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Hamilton Rapid Transit Preliminary Design and Feasibility Study

B-LINE

RISK ASSESSMENT REPORT

Version:2.0

METROLINX

An agency of the Government of Ontario

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Hamilton
Public Works

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DIALOG

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1.0 Introduction

This report is part of and should be read in conjunction with the project implementation plan; it elaborates on the identified risk elements for the implementation of the B-Line LRT. The report also presents a critical path which was developed based on the risk assessment process. The critical path and all associated risk elements presented should be reviewed in the next design phase.

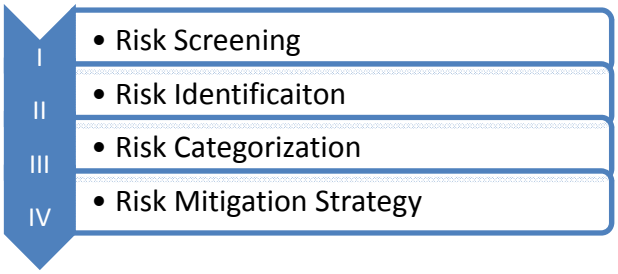
Risk, as an inherent element in any project, appears at different stages with different levels of importance and impacts. The purpose of the risk assessment report is to reasonably identify the elements of risk and their foreseeable impacts in the different project implementation stages.

This report provides an overview of a linear risk analysis and provides a high level assessment of identifiable risks at the preliminary engineering phase for the Hamilton B-Line LRT Project.

2.0 Risk Assessment Process

Normally, a risk assessment process is a multidisciplinary collaborative effort which is carried out through a standard step by step process. The following figure shows the main elements of a risk analysis:

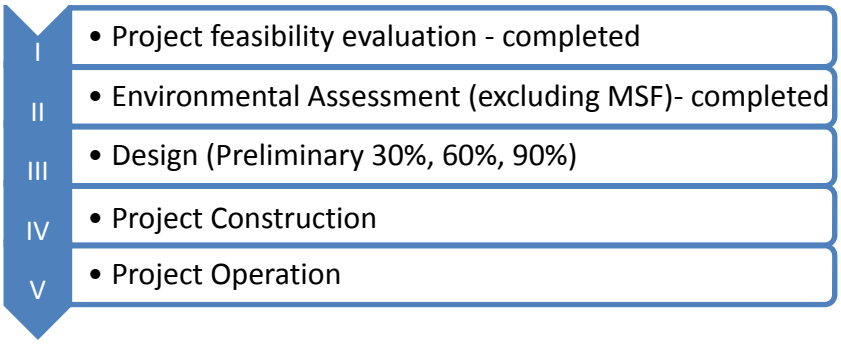
Figure 1: Risk assessment process



3.0 Risk screening

The risk screening process is an activity where all project components are broken down into subcomponents from project conception to project commissioning and if applicable, into the operation phase. This process incorporates stakeholders' contribution in the identification of risks. Following are the different project specific stages of project implementation.

Figure 2: Project implementation stages



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For the purpose of the current risk exercise, it is understood that project Stages I (Project Feasibility Evaluation) and II (Environmental Assessment) are completed, therefore there are no risks currently associated with them, except for an Environmental Assessment of the Maintenance and Storage Facility (MSF), which was excluded from the scope of Stage II.

Stage III – Design

Risk screening and identifications were carried out at a preliminary engineering level, and risks were identified along the corridor particularly where existing structural elements (such as bridges and walkways) interact with the proposed alignment. These elements are risks identified relative to cost or schedule rather than design. It should be noted at this level of design, the risk assessment is high level, as it is is based on the level of detail of the information currently available.

Stage IV – Construction

There are certain risks inherent in the construction phase. Some risks may be associated with design and others are associated with the environment within which the project is being introduced. The risks associated with the design can be minimized once the project heads towards the details design phase. The risks associated with the environment are site specific and are generally constant throughout the construction period. Examples include utility protection, traffic management, pedestrian movements, delivery of construction materials and space availability.

This document elaborates more on risks associated with design, as risks associated with construction will require further development in the next design phase when more information becomes available, and as more consultations can be carried out with all concerned stakeholders.

Stage V – Project Operation

During project operations there are two types of risks for the project; one mainly impacts project financial feasibility and is related to the system ridership. The other is related to the provision of a reliable, safe and cost effective operation. The risk related to ridership is not discussed in this document as its elements are outside the scope of this assessment. The risks related to operations is a two tier analysis; on one hand it is related to the staffing level, which is discussed under separate cover (see 'Preliminary Operations and Maintenance Plan Report'), on the other hand it is related to operational efficiency, this is related to aspects such as handling of downgraded operations (see 'Track Plan Report' under separate cover).

4.0 Preliminary Risk Screening-Identification for the B-Line LRT

Design

The following project specific elements were identified during the preliminary design stage:

- Bridge crossing over Highway 403 (including retaining walls and pier locations);
- Bridge over Red Hill Valley Parkway (including retaining walls);
- Availability and location of power source (Horizon utilities);
- Location of Maintenance and Storage Facility (MSF);
- Location of Utilities;
- Type of utility in duct banks (coaxial cable vs. Fibre optic, low voltage vs. Medium voltage);
- Location of traction power substations and their configuration (above or below ground);
- CP Rail crossing the LRT;
- Terminal Stop at McMaster University;

- Terminal Stop at Eastgate and bus terminal configuration;
- Access to loading bay zone of Fortinos grocery store over tracks;
- Potential removal/raising of pedestrian bridge on King Street.

Project Construction

The following site specific elements were identified in the construction stage.

- Location of MSF – pre-construction
- Property Acquisition - getting possession of site, clearing of site contents
- Construction **site organization and functioning**
- Intersection/Road Closures
- Changing to traffic directions of existing road lanes
- Traffic detouring

Operation

The following elements of operation were identified during the preliminary design stage:

- Safety and security plan related to private access/egress from proprieties along LRT guideway (signage, education program, training)
- Pedestrian interaction and safety program
- Vibration and electromagnetic interference (EMI)

5.0 Risk Categorization

Previously identified risks within the different project stages are further categorized as mild, medium and high. Table 1 shows the categorization of risk in graphical form and identifies risks that have a foreseeable impact on construction or cost. The categorization is a combined assessment of the likelihood and severity of each risk based on project knowledge, previous experience in design, and construction and operations of similar projects.

Table 2 elaborates on the risks identified in Table 1 and adds other risks elements that do not necessarily have an impact on construction schedule or design, but are discussed as a record of potential risk elements. Table 2 also elaborates on potential identification measures to be followed to mitigate risk. Further risk analysis should be carried out during detail design to ascertain that all risks are manageable and with a reasonably acceptable level.

Table 1: Items of Risk with Identifiable Impact in Construction Schedule and Cost

Risk I.D.	Item	Construction Schedule			Cost Uncertainty		
		High	Medium	Mild	High	Medium	mild
1	Bridge Crossing - 403		●		●		
2	Bridge Crossing – Red Hill Valley		●			●	
3	Availability and location of power source (Horizon Utilities)			●		●	
4	Location of Maintenance and Storage Facility (MSF)	●			●		
5	Location of Utilities	●			●		
6	Type of utility in duct banks (coaxial cable vs. Fibre optic, low voltage vs. Medium voltage)	●			●		
7	Location of Traction Power Sub-Stations and their configuration (above ground vs. Below ground)			●		●	
8	CP Rail crossing the LRT			●			●
9	Terminal Stop at McMaster University			●		●	

High ●
Medium ●
Mild ●

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Table 1: Items of Risk with Identifiable Impact in Construction Schedule and Cost (Continued)

Risk I.D.	Item	Construction Schedule			Cost Uncertainty		
		High	Medium	Mild	High	Medium	mild
10	Terminal Stop at Eastgate Square and bus terminal configuration			◎		●	
11	Access to Fortinos grocery store across LRT Track			◎			◎
12	Potential removal/raising of pedestrian bridge on King St. (Skywalk)		●			●	
13	Property acquisition and site availability (MSF & Terminals)	●			●		
14	Construction site organization and functioning		●			●	
15	Intersection/Road Closures	●					◎
16	Traffic detouring	●				●	
17	Safety and security related to property access			◎			◎
18	Pedestrian interaction and safety program			◎			◎

High ●
Medium ●
Mild ◎

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Table 2: Risk Assessment and Mitigation

Risk I.D.	Item	Risk Assessment	Mitigation
1	Highway 403 Bridge Crossing	The new 403 crossing should pose a medium risk to the construction schedule since, prior to the commencement, all the basic design elements will be incorporated. It does pose a higher risk in terms of an added uncertainty to the cost as the current cost estimate is based on a conceptual design and no information was available on soil conditions. Proposed alignment and conceptual cross sections of the new bridge have been shared with the Ministry of Transportation of Ontario.	Site investigations are to be carried out to identify soil conditions and determine soil profiles. Further collaboration and communication with the MTO will help in early identification of risk elements.
2	Red Hill Valley Bridge Crossing	The extent of the work to be done to the Red Hill Valley bridge is not extensive, although there could be a high risk to the construction schedule due to the fact that work on infrastructure generally needs to be uninterrupted. The envisaged cost risk is considered medium.	Site investigations are to be carried out to identify soil conditions. Further traffic simulations shall be carried out at a detailed design level to ascertain impacts and opportunities to the construction schedule as well as to develop options which could minimize conflicts during construction.
3	Availability and location of power source (Horizon Utilities)	The Traction Power Sub-Station (TPSS) range of locations are defined in the preliminary engineering phase (see 'Power Supply Report', under separate cover) although the length of the feeder line(s) from the high voltage line(s) is (are) uncertain at this time and will not be ascertained until the actual TPSS locations are fixed. Therefore, there is a mild risk to schedule and a medium risk to cost due to the unknown length of the high voltage lines feeding the Traction Power System.	Final TPSS locations shall be developed in consultation with Horizon Utilities to assess costs and benefits of different alternative sites.
4	Location of Maintenance and Storage Facility (MSF)	Several sites were investigated for the location of the MSF during the EA stage, none was defined as of yet as the preferred site. The definition of the site will have to go through a separate EA process, therefore imposing a delay in the overall project implementation. The conditions of the chosen site weight heavily on the construction schedule, construction cost and potentially the operating cost.	Definition of the MSF site should proceed as soon as possible to timely ascertain impacts on cost and schedule. The decision on whether the site is chosen from one of all studied sites or if new sites are added prior to defining the preferred site should be made opportunely as construction costs, construction schedule, location of special trackwork and operating cost must be revisited.

Table 2: Risk Assessment and Mitigation (Continued)

Risk I.D.	Item	Risk Assessment	Mitigation
5	Location of Utilities and Municipal Services	Utility locations score the highest on the risk identification for construction and cost. Accurate knowledge of the location of all utilities is a risk as the knowledge is based on the level of the survey information obtained. Utilities which have been identified that are offset from their actual locations are a high risk although the risk is not as high as not identifying some utilities along the corridor.	Preliminary Utility relocation drawings prepared in the preliminary engineering phase shall be shared with Utility companies for them to ascertain the accuracy of the information and confirm a strategy. Utility companies should review the information in detail and communicate discrepancies in locations and agreement/disagreement with the strategy. It is normal for a private utility company (hydro, communications) to carry out their own preliminary engineering, therefore, coordination for them to undertake the work should commence as soon as possible. The need of a utility locate campaign shall be established after consultations with utility companies. Areas with higher risk, such as pipeline crossings shall be discussed in further detail with a quality level A utility survey.
6	Type of utility in duct banks (coaxial cable vs. Fibre optic, low voltage vs. Medium voltage)	The contents of the identified duct banks are currently unknown for the hydro and communication networks. The level of importance, such as voltage or coaxial versus fibre optic has a significant impact in cost and it poses a risk to the length of time of the construction schedule. The risk level is high due to this item for both construction and cost.	The utility relocation strategy drawings shall be shared with all utility companies for them to ascertain the level of difficulty of mobilizing their plant from their current location. The utility companies, based on their own knowledge of the network, should provide input about the ideal segmentation of the works based on the type of plant and the type of service provided. It is expected that different companies will have different preferences regarding the optimum length and location of segmentation during the construction, therefore final determination of the construction segments shall be subject of further consultation process with stake holders.
7	Location of Traction Power Sub-stations and their configuration (Above ground vs. Below ground)	The lack of defined TPSS locations results in a mild risk to the construction schedule as it is envisaged that the definition of locations should be confirmed in advance of the commencement of construction. A higher risk is associated with the type of TPSS (at-grade or underground) depending on land availability and location.	Further work shall be carried out to ascertain potential sites for locations of the TPSS. Determination of the site shall be made in consideration of all being above ground, with underground being a possible mitigation option for areas where no land is available for an above ground option. The range of locations of the TPSS shall be compare against the City's data base of available sites.
8	CP Rail Crossing the LRT	Preliminary consultations with CP Rail indicate that the crossing of the LRT tracks with the railway line track is feasible. The detail design of the crossing must be reviewed and approved by CP prior to construction. It is unlikely that it will significantly affect either construction schedule or cost as long as clearance requirements as ascertain without special requirements. Operationally, it is foreseen that the LRT will stop at prior to crossing the rail line as currently required for all public transportation vehicle.	Minimum catenary height requirements shall be ascertain in further consultations with CPR, such can be achieved by using the maximum pantograph height of the vehicle. Further consultations should clarify If CPR plans to electrify their line, if such becomes a requirement, then such can be mitigated by requiring the vehicle to have a dual power source via an on-board battery which should power the LRV over the rail crossing as the catenary wire will be stopped some distance ahead of the rail crossing.

Table 2: Risk Assessment and Mitigation (Continued)

Risk I.D.	Item	Risk Assessment	Mitigation
9	Terminal Stop at McMaster University	Construction schedule risk is low as long as the consultation and further design work is expedited ahead of the bidding process. Cost risk in relation to development of the stop at this location is medium as there is no survey or utility information in this zone. A consultation process shall continue for final definition of location and layout. An inherent risk of this location is the effects of the electro-magnetic interference on the microscope located at the university research facility. Such risk could be significantly high for the implementation programme and cost to mitigate such effects to acceptable levels could become prohibitive to the point of having to re-asses the location.	Continue the consultation process should be carried out with McMaster University to define the location and layout of the terminal stop to be able to define the cost of the works. The limiting values for EMU shall be defined in accordance with the level of sensitivity of the apparatus. Further study is recommended prior to finalizing the layout.
10	Terminal Stop at Eastgate Square and bus terminal configuration	Construction Schedule risk is low as long as the consultation and further design work is expedited ahead of the bidding process. Cost risk is high in this case as negotiation with a private developer in some cases is associated with a higher cost risks.	Consultation process should be carried out with the property owner of Eastgate Square to define the location and layout of the terminal stop to be able to define the cost of the works. The benefits of a transit stop within privately-owned grounds should be brought forwards as a major benefit for future development.
11	Access to Fortinos loading unloading zone over tracks	This item poses a risk to the operation rather than the construction. Cost risk is identified as medium as it is uncertain what traffic control devices will be required for the safe ingress and egress of the trucks from the loading unloading zone. Preliminary analysis has identified that trucks need to cross the guideway to manoeuvre, and such manoeuvre will be in conflict the LRT operations.	Further analysis and consultation with the plaza owner will be required. Potential to require special signalling for this access should be further evaluated.
12	Potential removal/raising of pedestrian bridge on King St. (Skyway)	This structure has sub-standard clearance of 4.2m. Fixation of the catenary wires underneath the bridge will further reduce such clearance and the risk of a large truck driving along the guideway and potentially coming into contact with a live 750 kV wire is unacceptable. Serious consideration shall be given to removing the structure or modifying the connecting levels at both ends to accommodate raising it to an acceptable level. Previous cases of trucks grazing the underside of the bridge have been reported.	Further consultations shall be made to determine if the removing the structure is feasible. Timely communication with stakeholders is essential.
13	Property acquisition and site availability (possession and clearance of site)	Property acquisition as a result of the project is not extensive and impacts to structures are minimized along the corridor. It is foreseen that risk to the construction schedule is low as property shall be secured prior to the commencement of the construction phase. The risk on cost will be mild as it is not expected to have large deviations from the initial property value estimate done during preliminary design. On the other hand, construction schedule risk could be high if the general contractor is responsible for securing property.	Agreed design of the footprint of the terminal stops shall proceed to ascertain property requirements.

Table 2: Risk Assessment and Mitigation (Continued)

Risk I.D.	Item	Risk Assessment	Mitigation
14	Construction site organization and functioning	These risks are normally managed by conducting a workshop with the Contractor whereby the planned construction staging is distributed for comments and early risk identification. Imposing a construction sequence on a contractor normally results in higher cost than if performance parameters are defined.	Carry out workshop with contractor for early discussions with the potential bidders about experience and plans.
15	Intersection / Road Closures	During the construction stages, closing roads and intersections will carry a high risk to the schedule. A successful construction staging plan is required incorporating substantial coordination and public awareness campaigns. Such a high risk in a constrained urban area might also drive the cost higher than expected.	Further detailed analysis of the proposed stages shall be carried out and consulted vis-a-vis the nature of the businesses in each sector.
16	Traffic Detouring	This item carried similar risk assessment at Risk I.D. 17.	This item needs close coordination with the City Transportation Department to obtain real time impacts of traffic direction changes and detours during construction phase.
17	Safety and Security related to property access	Safe access to properties is a risk that will affect the project both during the construction and during the operations. Given that the construction is for a defined length, it is therefore a finite effect and mitigation measures can bring the risk to acceptable levels. However, the operation time is undefined and there is a potential for collisions or LRT vehicles and road vehicles that make unsafe turns can occur. Almost half of the alignment is side running with the guideway at the same elevation as the road, therefore potential intrusion of the guideway space by vehicles other than LRVs is an expected risk.	Special attention is required to the access of CSO tanks ground just west of Breadlebane Street. At this location, a recommendation has been made in the design to limit access to authorized vehicles only as a risk mitigation measure. Continuous public education campaigns shall be undertaken during construction and prior to system operation to mitigate this risk.
18	Pedestrian interaction safety program	Similarly to the risk of vehicle to vehicle collision, there is also the risk of pedestrian to LRT vehicle collision.	The detail design stage should identify where additional signage would be required to alerts the pedestrian of potential dangers of crossing the guideway at unauthorized locations. Also, a safety and security publicity campaign should be developed in the next design phase to educate the public.

6.0 Preliminary Critical Path Risk Assessment

Figure 3 shows the preliminary critical path analysis which is supported by the findings of the risk assessment process. Some activities in the project procurement process phase could be simultaneously carried out with proper consultant support to potentially reduce the length of this phase from 20 months, reducing the delivery time of the overall project.

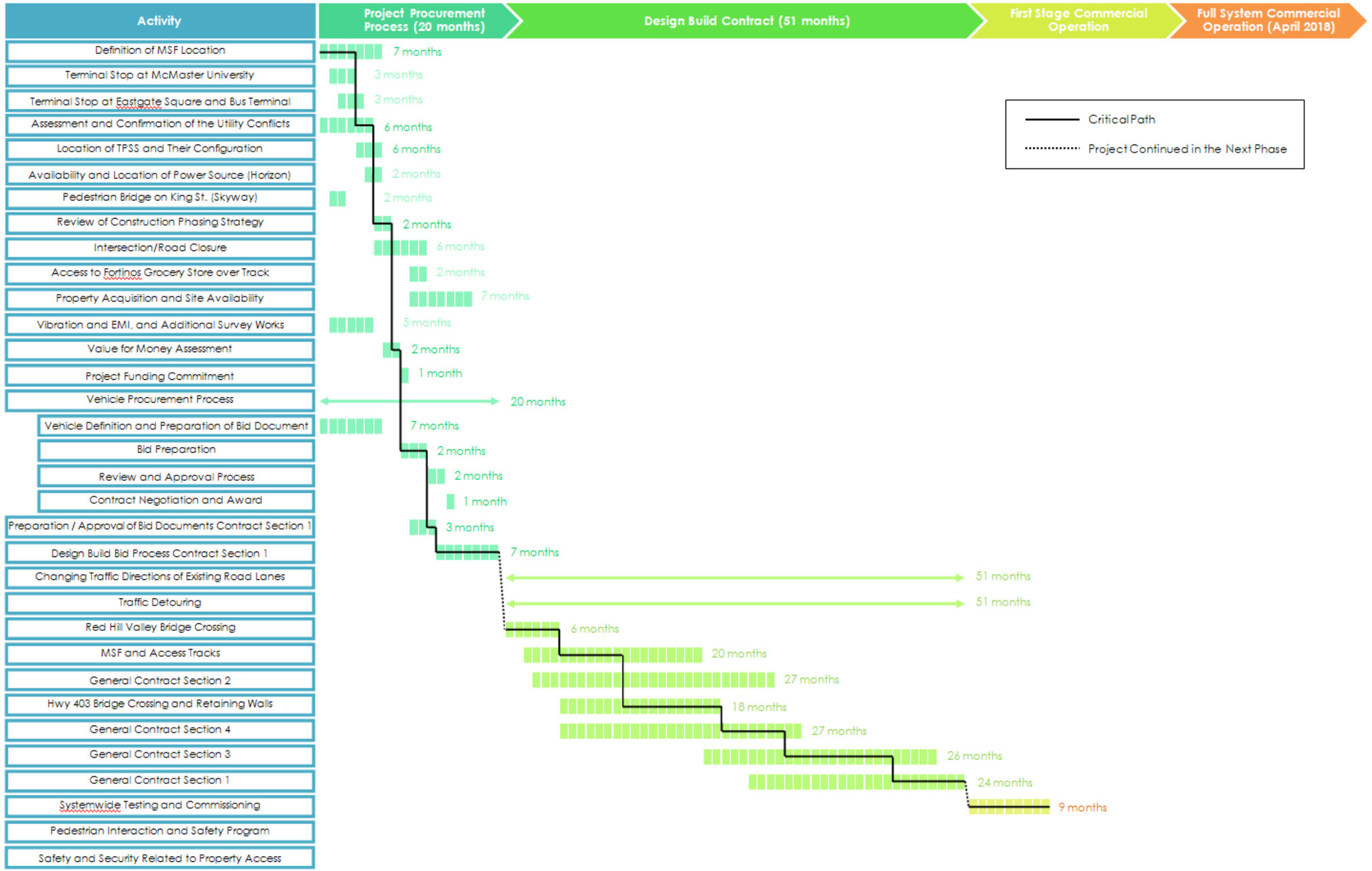
7.0 Risk Mitigation Strategy

If the project is implemented by a traditional Bid-Build procurement process, then further work on items posing a high risk to project implementation should be subjected to further consultation to bring the risk to an acceptable level prior to continuing to the detail design phase.

As defined in the construction phasing strategy, the design-build approach is recommended for this project as the traditional implementation of bid-build will result in longer overall implementation period as a design consultant will be hired to undertake the detail design in advance of tendering bids for construction. It is recommended that a risk workshop be carried out with the potential proponents for preliminary risk analysis.

Risk transfer and Risk sharing should be evaluated in the potential scenario that the project is procured via a Design-Build process whereby the proponent will assume all the above identified risks while pricing the project. This method would be more expeditious than the traditional Bid-Build approach, although it assumes a higher cost to the owner for the risk transfer. Usually, these costs are offset by the benefits of commencing operations earlier.

Figure 3: Critical Path Analysis



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