL	3.5	0.12	0.24			ASPHALT	
0+90	EBL	1	0.1	0.2			ASPHALT	
0+150	EBL	3.5	0	0			ASPHALT	
0+210	EBL	1	0	0			ASPHALT	
0+270	EBL	3.5	0	0			ASPHALT	
0+330	EBL	1	0	0			ASPHALT	
0+390	EBL	3.5	0.06	0.12			ASPHALT	
0+450	EBL	1	0.08	0.16			ASPHALT	
0+510	EBL	3.5	0.17	0.34			ASPHALT	
0+570	EBL	1	0.1	0.2			ASPHALT	
0+630	EBL	3.5	0.1	0.2			ASPHALT	
0+690	EBL	1	0.09	0.18			ASPHALT	
0+750	EBL	3.5	0.12	0.24			ASPHALT	
0+810	EBL	1	0.19	0.38			ASPHALT	
0+870	EBL	3.5	0	0			ASPHALT	
Station 0+00 start point at Highway 19A								
			Average	0.073				
			Std Dev	0.093775				
			Deflection = D54+2s		0.26005			
			Temperature Air 20°C					
			Pavement Temperature 24°C					
			Seasonal Correction based on Jingle Pot Road					
			Deflection = F24*1.44		0.374472			
The road classification is Arterial as as outlined in the City of Nanaimo Manual of Engineering								
Standards and Specifications Section 9.06 Minimum Base and Pavement Strengths. The								
maximum Benkelman Beam deflection for Arterial is 0.75 mm which was not exceeded in the results.								

Beam Results		Fifth Street from Wakesiah Avenue to Highway 19						
		ENG.VGEO03461-01						
Station	**Lane**	**Offset from curb line (m)**	**Gauge Reading**	**2X Gauge**			**Surface**	
0+00	WBL	1	0.12	0.24			ASPHALT	
0+60	WBL	3.5	0.06	0.12			ASPHALT	
0+120	WBL	1	0.02	0.04			ASPHALT	
1+180	WBL	3.5	0.16	0.32			ASPHALT	
0+240	WBL	1	0.21	0.42			ASPHALT	
0+300	WBL	3.5	0.18	0.36			ASPHALT	
0+360	WBL	1	0.02	0.04			ASPHALT	
0+420	WBL	3.5	0.02	0.04			ASPHALT	
0+480	WBL	1	0.09	0.18			ASPHALT	
0+540	WBL	3.5	0.13	0.26			ASPHALT	
0+600	WBL	1	0.15	0.3			ASPHALT	
0+660	WBL	3.5	0.07	0.14			ASPHALT	
0+720	WBL	1	0.05	0.1			ASPHALT	
0+780	WBL	3.5	0.13	0.26			ASPHALT	
0+840	WBL	1	0.14	0.28			ASPHALT	
0+870	WBL	3.5	0.05	0.1			ASPHALT	
Station 0+00 start point at Wakesiah Avenue								
			Average	0.198				
			Std Dev	0.1471181				
			Deflection = D54+2s		0.491736			
			Temperature Air 20°C					
			Pavement Temperature 24°C					
			Seasonal Correction based on Jingle Pot Road					
			Deflection = F24*1.44		0.7081			
The road classification is Arterial as as outlined in the City of Nanaimo Manual of Engineering								
Standards and Specifications Section 9.06 Minimum Base and Pavement Strengths. The maximum								
Benkelman Beam deflection for Arterial is 0.75 mm which was not exceeded in the results.								

Beam Results		Wakesiah Street from 6th Street to 1st Street						
		ENG.VGEO03461-01						
Station	**Lane**	**Offset (m)**	**Gauge**	**2X Gauge**			**Surface**	
		from curbline	**Reading**					
0+00	NBL	1	0.21	0.42			ASPHALT	
0+30	NBL	3.5	0.1	0.2			ASPHALT	
0+90	NBL	1	0.02	0.04			ASPHALT	
0+150	NBL	3.5	0.16	0.32			ASPHALT	
0+210	NBL	1	0.21	0.42			ASPHALT	
0+270	NBL	3.5	0.18	0.36			ASPHALT	
0+330	NBL	1	0.02	0.04			ASPHALT	
0+390	NBL	3.5	0.02	0.04			ASPHALT	
0+450	NBL	1	0.09	0.18			ASPHALT	
0+510	NBL	3.5	0.13	0.26			ASPHALT	
0+570	NBL	1	0.15	0.3			ASPHALT	
0+630	NBL	3.5	0.07	0.14			ASPHALT	
0+690	NBL	1	0.05	0.1			ASPHALT	
0+750	NBL	3.5	0.13	0.26			ASPHALT	
0+810	NBL	1	0.14	0.28			ASPHALT	
0+870	NBL	3.5	0.05	0.1			ASPHALT	
0+930	NBL	1	0.09	0.18			ASPHALT	
0+990	NBL	3.5	0.08	0.16			ASPHALT	
1+050	NBL	1	0.03	0.06			ASPHALT	
1+110	NBL	3.5	0.15	0.3			ASPHALT	
1+170	NBL	1	0.17	0.34			ASPHALT	
1+230	NBL	3.5	0.3	0.6			ASPHALT	
1+290	NBL	1	0.31	0.62			ASPHALT	
1+350	NBL	3.5	0.07	0.14			ASPHALT	
1+410	NBL	1	0.04	0.08			ASPHALT	
1+470	NBL	3.5	0.03	0.06			ASPHALT	
1+530	NBL	1	0.07	0.14			ASPHALT	
1+590	NBL	3.5	0.06	0.12			ASPHALT	
1+650	NBL	1	0.06	0.12			ASPHALT	
1+710	NBL	3.5	0.02	0.04			ASPHALT	
1+770	NBL	1	0.02	0.04			ASPHALT	
1+830	NBL	3.5	0.3	0.6			ASPHALT	
1+890	NBL	1	0.12	0.24			ASPHALT	
1+950	NBL	3.5	0.14	0.28			ASPHALT	
2+010	NBL	1	0.08	0.16			ASPHALT	
2+070	NBL	3.5	0.13	0.26			ASPHALT	
2+130	NBL	1	0.04	0.08			ASPHALT	
2+190	NBL	3.5	0.12	0.24			ASPHALT	
2+250	NBL	1	0.01	0.02			ASPHALT	
2+310	NBL	3.5	0.04	0.08			ASPHALT	
2+370	NBL	1	0.18	0.36			ASPHALT	
2+240	NBL	3.5	0.08	0.16			ASPHALT	
2+490	NBL	1	0.05	0.1			ASPHALT	
2+550	NBL	3.5	0.04	0.08			ASPHALT	
Station 0+00 start point at 6th Street								
			Average	0.207				
			Std Dev	0.1536875				
		Deflection = D54+2s			0.514648			
		Temperature Air 20°C						
		Pavement Temperature 24°C						
	Seasonal Correction based on Jingle Pot Road							
		Deflection = F56*1.44			0.741093			

The road classification is Collector as as outlined in the City of Nanaimo Manual of Engineering Standards and Specifications Section 9.06 Minimum Base and Pavement Strengths. The maximum Benkelman Beam deflection for a Collector is 1.25 mm which was not exceeded in the results.

Beam Results		Wakesiah Street from 1st to 6th Street						
		ENG.VGEO03461-01						
Station	**Lane**	**Offset (m)**	**Gauge Reading**	**2X Gauge**				
0+00	SBL	1	0	0				
0+60	SBL	3.5	0.09	0.18				
0+120	SBL	1	0.01	0.02				
0+180	SBL	3.5	0.03	0.06				
0+240	SBL	1	0.12	0.24				
0+300	SBL	3.5	0.14	0.28				
0+360	SBL	1	0.04	0.08				
0+420	SBL	3.5	0.02	0.04				
0+480	SBL	1	0.1	0.2				
0+540	SBL	3.5	0.22	0.44				
0+600	SBL	1	0.22	0.44				
0+660	SBL	3.5	0.07	0.14				
0+720	SBL	1	0.16	0.32				
0+780	SBL	3.5	0.02	0.04				
0+840	SBL	1	0.11	0.22				
0+900	SBL	3.5	0.03	0.06				
0+960	SBL	1	0.04	0.08				
1+020	SBL	3.5	0.03	0.06				
1+080	SBL	1	0.11	0.22				
1+140	SBL	3.5	0.03	0.06				
1+200	SBL	1	0.01	0.02				
1+260	SBL	3.5	0.03	0.06				
1+320	SBL	1	0.31	0.62				
1+380	SBL	3.5	0.28	0.56				
1+440	SBL	1	0.02	0.04				
1+500	SBL	3.5	0.31	0.62				
1+560	SBL	1	0.21	0.42				
1+620	SBL	3.5	0.08	0.16				
1+680	SBL	1	0.13	0.26				
1+740	SBL	3.5	0.22	0.44				
1+800	SBL	1	0.21	0.42				
1+860	SBL	3.5	0.1	0.2				
1+920	SBL	1	0.19	0.38				
1+980	SBL	3.5	0.1	0.2				
2+040	SBL	1	0.17	0.34				
2+100	SBL	3.5	0.2	0.4				
2+160	SBL	1	0.13	0.26				
2+220	SBL	3.5	0.17	0.34				
2+280	SBL	1	0.16	0.32				
2+340	SBL	3.5	0.14	0.28				
2+400	SBL	1	0.24	0.48				
2+460	SBL	3.5	0.05	0.1				
2+520	SBL	1	0.13	0.26				
2+580	SBL	3.5	0.05	0.1				
Station 0+00 start point at 1st Street								
			Average	0.238				
			Std Dev	0.16977075				
		Deflection = D54+2s			0.577269			
		Temperature Air 20°C						
		Pavement Temperature 24°C						
	Seasonal Correction based on Jingle Pot Road							
		Deflection = F56*1.44			0.831267			

The road classification is Collector as as outlined in the City of Nanaimo Manual of Engineering Standards and Specifications Section 9.06 Minimum Base and Pavement Strengths. The maximum Benkelman Beam deflection for a Collector is 1.25 mm which was not exceeded in the results.

Appendix C Storm Sewer Sizing and Hydraulic Analysis

CITY OF NANAIMO
THE HARBOUR CITY

Engineering & Public Works Department

CityProjects D314

Date: April 18, 2019

Subject: Wakesiah Stormsewer Upgrade – Sizing Calculations

To: Marek Hanel, P.Eng.

From: Chris Lang, P.Eng.

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1. Background

As part of the Wakesiah Corridor Improvement project, several utilities require upgrades prior to completing the surface works component. The existing concrete and corrugated metal pipe (CMP) storm sewer (age unknown) between Fourth Street and Cat Stream have structural deficiencies, root intrusions, and are corroding as identified by CCTV condition assessment causing operational and maintenance issues. For the purpose of functional design the new pipe sizes will be identified and will utilize the existing inverts with a preferred alignment; this will be confirmed during detailed design.

As discussed at the project initiation meeting, the proposed storm sewer sizing was reviewed using the rational method. The calculations for the 5 and 100 year return events are included with this submission.

2. Hydrology

Hydrologic calculations were completed using the Rational Method given the urban drainage area of 13.1ha. The contributing catchment areas were delineated based on existing contours and connectivity to the storm sewer (Figure 1). Time of concentration (Tc) was calculated using the Kirpick formula and taken as 5 minutes for each catchment area.

The coefficient of runoff "C" for each catchment was selected based on ground slope, type of ground or surface cover, and the expected ultimate land use within the drainage areas. Considering this, the runoff coefficient was slightly increased for existing areas (based on the existing impervious area through orthographic imagery) to account for an expected increase in impervious area as commercial/mixed use developments occur along the corridor. The majority of catchment areas were allocated a runoff coefficient of between 0.85 and 0.90.

Since the original sewer construction, a significant input to the system was added at MH 11A to include surface drainage from the NDSS, Nanaimo Aquatic Centre (NAC), and the sportsfields to the west (Catchments D1, D2, E1, and E2). The drainage network connectivity is unknown and a large portion of the Serauxmen sportsfield is serviced by underdrains with surface storage potential. All of this runoff is captured via the piped system through the NDSS and NAC parking lots with a single discharge point at MH11A. Flow into the manhole here is restricted by a single 300mm pipe connection which acts as an orifice control to limit discharge and surcharge the upstream system to provide storage for medium and large rainfall events.

For the purpose of the functional design, input from this area was defined hydraulically with the Hydraulic Grade Line (HGL) elevations for the 5-year event taken as full pipe flow (59.87m), and a maximum of 150mm of ponding in the parking lot for the 100-year return event (61.45m). While this approach is suitable for the approximate pipe sizing of the upgraded sewer, additional effort should be undertaken during detailed design to confirm the stormwater management design for this contributing areas, specifically inputs to the municipal system for the 5- and 100-year return events, including tailwater effects. This connection also serves as a fixed invert in relation to any vertical change proposed of the upgraded sewer.

The City of Nanaimo recognizes climate is changing and rainfall patterns are subject to change. To accommodate this the sizing of the storm included a 10% increase in design peak flow for the minor system under the 1:5 year return event, and a 20% increase in design peak flow for the major system under the 1:100 year return event.

3. Hydraulics

Per the MOESS the minor system conveyance capacity was sized to convey the 1:5-year return event with no surcharging (Table 1). The major system conveyance capacity was sized based on pressure pipe flow/surcharged conditions to convey the 1:100-year return event (Table 2). With the exception of the NDSS parking lot, there is no existing storage or detention volumes connected to the current system. Quality controls and/or rainwater infiltration best management practices (BMPs) were not reviewed and their potential is to be assessed during the design phase. It is suggested that any quantity control or storage components of potential surface features implemented during detailed design be omitted from the capacity calculations for the system, to maintain a conservative sizing approach.

The empirical Hazen-Williams equation defines the discharge-head loss relationship for water flowing in full (pressurized) pipes. Using this, the hydraulic grade line (HGL) was plotted for the 1:100 year return event starting at the outlet to Cat Stream. In the absence of flow

conditions in the creek for this event, it was assumed that the tailwater would fully submerge the proposed 900mm inlet. Two sections show non-pressurized flow under this scenario based on significant grade changes within the alignment.

It should be noted that under the 1:100 year event there is surcharging in the storm sewer, however based on the current design, the HGL is expected to remain below the road (rim) elevation with a slight exception at MH13. A sketch of the 1:100 year HGL has been included in Figure 2. Proposed pipe sizes for each section are identified in Table 2 for the purpose of the functional design.

It should also be noted that the existing 450mm Reinforced Concrete Pipe at the upstream end (between MH14 and MH13) is adequately sized in good structural condition and does not need to be replaced.

4. Alignment

For the majority of the existing stormsewer, an on-line replacement is the preferred approach. An offline replacement would necessitate installing the new pipe closer to an existing 700mm dia. steel transmission main which follows the centreline of Wakesiah Avenue. Fixed connections at MH 11, 11A, 12, and 13 limit the potential to vertically re-align the new sewer, however there are some mild opportunities to better distribute grade and balance energy/capacity condition for the storm sewer that can be undertaken during detailed design.

5. Summary

It is recommended that the pipe sizes identified in Table 2 be used for sizing requirements at the concept stage, and further analysis be taken to determine the most appropriate alignment given proposed work and existing utility conflicts. In similar fashion, a review of the vertical profile of the proposed storm sewer should be confirmed to balance energy, capacity, and minimize unnecessarily deep sections.

Prepared By

Chris Lang

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
C. LANG
33456
4/12/19

Chris Lang, P. Eng.
Project Engineer
Engineering Projects Section

9.13.2018

Reference data

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Date	By	Revisions	Eng.
1	17/04/2019	CL	SUBMITTED FOR CONSULTANT REVIEW	ENG

Design by Date
Drawn by
Checked by
Approved by
Seal

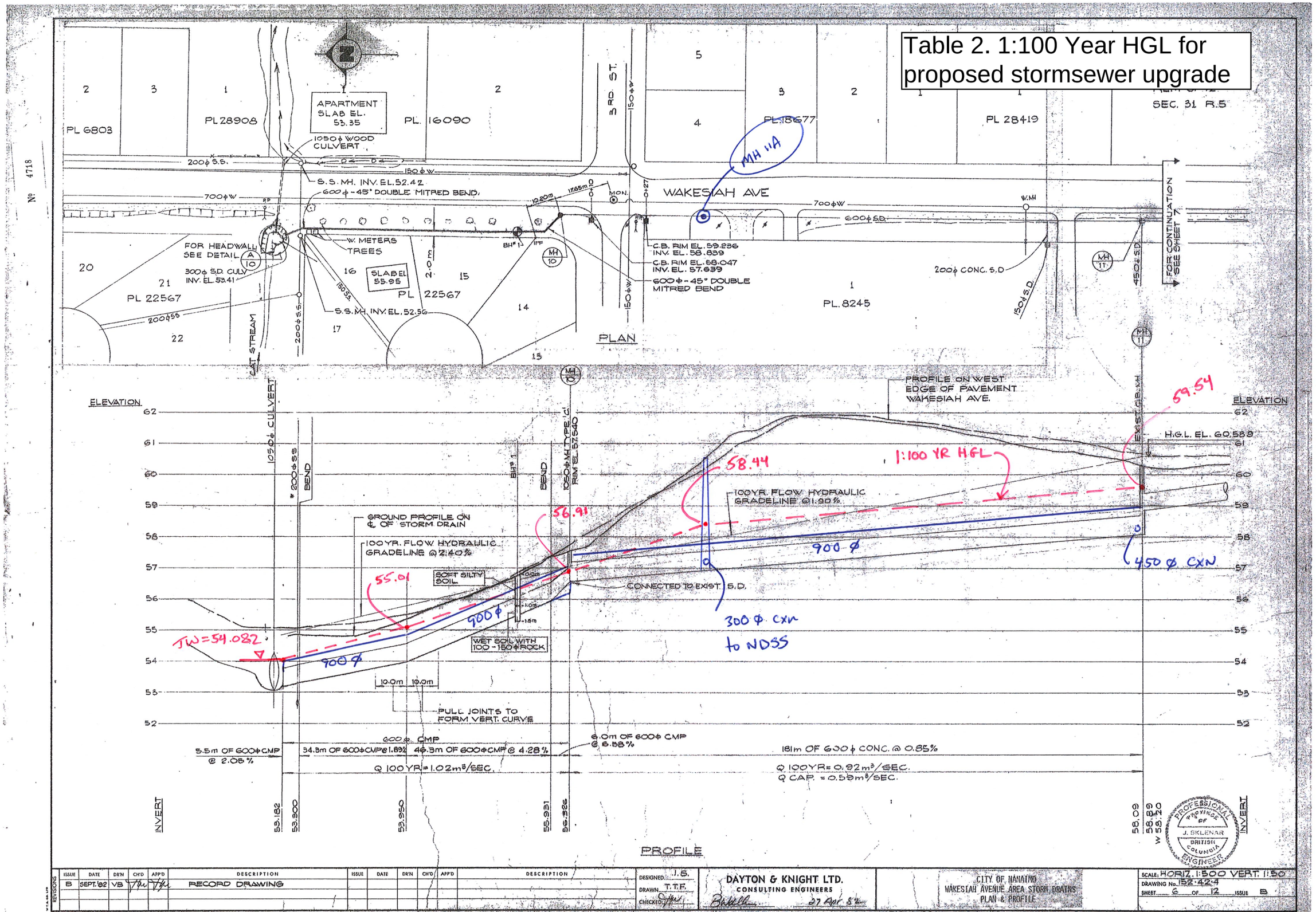
CITY OF NANAIMO
THE HARBOUR CITY

Scale 1:1250
Horiz. Vert.
Consult.Dwg Sheet of
Eng File No.
Dwg No.

Project
WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Title
FIGURE 1. STORM CATCHMENT AREAS

Table 2. 1:100 Year HGL for proposed stormsewer upgrade



REVISIONS	ISSUE	DATE	DR'N	CH'D	APP'D	DESCRIPTION
	B	SEPT. '82	VB			RECORD DRAWING

DESIGNED J.S.
DRAWN T.T.F.
CHECKED

DAYTON & KNIGHT LTD.
CONSULTING ENGINEERS
27 Apr 82

CITY OF NANAIMO
WAKESIAH AVENUE AREA STORM DRAINS
PLAN & PROFILE

SCALE: HORIZ. 1:500 VERT. 1:50
DRAWING No. 152-424
SHEET 6 OF 12 ISSUE B

4718-4-82

№ 4719

REM. S½ SEC. 31 R.5

PL 28419

PL 6830

FOSTER ST.

PL. 5910

1 2 3 4 5 6 7 8 9

1 11 10

PL 1325

13 12 11 10 9 8

4TH ST.

INSTALL AN ASPHALT CURB ON THE EAST SIDE OF EXIST. WHITE LINE PROVIDE DRIVEWAY ACCESS

START OF CURB

END OF CURB

INSTALL CB

WAKESIAH AVE.

FOR CONTINUATION SEE SHEET 6

FOR CONTINUATION SEE SHEET 5

FOR CONTINUATION SEE SHEET 4

W.M.H.

INV. EL. 59.85

200ϕ CONC.

150ϕ S.D.

25ϕ W

GRASS

450ϕ S.D.

POWER CABLE

SCHOOL BLDG.

POSSIBLE BACKWATER VALVE MANHOLE

DELETED

E.T.V. STUDIO

EXIST. MH

BOILER ROOM ELEV. 59.36

700ϕ W

600ϕ S.D.

380ϕ S.D.

TRAFFIC BARRIERS (TYP.)

PL. 8245

150ϕ CONC.

200ϕ CONC. S.D.

450ϕ S.D.

C.B. MH

150 S.D.

SIDEWALK

C.B. RIM EL. 67.074

C.B. C.B. C.B.

800ϕ W

500ϕ CAPPED STUB

C.B. RIM EL. 67.384 INV. EL. 66.954

C.B. RIM EL. 68.725, INV. EL. 68.292 4.0m O/S ft.

250ϕ S.S

PL. 12513

INV. EL. 66.58

FOR SWALE ACROSS DRIVEWAY SEE DETAIL SHEET 5

SEE DETAIL 4/4

PLAN

ELEVATION

APPROXIMATE GROUND PROFILE ON ℄ OF EXISTING PIPE

EXIST. C.B. MH

EXIST. C.B.

EXIST. WM @ C.B. LEAD X-ING

65.51

62.20

60.56

59.54

H.G.L. ELEV. 60.827

100 YR. FLOW HYDRAULIC GRADE LINE @ 0.08%

100 YR. FLOW HYDRAULIC GRADE LINE @ 0.42%

100 YR. FLOW HYDRAULIC GRADE LINE @ 0.034%

H.G.L. ELEV. 60.588 0.42%

H.G.L. ELEV. 60.812

675ϕ

825 ϕ

EXISTING 450 ϕ PIPE PLUGGED WITH CONCRETE

1050ϕ MH TYPE 'A' C/W INCREASER RIM EL. 67.257

BH #6

APPROX PROFILE ℄ OF S.D.

1m HARD PAN 2m

EXISTING 55.0m OF 600ϕ CONC. @ 1.19%

Q 100 YR = 0.42 m³/SEC. Q CAP. = 0.68 m³/SEC.

EXISTING 45.0m OF 600ϕ WOODSTAVE @ 1.32%

Q 100 YR = 0.42 m³/SEC. Q CAP. = 0.74 m³/SEC

EXISTING 39.0m OF 600ϕ CMP @ 1.32%

Q 100 YR = 0.12 m³/SEC. Q CAP. 0.48 m³/SEC

EXISTING 31.0m OF 450ϕ CMP @ 3.88%

Q 100 YR = 0.12 m³/SEC. Q CAP = 0.79 m³/SEC.

EXISTING 61.0m OF 450ϕ CONC. @ 3.88 %

Q 100 YR = 0.12 m³/SEC. Q CAP. = 0.58 m³/SEC.

500ϕ CMP

111.20 m @ 2.73 %

Q 100 YR = 0.74 m³/SEC.

INVERTS

56.09 W 56.20

59.52 SW 59.64

60.14±

60.66 W 61.24 SW 61.20

62.75±

65.12

64.701 64.591

INVERTS

PROFILE

REVISIONS	ISSUE	DATE	DR'N	CH'D	APP'D	DESCRIPTION
	B	SEPT. '82	VB			RECORD DRAWING

DESIGNED J.S.
DRAWN T.T.F.
CHECKED

DAYTON & KNIGHT LTD.
CONSULTING ENGINEERS
27 Apr 82

CITY OF NANAIMO
WAKESIAH AVENUE AREA STORM DRAINS
PLAN & PROFILE

SCALE: HORIZ. 1:500 VERT. 1:50
DRAWING No. 152.42.4
SHEET 7 OF 12 ISSUE B

4719-4-82

CITY OF NANAIMO ***Storm Sewer Design Sheet***	Q=CIA x 2.78 "n"=0.013	Single fam. Res.	0.50 to 0.80
PROJECT : **Wakesiah Storm Sewer Improvements - CPMS 1588**	Inlet Time Tc Min: 5.00min Max : 10.00 min	Low dens mult. fam.	0.50 to 0.80
Return Period: **5-year, 24-hour event**	Rural, Parks,Golf courses 0.25 to 0.55	Commercial	0.65 to 0.90
Design By : C. Lang		Industrial	0.80 to 1.00

DRAINAGE AREA DATA **PIPE DATA**

MH to MH	AREA (A)	Coeff. (C)	Area x Coeff. (A x C)	Accum. (A x C)	Time of Conc. (Tc)	Rainfall Intensity	Const. (2.78)	Q	Q+ 10%	LENGTH	DIA	S %	Capacity	Velocity	Time	% CAP	COMMENTS
	(ha)					(mm/hr)		(L/s)	(L/s)	(m)	(m)		(L/s)	(m/s)	(m)		
Catch A	1.41	0.90	1.27	1.27	5.00	58.37	2.78	206									
MH14 - MH13								206	227	61.00	0.450	3.880	562	3.53	0.29	40.33	**Pipe OK - do not replace**
Catch B	1.53	0.85	1.30	1.30	5.00	58.37	2.78	211									
MH13 - MH12								417	459	84.00	0.600	1.320	705	2.50	0.56	65.01	**39m of CSP, 45m of Woodstave**
Catch C	2.05	0.85	1.74	1.74	5.00	58.37	2.78	283									
MH12 - MH11								700	770	53.00	0.750	1.190	1214	2.75	0.32	63.38	**Upsize to 750mm from 600mm**
Catch F	0.31	0.40	0.12	0.12	5.00	58.37	2.78	20									
MH11 - MH11A								720	792	161.00	0.750	0.850	1026	2.32	1.15	77.14	**Upsize to 750mm from 600mm**
Catch D1, D2, E1, E2	7.43	0.90	6.69	6.69	5.00	58.37	2.78	475									
MH11A -MH10								1195	1314	20.00	0.900	0.850	1669	2.62	0.13	78.75	**Upsize to 825mm from 600mm**
Catch G	0.13	0.90	0.12	0.12	5.00	58.37	2.78	19									
MH10 - V. BEND								1214	1335	46.00	0.900	4.280	3745	5.89	0.13	35.65	**Upsize to 900mm from 600mm**
Catch H	0.27	0.90	0.24	0.24	5.00	58.37	2.78	39									
V. BEND - OUT								1253	1379	34.00	0.900	1.890	2489	3.91	0.14	55.39	**Upsize to 900mm from 600mm**

$R=AxT^{B}$

475 NDSS 1:5 year peak flow estimated at MH-11A

CITY OF NANAIMO	***Storm Sewer Design Sheet***								Q=CIA x 2.78 "n"=0.013							Single fam. Res.	0.50 to 0.80	$Friction\ Slope\ (Hazen-Williams)\ S_f = \left[\frac{Q}{0.85CR^{0.63}A}\right]^{1.85}$				
PROJECT :	**Wakesiah Storm Sewer Improvements - CPMS 1588**								Inlet Time Tc Min: 5.00min Max : 10.00 min							Low dens mult. fam.	0.50 to 0.80				
Return Period:	**100-year, 24-hour event**								Rural, Parks,Golf courses 0.25 to 0.55							Commercial	0.65 to 0.90	C= 120			
Design By :	C. Lang															Industrial	0.80 to 1.00	U/S HGL = D/S HGL + (Sf x L)			
DRAINAGE AREA DATA									**PIPE DATA**									**HGL ANALYSIS**				
MH to MH	AREA (A)	Coeff. (C)	Area x Coeff. (A x C)	Accum. (A x C)	Time of Conc. (Tc)	Rainfall Intensity	Const. (2.78)	Q	Q+ 20%	LENGTH	DIA	S %	Capacity	Velocity	Time	% CAP	COMMENTS	Friction Slope (%)	D/S HGL (m)	U/S HGL (m)	U/S Rim Elev (m)	Upstream Freeboard (m)
	(ha)					(mm/hr)		(L/s)	(L/s)	(m)	(m)		(L/s)	(m/s)	(m)							
Catch A	1.41	0.90	1.27	1.27	5.00	116.83	2.78	412														
MH14 - MH13								412	495	61.00	0.450	3.880	562	3.53	0.29	88.07	**Pipe OK - do not replace**	3.82	62.20	65.51	66.3	
Catch B	1.53	0.85	1.30	1.30	5.00	116.83	2.78	422														
MH13 - MH12								835	1001	84.00	0.675	2.100	1218	3.40	0.41	82.21	**Upsize to 675mm from 600mm**	1.96	60.56	62.20	62.1	-0.10
Catch C	2.05	0.85	1.74	1.74	5.00	116.83	2.78	566														
MH12 - MH11								1400	1681	53.00	0.825	2.100	2080	3.89	0.23	80.79	**Upsize to 825mm from 600mm**	1.92	59.54	60.56	60.7	0.14
Catch F	0.31	0.40	0.12	0.12	5.00	116.83	2.78	40														
MH11 - MH11A								1441	1729	161.00	0.900	0.850	1669	2.62	1.02	103.59	**Upsize to 900mm from 600mm**	1.33	58.44	59.54	60.7	1.16
Catch D1, D2, E1, E2	7.43	0.90	6.69	6.69	5.00	116.83	2.78	576														
MH11A -MH10								2017	2420	20.00	0.900	0.850	1669	2.62	0.13	145.00	**Upsize to 900mm from 600mm**	2.47	56.91	58.44	60.3	1.86
Catch G	0.13	0.90	0.12	0.12	5.00	116.83	2.78	38														
MH10 - V. BEND								2055	2466	46.00	0.900	4.280	3745	5.89	0.13	65.84	**Upsize to 900mm from 600mm**	2.56	55.01	56.91	57.5	0.59
Catch H	0.27	0.90	0.24	0.24	5.00	116.83	2.78	79														
V. BEND - OUT								2134	2560	34.00	0.900	1.890	2489	3.91	0.14	102.88	**Upsize to 900mm from 600mm**	2.74	54.082	55.01	N/A	

$R = AxT^{B}$

576 NDSS 1:100 year peak flow estimated at MH-11A

Appendix D Technical Memorandum

PARSONS

Suite 101 – 3795 Carey Road | Victoria, BC V8Z 6T8
Direct: 250.477.2206 | **Fax:** 250.477.2207 | www.parsons.com

Technical Memorandum

To: Marek Hanel, P.Eng.
Parsons Inc.

From: Tim Murphy, AScT, MBA, PMP, Eng.L., P.L. (Eng.), RSP

Re: **Wakesiah Avenue Improvements**

Date: April 26, 2019

The propose improvements to Wakesiah Avenue include a number of changes to the existing geometric design and traffic controls. These changes include:

- Removal of the channelized right turn lanes;
- Replacing Special Crosswalks with Pedestrian Signals;
- Bike Boxes for Two-Staged Left Turns, without No Right Turn on Red Prohibitions.

The rationale for these proposed changes is discussed in the subsections below.

Channelized Right Turn Lane Removal – Traffic Impacts

The analysis of removing the channelized right turn laning configuration from three signalized intersections along Wakesiah Avenue involves the quantification of intersection and movement delays on a per vehicle basis from which Level of Service (LOS) and the processed traffic volume compared to the capacity for each traffic movement. The intersection analysis was undertaken using the traffic modelling software Synchro Version 9.0. The software uses key inputs such as intersection turning movements, traffic composition, lane geometry, and signal timing parameters, to measure key outputs such as the average delay per vehicle of all vehicles making specific movements over the peak hour, the associated LOS, and the volume to capacity ratio.

Control delay, measured in seconds per vehicle, has traditionally been translated into Level of Service ratings between A and F, which represents the quality of service experienced by the driver. These ratings are described in ***Table 1*** for signalized intersections and unsignalized intersections:

Table 1: Intersection Level of Service

LOS	Control Delay (seconds/vehicle)	
	Signalized Intersection	Unsignalized Intersection
A	≤10	≤10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	>80	>50

Level of service ratings of A to D are normally considered acceptable for signalized intersections in urban areas. A LOS of E or worse has been set as critical thresholds for this study, although movements with LOS D have also been presented. A summary of the LOS and intersection capacity performance metrics is shown in ***Table 2***.

Table 2: Performance Metrics Critical Threshold Summary

Metric	Critical Threshold
Level of Service	LOS E or F
Volume to Capacity Ratio	>0.95

The intersection of Wakesiah Avenue and Second Street was analyzed as the existing intersection configuration with the southbound right turn channelization and as an intersection configuration without the southbound right turn channelization. For the analysis, the traffic signal timings were optimized for both the with channelization and without channelization options. The output of the analysis is shown in ***Tables 3 and 4***, respectively. As can be seen in these tables, removing the right turn channelization had very little impact to the performance of the intersection.

Table 3 – Second Street Intersection Performance (With SB right turn channelization)

Direction	AM Peak Hour			PM Peak Hour		
	Traffic Volume	v/c Ratio	LOS	Traffic Volume	v/c Ratio	LOS
NBL	9	0.03	B	4	0.02	A
NBT	41	0.27	A	37	0.18	A
NBR	107			92		
SBL	103	0.25	B	184	0.36	B
SBT	25	0.05	B	56	0.08	A
SBR	37	0.14	A	78	0.13	A
WBL	52	0.22	B	130	0.38	B
WBT	326	0.86	C	220	0.71	B
WBR	160			162		
EBL	67	0.69	D	52	0.33	B
EBT	365	0.55	B	191	0.38	B
EBR	12			6		
Overall			B			B

Table 4 –Second Street Intersection Performance (Without SB right turn channelization)

Direction	AM Peak Hour			PM Peak Hour		
	Traffic Volume	v/c Ratio	LOS	Traffic Volume	v/c Ratio	LOS
NBL	9	0.03	B	4	0.02	A
NBT	41	0.27	A	37	0.18	A
NBR	107			92		
SBL	103	0.25	B	184	0.36	B
SBT	25	0.18	A	56	0.21	A
SBR	37			78		
WBL	52	0.22	B	130	0.38	B
WBT	326	0.86	C	220	0.71	B
WBR	160			162		
EBL	67	0.69	D	52	0.33	B
EBT	365	0.55	B	191	0.38	B
EBR	12			6		
Overall			B			B

Similarly, the Wakesiah Avenue / Fourth Street intersection and the Wakesiah Avenue / Fifth Street intersection were analyzed as the existing intersection configurations with the southbound right turn channelization and as an intersection configuration without the southbound right turn channelization.

The results of the analysis for the with and without right turn lane channelization options for the Wakesiah Avenue and Fourth Street intersection are shown in ***Tables 5 and 6***, respectively. The analysis shows there is very little change to the performance of the intersection with the removal of the right turn channelization.

The results of the analysis for the with and without right turn lane channelization options for the Wakesiah Avenue and Fifth Street intersection are shown in ***Tables 7 and 8***, respectively. The analysis shows there is very little change to the intersection performance with the removal of the right turn channelization.

Table 5 – Fourth Street Intersection Performance (With SB right turn channelization)

Direction	AM Peak Hour			PM Peak Hour		
	Traffic Volume	v/c Ratio	LOS	Traffic Volume	v/c Ratio	LOS
NBL	114	0.27	A	38	0.12	A
NBT	262	0.34	A	264	0.35	A
NBR	10			15		
SBL	62	0.21	A	76	0.17	A
SBT	330	0.34	A	332	0.43	B
SBR	207	0.26	A	73	0.11	A
WBL	17	0.14	B	12	0.04	A
WBT	50	0.37	A	20	0.18	A
WBR	66			73		
EBL	50	0.31	B	167	0.67	C
EBT	16	0.18	A	29	0.22	A
EBR	34			49		
Overall			A			B

Table 6 – Fourth Street Intersection Performance (Without SB right turn channelization)

Direction	AM Peak Hour			PM Peak Hour		
	Traffic Volume	v/c Ratio	LOS	Traffic Volume	v/c Ratio	LOS
NBL	114	0.34	A	38	0.13	A
NBT	262	0.29	A	264	0.33	A
NBR	10			15		
SBL	62	0.18	A	76	0.17	A
SBT	330	0.52	A	332	0.51	B
SBR	207			73		
WBL	17	0.18	B	12	0.04	B
WBT	50	0.45	B	20	0.19	A
WBR	66			73		
EBL	50	0.40	C	167	0.68	C
EBT	16	0.22	B	29	0.23	A
EBR	34			49		
Overall			A			B

Table 7 – Fifth Street Intersection Performance (With SB right turn channelization)

Direction	AM Peak Hour			PM Peak Hour		
	Traffic Volume	v/c Ratio	LOS	Traffic Volume	v/c Ratio	LOS
NBL	105	0.29	B	80	0.21	A
NBT	121	0.20	B	80	0.13	A
NBR	1			1		
SBL	71	0.16	B	147	0.33	B
SBT	113	0.18	B	163	0.23	A
SBR	141	0.25	A	76	0.11	A
WBL	2	0.01	A	6	0.03	A
WBT	209	0.59	B	169	0.54	B
WBR	106			108		
EBL	144	0.82	D	87	0.03	B
EBT	147	0.39	B	219	0.54	B
EBR	48			95		
Overall			B			B

Table 8 – Fifth Street Intersection Performance (Without SB right turn channelization)

Direction	AM Peak Hour			PM Peak Hour		
	Traffic Volume	v/c Ratio	LOS	Traffic Volume	v/c Ratio	LOS
NBL	105	0.38	B	80	0.22	A
NBT	121	0.20	A	80	0.13	A
NBR	1			1		
SBL	71	0.16	A	147	0.33	B
SBT	113	0.42	A	163	0.33	A
SBR	141			76		
WBL	2	0.01	A	6	0.03	A
WBT	209	0.60	B	169	0.54	B
WBR	106			108		
EBL	144	0.83	D	87	0.34	B
EBT	147	0.39	A	219	0.62	B
EBR	48			95		
Overall			B			B

In addition to the operational analysis discussed above which shows there is no degrading of the performance of the intersections with the removal of the right turn lanes, there are also safety benefits that would be realized with the removal of the right turn lanes and triangular islands. The intersection curb returns with a reduced radius reduces the speeds of right turning vehicles, and makes pedestrians and cyclists more visible to approaching motorists, as they are positioned closer to the parallel through travel lanes when waiting to cross the intersecting road. This improves the safety for pedestrians and cyclists at the intersections.

Replacing Special Crosswalks with Pedestrian Signals

The proposed improvements for Wakesiah Avenue include upgrading of an existing special crosswalks to pedestrian signals on Foster St.. Special crosswalks are effective in drawing motorist's attention to crossing pedestrians when the amber flashers been activated. However, there are some drawbacks with these traffic control devices. Motorists approaching the intersection may be too close to the intersection to stop when the amber flashers are activated. This could cause conflicts should pedestrians step onto the road immediately after the amber flashers start flashing. Pedestrians approaching the crossing when the amber flashers are already activated may step onto the road to cross but not be able to completely cross the road before the ambler flashers stop flashing.

Upgrading these pedestrian crossing to pedestrian signals would provide clear guidance to pedestrians when to cross the road and when to wait, and provide sufficient time for the pedestrians to cross the road. The signals would also provide amber and all-red clearance intervals for motorists to ensure they can bring their vehicles to a stop before the pedestrians start to cross the road.

Bike Boxes for Two-Staged Left Turns and No Right Turn on Red Prohibitions

The proposed improvements to Wakesiah Avenue include Bike Boxes to facilitate two-staged left turns for cyclists at signalized intersections. The installation of Bike Boxes for two-staged left turns has often included the prohibition of right turn on red at the signalized intersection. This can reduce the capacity for right turning vehicles at intersections in some cases. However, if the through traffic is significant, stopped through traffic at a red light in a single approach lane will also impede right turning traffic at the intersection. Some municipalities in Canada, where turning right on red is legal, have implemented these Bike Boxes without the turn prohibitions. An example of this is shown in ***Figure 1***, which is a picture of an intersection in the City of Surrey.

Figure 1 – City of Surrey Intersection with Bike Boxes

If you have any questions related to this memorandum, please contact the undersigned.

Tim Murphy, AScT, MBA, PMP, Eng.L., P.L. (Eng.), RSP

Appendix E Stakeholder Consultation Forms

Appendix F Summary of Public Survey & Consultation

CITY OF NANAIMO
WAKESIAH AVENUE
CORRIDOR IMPROVEMENTS

Public Engagement Summary Report

APRIL 2019

CITY OF NANAIMO
THE HARBOUR CITY

PARSONS

zinc
COMMUNICATION STRATEGIES

#WakesiahUpgrades

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS ENGAGEMENT DASHBOARD

APRIL 2019

Project Summary

The City of Nanaimo is planning major upgrades to the Wakesiah Avenue corridor beginning in 2020. The improvement project takes in an area of approximately two kilometres along Wakesiah Avenue from First Street to Sixth Street. Residents were asked to weigh in with their opinions on components of the project design, including transportation, parking and community features. This feedback will help ensure that local knowledge is considered and informs the final design.

PUBLIC PARTICIPATION FOCUS:

INFORM
Introduce the Wakesiah Avenue Corridor Improvement project

CONSULT
Collect feedback on the conceptual design/plans for the corridor

ENGAGEMENT OPPORTUNITIES

ONLINE SURVEY

Posted on the City of Nanaimo website from March 18 – April 8, 2019
and promoted on social media + via a flyer distributed to area residents

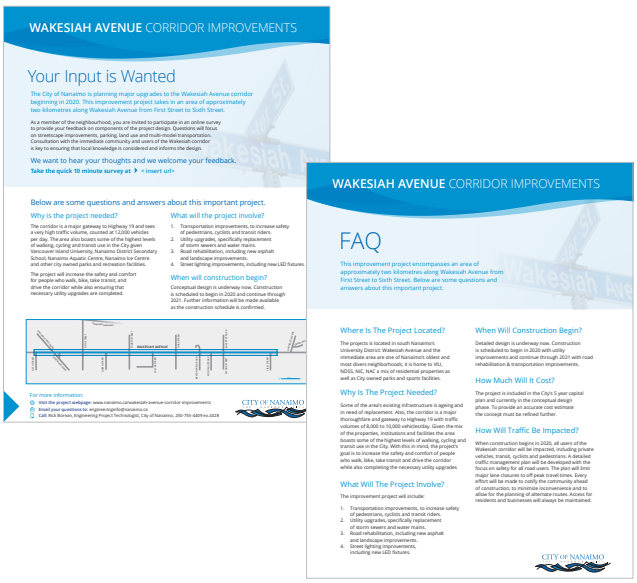
342
Residents participated in online survey

XXX
Flyers distributed to area residents

179
Survey respondents regularly walk along Wakesiah Ave

148
Survey respondents commute along Wakesiah Ave daily

182
Survey respondents preferred multi-use paths for cycling



TOP 3 FEEDBACK THEMES

1. Intersection and crosswalk safety

2. Improved pedestrian and cyclist options

3. Boulevards, greenspace and landscaped medians over parking

What's Next?

The feedback received will assist the City of Nanaimo in determining a new street design that will increase the comfort and safety of people who walk, bike, take transit and drive the Wakesiah Avenue corridor.

Final design is expected in mid-2019, with construction scheduled to begin in 2020 and continue through 2021.

#WakesiahUpgrades

Contents

Introduction

The City of Nanaimo is planning major upgrades to the Wakesiah Avenue corridor beginning in 2020. This improvement project takes in an area of approximately two kilometres along Wakesiah Avenue from First Street to Sixth Street.

The corridor is a major gateway to Highway 19 and sees a very high traffic volume, counted at 12,000 vehicles per day. The area also boasts some of the highest levels of walking, cycling and transit use in the City as it is home to Vancouver Island University, Nanaimo District Secondary School, Nanaimo Aquatic Centre, Nanaimo Ice Centre and other city owned parks and recreation facilities. The project's goal is to increase the safety and comfort for people who walk, bike, take transit and drive the corridor while also ensuring necessary utility upgrades are completed. The project will involve:

- Transportation improvements, to increase safety of pedestrians, cyclists and transit users
- Utility upgrades, specifically replacement of storm sewers and water mains
- Road rehabilitation, including new asphalt and landscape improvements
- Street lighting improvements, including new LED fixtures

In order to ensure local knowledge was considered and informed the final design, community stakeholders, area residents and the broader Nanaimo community were asked to provide their feedback with respect to components of project design. Another important objective was to use this opportunity to inform neighbours, stakeholders and the general public about the Wakesiah Avenue Corridor Improvement project and raise awareness about plans for construction in 2020 through 2021.

ENGAGEMENT GOALS

The goals guiding this engagement were:

1. Provide area residents and affected parties with information about the project, as well as opportunities and processes for providing feedback.
2. Identify and obtain relevant local knowledge and information.
3. Identify concerns and collect feedback to inform final project design.
4. Build long-lasting relationships, communications channels and overall trust with key stakeholders and influencers.

ENGAGEMENT STRATEGY

Two distinct processes were used during this engagement process:

1. **Direct, One-on-One Consultations:** Early outreach with impacted stakeholders and community partners, including Vancouver Island University, Nanaimo District Secondary School, Regional District of Nanaimo Transit, as well as staff at the city owned and operated Nanaimo Ice Centre and Nanaimo Aquatic Centre, occurred in the fall of 2018 and early spring of 2019.

2. **Online Survey Tool:** Using Survey Monkey, an online survey, consisting of 19 question was posted to the City of Nanaimo website (the Wakesiah Avenue Corridor Improvements project page specifically) and promoted in order that the larger community could provide input into aspects of project design, including transportation, parking, landscaping and community features.

Engagement Results

DIRECT CONSULTATION WITH VIU, NDSS AND RDN TRANSIT

Feedback received from Vancouver Island University, Nanaimo District Secondary School and Regional District of Nanaimo Transit, during meetings held throughout the fall of 2018 and spring of 2019, may be summarized as follows:

(Parsons to provide summary of issues/themes emerging from discussions)

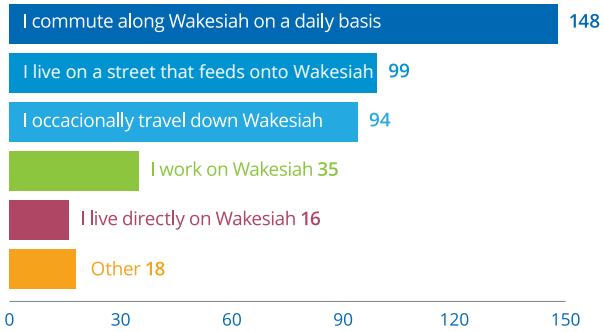
ONLINE SURVEY RESULTS

Area residents and the broader Nanaimo community/general public were asked to weigh in with their opinions and ideas by responding to an online survey located at: **www.nanaimo.ca/your-government/projects/projects-detail/wakesiah-avenue-corridor-improvements**

Participation in the online survey was encouraged through delivery of a flyer to neighbourhood residents/businesses, execution of a social media campaign using Facebook/Twitter from March 19-April 5, and publication in the City of Nanaimo Updates, a weekly digital newsletter.

The online survey ran from March 18 to April 8, 2019 offering a three-week window for those interested in contributing. A total of 342 individuals responded to the survey. Results are broken down on the following pages.

Q1: What statement best describes you?



The survey achieved its goal of reaching residents directly impacted by planned improvements/changes to the transportation corridor.

Q2: What is your postal code?

POSTAL CODE	# OF RESPONDENTS
V9R	232
V9T	44
V9S	42
V9V	10
V9X	8
V0J	1
V2K	1
V1Y	1
No Code	3

With the exception of six respondents, all postal codes (336) were from Nanaimo.

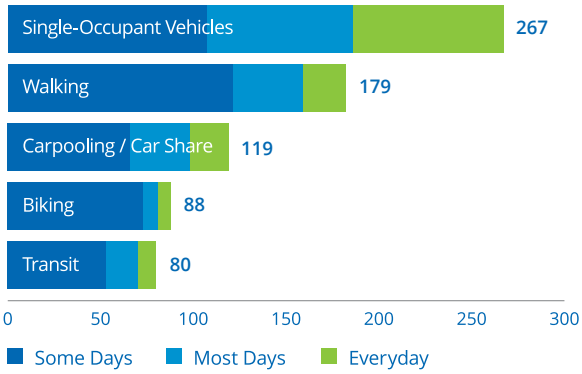
Q3: What age bracket do you fall within?

AGE BRACKET	# OF RESPONDENTS
35-49	140
20-34	89
50-64	86
65+	20
Under 19	7

Q4: Do you attend or does another individual at your residence attend either Vancouver Island University or Nanaimo District Secondary School?

Y/N	# OF RESPONDENTS
No	203 (59%)
Yes	139 (41%)

Q5: How do you travel along Wakesiah?



Q6: Overall, how happy are you with Wakesiah Avenue's current condition?

Neutral was the most common response for almost all categories, excepting traffic conditions.

Somewhat disappointed was the second most common response for all categories, excepting traffic conditions.

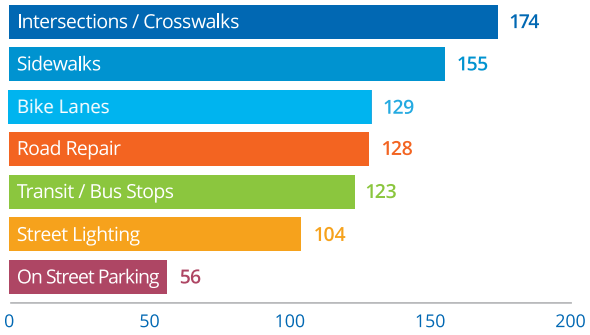
41%
respondents somewhat disappointed with current traffic conditions

25%
respondents very disappointed with current traffic conditions + bus stops/shelters

19%
respondents very disappointed in parking + bike facilities

25%
respondents somewhat happy with crosswalks + sidewalks

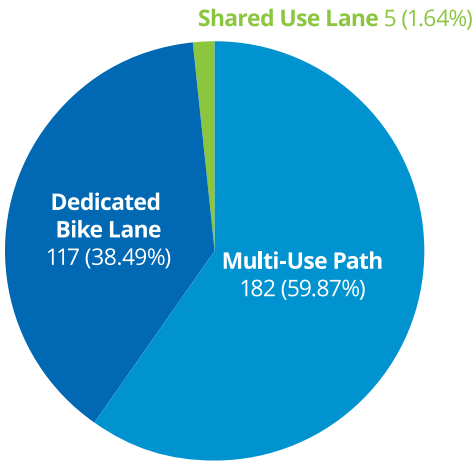
Q7: How would you rank the importance of each of the street features below to improve during the design of the Wakesiah Avenue corridor?



161 respondents also provided written comments. The following themes emerged:

1. **Traffic/congestion/crossing issues at NDSS:** The need to have pedestrian-controlled crossing lights to benefit both pedestrians crossing and motorists waiting was identified by respondents. Also, some called for an overpass rather than a crossing, for safety reasons.
2. **Bus pullouts:** The need for bus pullouts was identified by respondents, to prevent traffic from backing up.
3. **Sidewalks:** The inconsistency of sidewalks (some areas have them, some don't), disrepair of sidewalks in some areas, and lack of ability to use sidewalks in some areas after snow removal was identified by respondents.
4. **Lighting at crosswalks:** The need for better (or any) lighting at crosswalks was mentioned as a significant concern by respondents.

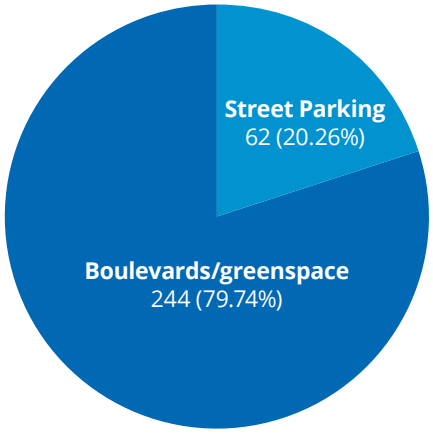
Q8: What type of cycling infrastructure would you prefer to use if cycling through the Wakesiah Avenue corridor?



Q9: The Nanaimo Transportation Master Plan (NTMP) supports the installation of dedicated bike lanes on Fifth Street, from Wakesiah Avenue to the Nanaimo Parkway, to improve connection to the College Park area. Would you make use of these bike lanes?

Y/N	# OF RESPONDENTS
No	163 (53%)
Yes	146 (47%)

Q10: The lack of parking in the neighbourhood is often brought to our attention. Additional space along Wakesiah Avenue could be used for on-street parking, but also for boulevards and greenspace. Which land use would you like to see given a higher priority?



Q11: One concept for the corridor is to eliminate on-street parking along Wakesiah Avenue between Third Street and Fifth Street. This would give a stronger character to the streetscape along Vancouver Island University and Nanaimo District Secondary School, while also providing a greener corridor and improving cyclist and pedestrian safety. Do you support this approach?

Y/N	# OF RESPONDENTS
Yes	273 (90%)
No	32 (10%)

Q12: We are considering including landscaped medians along the corridor to improve vehicle/pedestrian safety and aesthetics. Which of the following options would you prefer? (Maintenance Costs $)

Q13: Rain gardens (Bioswales) are features used to provide quality improvements and quantity reduction in drainage runoff. Do you support the installation of these features where appropriate?

Y/N	# OF RESPONDENTS
Yes	285 (94%)
No	17 (6%)

Q14: Decorative designs for crosswalks are known to provide a sense of identity to a community. A decorative art design is being considered for the crosswalk at Wakesiah and Foster to reflect the Nanaimo District Secondary School. Would you be supportive of this approach?

Y/N	# OF RESPONDENTS
Yes	234 (78%)
No	65 (22%)

Q15: If you answered no to the above question, are there any other themes beyond regular crosswalks that you would like to see installed?

29
Regular crosswalks (no design)

7
First Nations art design

6
Install flashing lights

2
Rainbow art design

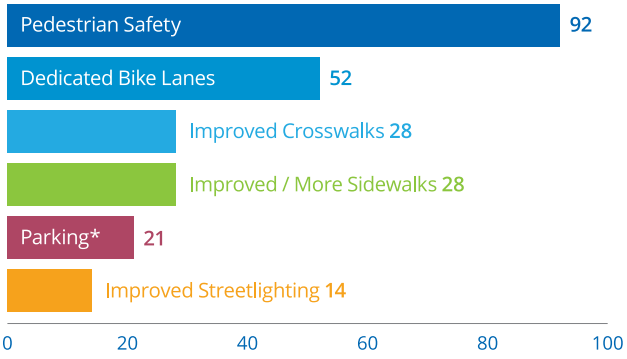
1
Add garbage receptacles

The remaining responses were divided among those wanting a contest, having VIU or NDSS students decide, installation of an overpass instead, local artists donating free artwork, etc.

Q16: Improvement of the sidewalk near Cat Stream (west side, between Second Street and Third Street) would require the removal of a few Poplar trees as shown below. Improvements to the Cat Stream riparian area would be completed to offset the loss. Do you support the removal of these trees to increase pedestrian safety here?

Y/N	# OF RESPONDENTS
Yes	273 (91%)
No	27 (9%)

Q17: What 2 things about Wakesiah Avenue do you think are the top priorities to address during the design process?



*Parking was divided between those who wanted more parking, those who wanted less on-street parking, those who wanted resident-only and other parking infractions better enforced, and those who just wanted parking issues “solved”.

Q18: Do you have any other comments, questions or concerns?

There were 121 responses to this call for further comments, questions or concerns, generating a wide variety of general responses, varying from "no additional comment" to "thank you for providing this survey" to a couple of mentions of poplar tree removal (covered in Q16).

Specific themes that emerged were:

- **Requests for dedicated bike lanes**
- **Parking requests:** more parking, on-street parking reduced
- **Pedestrian considerations:**
    1. Sidewalks (respondents wanting better maintenance/repair/snow removal)
    2. Addition of trees, landscaping, pedestrian-first planning, improving walking paths, etc.
    3. Lighting
    4. Crosswalks

THEMES OF FEEDBACK

1. **Intersection and crosswalk safety:**
   Addressing intersections and crosswalks was ranked as the highest priority for respondents. Significant concerns were expressed about pedestrian crossing issues at Nanaimo District Secondary School, with many respondents suggesting the need for pedestrian-controlled crossing lights to benefit both pedestrians crossing and motorists waiting, with some calling for an overpass rather than a crossing, for safety reasons. Lighting at crosswalks and improved street lighting generally is highly supported.

2. **Improved pedestrian and cyclist options:**
   While respondents most commonly travel along the corridor in vehicles, strong support for design features to improve pedestrian and cyclist safety was expressed. Respondents are overwhelmingly in favour of separating pedestrian and cycling infrastructure from vehicle traffic through installation of a multi-use path. Improving sidewalk infrastructure is also important to respondents. The inconsistency and state of disrepair of existing sidewalks was a common comment. Similarly, respondents noted the importance of pull-outs for transit buses, again to improve transit rider and vehicle safety.

3. **Traffic conditions and congestion concerns:**
   Traffic conditions and congestion were cited as significant concerns by respondents, specifically the volume of traffic along the corridor and congestion at Nanaimo District Secondary School. Respondents are seeking improvements to congestion through the corridor project.

4. **Boulevards, greenspace and landscaped medians over parking:**
   Respondents expressed strong support for the installation of boulevards, greenspace and landscaped medians along the corridor. Respondents are supportive of eliminating street parking in order to install boulevards and greenspace to allow for a greener corridor and improve cyclist and pedestrian safety. Hardscape/drought resistant medians are preferred. Respondents also supported the installation of rain gardens (bioswales) where appropriate.

5. **A desire for consistent approach to corridor design:**
   Respondents expressed dissatisfaction with the current “patchwork” infrastructure along Wakesiah Avenue, and are supportive of a consistent approach to infrastructure components, such as sidewalks, cycling lanes and crosswalks along the entire length of corridor.

Conclusion

The engagement exercise received a good level of public participation and generated valuable feedback on the corridor's conceptual design and potential project components. The survey achieved its goal of reaching residents directly impacted by planned improvements/changes to the transportation corridor.

Based on the feedback and comments received, the City of Nanaimo can move forward with confidence towards finalizing project design incorporating a consistent approach to pedestrian, cycling and transit infrastructure along the length of the Wakesiah Avenue corridor, while undertaking road rehabilitation and incorporating "greener" landscape improvements. The primary consideration for respondents is improving pedestrian and cyclist safety along the corridor.

Next Steps

1. **Follow up with survey respondents and project stakeholders:**

   Ensuring that the results of this public engagement are shared with survey respondents and project stakeholders is key to building trust and positive long-term relationships. A summary of the survey results should be shared on the project webpage and provided directly to those who included their email address to receive further project updates.

2. **Prepare for the next stage of the project:**

   With this engagement complete, the project team should turn its attention to preparing for the construction phase of the project, which includes development of a communications strategy to keep the community informed of project progress and identification of potential opportunities for further engagement.

APPENDICES

APPENDIX 1 – NEIGHBOURHOOD FLYER

WAKESIAH AVENUE CORRIDOR IMPROVEMENTS

Your Input is Wanted

The City of Nanaimo is planning major upgrades to the Wakesiah Avenue corridor beginning in 2020. This improvement project takes in an area of approximately two kilometres along Wakesiah Avenue from First Street to Sixth Street.

As a member of the neighbourhood, you are invited to participate in an online survey to provide your feedback on components of the project design. Questions will focus on streetscape improvements, parking, land use and multi-model transportation. Consultation with the immediate community and users of the Wakesiah corridor is key to ensuring that local knowledge is considered and informs the design.

We want to hear your thoughts and we welcome your feedback.

Take the quick 10 minute survey at ▶ < insert url>

Below are some questions and answers about this important project.

Why is the project needed?

The corridor is a major gateway to Highway 19 and sees a very high traffic volume, counted at 12,000 vehicles per day. The area also boasts some of the highest levels of walking, cycling and transit use in the City given Vancouver Island University, Nanaimo District Secondary School, Nanaimo Aquatic Centre, Nanaimo Ice Centre and other city owned parks and recreation facilities.

The project will increase the safety and comfort for people who walk, bike, take transit, and drive the corridor while also ensuring that necessary utility upgrades are completed.

What will the project involve?

1. Transportation improvements, to increase safety of pedestrians, cyclists and transit riders.
2. Utility upgrades, specifically replacement of storm sewers and water mains.
3. Road rehabilitation, including new asphalt and landscape improvements.
4. Street lighting improvements, including new LED fixtures.

When will construction begin?

Conceptual design is underway now. Construction is scheduled to begin in 2020 and continue through 2021. Further information will be made available as the construction schedule is confirmed.

For more information:

Visit the project webpage: www.nanaimo.ca/wakesiah-avenue-corridor-improvements
Email your questions to: engineeringinfo@nanaimo.ca
Call: Rick Borean, Engineering Project Technologist, City of Nanaimo, 250-755-4409 ex.4328

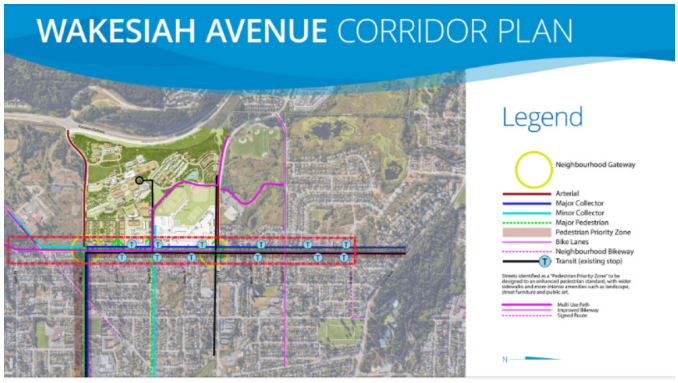
CITY OF NANAIMO
THE HARBOUR CITY

APPENDIX 2 – SAMPLE SOCIAL MEDIA POSTS

City of Nanaimo Local Government
April 5 at 8:15 AM ·

Hey, Nanaimo! There's still time to provide your input on some major upgrades planned for the Wakesiah Ave corridor. Participate in our online survey, which closes April 9, to offer your input on the project's design, including landscaping features, crosswalk design, parking, community land use and cycling/pedestrian use.

Learn more and take the survey here: http://ow.ly/BTKp30o7E68



6 5 Comments 10 Shares

City of Nanaimo Local Government
March 29 at 9:51 AM ·

Did you know that Wakesiah Avenue sees 12,000 vehicles each day and has some of the highest levels of walking, cycling and transit in the City? Participate in the City's online survey to offer your input on a new corridor design including landscaping features, crosswalks, parking, community land use and cycling/pedestrian use.
Learn more and take the survey here: http://ow.ly/BTKp30o7E68

23 1 Comment 16 Shares

Appendix G Class “C” Cost Estimate

PARSONS

Wakesiah Avenue Corridor Improvements

Class "C" Cost Estimate
6/27/2019

			SIXTH ST. to HAREWOOD RD.		HAREWOOD RD. to FIFTH ST.		FIFTH ST. to QUEEN ST.		QUEEN ST. to FOURTH STREET		FOURTH ST. to FOSTER ST.		FOSTER ST. to THIRD ST.		THIRD ST. to SECOND ST.		SECOND ST. to FIRST ST.		FIFTH ST. WAKESIAH TO HWY 19		SUBTOTALS
	UNIT OF MEASURE	UNIT PRICE	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	
ROAD WORKS																					
Road Widening (1.5m av.)	l. m.	$ 210.00	160	$ 33,600.00		$ -	190	$ 39,900.00	220	$ 46,200.00	240	$ 50,400.00	185	$ 38,850.00		$ -		$ -		$ -	$ 208,950.00
Multi-Use Pathway (3.0m)	l. m.	$ 200.00	50	$ 10,000.00	255	$ 51,000.00	190	$ 38,000.00	220	$ 44,000.00	240	$ 48,000.00	185	$ 37,000.00		$ -		$ -		$ -	$ 228,000.00
Pavement Restoration	sq. m.	$ 62.00		$ -	880	$ 54,560.00	2840	$ 176,080.00	3520	$ 218,240.00	2770	$ 171,740.00	2170	$ 134,540.00	5840	$ 362,080.00		$ -	9680	$ 600,160.00	$ 1,717,400.00
Corner Ramp	ea	$ 10,000.00	1	$ 10,000.00	5	$ 50,000.00	4	$ 40,000.00	6	$ 60,000.00	4	$ 40,000.00	4	$ 40,000.00	10	$ 100,000.00	2	$ 20,000.00		$ -	$ 360,000.00
Concrete Sidewalk (2.0 m)	l. m.	$ 175.00		$ -		$ -		$ -		$ -		$ -	65	$ 11,375.00	470	$ 82,250.00	25	$ 4,375.00		$ -	$ 98,000.00
Curb and Gutter	l. m.	$ 150.00	0	$ -	255	$ 38,250.00	490	$ 73,500.00	570	$ 85,500.00	670	$ 100,500.00	530	$ 79,500.00	350	$ 52,500.00	25	$ 3,750.00		$ -	$ 433,500.00
Bus Stop	L.S.	$ 15,000.00		$ -		$ -	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	2	$ 30,000.00	3	$ 45,000.00	4	$ 60,000.00		$ -	$ 180,000.00
Driveway Connections	ea	$ 1,250.00		$ -		$ -	7	$ 8,750.00	8	$ 10,000.00	11	$ 13,750.00	5	$ 6,250.00		$ -		$ -		$ -	$ 38,750.00
Landscaping/Rain Garden/Irrigation	sq. m.	$ 85.00		$ -	220	$ 18,700.00	1020	$ 86,700.00	920	$ 78,200.00	820	$ 69,700.00	720	$ 61,200.00	510	$ 43,350.00	125	$ 10,625.00		$ -	$ 368,475.00
Miscellaneous Removals	L.S.			$ 10,000.00		$ 15,000.00		$ 15,000.00		$ 20,000.00		$ 20,000.00		$ 20,000.00		$ 20,000.00		$ 5,000.00			$ 125,000.00
Miscellaneous Grading/Retaining walls	L.S.	$ 100.00	40	$ 4,000.00	255	$ 25,500.00	190	$ 19,000.00	220	$ 22,000.00	240	$ 24,000.00	185	$ 18,500.00	350	$ 35,000.00	0	$ -			$ 148,000.00
Line Painting and Signing	L.S.	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 20,000.00	$ 140,000.00
																					$ 4,046,075.00
UTILITIES																					
Storm																					
Storm General Upgrades	l. m.	$ 200.00		$ -	255	$ 51,000.00	190	$ 38,000.00	220	$ 44,000.00	240	$ 48,000.00	185	$ 37,000.00		$ -		$ -		$ -	$ 218,000.00
Surface Drainage (CB's)	L.S.	$ 12,000.00		$ -	0.5	$ 6,000.00	1	$ 12,000.00	1	$ 12,000.00	1	$ 12,000.00	1	$ 12,000.00		$ -		$ -		$ -	$ 54,000.00
Storm Water Management	L.S.	$ 10,000.00		$ -	1	$ 10,000.00		$ -		$ -		$ -		$ -	1	$ 10,000.00		$ -		$ -	$ 20,000.00
450mm Dia. Storm Pipe	l. m.	$ 550.00		$ -		$ -		$ -		$ -	61	$ 33,550.00		$ -		$ -		$ -		$ -	$ 33,550.00
600mm Dia. Storm Pipe	l. m.	$ 700.00		$ -		$ -		$ -		$ -	84	$ 58,800.00		$ -		$ -		$ -		$ -	$ 58,800.00
750mm Dia Storm Pipe	l. m.	$ 900.00		$ -		$ -		$ -		$ -		$ -	214	$ 192,600.00		$ -		$ -		$ -	$ 192,600.00
900mm Dia. Storm Pipe	l. m.	$ 1,100.00		$ -		$ -		$ -		$ -		$ -	20	$ 22,000.00	80	$ 88,000.00		$ -		$ -	$ 110,000.00
Storm Manhole	ea	$ 7,500.00		$ -		$ -		$ -		$ -	2	$ 15,000.00	2	$ 15,000.00	2	$ 15,000.00		$ -		$ -	$ 45,000.00
Water																					
250mm Dia. PVC	l.m.	$ 700.00		$ -		$ -		$ -		$ -		$ -	105	$ 73,500.00	420	$ 294,000.00	425	$ 297,500.00		$ -	$ 665,000.00
Valve Assembly	ea	$ 12,000.00		$ -		$ -		$ -		$ -		$ -	1	$ 12,000.00	3	$ 36,000.00	1	$ 12,000.00		$ -	$ 60,000.00
Services Upgrades	ea	$ 1,750.00		$ -		$ -		$ -		$ -		$ -	4	$ 7,000.00	13	$ 22,750.00	23	$ 40,250.00		$ -	$ 70,000.00
Miscellaneous																					
Misc. Adjustments	L.S.	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 10,000.00	$ 30,000.00
Power/Comm																					
Hydro/Tel Relocates	L.S.	$ 20,000.00	0	$ -	1	$ 20,000.00	1	$ 20,000.00	1	$ 20,000.00	1	$ 20,000.00	1	$ 20,000.00	1	$ 20,000.00		$ -		$ -	$ 120,000.00
																					$ 1,676,950.00
ELECTRICAL																					
Street Lighting	L.S.	$ 50,000.00	1	$ 50,000.00	1	$ 50,000.00	1	$ 54,000.00	1	$ 54,000.00	1	$ 50,000.00	1	$ 50,000.00	1	$ 50,000.00	1	$ 50,000.00		$ -	$ 408,000.00
New Traffic Signal	L.S.	$ 200,000.00		$ -		$ -		$ -	0.05	$ 10,000.00	1	$ 200,000.00		$ -		$ -	1	$ 200,000.00		$ -	$ 410,000.00
Ex. Traffic Signals Upgrades	L.S.	$ 50,000.00		$ -	1	$ 50,000.00		$ -	1	$ 50,000.00		$ -	1	$ 50,000.00	1	$ 50,000.00				$ -	$ 200,000.00
																					$ 1,018,000.00
SUBTOTALS				$ 135,100.00		$ 457,510.00		$ 653,430.00		$ 806,640.00		$ 1,007,940.00		$ 985,815.00		$ 1,343,430.00		$ 721,000.00		$ 630,160.00	**$ 6,741,025.00**
Contingency	Construction	30%		$ 40,600.00		$ 137,300.00		$ 196,100.00		$ 242,000.00		$ 302,400.00		$ 295,800.00		$ 403,100.00		$ 216,300.00		$ 189,100.00	**$ 2,022,400.00**
Engineering/Environmental	Engineering	5%		$ 6,800.00		$ 22,900.00		$ 32,700.00		$ 40,400.00		$ 50,400.00		$ 49,300.00		$ 67,200.00		$ 36,100.00		$ 31,600.00	**$ 337,100.00**
TOTALS				$ 182,500.00		$ 617,710.00		$ 882,230.00		$ 1,089,040.00		$ 1,360,740.00		$ 1,330,915.00		$ 1,813,730.00		$ 973,400.00		$ 850,860.00	**$ 9,101,125.00**