Region of Waterloo
Stage 1 Light Rail Transit Project

Performance Output Specifications
Article 3
Utility Infrastructure

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ARTICLE 3 UTILITY INFRASTRUCTURE

3.1 General

(a) The purpose of this Article is to provide design specifications for the underground infrastructure works. Project Co's solution to underground infrastructure installation, reconstruction or relocation shall expand on these requirements. Project Co shall prepare a Basis of Design Report - Underground Infrastructure with specifications and concept drawings, which explain Project Co's approach to utility design work in greater detail and in a site specific manner. The presentation of specific Civil design requirements within this Article must not be construed to limit or modify in any way Project Co's responsibility to provide a holistic, comprehensive, and fully functional solutions to all underground infrastructure conditions. The Basis of Design Report – Underground Infrastructure shall address every aspect of the design requirements cited in this Article. The rationale for all deviations or variances from any requirement cited this Article must be fully described in the Basis of Design Report – Underground Infrastructure, which is referred to within this Article as the Basis of Design Report.

(b) This Section describes the design requirements for the LRT and associated infrastructure improvements:

(i) Approvals and Permitting

(ii) Public Infrastructure Works

(iii) Utility Design and Relocation

3.2 Cited References

(a) The following is not intended to capture and/or cover all cited references of all applicable Codes, Standards and Regulations of design, construction, inspection, legal, quality and safety requirements and/or enforcement policies. Project Co shall comply with all during the Project Agreement.

(b) Project Co shall in all cases of conflicting Code, Standard, and Regulation utilize the most Stringent Code, Standard and Regulation. Project Co shall utilize the latest edition and amendments in all cases.

(i) Canada Standards Association (CSA)

(ii) Canadian Environmental Protection Act

(iii) Environmental Protection Act, R.S.O. 1990, c. E.19

(iv) Ontario Water Resources Act, R.S.O. 1990, c. O.40

(v) Occupational Health and Safety Act (OHSA)

(vi) Department of Fisheries and Oceans Fisheries Act

(vii) Grand River Conservation Authority (GRCA) Policies for the Administration of the Development, Interference with wetland and alterations to shorelines and watercourse regulation (O.Reg. 150/06)

(viii) Region of Waterloo Regional Transportation Corridor Design Guidelines

(ix) Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services (DGSSMS)

(x) City of Kitchener Urban Design Manual

(xi) City of Waterloo Urban Design Manual

(xii) Grand River Conservation Authority (GRCA) Policies for the Administration of the Development, Interference with wetland and alterations to shorelines and watercourse regulation (O.Reg. 150/06)

(xiii) Grand River Conservation Authority Erosion and Sediment Control Guidelines

(xiv) Ontario Ministry of the Environment Stormwater Management Planning and Design Manual 2003

(xv) Low Impact Development Stormwater Management Planning and Design Guide Version 1, 2010 – Credit Valley Conservation Authority

(xvi) Environmental Guide for Fish and Fish Habitat, MTO

(xvii) Environmental Guide for Noise, MTO

(xviii) Ontario Provincial Standards and Specifications (OPS) User's Guide

(xix) OPS Specifications for Roads and Municipal Services, Vol 1, General Conditions of Project Agreement and Specifications for Construction (Div 1 to 9)

(xx) OPS Specifications for Roads and Municipal Services, Vol 2, Specifications for Material

(xxi) OPS Specifications for Roads and Municipal Services, Vol 3, Drawings for roads, barriers, drainage, sanitary sewers, watermains and structures

(xxii) OPS Specifications for Roads and Municipal Services, Vol 4, Drawings for Electrical Work

c) Reference Drawings

(i) Utility Conflicts – Appendix M

(ii) Utility Crossing Encasement Detail – Appendix J

(iii) Utility Exclusion Zone – Appendix J

(iii) Public Infrastructure Works – Appendix N

3.3 Approvals and Permitting

(a) General

(i) Project Co shall be responsible for all planning, design, construction and close-out approvals and permitting including all of the costs of preparing, submitting and review of the permits by the approving authority.

(ii) The Region of Waterloo will review and sign all permits that require owner consent. This review and signature shall be coordinated with the milestone submissions and review periods designated in the RFP.

(b) Anticipated Permitting

(i) The following is an anticipated list of permits and approvals required for the civil component of the project. This list is intended to provide Project Co with a general understanding of the permitting requirements and is not a comprehensive list of all potential approvals.

A. Environmental Compliance Approvals – Ministry of the Environment – Sanitary Sewers and Infrastructure, Storm Sewers and Infrastructure, Air and Noise Approvals. Note: Region of Waterloo is a Transfer of Authority Approval Agency.

B. Drinking Water Licence – Ministry of the Environment – Managed by Kitchener Utilities, City of Waterloo and Region of Waterloo in accordance with watermain ownership.

C. Grand River Conservation Authority – Development, Interference with wetland and alterations to shorelines and watercourses, review agency in land development.

D. Region of Waterloo – Road Occupancy, Traffic Management, Site Plan Control, Utility Relocation, Streetscaping and Landscaping, Urban Design.

E. City of Waterloo – Road Occupancy, Traffic Management, Site Plan Control, Utility Relocation, Streetscaping and Landscaping, Urban Design, Municipal Consent.

F. City of Kitchener – Road Occupancy, Traffic Management, Site Plan Control, Utility Relocation, Streetscaping and Landscaping, Urban Design, Municipal Consent.

G. Ministry of Transportation – Encroachment Permit, Construction Permits

H. CN Rail – Encroachment Permit, Utility Undercrossing Permit, Construction Permits

I. GEXR Rail - Encroachment Permit, Utility Undercrossing Permit, Construction Permits

J. Hydro One Networks – Access Permits

K. Infrastructure Ontario and Lands Corporation – Access and Construction Permits

L. Third Party Utilities – Relocation Review and Permitting

3.4 Public Infrastructure Works

(a) "Public Infrastructure Work (PIW)" is defined as work elements that Project Co has design, construction, testing and acceptance responsibilities but has no responsibility for ongoing maintenance after PIW is accepted for beneficial use by the Authority Having Jurisdiction. Project Co shall be responsible for the maintenance and up keep of all Public Infrastructure Work (PIW) performed by Project Co within the Project Agreement and on behalf of the Region, respective City, railroad, and public agency having jurisdiction and ownership rights of the plant until acceptance and beneficial use of the PIW on or before the commencement of Light Rail Transit revenue operation by Project Co; or until the Region, respective City, railroad, and agency having jurisdiction and ownership rights takes control of the plant in accordance with the Project

Agreement "Possession and Use" requirements. This does not include Project Co's responsibility for control of all maintenance and up keep of the LRT guideway infrastructure.

(b) The Region and Municipalities have proposed capital projects that intersect/overlay the proposed LRT corridor. It is the intent of the Region that Project Co complete these works as part of the overall project to avoid undue or duplication of disruption to residents and businesses along the corridor. Schedule 15-2 Article 2 details Project Co related scope. For projects that have an underground infrastructure component, the requirements of this section shall be enforced.

3.5 Utility Design and Relocation – General

(a) The construction of this Project is expected to require the relocation of public and private utilities. Efforts shall be made to avoid impacts to major facilities. However, utility line relocations shall be necessary where a line conflicts with the proposed improvements, or where the ground cover on the utility would be reduced to less than the allowable minimum. The design of utility relocations shall be guided by the following principles and criteria:

(i) The responsibility matrix to detail the division of responsibility, cost, design, construction and coordination is provided in Exhibit 3.5

Exhibit 3.5 Utility Responsibility Matrix

Utility / Third Party Owners	Design / Design Review / Construction Layout / Record Drawings		Construction / Construction Cost	
	Early Works	Non - Early Works	Early Works	Non - Early Works
All Stream	N/A	Utility Owner	N/A	Region/ Utility Owner
Bell Canada	Utility Owner	Utility Owner	Region/ Utility Owner	Region/ Utility Owner
360	Utility Owner	Utility Owner	Region/ Utility Owner	Region/ Utility Owner
CNR	N/A	Project Co.[1]	Region/ Utility Owner[1]	Region/Utility Owner[1]
City of Waterloo (Wet Utilities)	N/A	Project Co.	N/A	Project Co.
Grand River Hospital (GRH)	N/A	GRH	N/A	GRH
Hydro One	Utility Owner	N/A	Region/ Utility Owner	N/A
Kitchener Utilities (Wet Utilities)	N/A	Project Co.	N/A	Project Co.
Kitchener Gas	Utility Owner	Utility Owner	Region/ Utility Owner	Region/ Utility Owner
KW Hydro	Utility Owner	Utility Owner	Region/ Utility Owner	Region/ Utility Owner
Rogers (Buried Infrastructure only)	Utility Owner	Utility Owner	Region/ Utility Owner	Region/ Utility Owner

Exhibit 3.5 Utility Responsibility Matrix				
Utility / Third Party Owners	**Design / Design Review / Construction Layout / Record Drawings**		**Construction / Construction Cost**	
	Early Works	Non - Early Works	Early Works	Non - Early Works
Telus	Utility Owner	Utility Owner/ Project Co.	Region/ Utility Owner	Region/ Utility Owner
Union Gas	Utility Owner	Utility Owner/ Project Co.	Region/ Utility Owner	Utility Owner
University of Waterloo (Wet Utilities)	N/A	Project Co.	N/A	Project Co.
Waterloo North Hydro	Utility Owner	Utility Owner	Region/ Utility Owner	Region/ Utility Owner

Notes:

All "***Coordination***" is Project Co. responsibility, following Commercial Close.

Early Works - "Early Works" means the projects initiated by the Region prior to Commercial Close described in the Summary of Utility Relocation Work set forth in Exhibit 3.5.1 of Schedule 15-2 – Design and Construction Requirements of the Output Specifications.

Non-Early Works - "Non-Early Works" means works commencing after Project Co. assumes section of road and Project Co. is responsible for the coordination.

"Construction" – All underground and above ground works including, but not limited to excavation, installation (in bedding provided by utility or in sleeve provided by Project Co.), connection, commissioning, backfill, compaction and quality assurance testing up to the final grade for landscaped or boulevard areas and to subgrade level in all travelled areas (sidewalks, roads, etc.).

"Design" – Preparation of the functional and detailed design of the proposed infrastructure compliant with the appropriate authority having jurisdiction including obtaining and payment for any and all permits, approvals and municipal consents necessary for completion of the works. This shall include coordination with Project Co. and provision of design drawings and schedules to facilitate said coordination.

"Construction Layout" – Provision of survey services to physically layout the proposed infrastructure for the purposes of construction as defined in this article.

"Record Drawings" – Provision of detailed, accurate record drawings indicating the location, size and configuration of the proposed works in AutoCAD format suitable for both Regional documentation and Project Co. use for design coordination and utility conflict management.

[1]Obligations related to CN are further expanded on in PA Schedule 16 and PSOS.

(ii) Utility work involving maintenance, support, and relocation of utilities shall be designed to conform to the applicable specifications, criteria, and standard drawings of the concerned private utility corporations or public agencies. The proposed designs shall be provided to the concerned private utility corporations or public agencies for review.

(iii) The design of utility relocations shall be compatible with the existing utility system, which is being modified. The designs shall also attempt to accommodate available future utility plans for the Project area.

(iv) Utility crossings of LRT corridor shall be kept to a minimum. Under no circumstances shall utility lines be permitted to cross under at-grade switching areas. Where crossing of an at-grade LRT corridor cannot be avoided, utility lines shall be encased in a non-conductive sleeve as required to minimize the effect upon future maintenance operations. Similarly, existing or relocated utility crossings of existing high-volume roadways (King St., Northfield Dr., Erb St., Caroline St., Charles St., Courtland Ave.) shall also be encased, to minimize disruption to traffic during future maintenance operations. Utility crossings shall be as perpendicular to the LRT corridor or roadway alignment as possible.

(v) Non-metallic sleeves (full or split) shall be sized as follows:

A. Sleeves shall be required for all utilities with an outside diameter of 450mm or less. Utilities with an outside greater than 450mm do not require sleeves; however efforts shall be made to minimize/eliminate joints under the LRT trackway.

B. Sleeves for shallow utilities (gas, electric, telecommunications, private services etc.) shall be extended from outer roadway curb to outer roadway curb so access can be made without a road cut.

C. Sleeves for deep utilities (water, storm, sanitary) shall be extended:

1. to the a minimum of 2.5 m offset from the LRT trackway in roadway sections

2. to a minimum of 2.5 m offset from the edge of the travelled road parallel to the LRT trackway at intersections to allow for access without the need for intersection closure

D. Communications – Minimum 100 mm diameter

E. Service Connections

1. Communications – Minimum 50 mm diameter

2. Water Service – Minimum 50 mm diameter

3. Sanitary/Storm Service – Minimum 150 mm diameter

F. Municipal Infrastructure – Minimum 50 mm annular space between outside diameter of utility and inside diameter of sleeve using standard pipe sizes.

G. Watermains – Minimum 50 mm annular space with allowance for one pipe size increase using standard pipe sizes

H. Hydro

1. Secondary – 75 mm diameter

2. Primary – Concrete Encased Duct Structure – Number of Ducts to match existing

I. With the exception of watermains, all other existing utilities may achieve the performance objective by the installation of a parallel empty sleeve capped on both ends immediately beside the utility being protected. This will allow for future replacement of the infrastructure without the requirement to replace in service utilities provided that they are not in conflict with the proposed works.

(vi) Metallic sleeves

A. Natural Gas sleeves shall be steel, compliant with the requirements of the CSA Standard Z662-11

(vii) Infrastructure that crosses or is parallel to the LRT trackway and is a minimum of 3 m below proposed top of rail may remain in place with the approval of the infrastructure's operating authority provided that an effective replacement/restoration method can be achieved without the need for a sleeve or open cut excavation. Maintenance access to the infrastructure must be achievable from a location that is outside of the exclusion zone around the LRT trackway or Project Co must enter into an operation and maintenance agreement that will delineate access notification and LRT impacts of said access.

(viii) New utility crossings under existing railways shall be made by boring, jacking, or tunneling. Open-trench methods may be considered under streets, parking lots.

(ix) Utility facilities extending longitudinally within the LRT corridor exclusion zone shall be limited to those serving System facilities unless otherwise noted.

(x) Any existing communications and signal systems shall be maintained at all times.

(b) Early Works Utility Relocation

(i) Several utilities are proposed to be or have been relocated in advance of the LRT construction. Exhibit 3.5-1 illustrates the limits/extent of the current relocation proposed and approximate timelines. Proposed and As-built drawings will be provided to Project Co by the appropriate utility within 30 days of completion of the design/installation unless otherwise negotiated by Project Co with the individual utility agency. The intent of that relocation was a permanent location and Project Co shall make all efforts to avoid disturbing this infrastructure.

(ii) Project Co shall be responsible for the removal of abandoned structures encountered during LRT construction.

(iii) Utility Early Works drawings are included in Appendix O.

Exhibit 3.5-1

Summary of Utility Relocation Work – Early Works

Facility Description	Location	Owner	Description	Date Completed / Proposed	Reference Drawing
Communications	King St. – Allen to Francis St.	Bell Canada	Relocate all existing duct bank and structures to a location generally 2 m from west property line.	Civil Works – December 31, 2013 Cable and Splicing – December 31, 2014	Plan 407 to 423, 701 dated June 19, 2013
Communications	Hayward Ave – Courtland to RR tracks	Bell Canada	Relocate buried plant from south boulevard to north boulevard	Civil Work – March 31, 2014 2013 Cable and Splicing – July 1, 2014	Design not complete will provide to Project Co post RFP close.
Communications	Various Locations King St. – William St. to Wellington St.	Rogers/Telus	Joint structure within 2 m of east property line	Civil Works – Summer 2013 Cable and Splicing – Fall 2013	Rogers/Telus Buried Permit Plan Sheet 1-11 Dated June 6, 2013
Electrical Transmission	Hydro One Corridor – Courtland to Fairview Park Mall past the termination of Phase 1 LRT	Hydro One Networks	Relocation of 115 kV overhead transmission lines and towers from Courtland to Fairview Park Mall to new underground duct location.	Fall 2014 – refer to Schedule 15-2 Article 18	HONI-1 to HONI-8 Dated May 28, 2013
Electrical Distribution ***Underground***	Various throughout downtown City of Kitchener	Kitchener Wilmot Hydro	Relocation of existing infrastructure underground and above ground to minimize conflict with proposed LRT.	Start Dec 2012 Completion Fall 2015 Refer to Schedule 15-2 Article 18 of Performance Output Specifications	KWH Underground Distribution Sheet 1-5 Dated September 13, 2013
Electrical Distribution ***Overhead***	Courtland Ave – Hayward to Balzer	Kitchener Wilmot Hydro	Relocation of aerial pole line from west side of Courtland Ave to east side of Courtland Ave	Summer 2013	B10081 Drawing 1 to 4 Dated January 22, 2013

Exhibit 3.5-1

Summary of Utility Relocation Work – Early Works

Facility Description	Location	Owner	Description	Date Completed / Proposed	Reference Drawing
Gas Distribution	Hayward Ave – Courtland Ave to RR tracks	Kitchener Utilities	Relocate existing gasmain to near north property line	Summer 2013	As-Builts will be provided to Project Co post RFP close.
Gas Distribution	Crossing of Hydro One Corridor at closed road allowance (projection of Vanier Drive)	Kitchener Utilities	Relocate existing gasmain vertically to accommodate Hydro One Duct Structure and LRT rapidway	Fall 2013	As-Builts will be provided to Project Co post RFP close.
Gas Distribution	King Street from Union to Wellington	Kitchener Utilities	Relocate existing gasmain along both sides of King Street	Summer 2013	As-Builts will be provided to Project Co post RFP close.
Gas Distribution	Ottawa Street from Mill to Charles	Kitchener Utilities	Relocate existing gasmain to near south property line	Fall 2013	As-Builts will be provided to Project Co post RFP close.
Gas Distribution	Caroline Street from Erb Street to John Street	Union Gas	Relocation/abandonment of existing gas distribution infrastructure to minimize conflict with proposed LRT	Fall 2013	LRT Phase 4 – Caroline Street South dated August 2, 2013
Gas Distribution	King Street From William to Union	Union Gas	Relocation/abandonment of existing gas distribution infrastructure to minimize conflict with proposed LRT.	Fall 2013	As-Builts will be provided to Project Co post RFP close.

(c) Utility Relocation

(i) Relocation of private/franchised utilities (e.g., Union Gas, Rogers, Bell, Allstream, Atria, etc.) shall be completed by the utility owner. Project Co shall contact all franchised and Third Party utility owners to coordinate relocation efforts. Project Co's plans and specifications shall depict the work performed by others. Project Co shall be responsible for the provision and installation of any sleeves including providing access to utilities for installation of their infrastructure and any associated reinstatements.

(ii) All other utility relocation construction activities shall be rearranged using one of the following procedures as part of Project Co's responsibilities:

A. Supported and protected in place during construction and continued in service following completion of the LRT facilities.

B. Temporarily relocated and maintained, then, upon completion of LRT facilities, restored to approximately the original location.

C. Temporarily relocated and maintained, then, upon completion of the System facilities, replaced by new utilities.

D. Permanently relocated beyond the immediate limits of LRT construction.

E. Replacement with a new facility to be supported and maintained in place during construction, and then to continue in service following completion of the LRT facilities.

(iii) Where municipal utilities (water, sanitary, storm) do not currently meet minimize size requirements as detailed in the Regional or Municipal Design Guidelines, the relocated installation shall comply with the current minimum size requirement.

(iv) A list of the utility relocations/impacts are provided in Appendix M. This list is based the Functional Design. Project Co shall prepare and submit a schedule of utility relocations affected by construction of the LRT in the format indicated in Exhibit 3.5-2. This shall be included in the Project Schedule of Values.

(d) Maintenance of Utility Service Connections

(i) Utility service to adjacent properties along the LRT trackway shall be maintained during construction. Maintenance of service may be accomplished by supporting existing facilities in place, by providing alternative temporary facilities, or by supplying from other points.

Exhibit 3.5-2 (example)
Summary of Utility Relocation Work

Facility Description	Location	Owner	Method of Conflict Resolution	Drawing Reference
Gas Main (dia.)	Sta XXXX+xx to Sta XXXX+xx	Union Gas	Relocate X linear metres of main to 0.6 metres offset from north side of King St. N.	UTIL-G-1
Water Main (dia.)	Sta XXXX+xx to Sta XXXX+xx	City of Waterloo	Vertical relocation around proposed storm pipe (X linear metres)	UTIL-W-1
Trunk Sanitary Sewer (dia.)	Sta XXXX+xx to Sta XXXX+xx	City of Kitchener	Protect and maintain during construction	UTIL-SAN-1

(e) Restoration of Areas Disturbed by Utility Work

(i) All pavement restoration related to utility rearrangement in public streets shall conform to the current specifications and practices of the Municipality involved. Restored pavements shall be the same materials and widths that existed prior to LRT construction, except for

instances where the existing road configuration is no longer to remain; the restoration shall meet current specifications and practice of the appropriate agency.

(f) Utility Relocation Costs

(i) All costs associated with wet utility (sanitary, storm, water) relocations that are required for completion of the Project shall be the responsibility of Project Co unless otherwise negotiated between Project Co. and the Utility.

(ii) All costs associated with dry utility (gas, electric, communications, other) relocations that are required for completion of the Project shall be the responsibility of the utility or as detailed in Exhibit 3.5 – Utility Responsibility Matrix with coordination by Project Co.

(g) Utilities to be Reconstructed

(i) Some Utilities within the corridor are reaching the end of their useful life and it is the intent of the Region for Project Co to reconstruct some utilities that may not be in conflict with the proposed LRT construction. Utilities to be relocated are indicated in the Utility Matrix in Appendix M or in the PIW drawings (Appendix N) or specifications (Schedule 15-2 Article 2). The specification for the specific works shall comply with the DGSSMS and requirements below.

3.6 Sanitary Sewer

(a) Design Procedures

(i) Project Co shall perform, seal (Professional Engineer Licensed in Ontario), and provide all sanitary sizing and hydraulic calculations, including computer-generated input/output sheets, along with all worksheets and exhibits used to define the drainage area. The design shall include a sizing review based on the contributing area and current land zoning in accordance with the Municipal Guidelines and the MOE Design Guidelines for pipe sizing. Where a pipe size as selected based on the contributing area and current land zoning is greater than 50% full at maximum day flow, the pipe size provided and installed shall be increased one standard pipe size to account for future growth and zoning changes. Project Co shall be provided access to the City GIS information on the existing sanitary drainage areas. This shall be provided as part of the Basis of Design Report.

(ii) A design report shall be prepared compliant with MOE Design Guidelines suitable for submission and approval of the Ministry of the Environment by the Region of Waterloo under the Transfer of Review process.

(b) Alignment

(i) Project Co shall design the relocation and/or protection of the existing sanitary sewer to maintain existing sanitary sewer capacity and access for maintenance. In locations where a sanitary manhole is in conflict with the LRT trackway, the manhole structure shall be relocated to a location where the distance between upstream and downstream manholes are maintained within municipal and provincial guidelines and where practical outside the travelled wheel path of the roadway parallel to the LRT trackway. Optimally, the relocated sewer section will be extended to the nearest existing manhole; however, a flexible connection at the extents of the sleeve may be permitted on the case by case basis.

(c) Buildings

(i) As part of the development of the OMSF and substations, a sanitary service shall be required and shall be designed in accordance with Regional and Municipal standards.

(d) Design Criteria and Standards

(i) Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services – Part B

(ii) The potential of a high water table in portions of the Project area may exist and the proximity of the sanitary sewers on the Project shall be considered in the design of certain system components.

3.7 Storm Sewer – LRT Design

(a) Project Co shall design the storm drainage system to provide for safe operations of the LRT trackway and the adjoining roadway network, by providing a system that addresses the future drainage patterns established with the LRT Project in-place. The design for the system shall also address current drainage concerns on existing roadways where the drainage system of the roadway is affected by the Project.

(b) Intent

(i) Stormwater collection, treatment and disposal associated with the LRT shall be consistent with Regional and local municipal practice for public roadways through the minimization of downstream impacts (quantity and quality).

(ii) Where practical, Low Impact Design (LID) practices shall be around LRT facilities (Traction Power Substations, OMSF, Stations, etc.)

(c) Design Criteria and Standards

(i) Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services – Part B

(ii) All on-Region drainage facilities shall conform to the Region's and/or governing agency design standards. Off-Region drainage facilities shall be based on the criteria and standards of the agency's having jurisdiction.

(d) Design Procedures

(i) Project Co shall perform, seal, and provide all hydrologic and hydraulic calculations, including computer-generated input/output sheets, along with all worksheets and exhibits used to define the drainage area. This shall be provided as part of the Basis of Design Report.

(ii) The sections below describe the general procedures that shall be used to design the proposed drainage improvements.

(iii) Hydrology - Proposed grading designs shall be used to establish future overland flow patterns and to compute watershed areas. The Rational Method shall be used to compute surface runoff volumes. The runoff coefficients for various surfaces shall be based on the MOE Design Guidelines, applied to post LRT construction conditions.. Rainfall intensity, frequency, and duration parameters shall be based on IDF curve equation parameters provided by the individual municipalities in their development manuals. A 5-

year design storm shall be used for the design of roadways, local streets, parking and station areas except that underpasses and depressed segments of these roadways shall be subject to a Regional Storm design storm. Where a pipe size as selected based on the contributing area and current land impervious area is greater than 80% full during the 5 year peak flow using a Rational Method calculation, the pipe size provided and installed shall be increased one standard pipe size to account for future growth and changes in impervious area

(iv) The hydraulic design of new or modified LRT bridges and culverts shall be based on the Regional Storm with the requirement of no change in flood elevation resulting from the construction of the works.

(v) Inlet Placement - Drainage basins shall be spaced as indicated in the Regional and City Guidelines. Basin frames, grates, and curb pieces (where required) shall be selected as appropriate to each location. Special basin requirements shall be applied at profile low points. Where bicycle or pedestrian traffic is anticipated, reticuline grates or side inlets shall be installed. Side inlets are the Regional Standard and shall be used unless there is a specific technical reason to deviate. Trench drains may be used within and adjacent to the trackway and shall be designed for H-20 Loading and Full traffic H-20 loading for areas where the trench drain may be located under the wheel path for vehicles using the roadway or access. Reticulated catchbasin inlets are permitted adjacent to the track curb provided access is maintained for catchbasin replacement without undermining the track bed.

(vi) At some Project locations, the proposed design calls for modifications to existing drainage structures. These modifications shall be designed in accordance with the specifications and details of the agency having jurisdiction over the area drained.

A. Waterloo Spur – Drainage from adjacent properties may be directed into the railside ditches. This drainage shall be maintained by Project Co along existing alignments and within the currently available right-of-way.

B. University of Waterloo LRT Station – Existing Stormwater Quantity and Quality control facilities are located adjacent to the proposed LRT trackway. The operational efficiency of the quantity and quality shall either be maintained or provided by Project Co in proximity to the existing facility within the existing right-of-way.

C. Huron Spur - Drainage from adjacent properties may be directed into the railside ditches. This drainage shall be maintained by Project Co along existing alignments and within the currently available right-of-way.

(vii) Pipe Network Design - The results of the Rational Method analysis shall be used to establish flows entering the storm system with pipe sizing in accordance with Regional Standards. Hydraulic analyses shall use the Manning equation as a basis. Existing topography, pipe cover requirements, and pipe flow velocity criteria shall govern pipe slopes.

(viii) Where connections to existing systems are proposed, downstream conditions shall be checked to confirm that the existing system has adequate capacity to accommodate proposed conditions. This review shall include an investigation of outlet conditions to determine the type of outlet control under which the existing system(s) is operating.

(ix) Under no circumstances shall storm drainage be diverted to sanitary sewer systems.

(x) Acceptable Materials

A. Pipe materials shall be selected based on the criteria of the governing agency and the subsurface conditions. If required, an economic analysis of the relative costs of acceptable material options shall be performed.

(e) Effect of Water Table on Design

(i) The potential of a high water table in portions of the Project area may exist and the proximity of the primary outfalls for large portions of the Project shall be considered in the design of certain drainage system components.

(ii) Storm Sewers shall be designed in areas of high groundwater table to collect and convey groundwater in a manner mitigating impacts on adjacent structures, granular base, and pavements.

(f) Specific Drainage Requirements of LRT Segments

(i) Specific Project areas requiring special attention to drainage include:

A. All Platform areas

1. Due to increased impervious areas;

B. Northfield Drive Intersection with the LRT;

1. Transition from street running to ballasted track;

2. Existing drainage channels to be maintained.

C. Operations and Maintenance Facility and Yard

1. Significant change in use and impervious area;

2. Proximity to Forwell Creek and GRCA Regulated Area;

3. Site Plan Control Approval.

D. Waterloo Spur Alignment including Father Bauer Drive and Erb Street

1. Rural Cross Section

2. Outlet to Laurel Creek

E. King and Victoria Street Grade Separation including the Canadian National Railway Reconstruction

1. 5 year storm flow to be conveyed by storm connection to the Victoria St. Storm Sewer.

2. A Stormwater pumping system including backup generator and outlet shall be designed for the worst case scenario for peak flow and operation period for all storm events from the 5 year storm up to the Regional Storm.

3. Collection system and forcemain to suitable outlet (refer to RT EA report for feasible solution)

F. Huron Spur Alignment

1. Rural Cross Section
2. Outlets to Schneider Creek

3.8 Storm Sewer – Relocation

(a) Intent:

(i) Unless indicated otherwise Project Co shall relocate any and all storm sewers, manholes and appurtenances that are in conflict with the LRT trackway and the exclusion envelope to a location where their function is maintained. This shall include upsizing pipes to maintain capacity at a reduced gradient.

(ii) Where practical, crossings shall be maintained at the current location and sleeved as appropriate.

(iii) Materials and Methods shall be as per DGSSMS – Part B.

(iv) Testing and Acceptance as per DGSSMS – Part B

3.9 Water Distribution

(a) Intent:

(i) Unless indicated otherwise Project Co shall relocate any and all watermains, valves and appurtenances that are in conflict with the LRT trackway and the exclusion envelope to a location where their function is maintained.

(ii) Watermain crossings of the LRT trackway shall be replaced at a minimum for the full length of the crossing including the exclusion zone with an appropriate valve consistent with the governing authority's requirements at both ends of the crossing. A non-metallic sleeve shall be provided with adequate annular space to allow for the upsizing of the watermain in the future.

(iii) Fire Hydrants shall be installed as per MOE Design Guidelines and the latest edition of the Fire Underwriters Survey for Public Fire. Alternate fire hydrant side of the road to ensure access to fire hydrants on both sides of the LRT tracks. Maximum distance between hydrants shall be 90 m radial distance.

(iv) Materials and Methods shall be as per DGSSMS.

(v) Temporary Water Service to be provided including maintenance of fire protection and acceptable municipal water pressure in accordance with the MOE Design Guidelines.

3.10 Natural Gas

(a) Intent:

(i) Unless indicated otherwise Project Co shall coordinate with the gas utility to relocate any and all gas mains, valves and appurtenances that are in conflict with the LRT trackway and the exclusion envelope to a location where their function is maintained.

(ii) Gas crossings of the LRT trackway shall be replaced at a minimum for the full length of the crossing including the exclusion zone with appurtenances consistent with the governing authority's requirements at both ends of the crossing. A non-metallic sleeve shall be provided by Project Co with adequate annular space as required by the utility operating authority to permit future trenchless replacement of the infrastructure.

(b) Special Provisions

(i) Minimum 1.68m depth for gas main casing at LRT crossing locations per Transport Canada railway crossing requirements for oil and gas pipelines (TC E-10)

(ii) Minimum 3.05m depth of gas main when uncased at LRT crossing locations per Transport Canada railway crossing requirements for oil and gas pipelines (TC E-10)

(iii) Casings to extend for entire width of Right-of-Way when PE carrier pipe is being used per Transport Canada railway crossing requirements for oil and gas pipelines (TC E-10)

(iv) Union Gas to be added to all crossing permits

(v) Kitchener Utilities – Project Co. to provide steel sleeves as per compliant with the requirements of the CSA Standard Z662-11 and Transport Canada railway crossing requirements for oil and gas pipelines (TC E-10)

(vi) Union Gas - Union Gas will specify and supply all material & casings required

3.11 Electrical Distribution

(a) Underground

(i) Intent:

A. Unless indicated otherwise Project Co shall coordinate with the electrical utility to relocate any and all underground electrical distribution or transmission infrastructure and appurtenances that are in conflict with the LRT trackway and the exclusion envelope to a location where their function is maintained.

B. Electrical crossings of the LRT trackway shall be replaced at a minimum for the full length of the crossing including the exclusion zone with appurtenances consistent with the governing authority's requirements at both ends of the crossing. A non-metallic sleeve shall be provided by Project Co with adequate annular space as required by the utility operating authority to permit future trenchless replacement of the infrastructure. The electrical authority will complete all wiring with their own forces. Project Co shall coordinate this work with the authority.

(b) Overhead

(i) Intent:

A. Unless indicated otherwise Project Co shall coordinate with the electrical utility to relocate any and all overhead electrical distribution or transmission infrastructure and appurtenances that are in conflict with the LRT trackway and the exclusion envelope to an underground location where their function is maintained.

B. Electrical crossings of the LRT trackway shall be replaced at a minimum for the full length of the crossing extending to the nearest utility pole including the exclusion zone with appurtenances consistent with the governing authority's requirements at both ends of the crossing. A non-metallic sleeve shall be provided by Project Co with adequate annular space as required by the utility operating authority to permit future trenchless replacement of the infrastructure.

(c) Municipal – Wonders of Winter

(i) Intent:

A. Within Waterloo Park, the Wonders of Winter seasonal light display supplied by a localized secondary service feed to individual dual outlets. Project Co shall relocate the service out of the Waterloo Spur corridor to maintain the service and have that service in operation during the November to January each year.

(d) KW Hydro Duct Bank Requirements

(i) Refer to the following required duct bank crossings to be provided by Project Co. for existing KW Hydro utility relocations and the numbers of ducts required. Exact locations to be confirmed with KW Hydro upon design development.

EXHIBIT 3.11-1 KW Hydro Duct Bank Requirements
From PB 270 (47 Duke St. W.) going across Duke St. (4 ducts)
From PB 354 (10 Duke St. W.) going across Duke St. (4 ducts)
From PB 23 (corner of Queen St. N. and Duke St. W.) to PB172 across Duke St. (15 ducts)
From PB1008 to (22 Duke St. E.) (2 ducts)
From PB1010 to (32 Duke St. E.) (2 ducts)
From PB684 (corner of King St. E and Borden Ave.) across Borden Ave. (15 ducts)
Intersection of Gaukel St. and Charles St. E. 3 crossings (PB65 to PB66), (PB393 to PB66) and (PB394 to 27 Gaukel St.) (15 ducts each)
Intersection of MT-Hope and King St. W. (3phase crossing 9 ducts)
King St. W. 765 and 749 King St. W. services. (2 ducts)
741 and 737 King St. W. services (2 ducts)
Intersection of King St. W. and Andrew St. 2 services (4 ducts)
Intersection of King St. W. and Agnes St. 1 service (2 ducts)
Intersection of King St. W. and Louisa St. 2 services (4 ducts)
670 King St. W. 1 service (2 ducts)
655 King St. W. 1 service (2 ducts)
Intersection of King St. W. and Wellington St. 3 phases (9 ducts)

641 King St. W. 1 service (2 ducts)
Intersection of King St. W. and Breightaupt St. 3 phases (9 ducts)
Intersection of Eby St. and Charles St. E. 3 phases (9 ducts)
Intersection ofn Charles St. E. and Cedar St. 3 phases (9 ducts)
Intersection of Charles St. E. and Madison Ave. service (2 ducts)
Charles St. E. @ Cameron St. 1 service (2 ducts)
Intersection of Charles St. E. and Pandora St. 1 service (2 ducts)
Intersection of Charles St. E. and Kent Ave. 3 phases (9 ducts)
475 Charles St. E. 1 service (2 ducts)
85 Ottawa St. 1 service (2 ducts)
89 Ottawa St. 1 service (2 ducts)
109 Ottawa St. 1 service (2 ducts)
473 Nyberg St. 1 service off Ottawa St. (2 ducts)
Dundas Ave. and Ottawa St. 3 phases (9 ducts)
Bedford Ave. and Ottawa St. 3 phases (9 ducts)
189 Ottawa St. 1 service (2 ducts)
197 Ottawa St. 2 services (4 ducts)
Coutland Ave. and Ottawa St. intersection 3 phases (9 ducts)
241 Ottawa St. 3 services (9 ducts)
Lilac St. and Ottawa St. 1 phase crossing (3 ducts)
268 Ottawa St. 2 services (4 ducts)
285 Ottawa St. 2 services (4 ducts)
293 Ottawa St. 1 service (2 ducts)
Acadia St. and Ottawa St. 1 phases (3 ducts)

315 Ottawa St. 2 services (4 ducts)
Mill and Ottawa St. intersection 2 crossing of 3 phases circuits (12 ducts)

3.12 Telecommunications

(a) Underground

(i) Intent:

A. Unless indicated otherwise Project Co shall coordinate with the telecommunication utility to relocate any and all underground telecommunication infrastructure and appurtenances that are in conflict with the LRT trackway and the exclusion envelope to a location where their function is maintained.

B. Telecommunication crossings of the LRT trackway shall be replaced at a minimum for the full length of the crossing including the exclusion zone with appurtenances consistent with the governing authority's requirements at both ends of the crossing. A non-metallic sleeve shall be provided by Project Co with adequate annular space as required by the utility operating authority to permit future trenchless replacement of the infrastructure.

(b) Overhead

(i) Intent:

A. Unless indicated otherwise Project Co shall coordinate with the telecommunication utility to relocate any and all overhead telecommunication infrastructure and appurtenances that are in conflict with the LRT trackway and the exclusion envelope to an underground location where their function is maintained.

B. Telecommunication crossings of the LRT trackway shall be replaced at a minimum for the full length of the crossing extending to the nearest utility pole including the exclusion zone with appurtenances consistent with the governing authority's requirements at both ends of the crossing. A non-metallic sleeve shall be provided by Project Co with adequate annular space as required by the utility operating authority to permit future trenchless replacement of the infrastructure.

3.13 Service Connections

(a) Project Co shall be responsible for replacing or extending all existing service connections for sanitary, storm and water to the proposed limit of right-of-way. Service connections shall be made using materials and methods as defined in referenced municipal standards and guidelines. Any disturbance of private property required for a service connection shall be either completed within a defined construction easement or with written approval of the landowner.

(b) Project Co shall coordinate the installation with the appropriate utility for the replacement or extension of all existing service connections for electrical, telecommunications, cable, gas, etc. Any work to the proposed limit of the right-of-way shall be reinstated in accordance with the provisions of this Article by Project Co. Any work on private property shall be completed and reinstated by the respective utility as coordinated by Project Co.

(c) Project Co shall notify the Region of any potential cross-connections between sanitary and storm sewers and any illegal downspout or perimeter drains. If practical, the Region or City may direct that these connections are disconnected; however, if no direction is provided, they shall be considered as grandfathered and shall be reconnected.

3.14 Prospect Sleeves / Duct Banks

(a) Project Co shall install prospect sleeves at strategic locations along the alignment. For the purposes for pricing, a unit price shall apply for each of these sleeves.. At each location five sleeves shall be installed as follows:

(i) Sanitary Sleeve – 300 mm diameter at min. 2% slope towards the sanitary sewer main line at a site specific depth that maximize the drainage capacity at the upstream elevation.

(ii) Watermain Sleeve – 300 mm diameter installed level at 1.5 m below top of rail (top of sleeve)

(iii) Gas Sleeve – 100 mm diameter installed level at 1.3 m below top of rail (top of sleeve)

(iv) Communication Sleeves – Two – 100 mm diameter installed level at 1.3 m below top of rail.

(b) Specific Prospect Sleeve Locations for the following utilities can be found in Appendix O:

(i) Rogers Telecommunications

(c) Specific duct bank locations have been identified by Kitchener Wilmot Hydro and Waterloo North Hydro for inclusion in Project Co's scope. Refer to Appendix O.

3.15 Environmental Considerations

(a) Refer to Schedule 15-2 Article 4 for Environmental Design Criteria.

(b) In areas where any soil/groundwater contamination is identified, a clay seal as per OPSD 802.095 using bentonite as the sealing material, shall be used every 30 m within the area of contamination to prevent migration of contamination. This shall apply to all parallel utilities installed/coordinated by Project Co. and to all services that may come from area with known/suspected contamination.