City of Terrace

Pedestrian Overpass Concept Design and Feasibility Study

Final Report

June 18th, 2018

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PARSONS

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June 18th, 2018

David Block, Director of Development Services
City of Terrace
5003 Graham Ave.
Terrace, BC V8G 1B3

Subject: Pedestrian Overpass Concept Design & Feasibility Study Report – Final Report Submission

Parsons Ref No: 476699

Dear David,

Please find enclosed Parsons Inc.'s final 'Pedestrian Overpass Concept Design and Feasibility Study' report regarding the proposed pedestrian crossing of CN's yard at Kalum Street within the City of Terrace (the City). The two undersigned British Columbia registered Professional Engineers have been included at all stages during the preparation of this report. They have to the best of their knowledge, based on the information available at the time of submission, supervised and undertaken the production of a sound report upon which decisions regarding the future of this proposed pedestrian overpass can be made by the City.

It has been a pleasure working with the City on this assignment. Thanks again for the opportunity to consult on this proposed pedestrian overpass. We look forward to making our presentation of this project / outlining our final report to your Mayor and City Council on June 25th. Please do not hesitate to call or e-mail with any questions or further work-requests as you go forward with this project and please note our keen interest in continuing the assignment into preliminary and detailed bridge design.

Sincerely,

PROFESSIONAL PROVINCE OF P. C. PHILLIPS # 35547 BRITISH COLUMBIA ENGINEER

2018/06/18

Peter Phillips, M.Eng., P.Eng.,

Project Manager

PROFESSIONAL PROVINCE OF A. MOROZ # 46625 BRITISH COLUMBIA ENGINEER

2018/06/18

Alexander Moroz, P.Eng.,

Bridge Engineer

Executive Summary

Parsons Inc. (Parsons) was retained by the City of Terrace (the City) to undertake a feasibility and conceptual design of a pedestrian overpass at Kalum Street over the existing CN railyard to increase safety, accessibility, and connectivity in the community. The primary goals of this project are to asses the feasibility of a pedestrian overpass at this specific location, develop a conceptual design option with architectural rendering, and provide a +/-20% construction capital cost estimate along with a lifecycle cost estimate.

The CN railyard consists of mainline and siding tracks. This location historically had an at-grade crossing of CN's property and the local communities developed along this crossing route as it provided connectivity between the north and south sides of the track. In the late 1970s, this crossing was removed to accommodate the expansion of CN's railyard, thus creating a separation in the community. There are currently limited safe crossing opportunities of CN's property in Terrace and several fatalities have occurred in recent years due to illegal "goat-trail" crossings. Previous studies have identified the need for additional crossings of CN tracks, including at this specific location. Parsons reviewed previous City planning documents which support the need for a pedestrian overpass at this location.

The most challenging aspect of an overpass at this location is construction and erection of a mainspan structure over 15 active CN tracks. Minimum span lengths are in the order of 80 m considering CN clearance requirements. Parsons engaged with CN regarding this project. Although CN is strongly in support of an overpass to increase safety, they do not currently accept any options near Kalum Street which have City infrastructure placed on their property. The three alignments considered in this study all have at least some infrastructure on CN property, especially the preferred Alignment A. Without access to CN lands, any potential alignment will have significantly increased costs and complexity and be undesirable from sightline and urban realm perspectives. Therefore, the City has elected for this study to proceed assuming access to CN lands can be obtained with appropriate future City-CN engagement and negotiation. Parsons strongly recommends that the City engage CN in property acquisition discussions immediately within preliminary design.

Three alignments near Kalum Street were developed by the entire Project Team during Parsons' site visit to the City of Terrace on April 9th, 2018. These options were further evaluated, and Alignment A was found to be the preferred option for many reasons, which was consistent with the City's preference. Alignment A consists of a mainspan just to the west of Kalum Street with ramps landing on the old Co-op property to the north and in the existing CN storage yard on the south. The alignment utilizes ramps and stairs at both ends of the mainspan structure to provide direct connectivity to Kalum Street, the Grand Trunk pathway, and the George Little House. The ramps provide the required access across the tracks for reduced mobility users and bicyclists. A steel through-truss or steel arch type structure was considered for the mainspan in order to help manage erectability issues and costs: i.e. keeping a relatively light weight to mainspan length ratio, which can potentially be lifted into place over the tracks in one piece, and having a shallow superstructure thickness below the top of mainspan deck to keep the structure as low as possible over the tracks and accordingly the bridge ramp lengths as short as possible, will help with erectability and/or costs. An arch type structure was selected as the proposed structure type in consultation with the City and is considered by Parsons to be a cost-effective crossing solution for this site.

In terms of maintenance, the City preferred a weathering steel mainspan structure to a painted structure due to the high lifecycle costs associated with re-coating the span over live CN traffic. As well, the geometry of the ramps was designed so that the City can drive their snow plow vehicles on the structure, including turnaround areas at the ends of the mainspan. The north turnaround area will double as a viewing platform with wayfinding features as it will have a key view of the downtown core as well as the mountains surrounding the City.

Based on the background, code, standard, and best-practice information reviewed, and our discussions with City staff as part of this study, Parsons recommends that the City continue to pursue the proposed pedestrian overpass at the Kalum Street location to provide a crossing of the tracks which will greatly increase safety, accessibility, connectivity in the community, and benefit the overall public realm in general. The +/-20% capital cost calculated by Parsons for this recommendation is $11.6M which is on the low end of the previous high-level estimate of $10-15M made by others. Parsons has significant experience in planning, designing, and monitoring construction of pedestrian overpass structures such as this and would be more than happy to help the City continue this project forward.

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1.0 Introduction

The City of Terrace (the City) has engaged Parsons Inc. (Parsons) to undertake a feasibility study and conceptual design of a pedestrian overpass across the existing CN mainline and siding tracks at Kalum Street, see **Figure 1**.

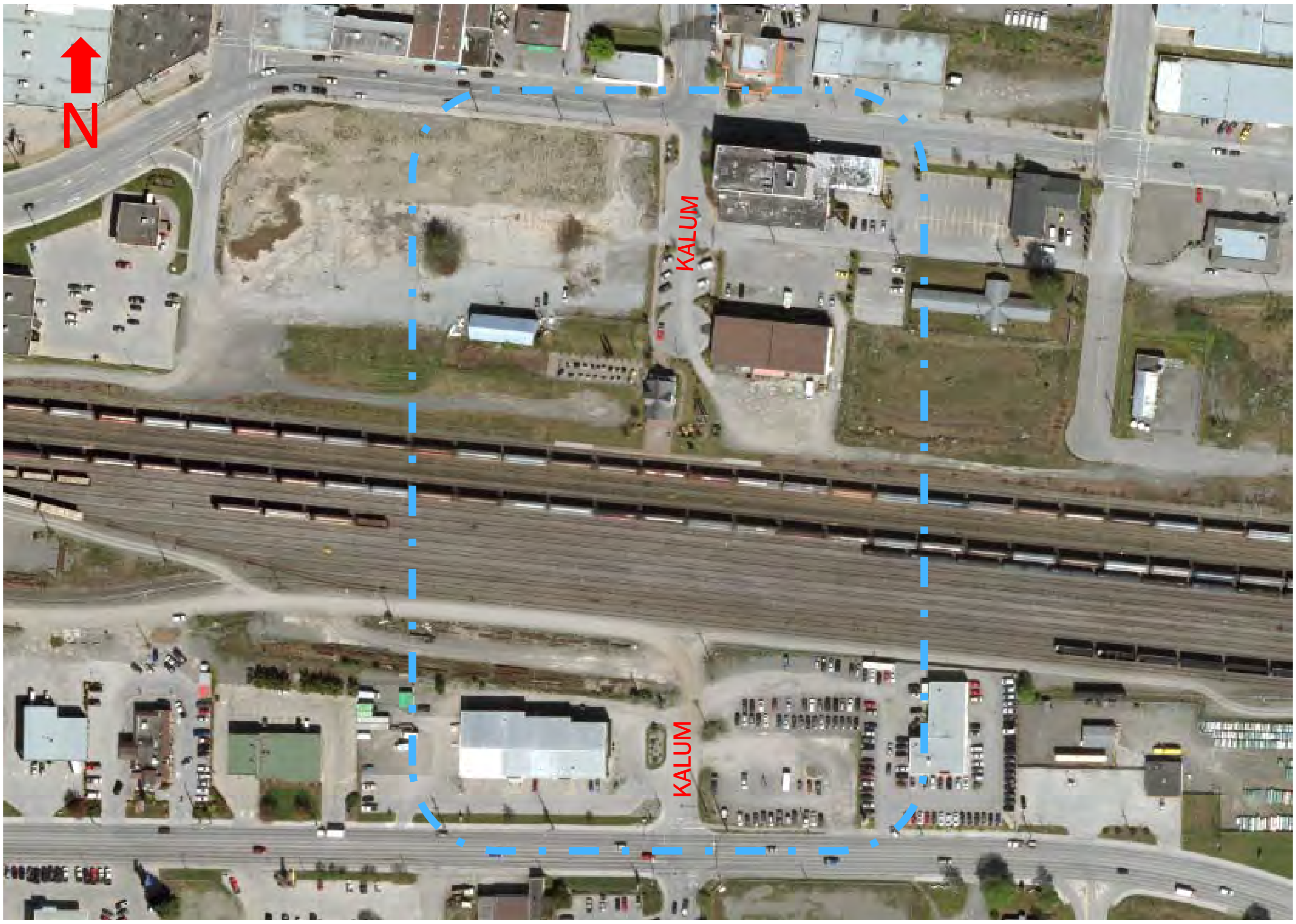

Figure 1 – Study Area

This location historically had an at-grade crossing of CN's property. The local communities developed along this crossing route as it provided necessary connectivity to the north and south sides of the tracks. In the late 1970s, this crossing was removed to accommodate the expansion of CN's railyard, creating a separation in the community. There are currently limited safe crossing opportunities of CN's property in Terrace and several fatalities have occurred in recent years due to illegal "goat-trail" crossings. Previous studies have identified the need for additional crossing opportunities, specifically at this location.

The City has not had a detailed study for a pedestrian overpass at this location. Previous planning documents completed by others give a very high-level cost estimate in the range of $10-15 million.

The feasibility study includes the following:

- Review of all relevant documents currently in existence for the site;
- Recommendations for investigations to supplement the current available information, where required;
- Assessment of current and future demands for a pedestrian overpass at this location;

- Understanding the site, economic, and socio-cultural constraints to a new pedestrian overpass' ultimate construction and providing solutions to such constraints;
- Preparation of risk assessments for the site; and
- Coordination with the City and CN.

The Conceptual Design includes the following:

- Creation and preliminary analysis of possible alignments and structural types for the proposed overpass;
- Conceptual design of one alignment, profile and mainspan structure type;
- Proposed construction sequence;
- High quality rendering showing the proposed overpass structure;
- 2-3 engineering drawings showing basic structural information of the proposed concept;
- Construction cost estimates;
- Lifecycle costs for the proposed structure; and
- Final resolution of any constraints identified during the feasibility studies and preparation of draft and final reports.

1.1 OBJECTIVES

The primary objectives of this study are to:

- Confirm the feasibility of placing a pedestrian overpass at this location to increase safety, accessibility, and connectivity within the City;
- Give the City a true understanding of the challenges involved in constructing the proposed overpass and identifying future tasks to be undertaken as part of preliminary design; and
- Give the City a detailed cost estimate, +/- 20% for constructing the proposed overpass.

Regular biweekly meetings were had between the City and Parsons to discuss and come to decisions surrounding the challenges of this assignment, to effectively and efficiently meet the above objectives. See Appendix G for the meeting minute records of these meetings. The meeting minutes are a source for further background on the various items studied as part of this assignment and on the reasons for the decisions made by the project team and are considered integral records to this work.

2.0 Site Information

The proposed pedestrian overpass is to cross the existing CN yard and siding tracks within the vicinity of Kalum Street. There is a total of 15 tracks to cross at this location. The next available crossing for pedestrians is at the Sande overpass which carries Highway 16, approximately 640 m to the west

The general site is characterized by:

- CN's mainline and siding running east-west, dividing the City into northern and southern halves;
- Large gaps in fencing along the length of the CN yard, allowing illegal crossing of the tracks (this has resulted in fatalities);
- Downtown area immediately north of CN;
  - The City owns the property to the west of Kalum Street and is currently not developed. Plans are to develop this area with commercial services including a future museum, plaza, potentially a continuation of the Grand Trunk Pathway, and possibly a hotel;
  - The property to the east of Kalum is partially developed;

- Commercial service area immediately south of CN, which is fully developed; and
- Residential areas beyond the immediate north and south areas.

2.1 TOPOGRAPHIC INFORMATION

The City of Terrace has provided 1 m contours (from 2013), cadastral, and utilities information for the project area. No additional surveys were undertaken as this is outside the scope of this study. Parsons will identify any missing information which is to be obtained during the preliminary design stage should the City proceed with constructing the proposed pedestrian overpass.

The information provided by the City will be used for the bridge alignments and profiles. The project site is generally flat; most of the 1 m contours within the project area are at the same elevation making it difficult to quantify the effect on ramp length from changes in elevations less than 1 m. A 1 m elevation change corresponds to 20 m of ramp at 5% grade. Conservative increases in ramp length will be made based on site observations for the purpose of this study.

It is recommended that in preliminary design, a topographic survey be taken of the immediate project area, including contours at 0.25 m intervals.

2.2 HYDROLOGY INFORMATION

The project area is approximately 650 m from the Skeena River and 10 m above the water level of the river. The Floodplain Hazard Assessment, as presented in the *Appendix D – Floodplain Hazard Assessment* of the OCP, shows that the project area is outside of the 200-year floodplain. A hydrology study is outside the scope of this study.

It is recommended that actual ground water levels are determined for the preliminary design stage.

Parsons obtained precipitation data for the City of Terrace from Environment Canada. The maximum monthly rainfall from the data obtained was 132 mm in November and the maximum monthly snowfall was 88 cm in January. The precipitation information obtained from Environment Canada will be utilized for recommending drainage feature sizes and provide input to snow removal considerations on the structure in preliminary and detailed design.

2.3 GEOTECHNICAL INFORMATION

There is no geotechnical information available for the project area and site investigation/geotechnical consultation is outside the scope of this project. Parsons scope of work included a desk study of the proposed pedestrian overpass. The description of the structural type, bridge design, bridge construction, alignment consideration, and construction cost estimate, etc. is primarily based on the topographical condition, site constraints and previous similar projects experience. A normal soil condition and common foundation type, in the form of concrete piles, is assumed for the proposed overpass and included in this conceptual design report. It is to be noted that the geotechnical condition can have large impacts on the bridge design and construction. For the purpose of cost estimation, a concrete pile foundation system is assumed for the approach span and mainspan.

An in-depth geotechnical investigation (including physical site investigations/drilled bore holes) would have to be undertaken as part of the preliminary design stage.

Figure 2 taken from 'BC Geological Survey, Geofile 2007-10, Geotour guide for Terrace, BC' gives some general insight to the geological profile of the City of Terrace. This figure would suggest that the upper soil profile consists of gravel material overlaying a thick clay and slit layer which includes a gravel aquifer overlaying bedrock, however this does not provide insight to the local soil profile.

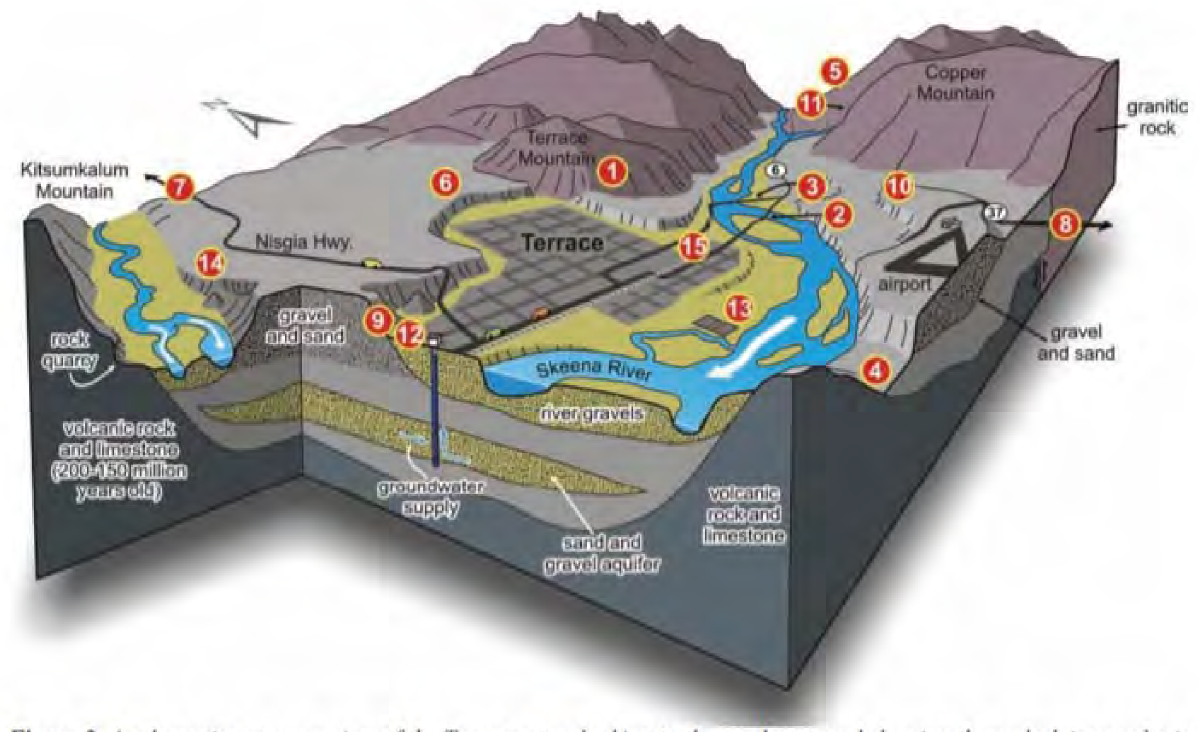

***Figure 2.** A schematic cut-away view of the Terrace area looking to the northeast, and showing the underlying geological materials. Circled numbers indicate the location of **Geotour** stops discussed in the guide.**1.** Terrace Mountain lookout. **2.** Ferry Island Park river gravels. **3.** Old Bridge and Skeena River. **4.**Old Remo Road Limestone. **5.** Kleanza Creek Provincial Park. **6.** Heritage Park Museum mining displays. **7.** Nass Valley lava flow. **8.** Mount Layton hotsprings. **9.** Sand and gravel quarry. **10.** Concrete plant, Thornhill. **11.** Copper River landslide. **12.** Frank Street municipal water well. **13.** Municipal wastewater treatment plant. **14.** Municipal landfill. **15.** Gasoline rail terminal.*

Figure 2 – Geological Profile of the City of Terrace. Taken from ‘BC Geological Survey, Geofile 2007-10, Geotour guide for Terrace, BC.’

2.4 SEISMIC HAZARD

The seismic hazard, as determined by the Geological Survey of Canada and accessed through http://www.earthquakescanada.nrcan.gc.ca//index-en.php is considered relatively low for the project area. The peak ground acceleration (PGA) at the site is 0.072 g for a 2% probability of occurrence in 50 years. For reference, Vancouver (high seismic hazard) has a PGA of 0.367 g and Winnipeg (low seismic hazard) has a PGA of 0.032 g.

The soil conditions also play a part in assessing the seismic hazard of a site. Hard rock conditions would decrease the effects of an earthquake on a structure while soft soil conditions would amplify it. As part of the geotechnical investigation, the site soil class will need to be determined for seismic design considerations.

The importance category as defined in the Canadian Highway Bridge Design Code of the proposed structure for the City of Terrace would be Other. However, as this structure would be crossing critical CN infrastructure, CN has designated this crossing as a major-route. The importance category is used to define the seismic design requirements for a given structure, which would be determined in preliminary design based on the proposed structure’s seismic behaviour and seismic hazard. Considering the corresponding spectral value of S(1.0) = 0.12 for the project site location and assuming a fundamental period of the proposed bridge is larger than 0.5 sec, the seismic performance category 2 is obtained in accordance with CHBDC S6-14. A performance-based design approach will be undertaken for the seismic design of the proposed pedestrian overpass.

2.5 UTILITIES

The location of existing and above ground utilities was identified through the information provided by the City (sanitary, storm and water) and by making a locate request to BC One (PNG (Gas), Telus, BC Hydro and Citywest Cable). No information regarding City street lighting or traffic was made available, these utilities are not expected to be within the project area.

It was observed on site that CN has overhead utilities within their yard, to the west of the study area. As we have found on previous pedestrian bridge projects, utility locations can have a dramatic effect on the planning of alignments and profiles.

Discrepancies in overhead pole locations between Telus, Hydro, and aerial images were noted when overlaying the information. This is expected considering the information provided by these utilities is approximate and not guaranteed. For this study, the information is sufficient as the general location of utilities were identified and conservative setbacks can be considered. In general, Parsons maintains 3.0 m setbacks between structures and utilities as a minimum.

Just west of the George Little House, the TELUS locates show a building entrance terminal symbol (looks similar to a ground rod symbol). Parsons contacted TELUS who indicated this is a building entrance terminal and would be on or in the building, not in the empty area as shown on the locate.

Along the Kalum Street right-of-way between Highway 16 and Greig Avenue, including through the CN yard, there are a considerable number of underground utilities: Telus copper and fiber optic cables, PNG gasmain, City water and City sanitary. These utilities discourage the option of placing any structural foundation on the Kalum Street right-of-way. There is a BC Hydro overhead on the east side of Kalum, crossing the CN tracks which discourage any structure spanning east to west over the Kalum Street right-of-way.

On the south side of the CN yard, west of Kalum there are overhead Telus and BC Hydro lines, and buried City water, storm and sanitary.

Along Emerson Street, including through the CN yard, there is a buried 1500 mm CSP stormwater main. Please see *Appendix A* for utility site plan.

A detailed locate survey of underground utilities should be undertaken as part of preliminary design, in conjunction with the topographic survey.

2.6 LAND OWNERSHIP

The City owns the land to the north of CN, west of Kalum Street, referred to as the old co-op property. This land is currently undeveloped for the most part. The Garden Shed building in the southeast quadrant is expected to be removed prior to any further development. Tiny Town is in the same quadrant, which is not owned by the City and is expected to eventually be relocated. The City intends to develop the majority of this land with commercial property, a future museum and a plaza. The parcel running east-west on the south side of the co-op property presents an ideal location for a north approach ramp as it is understood there are no current plans for this parcel and it is adjacent to the CN property.

The property north of CN and east of Kalum Street is private and hosts a commercial building that includes Sears (closing) and a bottle return depot. Further east of this, the property is undeveloped private property.

The George Little House is located on a fee-simple parcel on a closed, former historical road/highway dedication (Kalum Street) immediately north of CN property. The George Little House also hosts the VIA station.

The south side of CN is fully developed commercial services properties.

CN's property/right-of-way is roughly 90 m wide at the study location adjacent to Kalum Street. There is a CN storage yard on the south side, just west of Kalum Street which would present a favorable location to put the structure's abutments and south approach ramps. Kalum Street on the south side of CN provides an access road for CN vehicles to the east and west.

See *Appendix A* for property plan of the site area.

2.7 CN

Parsons complied a series of questions regarding the proposed overpass at Kalum Street and forwarded them to CN for review and comment. See *Appendix F* for the document Parsons sent to CN and CN's standard clearance envelope requirements. CN's response to Parsons' questions regarding the project are summarized here.

CN is strongly in support of the project as it will increase safety in the area. However, they currently do not accept any options which place City infrastructure onto their right-of-way. This includes the acquisition of the storage yard on the southwest side of Kalum Street for any ramps.

This yard is a switching yard and has continuous activity 24/7 and at least 12 trains pass through per day. Planned expansion is not currently confirmed but this can change from year to year.

Use of the yard and tracks during construction for limited time(s) for installing the mainspan by crane(s) or using temporary supports would be possible. Certain types of work, including lifting over active traffic would be allowed by CN. The erection procedure and all work activity within CN would have to be reviewed in detail by CN and how it would affect their operations. If the yard/tracks are to be used, there would be associated costs. In addition, the City would have to cover the costs of flaggers when construction activities are taking place within CN Right-of-Way.

All Transport Canada and CN standards are to be followed within CN property. Snow removal and water drainage on the proposed structure would need to be designed such that it does not impact CN Right-of-Way. CN has stated that a full enclosure of the overpass would be preferred. A 2.4 m high railing system, with spaces no bigger than 50 x 50 mm, will be used as this will provide a preferable pedestrian experience compared to a full enclosure. The mainspan railing can also be designed as a means-prevention railing.

A formal review of any proposed structure would be required by CN and there would be an associated cost for this review.

2.7.1 FENCING ALONG CN

There are several gaps in the fencing along CN property which allow illegal crossing of the tracks, as shown in Figure 3 which was provided by the City. Some (north side only) of the existing fencing is owned and maintained by the City. It is understood that CN is considering a proposal for additional fencing along the CN property. Fencing the remaining gaps is critical to the feasibility of putting a pedestrian overpass in this location. If the gaps in the fence remain, those who currently cross the tracks may continue to do so as the pedestrian crossing will still pose a longer route across. This will also require that the access roads to CN's property be gated. CN is in support of installing additional fencing in the area as part of the proposed overpass to increase safety and prevent trespassing.

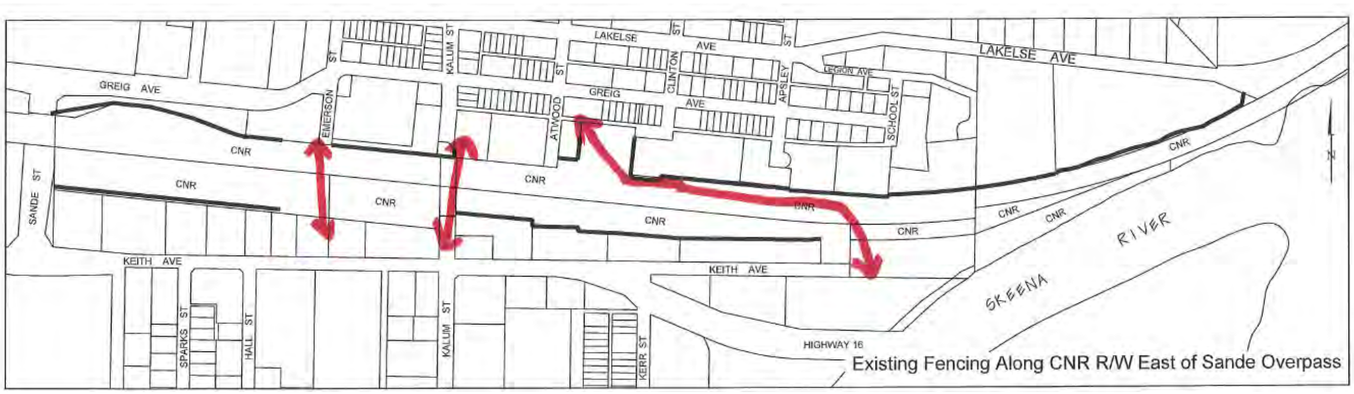

Figure 3 – Sketch showing existing fencing and goat-trails across CN property (provided by the City).

The type of fencing should be robust and include:

- Thick gauge metal and/or welding which cannot be easily cut;
- Small apertures which would not allow persons to pass through the fences or discard garbage through the fences;

- Tall enough that lobbing garbage into the rail corridor would be prohibited;
- Apertures of reasonable size to maintain good sightlines;
- Aperture with long axes oriented vertically to prevent climbing;
- Strong stable foundations which would prevent the fences from being tipped-over;
- Aesthetic characteristics to match the site and landscaping in the fences near the approaches to the bridge;
- Corrosion resistant details;
- Maintenance-free detailing; and
- Avoid paneling to prevent graffiti.

Figure 4 below shows examples of 8 ft high robust fencing.

Figure 4 – Examples of Robust fencing for along CN.

3.0 Summary of Requirements

The following sections identify the various requirements that will be applicable to the structure, based on discussions with the City, applicable codes and standards and best practices. It also includes a review of available background information regarding the project.

3.1 CODE REQUIREMENTS

The City of Terrace does not have their own standards regarding pedestrian bridge design. The Pedestrian overpass will be designed in accordance with the following standards and codes, and industry best practice:

- The Canadian Highway Bridge Design Code (CHBDC), latest edition;
- LRFD Guide Specification for the Design of Pedestrian Bridges, latest edition;
- BC MoTI Bridge Standards and Procedures Manual, Volume 1 Supplement to CHBDC S6, latest edition;
- BC Access Handbook, latest edition;
- BC MoTI Standard Specifications for Highway Construction Volume 1 & 2;
- The City of Terrace Active Transportation Plan, latest edition;

- Downtown Plan, City of Terrace, latest edition;
- Transport Canada Standards Respecting Railway Clearances, May 14, 1992 (TC E-05) and CN Protection and Minimum clearances for Overhead Bridges standard K1U-10.2 m.

3.2 BACKGROUND REPORTS

The following reports were made available to and reviewed by Parsons:

- Transportation Master Plan, City of Terrace (2017);
- Terrace Transportation Corridor Study (2009);
- City of Terrace Zoning Bylaw No. 2069-2014;
- Parks and Recreation Master Plan, City of Terrace (2015);
- Official Community Plan, City of Terrace (2018);
- Grand Trunk Pathway Master Plan (2008);
- Active Transportation Plan, City of Terrace (2009);
- Terrace 2050 Buildings and Transportation;
- Downtown Plan, City of Terrace (2008);
  - It is understood that the Downtown Plan is being updated at the time of this study. Based on discussions with the City, updates are not anticipated to have an impact on this project.

In addition to the provided documents, Parsons made use of the City's online GIS mapping software, Terramap.

3.3 SLOPES, HEIGHTS, AND SPACE LIMITATIONS

3.3.1 SLOPES AND HEIGHTS

This bridge will be raised so that the underside of its deck soffit clears the CN Rail clearance envelope of 7.01 m provided to Parsons by CN Rail, see *Appendix F Protection and Minimum Clearances for Overhead Bridges* standard drawing. The design of a new structure will need to be coordinated with CN Rail's engineering department.

The longitudinal profile of the mainspan of a new bridge will consist of a parabolic curve with a 5% slope at each of the abutments and reach an apogee at its middle. At this site, Parsons will attempt to have all approach structures remain under 5% so that landings will not be required – i.e. as 5% is the desirable grade for accessibility. However, providing 8.33% slopes to the approach ramps with intermediate landings would greatly shorten the overall length of the structure and thus reduce costs. The recommended distance between landings along a ramp is 9 m, consistent with BC Access Handbook and best practices of other Cities. There are locations along the Grand Truck Pathway which currently have slopes at 8.33% with regular landings. Therefore, providing this grade on the structure ramps would be consistent with other parts of the City's pathway infrastructure and was pursued further in this study.

The slope on the turns of the approach ramps will be limited to 2% to make the turn manageable for reduce mobility users.

<u>*Transverse slopes:*</u> All bridges and pathways will be crowned with a 2% cross fall to facilitate drainage.

3.3.2 SPACE LIMITATIONS

Potential conflicts with existing utilities have already been presented, see Section 2.5. Given that the City only owns property at the northwest quadrant of the project site, obtaining access to land from CN or private property owners on the south side is necessary to construct this pedestrian overpass and will have a significant (if not deciding) impact on the chosen alignment. See Section 2.6 for details on land ownership.

Set Back from Tracks: Transport Canada *Standards Respecting Railway Clearances May 14, 1992 (TC E-05)* and CN Standard *Protection and Minimum Clearances for Overhead Bridges* (see *Appendix F*) identifies that any structure must be no less than 7.925 m from the centerline of a track where a maintenance road is required. Further, crash walls or crash wall designs for the substructure can be omitted if the substructure is 8.0 m or more from the centerline of the track, based on best practices. Therefore, any substructure components will be placed at least 8.0 m from the centerline of the track.

Other Clearances*:* There is no specified minimum clearance to overhead power lines, but the intent is to keep a reasonable distance from bridge users to prevent any possibility of coming into contact with the lines, even if reaching out purposely with a 2 m long object. The overhead lines will also not be able to sway in the wind far enough to come into contract with any part of the bridge. Any structure within 10 m of BC Hydro infrastructure will need to be reviewed by BC Hydro on a case by case basis.

Bridge Clearance Envelope*:* The clear width of the pedestrian overpass will be 3.0 m, consistent with the Active Transportation Plan, Grand Trunk Master Plan, and best practices. The vertical clearance, measured from the top of the deck, along the pedestrian overpass is recommended to be 3.0 m, consistent with best practices.

3.3.3 MAINSPAN AND STRUCTURE LENGTH

The mainspan will need to be above the CN Clearance envelope of 7.01 m over a distance of at least 75 m (minimum perpendicular distance over tracks plus CN horizontal envelope for maintenance access). The actual elevation of the existing top of rail is unknown, but there appears to be minimal height in the ballast bed as observed during the site visit, therefore the top of rail is assumed to be the height of the rail above the existing ground. For estimating ramp lengths, an 8.0 m height is assumed between the top of ground and the top of the deck. The actual clearance height will have to be determined in preliminary design based on existing top of rail elevation, existing ground elevation, deflection of the mainspan and depth of structural members below the top of deck.

If 5% grades are used the structure would have a total length in the order of 400 m. If 8.33% grade with regular landings every 9.0 m are used, the structure would have a total length in the order of 300 m. Other aspects such as skew of the mainspan over CN, actual position of the abutments and local changes in elevation will affect the actual length of the structure.

The slopes, heights and span lengths will be detailed for the final chosen alignment.

3.4 STAIRCASES

Staircases for quicker access and egress by pedestrians should be provided in addition to sidewalks/ramps. This is particularly important given long anticipated lengths of the approach ramps. Providing stairs allows significant travel time savings for able-bodied users approaching the bridge from the opposite direction of the ramps. Providing multiple and convenient access opportunities at this site is particularly important to prevent cross-cutting behaviour through CN Rail property, as currently observed.

Straight stairs are preferred so as to eliminate any hiding spots associated with a switch-back style stair case. To minimize snow removal effects on the stairs, an open grating type system will be used.

The rise/run of the steps used will be 165/305 mm (54.1% grade). The NBCC and BC Accessibility Handbook allows for a rise/run of 180/280 mm (64.3% grade), however Parsons has learned from other pedestrian overpass projects that this grade is too steep for most users. Stair width will be a minimum 3.0 m wide. Cycle wheel ramps on stairs for bicycles will be provided to allow a more direct route for users as well. The maximum height between landings will be 3.7 m, consistent with the NBCC and BC Building Access Handbook. This results in an overall grade of 44% for the stairs.

3.5 STAKEHOLDERS IDENTIFIED

The following stakeholders have been identified for this project:

- CN Rail;
- VIA/George Little House;
- Utilities;
  - Telus;
  - BC Hydro;
  - PNG; and
  - Citywest Cable.

3.6 CURRENT AND FUTURE POPULATION AND EMPLOYMENT

The 2018 Official Community Plan (OCP) based on the 2011 census, shows that the City of Terrace's population is composed of 68% Caucasian, 22% Aboriginal and 11% Immigrants. Among these, 15% are seniors, 18% are under the age of 15 and 67% correspond to the working-age population.

For the 2025 population conditions based on a 2015 survey carried out by the City of Terrace, the OCP evaluates three different scenarios ranging from the low to high growth. The results of those three scenarios are shown in **Table 1** below.

Table 1 – Projected Population Growth, Reproduced from the OCP

Population	Period	Period Growth Increase
12,494	2015	
19,011	2015-2031	2.85% *
13,823	2015-2025	10.6% Low
16,061	2015-2025	29% Medium
19,105	2015-2025	54% High

*** Natural growth trend per year under the existing conditions.**

Regarding 2025 employment perspectives, the OCP evaluates the same three growth scenarios. In the low growth scenario, a manufacturing facility is built at the Skeena Industrial Development Park, along with a regional mine. This scenario presume that the regional economic activity continues at existing levels. For the medium growth scenario three manufacturing facilities are built at the Skeena Industrial Development Park, along with two regional mines, and one LNG facility with associated pipelines; and finally, for the high growth scenario, ten manufacturing facilities are built at the Skeena Industrial Development Park along with two regional mines, and three LNG facilities with their corresponding pipelines. A detailed description of the assumptions regarding employment and growth can be found in the 2018 OCP.

3.7 CURRENT AND FUTURE TRANSPORTATION NETWORKS AROUND THE SITE

For the purpose of this study, the transportation network is classified according to the mode of transport: private car, public transit, walk, and bicycle being primary modes of transportation by the population.

Currently, there are only three crossings for walking users between the north and south parts of the city, all are west of the proposed crossing at Kalum Street. These crossings are located at Frank Street, Kenney Street and Sande Street. The lack of north-south crossing infrastructure east of the Sande Street overpass is causing unauthorized and unsafe crossings over the CN rail tracks along Emerson Street, Kalum Street, Atwood Street and School Street. For cycling infrastructure, based on data obtained from the 2018 OCP, there is only one officially designated and existing crossing location connecting the north and south sides of the City, located at Kenney Street. However, in the OCP, new designated crossings at Frank Street and Sande Street overpass are proposed. These two locations can be used by cyclists, but there is no existing cycling infrastructure at these locations.

The OCP documents the existing and proposed roadway network infrastructure (Schedule D in the OCP), sidewalk/pathway infrastructure (Schedule E in the OCP) and cycling infrastructure (Schedule F in the OCP). The OCP proposes a pedestrian only crossing at Kalum Street and a cyclist crossing on the west side of the City at Frank Street. Given that the proposed crossing will be fully accessible with ramps, it will serve cyclists as well.

The 2009 Active Transportation Plan documents existing and future active transportation infrastructure and recommends a crossing for both cyclists and pedestrians at Kalum Street.

Future crossing infrastructure proposed in the OCP and Active Transportation Plan are to be primarily provided to the west of the Sande Street Overpass. A pedestrian crossing is proposed at the east end of the City near the River in the OCP. From a safety perspective, this crossing is no longer a priority for the City because CN has fenced the area, preventing illegal crossings, but it is still desirable from recreational standpoint and the City may pursue it in the future.

The 2017 Transportation Master Plan (TMP) proposes a set of projects that will address the potential transportation demands for all modes of transport, based on the 2030 medium growth scenario. The TMP does not include a crossing at Kalum Street because the high-level cost estimate is in the range of $10-$15 million, which could be used to address other issues throughout the community. The key objective of this study is to prepare a detailed cost estimate, giving the City a much better idea if a crossing at Kalum Street is economically feasible. The TMP also includes the easternmost crossing by the river which is no longer intended to be undertaken as discussed.

3.8 DESIRE LINES AND PEDESTRIAN CIRCULATIONS

Figure 5 below illustrates how active transport users currently move between the north and south parts of the city within the project area. The red lines show how some pedestrians solve their travel needs using goat-trails trespassing on CN Right-of-Way, instead of the provided infrastructure. The red lines are based on information provided by the City (Figure 5) and clearly demonstrate there are desired lines across CN where infrastructure is not currently provided.

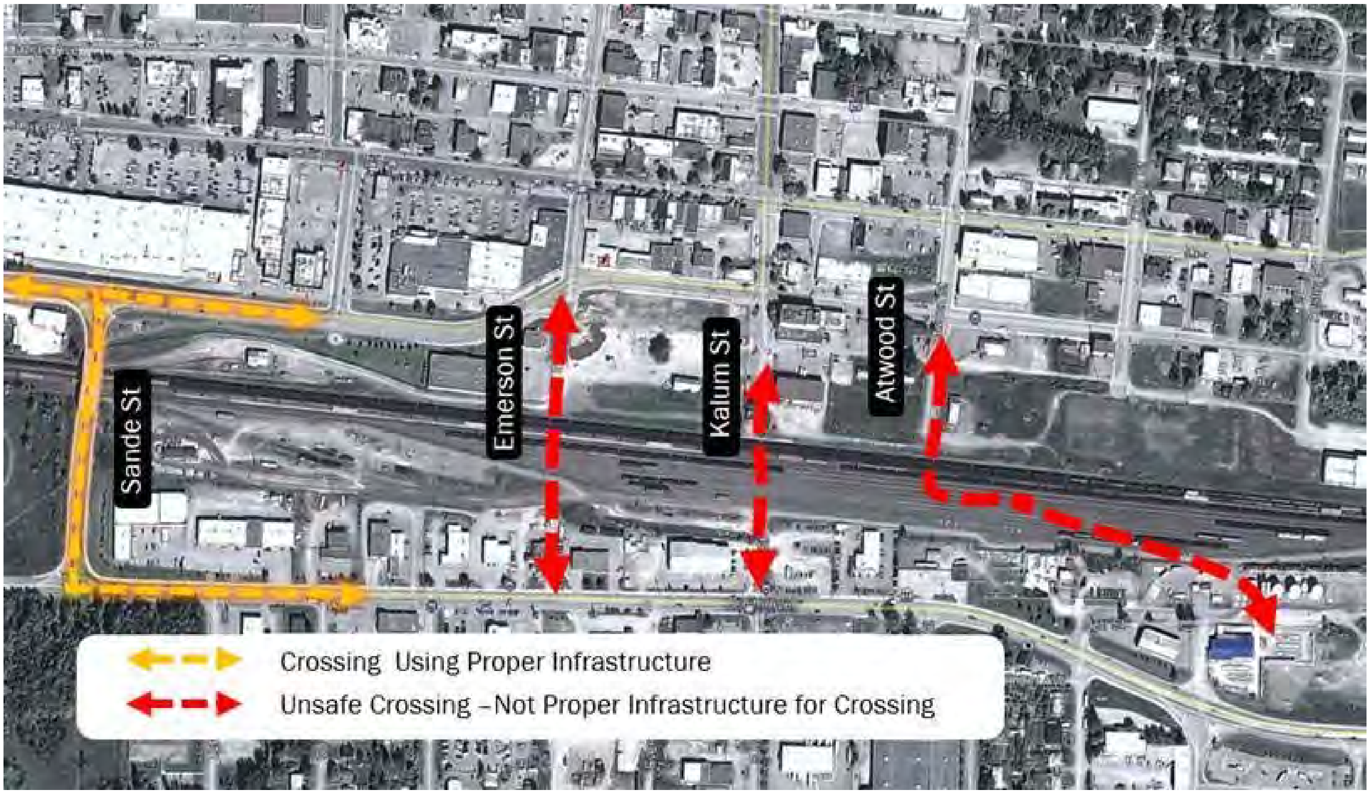

Figure 5 – Active transport desire lines for crossing CN in project area.

There is limited information available to assess pedestrian and cyclist movements within the project area. In order to understand pedestrian/cycling movements around the project area, Parsons used the information made available by Strava https://www.strava.com/heatmap#13.49/-128.60859/54.51357/hot/all. The web page provides a heat map showing heavily travelled routes by runners and cyclists who use the app. The Strava program utilises algorithms which filter out data from moving vehicles. A heat map is simply a colour intensity map showing colour variances where users undertake the most activity. It is acknowledged that this information only considers persons who use the Strava app and targets recreational runners and cyclists versus persons commuting to work and other destinations. Therefore, it can only provide a limited picture of the actual pedestrian/cycling movements.

Figure 6 shows the heat map for people walking/running through the project area. The most intense activity lines are shown in white while the least intense activity lines are shown in dark purple.

Figure 6 – Heat Map of Walking/Running Users - Source: Strava app users in the City of Terrace.

Desire lines in the heat map show a strong tendency for pedestrians to use the Sande Street overpass to complete trips to Kalum Street on either side of the CN yard. This desire line suggests the need for a new crossing east of the existing Sande Street overpass in order to reduce the walking distance.

Cycling activity was also analysed using the Strava App. Figure 7 illustrates the heat map for people cycling for commuting or recreational purposes. The most intense activity lines are shown in white, while the least intense activity lines are shown in dark blue.

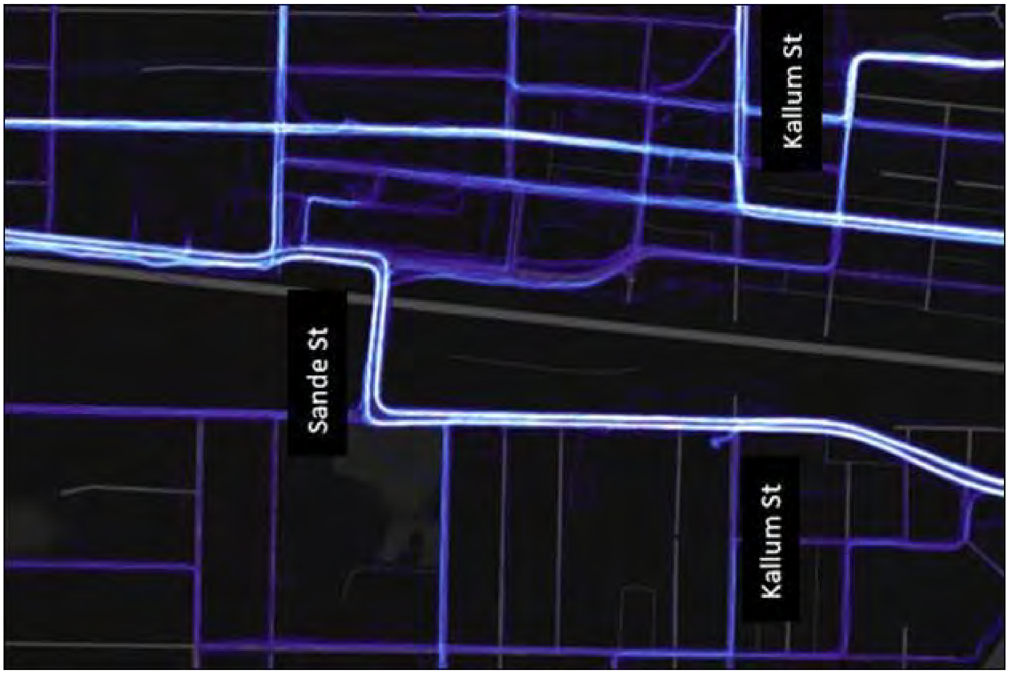

Figure 7 – Heat Map of Bicycle Riders - Source: Strava app users in the City of Terrace.

Desire lines in the heat map show a strong tendency for cyclists to move east-west along Highway 16 and use the Sande Street Overpass to cross CN. Allowing the cyclist to use the proposed crossing infrastructure at Kalum Street can help in reducing the need to use the Sande Street overpass, which is not currently a designated bike route but is proposed to become one.

3.9 FUTURE POTENTIAL DEMAND

Table 2 below shows the transportation modes trip distribution of the City of Terrace, based on the 2006 Statistics Canada Census which is the most recent available information and is used in the TMP. In 2006, active transportation represents 13% of trips made, which is higher than the average for British Columbia.

Table 2 – Transportation Modes Distribution City of Terrace and B.C.-Source 2017 TMP.

Transportation Mode	City of Terrace	B.C.
Public Transit	1%	10%
Walk/Bicycle	13%	9%
Car, Truck or Van as Driver	74%	72%
Car, Truck or Van as Passenger	11%	8%
Other	1%	1%

Table 3 shows the estimated population and trips in the year 2030, based on the medium growth scenario, consistent with the OCP and TMP studies.

Table 3 – 2030 City of Terrace Population and Estimated Trips.

Year	Population	Estimated Trips per Weekday
2015	12,494 Existing	26,544 Existing
2030	7,590 Additional	16,383 Additional
Totals 2030	20,084	42,927

The City has a target of 30% for active transportation trips, as stated in the document Terrace 2050 Buildings and Transportation. If linear growth is assumed for the active transportation modal split, we find that for the year 2030 the City will have around 22% of its residents making their trips by walking or cycling. Based on the information in Table 3.

Regarding the number of 2030 estimated trips, and assuming 22% of those trips are going to be made by active transportation modes (walking and cycling), the expected active transportation trips for the year 2030 for the City of Terrace are 9,443 trips per weekday. This equates to 3,778 residents, assuming 2.5 trips per person (consistent with the TMP). This estimated number of trips/travelling residents is for the entire City and therefore, the actual number of trips and users at the structure will be significantly less as all the population and activities are not concentrated at the project site.

Given the population and trip growth information discussed, there is no apparent need to provide a structure at Kalum Street with a clear travel width greater than the standard 3.0 m multi-use pathway width. The forecast information is only up to 2030 but it is unlikely that population and trip growth over the next 75 years (design life of structure) would warrant a wider structure width.

3.10 CONSTRUCTION OVER CN

The most suitable method of erecting the bridge for this project will depend on contractor expertise, the structural system chosen, rail traffic constraints, and site constraints. Erection will have to be coordinated with CN Rail's allowable windows (if any) to close the line (i.e. possibly during overnight erection windows). Construction of the new bridge can be accomplished with minimal to no interference to rail traffic if the correct bridge option and construction sequencing is chosen. Significant parts of the bridge can be pre-fabricated, delivered to site, and lifted into place during limited night closures. The proposed alignment will have to be evaluated for constructability in terms of an assembly area, then moved to the laydown area and then finally craned into its final position on the abutments.

3.11 DECK DRAINAGE AND STORMWATER

The deck will have curbs along the length of the structure and deck drainage will be directed to the ends of the structure by providing proper slopes to the bridge. Due to the length of the anticipated structure, deck drains and/or scuppers cannot be eliminated but they will be minimized. Wherever possible, drainage water will not be allowed to pass over expansion joints to minimize water related deterioration. Flow of drainage water will be controlled to protect abutment seats and bearings.

Bridge drainage water will not be allowed to drain onto CN property.

Stormwater runoff collecting on the proposed structure will have to be directed to the existing storm sewer outfalls. On the north side, the storm sewer manhole at the west end of the ramp presents an ideal tie-in location as it is situated at the lowest end of the ramp. Otherwise, for the elevated north end of the mainspan and the at-grade plaza area adjacent to he George Little House, stormwater drainage could be directed to existing stormwater infrastructure on Kalum Street as there is an existing storm sewer at the northeast corner of the project limits. For the south ramp, the manholes at the northwest quadrant of the intersection of Kalum Street and Keith Avenue present a tie-in location which will require some buried storm pipe to connect the bridge drainage system to the existing storm sewer system. It will need to be confirmed that there is no conflict with crossing-over and/or other adjacency issues with existing buried utilities here (i.e. gas lines. Water, sanitary). For the south side, Parsons recommends draining the end of the mainspan, the south ramp mid-height turn-around (i.e. at the ramp's western-most point), and at the end of the ramp at its bottom.

In detailed design stormwater flows will need to be quantified to assess existing and proposed flow rates being directed towards the referenced existing storm sewer systems. Any increases in peak flow rates will require further evaluation to determine if it presents any capacity issues. However, considering the minimal surface area of the structure and existing land uses covered by the proposed bridge deck and ramp, the additional flow is not anticipated to be significant.

Clean-outs in any drainage piping designed shall be provided in order to assist with properly maintaining the stormwater drainage system going forward.

All at-grade pathways shall be designed with drainage in mind in order to avoid any future ponding/or erosion issues.

3.12 SNOW CLEARING

The City of Terrace experiences significant snow falls. Given the length of the structure, snow removal efforts will be significant over the ramps and mainspan. Snow removal on the mainspan is also complicated by the fact that CN will not allow snow to be dumped directly onto their property.

The City would like to use their existing sidewalk snow clearing equipment on the structure as much as possible, therefore the structure will need to accommodate their size, turning radii and weight. The City uses the Holder C992 tractor for snow clearing along sidewalks, see Appendix B for specification information. Parsons prepared preliminary sketches of the C992 tractor on the ramp to get a sense of the available clearance and shared this with the City (see Appendix B). Dimensions of the tractor and attachments were obtained from the City and through supplier information. Maximum dimensions were considered for the tractor, sander, plow and snow blower. The attachment catalogues did not provide length of attachments; therefore, the lengths were assumed based on photographs. Based on the tight clearances on the turn, the width of the ramp at U-turns should be increased from the standard 3.0 m clear travel width to provide more clearance.

In addition to wider ramps at the turns, turn around areas are to be provided for the snow plow at the top of the ramps. Based on preliminary sketches, a 5.0 m radius circle is anticipated to provide adequate room for a C992 holder to turn around in a circle or by completing 3-point turns. In preliminary design, turning movements should be assessed based on the actual measured dimensions of the tractor and attachments (considering any future vehicles to be used, if known). In addition to clearance, the structure will have to be designed for the weight of the tractor.

The snow removal methodology to the structure will be:

- *Ramps:* The City will push/blow snow off the side of the structure, away from CN and private property.
- *Stairs:* The City will push snow off to the side and through the open grating, as needed.
- *Mainspan:* The City will push snow to the ends of the mainspan where it will then be cleared off the structure similar to the ramps.

Placing a roof on the structure and closed barriers on the sides, to reduce the amount of snow accumulation on the mainspan deck was considered but the City was not in favour of this option. A proprietary snow melting system, Hott-Wire, was also considered but not perused further because of concerns regarding durability of the system over the lifespan of the structure.

Pushing the snow over half the length of the mainspan may be considered to be a significant task to accomplish by hand. The City could consider shovelling snow into the flatbed of their plow which could then haul the snow off the bridge instead of pushing the snow all the way by hand.

3.13 MAINTAINABILITY AND DURABILITY

Durability is a very important aspect of every bridge design, particularly in regions with high temperature fluctuations and where road salts are used, such as Terrace. Because of this, materials and details will need to be used that can withstand harsh winter conditions and last for years without the need for replacement and with minimum maintenance.

In detailed design, a number of considerations need to be made. The bridge should use easily maintainable materials, including stainless steel where not prohibitive from a cost standpoint. The chosen deck material will need to be durable or have a durable top layer (e.g. if a glulam deck would be used). Railings should be either galvanized steel, aluminum, or stainless steel. Substructure elements, such as abutments and pile caps should be concrete with an ample amount of cover to the reinforcing steel and have galvanized reinforcement as per relevant standards and codes.

Detailing should recognize and mitigate areas of potential durability issues and aim to minimize the cost of long-term maintenance.

For structural steel members, corrosion protection can be accomplished by either a coating system (typically a 3-part coating system) or through the use of weathering steel. A coating system can provide better aesthetics however there are significant life cycle costs associated with a coating system. Typical lifetimes of a coating system are in the order of 25 years. Replacing a coating system is a considerable and costly task which will require scaffolding and enclosures of the structure and coordination with CN. Weathering steel develops its own patina which prevents further corrosion. It does not require any maintenance over its lifetime. However, weathering steel looks like rust, which is generally not viewed as aesthetically pleasing.

Should a weathering steel option be perused, localized painting would be applied to areas exposed to regular water and de-icing run-off (i.e. end of span at expansion joints and deck hangers). This coating would be applied on the weathering steel and applied only once for added long-term corrosion protection to these problem areas. In addition, the size of weathering steel members would be slightly increased to account for the relatively low rate of corrosion over the lifetime of the structure.

3.14 BEARINGS AND EXPANSION JOINTS

In detailed design, bearings and expansion joints should be designed to consider maintenance and lifecycle costs. Approach spans will be continuous over piers as much as possible to avoid large numbers of bearings and expansion joints.

For the anticipated main span and approach span lengths, the type of bearings will be elastomeric bearings with sliding plates to accommodate thermal movements. For long-term durability of the bearings, spherical or cylindrical bearings with sliding plates could be used. The expansion joints will be strip seals or compression seals which can accommodate the anticipated movement ranges.

The number of expansion joints in the approach spans should be minimized as much as possible by making approach spans continuous. In addition, they must be designed to withstand the impact of snow removal equipment and to provide a smooth surface for users (i.e. no large bumps or tripping hazards when passing over expansion joints). Bearings and expansion joints should be detailed to be easily inspectable and easily replaceable.

3.15 RAILINGS

Steel railings will be installed along each side of the mainspan bridge deck, and along the approach ramps. Railing members' configurations will be as such to greatly hinder the possibility of climbing the railings or hopping over the railings. Based on our experience with similar projects over CN, the railings need to be cognisant of deterring users from throwing objects over the mainspan at passing trains while also preventing footbridge users from feeling constrained by providing too much enclosure.

If and where necessary, the mainspan structural members will be kept out of reach of pedestrians by positioning them at least 1 m beyond the outsides of the railings.

A grab rail will be provided at a height of 920 mm above the deck and a bicycle railing will be provided at a height of 1,400 mm above the deck, consistent with the CHBDC and BC Access Handbook.

Overtop of the CN yard, a 2.4 m (8 ft) high railing will be provided to prevent users from throwing objects off the structure. In addition, the openings in this railing will have to be no bigger than 50 x 50 mm to prevent objects (such a beer bottles for example) being pushed through. The railing over the mainspan can also be designed to function as a means-prevention railing.

In detailed design, several railing options should be looked at including vertical pickets, stainless steel mesh, railing sloping inwards or outwards, aesthetic reveals, and more.

The approach pathways, where required, should be guarded from embankment slopes steeper than 3:1 with a railing. Also, thought must be given in detailed design to ensure that 'side-cutting' of shallow slopes and 'side-cutting' through fences by pedestrians and cyclists, instead of using the marked pathways, is avoided. This could be accomplished through the use of vegetation and/or landscaping elements as well as railings.

The design of the railing system also provides an opportunity to mimic the contextual expression of the site. Unique characteristics, in this regard, should be looked-into during detailed design. The railing also presents the opportunity to introduce some wood components, for example the handrails could be made of wood.

Handrails shall be designed to be easily replaceable and in Parsons' experience that means designing the handrails in bolt or screw-in panel sections.

3.16 VISIBILITY OF STRUCTURE

As noted in the wayfinding section, due to the height and length of the structure, it will provide a prevalent icon within the area. This can be understood as an opportunity to create a well considered design that provides a point of pride for the community. The visibility of the structure permits a key reference point as residents and visitors move north-south through the community.

Given this prominence, the project will ensure the structure is designed to provide visual interest for the users, celebrating the scale and technical undertaking of the project.

3.17 PEDESTRIAN EXPERIENCE AND WAYFINDING

The new pedestrian bridge provides an important opportunity for the City of Terrace to create a key icon for the community. Given the bridge's location and height, the structure will be highly visible throughout the area. As such, the bridge will have the ability to serve as a key reference marker for the area, providing wayfinding opportunities for visitors and residents alike.

While using the pedestrian crossing, there exists the prospect of creating a viewing platform that will command a key view to the downtown core as well as the mountains surrounding the City.

3.18 AESTHETIC DESIGN

The pedestrian bridge is located to the south of the downtown core which has a Downtown Plan and Downtown Design Guidelines identifying preference for a historic design aesthetic. Further, the bridge will be located over an active railway corridor, which in turn conjures images of a specific nature.

Given these contextual references, the design team will consider opportunities for the proposed structure types to integrate with the historic and railway styles and provide a balanced design approach in order to fit within the overall context of the area.

The design consideration will extend to the ramps, viewing platform(s) and stairways so as to provide a cohesive and sensitive aesthetic approach.

3.19 LIGHTING

While the pedestrian structure will command a prominent presence in the City of Terrace, the lighting design will take a balanced approach. Important considerations will be given to ensure the lighting accentuates the bridge structure as a key civic role, while avoiding any lighting conflicts with railway operations. It will also be important to avoid any up lighting to limit lighting pollution in the area.

Further, lighting design will look to existing street lighting infrastructure and provide additional general lighting to ensure a safe and comfortable level of illumination is maintained across the structure. Feature lighting will be reviewed in localized areas in order to highlight specific design elements, thereby increasing user experience.

Specifications will be considered in terms of lighting performance in the localized climate, system of installation and ease of maintenance, lifecycle costs and energy consumption.

3.20 LANDSCAPE DESIGN

Landscape design for the project will focus on opportunities to stitch the proposed structure into the existing fabric, thereby providing a seamless and enticing pedestrian experience.

The south ramp and stairs will be designed to integrate into the existing pedestrian systems, providing connections to the local context. On the north side of the structure, ramps will be located to provide connection to the Grand Trunk Pathway to the west, with stairs being located for ease of connection to Kalum Street, George Little House and downtown.

Existing trees/greenery: Although some impacts may be unavoidable, care will be taken to avoid having to damage existing greenery due to the proposed new pedestrian crossing and pathways. The alignments for an updated crossing at this site will be cognisant of impacts to trees/greenery. Compensation for tree removals may be required where removal of existing trees and shrubs is necessary to accommodate the proposed new locations and grades of the bridge.

3.21 ENVIRONMENT

3.21.1 BIOPHYSICAL

The project site is outside of any environmentally sensitive areas, as identified in Schedule B – Appendix A – ESA of the Official Community Plan. A brief environmental high-level screening of the project site indicates that it is outside of any designated environmentally sensitive areas. The study area is located in a disturbed and busy locale, which reduces habitat potential for many listed sensitive species for that region. The Species At Risk Act (SARA) that occur in this region include: Western Toad (G4), Coastal Tailed Frog (G4), Marbled Murrelet (G3), Common Nighthawk (G5), Olive-sided Flycatcher (G4), Rusty Blackbird (G4), Peregrine Falcon, pealei subspecies (G4T3), Northern Abalone (G3G4), Barn Swallow (G5), Little Brown Myotis (G3), cryptic paw (G4), Band-tailed Pigeon (G4), Whitebark Pine (G3G4), oldgrowth speckledbelly (G3G4) and Caribou (northern mountain population) (G5T4T5). Migratory Birds Convention Act (MBCA) would have seasonal requirements to address nesting birds during the summer season for uplands. Some open lots and nearby buildings could provide attractants to seasonal nesting birds and should be considered and reviewed relative to project scheduling and mitigation measures for planned works.

3.21.2 CONTAMINATION

Based on discussions with the City and Parsons previous experience with projects near railways, it is assumed excavated materials will have a high probability of encountering contaminated soil and/or groundwater (depending on depths of pilings/excavations). A quick review of aerial satellite information revealed past and current land-uses that could result in potential contaminated materials (i.e., hydrocarbons from fueling stations and car sales/parking lots). The BC iMAP database indicates several (>6) waste environmental remediation sites that have occurred in or immediately adjacent to the project area. A few environmental monitoring stations also were mapped in this vicinity. It is understood that the majority of the former Co-op property is considered remediated, with the remaining areas along the east and south edges still to be addressed.

Therefore, it will be required to monitor and assess soil/groundwater during pilings/other excavation works and appropriately dispose of any excavated material during the construction of the proposed pedestrian overpass. In addition, a plan should be put in place to mitigate the exposure risk of workers in the area to possible contaminates.

3.22 HERITAGE AND HISTORIC SENSITIVITY

The pedestrian structure will be located in the vicinity of the historic George Little House and to the south of the downtown core. The City has committed to providing land (0.5 acres) on the eastern side of the former Co-op Site to the Terrace and District Museum Society for the purpose of developing a museum in the downtown core. There is a desire by the Society to have the building constructed in time for the City's 100-year anniversary (2027).

Given the adjacency to these important historic points, the bridge will need to make reference to the historic nature of the context, while respecting the scale and location of the area.

Opportunities to avoid significant overshadowing and interruption of these historic assets to the community will be carefully considered. Locations for landings and piers will be designed to respect current historic reference points and where possible, to promote an increase in engagement with the historic context.

The design will also be reviewed for the potential to provide additional historical signage and informational material. An example of this might be to include historical information at the viewing platform outlining the development of Terrace, which would be uniquely appearing from this elevated vantage point.

The archaeology Borden Number area for this location is GdTd. BC RAAD Archaeology Site Map Tool identifies a historic site located at the end of Kalum St. on the north side, with Borden Number GdTd-49. This is presumed to be the George Little House, which should be confirmed in the preliminary design stage by undertaking an Archaeological Overview Assessment (AOA). The AOA will also identify if a formal Archaeological Impact Assessment (AIA) is required. Based on the current information and the fact that the project area consists of previously disturbed land, an AIA is not anticipated to be required. Should an AIA be required to formally assess the site, a First Nations review period would be required.

3.23 SUSTAINABILITY

It is assumed that access to this pedestrian bridge project will be through existing infrastructure and that any areas used as staging/storage areas would be sited on developed or previously disturbed areas. Furthermore, it is assumed that this project will have an erosion & sediment control plan to protect greenspaces, natural areas, and surface drainage from short-term impacts during construction.

True sustainability in the context of a footbridge is found in the efficient use of materials, improving the socio-cultural environment, and creating a long-term positive effect for users and passers-by.

To support sustainable initiatives that results in a responsible bridge design that incorporates environmental stewardship, Parsons' pursues conditions relating to landscape design, material procurement, and maintaining a sensitive approach to construction. Sustainable conditions to be reviewed and incorporated into the detailed design may include: xeriscaping, specifying steel with recycled content, fly ash and silica fume content in concrete*, a minimal construction field, LED handrail lights to minimize power consumption, storm ponds and oil-grit separators to treat drainage water, etc.

* Fly ash and silica fume can be used to reduce cement content for concrete construction which, overall, makes concrete a more sustainable and 'green' product. Generally, steel is considered a more sustainable product in this regard. The use of recycled materials can also be considered. The use of wood including cross-laminated timber for the bridge deck can be considered as well.

4.0 Structure Accessibility

Access to the overpass can be provided by a combination of elevated sidewalks, ramps, stairs, elevator, and escalators. The City would like to provide complete accessibility to pedestrians, cyclists, and users with reduced mobility over the structure. The various access options were discussed between Parsons and the City at the start-up meeting and it was made clear that the City was not interested in elevators or escalators due to the associated maintenance, effort to energize them and potential to attract unsavoury behaviour. Therefore, complete accessibility will be provided by approach ramps and/or elevated sidewalks. Stairs will also be included at the end of the mainspan to reduce the overall travel distance for able-bodied users.

The maximum grade for the approaches, which is considered accessible to all is 5%. Therefore a 5% grade will be targeted for all alignments to keep the ramps as short as possible while still being considered accessible. In some cases, depending on the alignment, steeper grades may be required due to property /geometry issues. The maximum grade that will be considered is 8.33% with 1.5 m long landings spaced at intervals of 9.0 m (this equates to an overall 7.14% grade), which is also acceptable if necessary by accessibility best-practice. There is precedent along the Grand Trunk Pathway of 8.33% grades in the City of Terrace.

The radius of turns on the ramps will be made 5.0 m to provide smooth gradual turns for cyclists instead of switch backs which are difficult for cyclists to navigate. As a representation of best practice, in regards to a recommendation on turning radius for cyclist pathways, The City of Calgary *Parks 2017 Development Guidelines and Standard Specifications: Landscape Construction* states that a 5.0 m design curve radius is suitable for speeds of 15 km/hr and below. In addition, this radius is larger than the City's snow plows minimum inside turn radius, which will allow them to take these turns.

5.0 Alignment

During Parsons site visit to the City of Terrace, the entire project team developed three alignment options, labelled Alignment A, B and C. The alignments discussed in this section are generally the same concept but refined a little further with the use of drafting software to confirm lengths and overall footprint of the proposed structure alignment. There was a clear consensus among the group that alignment A is the preferred option but requires a significant portion of CN's storage yard.

All alignments include ramps with grades between 5% to 8.33% and stairs. All turns for all alignments consist of 5 m radius. Abutments are placed 8 m from the centerline of the nearest track to maintain the shortest mainspan possible. This would require easements from CN for this. If these can not be obtained, the mainspan will increase and the footprint of the ramps will be pushed further away from CN property. During preliminary design, consideration will need to be given to allowable clearance to the tracks for formwork and falsework during construction, which will need to be approved by CN, and may require that the abutments be pushed further out by a meter or so.

On-grade ramps, supported by Redi-Rock retaining walls are assumed to start at an elevation of 2 m above ground.

For all options, appropriate fencing would have to be placed to reduce the remaining gaps in the existing fencing, otherwise those who currently use the goat-trails will likely continue to do so. This will require gates be installed at all CN access points as well. In addition, fencing will be used to prevent loitering under the approach ramps.

As stated in Section 2.7, CN will not currently accept an option which places City infrastructure onto their property. The proposed Alignment A, B and C presented here have at least some infrastructure on CN property. Impact to any potential alignment not using CN property will significantly increase the costs and complexity of any overpass or present an option which is very undesirable from a sightline and urban realm perspective. The scope of this project is to study an overpass at Kalum Street, therefore other crossing locations away from Kalum Street are not considered. The City has elected that this study proceeds assuming access to CN land can be obtained. This is a reasonable course of action as alignments with infrastructure completely outside of CN property may not be feasible for the City. Should the City proceed with the project further, discussions will have to take place with CN regarding land acquisition/easements.

Another alignment that was not explored in detail and would not have required CN property would be to go from the Honda Dealership Property in the southeast to the old co-op property in the northwest. This would require a mainspan in the order of 110 m and relocation of the existing overhead utilities currently crossing CN at Kalum Street. Beyond this and as discussed below for Alignments A, B and C, there are no alignments which are evidently practical for a crossing at Kalum Street. This stresses how critical access to CN property is for the feasibility of a pedestrian overpass crossing at Kalum Street.

5.1 ALIGNMENT A

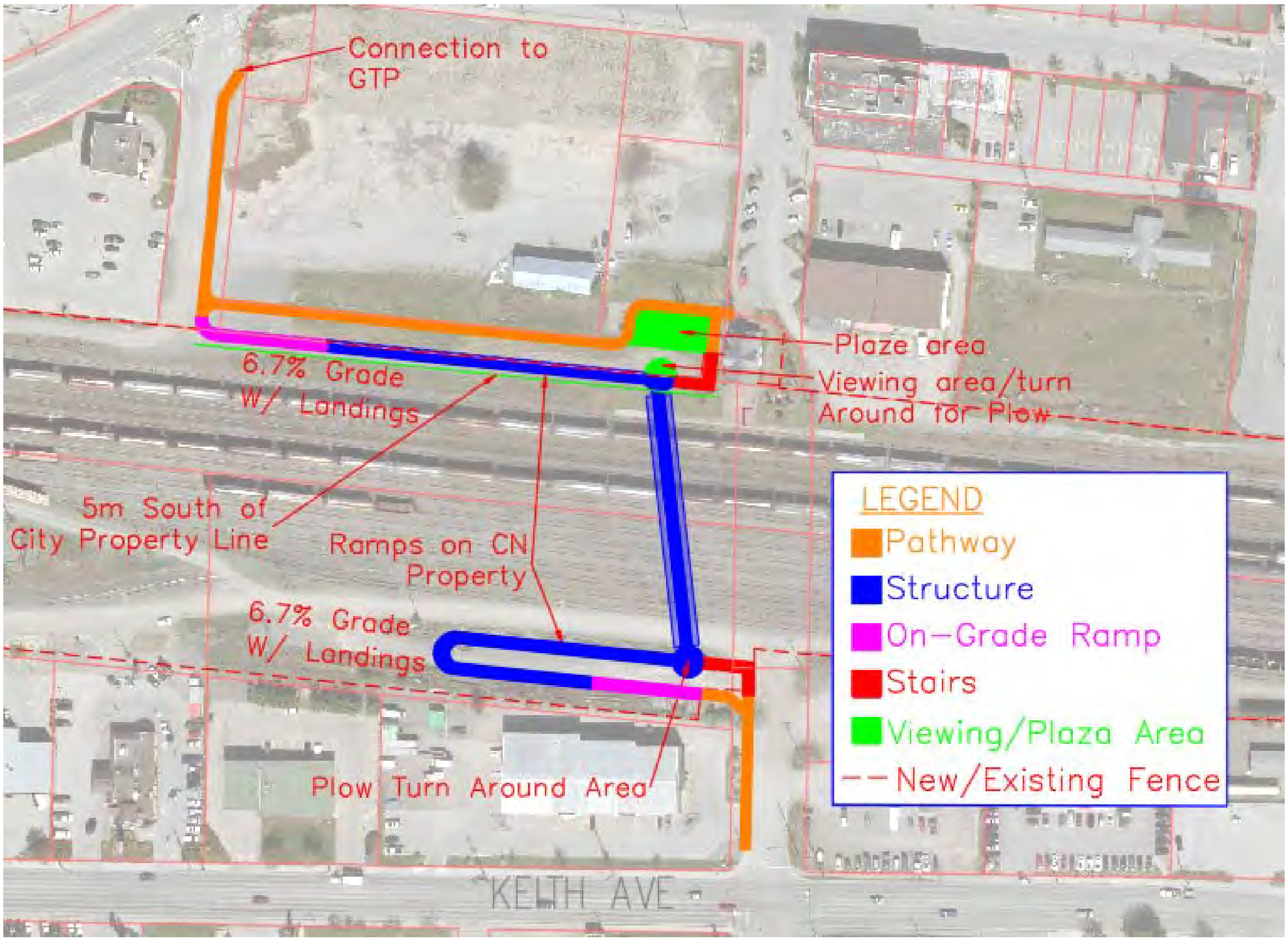

Figure 8 – Preliminary Alignment A.

Figure 8 shows the preliminary Alignment A. Table 4 below summarizes the benefits and drawbacks to Alignment A.

Alignment A spans the CN yard on the west side of Kalum Street. On the north, the abutment is placed 8.0 m from the centerline of the nearest rail track which would require an easement from CN. If this can't be obtained, the abutment can be pushed further back to within 5 m of the City property or onto existing City property, but this will push the ramps and pathways further north and increase the main span. The north abutment is placed approximately 15 m from the George Little House. The visual impact of what will be a large and imposing structure to the side of the George Little House is not a concern to the City and the Contract Manager of the George Little House as the primary view of the George Little House is from the front (north) for the public.

The north ramp length is set so that it ends at Emerson Street as requested by the City, and no turn back is required on the ramp. To accomplish this, an overall grade of 5.7% is required, which corresponds to a ramp grade of 6.7% with regular 1.5 m long landings every 9.0 m. Stairs at the north abutment are provided to give a direct route to Kalum Street.

On the southside, the abutment and ramp will be placed entirely on the CN storage yard, requiring an area in the order of 0.6 acres. The abutment is placed 8.0 m from the centerline of the nearest track. There is a local depression in this area that is less than a metre deep, therefore the ramp has been extended by 20 m to consider this. The mainspan is skewed so that the south abutment and stairs are not directly behind the building immediately to the south, to improve sightlines and overall feeling of safety to the structure. Sightlines from HWY 16 to the rest of the south ramp however, are less than favourable as they are blocked by the building. Ramps are set at 6.7% grade with regular 1.5 m long landings every 9.0 m to match the north side.

The mainspan required for this option as presented would be in the order of 80 m and the total structure length would be 330 m plus another 75 m of on-grade ramps.

There are minimal impacts to existing utilities anticipated for this proposed alignment. There is an existing stormwater manhole at the west end of the north ramp. Currently, the on-grade path partially overlaps with the manhole. It would be acceptable for the manhole to be within the on-grade pathway, but not preferable. In addition, the end of the on-grade ramp supported by retaining wall system crosses overtop of this 1,500 mm Dia. stormwater sewer. It would need to be confirmed that the pipe can handle the additional loads, if not the ramp can simply be shortened to end before it. In preliminary design the actual location of the manhole and sewer pipe would be determined, and the alignment adjusted as required.

On the southside, the ramp is approximately 2.0 m from the existing overhead lines on the south side of the ramp. When the exact location of the poles and overhead are determined in preliminary design, the ramp alignment will be adjusted slightly to ensure that there is at least 3.0 m setback from structure to the overhead lines and poles.

To guarantee a seamless connection for cyclists between the south-end of the overpass ramp-and the future OCP active transportation network planned along Highway 16. it is suggested that a 3.0 m multi-use pathway is installed along the west side of South Kalum Street between the end of the ramp and the Hwy 16 intersection. In preliminary design, this connection shall be designed with consideration made to the aerial and underground utilities present in the area.

A plaza is provided adjacent to the George Little House at the bottom of the northeast stairs. Turnaround areas for a snow plow are provided at the ends of the mainspan. The turnaround area is currently assumed to be a circle with a radius of 5 m, but the actual dimension should be determined based on a turning movement study of the snow plow during preliminary design. The width of the ramps at the U-turns is made wider to accommodate the snow plow. The turnaround area on the north side would double as a viewing area with wayfinding.

Should the City not be able to obtain the access to the storage yard on the south side of CN property, this alignment is not feasible as there is no location for the south ramp. Ramps on Kalum Street are not feasible due to access to the various private property and CN, and significant utilities.

Table 4 – Overall benefits and drawbacks to Alignment A.

Overall Benefits	Overall Drawbacks
• Minimal utility impacts anticipated. • Ramps and stairs on the north side provide direct access to Emerson Street, Grand Trunk Pathway, Kalum Street and the George Little House. • Stairs on the southside provide direct access to Kalum Street. • Only require property acquisition from one stakeholder (CN).	• Requires a large portion of CN storage yard to be acquired (south side of CN, west of Kalum), otherwise this alignment would not be feasible. • Ideally would also acquire up to 5 m of CN land on the north side plus an easement for the north pier to minimize the mainspan. • Sightlines to the south ramp are blocked by the existing Your Decor building.

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• Option provides a plaza area that can be well integrated with the George Little House and future museum. • Option provides a viewing area at the north abutment. • Currently, good sightlines to the north ramp and stairs.	

5.2 ALIGNMENT B

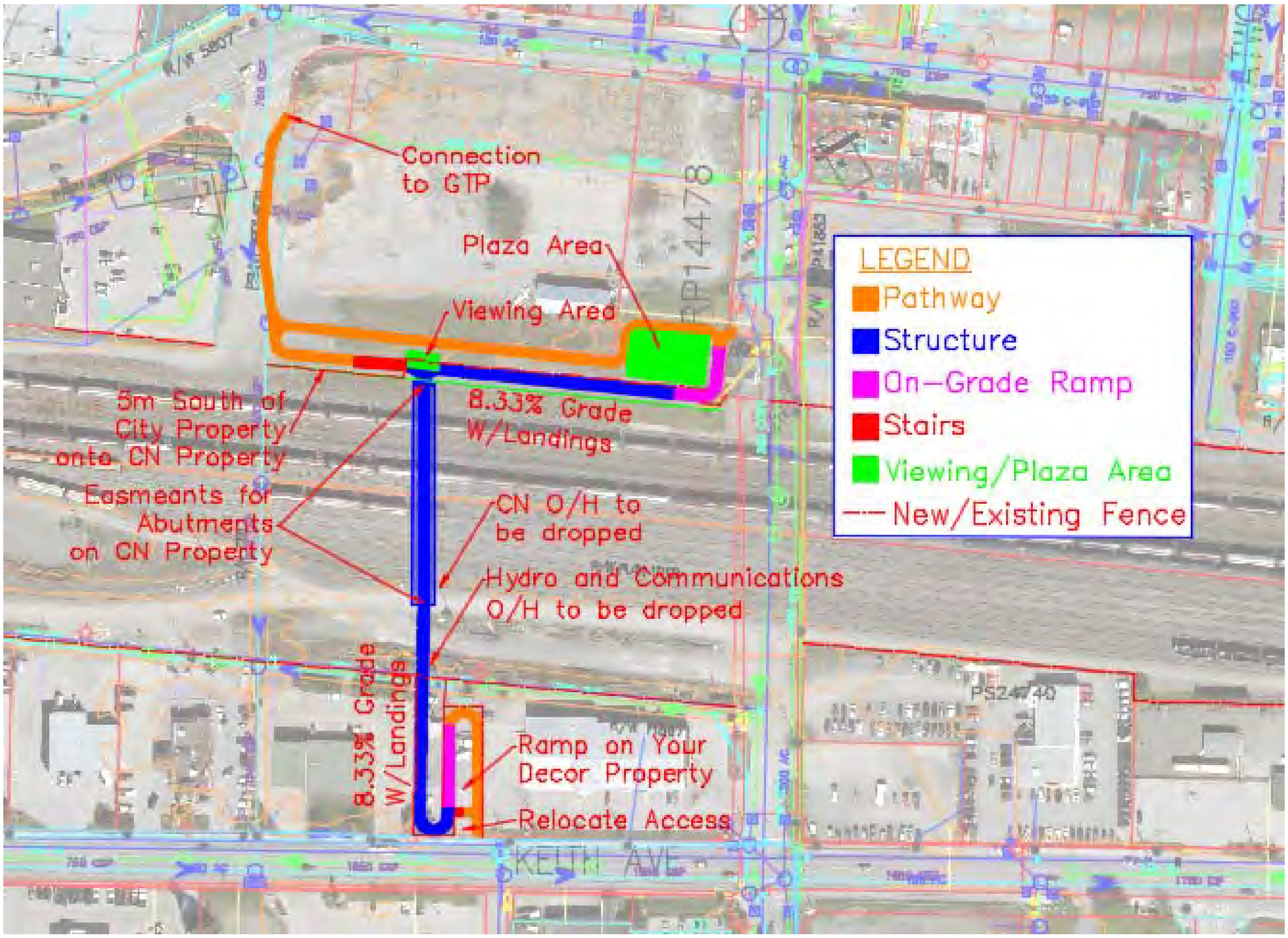


Figure 9 – Preliminary Alignment B.

Figure 9 shows the preliminary Alignment B. Table 5 below summarizes the benefits and drawbacks to Alignment B.

Alignment B crosses the CN yard approximately 110 m west of Kalum Street. On the north side, the ramp and stairs would land on CN property, within 5 m south of the existing property line. An easement will be needed to place the north abutment 8 m from the centerline of the nearest track. More importantly, an easement on the south side in the CN storage yard for the south abutment, 8 m of the centerline of the nearest track, would be critical. If these easements are not obtained, the mainspan could be as long as 115 m, significantly increasing costs and construction complexity. This would also result in the start of the elevation drop of the south ramp beginning at the property line, but the ramp structure would still be able to fit within the current proposed alignment of the south ramp.

On the southside, a significant portion (approximately 25 m east of the west property line) of the Your Decor Property would need to be acquired for the ramp and pathway to Highway 16 sidewalks. It would also require the relocation of the Your Decor property access to Highway 16 at the west end.

This option does not provide direct access to Kalum Street on the south side and it also has the mainspan the furthest away from the Kalum St. of the three proposed options, which is close to going beyond the scope of the study location.

Both ramps are currently put to 8.33% to fit within the property/site limitations. The mainspan will need to be slightly skewed to accommodate the north ramp in-between the mainspan and George Little House. Alternatively, the ramp could turn back towards the west, cutting through the proposed plaza to provide a smaller grade.

In terms of utilities, overheads on CN and on the southside of CN will need to be dropped into underground ducts where the structure spans. This is the most significant utility relocations of the three options but is not a major undertaking. Any piers or abutments will need to avoid the buried utilities along the south side of CN.

The mainspan as presented is in the order of 80 m, and the total structure length is 265 m plus another 60 m of on-grade ramps.

A plaza is provided adjacent to the George Little House at the bottom of the north ramp. A viewing area is placed at the top of the ramp at the north abutment which would also function as a turnaround area for the snow plow. A similar turnaround area would need to be provided at the south end of the mainspan (not shown in sketch) for the snow plow. The width of the ramps at the U-turns would be increased to accommodate the snow plows.

Table 5 – Overall benefits and drawbacks to Alignment B.

Overall Benefits	Overall Drawbacks
• Ramps and stairs on the north side provide direct access to Emerson Street, Grand Trunk Pathway, and the George Little House. • Option provides a plaza area that can be well integrated with the George Little House and future museum. • Option provides a viewing area at the north abutment. • Currently, good sightlines to the north ramp and stairs.	• Need to acquire property from Private property owner and an easement from CN, both on the south side. • Ideally would also acquire up to 5 m of CN land on the north side plus an easement for the north pier to minimize the mainspan. • South ramps and stairs do not provide direct access to Kalum Street. • Sightlines to the south ramp will be blocked by existing commercial buildings on either side. • Mainspan is furthest away from Kalum St. compared to other options. • Utility impacts are greatest for this option, but still relatively simple. • Required to relocate Your Décor property access to HWY 16.

5.3 ALIGNMENT C

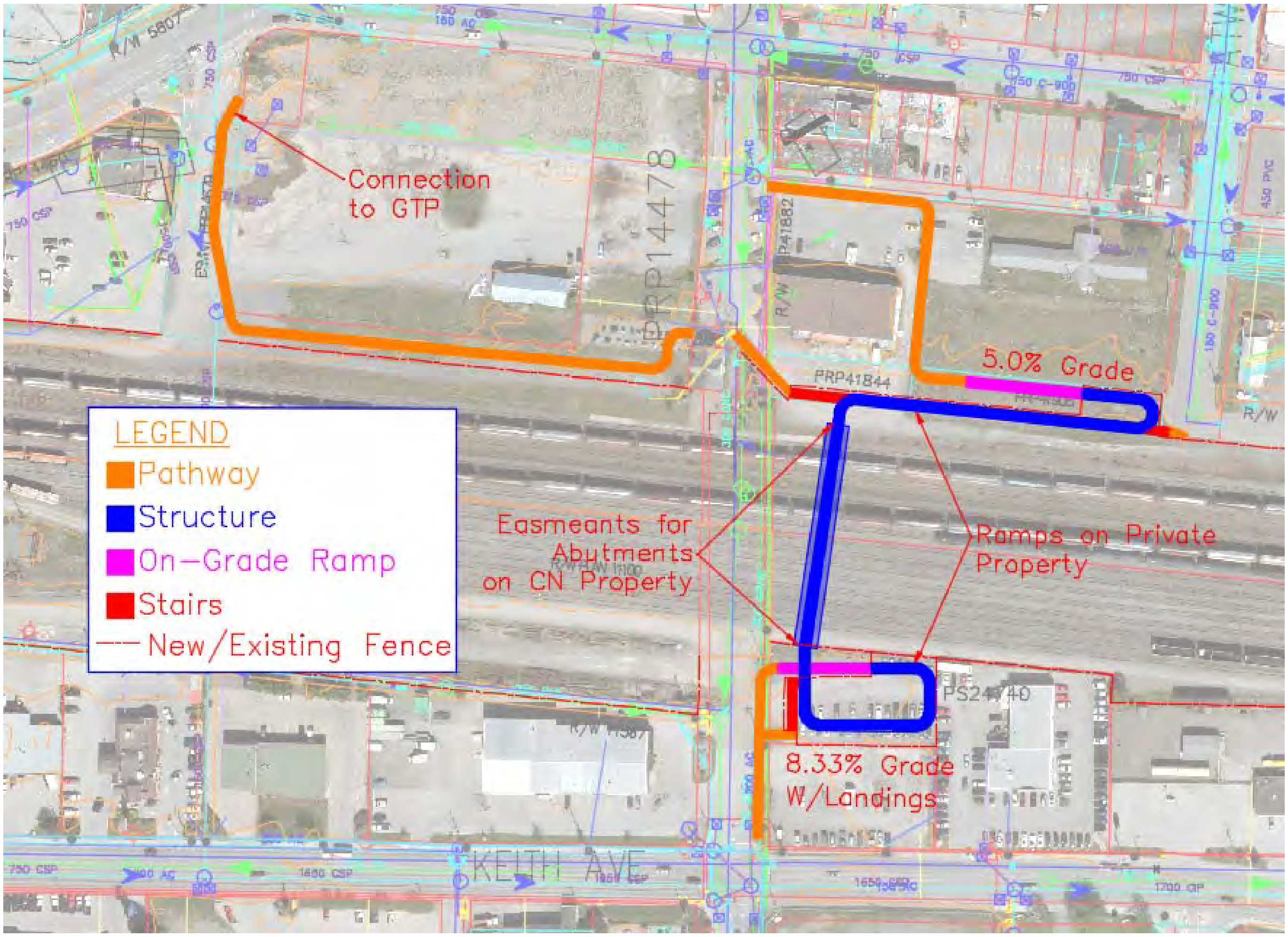


Figure 10 – Preliminary Alignment C.

Figure 10 shows the preliminary Alignment C. Table 6 below summarizes the benefits and drawbacks to Alignment C

The mainspan crosses the CN yard on the east side of Kalum Street and is currently placed a minimum of 10 m from the existing overhead utilities crossing CN. The proximity of the hydro lines to the mainspan would give a negative impact to the pedestrian experience when crossing the structure.

The north ramp is placed on private property immediately north of the CN yard with the north abutment landing at the edge of the VIA platform and 8 m from the centerline of the nearest track. An easement on CN for the north abutment would be required to keep the mainspan to a minimum and to avoid pushing the ramp further north where it will encroach on the Sears building's loading area. For the same reason, the pathway at the end of the north ramp turns north before the Sears building and goes around to connect to Kalum Street. A small staircase is provided at Atwood Street to provide direct access. A staircase is provided at the start of the north ramp to provide direct access to Kalum Street. The north ramp has a grade of 5.0% but this could be reduced to minimize costs and the overall footprint of the ramp.

The south ramp and abutment would be placed entirely within the Honda dealership parking area. This requires 8.33% grade ramps with regular landings and for the ramp to go underneath itself near the south abutment. Other alignments for the south ramp that were explored encroached on the 7-11 property or Honda building, or resulted in unnecessarily long ramps with multiple turns to fit within the property. The ramp going underneath itself and behind the stairs is not ideal from a sightlines perspective. Stairs are provided just south of the south abutment for direct access to Kalum Street.

There are no major utility impacts anticipated other than building pathways above buried infrastructure. However, given the proximity of the mainspan and ramps to overhead and underground utilities, there is a potential for complications depending on actual utility locations and specific utility set back distances required by their owners.

The pathway on south Kalum Street would need to contend with the existing Hydro Poles. This would be reviewed during preliminary design based on actual pole locations. The pathway could move to the east side of Kalum Street but there are also Telus poles which may present a conflict.

The mainspan is in the order of 80 m. The total structure length is in the order of 315 m with an additional 70 m of on-grade ramps.

A plaza on the north side is not provided in this option because there is limited space behind the Sears building considering their loading area and also because this is not an attractive location. In addition, the Sears building blocks sightlines to this area of the ramp which presents a safety concern for users. Further east along the ramp, the area is vacant and less appealing of a location for a Plaza. Turn around areas would be provided at the south and north end of the mainspan for the snow plow (not shown in sketch). There would be no intention of making the north turnaround area double as a viewing platform with wayfinding given the less than desirable area it overlooks.

This option requires significant length of on-grade pathways, compared to the other options, to provide connectivity to the Grand Trunk Pathway to the west.

This option has the least amount of infrastructure on CN property, i.e. just the north abutment lands on CN property. The north abutment could be pushed back so that it no longer requires CN property, but the ramp will encroach on the Sears building's loading area. Of the three alignments considered, Alignment C would be the most feasible option which does not require CN property, however this is the least desirable given the location of the ramps on the north side and the challenges with fitting the ramps on the south side. In addition, land from multiple private property owners must be acquired for the ramps.

Table 6 – Overall benefits and drawbacks to Alignment C.

Overall Benefits	Overall Drawbacks
• Stairs provide direct access to either side of Kalum Street. • Stairs at the east end of the north ramp provide direct access to Atwood Street. • This option is the most feasible of the three if no access to CN is granted.	• The opportunity to place a viewing platform and plaza area are less appealing for this option. • The City considers the east side of Kalum Street on the north side as less appealing than the west for ramp locations. • An easement for the north abutment is required on CN property, otherwise the ramps will get pushed back towards the Sears loading area. • In addition to easement from CN, private property on the north and south side needs to be acquired. • Both ramps do not provide direct access to Kalum Street. • Option does not integrate with the current George Little House. • Long on-grade pathways are required for connectivity to the Grand Trunk Pathway. • Mainspan proximity to overhead lines will detract from the pedestrian experience over the structure. • No utility relocations are anticipated but there is potential considering the close proximity of the mainspan and ramps to existing utilities.

5.4 EVALUATION CRITERIA FOR ALIGNMENT ALTERNATIVES

The following evaluation criteria was developed for the purpose of selecting the best functional alignment for the site. A total of 11 criteria were developed. Criteria were not included in this evaluation where bridge ranks did not differ between alignments. The ranks for each criterion are described below.

1. **Sightline, Safety, Lighting, CPTED**

   Considers the sightlines, level of lighting, CPTED required to enhance safety and perceived safety;

   1) Sightlines are a major concern; and/or alignment requires significant lighting, CPTED considerations;
   2) Sightlines are a major/moderate concern; and/or alignment requires moderate lighting, CPTED considerations;
   3) Sightlines are not a major concern; Alignment requires minimal lighting, CPTED considerations.

2. **Construction Complexity**

   Considers form work usage, crane positioning, construction over/near tracks, staging, demolitions, etc.;

   1) Construction of the Alignment under consideration is significantly more difficult than an average bridge;
   2) Construction of the Alignment under consideration is moderately more difficult than the average bridge;
   3) Construction of the Alignment under consideration is about the same complexity as an average bridge;
   4) Construction of the Alignment under consideration is moderately less difficult than the average bridge; and
   5) Construction of the Alignment under consideration is significantly less difficult than the average bridge.

3. **Environmental Impacts**

   Considers the footprint of the structure which is anticipated to be on contaminated CN property;

   1) Large portion of structures footprint is on CN land compared to the other options;
   2) Small portion of the structures footprint is on CN land compared to the other options; and
   3) Little to no portion of the structures footprint is on CN land compared to the other options.

4. **Convenience of Crossing CN to either end of Kalum Street for able-bodied users**

   Considers the length of the structure and the overall directness of the alignment for travelling between north and south Kalum Street for able-bodied persons.

   1) Alignment does not provide a direct route;
   2) Alignment provides somewhat of a direct route; and
   3) Alignment provides a direct route.

5. **Convenience of Crossing CN to either end of Kalum Street for non-able-bodied users and cyclists**

   Considers the length of the structure and the overall directness of the alignment for travelling between north and south Kalum Street for non-able-bodied users and cyclists.

   1) Alignment does not provide a direct route;
   2) Alignment provides somewhat of a direct route; and
   3) Alignment provides a direct route.

6. **Integration with Grand Trunk Pathway**

   Considers the bridge access points, their interaction and directness with the current Grand Trunk Pathway, using proposed pathway on Emerson Street and existing sidewalks on Greig Ave.

   1) Does not provides a direct route to the Grand Trunk Pathway;

2) Provides a somewhat direct route to the Grand Trunk Pathway; and

3) Provides a direct route to the Grand Trunk Pathway.

7. Integration with George Little House

Considers the bridge access points, their interaction and directness to the George Little House

1) Does not provides a direct route to the George Little House;

2) Provides a somewhat direct route to the George Little House; and

3) Provides a direct route to the George Little House.

8. Proximity of Mainspan to Kalum St.

Considers the location of the main span crossing relative to the study area, Kalum Street.

1) More than 100 m from Kalum Street;

2) Between 100-50 m from Kalum Street; and

3) Within 50 m of Kalum Street.

9. Capital Cost

Cost is reflective of the length of structure. The approach structure types are considered to be the same for each alignment, therefore the magnitude of cost is simply a function of length of structure ramp and on-grade ramp.

1) Bridge costs significantly more than the average costs under consideration (more than 25%).;

2) Bridge costs more than the average costs under consideration (more than 10%);

3) Bridge costs about the same as the average costs under consideration (within 5%);

4) Bridge costs less than the average costs under consideration (more than 10%); and

5) Bridge costs less than the average costs under consideration (more than 25%).

10. Utility Interruption

1) Interruption to utilities for the Alignment under consideration causes more than $100,000 additional cost for the project than the average cost for the utility interruptions of the Alignments under comparison.

2) Interruption to utilities for the Alignment under consideration causes an additional $20,000 to $100,000 more cost for the project than the average cost for the utility interruptions of the Alignments under comparison.

3) Interruption to utilities for the Alignment under consideration causes no change to the cost for the project than the average cost for the utility interruptions of the Alignments under comparison (within $20,000 of the average).

4) Interruption to utilities for the Alignment under consideration causes a decrease in cost for the project of $20,000 to $100,000 as compared to the average cost for the utility interruptions of the Alignments under comparison.

5) Interruption to utilities for the Alignment under consideration causes more than $100,000 additional savings as compared to the average cost for the utility interruptions of the Alignments under comparison.

11. Opportunity for Plaza and Viewing Area

Considers if the option could provide an appealing viewing area and/or plaza that is well integrated with the proposed alignment, George Little House and future museum and plaza area.

1) Provides no opportunity for a viewing area or a plaza;

2) Provides an opportunity for a viewing area or a plaza; and

3) Provides an opportunity for a viewing area and a plaza.

12. Impact on Property Acquisition

Considers the area of property which would need to be acquired and the number of stakeholders to interact with.

1) More property impacts than other options being considered
2) Average property impacts of the options being considered
3) Less property impacts than the other options being considered

Table 7 summarizes the evaluation rating for each considered alignment.

Table 7 – Evaluation of preliminary alignment options.

Criteria		Alignment		
		A	B	C
1	Sightline, Safety, Lighting, CPTED	2.5	2.5	1
2	Construction Complexity	3	2	2
3	Environmental Impacts	1	2	3
4	Convenience of Crossing CN to either end of Kalum Street for able-bodied users	3	1	3
5	Convenience of Crossing CN to either end of Kalum Street for non-able-bodied users and cyclists	1.5	1	1
6	Integration with Grand Trunk Pathway	3	2	1
7	Integration with George Little House	3	2.5	2.5
8	Proximity of Mainspan to Kalum St.	3	1	3
9	Capital Cost*	2.5	4	3
10	Utility Interruption	5	4	4.5
11	Opportunity for Plaza and Viewing Area	3	3	1
12	Impact on Property Acquisition	2	1.5	1
Total points		32.5	26.5	26
Ranking		1	2	3

*Capital cost ranking can be made equal for all alignments if the maximum acceptable grades are used.

Based on the ranking completed above, Alignment A is the preferred alignment of the three and is consistent with the City's preference for alignment A. A commitment from CN to allow the City to acquire or get an easement for the storage yard on the southside should be obtained before proceeding to preliminary design of the preferred option. If not, alignment C may be the only viable option (assuming private property can be acquired) but is the least preferable option of the three.

6.0 Structure Type

There are two main structure types which are considered viable for the mainspan: steel arch and steel through-truss. Structure types which have their main structural elements below the deck (i.e. deck on girder) are not considered viable because they increase the height of the deck above the CN clearance envelope which in turn significantly increases the length of approach ramps needed. A typical span-to-depth ratio for a girder is around 20:1 which would give unrealistically deep girder depths for this project. Cable-stay and suspension style structures are also not considered viable here because they:

- Will require back spans which would need to continue perpendicular to each side of the railway corridor for quite some distances,
- Have much more complex erection procedures than an arch or a truss and Parsons is trying to limit the complexities of erecting the structure over CN's tracks, and
- Would be much more expensive than an arch or a truss.

These two choices also resulted from satisfying all site and design related requirements outlined previously in this report, to meet all requirements of standards and best-practice guides, to provide a cost-efficient and relatively maintenance-free structure, and also to meet City reviewers' comments that there is an opportunity here for the new bridge to be a significant / landmark feature for downtown Terrace.

Context sensitivity and design of the structure from an aesthetics perspective are important elements of the design. The existing site consists of an interesting mix of rail, commercial, historical, and roadway elements. The future redevelopments planned adjacent to this site also need to be heavily considered. A properly designed bridge can tie these current and future diverse urban elements together in addition to providing the functional requirement of crossing from the one side of the tracks to the other.

For this site, prefabricated mainspan elements that can be quickly lifted into place during limited closure windows over the CN are recommended by Parsons. The two structure types considered would be able to have their steelwork frames lifted in one piece by a crane over the rail corridor, with prefabricated deck sections lifted into place on top of their steelwork floor-systems thereafter. The mainspan steelwork will be fabricated in pieces that can be easily transported to site and then the pieces will be bolted together in a laydown area. Parsons always recommends that the full mainspan be shop trial fit together in order that there are no issues identified with the fabrication geometry on-site post-delivery.

For further cost-effectiveness, Parsons would design the structures to have simple geometry which leads to repetitive details which reduces labour time for fabrication. For the arch option, Parsons recommends using straight members bolted together with gusset plates to form a 'curved' arch. Bending straight members into curves is a costly and time-consuming task. Straight members, bolted together at appropriate distances will still present a gradual curve over the length of the mainspan.

Both the truss or arch mainspan option would have comparable overall capital costs. To avoid high-life cycle costs associated with coating systems for corrosion protection, weathering steel is recommended for this structure by Parsons. Providing a painted system may have improved aesthetics over a weathering steel system, however it may prove to be a logistical nightmare to repaint the structure over live CN traffic in the future. It is Parsons' experience that painted bridges require regular touch-ups and complete re-painting every 20-30 years, which means that for this structure, which will be designed for a 75-year design life as per the Canadian Highway Bridge Design Code, it would require repainting at least 2 times in its design-life. Parsons does recommend though that any areas of the weathering steel bridge that could collect moisture, such as bolted connection points in the floor-system, should be painted with a paint colour to match the weathering steel colour. These areas would then likely not need full re-painting in the design life of the structure as long as small touch-ups were completed at regular intervals.

The two structural systems proposed have overhead member requirements to maintain structural integrity of the span. In general, elimination of overhead bracing between the top cords would provide pedestrians with a feeling of openness while they pass over the bridge, but pedestrians still have the feeling of security due to the presence of the structural arches/trusses guiding their way. The overhead structural system should be designed to be very transparent and not inhibit good sightlines for users of the structure.

The abutments of the mainspan would be cast-in-place concrete piers for cost-effectiveness supported on large concrete pile caps and then supported on multiple cast-in-place lined augered piles. The cast-in-place concrete piers should be designed with an aesthetically pleasing shape and shall be placed in locations considering VIA Rail user sightlines below the mainspan.

For the purpose of cost estimations, the following assumptions have been made regarding the foundations and substructures:

- Approaches substructures are assumed to consist of 30 m deep 900 mm diameter concrete reinforced piles with a 750 mm concrete reinforced column with a pier cap. The same substructure is assumed for the turnaround areas/viewing areas.
- Mainspan substructures are assumed to consist of six 30 m deep 900 mm diameter concrete reinforced piles with a pile cap. 2.5 m diameter concrete reinforced columns are assumed for the mainspan with a pier cap.

6.1 DECK

For the deck, a full depth cast-in-place deck should be avoided as this would be difficult to coordinate and place over live CN traffic. Full-thickness precast concrete deck panels, including a form-lined wearing surface, with grouted transverse joints could be used. Also, deck panels made of lighter material such as wood and/or composite materials, with a site applied wearing surface, could be used. Innovative, lightweight, durable products exist in this regard, such as glass fibre reinforced polymer wrapped timber decking or decks made purely of fibre reinforced polymer. This should be evaluated further in preliminary design with the following items considered:

- Heavier panels will require a larger crane and potentially more access onto CN property.
- Installation of panels by crane needs to consider opening sizes in steel mainspan top overhead bracing.
- Lighter panels may be able to be slid out across the mainspan floor-system.
- Lighter panels may be able to be placed prior to erection of the mainspan depending on the additional weight.
- The weight of the deck will be an important factor in the overall design, if the structure is too light, it may vibrate in the wind, from CN trains passing beneath, or when the City runs their C992 tractor over the structure. If the deck is unnecessarily heavy, the main structural members would need to be unnecessarily large.

Steel decking systems were also considered by Parsons. The advantage to a steel decking system is that it is lighter than a concrete deck and depending on the system chosen, would have simpler, bolted-in, installation over CN. Examples of steel decking systems include orthotropic decks or steel deck paneling. However, corrosion of a steel deck is a concern over the lifetime of the structure. A site applied wearing surface would also be required in this case.

Another design consideration would be whether the deck should act compositely with the structural steel mainspan floor-system members or float on top of them on steel reinforced elastomeric bearings. This should be further evaluated during preliminary design as a composite system locks-up load, which can be detrimental if not detailed properly, but, on the other hand, can also help to keep structural steel member sizes to a minimum and therefore reduce costs.

The deck system should be further explored in preliminary design to choose an optimal solution considering cost, structure weight, vibration considerations, and installation/erection methodology. For the purpose of this study and the costing a 200 mm full-thickness precast concrete deck panel system, which is non-composite with the steel floor-system is assumed. Sides of the panels are assumed to be fabricated monolithically with 300 mm wide, 150 mm high curbs for attaching the guards and facilitating deck drainage.

6.2 OPTION 1: ARCH

A mainspan arch option would consist of vertical steel arches made of straight sections. Hollow Structural Steel (HSS) section would primarily be used as they are closed section-types which generally are better than I-section-types at not allowing water to sit on flanges and they have a cleaner look aesthetically. Member sizes are anticipated to exceed standard HSS sections available. In this case, built-up HSS sections can be made from individual steel plates welded together. The arches would be tied, meaning they have bottom cords, and therefore there would be no thrusts for the substructure elements to restrain. The thickness of the structural system below deck would be minimized as much as possible (in the order of 1000 mm max.) therefore minimizing the overall length of the ramps.

The mainspan deck would be supported on transverse floor beams attached between the lower arch cords. The top and bottom cords would be connected by crossed web members. Hangers are not proposed for the arches here as there would be material compatibility issues between the weathering steel arch cords and stainless steel or galfan coated steel hangers. Bracing between the top compression cords would need to be provided to ensure lateral stability but would be minimized as much as possible to provide an open feeling for users. As well, laterally, vierendeel trusses would be used if technically feasible as this would be cleaner looking than having cross bracings between the arches and be more favourable for deck panel installation if completed by crane.

By its configuration, this option will provide a visually interesting experience to the travelling public and will provide a point of interest to the community and those travelling along Highway 16. Bridges of this type often become valued by their communities and the public in general. The City noted that an arch structure, as viewed from the west at the Sande Street overpass, would complement the mountain landscape to the east.

The anticipated span length to arch height ratios which would be targeted are span length / 7.0 to 8.5. For an 80 m span, this would correspond to an arch with a height of 9.5 to 11.5 m (not including its elevation above the ground). Therefore, this would be a significant structure in the City's landscape.

Arches can pose a climbing hazard if pedestrians are allowed close enough to their ends. The arches would be designed with smooth surfaces and a steep enough grades that climbing would prove quite difficult. Also, railings can be considered in the design to prevent pedestrian access to the arches. This will already likely be accomplished by the 2.4 m high guards on the mainspan which are required over the rail-lines.

See Appendix D for preliminary structure sketch which was made for this option and Appendix H for architectural renderings of this option.

6.3 OPTION 2: THROUGH-TRUSS

There are a number of variations in truss bridge types depending on load transfer mechanism. Typical elements of trusses are top cords, bottom cords, verticals, diagonals, and bracings. Efficiency of a truss depends on the orientation of the top cords, diagonals, and verticals. Orientation of the members is often dictated by aesthetics.

A through truss at this site is anticipated to have a structure height of approximately 8 m. A Pratt-type geometry for the web members would be a relatively standard design. A more modern design-style would be what is shown as a preliminary sketch for this site in Appendix D without vertical web members or possibly to use a vierendeel-type configuration without diagonals. Lengths of the individual truss panels would need to be determined in detailed design to optimize the efficiency of the structure, but equilateral triangles are proposed as a starting point in preliminary design as shown in Appendix D.

The truss would be made of primarily of HSS sections, as described for the arch option. The thickness of the structural system below deck would be minimized as much as possible (in the order of 1000 mm max.) therefore minimizing the overall length of the ramps.

The mainspan deck would be supported on transverse floor beams attached between the truss bottom cords. Bracing between the top compression cords would need to be provided to ensure lateral stability but would be minimized as much as possible to provide an open feeling for users. As well, laterally, vierendeel trusses would be used if technically feasible as this would be cleaner looking than having cross bracings between the arches and be more favourable for deck panel installation if completed by crane.

Trusses can pose a climbing hazard if pedestrians are allowed close enough to their members. The trusses would be designed with smooth surfaces and with members at steep enough grades that climbing would prove quite difficult. Also, railings will be included and detailed to mitigate pedestrian access to the structural members. This would mostly already be accomplished by 2.4 m high guards on the mainspan which are required over the rail-lines.

6.4 EVALUATION OF STRUCTURE TYPE

The following evaluation criteria was developed for the purpose of selecting the highest rated structural system mainspan which would be advanced to preliminary design. A total of 4 criteria were developed specifically related to the mainspan of this bridge only. The ranks for each criterion are described below. Relevant criteria which would be the same for both options are not included in this list (e.g. durability, maintenance, environmental). In addition, lifecycle costs are not considered because they would be very similar for the two structures.

1. Aesthetic Considerations

   The following are factors to consider in the evaluation of aesthetics for the proposed overpass: visibility for users, context, visual continuity, pleasing bridge lines, substructure geometry, clarity of function, harmony of the bridge elements and proper design of details.

   1) Mainspan is much less aesthetically pleasing than a typical pedestrian bridge.
   2) Mainspan is slightly less aesthetically pleasing than a typical pedestrian bridge.
   3) Mainspan is equally aesthetically pleasing as compared to a typical pedestrian bridge.
   4) Mainspan is slightly more aesthetically pleasing than a typical pedestrian bridge.
   5) Mainspan is much more aesthetically pleasing than a typical pedestrian bridge.

2. Sightline, Safety, Lighting, CPTED

   Considers the sightlines, level of lighting, CPTED required to enhance safety and perceived safety.

   1) Sightlines are a major concern; and/or alignment requires significant lighting, CPTED considerations.
   2) Sightlines are a major/moderate concern; and/or alignment requires moderate lighting, CPTED considerations.
   3) Sightlines are not a major concern; Alignment requires minimal lighting, CPTED considerations.

3. Construction Complexity

   Considers form work usage, crane positioning, construction over/near tracks, staging, possible premanufacture, etc.

   1) Construction of the Alignment under consideration is significantly more difficult than an average bridge.
   2) Construction of the Alignment under consideration is moderately more difficult than the average bridge.
   3) Construction of the Alignment under consideration is about the same complexity as an average bridge.
   4) Construction of the Alignment under consideration is moderately less difficult than the average bridge.
   5) Construction of the Alignment under consideration is significantly less difficult than the average bridge.

4. Capital Cost

   Cost is reflective of the mainspan provided.

   1) Mainspan costs significantly more than the average costs under consideration (more than 25%).
   2) Mainspan costs more than the average costs under consideration (more than 10%).
   3) Mainspan costs about the same as the average costs under consideration (within 5%).
   4) Mainspan costs less than the average costs under consideration (more than 10%).
   5) Mainspan costs less than the average costs under consideration (more than 25%).

Table 8 summarizes the evaluation rating for each structural system.

Table 8 – Evaluation of mainspan structural system options.

Criteria		Structural System Option	
		Arch	Through-Truss
1	Aesthetic Considerations	4.5	3.5
2	Sightline, Safety, Lighting, CPTED	2.5	2
3	Construction Complexity	1.5	1.5
4	Capital Cost	3	3
	Total points	11.5	10
	Ranking	1	2

Based on this ranking assessment, the preferred option is an arch. Note, as well, that the City has provided the input that the arch option is preferable to the truss from an aesthetic point of views.

6.5 APPROACHES STRUCTURES

The approach structure type would be the same for either mainspan structure type: cast-in-place or precast concrete spans each about 20 m long, supported by cast-in-place concrete or steel columns on single cast-in-place lined augered piles. The depth of the approach span is anticipated to be in the order of 1.0 m. The structural ramps would be designed to be as sleek / slender as possible and will not detract from the aesthetics of the mainspan and should not interrupt sightlines at the site. Sides of the elevated ramps are assumed to be fabricated monolithically with 300 mm wide, 150 mm high curbs for attaching the railings and facilitating deck drainage. 3 m long approach slabs are recommended between all elevated and on-grade structures.

Lengths of the at-grade portions of the ramps supported by retaining walls (which are cheaper to construct than the elevated ramps as described above) would be determined in preliminary design but are currently assumed to start at elevations of 2 m above existing ground. The walking surfaces on the retaining walls would be cast-in-place concrete sidewalks. The retaining wall system would have an architectural finish with a rough and uneven surface pattern that is not inviting for graffiti. An example is shown below in Figure 11 as used on another Parsons pedestrian bridge project. Retaining walls would be founded on cast-in-place concrete spread footing foundations.

Figure 11 – Example of retaining wall system with architectural finish.

Approach pathways would be asphalt pathways and/or cast-in-place concrete sidewalks and would follow existing City standards.

Immediately off the mainspan at each end of the bridge there will be elevated structures, separated from the mainspan and the approach ramps with expansion joints, supporting the viewing area/snow plow turn-around at the north end of the mainspan and the snow plow turn-arounds at the south end of the mainspan. These 2 elevated areas can each be supported by singular concrete or steel piers on single cast-in-place lined augured piles. Staircases, supported by these 2 elevated areas, are to have open grating stairs to allow for snow to fall through and shall be supported on structural steelwork on top of cast-in-place spread footing foundations. Staircases shall have landings at max. 3.7 m, shall have 165 mm x 305 treads, be oriented in general so as to not cause any user sightline issues, and have standard grabrail height railings along their sides.

7.0 Preferred Option

Based on the ranking evaluations completed in Sections 5 and 6, and City input, Alignment A and an arch mainspan structure have been selected for further consideration of constructability, production of a rendering and cost estimation. See Appendix H for the renderings, Appendix E for the structure drawings, and Appendix C for the cost estimates.

7.1 CONSTRUCTABILITY

The main construction challenge to a overpass at Kalum St. is erecting the mainspan over 15 active CN mainline / siding tracks. The mainspan lift philosophy is such that the steelwork should be erected in a single lift by a crane in the order of 500T capacity. This sequencing will limit disruption to CN and the time the crane is required on-site, both which affect cost for this project. The actual method used though will be based on availability of crane, contractor's preference and experience, and final approval by CN.

The mainspan would be built outside of CN property on dollies or other moveable platforms within the former Co-op property. As shown in Figures 12 to 14, the mainspan would be oriented in a relatively NW-SE direction during assembly. Once the mainspan assembly is complete it will be slowly driven into CN property as close to its final position as possible within an extended track block, i.e. likely one 12-hour overnight period. Track protection and flagging will be required at this stage as well as final approval from CN. Parsons anticipates laying removeable compacted gravel and heavy duty composite ground protection access mats/pads through CN's property for access instead of removing and replacing track as it will not be able to be quickly accomplished. The crane will also be located within CN property for the lift. The lift will be done in a single radius, i.e. the boom does not move in or out. The span will be lifted straight-up from the dollies/moveable platforms at its correct Northing-Easting position but will have to be rotated slightly with come-alongs in the air to orient it correctly onto its bearings on the mainspan piers (i.e. on the ground the mainspan won't obviously fit between the mainspan piers).

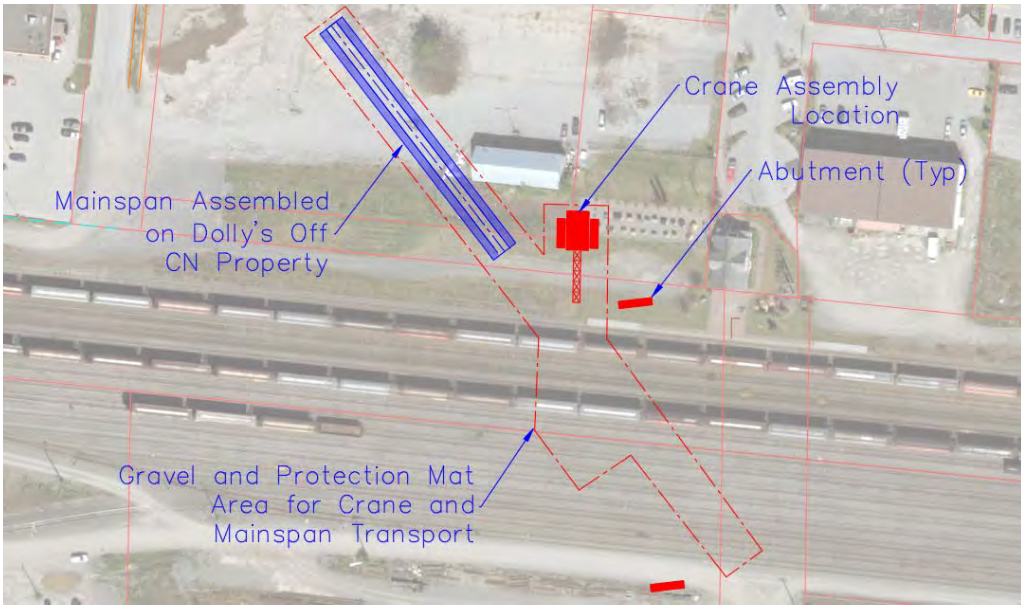


Figure 12 – Stage 1: Mainspan and Crane assembled off CN Property. Gravel and protection mats placed on CN tracks for crane and mainspan to move on top of.

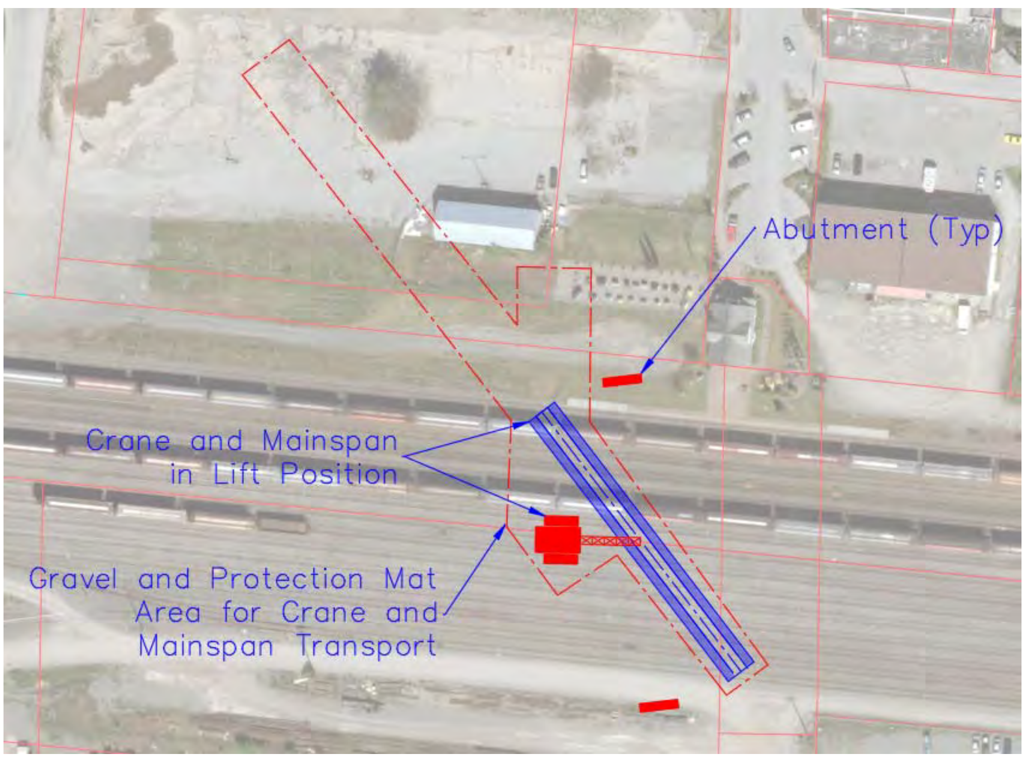


Figure 13 – Stage 2: Crane first moves to its lift position, then the main span is moved into its lift position on dolly's.

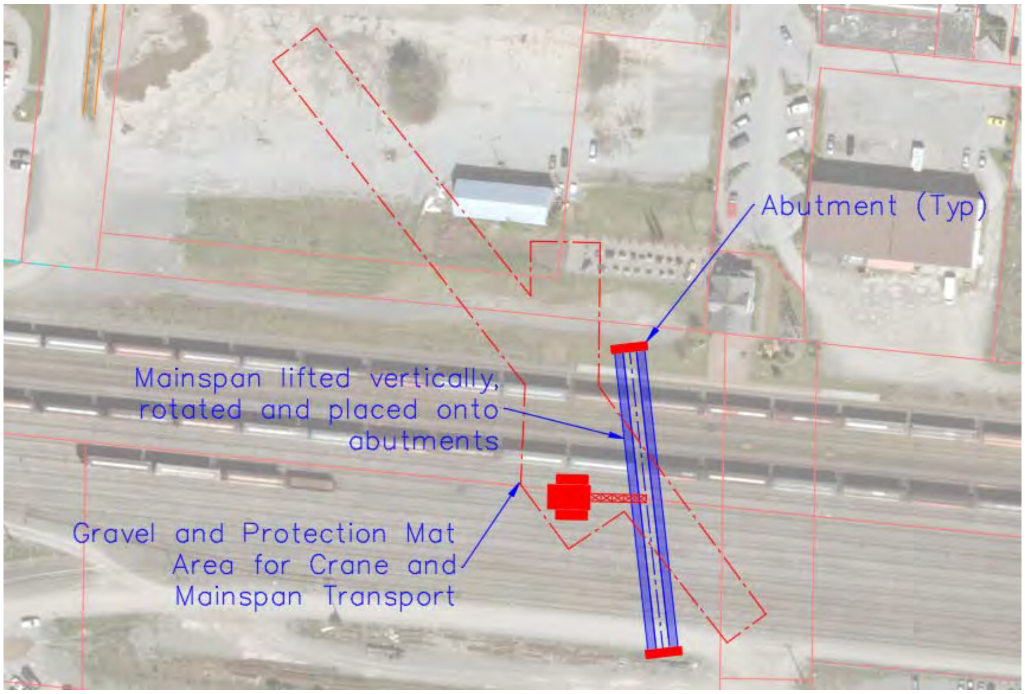


Figure 14 – Stage 3: Mainspan is lifted vertically above the top of abutments, rotated to aligned with abutments and then lowered into its final position on the abutments.

The next step is to place the mainspan deck prefabricated components onto the span through the steel mainspan top cord lateral compression struts, but this may or may not be able to occur within the same closure window as the mainspan lift due to limited timing within CN's property. Parsons does not recommend pouring a cast-in-place concrete deck over CN's property and therefore, as mentioned previously in this report, we recommend a prefabricated deck system be used. The prefabricated deck components could be placed during a few subsequent 4-6-hour windows coordinated with CN using a smaller crane and/or the same 500T crane. Positionings for the crane would be optimized by the Contractor to both the north or south of the tracks to avoid interrupting CN as much as possible. Any other finishing work for the mainspan (deck continuity work, expansion joints, railings, etc.) could be accomplished over live rail traffic.

Construction of pile caps, mainspan abutments, approach piers, and approach spans would be accomplished with conventical cast-in-place concrete techniques. The foundation is currently assumed to be cast-in-place concrete augured piles. Approach span formwork would be supported by falsework below. To minimize costs, the ends of the approach ramps would be on-grade and supported by a retaining wall system with an architectural finish. Staircases could be fabricated from slender structural steel members and supported on cast-in-place shallow footings.

7.2 CONSTRUCTION SEQUENCING

Based on our previous experience with construction of pedestrian overpasses, including over CN tracks, preliminary design, detailed design, and issued for tender documents could be finished within 4-6 months. Construction could be completed within 16-20 months thereafter.

Anticipated construction timings are*:

- Fabrication of structural steel components off site: 6 months;**
- Fabrication of precast deck components off site (8 weeks);**
- Utility relocations (if any): 4 weeks;
- Ship and assemble mainspan structural steel (8 weeks);
- Auguring for mainspan abutments and south ramp foundations (3 week);
- Cast-in-place piles and caps for mainspan abutments (3 weeks);

- Cast-in-place piers for mainspan abutments and south ramp (3 weeks);
- On-grade ramp for south approach (2 weeks);
- Ship precast deck components to site (1 week);
- Install mainspan bearings (1 week);
- Mobilize crane to site, prepare CN yard for crane, and lift mainspan steel in one piece into place (2 weeks);
- Install deck components and railings on mainspan (2 weeks);
- Cast-in-place south ramp spans on temporary falsework (4 weeks);
- Install railings on south ramps (2 weeks);
- Auguring for north ramp foundations (2 week);
- Cast-in-place piles for north ramp (2 week);
- Cast-in-place pier for north ramp (2 weeks);
- On-grade ramp for north approach (2 weeks);
- Cast-in-place north ramp spans on temporary falsework (4 weeks);
- Install railings on north ramp (2 weeks);
- Install expansion joints (2 weeks);
- Install staircases including cast-in-place concrete footings (1 week);
- On-grade asphalt pathways (3 weeks);
- Plaza area near George Little House (2 weeks);
- Landscaping: trees, shrubs, grass (2 weeks); and
- Continuous fencing along CN's property (3 weeks).

*It is assumed that the above items will overlap in order that the entire construction period only takes 16-20 months. The substructures for the mainspan and south ramp would begin initially concurrently with assembly of the mainspan steelwork on the north side in the former Co-op property. Once the mainspan abutments and structural steelwork are ready, the mainspan would be lifted in place so that construction could begin on the north ramps while the south ramps are finished. This would be followed by the asphalt pathways, plaza areas, and other final landscaping.

**It is best to order structural steel and precast components at least 6 months in advance and preferable to schedule tender in late Fall so that bridge prefabricated components will arrive on time for a following Summer construction start.

7.3 PROJECT COSTING

A -20%/+20% capital cost estimate of $11,561,366 for Alignment A with an arch mainspan has been prepared by Parsons. Accuracy of unit rates and costs have been optimized by using bid rates on recently tendered projects of similar scope and size. The cost estimate includes coordinating the future design stage with CN, engineering, QA services during construction, Contractor bonding and insurance, contingency, and City internal costs. As discussed, Alignment A uses CN's property and it is costed as such. The cost estimate does not account for CN property acquisition, which is extra to the costs shown, as this cost will be a negotiated process between CN and the City. The estimated capital cost of $11,561,366 is within the low range of the high-level $10-15M cost estimate by others, which also does not appear to include property acquisition costs.

Risk costing supports using a 15.58% contingency allowance at this stage. The accuracy of the estimates will get more refined as risk items are further managed through preliminary design, detailed design, and tender stages which will allow the contingency allowance to be reduced accordingly.

Ramp slopes are currently set at 6.7%, as discussed previously. If ramp slopes are changed or updated in preliminary design for any reason, costs for such changes can be estimated by the City in advance by taking the costs for the approach span items shown in Appendix C and linearly updating those costs by a ratio of the increased/decreased ramp lengths.

The lifecycle analyses completed by Parsons considered the proposed concept structure contained herein and anticipated required items over its lifetime that we've identified. Parsons has included expectations of costs required for the various line items identified and assigned an associated re-occurrence period to each item. Parsons then calculated present value of each anticipated line item and an overall equivalent annual amount for budgeting purposes over the 75-year design life of the potential structure. Note that each input to this process carries its own inherent uncertainty. Parsons used a 3.5% discount rate in our analyses as this is likely conservative, but this number can be easily changed (increased) in the analyses at any time to suit a City recommended value.

Parsons prepared lifecycle cost line items costs to -20%/+20% and gave our best estimates at re-occurrence periods. For City related maintenance items (e.g. power washing deck, snow removal, salting, etc.) Parsons gave their best estimates at the line item costs (i.e. based on our experience on previous projects) but would appreciate input from the City on these draft costs (e.g. labour rates for individuals undertaking this work). Subsequently, when actual costs are received from the City, Parsons can easily input them into our analyses and provide the City with an updated table.

The estimated equivalent annual amount in the lifecycle costing as currently analyzed is $26,256/year for the structure recommended in this report.

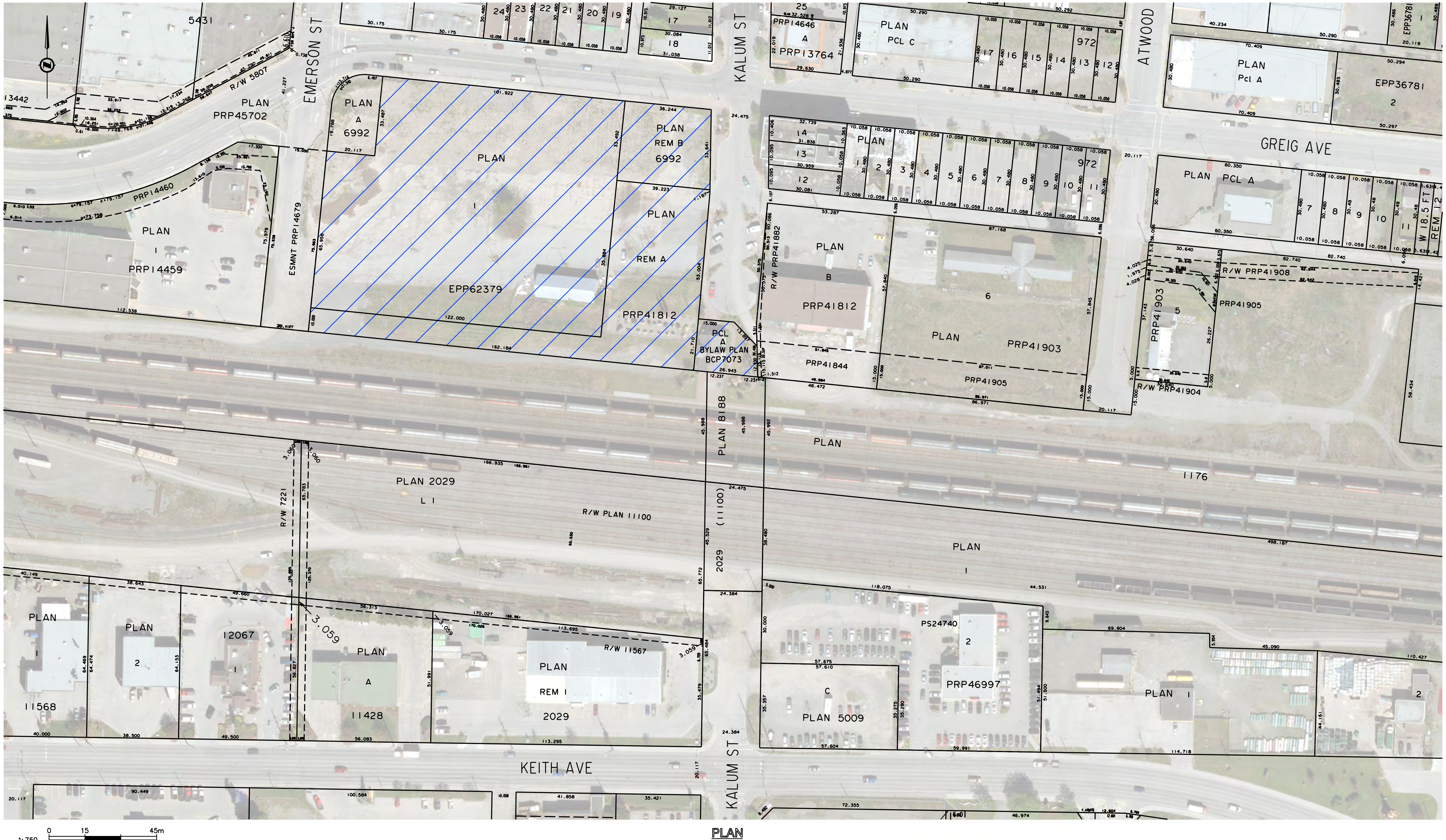
If the structural steel for the mainspan was fully painted instead of using weathering steel with only a few painted joints, it would be required to completely recoat the structure every 20-30 years. There are many site-specific factors which would ultimately determine an actual re-coating cost, such as coordination and access with CN. At a high-level, Parsons anticipates the total cost to be at least $1M and possibly more. If recoating every 25 years at a cost of $1M is considered, the equivalent annual amount would increase to $51,464/year.

The -20%/+20% capital cost estimate, risk cost calculations at this stage of the project, and lifecycle costs for Alignment A can be found in Appendix C. Costs for a truss mainspan superstructure would be comparable.

8.0 Final Recommendation

Parsons recommends that the City pursues a pedestrian overpass at the Kalum Street location to increase safety, accessibility and connectivity in the community. The feasibility of an overpass at this location is dependent on land acquisition/easement agreements from CN. Therefore, Parsons strongly recommends that the City engage CN in property acquisition discussions immediately within Preliminary design. Should the desired land acquisitions from CN become possible, then Parsons recommends alignment A with an arch type mainspan structure. The +/-20% capital cost calculated by Parsons for this recommendation is $11,561,366 with an approximate equivalent annual lifecycle cost of $26,256 per year.

Appendix A



PLAN
SCALE 1:750

LEGEND OF SYMBOLS

CITY OWNED PROPERTY

THE CITY OF TERRACE

DESIGN	A. MOROZ
DRAWN	S. FRASER
CHECK	
APPROVED	
DATE	APRIL 2018
SCALE	1:750
PROJECT No.	

PARSONS

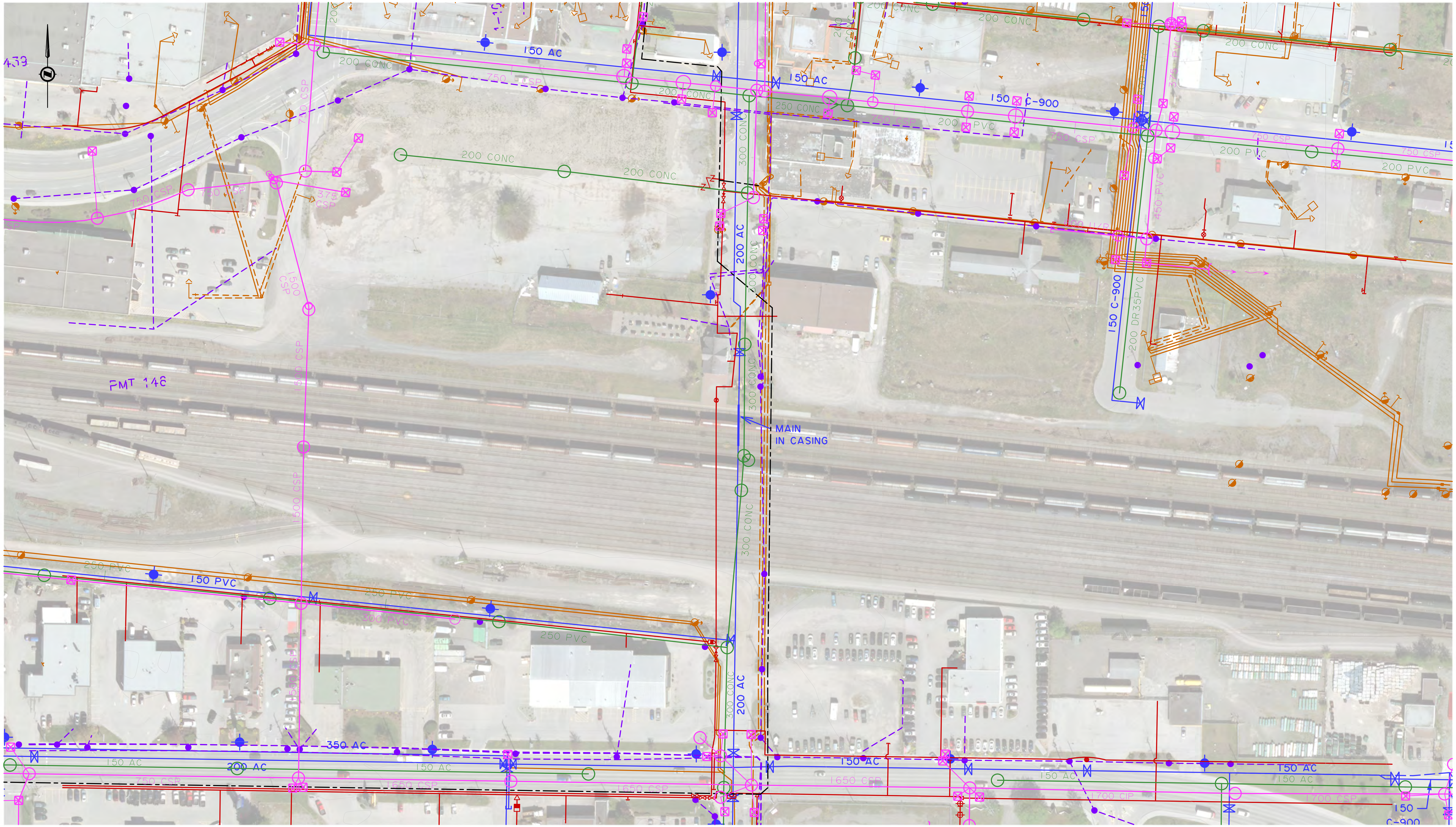
METROTOWER I, SUITE 2300, 4710 KINGSWAY,
BURNABY, BRITISH COLUMBIA, CANADA V5H 4M2
TEL: 604-438-5300 FAX: 604-438-5350
www.Parsons.com

CITY OF TERRACE

KALUM STREET PEDESTRIAN OVERPASS STUDY

PROPERTY SITE PLAN

SHEET No. 01
OF 02
REV.
DRAWING NO. SK01



1:750 0 15 45m

PLAN
SCALE 1:750

UTILITY LOCATIONS ARE AS PROVIDED BY RESPECTIVE UTILITY OWNER. EXACT LOCATIONS TO BE DETERMINED IN PRELIMINARY DESIGN.

LEGEND OF SYMBOLS

- SANITARY SEWER
- WATER
- STORM SEWER
- NATURAL GAS
- TELUS O/H CABLE
- TELUS FIBRE OPTIC CABLE
- TELUS U/G CABLE
- CITYWEST FIBRE OPTIC CABLES
- HYDRO O/H CABLES
- HYDRO U/G CABLES
- HYDRO POLE
- GATE VALVE
- FIRE HYDRANT
- TELUS POLE
- STORM SEWER CATCHBASIN
- STORM SEWER MANHOLE
- STORM SEWER CATCHBASIN MANHOLE
- SANITARY SEWER MANHOLE

THE CITY OF TERRACE

DESIGN	A. MOROZ
DRAWN	S. FRASER
CHECK	P. PHILLIPS
APPROVED	JUNE 2018
DATE	APRIL 2018
SCALE	1:750
PROJECT No.	476699

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CITY OF TERRACE
KALUM STREET PEDESTRIAN OVERPASS STUDY
UTILITY SITE PLAN

SHEET No. 02 OF 02 REV.
DRAWING NO. SK02

Appendix B

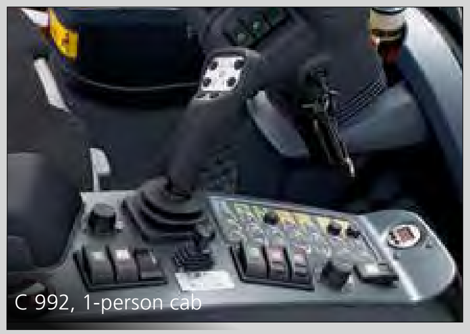
HOLDER TRACTORS INC.

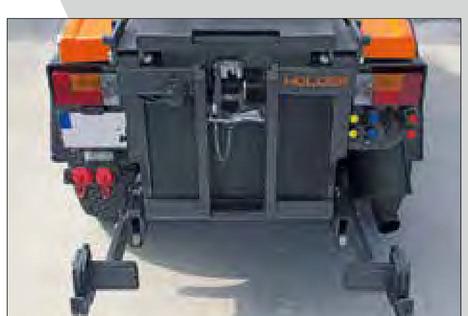
HOLDER C 992 / S 1090

BENEFITS, FEATURES AND TECHNICAL DATA

HOLDER C 992 / S 1090


S 1090, 2-person cab


C 992, 1-person cab



CAB

- ROPS certified
- Comfortable cab with air conditioning and 360° visibility
- Side windows and pop-up roof can be opened
- Very spacious even for tall and big drivers
- Heated, adjustable seat with air-suspension system
- Available with 1-person or 2-person cab
- 2-person cab includes armrest with integrated controls and buttons, synchronized with the seat suspension and a full-size comfortable passenger seat

View of attachments and excellent working comfort

OPERATING CONSOLE

- 1-hand operation
- Film protected control panel
- Programmable joystick
- Driving mode dial for 2 transport and 2 working modes

Individual setting options

SERVICE ACCESS

- Over-engine deck is hydraulically actuated for easy access to the engine
- Removable fenders
- Battery is accessible from the outside

Daily maintenance is possible without disassembling the attachments

FRONT ATTACHMENT OPTIONS

- Heavy-duty 3-point hitch moves 3-dimensionally with double-acting cylinders
- Arrester hooks are adjustable from CAT I to CAT II
- Maximum lifting capacity up to 5950 lb / 2700 kg
- Up to 4 double-acting control valves (flat face couplers are drip-free), with floating position, simultaneous attachment control possible
- Option of up to 32 US gpm / 120 l/min hydraulic flow
- Standard mechanical PTO shaft, operates from 540 rpm to 1000 rpm with the flip of a switch

REAR ATTACHMENT OPTIONS

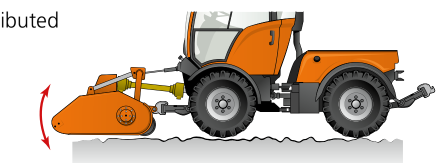
- Double-acting 3-point hitch with vibration dampening
- Arrester hooks are adjustable from CAT I to CAT II
- Maximum lifting capacity up to 3460 lb / 1570 kg
- Up to 2 double-acting control valves (flat face couplers are drip-free)
- Up to 21 US gpm / 80 l/min hydraulic
- PTO shaft, 540 rpm (hydraulically driven)

DUAL DRIVE: FUEL EFFICIENCY MADE EASY

- Uses the hydrostatic drive system for work and the direct drive system for high speed road travel saving up to 40% on fuel consumption when traveling.
- Automatically switches from hydrostatic to mechanical drive from approx. 16 mph / 26 km/h for fuel consumption optimisation.
- Because the hydrostatic pumps and motors are not driving the tractor, there is less wear and tear on these systems and less heat generated.

ELECTRO-HYDRAULIC ATTACHMENT RELIEF OPTION

- Weight of the attachment is automatically distributed throughout the entire vehicle
- The electro-hydraulic control eliminates wheel spinning
- More traction on slopes and slippery ground, increases stability when turning on a slop

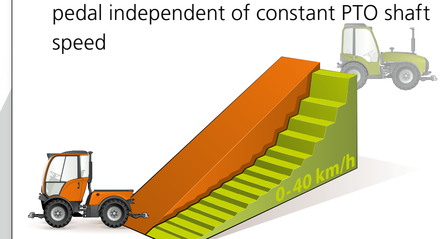


3 ATTACHMENT AREAS

- Front and rear lifts as well as 3rd attachment point over the engine
- Easy attachment mounting, one-person and no tools required

VARIABLE ACCELERATION UP TO 25 MPH / 40 KM/H

- No traction interruptions
- Transport mode: foot pedal variable speed control
- Working mode: speed control via dial on panel
- Special Driving System (SDS) gives the operator the possibility of speed control via foot pedal independent of constant PTO shaft speed



OTHER BENEFITS

- Cast-housing construction (heavier, higher power transmission)
- Variable speed control with hydrostat unit
- 100% differential lock from front to rear axle synchronizes rotation of all wheels
- Parking brake for inclines for safety in slopes
- Hydraulically actuated wet disc brake acting on all 4 wheels
- Corrosion protection: all steel components are coated using an electro coating process (EPD-coated) ensuring all corners and cavities are protected, plug-in couplings in ZiNi-coated, vehicle is waxed
- Transport speed up to 25 mph / 40 km/h and approved for street use

UNIQUE TECHNOLOGY

- Articulated steering
- Real four-wheel drive
- Four wheels of equal size
- Wheel load compensation
- Mechanical differential lock acting on both axles
- 4-wheel brake

For more information, visit www.holdertractors.ca

WIDE RANGE OF APPLICATION

- Mowing and grass-collecting
- Cylinder mowing and large area mowing
- Rotary and flail mulching
- Weed removal
- Scarifying and aeration
- Watering and high-pressure cleaning
- Sweeping and suction cleaning
- Lawn sweeping and synthetic turf cleaning
- Earth handling (front loader)
- Loading and transport
- Snow ploughing and snow blowing
- Snow sweeping and snow loading
- Salt spreading (with attachment, box or funnel spreader)
- Cross-country ski tracks

FIELDS OF APPLICATION:

- Green areas and synthetic turf
- Sports grounds and golf courses
- Sidewalks, roads and public open spaces
- Underground car parks and rails

SECTORS

- Municipalities and service providers
- Facility management
- Landscaping
- Airports, mining and military

Use up to 3 attachments at the same time with your Holder!

YOU ARE IN GOOD HANDS WITH HOLDER

- Long service life
- High stability of value
- 24 months guarantee
- 24-hour delivery of spare parts
- More than 15 years spare parts supply
- A network of dealers across North America
- Rental, financing and leasing

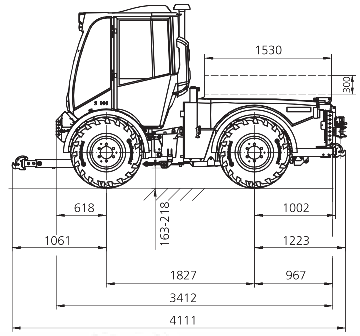
SEE HOLDER IN ACTION:
www.youtube.com/user/HolderTractorsInc

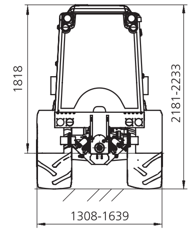
TECHNICAL DATA C 992 / S 1090

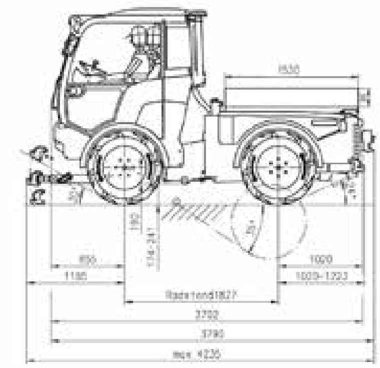
C 992 = 1-person cab
S 1090 = 2-person cab

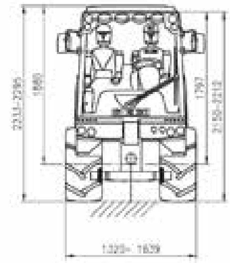
ENGINE	Deutz 4-cylinder 4-stroke turbo diesel
Displacement	1425 in³ / 3619 cm³
Power	68 kW / 92 HP
Torque	280 Nm
Cooling	Water cooled
Air filter	Dry air filter with acoustic warning signal
Fuel tank capacity	21.6 gal / 82 l
Alternator	Max. 95 A / 12 V
DRIVE	Hydrostatic drive Controlled with digital electronics Variable speed control with hydrostat unit Permanent four-wheel drive 4 wheels of the same size Optional: Dual Drive
Differential lock	From front to rear axle synchronizes rotation of all wheels Simultaneously switchable electrohydraulically Acts on both axles at 100% Stiff fixed drive from front to rear axle
Max. speed	25 mph / 40 km/h
PTO shafts	Load-dependent, independent engine power take-off Front 540/1000 rpm, optional rear 1000 rpm Electrohydraulic operated multi-plate clutch
Brakes	Hydraulically actuated wet multi-plate brake Acts as an all-wheel brake Electric stop brake acts on both axles
HYDRAULICS	Hydraulic pump 42.5 l/min, by request flow controller with tandem pump, 35 l/min + 27.5 l/min Both optionally expandable with additional device variable displacement pump 120 l/min.
Hydraulic oil quantity	12 gal / 45 l
Lifting force	Front 5959 lb / 2700 kg Rear 3307 lb / 1570 kg
Three-point lift	Heavy-duty 3-point hitch Arrester hook are adjustable from CAT I to CAT II.
Additional control valves	Up to 4 double-acting control valves, with floating position, simultaneous attachment control possible
CAB	Available with 1- or 2-person cab Heated, adjustable seat with air-suspension system 2-person cab has armrest, with integrated controls and buttons, synchronized with the seat suspension Air conditioning and activated carbon filter
Optional equipment	Heated front window and exterior rear-view mirror

WEIGHT	Including driver at 165 lb / 75 kg, depending on tires and equipment.	
	1-person cab:	**2-person cab:**
Empty weight	5816-6151 lb / 2638-2790 kg	6360-6775 lb / 2885-3073 kg
Gross vehicle weight	9921 lb / 4500 kg	
Gross axle weight rating	Front 5952 lb / 2700 kg Rear 6614 lb / 3000 kg	
Coupling load	Max. 1764 lb / 800 kg	
Towing capacity	Unbraked 5512 lb / 2500 kg Overrun braked 9921 lb / 4500 kg	
Maximum payload	4105 lb / 1862 kg	3560 lb / 1615 kg
DIMENSIONS	Depending on tires	
	1-person cab:	**2-person cab:**
Wheel base	72 in / 1827 mm	
Total length	134-162 in / 3412-4111 mm	146-167 in / 3702-4235 mm
Total height	86-88 in / 2181-2233 mm	88-90 in / 2233-2295 mm
Total outer width	51-65 in / 1308-1639 mm	52-65 in / 1320-1639 mm
Turning circle	Inside 84 in / 2130 mm	
Inner flatbed dimensions	60 x 47 x 8 in / 1530 x 1200 x 300 mm	







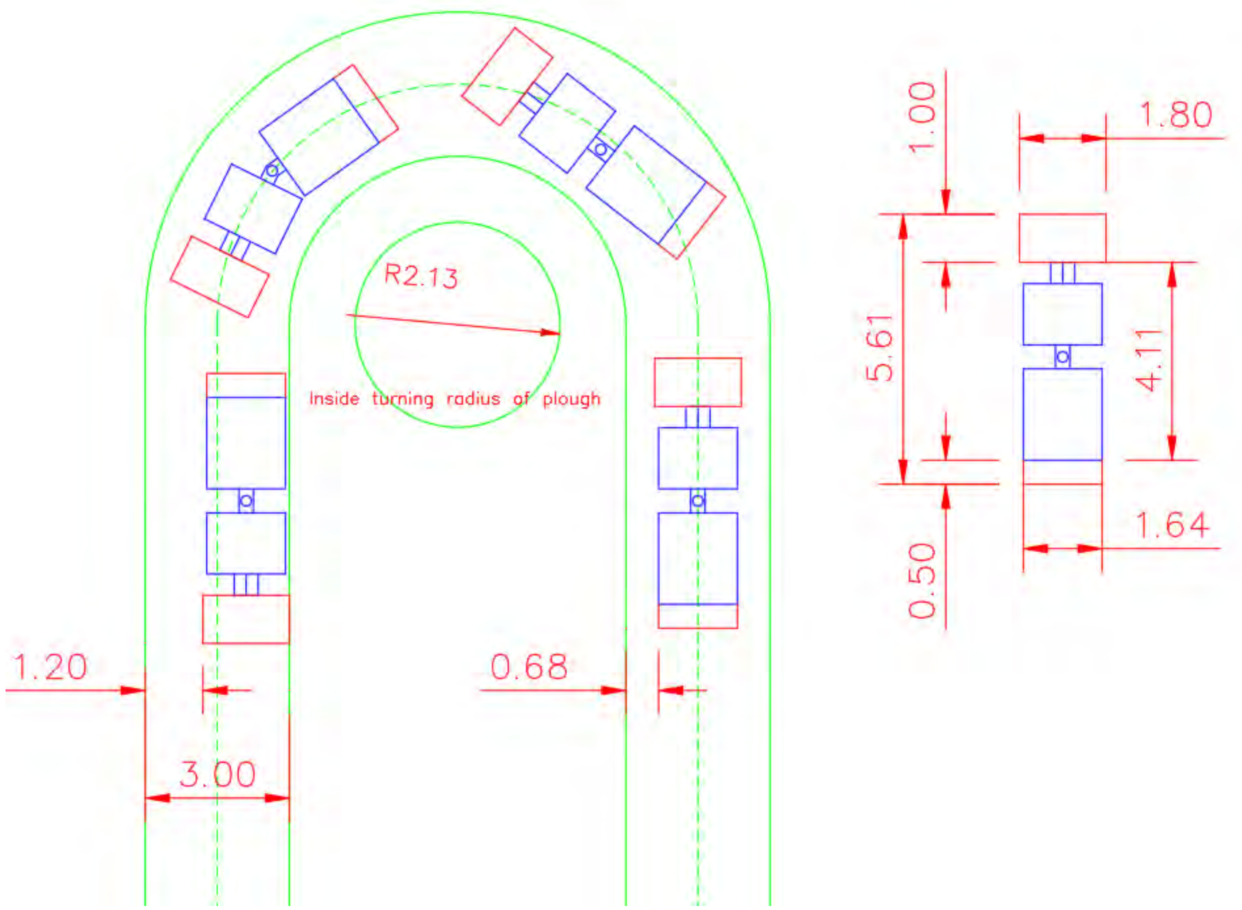


Subject to technical changes.
12/2014 Language: English ID no.: 992-12-14

For guidance, sales and service contact your Holder representative

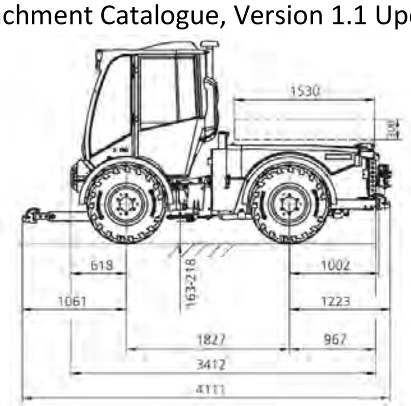
Holder Tractors Inc.
100 Bay Street | Embrun ON | Canada
Phone: 613.443.3200 | Fax: 613.443.9600
info@holdertractors.ca | **www.holdertractors.ca**

Prelimnary Clearance Sketch for Snowplough on Ramps



Notes:

- All units in meters.
- Radius of turn is 5m on the centerline.
- Holder C992 (single cab) considered. Blue lines shows the tractor overall dimensions. Red lines show the attachment added dimensions. Dimensions taken from Holder Tractors Inc. 2015 Bochure for Holder C992/S1090.
- Length of attachemnts is not included in catalgoue infromation. Currently, lengths of attachements are assumed based on photos. Width dimensions of attachments taken from Holder Tractor Inc. S-Series Attachment Catalogue, Version 1.1 Updatd 1/5/17.



Appendix C

PARSONS

11-Jun-2018

Kalum St. Ped. Overpass

Parsons Project No.: 476699

-20%/+20% CAPITAL COST ESTIMATE
SCHEDULE OF QUANTITIES AND UNIT PRICES

Alignment A
Arch Mainspan

Number	Item	Unit	Quantity	Unit Cost ($)	Cost ($)
1.0	Design and Site Investigation				
1.1	CN Engineering Review	LS	1	$25,000.00	$25,000.00
1.2	Migratory Birds Wildlife Sweep and Recommendations	LS	1	$10,000.00	$10,000.00
	Subtotal				**$35,000.00**
2.0	Demolitions, Removals				
2.1	Tree Removal and Compensation	Ea	4	$750.00	$3,000.00
2.2	Chain Link Fence Removal	m	165	$50.00	$8,250.00
	Subtotal				**$11,250.00**
3.0	Foundations				
3.1	Mobilization and Demobilization	LS	1	$35,000.00	$35,000.00
3.2	Footing Excavation	m^3	314	$30.00	$9,405.00
3.3	CIP Pile Concrete	m^3	477	$770.00	$367,389.63
3.4	CIP Pile Rebar	Tonne	74	$2,497.00	$185,857.16
	Subtotal				**$597,651.79**
4.0	Mainspan Abutments (2)				
4.1	Concrete Footings	m^3	62.0	$506.00	$31,392.24
4.2	Footing Formwork	m^2	45.2	$300.00	$13,560.00
4.3	Footing Rebar (Black)	Tonne	16.1	$2,500.00	$40,262.66
4.4	HPC Column Concrete	m^3	56.5	$750.00	$42,411.50
4.5	Column Formwork	m^2	141.4	$300.00	$42,411.50
4.6	Column Rebar (Black)	Tonne	14.7	$2,500.00	$36,698.90
4.7	HPC Pier Cap Concrete	m^3	42.0	$750.00	$31,500.00
4.8	Pier Cap Formwork	m^2	78.0	$300.00	$23,400.00
4.9	Pier Cap Rebar (Black)	Tonne	10.9	$2,500.00	$27,257.12
	Subtotal				**$288,893.93**
5.0	Ramp Piers North				
5.1	Concrete Footings	m^3	0.0	$506.00	$0.00
5.2	Footing Formwork	m^2	0.0	$300.00	$0.00
5.3	Footing Rebar (Black)	Tonne	0.0	$2,500.00	$0.00
5.4	Pier Concrete	m^3	12.7	$506.00	$6,426.89
5.5	Pier Formwork	m^2	117.8	$300.00	$35,342.92
5.6	Pier Rebar (Black)	Tonne	3.3	$2,500.00	$8,242.92

-20%/+20% CAPITAL COST ESTIMATE
SCHEDULE OF QUANTITIES AND UNIT PRICES

Alignment A
Arch Mainspan

5.7	HPC Pier Cap Concrete	m^3	20.0	$750.00	$15,000.00
5.8	Pier Cap Formwork	m^2	76.3	$300.00	$22,875.00
5.9	Pier Cap Rebar (Black)	Tonne	5.2	$2,500.00	$12,979.58
	Subtotal				**$100,867.31**
6.0	Ramp Piers South				
6.1	Concrete Footings	m^3	0.0	$506.00	$0.00
6.2	Footing Formwork	m^2	0.0	$300.00	$0.00
6.3	Footing Rebar (Black)	Tonne	0.0	$2,500.00	$0.00
6.4	Pier Concrete	m^3	15.9	$506.00	$8,047.58
6.5	Pier Formwork	m^2	117.8	$300.00	$35,342.92
6.6	Pier Rebar (Black)	Tonne	4.1	$2,500.00	$10,321.57
6.7	HPC Pier Cap Concrete	m^3	24.0	$750.00	$18,000.00
6.8	Pier Cap Formwork	m^2	91.5	$300.00	$27,450.00
6.9	Pier Cap Rebar (Black)	Tonne	6.2	$2,500.00	$15,575.50
	Subtotal				**$114,737.57**
7.0	On-Grade Ramp North				
7.1	Retaining Wall System with Architectural Finish	m^2	18.8	$650.00	$12,205.18
7.2	General Excavation	m^3	82.8	$30.00	$2,484.00
7.3	General Backfill	m^3	379.4	$30.00	$11,381.69
7.4	On-Grade Slab Concrete	m^3	33.1	$506.00	$16,758.72
7.5	On-Grade Slab Wearing Surface	m^2	0.0	$100.00	$0.00
7.6	On-Grade Slab Rebar (Stainless Steel)	Tonne	8.6	$6,000.00	$51,586.05
	Subtotal				**$94,415.64**
8.0	On-Grade Ramp South				
8.1	Retaining Wall System with Architectural Finish	m2	117.1	$650.00	$76,098.75
8.2	General Excavation	m^3	63.0	$30.00	$1,890.00
8.3	General Backfill	m^3	242.2	$30.00	$7,267.05
8.4	On-Grade Slab Concrete	m^3	25.2	$506.00	$12,751.20
8.5	On-Grade Slab Wearing Surface	m^2	0.0	$100.00	$0.00
8.6	On-Grade Slab Rebar (Stainless Steel)	Tonne	6.5	$6,000.00	$39,250.26
	Subtotal				**$137,257.26**
9.0	Superstructure - Main Span				
9.1	Supply and Fabrication	Tonne	150.0	$12,200.00	$1,830,000.00
9.2	Cost for Flaggers	LS	1.0	$4,000.00	$4,000.00
9.3	CN Property Access	LS	1.0	$20,000.00	$20,000.00

-20%/+20% CAPITAL COST ESTIMATE

SCHEDULE OF QUANTITIES AND UNIT PRICES

Alignment A
Arch Mainspan

9.4	Access Matting and Gravel Padding	LS	1.0	$40,000.00	$40,000.00
9.5	Shipping and Install	Tonne	150.0	$5,906.25	$885,937.50
9.6	Painting (bottom chords and floor beams)	m^2	530.0	$300.00	$159,000.00
	Subtotal				**$2,938,937.50**
10.0	CIP North Spans				
10.1	HPC Concrete	m^3	170.0	$750.00	$127,462.50
10.2	Formwork	m^2	721.0	$300.00	$216,300.00
10.3	Deck Rebar (Stainless Steel)	Tonne	44.1	$6,000.00	$264,705.61
10.4	Steel Stairs	Ea	1.0	$30,000.00	$30,000.00
	Subtotal				**$638,468.11**
11.0	CIP South Spans				
11.1	HPC Concrete	m^3	224.4	$750.00	$168,300.00
11.2	Formwork	m^2	952.0	$300.00	$285,600.00
11.3	Deck Rebar (Stainless Steel)	Tonne	58.3	$6,000.00	$349,514.20
11.4	Steel Stairs	Ea	1.0	$30,000.00	$30,000.00
	Subtotal				**$833,414.20**
12.0	Full Thickness Precast Deck Panels (Main Span)				
12.1	HPC Deck Concrete	m^3	66.4	$750.00	$49,815.00
12.2	Deck Formwork	m^2	0.0	$300.00	$0.00
12.3	Deck Rebar (Stainless Steel)	Tonne	14.4	$6,000.00	$86,210.39
12.4	Concrete Finishes (all)	LS	1.0	$8,250.00	$8,250.00
	Subtotal				**$144,275.39**
13.0	Turn-around Area at End of Mainspan (2)				
13.1	Pier Concrete	m^3	3.8	$506.00	$1,900.12
13.2	Pier Formwork	m^2	20.0	$300.00	$6,008.30
13.3	Pier Rebar (Black)	Tonne	0.9	$2,500.00	$2,196.78
13.4	HPC Deck Concrete	m^3	11.4	$750.00	$8,550.00
13.5	Deck Formwork	m^2	65.0	$300.00	$19,500.00
13.6	Deck Rebar (Stainless Steel)	Tonne	2.2	$6,000.00	$13,491.90
					$51,647.10
14.0	Expansion Joints and Bearings				
14.1	Mainspan Expansion Joints	m	7.2	$2,300.00	$16,560.00
14.2	Ramp Expansion Joints	m	36	$2,300.00	$82,800.00
14.3	Main Span Deck Bearings	Ea	22	$2,000.00	$44,000.00
14.4	Main Span Arch Bearings	Ea	4	$15,000.00	$60,000.00

PARSONS

11-Jun-2018

Kalum St. Ped. Overpass

Parsons Project No.: 476699

-20%/+20% CAPITAL COST ESTIMATE

SCHEDULE OF QUANTITIES AND UNIT PRICES

Alignment A
Arch Mainspan

14.5	Ramp Bearings	Ea	12	$5,000.00	$60,000.00
	Subtotal				**$263,360.00**
15.0	Handrails (Includes Finishes)				
15.1	Ramp Railing (1.4m High)	m	640	$1,200.00	$768,000.00
15.2	Mainspan Railing (2.4m High)	m	164	$1,800.00	$295,200.00
	Subtotal				**$1,063,200.00**
16.0	Landscaping and Pathways				
16.1	Grubbing	LS	1	$5,000.00	$5,000.00
16.2	Stripping and Stockpiling	LS	1	$7,500.00	$7,500.00
16.3	Removal of Contaminated Soil	m^3	60	$35.00	$2,100.00
16.4	Rough Grading and Fill	LS	1	$7,500.00	$7,500.00
16.5	Landscape Subgrade Preparation	LS	1	$7,500.00	$7,500.00
16.6	Hydroseeding	LS	1	$10,000.00	$10,000.00
16.7	Bushes, Trees and Plantings	LS	1	$15,000.00	$15,000.00
16.8	North Side Public Art fFatures and Plaza	LS	1	$10,000.00	$10,000.00
16.9	3m Asphalt Path	m	330	$500.00	$165,000.00
16.10	Removable Bollard	Ea	2	$1,000.00	$2,000.00
16.11	Topsoil: 150mm - Load, Haul and Place	m^2	400	$12.00	$4,800.00
16.12	Robust 2.4 m High Fence	m	753	$220.00	$165,660.00
16.13	Substantial Completion and 2 Year Inspection	LS	1	$10,000.00	$10,000.00
	Subtotal				**$412,060.00**
17.0	Lighting and Miscellaneous				
17.1	Bridge and Ramp Lighting	LS	1	$100,000.00	$100,000.00
	Subtotal				**$100,000.00**
18.0	Utilities and Drainage				
18.1	PVC Bridge Deck Drainage	LS	1	$5,000.00	$5,000.00
18.2	Connections to Storm Drains	LS	1	$10,000.00	$10,000.00
18.3	Relocates	LS	0	$10,000.00	$0.00
	Subtotal				**$15,000.00**
	Total				**$7,840,435.79**
	General Expenses, bonding and insurance (12%)				**$940,852.29**
	Contingency (15.58%)				**$1,368,124.68**
	Subtotal				**$10,149,412.76**
	Engineering Design				**$600,000.00**
	City Overhead (5%)				**$507,470.64**
	Quality Assurance Testing Required During Construction (3%)				**$304,482.38**

PARSONS

11-Jun-2018

Kalum St. Ped. Overpass

Parsons Project No.: 476699

-20%/+20% CAPITAL COST ESTIMATE

SCHEDULE OF QUANTITIES AND UNIT PRICES

Alignment A
Arch Mainspan

Grand Total	$11,561,365.79

Notes

1 Cost of stairs includes handrail

2 Lighting to provide 5 Lux average illumination

3 The lighting cost was done assuming no transformer installation required

4 Main span railing is 2.4 m high

5 The total weight of the main span arch was increased by 25% to account for the gusset plates, connections, stiffeners etc

6 The ramps were assumed to have a cross sectional area of 1.65 m2

7 The cost estimate doesn't account for property acquisition

8 Assuming no utility relocation

9 Painting is for the botton chord and floor beams only

10 No GST added

Kalum St. Ped. Overpass: Risk Costs

Item	Notes	Probability	Cost	Expected Value
Changes in Design Scope	1	0.30	100,000	$30,000
Changes in Construction Scope	2	0.30	200,000	$60,000
Construction Unknowns	3	0.50	200,000	$100,000
Accuracy of Estimates	4	1.00	878,129	$878,129
Construction Delays	5	0.50	200,000	$100,000
Construction Quality and Rework	6	0.50	200,000	$100,000
Delays - CN	7	0.50	200,000	$100,000
			Total	**$1,368,129**
			% of Estimated Construction Cost	**15.58%**

Notes

1. Major changes such as changing foundations, ramp slopes, location of bridge, additional open houses etc
2. Major changes during construction such as value added contractor options, constructibility/erection changes etc
3. Unknowns such as geotechnical conditions, unknown utilities, contaminated soils, etc
4. Confidence in engineers estimate (typically 10% of estimated construction cost)
5. Delays due to weather, steel fabrication, site conflicts, contractors performance, accidental utility interruptions etc Includes extra engineering time on site
6. Costs for retesting, rework, and assessments
7. Unexpected impacts on traffic and traffic control and/or bridge construction

* Items 5, 6 and potentially 7 should be bourne by the contractor

* Assumes property acquisition has already been handled

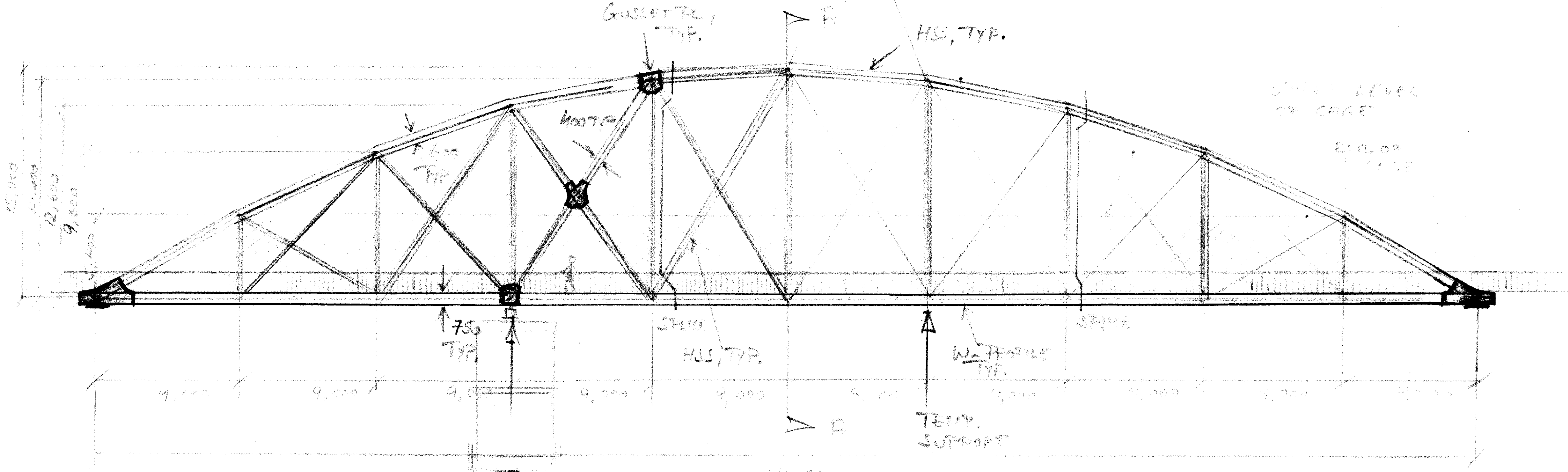
Kalum St. Ped. Overpass: Bridge Life Cycle Costs

Bridge life	75	yrs
Assumed Discount rate, DR	0.035	
1+DR	1.035	

Item	Occurrence	Cost/Occurrence	Repeat period	PV Factor	Present Value, PV_{75}
General Inspections	Visual every two years	2,000	2	12.98	$25,953
Arch Inspection	Hands-on every 5 years	4,000	5	4.92	$19,697
Deck and Bearing Washing	Cleaning every spring	1,000	1	26.41	$26,407
Winter Snow Clearing	Every winter	3,500	1	26.41	$92,423
Joint Seal Replacements	Every 20 years	3,000	20	0.93	$2,801
Joint Replacement	Every 50 years	100,000	50	0.20	$20,158
Paint Retouch	Every 5 years	2,500	5	4.92	$12,311
Re-caulking Deck Joints	Every 5 years	2,000	5	4.92	$9,849
Concrete deck repairs	Every 30 years	15,000	30	0.51	$7,673
Concrete Substructure Repairs	Every 40 years	10,000	40	0.31	$3,123
Handrail Maintenance	Every 30 years	50,000	30	0.51	$25,577
Lighting Maintenance	Every year	1,000	1	26.41	$26,407
Lighting Fixture Replacement	Every 10 years	10,000	10	2.25	$22,509
Pathway Maintenance	Every 5 years	3,000	1	26.41	$79,220
Pathway Replacement	Every 30 years	165,000	30	0.51	$84,403
Landscaping Maintenance	Every year	3,000	1	26.41	$79,220
Access to CN Property	Every 5 years	5,000	5	4.92	$24,622
Bearing Replacement	Every 30 years	180,000	30	0.51	$92,076
Recoat Concrete (Graffiti Maintenance)	Every 5 years	1,000	5	4.92	$4,924
Re-Grating Stairs	Every 25 years	10,000	25	0.68	$6,780
Clean Drains	Every 2 years	500	1	26.41	$13,203
Fencing Repair and Cleaning	Every 5 years	15,000	20	0.93	$14,007
				Total	**$693,343**
				Equivalent annual amount	**$26,256**

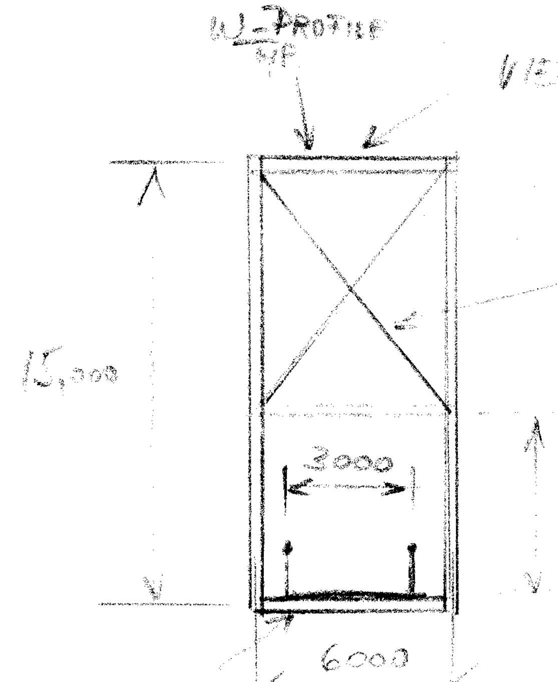
Appendix D

TRUSS ARCH IN WEATHERING STEEL



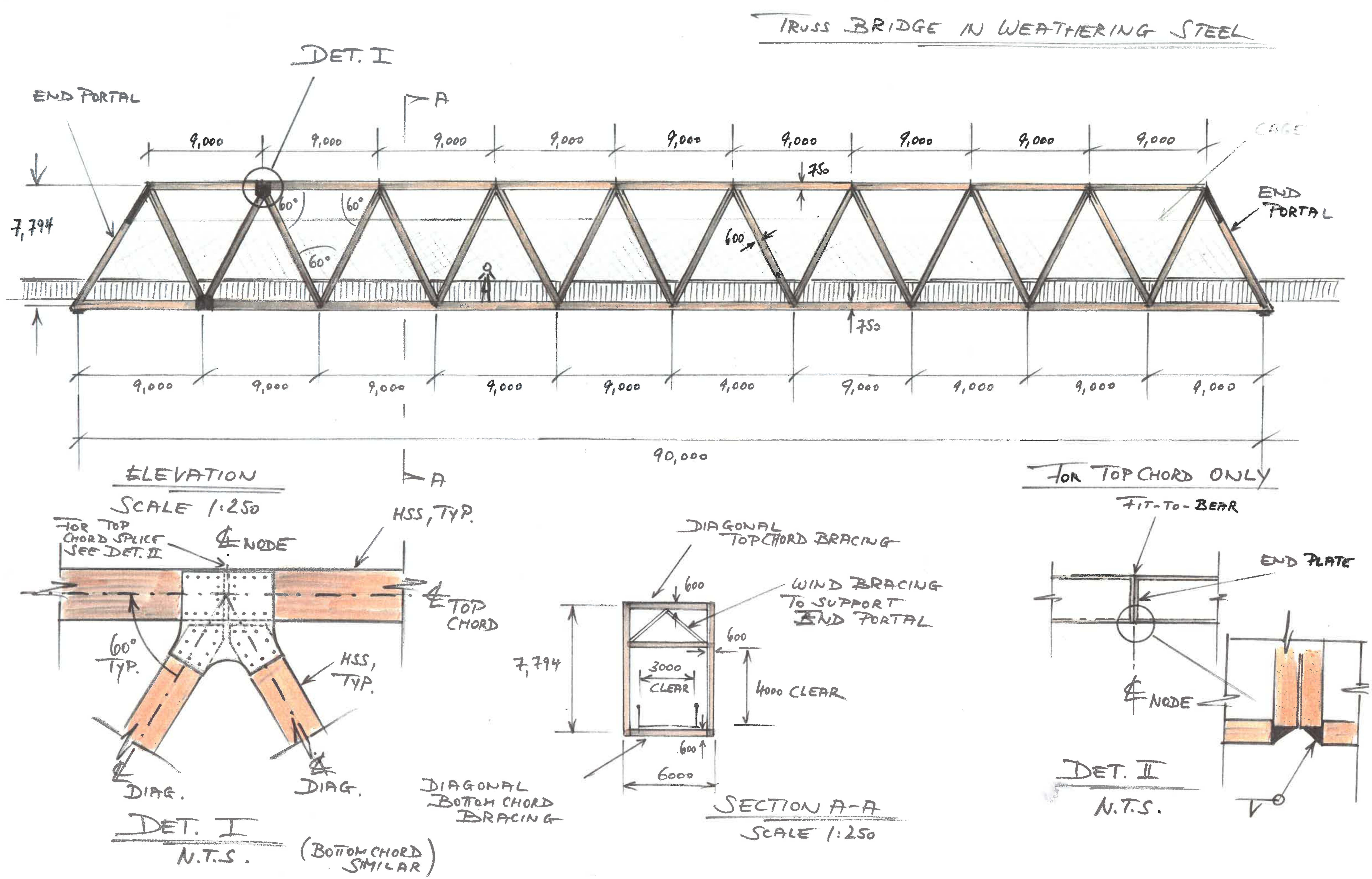
ELEVATION
SCALE 1:250

TEMP. SUPPORT W/ DOUBLE CONTAINER CAR

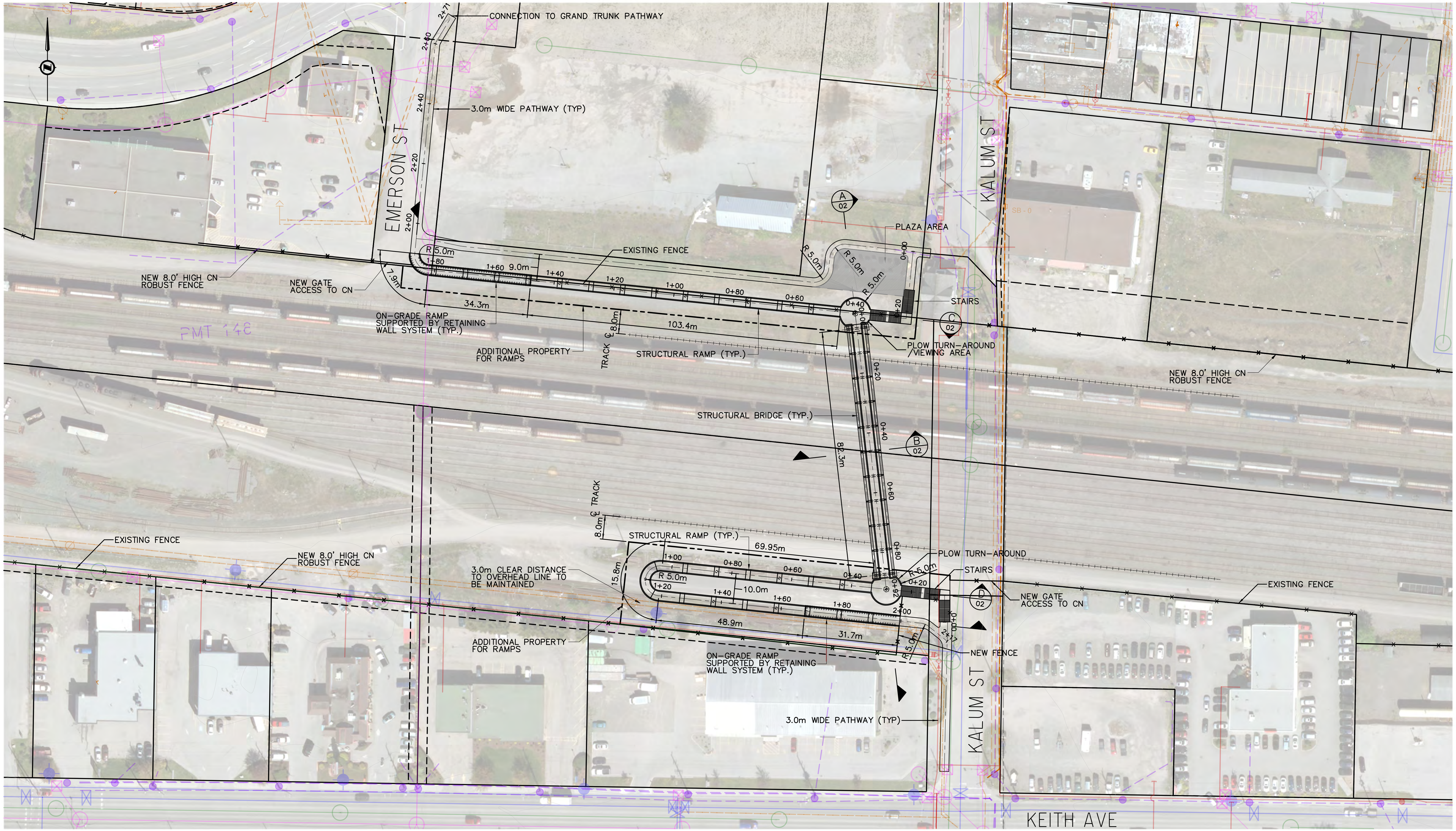


VIERENDEEL TRUSS BETWEEN BOTTOM CHORDS

SECTION A-A
SCALE 1:250


TRUSS BRIDGE IN WEATHERING STEEL
DET. I
END PORTAL
A
9,000
9,000
9,000
9,000
9,000
9,000
9,000
9,000
9,000
CAGE
750
60°
60°
60°
7,794
600
END PORTAL
750
9,000
9,000
9,000
9,000
9,000
9,000
9,000
9,000
9,000
9,000
90,000
ELEVATION
SCALE 1:250
A
FOR TOP CHORD ONLY
FOR TOP CHORD SPLICE SEE DET. II
℄ NODE
HSS, TYP.
℄ TOP CHORD
60° TYP.
HSS, TYP.
℄ DIAG.
℄ DIAG.
DET. I
N.T.S.
(BOTTOM CHORD SIMILAR)
DIAGONAL TOP CHORD BRACING
600
WIND BRACING TO SUPPORT END PORTAL
600
7,794
3000 CLEAR
4000 CLEAR
600
6000
DIAGONAL BOTTOM CHORD BRACING
SECTION A-A
SCALE 1:250
FIT-TO-BEAR
END PLATE
℄ NODE
DET. II
N.T.S.

Appendix E



1:750 0 15 45m

PLAN
SCALE 1:600

UTILITY LOCATIONS ARE AS PROVIDED BY RESPECTIVE UTILITY OWNER. EXACT LOCATIONS TO BE DETERMINED THROUGH LOCATES IN PRELIMINARY DESIGN.

LEGEND OF SYMBOLS

THE CITY OF TERRACE

DESIGN	A. MOROZ
DRAWN	S. FRASER
CHECK	P. PHILLIPS
APPROVED	JUNE 2018
DATE	APRIL 2018
SCALE	1:600
PROJECT No.	476699

PARSONS

METROTOWER II, SUITE 2300, 4710 KINGSWAY, BURNABY, BRITISH COLUMBIA, CANADA V5H 4M2
TEL: 604-438-5300 FAX: 604-438-5350
www.Parsons.com

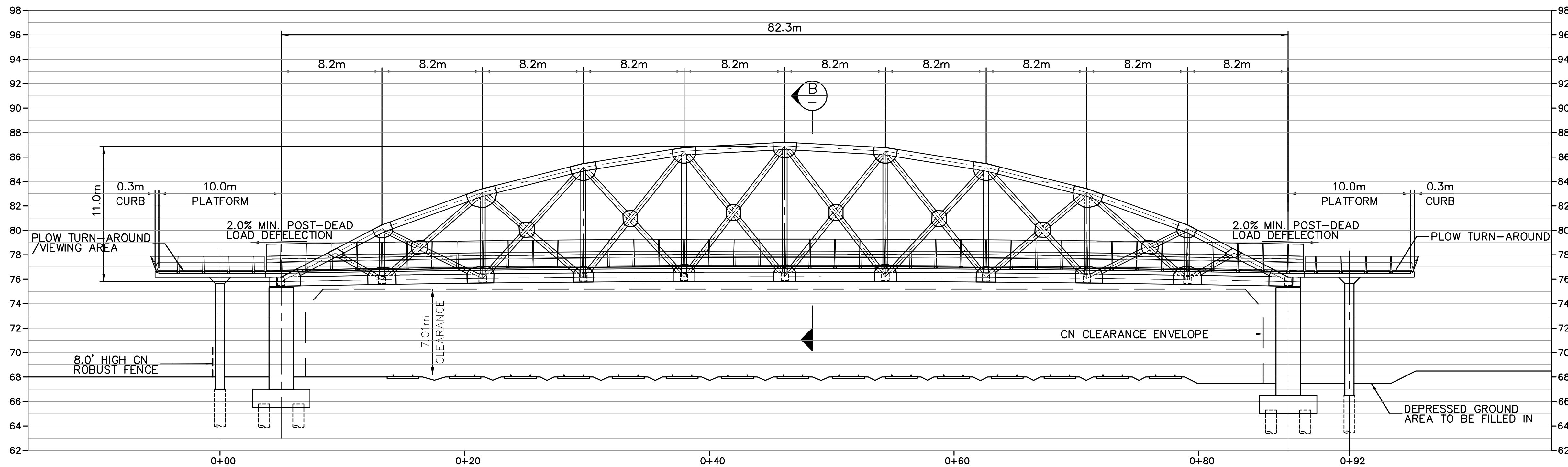
CITY OF TERRACE

KALUM STREET PEDESTRIAN OVERPASS STUDY

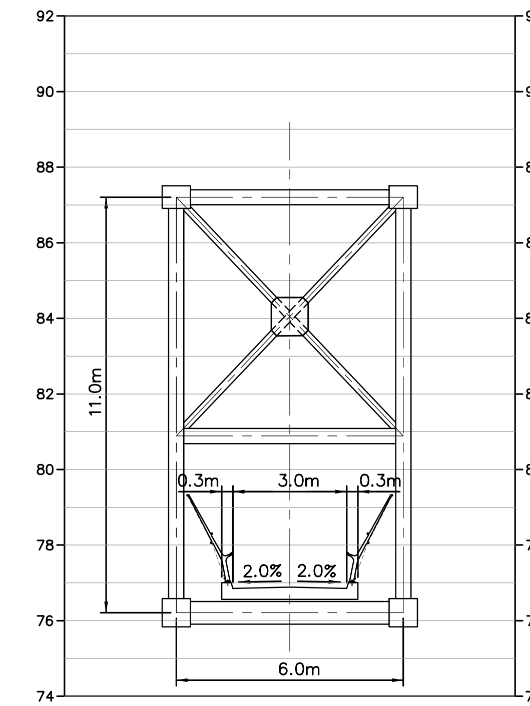
PEDESTRIAN BRIDGE SITE PLAN

SHEET No. 01 OF 02 REV.

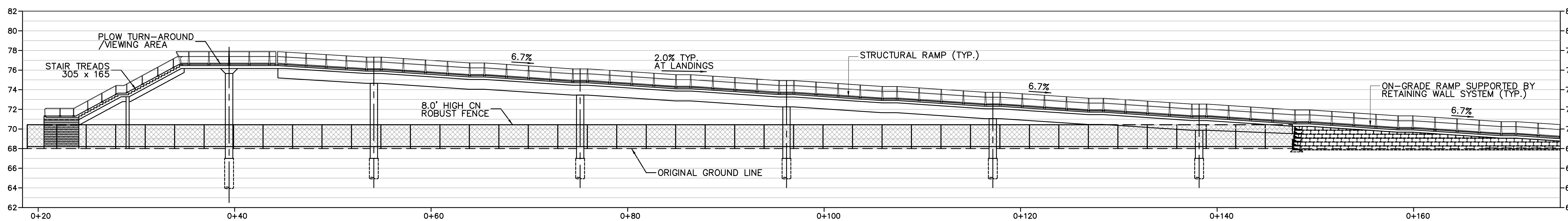
DRAWING NO. SK01



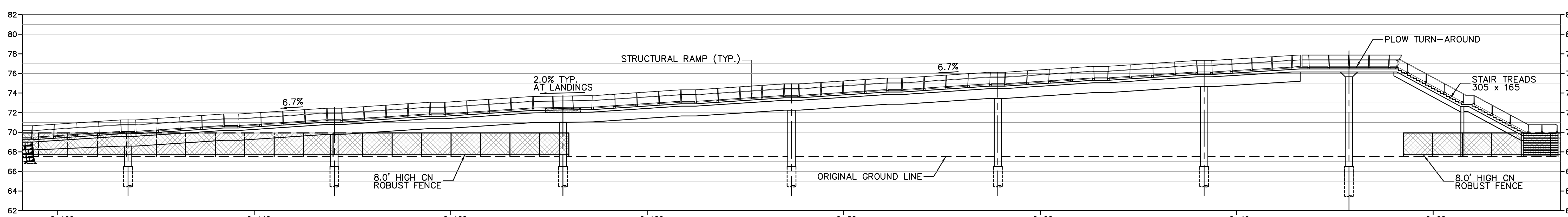
A SECTION 02
SCALE 1:200



B SECTION 02
SCALE 1:100



C SECTION – (NORTH RAMP) 02
SCALE 1:200



1:200 0 4 12m

D SECTION – (SOUTH RAMP) 02
SCALE 1:200

LEGEND OF SYMBOLS

THE CITY OF TERRACE

DESIGN	A. MOROZ
DRAWN	S. FRASER
CHECK	P. PHILLIPS
APPROVED	JUNE 2018
DATE	APRIL 2018
SCALE	1:200 1:100
PROJECT No.	476699

PARSONS

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CITY OF TERRACE

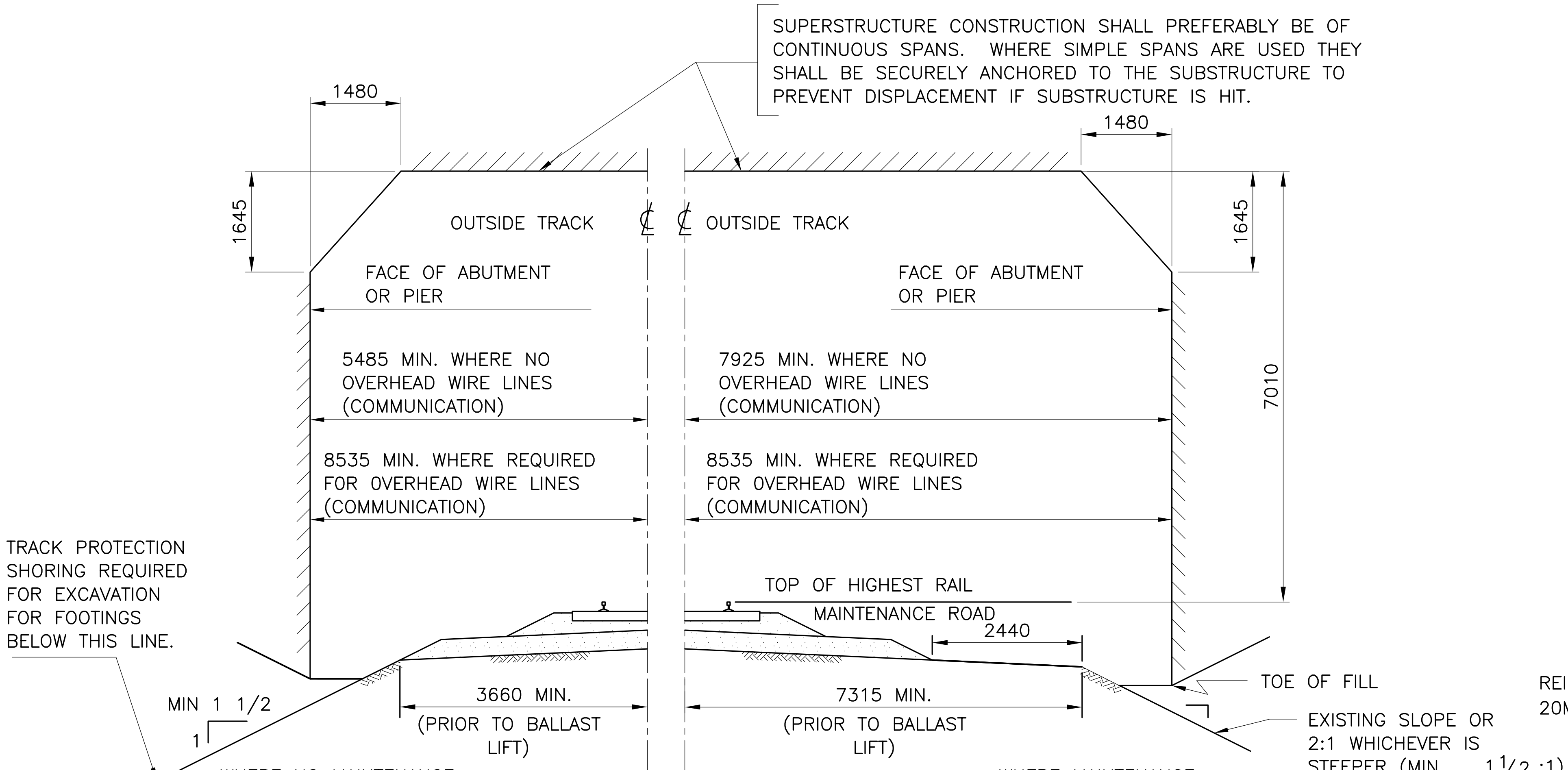
KALUM STREET PEDESTRIAN OVERPASS STUDY

PEDESTRIAN BRIDGE SECTIONS

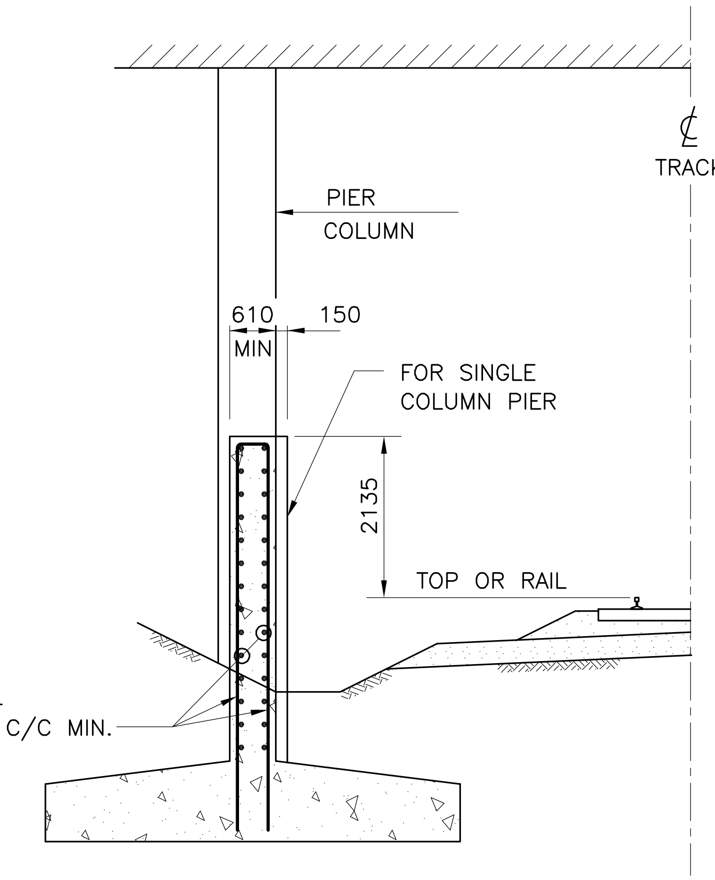
SHEET No. 02 OF 02 REV.

DRAWING NO. SK02

Appendix F



TYPICAL CROSS SECTION



PROTECTION WALL DETAIL

NOTES

- ALL HORIZONTAL DIMENSIONS ARE TO BE TAKEN PERPENDICULAR TO RAILWAY TRACKS.
- ALL VERTICAL DIMENSIONS ARE TO BE TAKEN FROM THE TOP OF RAIL.
- FOR TRACKS ON CURVE, CONSULT SYSTEM ENGINEER – TECHNICAL SERVICES.
- FOR RAILWAY REQUIREMENTS FOR ADDITIONAL FUTURE TRACK PROVISIONS AND FOR THE MINIMUM TEMPORARY CONSTRUCTION CLEARANCES CONSULT SYSTEM ENGINEER – TECHNICAL SERVICES
- NO WATER FROM DECK OF STRUCTURE SHALL DRAIN ONTO RAILWAY TRACK BETWEEN TRACK DITCHES.
- NO WATER FROM ROAD APPROACH EMBANKMENT SHALL DRAIN INTO RAILWAY DITCHES WITHOUT PROPER PROTECTION AGAINST EROSION OF SLOPE OR FILLING WITH FINES OF DITCHES.
- APPROACH SLOPES IF ADJACENT TO TRACKS ARE TO BE PAVED OR OTHERWISE PROTECTED FROM EROSION.
- ANY DEVIATION FROM THIS STANDARD MUST RECEIVE PRIOR APPROVAL OF THE CHIEF ENGINEER.

PIER PROTECTION

- PIERS WITHIN 7620 OF CENTER LINE OF ADJACENT TRACK SHALL BE OF SOLID HEAVY CONSTRUCTION OR SHALL BE PROTECTED BY REINFORCED CONCRETE PROTECTION WALL EXTENDING 2135 ABOVE TOP OF RAIL. WHERE 2 OR MORE COLUMNS COMPOSE A PIER, A PROTECTION WALL AT LEAST 610 THICK SHALL CONNECT THE COLUMNS. WHEN THE PIER CONSISTS OF A SINGLE COLUMN, THE PROTECTION WALL SHALL BE PARALLEL TO THE TRACK, 760 THICK, EXTEND AT LEAST 2135 BEYOND BOTH SIDES OF THE COLUMN, END PROJECT 150 BEYOND THE FACE OF THE COLUMN ON THE SIDE ADJACENT TO THE TRACK. PROTECTION WALL SHALL BE ANCHORED TO THE COLUMN AND FOOTINGS WITH ADEQUATE REINFORCING STEEL.
- DESIGN AND LOCATION OF PROTECTION WALLS SHALL BE VERIFIED WITH THE RAILWAY COMPANY.

*DOES NOT COVER THE EVENTUALITY OF ELECTRIFICATION

Drawn: Dessin: JHH	Checked: Vérification: GN	**PROTECTION AND MINIMUM CLEARANCES FOR OVERHEAD BRIDGES**
Scale: Echelle: AS NOTED	Date: DEC. 2/2005	
Office of chief engineer Bureau de L'Ingénieur en chef	CN	Drawing number Dessin Numero **K1U-10.2m** A

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May 7th, 2018

Gary Hanson, Public Works Officer
Canadian National Railway

Subject: Proposed Pedestrian Overpass at Kalum St., City of Terrace, BC

Dear Gary,

Parsons is undertaking a feasibility and conceptual design of a pedestrian overpass of the CN mainline and siding yard at Kalum Street in the City of Terrace, BC. The intent of the project is to increase safety and eliminate illegal trespassing/crossings of CN's tracks at-grade at Kalum Street.

As part of this project we would like to discuss the design and constructability of this overpass so that we can ensure it meets CN requirements. In the following pages, we have listed the various questions we currently have and also provided sketches of three alignment options which we are currently evaluating.

Once you have had the opportunity to review the provided information, we hope that we could have a teleconference this week with you and our Parsons project team to discuss this project and the best path forward to making it a reality.

Please do not hesitate to e-mail or call with any additional questions.

I greatly appreciate your time on this matter.

Sincerely,

Alex Chuchvaha

Alex Chuchvaha P. Eng.

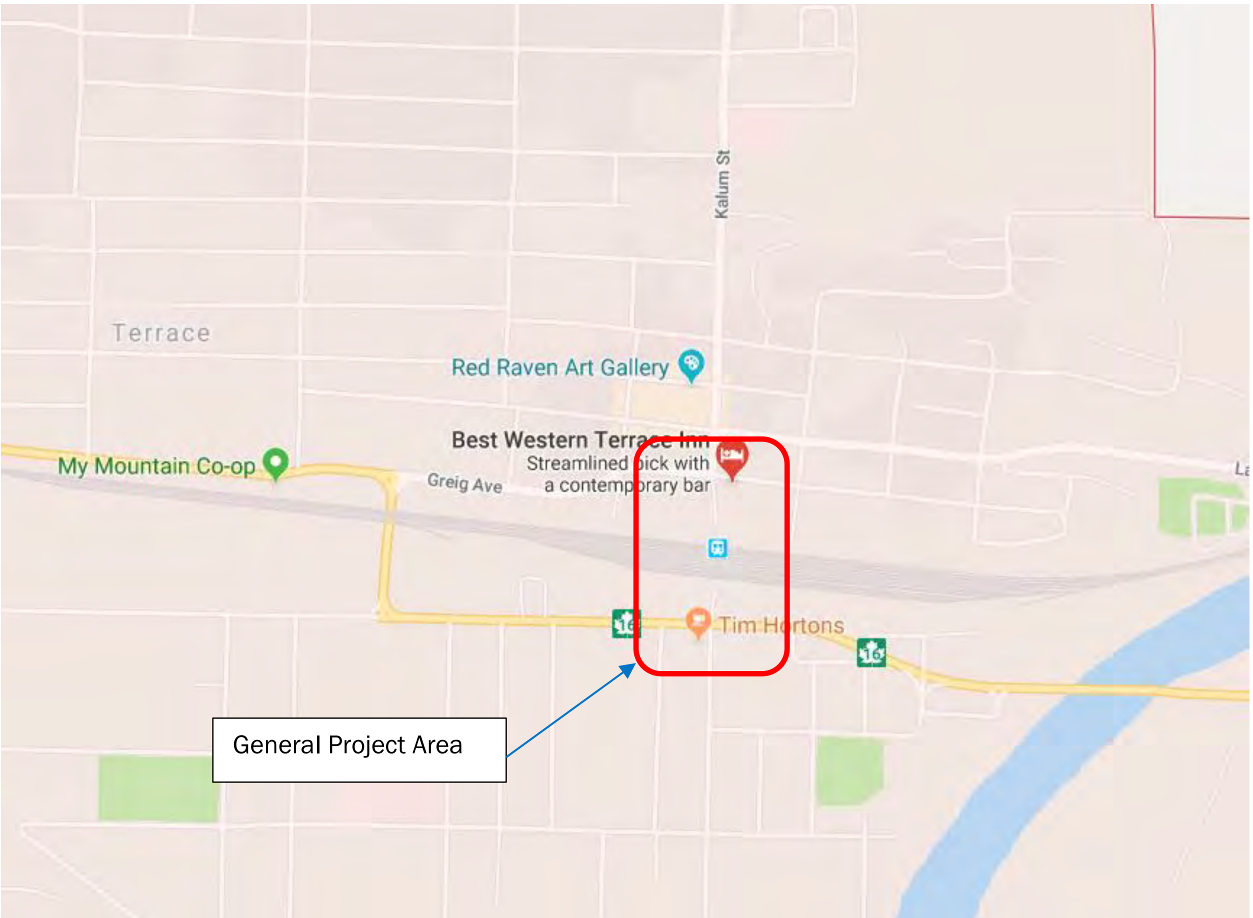
Principal Engineer

PARSONS

envision more

Background

Parsons is undertaking a feasibility and conceptual design of a pedestrian overpass of the CN mainline and siding yard a Kalum Street in the City of Terrace, BC. The intent of the project is to increase safety and eliminate illegal trespassing/crossings of CN's tracks at-grade at Kalum Street.



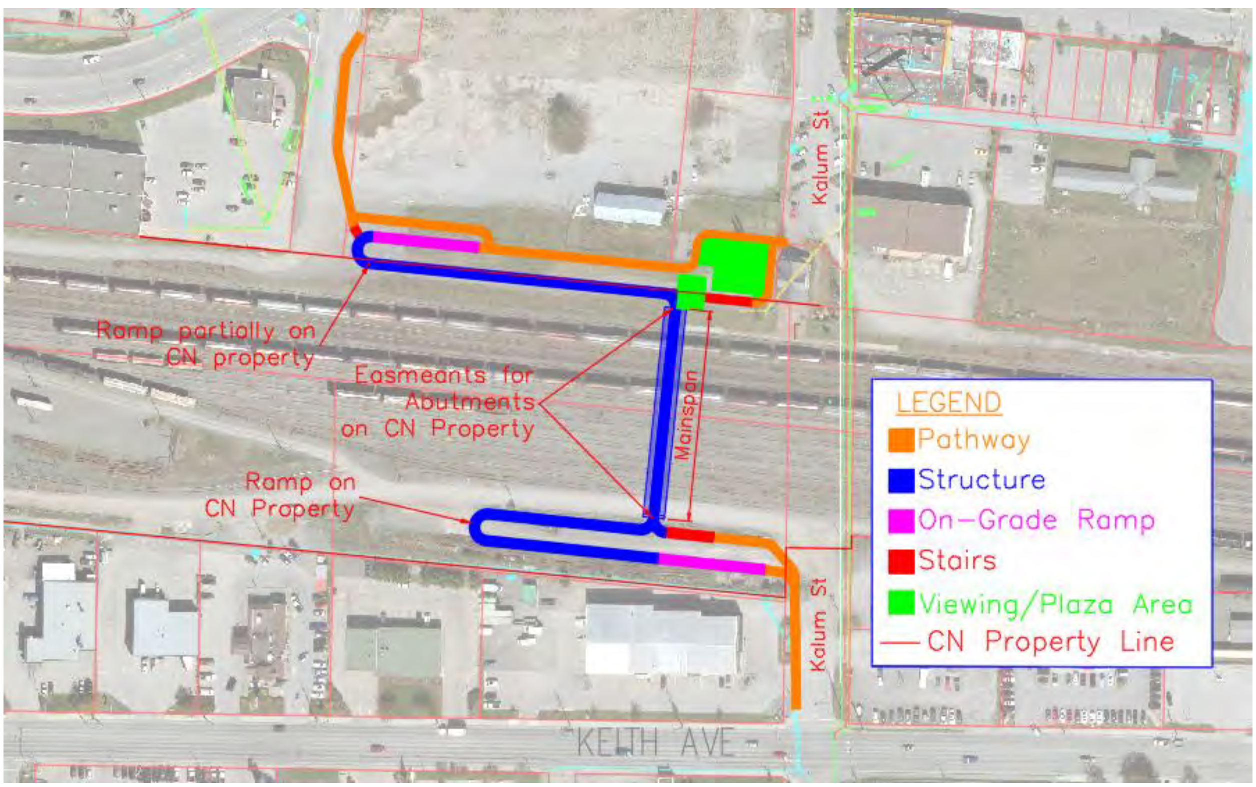
Parsons would like to discuss the feasibility of constructing a pedestrian overpass at this location with CN. We have three preliminary alignments that have been developed with the City of Terrace. Alignment A is the preferred option by the project team including the City of Terrace, followed by B, and then C. However, selection of the alignment will depend on support from CN in terms of feasibility. All alignments respect the clearance envelope set out in CN standard K1U-10.2m. The three alignments are shown in the sketches below along with relevant notes. In addition, below are various general questions we have for CN regarding this project.

General Project Questions

- CAD file for layout of yard available?
- Ditch locations, inlets, and outlets?
- Easement and/or property acquisitions?
  - Is use of CN storage yard on the southwest side of the project area available for the proposed overpass?
  - Will CN allow abutment easements at 8 m of the nearest track centerline and within 8m during construction for installation of below-ground foundations for the mainspan abutments?
  - Can the City acquire a portion of CN on the northwest side of the project area?
- Yard light pole interference in Alignment B below.

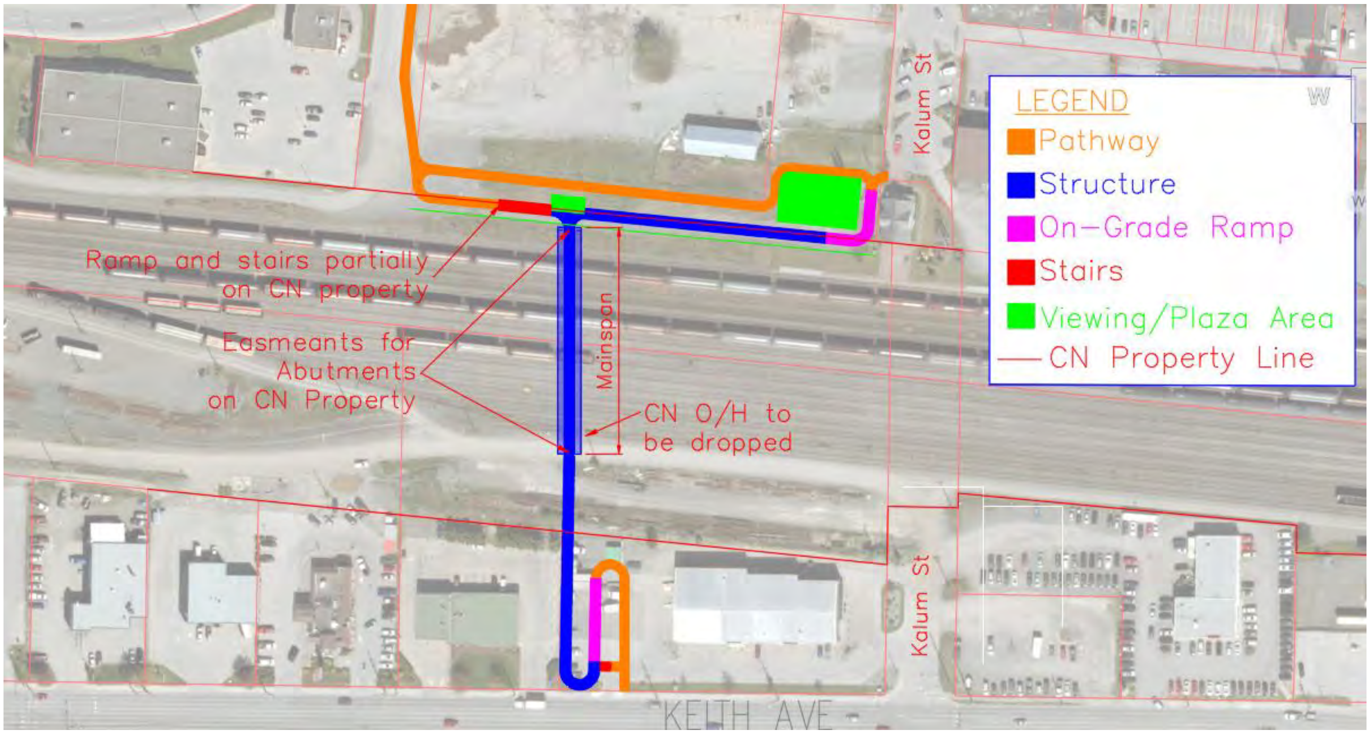
- Can yard/tracks be used at all during construction for limited time(s) for installing the mainspan by crane(s) and/or temporary supports? Is there an associated cost for use of the yard?
- Access to tracks from Kalum Street? Which CN accesses need to be maintained?
- Work blocks available? For only part of the yard? Bridge lift over live traffic?
- Train speed and frequency?
- Status of yard, i.e. expansion in the future?
- Who provides/pays for flagmen?
- Importance category (lifeline, major-route or other) of the proposed structure over CN for the purpose of seismic analysis/design?
- Which CN and/or VIA Rail standards are to be followed for this project/site?
- Sightline requirements for VIA Rail passengers at station?
- Enclosure/fencing requirements for the mainspan?
- Mainspan snow removal and drainage path not onto CN's property?
- Updated/new fencing installation along this stretch of track?
- Access to yard for bridge inspection and maintenance going forward?
- Any other items by CN to consider?

Alignment A



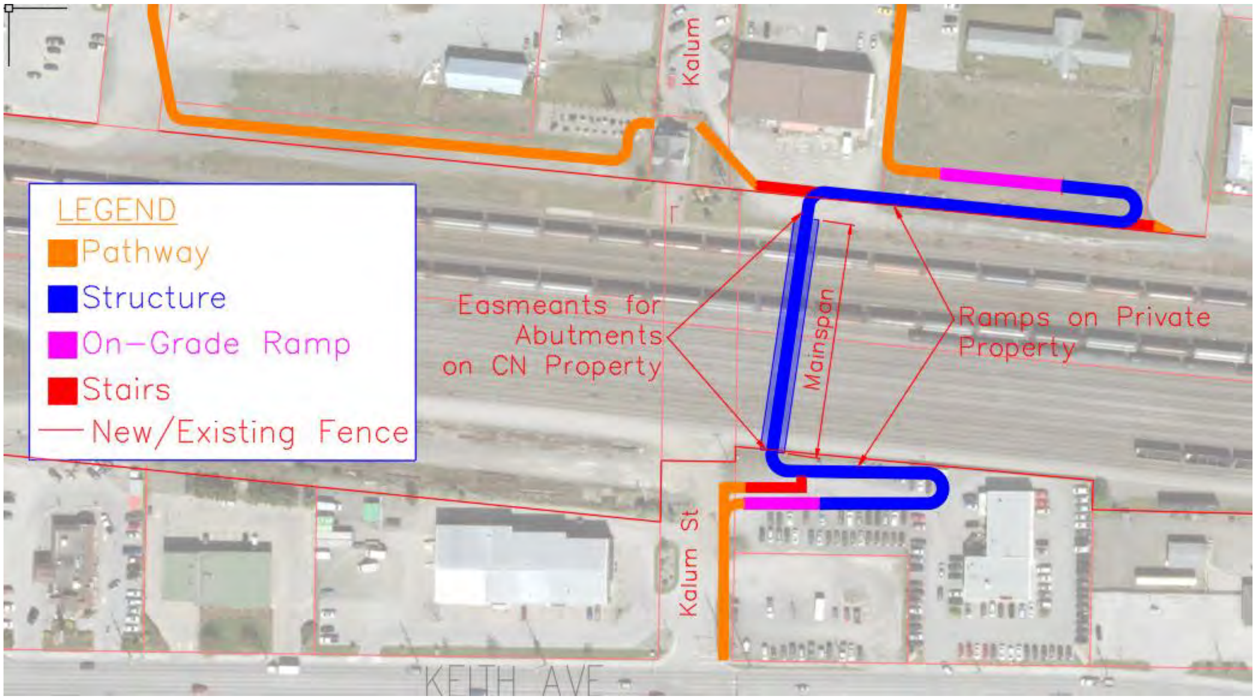
- The face of the abutments for the mainspan would be 8.0 m from the centerline of the nearest track and therefore would be on CN property and require easements. The edge of footings would likely be within 8.0 m of the centerline of nearest track (but be below ground).
- The structure would clear span over all CN tracks. This option would require the use of the CN storage yard on the south side for the permanent structure ramps.
- It would be preferred to obtain additional property from CN on the northwest side of the crossing for the north approach ramps.

Alignment B



- The face of the abutments for the mainspan would be 8.0 m from the centerline of the nearest track and therefore would be on CN property and require easements. The edge of footings would likely be within 8.0 m of the centerline of nearest track (but be below ground).
- The structure would clear span over all CN tracks.
- Clear-span from mainspan south abutment location to south edge of CN property.
- It would be preferred to obtain additional property from CN on the northwest side of the crossing for the north approach ramps/stairs.

Alignment C



- The face of the abutments for the mainspan would be 8.0 m from the centerline of the nearest track and therefore would be on CN property. The edge of footings would likely be within 8.0 m of the centerline of nearest track (but be below ground).
- The structure would clear span over all CN tracks.

Appendix G

Meeting minutes provide further background on the various items studied as part of this assignment and also on the reasons for the decisions made by the project team and are considered integral records to this work. However, meeting minutes are considered proprietary documents by the City of Terrace. Therefore, meeting minutes are only available upon special request to the City of Terrace.

Appendix H


• SPIRITS • COLD WINE • COLD BEER • SPIRITS • COLD WINE
CN
PRIVATE PROPERTY
CN YARD
TERRACE