

DIVISION 1

GENERAL REQUIREMENTS

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**SECTION 01010
SUMMARY OF WORK**

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SECTION 01010 SUMMARY OF WORK

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section outlines in general the work to be done under the Contract.

1.2 SUMMARY

- .1 This project involves a multi-disciplinary rehabilitation and upgrade of the Dufferin Transfer Station including upgrades to the existing pavement and curbs, the replacement of the existing Quonset Hut with a new prefabricated building, and the addition of a new storage bunker adjacent to the new prefabricated building.
- .2 Supervise, organize, coordinate and direct construction operations of subtrades and suppliers.
- .3 Organize and coordinate with all regulatory agencies. All costs resulting from this requirement are to be paid by the Contractor.
- .4 Supply, install and put in continuous successful operation all equipment and appurtenances. Include operating assistance to City as described herein.
- .5 All items as shown on the Contract Drawings and as detailed in these specifications.
- .6 Any and all electrical shutdown requests or in-plant road blockages or closure shall be submitted in accordance with Contract Documents.
- .7 For the maximum allowed shutdown time, refer to clause 1.5.5.
- .8 Contractor to provide outdoor lighting complete with integrated standby power to illuminate the area surrounding the switchgear during the shutdown.
- .9 Coordinate with Toronto Hydro for energization once all related requirements are met and the work has been finalized.
- .10 Construct, and maintain, unless otherwise specified or shown on the drawings, all temporary works and facilities required for the construction of the works. Remove temporary works and facilities when construction is completed. Temporary works and facilities include, but are not limited to the following:
 - .1 Electrical equipment and cabling.
 - .2 Scaffolding.

- .3 Protection for existing structures and facilities as necessary for the construction to proceed.
- .4 Weathering protection for existing and new equipment.
- .5 Heating and lighting.
- .11 Comply fully with and maintain facility access to the City of Toronto's operational requirements throughout the construction period, per Section 01040 – Coordination

1.3 DESCRIPTION OF WORK

- .1 The work to be done under this Contract consists of supplying all material, equipment and labour necessary for the complete construction of the alteration and additions and all other related work as shown on Contract Drawings, specified herein, or both, all in accordance with the terms of the Contract and the requirements of the City.
- .2 Without in any way limiting the scope of the foregoing, the work shall, in general, consist of:
 - .1 Civil:
 - .1 For the Pavement Rehabilitation Areas:
 - .1 The Base Scope of the project includes removing the existing pavement and underlying layers, followed by compacting and proof rolling the granular base in preparation for new pavement installation as specified in the contract drawings. All excavated material including the paving and underlying layers shall be hauled and disposed of as uncontaminated construction waste in compliance with Ontario Regulation 406/19.
 - .2 The Contractor is responsible for conducting testing as a Base Scope in accordance with Ontario Regulation 406/19 and the Soil Management Plan (SMP) to determine contamination levels (if any) and quantify amount of excavated underlying materials that is contaminated and need to be hauled to a Ministry of the Environment, Conservation and Parks (MECP) approved landfill at the Provisional rate outlined in the construction contract.
 - .2 For the Pre-engineered building and bunker area:
 - .1 The **Base** Scope of the project includes the excavation and removal of existing pavement along with its underlying layers. The contractor shall be responsible for the

transportation and disposal of all excavated paving materials (concrete, asphalt) as uncontaminated construction waste, in compliance with Ontario Regulation 406/19.

.2 The contractor shall be responsible for the haulage and disposal of excavated underlying contaminated materials as Base Scope in accordance with Ontario Regulation 406/19.

.3 Removal and installation of new concrete curbs, bollards, and restoration.

.4 Installation of a new Fire Route Signage in accordance with Toronto Chapter 880 and Fire Route Sign requirements.

.5 Installation of pavement markings as indicated in the contract drawings.

.2 Structural:

.1 Full demolition of existing Quonset Hut including the superstructure and existing foundation.

.2 Supply and installation of the new prefabricated steel storage building on slab on grade on helical piles.

.3 Supply and installation of the new storage bunker including concrete pushwalls on helical piles.

.3 Electrical:

.1 Replacing the disconnect switch in the Ash run area.

.2 Removing existing cables and running new cables from the maintenance building to the new storage unit.

.3 Extending the duct bank from the existing Quonset hut to the new storage unit.

.4 Addition and wiring of new equipment and lighting in the storage unit.

.5 Rewiring of the streetlights and security shack.

.4 Mechanical:

.1 Supply and installation of one (1) Exhaust Fan for the new Storage Bunker.

- .2 Supply and installation of four (4) Heaters for the new Storage Bunker.
 - .3 Supply and installation of outside air louver and damper for the new Storage Bunker.
 - .4 Supply and installation of exhaust air louver and damper for the new Storage Bunker.
 - .5 Supply and installation of wall mounted temperature transmitter to control the exhaust fan for the new Storage Bunker.
- .3 The work also includes the following:
- .1 Visiting the site during tendering to ensure familiarity with the work to be done and the site-specific conditions.
 - .2 Supply of all necessary labour, material, equipment, transportation, services and facilities.
 - .3 Protection of active or energized utilities in area of demolition.
 - .4 Ensuring that the existing facility remains in service.
 - .5 Detailed site survey.
 - .6 Pre-Construction condition survey of work areas.
 - .7 Daily cleanup of the work area.
 - .8 Site drainage during construction.
 - .9 Fencing, lighting and security.
 - .10 Removal of any graffiti from stations and temporary facilities.
 - .11 Maintaining existing roads used during construction and leaving these roads in as good a condition as they were prior to site work.
 - .12 Protection of watercourse.
 - .13 Protection and restoration of trees.
 - .14 Complete restoration of the site.

1.4 DESIGNATED SUBSTANCES

- .1 The facilities contain known designated substances such as trace amounts of asbestos. Refer to Appendices for detailed Designates Substance Surveys, and Division 2.

1.5 SEQUENCE OF WORK

- .1 The work shall be carried out in a staging sequence on the civil drawings to not disturb the Dufferin Transfer Station operation. All efforts will be made to safeguard the continued operation of the facility. Coordinate all construction activities through the Engineer with the City's Operations staff and verify that these activities do not interfere with the operation of the facility. The operation of the facility shall have priority over all construction activities.
- .2 The work is to be completed in the time stated in the Form of Tender. In this regard the Contractor is responsible for scheduling and the sequence of work.
- .3 When shutdowns and/or switch-overs of any facility process or electrical systems are required, the Contractor shall coordinate all trades involved. Coordination with City's operating staff shall be through the Engineer. Detailed written sequences are required to be submitted to the Engineer to permit such coordination. Refer to Section 01040 - Coordination, for scheduling constraints and limitations of construction.
- .4 The Contractor shall maintain access for City staff, other City contractors at all times.
- .5 The following constraints must be abided to during the construction:
 - .1 Operations to the transfer station, must be maintained per the Construction staging plan.
- .6 Refer to Contract Drawings for construction staging.

1.6 CONSTRUCTION SEQUENCING AND CONSTRAINTS

- .1 The Contractor is to coordinate the completion of the Work described in Section 1.1.1 as per Specification 01140 – Work Restrictions, Specification 01310 – Project Coordination, and Specification 01312 – Project Meetings.
- .2 Contractor to provide a detailed price breakdown for billing purposes within two (2) weeks of order to commence work in both electronic (native software format) and portable document format (PDF). Consultant is to provide a sample prior to contract order to commence. Breakdown is to be based on the specification divisions and provide adequate detail to monitor project basis. Mobilization and demobilization costs will be based on a prorated schedule based on overall timeline. The value designated for these services will be limited to a maximum of 2.5% of the total contract value.
- .3 Contractor to prepare a detailed time-task construction sequencing schedule using a computerized scheduling software package for the entire Contract. The baseline schedule is to be submitted within two (2) weeks of order to commence work and based on General Condition 3.5 in both electronic (native software format) and

portable document format (PDF). All milestones are to be shown on schedule including the critical path.

- .4 Contractor to coordinate construction and commissioning sequencing with the Consultant and City to ensure priority is given to the minimum overall facility functions and production requirements.
- .5 The following constraints must be considered by the Contractor in preparing the construction schedule for the Contract:
 - .1 Shutdowns are limited to weekends only. The proposed works shall be complete within the maximum allowed shutdown time as described below:
 - .1 From 1pm Saturday until 5am Tuesday if the work is done during an extended weekend due to statutory holiday;
 - .2 From 1pm Saturday until 5am Monday if the work is done during a regular weekend.
 - .2 If the shutdown period exceeds this time, Provisional Allowance for temporary standby power will be activated.

1.7 CONTRACTOR'S USE OF PREMISES

- .1 Confine construction activities to within the Limit of Construction shown on the drawings.
- .2 Make arrangements with other property owners if additional areas are required, and obtain written agreements and submit copies to the Engineer.
- .3 Minimize area utilized for construction consistent with efficient operations.
- .4 As provided in the Occupational Health and Safety Act, the Contractor must assume responsibility for all personnel on site.
- .5 Conform with local bylaws regarding traffic regulations and road blocks. At no time should any trucks or construction equipment hinder traffic flow on adjacent roads.
- .6 Conform with City bylaws regarding hours of work, and noise.
- .7 Assume full responsibility for protection and safekeeping of products/equipment under this Contract.
- .8 Obtain and pay for use of additional storage, access or work areas needed for operations under this Contract. All storage areas must be approved by the Consultant prior to use. Materials must be stored to ensure the preservation of their quality and fitness for use.

- .9 Protect all newly constructed work from damage of any form. Any portion of the work, which is damaged, must be rebuilt at the Contractor's expense to the satisfaction of the Consultant.
- .10 Clear site at least weekly of construction debris.
- .11 Supply, install and maintain temporary fencing where deemed necessary by the Engineer to make the site safe. Remove or relocate when directed by the Engineer. Contractor shall clearly delineate the entire perimeter the working area. Fencing shall comply with Section 01060.
- .12 Do not enter upon or occupy with workers, tools or materials of any nature, any lands or areas other than those designated as working areas on the Contract Drawings, except after consent has been received from the proper parties and a certified copy of such consent is furnished to the Engineer. Any rental or damages paid for occupying private lands other than those stipulated as working areas shall be at the Contractor's expense.
- .13 Return working areas to a pre-construction condition satisfactory to the Engineer.

1.8 HOURS OF WORK

- .1 Perform Work in conformity with all municipal bylaws with respect to noise control, hours of work, night work and holiday work.
- .2 Refer to Special Provision Construction and Traffic Constraints (GN102SP) for working hours during construction.
- .3 Deliveries must be made within contract hours unless approved otherwise. Large delivery trucks are not permitted to idle on neighbourhood streets prior to or after these work hours.

1.9 CITY OCCUPANCY

- .1 City will occupy premises during entire construction period for execution of normal operations.
- .2 Coordinate construction works with the City in order to minimize conflict and to facilitate continual operation of the existing Transfer Station until construction works are completed.

1.10 CONTRACT DOCUMENTS

- .1 Maintain at job site at least one copy of each of the following documents:
 - .1 Contract Drawings.
 - .2 Specifications.

- .3 Addenda.
- .4 Reviewed Shop Drawings.
- .5 Change Orders.
- .6 Field test reports.
- .7 Copy of approved work schedule.
- .8 Manufacturer's installation and application instructions.
- .9 Approvals and Permits.
- .10 Personnel Training Certificates

1.11 CONTRACT DRAWINGS

- .1 Contract Drawings form part of the Contract Documents.
 - .1 The City will provide electronic copy of all Contract Documents (drawings and specification) to the successful Contractor.
- .2 Additional drawings showing details in accordance with which work is to be constructed will be furnished from time to time by the Engineer and will become part of Contract Documents.
- .3 In every case any detailed Contract Drawings take precedence over general Contract Drawings.
- .4 Location of utilities shown on Contract Drawings are in accordance with best information available and are not guaranteed.
- .5 The Specifications must be read in conjunction with the drawings as a whole to obtain exact details of the work to be done. No claims resulting from the failure to do so will be entertained.
- .6 The Contractor shall be governed by figured dimensions, as given on the Drawings. Where required dimensions are not shown in figures, obtain such dimensions from the Engineer before proceeding with the construction of the portion of the work to which they refer.
- .7 The Drawings are prepared in SI units.
- .8 Additional drawings showing details in accordance with which the work is to be constructed may be supplied from time to time by the City. Such drawings are for the information of and assistance to the Contractor and will not become a basis for extra payment. The City may supply drawings covering additional work. These will be identified as additional work.

- .9 Contract Drawings give general location of cable trays, piping routes and equipment. Except where specific dimensions are indicated, locate equipment and piping to limit interference with access ways, crane routes and required headroom.
- .10 Maintain at Site one complete set of “Record” drawings and specifications including all red line markups. Make available to Consultant at any time.
- .11 Record Drawings shall be submitted to the Contract Administrator within 60 calendar days of Substantial Performance.

1.12 WORK COMPLIANCE

- .1 Build all work in a thoroughly substantial and workmanlike manner, in accordance with the Contract Drawings and Specifications, subject to such modifications and additions as may be deemed necessary during its execution. In no case will any work in excess of the requirements of the Drawings and Specifications be paid for, unless approved in writing by the Engineer.

1.13 ENGINEER DESIGN

- .1 Where specifications require work to be designed by an engineer, engage a professional engineer licensed in the Province of Ontario with demonstrated experience to design such work.
- .2 Pay all engineering fees for substitutions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01040
COORDINATION**

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1.3	LIMITATIONS OF CONSTRUCTION AND SCHEDULING CONSTRAINTS	2
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PART 2	PRODUCTS (NOT USED)	4
PART 3	EXECUTION (NOT USED)	4

SECTION 01040 COORDINATION

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section includes the requirement for the Contractor to coordinate his activities with the operation of existing facility, between his forces and subcontractors, other contractors and all stakeholders.

1.2 COORDINATING CONSTRUCTION WITH OPERATION OF EXISTING FACILITIES

- .1 Coordinate construction activities on the site and within existing buildings including pipe connections, building connections, mechanical, electrical and instrumentation connections through the Engineer, with the City or his designated staff.
- .2 The Dufferin Transfer Station facility operates Monday to Friday from 6AM to 6PM and is closed during the weekends. In the event of conflict between construction operations and routine operations, routine operation activities shall have priority. Take every precaution to avoid interfering with routine transfer station operation and maintenance. Reschedule construction operations, if required, without change to the contract price and time to completion.
- .3 Give sixty (60) working days written advance notice for any station shutdowns where the construction schedule requires that a portion of the existing works be taken out of service to facilitate construction. The City and Engineer will review the proposed timing for impact on station. Fifteen (15) working days prior to the planned shutdown contractor shall provide detailed plan incorporating the proposed construction methods, procedure and contingency plans. Shutdowns are subject to operational constraints within the transfer station.
- .4 Notification of shutdown requests shall be made in accordance with procedures outlined hereinafter.
- .5 The Contractor shall perform all restorative works such as, but not limited to: open doors, check for power, apply working grounds, and all similar restorative work.
- .6 The hours of operation, for this contract, are to be between 6 AM to 6 PM., Monday to Friday continuously; excluding Statutory Holidays. If required, submit a request in writing to the Engineer for approval to complete work outside normal working hours. Approval of this request is at the sole discretion of the Engineer.

1.3 LIMITATIONS OF CONSTRUCTION AND SCHEDULING CONSTRAINTS

- .1 No existing system shall be disconnected or otherwise made inoperable until all replacement equipment and material are on site and verified by the Engineer, complete with approved contingency plan and equipment.

1.4 SCHEDULING REQUIREMENTS

- .1 Submit a detailed work plan, showing schedule and “fall-back” dates, detailed coordination of all subtrades required, listing of personnel assigned, scheduled duration for each activity. Provide contingency plan in case of failure to meet the shutdown duration limit.
 - .1 Indicate all shut down periods.
 - .2 Indicate duration of any temporary work or facilities.
- .2 Allow minimum two (2) weeks for review and comment by the City and the Engineer. If work cannot commence on either the scheduled or fall back date, reschedule at no extra cost to the City.
- .3 Obtain approval of the detailed work plan from the City and Engineer before commencement of work.
- .4 Due to the critical nature of the facility, work shall be performed in minimum time, as per the initial schedule agreed upon. Costs due to lack of planning, organization, assigned manpower or effort will not be accepted.
- .5 All new work shall successfully operate at normal load under normal conditions for 72 continuous hours, and passed all associated testing, before proceeding with the next sequenced phased work.

1.5 UTILITY COORDINATION AND NOTIFICATION

- .1 Coordinate the Work with the various utilities noted below within the Site. Notify the applicable utilities prior to commencing the Work and, if damage occurs, or if conflicts or emergencies arise during the performance of the Work.
- .2 Power
 - .1 Agency and Contact:
 - .2 Work to be performed by the Agency:
 - .1 As shown on the Contract Drawings.
 - .3 Work to be performed by the Contractor:

- .1 As shown on the Contract Drawings and specified in the Contract Documents.
- .4 The City will be responsible for the payment of any direct charges to Toronto Hydro Electric System Ltd. for the permanent service to the Site.
- .3 Gas
 - .1 Agency and Contact:
 - .2 Work to be performed by the Agency:
 - .1 As shown on the Contract Drawings.
 - .3 Work to be performed by the Contractor:
 - .1 As shown on the Contract Drawings and specified in the Contract Documents.
 - .4 The City will be responsible for the payment of any direct charges to Enbridge Gas Inc. for the permanent service to the Site.
- .4 Notify, and coordinate with, all other utilities as necessary for the completion of the Work.
- .5 Coordinate with all utilities to ensure their availability on Site to suit the Contractor's schedule. The Contractor shall adjust its schedule, at no cost to the City, to suit the availability of the utility companies.

1.6 COORDINATION OF TRADES

- .1 Coordinate architectural, mechanical, electrical and structural work for equipment being installed; provide openings and embedments in existing walls and structures for pipes and conduits. Cut and make good, or excavate and backfill, as required and in a timely manner so that the work proceeds expeditiously.
- .2 Control equipment and wiring systems, specified or shown on electrical drawings for electrically operated equipment, are designed for the mechanical equipment as specified or as may be necessary for future requirements.
- .3 Should the Contractor wish to provide mechanical equipment requiring changes to electrical equipment, wiring or associated raceways, bear any extra expense for such changes to the electrical control equipment or wiring systems if such mechanical equipment is accepted by the Engineer.
- .4 The various divisions of these specifications have not necessarily been segregated into sub-trades or sub-contracts. It shall be the responsibility of the Contractor to define the scope of work required for each sub-trade.

- .5 Extras will not be considered based on differences of interpretation of the specifications, or work relating to a specific task appearing in several divisions with relation to which trade shall supply and install certain items or materials. Such coordination is entirely the responsibility of the Contractor.

1.7 COOPERATION WITH OTHER CONTRACTORS

- .1 Other contracts may be awarded to construct adjacent work to which this contract work connects.
- .2 At the interface with other contracts, jointly plan and coordinate with other contractors the work so that the project:
 - .1 Will not be delayed.
 - .2 Will not be endangered in any way.
 - .3 Will be correctly connected.

1.8 EXISTING DIMENSIONS

- .1 Existing dimensions shown on the Drawings are based on existing record drawings and, as such, are only approximate. Verify existing dimensions and details in the field before commencing new work. Report discrepancies to Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

Request for Equipment Shutdown

To:

Date:

Project No:

Request for Shutdown No:

Attention:

Project:

Reason for Shutdown:

Equipment to be Shut down:

Requested Date of Shutdown:

*Alternate Date of
Shutdown:*

Requested Time of Shutdown:

*Alternate Time of
Shutdown:*

**Anticipated Duration of
Shutdown:**

**Anticipated Completion of
Shutdown:**

Safety Procedures:		

Description of Activities:		

Assigned Personnel:

**Your response to this request for shutdown is
required by:**

Shutdown Acceptable:	
Alternate Shutdown Acceptable:	
Request for Shutdown Denied:	

Consultant	City

Reason for Denial:

Proposed Reschedule Date:

END OF SECTION

**SECTION 01050
FIELD ENGINEERING**

PART 1 GENERAL.....1

1.1 INTENT OF SECTION.....1

1.2 PRE-CONSTRUCTION AND POST-CONSTRUCTION SURVEY1

PART 2 PRODUCTS (NOT USED)1

PART 3 EXECUTION (NOT USED)1

**SECTION 01050
FIELD ENGINEERING**

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section includes activities required to document pre-existing and post construction conditions of the work, and to determine and manage damage caused by the Contractor.

1.2 PRE-CONSTRUCTION AND POST-CONSTRUCTION SURVEY

- .1 Prior to commencing any on-site construction activities or post-construction activities, the Contractor shall carry out the following pre-construction and post-construction surveys.
 - .1 This project is located within existing urban areas of the City of Toronto, and as such consideration must be given to the surrounding area and other facilities. The Contractor shall notify their insurance company in writing, with a copy to the Contract Administrator, of the requirement that the Contractor and Insurer undertake a condition survey of the work area and associated structures.
 - .2 The pre-construction and post-construction condition survey shall be carried out on all key areas of the existing transfer station, structures and surfaces within the vicinity of the proposed construction. The key areas are listed below but are not limited to:
 - .1 The existing pavement and curbs.
 - .2 The Quonset Hut.
 - .3 The Contractor shall provide a bound report including photos to the satisfaction of the Contract Administrator. The photos shall be titled and labeled such that existing locations and conditions are documented. Anything not included in the report shall be considered in normal operating condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01060
REGULATORY REQUIREMENTS

PART 1 GENERAL.....1

1.1 INTENT OF SECTION.....1

1.2 APPLICABLE CODES.....1

1.3 PERMITS, APPROVALS, LICENCES.....1

1.4 SUBMITTALS.....2

PART 2 PRODUCTS (NOT USED)2

PART 3 EXECUTION (NOT USED)2

SECTION 01060 REGULATORY REQUIREMENTS

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section includes requirements relating to approvals from regulatory agencies.

1.2 APPLICABLE CODES

- .1 Comply with the latest edition of the following statutes and codes and all amendments thereto:
 - .1 Occupational Health and Safety Act and Regulations for Construction Projects, covering safety, hazardous materials and Workplace Hazardous Material Information Ontario.
 - .2 The Ontario Building Code Act and Regulations.
 - .3 The Energy Act – Provincial Hydro Electrical Safety Codes and Bulletins, CSA Certification Standards and Electrical Bulletins.
 - .4 Ontario Regulation made pursuant to the Power Corporation Act regarding the Electrical Safety Code.
 - .5 Environmental Protection Act, Ontario Regulation 309.
 - .6 Codes and Standards of the National Fire Protection Association (NFPA).
 - .7 Ontario Electrical Safety Code (OESC).
 - .8 Toronto Hydro Electric System Limited (THESL).
 - .9 Technical Standards and Safety Authority.
 - .10 Ontario Fire Code.
 - .11 Toronto Municipal Code Chapter 629, Property Standards.
 - .12 Ministry of Environment Ontario Drinking Water Quality Standards.

1.3 PERMITS, APPROVALS, LICENCES

- .1 The Contractor shall arrange for all inspections required, including but not limited to the following parties:
 - .1 Electrical supply authorities.

- .2 Electrical Safety Authority (ESA).
- .2 The Consultant will:
 - .1 Obtain Building Permit.
 - .2 Obtain Electrical Safety Authority Plan Approvals, refer to Section 16010 “General Requirements”.
 - .3 Provide a set of contract drawings and specifications for each application, if required.
 - .4 Include the Contractor as an Approved Individual in the application packages so they can receive the building permit and coordinate inspection with ESA and TSSA.
- .3 The Contractor shall arrange for regular inspections and a final inspection, not limited to the following:
 - .1 City of Toronto Building Department.
 - .2 The Electrical Safety Authority.
 - .3 Technical Standards and Safety Authority (as required).

1.4 SUBMITTALS

- .1 Submit a copy of all permit applications.
- .2 Submit a copy of all inspection reports.
- .3 Submit certificates of approval from all inspecting authorities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01092
ABBREVIATIONS

PART 1 GENERAL.....1

1.1 ABBREVIATIONS.....1

PART 2 PRODUCTS (NOT USED)5

PART 3 EXECUTION (NOT USED)5

SECTION 01092 ABBREVIATIONS

PART 1 GENERAL

1.1 ABBREVIATIONS

- .1 When the following abbreviations are used in the contract documents, they have the meaning listed.
- | | | |
|-----|--------|--|
| .1 | AA | Aluminum Association (USA) |
| .2 | AAMA | American Architectural Manufacturers Association (USA) |
| .3 | AASHO | American Association of State Highway Officials |
| .4 | ACI | American Concrete Institute |
| .5 | AHA | American Hardboard Association |
| .6 | AICS | American Institute of Steel Construction |
| .7 | AISI | American Iron and Steel Institute |
| .8 | AITC | American Institute of Timber Construction |
| .9 | AMCA | Air Movement and Control Association Inc. |
| .10 | ANSI | American National Standards Institute |
| .11 | API | American Petroleum Institute |
| .12 | ARI | Air Conditioning and Refrigeration Institute |
| .13 | ASHRAE | America Society of Heating, Refrigeration and Air Conditioning Engineers |
| .14 | ASA | American Standards Association |
| .15 | ASME | American Society of Mechanical Engineers |
| .16 | ASTM | American Society for Testing & Materials |
| .17 | AWCI | Association of the Wall and Ceiling Industries |
| .18 | AWI | Architectural Woodwork Institute (USA) |
| .19 | AWMAC | Architectural Woodwork Manufacturer's Association of Canada |

.20	AWS	American Welding Society
.21	AWWA	American Water Works Association
.22	BCLMA	British Columbia Lumber Manufacturers' Association
.23	BTS	Bermondsey Transfer Station
.24	CCA	Canadian Construction Association
.25	CCDC	Canadian Construction Documents Committee
.26	CEC	Canadian Electrical Code (published by CSA)
.27	CETL	Canadian Edison Testing Laboratories
.28	CFFM	Canadian Forces Fire Marshal
.29	CGA	Canadian Gas Association
.30	CGSB	Canadian General Standards Board
.31	CISC	Canadian Institute of Steel Construction
.32	CITC	Canadian Institute of Timber Construction
.33	CLA	Canadian Lumberman's Association
.34	CMB	Construction Materials Board
.35	CMHC	Canadian Mortgage and Housing Corporation
.36	COFI	Council of Forest Industries of British Columbia
.37	CPCI	Canadian Prestressed Concrete Institute
.38	CPMA	Canadian Paint Manufacturers Association
.39	CRCA	Canadian Roofing Contractors' Association
.40	CS	Commercial Standard (USDC)
.41	CSA	Canadian Standards Association
.42	CSC	Construction Specifications Canada
.43	CSDFMA	Canadian Steel Door and Frame Manufacturing Association
.44	CSI	Construction Specifications Institute (USA)

.45	CSPI	Corrugated Steel Pipe Institute
.46	CSSBI	Canadian Sheet Steel Building Institute
.47	CWC	Canadian Wood Council
.48	CEC	The Consulting Engineering Group (USA)
.49	EEMAC	Electrical and Electronic Manufacturers' Association of Canada
.50	ESA	Electrical Safety Authority
.51	FCC	Fire Commissioner of Canada
.52	FM	Factory Mutual
.53	FS	Federal Specifications and/or Federal Standards (USA)
.54	ICPI	Interlocking Concrete Pavement Institute
.55	IEEE	Institute of Electrical and Electronics Engineers
.56	ISA	The Instrumentation, Systems and Automation Society
.57	MIL	Military Specifications (Naval Publications and Forms Center) (USA)
.58	MECP	Ministry of the Environment, Conservation and Parks.
.59	MTC	Ministry of Transportation and Communications (Ontario)
.60	MTO	Ministry of Transportation Ontario.
.61	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
.62	NAAMM	National Association of Architectural Metal Manufacturers
.63	NBC	National Building Code
.64	NBFU	National Board of Fire Underwriters (USA)
.65	NBS	National Bureau of Standards (USDC)
.66	NFC	National Fire Code.
.67	NEMA	National Electrical Manufacturers Association
.68	NFPA	National Fire Protection Association (USA)

.69	NFSA	National Fire Sprinkler Association
.70	NHLA	National Hardwood Lumber Association (USA)
.71	NLGA	National Lumber Grades Authority
.72	NRC	National Research Council of Canada
.73	NSC	National Standards of Canada
.74	NSF	National Sanitary Foundation
.75	OBC	Ontario Building Code 'The Building Code', Ontario Regulation, including amendments thereto.
.76	OESC	Ontario Electrical Safety Code
.77	OFC	Ontario Fire Code, 'The Fire Code', Ontario Regulation, including amendments thereto.
.78	OFM	Ontario Fire Marshal
.79	OIRCA	Ontario Industrial Roofing Contractors Association
.80	OPSS	Ontario Provincial Standard Specification
.81	PEI	Porcelain Enamel Institute (USA)
.82	PCI	Prestressed Concrete Institute
.83	QPL	Qualification Program List
.84	RRV	Richview Reservoir
.85	SAE	Society of Automotive Engineers
.86	SCC	Standards Council of Canada
.87	SJI	Steel Joist Institute
.88	SMACNA	Sheet Metal and Air Conditioning Contractors' National Association,
.89	SSPC	Structural Steel Painting Council
.90	TTMAC	Terrazzo, Tile and Marble Association of Canada
.91	USDC	United States Department of Commerce
.92	UL	Underwriters' Laboratories

.93	ULC	Underwriter Laboratories of Canada
.94	ULI	Underwriter Laboratories Incorporated (USA)
.95	USACE	United States Army Corps Engineers
.96	UNS	Unified Numbering System for Metals and Alloys (ASTM, SAE)
.97	WH	Warnock Hersey
.98	WPCF	Water Pollution Control Federation

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01100
SPECIAL PROCEDURES**

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**SECTION 01100
SPECIAL PROCEDURES**

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section includes permits and procedures which are to be followed by the Contractor during the completion of the Works.

1.2 GENERAL

- .1 Contractor to provide proof of training and/or certificates for staff working on site for the following:
 - .1 Confined Space Entry
 - .2 Working at Height
 - .3 WHMIS
 - .4 Asbestos Awareness
 - .5 Hot Work and Red Tag Permit
- .2 The Contractor is responsible for obtaining a Hot Work Permit, for all works completed in the transfer station.
- .3 The Contractor is responsible for the safeguarding of all material, buildings, equipment and work on the Contract. Any security measures required are at the Contractors own expense.
- .4 Provide protective measures for material, work and equipment as necessary or as directed by the Engineer.

1.3 HOT WORK PERMIT

- .1 Observe rules of City Safe Working Procedure SP 13.
- .2 Prior to starting work that requires welding, cutting, open flame or heat in hazardous or confined locations, or on and around heavy equipment, ensure a Hot Work Permit is issued in accordance with SP 13, included under the Information for Tenderers. Heavy equipment includes: bulldozers, tractor-trailers, trucks, earth moving equipment.
- .3 Copies of Safe Working Procedure SP 13 and a sample Hot Work Permit are appended to and form part of this Section. Ensure that all Contractor and subcontractor staff are familiar with the requirement of the Procedure prior to commencing work.

1.4 HOT WORK AND RED TAG PERMIT TRAINING

- .1 All Contractor forces, including sub-contractors, performing work under this Contract are required to have successfully completed “Managing Impairments Using FM Global’s Red Tag Permit System” (if any work involves, or is to be done on any fire protection system: exception - a fire detection system, if it is not a part of a fire protection system, i.e. it is not used to trip a gaseous suppression or sprinkler system) and/or “Managing Hot Work Using FM Global’s Hot Work Permit System”, as applicable to the scope of work.
- .2 In order to successfully complete the training, a grade of 80% is required. Contractor and sub-contractor staff must be re-certified every three years.
- .3 Each session requires less than one hour to complete, and the system can be accessed 24 hours a day, seven days a week from any computer connected to the Internet. No downloading is required. There is no limit to the number of people that can register.
- .4 To register, visit <http://training.fmglobal.com>. Note: Once enrolled for one course you are automatically enrolled for all courses. A copy of FM Global Online Training Guide is attached for reference.
- .5 Enter “City of Toronto” and the location of the City facility into the Job Title sign-up window so that FM Global can confirm Contractor is a City contractor.
- .6 Please allow 24 hours for confirmation of contractor authorization.
- .7 This is a mandatory requirement of the Contract and applicable work shall only be performed by those who have successfully completed the course.
- .8 Upon request by the City, either before commencement of the work or at any time throughout the duration of the Contract, Contractor shall submit written certificates confirming that Contractor and sub-contractor staff have successfully completed the applicable training session(s).

1.5 CONFINED SPACE PROCEDURES

- .1 Observe the rules of Safe Working Procedure SP 09 – Confined Space Entry.
- .2 The Contractor shall complete the following forms for each confined space entry:
 - .1 Confined Space Hazard Assessment (SP 09e).
 - .2 Confined Space Entry Control Plan (SP 09b).
 - .3 Confined Space Entry Permit and Rescue Plan (SP 09a).
- .3 A copy of all completed forms are to be kept on site. The Contractor shall provide the City a copy of the forms upon request.

- .4 A copy of the Safe Working Procedure SP 09, SP 09a, SP 09b and SP 09e are attached. Ensure that all Contractor and sub-contractor staff are familiar with the attached procedures prior to commencing work in a confined space.

1.6 CONTINGENCY PLAN

- .1 Prior to commencing construction, prepare a contingency plan for the control and cleanup of a spill. The contingency plan to include:
 - .1 The names and the telephone numbers of the persons in the local municipalities to be notified in the event of a spill.
 - .2 The names and the telephone numbers of the representatives of the fire, the police and the health departments of the local municipalities who are responsible to respond to emergency situations.
 - .3 The names and the telephone numbers of the companies experienced in the control and cleanup of hazardous material that would be called upon in an emergency involving a spill.
 - .4 The Contractor's proposal for the immediate containment and control of the spill.
 - .5 The name and the telephone number to the Contractor's representative responsible for preparing, implementing, directing, and supervising the contingency plant.
 - .6 Ensure the immediate availability of the products with which to effect temporary repair to broken pipelines and other services so the spill or other emission of a pollutant is immediately controlled and stopped and to mitigate the damages.
- .2 Submit for the Engineer's review and the review of other responsible parties a copy of the Contingency Plan and make appropriate changes to it based on review comments received.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01300
SUBMITTALS

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SECTION 01300 SUBMITTALS

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section defines the submittals required before, during and after construction, which include, but not limited to the following:
 - .1 Total Lump Sum Tender Price Breakdown.
 - .2 Payment Schedule and Payment Draws.
 - .3 Construction schedule showing critical path.
 - .4 Detailed Construction Workplan.
 - .5 Schedule of Submittals.
 - .6 Location and details of temporary works.
 - .7 Shop drawings and Samples.
 - .8 Operations and Maintenance Manual.
 - .9 Tests and Reports and Inspection Certificates.
 - .10 Training.
 - .11 Record Drawings.
- .2 Submittals shall be provided electronically, or where required physical submissions shall be provided. Submittals by facsimile transmission (fax) will not be acceptable.

1.2 TENDER PRICE BREAKDOWN

- .1 Submit within fourteen (14) days of signing the contract, a complete breakdown of the total lump sum tender price by base scope tasks. If in the sole opinion of the Engineer the breakdown is unbalanced or front-end loaded the breakdown will not be accepted. No payment applications will be processed until an acceptable tender price breakdown has been submitted.
- .2 This breakdown will be used for progress payment draws. As such, the breakdown will be subject to the review of the Engineer.

1.3 PAYMENT SCHEDULE

- .1 Within fourteen (14) days of receiving the Order to Commence work, submit a proposed payment schedule.

- .2 The schedule shall show the estimated value of each monthly application for payment to be submitted by the Contractor during the construction period and shall be correlated with the construction schedule.

1.4 CONSTRUCTION SHUTDOWN AND SUBMITTALS SCHEDULES

- .1 Within fourteen (14) days of receiving the order to commence work, submit one (1) copy of each construction schedule to the Engineer for review. Update schedules as required. Submit with the construction schedule a schedule of submittals. All submittals during the contract should be accounted for in this schedule of submittals.
- .2 Show the proposed progress and dates for submittal acceptance of the main items, structures and subtrades of the Contract in a clear, graphical manner in weekly stages.
- .3 The schedule must show critical path and float times, (critical path must be identified in a contrasting colour (red) from the other activities), as well as all tie-ins and shutdowns. The schedule shall be predicated on the completion of all work on or before the date of completion stated in the Form of Tender, and noted hereinafter.
- .4 Include the following in the schedule as a minimum:
 - .1 Mobilization and other preliminary activities.
 - .2 Obtaining permits.
 - .3 Shop Drawing Register with anticipated submission dates.
 - .4 Early procurement activities for long lead time items.
 - .5 Construction sequence, phases, constraints, and milestones.
 - .6 Delivery dates for major equipment items.
 - .7 Civil, structural, architectural, building services, electrical, and instrumentation and control work.
 - .8 Interfaces with work provided by the City and others.
 - .9 Startup and testing activities for equipment and systems.
 - .10 Commissioning and training activities.
 - .11 Contract closeout activities.
 - .12 Demobilization.
 - .13 Progress Completion (tracking).

- .5 Submit one (1) copy of the revised construction schedule every four (4) weeks.
- .6 Every two (2) weeks, submit to the Engineer a planning aid showing the major construction activities expected to occur during the following two (2) weeks.
- .7 The Engineer reserves the right to alter the manner or time for carrying out any portion of the works if he deems it in the City's interest to do so and no claim for extra payment will be considered due to additional work or delay resulting from such order.
- .8 Except for approved shutdowns, all station process operations must be maintained in operation without interruption throughout the period of this Contract. Co-operate to the fullest extent with the City's operating staff to achieve this, and schedule the work in accordance with these requirements. The detailed construction schedule shall show the date and duration of each of the proposed operations, utilities and services shutdown required. No deviation from this schedule will be permitted without having first obtained the written approval from the Engineer. Facility Operations take priority in cases where a process must be returned to operation due to critical /emergency situations.
- .9 The necessity of keeping the existing works in operation throughout the course of the Contract will require, in some instances that construction be carried out outside of normal working periods or in several stages of short duration. No extra payment in excess of the Contractor's Tendered Lump Sum will be made for the execution of such work.
- .10 Schedule and co-ordinate work in accordance with the requirements of Section 01040, Coordination.
- .11 Plan the work such that several connections can be made during any one shutdown and work continuously to complete the connections, etc. in order to keep the down time of the equipment to an absolute minimum. Where shutdown duration are specifically listed, show by means of a detailed sequence of events, how the work is to proceed, including utilization of available equipment and personnel throughout the shutdown. Where possible, coordinate alternate disciplines to carry out shutdown controlled work during the same shutdowns.

1.5 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- .1 Submit shop drawings, product data and samples requested by Engineer and where called for in other sections of the specifications.
- .2 Do not proceed with work until relevant submissions are reviewed by Engineer.
- .3 Present shop drawings, correspondence, data and specifications in SI Metric units.
- .4 Include in every shop drawing submission, a copy of the relevant specification section, with addendum updates included, and all referenced and applicable

sections. Check-mark each paragraph to indicate compliance with the specification or mark otherwise to indicate requested deviations from specified requirements. Check marks (✓) denote full compliance with a paragraph in its entirety. If deviations from the specifications are indicated, underline each point of deviation and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance with the specified requirements. Provide in the submittal a detailed, written justification for each deviation.

- .5 Notify Engineer, in writing, when resubmitting any revisions other than those requested by Engineer.
- .6 Submit shop drawings depicting material, equipment, erection diagrams and all other items to be incorporated into the Work.
- .7 Maintain a complete Shop Drawing Register showing the review status of all shop drawings on the Work. Provide the Engineer with a copy of to this record on a weekly basis.
- .8 Submit shop drawings to the Engineer for review with a Transmittal Form as reviewed by the Engineer. This Transmittal Form is a multi-part form. Type or print the appropriate information on the form to fully describe the drawings being sent for review. Retain one (1) copy of the form for filing and record purposes before drawings are sent to the Engineer.
- .9 The Contractor will submit electronic version of the shop drawings for review. The Engineer and City reserve the right to request a hard copy version of a shop drawing submission, should it be deemed necessary. When requested, the contractor shall supply one (1) hard copy.
- .10 Identify each shop drawing giving references such as:
 - .1 Provide a separate transmittal for each separate drawing.
 - .2 All sections of the Specifications pertaining to the submission.
 - .3 Location where equipment or material is to be installed.
 - .4 Name of sub-contractor or supplier.
 - .5 Title of drawing and date.
- .11 Contractor shall review and initial all shop drawings before submission to Engineer to confirm conformance to the specification. Shop drawings will not be reviewed, and will be returned and considered rejected, unless they have been previously checked and initialled by Contractor.
- .12 Make corrections or changes required by Engineer, and re-submit revised drawings.

- .13 Do not make changes to shop drawings after final review without written permission of Engineer.
- .14 The Contractor will allow fifteen (15) working days for the Engineer's review of each submission.
- .15 Submission of "Approved Equal" or alternative products will require additional time and review costs. The City may deduct from the contract price the additional engineering fees required to review the proposed alternative product. This will be done for each review/submission. Prior to submission as a shop drawing, all alternative product requests must have been submitted to the Engineer via the RFI process and approval granted.

1.6 PRODUCT DATA

- .1 An electronic shop drawing submittal process is to be utilized. Details of the shop drawing submission and return procedure will be communicated to the contractor at the commencement of the construction contract.
- .2 The Engineer and City reserve the right to request a hard copy version of a shop drawings submission, should it be deemed necessary. When requested, the contractor shall supply one (1) hard copy.
- .3 Shop drawing submission shall include as a minimum; product data sheets or brochures for requirements requested in specification Sections and as the Engineer may reasonably request where shop drawings will not be prepared due to standardized manufacture of product.
- .4 Where product data sheets are for multiple product sizes, materials, etc. Contractor is to clearly mark which products are being provided on the product data sheets.

1.7 ENGINEER'S REVIEW

- .1 This review by the Engineer is for the sole purpose of ascertaining conformance with the general design concept. This review will not mean that the Engineer approves the detail design inherent in the shop drawings. The responsibility for this will remain with the Contractor, and such review will not relieve the Contractor of his responsibility for errors or omissions in the shop drawings of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job-site, for information that pertains solely to fabrication processes or techniques of construction and installation and for coordination of the work of all sub-trades.
- .2 Review of drawings and specifications will, in every case, be subject to final acceptance of the equipment and materials after they have been put into commission, all guarantees have been fulfilled, and the general operation of the equipment and materials has been found satisfactory to the Engineer.

- .3 Review does not release Contractor of responsibility for the proper installation and performance of any material or equipment nor from the liability to replace same should it prove defective or deficient.
- .4 No order will be given for such work and such work will not proceed unless drawings have been returned marked either “Reviewed” or “Reviewed as Modified”.
- .5 Engineer will review and return shop drawings to the Contractor within fifteen (15) working days. No claims for delay will be entertained if review extends beyond this time.
- .6 For a given shop drawing, the Engineer will review each submission twice; once to provide initial comments and a second review to ensure comments are addressed in full. Should submissions beyond the first two (2) be required to provide sufficient clarity and detail, the Engineer shall reserve the right to reduce the progress draw payment for the period in which the additional shop drawing submission was reviewed by a fee of \$2,000, for each submission that was required beyond the first two (2). Upon completion of the contract, a credit shall be given to the City which shall reduce the contract amount by the total of all fees incurred. No claims for delay will be entertained if the justification given for the delay is any particular shop drawing requiring review more than two (2) times.
- .7 Following review by the Engineer, the shop drawing will be returned the Contractor marked with one (1) or more of the following notations:
 - .1 “REVIEWED” – The Contractor will make and distribute additional copies as required for execution of the Work. This procedure will not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the Contract.
 - .2 “REVIEWED AS MODIFIED” – The Contractor will make the necessary revisions and distribute additional copies as required for execution of the Work. This procedure will not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the Contract. Any mark-ups noted during the review period will be included on the final equipment shop drawing and included in the contractors close out documentation (e.g., O&M Manual).
 - .3 “REVISE AND RESUBMIT” – The Contractor will make the necessary revisions and resubmit revised drawings for review. Revised drawings will bear the drawing number of the first such drawing submittal and show the latest revision number applicable to the drawing by adding a suffix to the drawing number as – “REV. 1”, “REV. 2”, etc.
 - .4 “NOT REVIEWED” – This notation will be used separately to indicate when the Engineer has not reviewed the drawing. It may also be used in combination with the notation to revise and resubmit the drawing where

the Engineer lacks sufficient information to complete his review and requires the Contractor to resubmit the drawing for review after revision or further review by the Contractor.

1.8 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples as to origin and intended use in the Work.
- .2 Deliver samples prepaid to engineers design office.
- .3 Notify the Engineer in writing at the time of submission of deviations in samples from requirements of Contract Documents.

1.9 PERMITS TEST REPORTS AND INSPECTION CERTIFICATES

- .1 Refer to Section 01060, Regulatory Requirements for permitting.
- .2 All test reports, inspection certificates and start-up documentation shall be submitted to the Engineer for all new equipment prior to the Contractor requesting final inspection by the Engineer and bringing the equipment into service.

1.10 INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

- .1 Submit Installation, Operation and Maintenance Manuals in accordance with Section 01430 – Operation and Maintenance Manuals.

1.11 TRAINING – LESSON PLANS

- .1 Submit lesson plans and training materials in accordance with Section 01830 – Training.

1.12 AS-BUILT DRAWINGS

- .1 The Engineer will provide two (2) sets of full size ('D' – 24 in. x 36 in.) whiteprints for "As-Built" Drawing purposes.
- .2 Maintain project "As-Built" Drawings and record accurately all deviations from Drawings caused by site conditions and changes ordered by the Engineer.
- .3 Preservation:
 - .1 Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
 - .2 Make documents and samples available at all times for observation by the Engineer.
- .4 Making Entries on Drawings:

- .1 On one (1) set of whiteprints, using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
- .2 Date entries.
- .3 Call attention to entry by “cloud” drawn around area or areas affected.
- .4 Mark “As-Built” changes in red, on one (1) set of whiteprints.
- .5 Legibly mark to record actual changes made during construction, including, but not limited to:
 - .1 Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
 - .2 Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
 - .3 Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
 - .4 Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
 - .5 Relocation of electrical or process piping, valving, etc.
 - .6 Other significant deviations, which are concealed in construction and cannot be identified by visual inspection.
 - .7 Changes made by Addenda and Field Orders, Work Change Directive and Change Orders as per General Conditions, Written Amendment, and the Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
- .6 Dimensions on Schematic Layouts: Show on “As-Built” drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
 - .1 Clearly identify the item by accurate note such as “cast iron drain,” “galv. water,” and the like.
 - .2 Show, by symbol or note, vertical location of item (“under slab,” “in ceiling plenum,” “exposed,” and the like).

- .3 Make identification so descriptive that it may be related reliably to Specifications.
- .5 Prior to submitting, neatly transfer “As-Built” documentation to the second set of whiteprints using fine, red marker. Neatly print lettering and number in size to match original. Lines may be drawn free-hand, but shall be neat and accurate. Add at each Drawing Title Block Note: “AS-BUILT”. Also, circle on List of Drawings each title and number of Drawing marked with “AS-BUILT”.
- .6 Submit this second set of “As-Built” Drawings to the Engineer along with a scanned full size colour PDF of all drawings.
- .7 Substantial performance will not be issued until the As-Built drawings have been approved by the Engineer.

1.1 RECORD DRAWINGS

- .1 Provide two (2) sets of record Drawings for all Work completed by Contractor which require design by a Professional Engineer under the Contractors Work.
- .2 Record Drawings as defined by PEO’s document “Use of the Professional Engineer’s Seal”.
- .3 Prior to applying for Substantial Performance, provide two (2) sets of record Drawings to engineer

1.2 MONTHLY REVIEW

- .1 On site As-Built will be reviewed by the Engineer on a Monthly basis to ensure they are up to date and accurately reflect the work that has been carried out on site.
- .2 Review and acceptance of the As-Built shall be a condition of the first and subsequent payments to the Contractor.

1.3 PROFESSIONAL ENGINEER DESIGN

- .1 Where specifications require professional engineer design, such engineer is required to be registered in the related discipline in the Province of Ontario, unless otherwise accepted by the Engineer in writing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01310
PROJECT MANAGEMENT AND CO-ORDINATION

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SECTION 01310
PROJECT MANAGEMENT AND CO-ORDINATION

PART 1 GENERAL

1.1 DESCRIPTION

- .1 Co-ordination of progress schedules, submittals, use of site, temporary utilities, construction facilities, operations and construction Work, under the instructions of the Engineer.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

- .1 All Divisions and Sections are related to this Section.

1.3 CONSTRUCTION ORGANIZATION AND PRECONSTRUCTION MEETING

- .1 Within 10 working days after award of Contract, the Engineer will request a preconstruction meeting to discuss and resolve administrative procedures and responsibilities.
- .2 Attendance required:
 - .1 Contractor's Superintendent
 - .2 Engineer/Resident Inspector
 - .3 City's Project Manager
 - .4 Others as appropriate
- .3 The Engineer will establish a time and location for the meeting and notify concerned parties a minimum of 5 working days before the meeting.
- .4 The Agenda for the meeting is to include the following:
 - .1 Health and Safety.
 - .2 Appointment of official representative for participants in Work.
 - .3 Schedule of Work, progress scheduling, and permit status.
 - .4 Schedule of submission of shop drawings, samples, and colour chips.
 - .5 Temporary facilities, site sign, offices, storage sheds, utilities, and fences.
 - .6 Delivery schedule of specified equipment.
 - .7 Site security.

- .8 Proposed changes, change orders, procedures, approvals required, and administrative requirements.
- .9 Record drawings.
- .10 Maintenance.
- .11 Monthly progress claims, administrative procedures, photographs, and holdbacks.
- .12 Appointment of inspection and testing agencies or firms.
- .13 Insurances and transcript of policies.
- .5 Comply with Engineer's allocation of mobilization areas on the site for field offices and sheds, for access, traffic, and parking facilities including temporary utilities.
- .6 During construction, co-ordinate use of site and facilities through Engineer's procedures for intra-project communications, Submittals, reports and records, schedules, co-ordination of drawings, recommendations, and resolution of ambiguities and conflicts.

1.4 SCHEDULES MANAGEMENT

- .1 Submit to the Engineer within 10 working days of award of the Contract, the preliminary construction progress schedule, based on the tender and all required schedules.
- .2 After review by the Engineer, revise and resubmit all schedules to comply with revised project schedule.
- .3 Identify and track all critical items on all schedules and advise the Engineer of any changes to the schedules.
- .4 Actively manage and co-ordinate the work to avoid delays against reviewed schedules.
- .5 Revise schedules, reorganize and replace construction to minimize the impact of any identified delays.

1.5 CO-ORDINATION OF CONSTRUCTION

- .1 This is a lump sum contract to be completed in its entirety by the Contractor using the Contractor's own forces or the forces of individual subcontractors and subtrades.

- .2 All of the specifications and drawings shall be interpreted as one contract and the Contractor shall be wholly responsible for co-ordination of all work by the Contractor's own forces, subtrades or subcontractors to complete the work.
- .3 No Section or Division of these specifications shall be construed or interpreted as being the responsibility of any subtrade, subcontractor or supplier.
- .4 The Contractor shall examine the work of all trades and ensure that conditions are satisfactory for the completion of any subsequent work.
- .5 The Contractor shall notify the Engineer immediately of any adverse conditions which may affect subsequent work and shall not proceed with any subsequent work until such conditions are rectified.

1.6 CONSTRUCTION PROGRESS MEETINGS

- .1 During the course of the work and 10 working days prior to project substantial performance, the Engineer will schedule biweekly progress meetings.
- .2 The Engineer will distribute written notice of each meeting two (2) working days in advance of meeting date to the City, Contractor and other parties as required.
- .3 The Contractor will provide physical space and make arrangements for meetings.
- .4 Attendance required:
 - .1 Contractor's Superintendent.
 - .2 Engineer/Resident Inspector.
 - .3 City's Project Manager.
 - .4 Others as appropriate.
- .5 The Engineer is to record minutes of meetings and circulate these to attending parties and affected parties not in attendance within five (5) working days after meeting.
- .6 The Agenda for the meeting is to include the following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Review of Excess Soil Management Requirements, Permit and Approvals.
 - .4 Field observations, problems, and conflicts.

- .5 Problems that impede construction schedule.
- .6 Review of off-site fabrication delivery schedules.
- .7 Corrective measures and procedures to regain projected schedule.
- .8 Revision to construction schedule.
- .9 Progress schedule, during succeeding work period.
- .10 Review of submittal schedules.
- .11 Maintenance of quality standards.
- .12 Review proposed changes for effect on construction schedule and on completion date.
- .13 Other business.
- .7 Representatives of Contractor attending meeting should be thoroughly informed and knowledgeable with respect to proposed topic of discussion and authorized to act and make commitments with respect to matters agreed at meeting.

1.7 SUBMITTALS

- .1 Make all necessary submittals to the Engineer for review.
- .2 Submit preliminary shop drawings, product data and for review for compliance with Contract Documents; for field dimensions and clearances, for relation to available space, and for relation to the work of other contracts. After review, revise and resubmit by transmittal to the Engineer.
- .3 Submit all requests for payment to the Engineer.
- .4 Submit requests for interpretation of Contract Documents and obtain instructions to the Engineer.
- .5 Submit requests for Contract Change Directives to the Engineer.
- .6 Deliver all closeout submittals to the Engineer.

1.8 CO-ORDINATION DRAWINGS

- .1 Provide information required by the Engineer for preparation of co-ordination drawings.
- .2 Review and approve revised drawings for submittal to the Engineer.

1.9 CLOSEOUT PROCEDURES

- .1 Notify the Engineer in writing when the works are considered ready for the pre-initial operation Engineer's Inspection.
- .2 Accompany the Engineer on a preliminary inspection of the work to identify and confirm items for completion or correction.
- .3 Allow 5 working days from the date of notification to the first day of joint preliminary inspection.
- .4 Comply with the Engineer's written instructions for completion or correction of items prior to issuance of Certificate of Substantial Performance.
- .5 Complete all outstanding items of work or deficiencies identified in the Certificate of Substantial Performance in a timely manner as agreed with the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01320
CONSTRUCTION PROGRESS DOCUMENTATION

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SECTION 01320
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section outlines requirements for construction progress documentation.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

- .1 All divisions and sections are related to this Section.

1.3 SCHEDULES REQUIRED

- .1 Submit schedules as follows:
 - .1 Construction Progress Schedule.
 - .2 Submittal Schedule for Shop Drawings and Product Data.
 - .3 Submittal Schedule for Samples.
 - .4 Product Delivery Schedule.

1.4 FORMAT

- .1 Prepare schedules in the form of a horizontal bar chart.
- .2 Provide a separate bar for each major item of work or operation.
- .3 Split horizontally for projected and actual performance.
- .4 Provide horizontal time scale identifying first work day of each week.

1.5 SUBMISSION

- .1 Submit schedules for review within 10 working days after award of the Contract.
- .2 Submit two (2) copies to be retained by the Engineer.
- .3 The Engineer will review the schedules and return one reviewed copy within five (5) working days after receipt.
- .4 Resubmit finalized schedules to the Engineer within five (5) working days after return of the reviewed copy.
- .5 Submit revised progress schedule with each application for payment.
- .6 Distribute copies of revised schedule to:

- .1 Site office.
- .2 Other concerned parties.
- .7 Submission and review of the schedules shall be a condition of the first payment to the Contractor.
- .8 Instruct recipients to report to the Contractor within 10 working days, any problems anticipated by the timetable shown in the schedule.
- .9 The construction progress schedule shall clearly show the proposed progress on the main items of the Contract and shall indicate where applicable the labour, construction crews, plant and equipment to be employed.
- .10 The construction progress schedule shall indicate contract procurement activities for all major equipment with a delivery period longer than four (4) weeks.
- .11 The Engineer may require the Contractor to revise the construction progress schedule at any time where the actual work is at variance with the schedule. Revised schedules shall highlight any variance from the original schedule and indicate steps taken to meet the scheduled completion date. Four (4) copies of the revised construction progress schedule shall be submitted to the Engineer.
- .12 The Contractor shall be deemed to have included in the schedules for all reviews and approvals by the Engineer and other Agencies having jurisdiction and all operational testing, including I/O signal checks and plant computer program installation, in accordance with the sequence of construction and as outlined herein.

1.6 PROGRESS PHOTOGRAPHS

- .1 Take construction progress photographs delineating the status of the Works every week and submit to the Engineer along with every two-week look-ahead schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01400
QUALITY CONTROL**

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SECTION 01400 QUALITY CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section outlines the Contract requirements in regards to quality control during the construction of the required works.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

- .1 All divisions and sections are related to this Section.

1.3 GENERAL

- .1 Design workmanship and materials used for structures to comply with:
 - .1 Ontario Building Code.
 - .2 Building By-Laws of the City.
 - .3 National Building Code of Canada.
- .2 Where reference is made to a Standard or Standard Specification, latest revision at time of tender closing will apply.
- .3 Remove from site all materials rejected after delivery.
- .4 Adhere to manufacturer's recommendations with respect to handling, preparation, installation, testing, operation or protection of any product or material to be incorporated in work.
- .5 Ensure that all materials supplied are compatible with each other unless specific adjacent materials have been specified. Correct any defective work caused by non-compatibility of materials.

1.4 SUBMITTALS

- .1 Submit to Engineer full information on materials equipment, and related arrangements to be furnished.
- .2 Submit information in accordance with Section 01300 – Submittals.
- .3 Submit sufficient information to enable Engineer to determine whether proposed materials, equipment and arrangements meet contract requirements.

1.5 INSPECTION

- .1 Allow the Engineer access to the Works at all times. If part of Work is in preparation at locations other than the job site, allow access to such work whenever it is in progress.
- .2 All materials supplied by the Contractor are to be subject to review and inspection by the Engineer at the time of delivery and prior to installation or placement.
- .3 All work done by the Contractor will be subject to the inspection of the Engineer and all defective work repaired or replaced as directed.
- .4 Give timely notice requesting inspection if work is designated for special tests, inspections or reviews by the Engineer instructions.
- .5 If the Contractor covers or permits to be covered, work that has been designated for special tests, inspections or reviews before such is made, uncover such work, have inspections or tests satisfactorily completed and make good such work.
- .6 The Engineer may order any part of the Works to be examined if work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such work and pay cost of examination and correction.

1.6 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to the Works, off-site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

1.7 PROCEDURES

- .1 Notify appropriate agency and the Engineer in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.8 REJECTED WORK

- .1 Remove defective work, whether a result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by the Engineer as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.

- .2 Make good other contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of the Engineer it is not expedient to correct defective work or work not performed in accordance with the Contract Documents, the City may deduct from Contract Price difference in value between work performed and that called for by Contract Documents, amount of which shall be determined by the Engineer.

1.9 TESTS AND MIX DESIGNS

- .1 Furnish test results and mix designs as may be requested.
- .2 The cost of tests and mix designs beyond those called for in Contract Documents shall be appraised by the Engineer and may be authorized as recoverable.

1.10 MILL TESTS

- .1 Submit mill test certificates as required of Specifications Sections.

1.11 EQUIPMENT AND SYSTEMS

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

1.12 WORKMANSHIP

- .1 The quality of the workmanship and materials shall be first class and the Works shall present a neat and attractive appearance when finished.
- .2 If ordered by the Engineer, the Contractor shall make enough openings in the Works and/or materials as are necessary to inspect the works.
- .3 Should the Engineer find the work and/or materials so opened up to be faulty in any respect, the Contractor shall remove and make good all defective work and/or materials and shall bear the expense of all such opening, inspecting, and making good.
- .4 Should the Engineer find the work and/or materials so opened up to be in acceptable condition, the expense of such opening and closing will be borne by the Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01430
OPERATION AND MAINTENANCE MANUALS

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SECTION 01430
OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section outlines the process to be followed in the preparation of Operation & Maintenance Manuals, and defines the deliverables.

1.2 DEFINITIONS

- .1 Maintenance Operation: Any routine operation, including applicable testing checklists, required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.3 QUALITY ASSURANCE

- .1 Manuals for equipment and systems shall be prepared by equipment manufacturer or system Supplier.


1.4 SUBMITTAL PROCEDURE

- .1 Preliminary Manuals:
 - .1 Submit three (3) copies for Engineer's review prior to shipment date of equipment.
 - .2 If no exceptions are taken:
 - .1 One (1) copy will be returned to Contractor.
 - .2 One (1) copy will be retained in Engineer's file.
 - .3 One (1) copy will be retained by the City.
 - .4 Submit three (3) copies of Final Manual.
 - .3 If exceptions are noted requiring resubmittal:
 - .1 Two (2) copies will be returned to Contractor with comment sheet for revision.
 - .2 One (1) copy will be retained in Engineer's file.
 - .3 Resubmit three (3) copies revised Preliminary Manual for Engineer's review.
 - .4 Repeat until no exceptions are taken.

- .2 Final Manuals:
 - .1 Submit three (3) copies, not less than 30 days prior to equipment of system field testing or startup.
 - .2 If no exceptions are taken with the Final Manuals, Contractor will be so notified. Submit additional three (3) copies to Engineer.
 - .3 If exceptions are noted requiring resubmission, and at Engineer's option:
 - .1 All copies will be returned to Contractor for revision, or;
 - .2 All copies will be retained by Engineer and the necessary revision data will be requested from Contractor.
 - .4 Three (3) complete Final Manuals are required at Substantial Completion.

1.5 GENERAL

- .1 In addition to the Manual format listed below, provide a full digital manual in “PDF” format on a USB stick (thumb drive). Include the USB stick in the front sleeve of each hardcopy submission.
- .2 Manual Format:
 - .1 Size: 8-1/2 inches by 11 inches.
 - .2 Paper: 20-pound minimum, white for typed pages.
 - .3 Text: Manufacturer's printed data, or neatly typewritten.
 - .4 Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
 - .5 Provide tabbed dividers for each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.
 - .6 Provide each manual with title page, and typed table of contents with consecutive page numbers. Place table of contents for entire set, identified by volume number, in each binder.
 - .7 Cover: Identify each volume as shown in the typical cover sheet below.

 <p>THE CITY OF TORONTO</p> <p>DISTRICT OPERATIONS</p> <p>XXXXXXX TRANSFER STATION</p> <p>STATION ADDRESS</p> <p>OPERATIONS & MAINTENANCE MANUAL</p> <p>MONTH YEAR Revision 1.0</p> <p>Prepared by ABC COMPANY LTD.</p>

- .8 Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.
- .9 Binders:
 - .1 Preliminary Manuals: Heavy paper covers, or binders.
 - .2 Final Manuals: Commercial quality, substantial, permanent, three-ring or three-post binders with durable, white, cleanable, plastic binders.
 - .3 Maximum post width: 3 inches.
- .10 Table of contents neatly typewritten, arranged in a systematic order:
 - .1 Contractor, name of responsible principal, address, and telephone number.
 - .2 List of each product required to be included, indexed to content of each volume.
 - .3 List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
 - .1 Identify area of responsibility of each.

- .2 Provide local source of supply for parts and replacement.
- .4 Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
- .11 Product Data:
 - .1 Include only those sheets that are pertinent to specific product.
 - .2 Clearly annotate each sheet to:
 - .1 Identify specific product or part installed.
 - .2 Identify data applicable to installation.
 - .3 Delete references to inapplicable information.
- .12 Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
 - .1 Relations of component parts of equipment and systems.
 - .2 Control and flow diagrams.
 - .3 Coordinate drawings with Project record documents to assure correct illustration of completed installation.
 - .4 Do not use Project record documents as maintenance manual drawings.
 - .5 Provide reinforced punched binder tab, bind in with text.
 - .6 Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
 - .7 Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
 - .8 Identify Specification section and product on Drawings and envelopes.
- .13 Instructions and Procedures: Within text, as required to supplement product data.
 - .1 Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.

- .2 Organize in a consistent format under separate heading for each different procedure.
- .3 Provide a logical sequence of instructions for each procedure.
- .4 Provide information sheet for City's personnel, including:
 - .1 Proper procedures in the event of failure.
 - .2 Instances that might affect the validity of warranties or Bonds.

1.6 MANUALS FOR EQUIPMENT AND SYSTEMS

- .1 Content for Each Unit (or Common Units) and System:
 - .1 Description of unit and component parts, including controls, accessories, and appurtenances:
 - .1 Function, normal operating characteristics, and limiting conditions.
 - .2 Performance curves, engineering data, nameplate data, and tests.
 - .3 Complete nomenclature and commercial number of replaceable parts.
 - .2 Operating Procedures:
 - .1 Startup, break-in, routine, and normal operating instructions.
 - .2 Test procedures and results of factory tests where required.
 - .3 Regulation, control, stopping, and emergency instructions.
 - .4 Description of operation sequence by control manufacturer.
 - .5 Shutdown instructions for both short and extended durations.
 - .6 Summer and winter operating instructions, as applicable.
 - .7 Safety precautions.
 - .8 Special operating instructions.
 - .9 Installation instructions.
 - .3 Maintenance and Overhaul Procedures:
 - .1 Routine operations.

- .2 Guide to troubleshooting.
- .3 Disassembly, removal, repair, reinstallation, and reassembly.
- .4 Installation Instructions: Including alignment, adjusting, calibrating, and checking.
- .5 Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
- .6 Spare parts ordering instructions.
- .7 Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
- .8 Manufacturer's printed operating and maintenance instructions.
- .9 As-installed, color-coded piping diagrams.
- .10 Charts of valve tag numbers, with the location and function of each valve.
- .2 Content for Each Electric or Electronic Item or System:
 - .1 Description of Unit and Component Parts:
 - .1 Function, normal operating characteristics, and limiting conditions.
 - .2 Performance curves, engineering data, nameplate data, and tests.
 - .3 Complete nomenclature and commercial number of replaceable parts.
 - .4 Interconnection wiring diagrams, including all control and lighting systems.
 - .2 Circuit Directories of Panelboards:
 - .1 Electrical service.
 - .2 Controls.
 - .3 Communications.
 - .3 List of electrical relay settings, and control and alarm contact settings.
 - .4 Electrical interconnection wiring diagram, including control and lighting systems.
 - .5 As-built control diagrams by control manufacturer.

- .6 Operating Procedures:
 - .1 Routine and normal operating instructions.
 - .2 Sequences required.
 - .3 Safety precautions.
 - .4 Special operating instructions.
- .7 Maintenance Procedures:
 - .1 Routine operations.
 - .2 Guide to troubleshooting.
 - .3 Adjustment and checking.
 - .4 List of relay settings, control and alarm contact settings.
- .8 Manufacturer's printed operating and maintenance instructions.
- .9 List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
- .3 Maintenance Summary:
 - .1 Compile an individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or subunits.
 - .2 Format:
 - .1 Use Maintenance Summary Form bound at the end of this section, or an electronic facsimile of such.
 - .2 Each Maintenance Summary may take as many pages as required.
 - .3 Use only 8-1/2-inch by 11-inch size paper.
 - .4 Complete using typewriter or electronic printing.
 - .3 Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
 - .4 Recommended Spare Parts:
 - .1 Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.

- .2 “Unit” is the unit of measure for ordering the part.
- .3 “Quantity” is the number of units recommended.
- .4 “Unit Cost” is the current purchase price.

1.7 SUPPLEMENTS

- .1 The supplements listed below, following “END OF SECTION”, are part of this Specification.
 - .1 Forms: Maintenance Summary Form.

1.8 WMS EQUIPMENT INFORMATION DATABASE

- .1 Contractor to fill in all fields as identified in the WMS spreadsheet template provided in the package, for each piece of equipment supplied under this contract, including spare parts. An excel spreadsheet version will be supplied to the Contractor at the start of the project.
- .2 Contractor to submit draft and final versions of the WMS Equipment Information Database as part of the O&M manual submissions for review.
- .3 Refer to Section 13040.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

a. Name _____ Telephone No. _____

b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Standard Oil	Gulf	Arco	Or Equal
List symbols used in No. 7. above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR CITY’S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01505
MOBILIZATION AND DEMOBILIZATION

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PART 3	EXECUTION (NOT USED)	2

SECTION 01505
MOBILIZATION AND DEMOBILIZATION

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This Section specifies requirements of mobilizing and demobilizing at the Site.

1.2 MOBILIZATION

- .1 Mobilization includes the work required under Sections of Division 1 that must be performed prior to or at the start of the Contract. This includes but is not limited to:
 - .1 Obtaining certificates from all Utility Companies or Departments having facilities in the area of proposed work, confirming that a stake out of existing utilities has been done or indicating that there are no such services in the area of proposed work.
 - .2 Appointing a representative, and informing the Consultant for the purposes of Public Relations and Notices.
 - .3 Submitting of a construction schedule.
 - .4 Locating and confirming all survey control points.
 - .5 Submitting and resubmitting shop drawings, product data and samples.
 - .6 Submitting full information on materials and equipment to be furnished.
 - .7 Clearly marking trees to be preserved.
 - .8 Erecting signs, delineators, barricades and other traffic and warning signs.
 - .9 Erecting project signboards.
- .2 Includes for bringing on Site; workers, equipment, and machinery necessary to undertake the construction of the Works.
- .3 Includes for bringing offices on Site, including the Consultant's field office, and temporary power, telephone and other utilities as specified or required.
- .4 Includes the delivery, acceptance and storage of the materials necessary for initiating construction of the Works.

1.3 DEMOBILIZATION

- .1 Generally, demobilization covers the work required under Division 2 to Division 16, to be performed near the end or after completion of the construction. This includes but is not limited to:
 - .1 Disconnection of all temporary utilities and removal of offices and temporary facilities for the Site.
 - .2 Removal of project signs and supporting framework.
 - .3 Reinstate all disturbed areas during construction to original, better or specified condition.

1.4 BASIS OF PAYMENT

- .1 Sixty percent (60%) of the price bid for this item will be allowed for mobilization with the balance to demobilization.
- .2 Payment for mobilization will be included into the first progress payment certificate.
- .3 The Consultant may allow only a partial payment to reflect the degree to which mobilization has been carried out.
- .4 Payment for demobilization will be in full upon completion. The Engineer may allow only a partial payment for demobilization.
- .5 Should the completion of the work be delayed, the Engineer may allow only a partial payment for demobilization to reflect the degree to which demobilization has been carried out.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01535
TEMPORARY FACILITIES**

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1.6	TEMPORARY BUILDINGS	2
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PART 3	EXECUTION (NOT USED)	6

**SECTION 01535
TEMPORARY FACILITIES**

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section specifies requirements for construction facilities not incorporated into the final or permanent work.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- .1 Temporary Controls: Section 01560.

1.3 GENERAL

- .1 Furnish, install and maintain temporary facilities required for construction of works.
- .2 Temporary building will be located as shown on Contract Drawings as approved by the Engineer.
- .3 Remove temporary facilities upon Substantial Completion of Contract or when directed by the Engineer.

1.4 ACCESS TO THE SITE FOR CONSTRUCTION DELIVERIES

- .1 Space on the sites is limited. Construction deliveries and equipment are to be off-loaded and removed from the parking areas and/or driveway without delay.
- .2 Coordinate all deliveries so that all required equipment for unloading is present at the site at the time of delivery.
- .3 Provide a minimum of 48 hours' notice of any deliveries to the Contract Administrator.
 - .1 Coordinate delivery schedules through the Contract Administrator to meet the requirements of the City's operations personnel working from all sites.
- .4 The Contract Administrator will not accept deliveries of any construction materials on behalf of the Contractor.

1.5 ACCESS TO THE SITE FOR CONSTRUCTION PERSONNEL

- .1 Access to the site for construction personnel is also used by other contractors, Engineer, the Contract Administrator, the City, and Toronto Hydro.
- .2 The Contractor's personnel, subcontractors and all engaged parties related to the scope of this contract must sign in and out daily at the City's Shift Supervisor Office.

- .3 Contractor's personnel are to park vehicles as directed by the Contract Administrator. If sufficient space is not available in the parking lot, arrange for parking elsewhere at no additional cost to the City. Do not park construction vehicles, equipment or cars on roads or grass areas within the site.
- .4 Access into the site and exit from the site for construction personnel is restricted. All contractor's personnel shall have positive visual identification and shall produce said identification whenever asked by the Contract Administrator or City staff. Any person without valid identification will be removed from the site. No additional cost shall be incurred by the City for persons removed from site. Contractor personnel shall be logged on and off site and a log book maintained and made available by the Contractor for review by the Contract Administrator as required. A daily sheet maintained by the Contractor shall be provided to the Contract Administrator at the beginning and end of each day.

1.6 TEMPORARY BUILDINGS

- .1 Provide one (1) Field Office for the Engineer at the location approved by Engineer, for the start of mobilization.
- .2 Keep temporary buildings clean and free from nuisance so as not to become a danger to adjoining facilities or to form grounds for complaints from adjacent property owners.
- .3 Furnish and maintain satisfactory weathertight structures with raised floors as may be required to adequately protect those materials stored on site, which may otherwise be damaged by the weather.
- .4 Relocate as necessary or as directed by the Engineer.
- .5 Provide remotely monitored security system and service for all temporary buildings for the duration of the contract.

1.7 TEMPORARY UTILITIES

- .1 Provide all temporary internet, drinking water, power and lighting systems required during construction. Provide all necessary cables, panelboards, outlets and enclosures.
- .2 Make all necessary applications, obtain permits and pay for all fees and charges for service and use.
- .3 Provide each field office with high-speed internet access. Provide one (1) internet jack and wireless router. All costs associated with the internet to be paid for by the Contractor.
- .4 Temporary power and light system subject to the inspection and approval of local Hydro authority.

- .5 The maximum temporary power available will be 600VAC 60A.

1.8 FIRST AID FACILITIES

- .1 Provide and maintain on-site completely equipped first-aid facilities in a clean and orderly condition, and readily accessible to all staff at all times.
- .2 Designate certain employees who are properly instructed to be in charge of first-aid. At least one such employee will always be available on the site while work is being carried on.
- .3 Conspicuously post telephone call lists for summoning aid, such as doctors, ambulances, rescue squads, etc.
- .4 Furnish facilities and equipment as required by the Workplace Safety and Insurance Act and the Ministry of Labour.

1.9 SANITARY FACILITIES

- .1 Provide sufficient sanitary facilities in accordance with the MOL requirements for all persons employed on Contract subject to approval of type, size and location by the local health authorities, the Ontario Ministry of Environment, Conservation and Parks, and the Engineer.
- .2 Maintain facilities with all required toilet room supplies in a clean and sanitary condition and disinfect frequently.
- .3 Prohibit the committing of sanitary nuisance on the site.
- .4 Provide at the Contractor's expense an adequate, hygienic, warm, comfortable shelter, accessible during the meal hours and inclement weather, to all workers employed on the Work, its location to be approved by the Engineer.
- .5 Remove any contaminated soil and replace with fresh clean material. Leave site in a clean sanitary condition.

1.10 ENGINEER'S FIELD OFFICE

- .1 Provide all materials for and fully erect and service field office for the exclusive use of the Engineer and his staff. The office or, as an alternative, an approved type of trailer, will be a windproof, insulated and watertight structure lined with suitable panelling, conforming with the specified dimensions and layout approved by the Engineer. The height from the floor to the ceiling shall not be less than 2400 mm. Included within this field office shall be rooms for a Senior Site Inspector (10 m²), a Site Inspector (10 m²), and Assistant/Visitor (10 m²), a meeting area (11 m²), and washroom facilities (7 m²) for a total plan area of at least 48 m². If required, separate trailers for the meeting area and washroom facilities may be provided. The building(s) shall be provided with at least two exterior doors.

- .2 Provide the following furnishings and equipment for the duration of the Contract, which will remain the property of the Contractor at the end of the Contract:
 - .1 1.0 x 2.5 m flat table and eight (8) stacking chairs.
 - .2 1.0 x 2.5 m sloping plan table.
 - .3 One (1) drafting stool (710 mm high).
 - .4 One (1) double pedestal desk with keys.
 - .5 One (1) swivel type office chair.
 - .6 One (1) wastepaper basket.
 - .7 One (1) three-tier steel bookcase.
 - .8 One (1) standard four drawer legal-size lockable steel filing cabinet with three (3) sets of keys.
 - .9 One (1) 11 cubic foot compact fridge.
 - .10 One (1) 1.1 cubic foot 1100 W microwave.
 - .11 Provide one (1) all-in-one printing system complete with copying and scanning functions with 11 inches x 17 inches and color capabilities.
- .3 Provide heated washroom facilities in field office with hot and cold water, exhaust fan and maintain a supply of paper towels and toilet tissue.
- .4 Provide adequate road access and parking facilities for two (2) cars with a satisfactory wearing surface. Parking is for the sole use of the Engineer and City's staff. Provide a walkway from the office door to the parking area and keep both free of mud and snow.
- .5 Include fluorescent ceiling lights and other lights, switches, electrical outlets, medicine cabinet with mirror, first-aid kit, window shades, window with screens, and door with screens to the satisfaction of the Engineer.
- .6 Provide heating system to maintain a temperature of 20°C at outside temperatures of -20°C to the satisfaction of the Engineer.
- .7 Provide cooling system to maintain a temperature of 22°C at outside temperatures of 35°C to the satisfaction of the Engineer.
- .8 Provide Janitor Services once per week.

- .9 Provide maintenance for all computer equipment, printers, photocopiers, fax machines for the duration of the contract. Provide all required paper, ink cartridges, toner, etc. for all machines.
- .10 Provide and maintain the field offices and conveniences for engineer at least until 45 days from the date of publication of the substantial performance certificate.
- .11 Provide a lockable main door with four (4) sets of keys available to the Engineer and the City.
- .12 Use every reasonable precaution to protect the office against fire, theft, or other damage.
- .13 Indemnify the City and its agents against loss by fire, theft or injury to the offices or their contents.
- .14 Provide at least three windows, minimum 2.0 m², opening type with screens, in each field office.
- .15 Contractor is responsible for connecting, maintaining and disconnecting all telephone, electrical, heating and plumbing utilities and any approvals or permits required.
- .16 Remove at the direction of Engineer or City.
- .17 Contractor is responsible for removal of graffiti from trailers.

1.11 CONSTRUCTION PARKING

- .1 Parking will be permitted on Site provided it does not disrupt the performance of Dufferin Transfer Station's daily Operation, and only as permitted by the Engineer.

1.12 FIRE PROTECTION

- .1 Provide and maintain temporary fire protection equipment during performance of the Works required by governing codes, regulations and bylaws.
- .2 The Contractor shall enforce all laws, regulations and bylaws regarding signs, advertisements, fires, and smoking.

1.13 DEICING AGENTS

- .1 Do not use calcium chloride on access roads.
- .2 Prevent contamination of cast-in-place concrete by deicing agents.

1.14 SECURITY

- .1 If latches, doors or other openings leading into the facility are not secure, Contractor is responsible to maintain continuously manned site security.
- .2 It is the Contractor's responsibility to secure materials, tools and equipment. The City is not responsible for providing security services.
- .3 Contractor shall remove graffiti at own cost.

1.15 DISPOSAL OF RUBBISH

- .1 On a daily basis as the Work progresses and on completion, clean up the site rubbish and surplus material resulting from the Work.
- .2 Remove from site all rubbish and surplus material on a weekly basis.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01550
ACCESS ROADS AND PARKING AREAS

PART 1 GENERAL.....1

1.1 RELATED SECTIONS.....1

1.2 INSTALLATION/REMOVAL1

1.3 ACCESS ROADS/ACCESS WALKWAYS1

1.4 ACCESS TO UTILITY INSTALLATIONS.....1

1.5 CONSTRUCTION PARKING1

PART 2 PRODUCTS2

PART 3 EXECUTION2

SECTION 01550
ACCESS ROADS AND PARKING AREAS

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01570 – Temporary Controls.

1.2 INSTALLATION/REMOVAL

- .1 Maintain construction access and parking areas as required.

1.3 ACCESS ROADS/ACCESS WALKWAYS

- .1 Comply with all requirements in Section 01140 – Work Restrictions.
- .2 Provide and maintain adequate access to Site. During entire project timeline, maintain all access roads in the condition that they were found.
- .3 Prior to final inspection, obtain and submit to the Consultant written signed releases from owners of all roads used for Sites access, verifying that roads have been adequately restored and left in a satisfactory condition. Contractor to pay for any damage or mess resulting from contractors' use of on-site or local City-owned roads as related to the associated Contract work.
- .4 Trim loads of trucks hauling excavated material, cement, sand, stone, gravel, debris or other loose material before leaving the site, and ensure that the bodies of such vehicles are tight so that no spillage of loads occurs.
- .5 Road closures must be coordinated with plant operation and maintenance personnel. Contractor to submit traffic management and staging area plans and submit to the City for approval.

1.4 ACCESS TO UTILITY INSTALLATIONS

- .1 Do not obstruct hydrants, valve or control pit covers, valve boxes, curb stop boxes, fire or police call boxes, and all other utility controls, warning systems, and appurtenances.

1.5 CONSTRUCTION PARKING

- .1 Parking will be permitted on Site provided it does not disrupt City's operations and performance of Work, and only as permitted by the Consultant.
- .2 Parking is to be limited to the permitted area shown on Contract Drawings, within the Contract limit of work.

PART 2 PRODUCTS

.1 Not Used

PART 3 EXECUTION

.1 Not Used

END OF SECTION

**SECTION 01560
TEMPORARY CONTROLS**

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1.5	NOTIFICATION OF UTILITIES	1
1.6	EXISTING SERVICES AND STRUCTURES.....	2
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1.8	PROTECTION AGAINST FREEZING	2
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1.15	INFORMATIONAL AND WARNING DEVICES	4
1.16	PROTECTION OF TREES	5
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PART 2	PRODUCTS (NOT USED)	5
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SECTION 01560 TEMPORARY CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section includes temporary controls not incorporated into the final or permanent work.

1.2 GENERAL

- .1 Contractor is responsible for safeguarding of all material, buildings, equipment and work on Contract. Any security measures required are at his own expense.
- .2 Provide adequate measures for the protection of such material, work and equipment as necessary or as directed by the Engineer.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Temporary Facilities: Section 01535

1.4 TEMPORARY FENCING

- .1 Erect a temporary fence around all project areas, as shown on Drawings, for the protection of trees and private property. The use of any areas other than that specified will not to be allowed.
- .2 On completion of the Contract, remove all temporary fences and barriers erected.

1.5 NOTIFICATION OF UTILITIES

- .1 On and off-site locations of various services and utilities are shown to the best available information but no guarantee is given that the locations are absolutely accurate, or that structures or utilities other than those shown are not present.
- .2 Use all necessary precautions to prevent damage to any structure due to water pressure during and after construction and until such structure is accepted and taken over by the City.
- .3 Notify at least 48 hours, or as required by regulations, in writing, with a copy to the Engineer, any and all Authorities and Utility Companies before approaching utility or right of way. This includes work in the vicinity of gas pipelines, oil pipelines, watermains, sewers, telephone lines, electrical power lines and other work or structures connected with these utilities.
- .4 Request owners of all underground services to locate, stake, and clearly mark in field all services that are located on or near line of proposed work.

- .5 Obtain certificates from all Utility Companies or Departments having facilities in area of proposed work certifying that facilities have been marked to confirm utility location.

1.6 EXISTING SERVICES AND STRUCTURES

- .1 Sustain in place and protect from damage any and all gas mains, public or private sewers or drains, conduits, service pipes, sidewalks, curbs and all other structures or property in vicinity of work, whether above or underground.
- .2 Repair immediately all sewers and drains that are broken during construction.
- .3 If gas mains or services are broken, stop flow of gas from pipe and immediately notify utility company who will repair or supervise and inspect repair of damaged main or service.
- .4 Where this Contract joins with existing structures, pipes, etc., carry out work so as not to cause damage to Contractor's work or the existing work.
- .5 Notify Engineer immediately in writing should any drains, connections, sewers, culverts, cables, structures, or any other utility within the limits of this Contract be unexpectedly encountered, and whether these drains, etc., obstruct the proposed work and thus prevent the progress of this contract.
- .6 Prevent dust and dirt from entering existing buildings or areas where equipment is stored or is operating.
- .7 Prevent dust, water or other deleterious substances from entering areas with existing electrical, heating ventilating, pumping and other equipment.
- .8 Where existing wall sections are removed or where pipes are installed through existing walls or where any dust-generating operation is necessary, provide a suitable temporary wall or enclosure suitably reinforced and sealed to prevent dust entering the existing area. When work is completed remove temporary dust control device and thoroughly clean all areas affected by the work.

1.7 NEWLY CONSTRUCTED WORKS

- .1 Protect any newly constructed work from damage.
- .2 Do not wheel or place heavy loads on, and use caution when working with equipment or materials around, any newly constructed works.
- .3 Replace or repair in a manner approved by the Engineer.

1.8 PROTECTION AGAINST FREEZING

- .1 Furnish all necessary equipment and fuel for heating buildings and structures during construction. Maintain a minimum temperature of 10°C in interior areas

for mechanical, electrical, masonry, painting and other work susceptible to frost damage.

- .2 Drain pipelines in trench that may be left exposed in winter. Drain pipelines below concrete slabs or in areas too large to heat practically.
- .3 Refer to other Divisions of these Specifications, as applicable, for detailed cold-weather procedures for cast-in-place concrete, masonry, finishes, mechanical work and electrical work respectively.
- .4 Protect any existing works when exposed.

1.9 DISPOSAL

- .1 Do not empty fuel, lubricants or pesticides into sewers or watercourses.
- .2 Dispose of all construction debris in an approved location.

1.10 CONTAMINATION

- .1 Do not allow contents of any sewer, drain or inlet connection to flow into trench.
- .2 Remove all offensive matter from proximity of work as directed by Engineer.

1.11 USE OF LOCAL ROADS

- .1 Conduct operations on the site so that the use of adjacent roads by vehicles employed under this Contract will not endanger public, pedestrian and vehicular traffic thereon nor hinder the use of such facilities.
- .2 Conduct operations along roads and highways in such a manner that inconveniences and hazards to traffic are minimized.
- .3 Truck and equipment operations on all roads shall be governed by The Highway Traffic Act, local traffic ordinances and regulations of the local Fire, Police, Traffic, and Works Departments.
- .4 Maintain roadways safe for traffic.
- .5 Maintain the cleanliness of adjacent roads and property occupied by Contractor from waste material or refuse resulting from operations to the satisfaction of the Engineer.
- .6 Trucks hauling excavated material, concrete, sand, stone or other loose material to or from the site shall have their loads trimmed and their bodies shall be tight in order that no spillage of their loads will occur.

- .7 Should the Contractor, in the opinion of the Engineer, be negligent in his duties in maintaining proper street cleanliness, the City will arrange the necessary steps to perform such cleaning and shall charge the Contractor all costs therefore.

1.12 ACCESS

- .1 Provide access route for landowners to cross rights-of-way, easements, or temporary work areas during all phases of construction.

1.13 TRAFFIC APPROVALS AND NOTICES

- .1 Obtain approval from Engineer for closing any road to traffic.
- .2 Notify Fire Department, Police Department, Works Department, Engineer and any other necessary authority of approximate times and duration roads will be closed.

1.14 TRAFFIC CONTROL

- .1 Provide all flagmen necessary to direct flow of traffic.
- .2 Provide and maintain traffic and warning signs as required.
- .3 Provide and maintain detours for traffic where required. Mark detours as directed by appropriate road authority, Works Department and Engineer.
- .4 Make arrangements with appropriate authorities if single lane conditions continue past normal working hours.
- .5 Supply and place crushed stone or other material as required on road shoulder to maintain traffic on road shoulders as required.

1.15 INFORMATIONAL AND WARNING DEVICES

- .1 Provide and maintain signs and other devices required to indicate construction activities or other temporary and unusual conditions resulting from project work, which may require road user response.
- .2 Supply and erect signs, delineators, barricades and miscellaneous warning devices as specified by the appropriate authorities.
- .3 Continually maintain traffic control devices in use by:
 - .1 Checking signs daily for legibility, damage, suitability and location. Clean, repair or replace to ensure clarity and reflectance.
 - .2 Removing or covering signs which do not apply to conditions existing from day to day.

1.16 PROTECTION OF TREES

- .1 Protect all trees and plants that are designated to remain including those outside contract limits and easements.
- .2 Clearly mark trees and plants to be preserved to prevent inadvertent damage.
- .3 Erect snow fencing around drip line of trees within working area.
- .4 Do not stockpile material within drip line.
- .5 Do not allow traffic, vehicles or equipment to compact soil within drip line.
- .6 Do not cut tree roots.
- .7 Tunnel under or around roots by hand digging without damaging roots.
- .8 Treat all damaged roots over 25 mm in diameter immediately with approved tree paint.
- .9 Brace trees potentially undermined by trench construction to unaffected trees by means of cables and turnbuckles, for the period of open trench construction.
- .10 Do not cut down any tree or bush without the written permission of the Engineer and/or local Municipality.
- .11 In addition to the above, protection of trees shall follow detail TP-1 and the “Tree Protection Policy and Specification for Construction Near Trees” (July 2016) document by the Parks, Forestry & Recreation, Urban Forestry.

1.17 DAMAGED TREES

- .1 Replace all trees that have been damaged beyond saving.
- .2 Replace trees with similar size and species or as approved by Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01561
ENVIRONMENTAL PROTECTION

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1.7	SPILLS	2
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1.11	REMOVAL AND DISPOSAL OF HAZARDOUS MATERIALS	3
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SECTION 01561
ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section specifies requirements for environmental controls including control of noise, dust, surface water and erosion, various pollution control methods and handling of Designated Substances as well as compliance with the Occupational Health and Safety Act and Site Safety.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

- .1 All Divisions and Sections are related to this Section.

1.3 GENERAL

- .1 Establish and maintain site procedures such that noise levels from construction areas are minimized.
- .2 Control noise level in accordance with local by-laws and Ministry of the Environment (MOE) Standards.
- .3 Prevent dust nuisance resulting from construction operations at all locations on the site.
- .4 Ensure that no mud from trucks gets onto any public streets,

1.4 MEASURES

- .1 Noise Controls:
 - .1 Use vehicles and equipment with efficient muffling devices.
 - .2 Provide and use devices that will minimize noise levels in construction areas.
- .2 Dust Controls:
 - .1 Use water, brine or calcium chloride to control dust.
 - .2 Minimize use of calcium chloride and brine, particularly in close proximity to watercourses, aquifers or agricultural lands.
 - .3 Transport dusty materials in covered haulage vehicles.
 - .4 Public roadways shall be kept clean and free of mud unless closed to through traffic with the permission of the Engineer. In the event that any

public roadways are impacted by dust or mud from the construction site or trucks, the contractor shall be required to clean these in a timely manner, and at a minimum at the end of the day.

1.5 REFUELLING AREAS

- .1 Review all proposed construction areas to plan access routes and fuelling areas. Brows of hills, around sharp curves or at other locations where oncoming traffic would not otherwise have adequate warning.
- .2 Establish suitable fuelling and maintenance areas and obtain approval from the Engineer.
- .3 Do not refuel or maintain equipment adjacent to or in watercourse or over water supply aquifers unless non-spill facilities are used.
- .4 Do not fuel equipment within 30 metres of any watercourse unless otherwise non-spill facilities are used.

1.6 CLEANING EQUIPMENT

- .1 Do not clean equipment in streams.
- .2 Clean construction equipment prior to entering roadways. At a minimum, all construction equipment should be cleaned weekly.
- .3 Do not clean equipment in locations where debris can gain access to sewers, watercourses or aquifers.

1.7 SPILLS

- .1 Submit procedures for interception, rapid clean up and disposal of any spillage that may occur, for the Engineer's review, prior to commencing work.
- .2 Be prepared at all times to intercept, clean-up and dispose of any spillage that may occur whether on land or water.
- .3 Keep all materials required for clean-up of spillages readily accessible on site.
- .4 Report immediately any spills causing damage to the environment to the City of Toronto and the Ministry of Environment and Climate Change 24 hour Environmental Spill Reporting Line (1-800-268-6060).

1.8 USE OF PESTICIDES

- .1 Co-ordinate the use of herbicides, pesticides and fungicides with landowners and occupants and City Pesticides Control Office of the MOECC and obtain all necessary approvals prior to use.

- .2 Obtain approval prior to using any herbicides, pesticides and fungicides within an aquifer protection area.

1.9 SENSITIVE AREAS

- .1 Inform the Engineer in writing of the particular schedule for each river crossing, channelizing or other work in the designated sensitive areas.
- .2 Prohibit encroachment on unique natural areas and establish boundary protection and signage to avoid such encroachment.
- .3 Do not disturb habitats of rare or endangered species. Agree and implement mitigative measures with the Engineer.
- .4 Protect wetland sites used as feeding or breeding areas by migratory fowls or as habitats for other animals and establish boundary protection and signage to avoid such encroachment.
- .5 Schedule construction in sensitive areas so that there will be minimal interference with water uses including fish migration or spawning, or disruption of incubation period of eggs.
- .6 Keep removal of vegetation to a minimum.
- .7 Contain and deposit on land all aquatic plants uprooted or cut prior to or during construction.

1.10 MANAGEMENT AND DISPOSAL OF EXCESS MATERIALS

- .1 The requirements of OPSS 180 shall apply except for the following revision/amendments:
 - .1 Subsection 180.07.02, Conditions on management by Re-Use, shall be amended by the addition of the following: “Recycled hot mix asphalt or excess bituminous pavement shall not be used as trench backfill or bedding.”
 - .2 Subsection 180.07.04, Conditions on Management by Open Burning, shall be deleted. No open burning will be permitted.
 - .3 The City must be given first right of refusal of any excess materials.

1.11 REMOVAL AND DISPOSAL OF HAZARDOUS MATERIALS

- .1 Hazardous materials shall be removed from the site and handled in accordance with MOECC Regulations current at the time of construction.

- .2 Comply with the governing Ministry of Labour Regulations respecting protection of works, remedial handling and disposition of the Designated Substances encountered.
- .3 Prior to commencement of work on or about any Designated Substances, provide written notification to the MOECC of the location(s) proposed for disposal of Designated Substances. Provide a copy of said notification to the Engineer a minimum of ten (10) working days in advance of starting work on or about any Designated Substances.
- .4 In the event that the MOECC has concerns with any proposed disposal location, further notification shall be provided until the MOECC's concerns have been addressed.
- .5 Do not empty fuel, lubricants, herbicides, pesticides, fungicides, paint materials, solvents or other chemicals into sewers or watercourses.

1.12 COMPLIANCE WITH THE OCCUPATIONAL HEALTH AND SAFETY ACT

- .1 It is specifically drawn to the attention of the Contractor that the Occupational Health and Safety Act provides, in addition to other items that:
 - .1 A Constructor shall ensure, on a project undertaken by the Contractor that:
 - .1 The measures and procedures prescribed by this Act and regulations are carried out on the project.
 - .2 Every employer and every worker performing work on the project complies with this Act and the regulations.
 - .3 The health and safety of workers on the project is protected.
 - .4 This Contract is deemed to be an individual project for the purposes of the Occupational Health and Safety Act and the regulations made thereunder and the Contractor to whom the Contract is awarded unequivocally acknowledges that he is the Constructor as defined in the said Act on this project and shall carry out all of the obligations and shall bear all of the responsibilities of the Constructor as set out in the said Act and Regulations.
 - .5 If the Owner is designated as the "Constructor" as a result of the Contractor's actions, all the increases in costs shall be borne by the Contractor.
 - .6 All Occupational Health and Safety Act Regulations for construction projects are to be strictly adhered to.

- .7 The Contractor shall submit a work safety plan detailing safety precautions to be implemented during completion of this Contract. The items detailed shall include, as a minimum:
 - .1 Excavation, shoring, backfill.
 - .2 Valve, Equipment Installations.
 - .3 Concrete formwork, reinforcement installation and concrete casting.
 - .4 Electrical Works.

1.13 FIRES

- .1 Fires and burning of rubbish on-site is not permitted.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01580
PROJECT IDENTIFICATION AND SIGNS

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1.1	CONSTRUCTION SIGN.....	1
PART 2	PRODUCTS	1
PART 3	EXECUTION	1

SECTION 01580
PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.1 CONSTRUCTION SIGN

- .1 Erect, within four (4) weeks of Contract award, one (1) 1200 mm x 1200 mm project sign for each site (two in total for 35 & 75 Vanley Cres), as per City Construction Standards, in the location designated by the Consultant. Signs are to be printed directly on 6 mm alupanel complete with anti-graffiti coating.
- .2 Indicate on sign the name of the project, City, Consultant, Contractor. Proposed sign shall be submitted as a shop drawing for review.
- .3 Maintain signs in good condition for the duration of Work. Clean periodically.
- .4 No other signs or advertisements, other than warning signs, are permitted on site.
- .5 Upon completion of construction, remove the Construction Signs and restore site of sign to match surrounding area and to the satisfaction of the Consultant.

PART 2 PRODUCTS

- .1 Not Used

PART 3 EXECUTION

- .1 Not Used.

END OF SECTION

SECTION 01600
MATERIALS AND EQUIPMENT

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PART 2	PRODUCTS (NOT USED)	3
PART 3	EXECUTION (NOT USED)	3

SECTION 01600 MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section covers articles relating to quality of materials and equipment. Detailed requirements in other Sections of the specification supersede these requirements.

1.2 MATERIALS

- .1 Provide all materials and equipment new.
- .2 Construct and finish work in a workmanlike manner. Provide materials suitable for the service intended, selected and fabricated in accordance with the best engineering and manufacturing practices.
- .3 Design machinery with working parts easily accessible for inspection and repair, easily duplicated and suitable for service intended.
- .4 Protect machined and finished surfaces from corrosion and damage during shipment and installation. Carefully pack machines for shipment and protect electrical equipment from moisture damage. Protect bearings, seals and glands from grit and foreign matter.
- .5 Remove rejected equipment damaged during shipment and replace with new identical equipment.
- .6 Supply all equipment with corrosion-resistant metal nameplates fitted securely in an easily read location complete with impressed type inscriptions giving information as applicable:
- .7 Operate mechanical equipment furnished satisfactorily without excessive wear, excessive lubrication and without requiring undue attention by operating staff.

1.3 INSTALLATION – GENERAL

- .1 Examine site conditions and report unacceptable conditions in writing. Commencing work will imply acceptance of site conditions.
- .2 Promptly remove rejected products from the site and replace with new products.
- .3 Provide calibration reports for each piece of equipment, as applicable, in a format acceptable to the Engineer.

1.4 INSTALLATION OF EQUIPMENT

- .1 Install, calibrate and test equipment in accordance with manufacturer's written instructions and when specified, under supervision of competent experts provided by the equipment manufacturer.
- .2 Erect equipment on foundations complete with suitably sized anchor bolts and take special care to ensure true alignment of all parts. Have qualified millwrights align the units after their sole plates have been shimmed at the anchor bolts. Recheck alignment after securing equipment to its foundation before grouting sole plates in place.
- .3 Erect equipment level and plumb.
- .4 Provide all materials necessary to install equipment. Install piping and miscellaneous items supplied as part of the equipment.
- .5 Manufacturer's instructions are the minimum standard for the installation.

1.5 CLEANLINESS OF WORK

- .1 Keep occupied property and work neat and orderly. Remove all waste, rubbish and debris weekly. Remove equipment, temporary facilities and excess materials from the property when they are no longer needed for progress of the work. After completing the work leave the property neat and orderly.
- .2 After testing leave structures and equipment thoroughly cleaned of debris and foreign matter. Leave pipe systems thoroughly clean and ready for operation.
- .3 Clean installed units and items after adjacent work has been completed.

1.6 EVIDENCE OF CONFORMING TO STANDARD

- .1 Where materials are specified to conform to a standard - for example, reinforcing steel, G30.12 M Grade 400 - provide mill reports, invoices or other statements which certify that materials are in fact to the specified standard.
- .2 Where the Contractor proposes to use materials not manufactured to a standard, provide test reports, which show that the proposed material meets or exceeds the requirements of the specified standard.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Arrange for delivery to the site, and protection of materials and equipment.
 - .1 Schedule delivery of equipment only when building is far enough advanced to protect units from weather and construction dust and debris.

- .2 Provide equipment and labour to unload, move and place units in final position.
- .3 Protect materials and equipment from damage.
- .2 Specification Sections may contain additional requirements for delivery, storage and handling.

1.8 USE OF LIFTING DEVICES

- .1 Contractor is responsible to certify any existing cranes and/or lifting devices before and after use and provide copies of supporting documentation to Engineer.
- .2 Contractor is solely responsible for all repairs required prior to use of the cranes and/or lifting devices at their own cost
- .3 Any repairs requires resulting from use of the cranes and/or lifting devices shall be completed by the contractor at their cost prior to re-certifying the cranes.
- .4 The contractor shall be responsible for arranging any training required for use of the equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01610
BASIC PRODUCT REQUIREMENTS

PART 1 GENERAL.....1

1.1 QUALITY1

1.2 AVAILABILITY.....1

1.3 STORAGE, HANDLING AND PROTECTION2

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SECTION 01610 BASIC PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 QUALITY

- .1 Products, materials, equipment and articles (referred to as Products throughout the specifications) incorporated in Work are to be new, not damaged or defective, and of the best quality (compatible with specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- .2 Products comprised of multiple components, as specified, are to be purchased as a single system from one supplier. Provision of sub-components, as identified on a manufacturer's shop drawings, are to be supplied from the manufacturer. Requests to substitute subcomponents of a system must be made at the time of shop drawing submission. The decision to accept substitution rests strictly with the Consultant.
- .3 Defective Products, whenever identified prior to the completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility but is a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.
- .4 Should any dispute arise as to the quality or fitness of Products, the decision rests strictly with the Consultant.
- .5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the building.
- .6 Permanent labels, trademarks and nameplates on Products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.2 AVAILABILITY

- .1 Immediately upon signing the Contract, review Product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of Products are foreseeable, notify the Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In the event of failure to notify the Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Consultant reserves the right to substitute more readily available products of similar character, at no increase in Contract Amount.

1.3 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in a heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged Products to the satisfaction of the Consultant at no cost to the City.

1.4 TRANSPORTATION

- .1 Pay costs of transportation of Products required in the performance of Work.
- .2 Transportation cost of Products furnished by City will be paid for by the City. Unload, handle and store such Products.

1.5 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected specification Section. Submerged or wetted fasteners are to be stainless steel unless other material is specifically requested in the affected specification Section.
- .4 Space anchors within their load limit or shear capacity and ensure they provide

positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.6 QUANTITIES

.1 Materials indicating quantity and/or dimension, which are shown on the drawings or in the specifications, are intended only to assist Contractor with quantity takeoff. Quantities and dimensions shown therein are not guaranteed to be accurate and must be checked by Contractor prior to placing an order for such materials.

.2 Claims for additional payment resulting from variations between quantities shown on the schedules and those actually installed will not be accepted.

1.7 OWNERSHIP

.1 All materials provided by Contractor for execution of Work will vest in and become the property of City upon delivery to Site, but will remain in the custody and at the risk of Contractor until Final Completion.

PART 2 PRODUCTS

.1 Not Used

PART 3 EXECUTION

.1 Not Used

END OF SECTION

**SECTION 01631
SUBSTITUTIONS**

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SECTION 01631 SUBSTITUTIONS

PART 1 GENERAL

1.1 SUMMARY

- .1 This section covers equivalents and alternatives.

1.2 INTENT

- .1 The Tender shall be based only on products, materials and equipment specified or listed in the Contract documents.

1.3 DEFINITIONS

- .1 "First-Named Supplier" and "First-Named Product" mean, respectively, a Supplier and Product upon which the quality and design of the Work has been based, as specified in the Contract Documents.
- .2 "Equivalent" means a Supplier or Product that is listed after the First-Named Supplier or First-Named in the Contract Documents.
- .3 "Alternative" means a Supplier or Product proposed by the Contractor, or an alternate method of undertaking the Work proposed by the Contractor, that is not listed or specified in the Contract Documents.

1.4 FIRST NAMED AND EQUIVALENT EQUIPMENT AND MATERIAL

- .1 The Total Lump Sum Price Bid offered in the Tender must be based on the first named or one of the other equivalent named products or suppliers listed in the Contract Documents.

Where more than one trade or supplier's name is given, the design, as shown on the Drawings and as specified, has been based on the first name listed.
- .2 The equivalent material and equipment supplied must be equal in quality, material and performance (including maximum and minimum criteria specified or implied) to the material/equipment first named in the specification.
- .3 Any design, detailing, and/or construction changes necessitated by the use of equivalent trade or supplier's names given, are the sole responsibility of the Contractor and shall be at the expense of the Contractor. The Contractor shall be responsible for coordinating these additional requirements assuring the proper fit and matching of all equivalent equipment and materials.

1.5 REQUESTS FOR ALTERNATIVES

- .1 No ruling on a proposed alternative will be made prior to acceptance of a tender. No alternative shall be made without the prior approval of the Consultant. No tender price shall be based on a presumed acceptance by the City of an alternative.

After the acceptance of a tender, the Contractor may apply to the Consultant to review a non-named product or equipment or supplier for approval, as an alternative for the specified product or supplier. All requests for alternatives must be accompanied by a detailed listing of the expected cost saving to the City. The method of payment to the Consultant shall be determined during the Contract Administration and shall be subject to the consensus of the all City, Consultant and Contractor Project Managers. Acceptable payment arrangements may include, but are not limited to, direct payment by the Contractor under a separate subcontract, reimbursement through approved change orders, or other mechanisms mutually agreed upon by the Contractor and the City. The cost for the Consultant's review is to be agreed upon prior to commencing the Consultant's review based on the following process:

- .1 Contractor proposes alternative with information as per the requirements of Section 01631.
- .2 Consultant provides a lump sum engineering fee to Contractor to review the proposed alternative. Details of the fees will not be provided to the Contractor.
- .3 Contractor advises Consultant if Contractor would like Consultant to proceed further.
- .4 Consultant prepares a CCO for engineering fees and submits the CCO to the City for approval. The City approval process may take several weeks to complete. Consultant prepares credit CCO for Contractor to sign.
- .5 Contractor signs CCO and sends to Consultant.
- .6 Consultant issues CCO credit to City.
- .7 City signs CCO.
- .8 Consultant issues executed CCO to Contractor.
- .9 City authorizes Consultant to proceed with the alternative review.
- .10 Consultant starts to review the alternative product.

- .11 Consultant advises Contractor if submission is accepted or fails in accordance with requirements of Section 01631.
- .2 Alternatives shall not be considered when they are indicated or implied on Shop Drawings or product data submittals without a separate written request.
- .3 Requests for alternatives shall include any request for changes from the Contractor that require significant design changes, redesign or significant design reviews.
- .4 A request for alternatives constitutes a representation that the Contractor:
 - .1 Has investigated the proposed product or supplier and determined that it meets or exceeds the quality level of the specified product or supplier.
 - .2 Shall provide the same warranty for the alternative as for the specified product or supplier.
 - .3 Shall coordinate the installation and make changes to other Work which may be required for the Work to be complete at the Contractor's expense and at no additional cost to the City.
 - .4 Waives claims for additional costs or time extension which may subsequently become apparent.
 - .5 Shall reimburse the City for review or redesign services.
 - .6 Request for alternatives shall be made by written application to the Consultant and shall include sufficient data to enable the Consultant to assess the acceptability of requirements, including the following:
 - .1 All submittal information required for the specified equipment, including all deviations from the specified requirements and/or necessitated by the requested substitution.
 - .2 Materials of construction, including material specifications and references.
 - .3 Dimensional drawings, showing required access and clearances, including any changes to the work required to accommodate the proposed substitution.
 - .4 Drawings and details showing changes if the offered alternative necessitates changes to or coordination with other portions of the Work. Perform these changes as part of the alternative material or equipment at no additional cost.

- .5 Certification that the proposed alternative will adequately perform the function and achieve the results called for by the general design, be similar and of equal substance to that specified and be suited to the same use as that specified with the same or better warranty.
 - .6 Information and performance characteristics for all system components and ancillary devices to be furnished as part of the proposed alternative.
 - .7 Illustration of the impact that acceptance of the proposed alternative has on achievement of Substantial Completion.
 - .8 Itemization of all costs including any licenses fee or royalty that shall result directly or indirectly from the acceptance of the proposed alternative. Include redesign and cost of claims of any other contract affected by the resulting change.
 - .9 Credit or cost increase offered if the proposed alternative is accepted and a waiver of claims for additional expenses which may subsequently become apparent.
 - .10 Recommended maintenance requirements and availability of spare parts and service.
 - .11 Written confirmation from Subcontractors and Suppliers on cost, schedule, and technical requirements if requested by the Consultant.
-
- .7 In all cases, the proposed alternative must be justified by the Contractor in its written application to the Consultant indicating reasons why it wishes to substitute and be accompanied by sufficient descriptive and technical information for the Consultant to thoroughly compare articles or group of articles with that specified. Failure to comply with this requirement to the Consultant's satisfaction may result in rejection of the request due to insufficient information or time to evaluate same.
 - .8 Allow sufficient time for evaluation of alternatives.
 - .9 Failure to comply with the requirements under this Section to the City's and Consultant's satisfaction will result in rejection of the request due to insufficient information.
 - .10 All applications and submissions related to alternatives shall only be made by the Contractor and not by any Subcontractors or Suppliers.
 - .11 The acceptance or rejection of the proposed alternative is at the discretion of the City, and the City's decision is final.

- .12 Contractor assumes liabilities and additional costs that may subsequently arise as a result of the accepted alternative.

PART 2 PRODUCTS

- .1 Not Used

PART 3 EXECUTION

- .1 Not Used

END OF SECTION

SECTION 01640
WMS ENTITY INFORMATION WORKSHEET

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SECTION 01640
WMS ENTITY INFORMATION WORKSHEET

PART 1 GENERAL

1.1 SCOPE

- .1 This Section contains requirements for the collection and submission of equipment, or Entity, information in the form of a single Entity Information Worksheet (EIW) that captures information for all equipment under this Contract pertinent to the operation and maintenance of facility equipment and is integral to the City's ability to develop maintenance schedules and manage assets.
- .2 Collect information and provide in the specified format, for all equipment listed in the attached Contract EIW. The specified format is designed to integrate with the City's Work Management System (WMS) database that collects, stores and manages data for asset management purposes.
- .3 The EIW information provided will be utilized by the City to:
 - .1 Facilitate the on-going asset identification and inventory, asset valuation and procurement, and maintenance and lifecycle analysis of equipment provided under this Contract.
 - .2 Assist with maintenance of equipment provided under this Contract to ensure warranty requirements are satisfied.

1.2 DEFINITIONS

- .1 Entity: means a piece of tagged equipment provided under this Contract, and intended to be managed throughout its life cycle.
- .2 Entity Information Worksheet (EIW): means a spreadsheet database that captures information pertinent to the operation and maintenance of equipment provided under this Contract, and used by the City to develop maintenance schedules and manage assets.
- .3 Contract EIW means the EIW developed as part of the design for this Project, supplied as part of the Tender, and to be completed by the Contractor as part of this Contract.
- .4 Sample Completed EIW: means an EIW completed under another similar project and presented as a representative sample of the content required in the final Contract EIW.
- .5 Work Management System (WMS): means a computerized maintenance management system (CMMS) software package used for work planning and scheduling.

- .6 WMS Entity Information Workflow: means a flowchart illustrating the sequence of activities and operations required to develop a complete Entity Information Worksheet from its conception, and the roles played by various parties in completing this sequence for any capital project.
- .7 Original Equipment Manufacturer (OEM): means a firm that manufactures components or parts included in the finished product made by another firm.
- .8 PCS or Process Control System: means a system for real-time monitoring and control of water and wastewater treatment plants, and water supply, and sewage pumping stations by comparing the monitored data to established set points and taking corrective action(s).
- .9 OMU or Operational Maintenance Unit: is an arm of Toronto Water responsible for the standardization of work management and maintenance practices. This group consists of a Reliability Engineering Group and Maintenance Planners and Schedulers.
- .10 ASPOM: means Area Supervisor Plant Operations and Maintenance.

1.3 RELATED SECTIONS

- .1 General Conditions and Divisions 1 to 16 apply to the Work of this Section
- .2 Section 13040 – Equipment and Data Tagging

1.4 APPENDICES

- .1 The Contract EIW is appended to the Contract documents.
 - .1 "Contract 25SWM-IRM-042CDU Entity Information WorkSheet.xls".

1.5 QUALITY ASSURANCE

- .1 The Contract EIW shall have all applicable fields (columns) accurately completed for each record (row) of identified equipment, including spare parts, in accordance with clause 3.12 of Section 13040 – Equipment and Data Tagging.
- .2 Summarize recommended maintenance requirements from Original Equipment Manufacturer (OEM) manuals, or other written documentation from the manufacturer or service representative. Cover all tasks required to meet warranty conditions, and to optimize equipment performance and lifespan.

1.6 RESPONSIBILITIES

- .1 The development of the EIW requires input from several stakeholders, including:
 - .1 Contractor and Subcontractors;

- .2 Consultant and Subconsultants;
 - .3 OMU Reliability Engineering Group;
 - .4 ASPOM; and
 - .5 PCS Group.
- .2 The responsibilities for filling in each column of data in the EIW are provided in the first row of the "Project data Table" of all Tabs of the Contract EIW file provided with this Specification Section, i.e., article 1.4.1.1. In general, the Consultant is responsible for completing all columns in the "General Info" Tab, and the Contractor is responsible for completing all columns in all other Tabs. This is to be used as a guideline for populating the Contract EIW, however, it is ultimately the Contractor's responsibility to develop and maintain an up to date Contract EIW during the course of the Project.
- .3 The responsibilities for the review and approval of the collected data as well as the sequencing of review periods are outlined in the Entity Information Workflow chart attached to this Specification Section.

1.7 SUBMITTALS

- .1 Submit the EIW within 10 Working Days of a returned shop drawing approval with the applicable data for the equipment included in the approved shop drawings.
- .2 The EIW is then to be reviewed and commented on and/or approved within the following 10 Working Days as part of the QA/QC procedure by the Consultant. Complete any subsequent edits requested by the Consultant within 5 Working Days of the request and re-submit to Consultant.
- .3 Submit draft final EIW, approved by the Consultant, within 60 calendar days prior to substantial performance.
- .4 Within 15 Working Days following acceptance of commissioning of any equipment or system, the EIW data previously entered at the shop drawing stage is to be re-examined by the Contractor for accuracy and updates, including edits requested by the Consultant, and re-submitted to the Consultant.
- .5 Within 30 Working Days of the Contractor's post-commissioning review of the EIW data, the Consultant is to perform a QA/QC check and comment and/or approve as necessary.

1.8 MEASUREMENT FOR PAYMENT

- .1 Provide a separate line item in the payment breakdown for Contract EIW submittals.

- .2 Payment for this item will be released based on the percentage of work complete and the lump sum amount assigned to this line item.
- .3 No payment for any work will be made over 90% of the Contract value on this payment item until all documentation for Operations and Maintenance manuals, and WMS documentation are received and accepted as satisfactory by the Consultant.

PART 2 PRODUCTS

2.1 FORMAT AND CONTENT

- .1 Provide all information for all Entities requested according to the format in the Contract EIW supplied at the time of Tender. A Sample Completed EIW is appended to this Section for reference purposes and to demonstrate the level of detail expected in the submission.
- .2 Provide the Contract EIW in Microsoft Excel 2003-2007 format.
- .3 Provide the following information, where applicable, for each Entity identified in the Contract EIW. Conform to the requirements of Section 13040 – Equipment and Data Tagging. In the case of conflict or discrepancy, the requirements of this Section shall govern. Refer to each Entity by its name and tag number.
 - .1 Complete "Procurement Information" columns for all Entities provided.
 - .1 OEM Name: provided by Contractor
 - .2 OEM Address: provided by Contractor
 - .3 OEM Phone Number: provided by Contractor
 - .4 Supplier Name: provided by Contractor
 - .5 Supplier Address: provided by Contractor
 - .6 Supplier Phone Number: provided by Contractor
 - .7 Purchase Order/Contract #: provided by Contractor. This is the Purchase Order, Contract Number, or other identifier issued to the Supplier.
 - .8 Original Cost_1: provided by Contractor
 - .9 Purchase Date: provided by Contractor
 - .10 Model Number / Style: provided by Contractor

- .11 Serial Number: provided by Contractor
- .12 Catalog Number: provided by Contractor
- .13 Original Equipment Number: provided by Contractor
- .14 Manufacture Date: provided by Contractor
- .15 Additional Information: provided by Contractor
- .2 Complete "Motor Add-on" columns for all Entities representing or consisting of electric motor assemblies (e.g., pump-motor set).
 - .1 Motor Function: provided by Contractor
 - .2 Serial Number: provided by Contractor
 - .3 Watts 1 (KW, W): provided by Contractor
 - .4 Watts 2 (KW, W): provided by Contractor
 - .5 Horse Power: provided by Contractor
 - .6 RPM: provided by Contractor
 - .7 AC or DC: provided by Contractor
 - .8 Number of Phases: provided by Contractor
 - .9 Cycles (Hz): provided by Contractor
 - .10 Frame Size: provided by Contractor
 - .11 Frame Type (TEFC, DE, ODP): provided by Contractor
 - .12 Amperage (A, mA): provided by Contractor
 - .13 Voltage: provided by Contractor
 - .14 Voltage Abbreviation: provided by Contractor
 - .15 Inboard Bearing Part #: provided by Contractor
 - .16 Outboard Bearing Part #: provided by Contractor
 - .17 Winding Configuration (Y, Delta): provided by Contractor
 - .18 Type (Ind, Sychr, Series, Shunt): provided by Contractor

- .19 Mount (Horizontal, Vertical): provided by Contractor
- .20 Shaft (Single or Double Output): provided by Contractor
- .21 Weight_1: provided by Contractor
- .22 Additional Nameplate Info – Provided by Contractor
- .3 Complete "Valve Add-on" columns for all Entities representing valves or consisting of valves (e.g., valves, strainers, etc.).
 - .1 Process Application: provided by Contractor
 - .2 Valve Type: provided by Contractor
 - .3 Connection Type: provided by Contractor
 - .4 Valve Size: provided by Contractor
 - .5 Body Type: provided by Contractor
 - .6 Pressure Rating: provided by Contractor
 - .7 Seat Material: provided by Contractor
 - .8 Packing Material/Size: provided by Contractor
 - .9 Interior Coated: provided by Contractor
 - .10 Number of Rotations: provided by Contractor
 - .11 Operator Manufacture: provided by Contractor
 - .12 Operator Type: provided by Contractor
 - .13 Operator Model Number: provided by Contractor
 - .14 Operator Size: provided by Contractor
 - .15 Operating Torque: provided by Contractor
 - .16 Clockwise to Open: provided by Contractor
 - .17 Additional Operator Info: provided by Contractor
 - .18 Actuator Name Plate Info: provided by Contractor
 - .19 Additional Valve Info. provided by Contractor

- .4 Complete "Pump Add-on" columns for all Entities representing or consisting of pump assemblies (e.g., pump-motor set).
 - .1 Flow Rate (L/sec, USgpm, IMgpm, etc.): provided by Contractor
 - .2 Head (M, FT) _1: provided by Contractor
 - .3 RPM: provided by Contractor
 - .4 Suction Diameter_1 (in, mm): provided by Contractor
 - .5 Discharge Diameter_1 (in, mm): provided by Contractor
 - .6 Seal Type (Mech, Packing): provided by Contractor
 - .7 Number of Stages: provided by Contractor
 - .8 Lubrication (oil, grease): provided by Contractor
 - .9 Impeller Diameter_1 (in, mm): provided by Contractor
 - .10 Impeller Sleeve Diameter_1: provided by Contractor
 - .11 Number of Impeller Vanes: provided by Contractor
 - .12 Impeller Material: provided by Contractor
 - .13 Rotation (CW, CCW): provided by Contractor
 - .14 Inboard Bearing Part # / Type: provided by Contractor
 - .15 Outboard Bearing Part # / Type: provided by Contractor
 - .16 Thrust Bearing Part # / Type: provided by Contractor
 - .17 Additional Nameplate Info": provided by Contractor
 - .18 Drive (Direct, Belt or Gear Box): provided by Contractor
 - .19 Coupling Type and Size: provided by Contractor
 - .20 Belt Type and Size: provided by Contractor
- .5 Complete "Heater Add-on" columns for all Entities representing or consisting of heaters.
 - .1 KW Rating: provided by Contractor
 - .2 Voltage Primary: provided by Contractor

- .3 Voltage Primary Abbreviation: provided by Contractor
- .4 Number of Phases: provided by Contractor
- .5 Control Voltage: provided by Contractor
- .6 Control Voltage Abbreviation: provided by Contractor
- .7 Style/Type: provided by Contractor
- .8 Current: provided by Contractor
- .9 Additional Information: provided by Contractor
- .6 Complete "Instrument Add-on" columns for all Entities representing or consisting of instrumentation (e.g., transmitters, analyzers, gauges, etc.).
 - .1 Supply: provided by Contractor
 - .2 Display: provided by Contractor
 - .3 Input: provided by Contractor
 - .4 Output: provided by Contractor
 - .5 Range: provided by Contractor
 - .6 Calibration Range: provided by Contractor
 - .7 Activation Parameter: provided by Contractor
 - .8 Pressure Rating: provided by Contractor
- .7 Complete "HVAC Add-on" columns for all entities representing or consisting of HVAC equipment.
 - .1 Type (Draw-Thru or Blow-Thru): provided by Contractor
 - .2 CFM Rating: provided by Contractor
 - .3 Static Pressure Rating: provided by Contractor
 - .4 Drive (Direct, Belt or Gear Box): provided by Contractor
 - .5 Pulley Dimensions - Motor: provided by Contractor
 - .6 Pulley Dimensions - Fan: provided by Contractor
 - .7 Belt Size and Quantity: provided by Contractor

- .8 Inboard Fan Bearing #: provided by Contractor
- .9 Outboard Fan Bearing #: provided by Contractor
- .10 Coupling Type and Size: provided by Contractor
- .11 Cooling Coil Description: provided by Contractor
- .12 Filter Type Description: provided by Contractor
- .13 Filter Dimensions and #: provided by Contractor
- .14 Evaporator Style: provided by Contractor
- .15 Evaporator Dimensions: provided by Contractor
- .16 Humidification Info. provided by Contractor
- .17 Compressor Name Plate Info. provided by Contractor
- .18 Damper Info. provided by Contractor
- .19 Additional Information: provided by Contractor
- .8 Complete "Breaker Add-on" columns for all Entities representing or consisting of electrical breakers (e.g., control panels with breakers, starters, etc.).
 - .1 Type: provided by Contractor
 - .2 Insulation Medium: provided by Contractor
 - .3 Load Voltage: provided by Contractor
 - .4 Frame Size Amp. provided by Contractor
 - .5 Modular Trip Unit: provided by Contractor
 - .6 Trip Unit Type: provided by Contractor
 - .7 Trip Unit Sensor Rating I_n : provided by Contractor
 - .8 Trip Unit OEM Name: provided by Contractor
 - .9 Trip Unit Model: provided by Contractor
 - .10 Separate CT/PT: provided by Contractor
 - .11 Separate Protection Relay: provided by Contractor

- .9 Complete “Transformer Add-on” columns for all entities representing or consisting of electrical transformers.
 - .1 Primary Voltage (Centre Tap): provided by Contractor
 - .2 Secondary Voltage: provided by Contractor
 - .3 kVA Rating (@max cooling): provided by Contractor
 - .4 % Impedance: provided by Contractor
 - .5 Cooling Type: provided by Contractor
 - .6 Winding Configuration: provided by Contractor
 - .7 Core Construction: provided by Contractor
 - .8 Oil Filled/Dry Type: provided by Contractor
 - .9 Oil Type: provided by Contractor
 - .10 Sudden Pressure relay OEM and Model: provided by Contractor
 - .11 Cable Terminal Type: provided by Contractor
 - .12 NGR Resistance: provided by Contractor
 - .13 NGR Ratings: provided by Contractor
 - .14 Online Gas Monitor Installed: provided by Contractor
- .10 Complete “Starter Add-on” columns for all entities representing or consisting of Electrical Motor Starters or Variable Frequency Drives (VFD).
 - .1 Load Voltage: provided by Contractor
 - .2 Load F.L.A.: provided by Contractor
 - .3 Number of Phases: provided by Contractor
 - .4 Starter - Configuration: provided by Contractor
 - .5 Starter - Starting method: provided by Contractor
 - .6 All Overload Element(s) Type(s): provided by Contractor
 - .7 Respective Overload Element(s) Location(s): provided by Contractor

- .8 Starter Contactor - OEM and Model #: provided by Contractor
- .9 Starter Contactor - Max Amps.: provided by Contractor
- .10 Starter Contactor - Coil Voltage: provided by Contractor
- .11 Contact Insulation Medium (for MV) : provided by Contractor
- .12 Starter Control Transformer VA: provided by Contractor
- .13 Starter Control Fuse - OEM and Catalog No.: provided by Contractor
- .14 Main Fuse - OEM and Catalog No.: provided by Contractor
- .15 μ -Processor Relay - OEM and Model No.: provided by Contractor
- .16 Soft starter - OEM and Model No.: provided by Contractor
- .17 VFD controller - OEM and Model No.: provided by Contractor
- .11 Complete "Recommended Maintenance Based on Manufacturer's Recommendations" columns for all Entities, including the following.
 - .1 "Individual work task title" – provide a task name for the specific maintenance task to be completed (e.g., "Exercise Valve", Replace Gearbox Oil", "Manual Calibration", etc.).
 - .2 "Task Description" – provide detailed task description including:
 - .1 Instructions;
 - .2 Materials required;
 - .3 Tools required; and
 - .4 Safety considerations (e.g., lockout/tagout considerations, PPE requirements).
 - .3 "Trade Requirements" – provide description of trade requirements for each task – including number of tradespersons required (e.g., "2 millwrights").
 - .4 "Estimated Trade Time Requirement" – provide estimate of work time required to complete the maintenance task (e.g., "15 minutes", "2 hours", etc.).

- .5 "Task Frequency" – provide frequency of task to maintain equipment (e.g., "annually", "weekly", "every 6 months", etc.).
- .12 All required Entity cost data shall include the following as individual cost items:
 - .1 Supply cost (i.e., equipment procurement costs) for specialty/custom (higher value) procured equipment (i.e., larger pumps, blowers, tanks, specialty valves, instruments, motors, full skids, UPS). Costs are not required for standard/generic equipment (smaller valves, gauges, off-the-shelf components).

PART 3 EXECUTION

3.1 WMS ENTITY INFORMATION WORKSHEET WORKSHOP[S]

- .1 Attend a WMS EIW Workshop within 15 Working Days of initial set of shop drawing acceptance by Consultant.
- .2 Where the project requires phased testing and start-up activities, meet with Consultant to conduct WMS Entity Information Workshop for equipment items and systems corresponding to the current phase. Where the Project requires a single testing and start-up activity a single WMS Entity Information Workshop will be required.
- .3 The intent of workshop[s] is to ensure all parties involved in the development and review of the EIW have a full understanding of the scope and proper content of data entries, and have an opportunity to discuss:
 - .1 Roles and responsibilities;
 - .2 Schedule and staging; and
 - .3 Methods of maintaining and updating the Contract EIW as the project progresses (e.g., document management system).
- .4 The intent of holding the workshop[s] after the initial set of shop drawings is accepted is to allow the meeting attendees to utilize the accepted Contract shop drawings as examples when reviewing the requirements for populating the Contract EIW.
- .5 The Workshop will be held on Site or virtually. The Consultant will preside at the workshop[s], record minutes and distribute the minutes. The Contractor is responsible for distributing minutes to all Subcontractors and other parties affected by decisions made at the workshop[s].
- .6 Workshop attendance required:

- .1 Contractor's Site Superintendent.
- .2 Contractor's Project Manager.
- .3 Contractor's Start-up Manager.
- .4 Consultant's representatives.
- .5 City's Engineering, OMU and Operations representatives.
- .7 Workshop Agenda to include the following.
 - .1 Review the Contract EIW and Sample Completed EIW provided at the time of Tender for scope of data to be completed by Contractor.
 - .2 Review initial (draft) of Contract EIW completed by Contractor after initial set of shop drawings.
 - .3 Review process for further draft submissions, updates and review periods, and final submission.
 - .1 Draft submission is in reference to the initial Contract EIW populated by the Contractor, after acceptance of the initial set of shop drawings.
 - .2 Confirm the frequency and duration of review and approval periods and phasing of submissions of the EIW and the manner of which the reviews will be completed (i.e., regular review of EIW updates against approved shop drawings as part of a QA/QC process).
 - .3 Remind participants of the requirements for Substantial Performance and submission of the final Contract EIW.
 - .4 A flowchart of the general process is attached at the end of this Section.
 - .5 The Contractor is not expected to invite vendors to this session but will disseminate information to vendors and Subcontractors following this workshop.

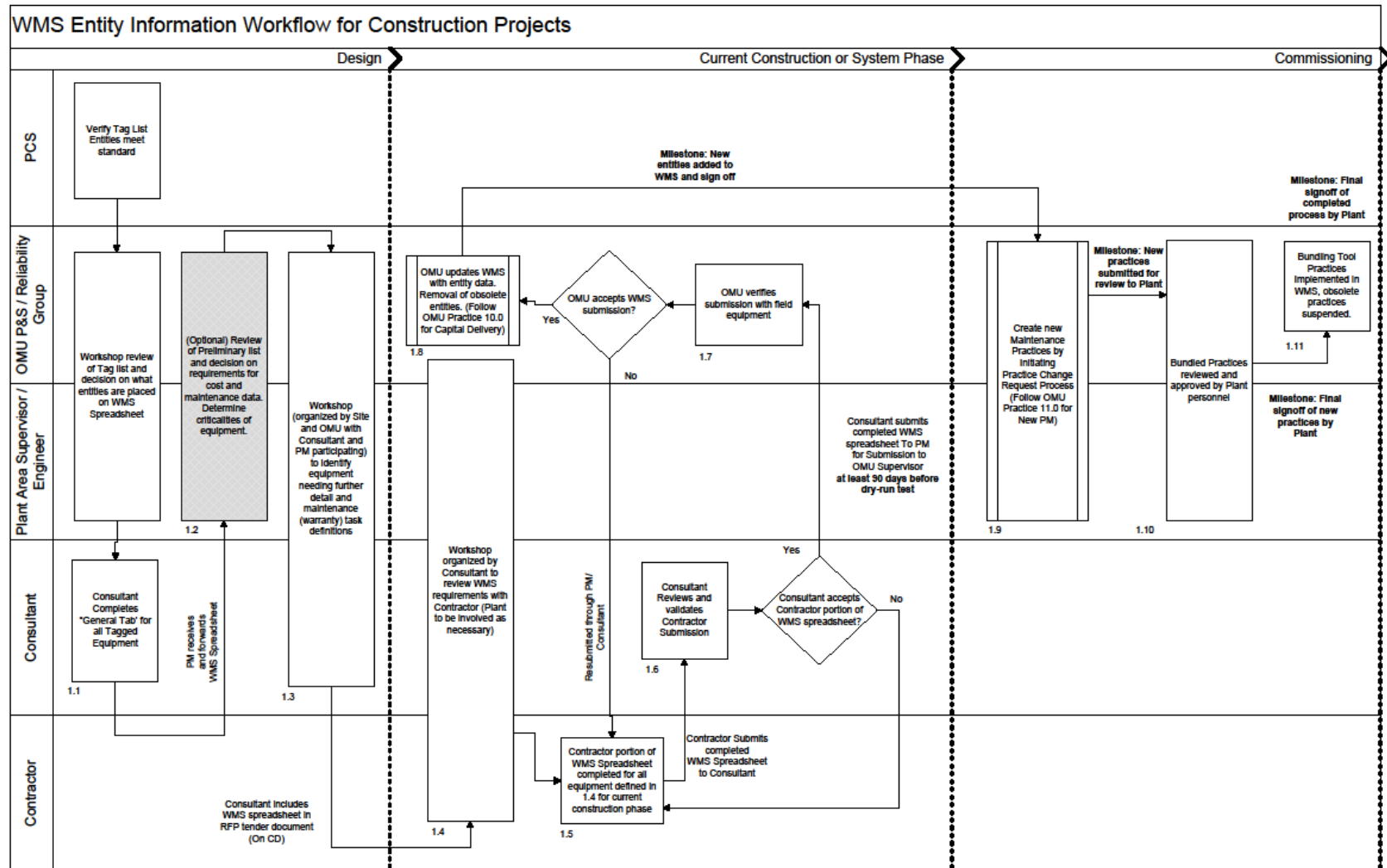
3.2 PROGRESS MEETINGS

- .1 Review progress of populating the Contract EIW periodically at regular Progress Meetings, or as required by progress of the Work. Include an agenda item at each regular progress meeting to review the current status of the Contract EIW.
Review to include:

- .1 Confirmation that any equipment shop drawings submitted since the last progress meeting have had their Entity information included in the Contract EIW.
 - .2 Confirmation that QA/QC procedures and acceptance by the applicable QA/QC authority has been completed since the last progress meeting (see flow chart attached to this Section for further details on QA/QC procedures).
 - .3 A look ahead at upcoming works and submittals that will be included in the EIW within the period before the next review meeting.
- .2 Maintain coordination of efforts, review progress of data entry, discuss requests for edits, and resolve problems that may develop.

3.3 ATTACHMENTS

- .1 WMS Entity Information Workflow.



END OF SECTION

SECTION 01650
MANUFACTURER'S SERVICES

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SECTION 01650
MANUFACTURER'S SERVICES

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section defines the requirements to have the equipment manufacturer inspect, check, adjust and commission their equipment at the job site and train City's personnel. Certification that their equipment is installed to their satisfaction and performing in accordance with specification is also required.

1.2 DEFINITIONS

- .1 Person-Day: One person for 8 hours within regular Contractor working hours.

1.3 SUBMITTALS

- .1 Training Schedule: Submit not less than three (3) weeks prior to start of equipment installation and revise as necessary for acceptance.
- .2 Lesson Plan: Submit proposed lesson plan not less than three (3) weeks prior to scheduled training and revise as necessary for acceptance.

1.4 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

- .1 Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system. Additional qualifications may be specified elsewhere.
- .2 Representative subject to acceptance by City and Engineer. No substitute representatives will be allowed unless prior written approval has been given by Engineer.

PART 2 PRODUCTS

2.1 GENERAL

- .1 At a minimum, the following products require Manufacturer's Services:
 - .1 Fire Protection System
 - .2 Supply / Exhaust Fans
 - .3 HVAC Controls
- .4 EXECUTION

2.2 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- .1 Furnish manufacturers' services when required by an individual specification section, to meet the requirements of that Section.
- .2 Schedule manufacturer's services to avoid conflict with other onsite testing or other manufacturers' onsite services.
- .3 Determine, before scheduling services, that all conditions necessary to allow successful testing have been met.
- .4 Only those days of service approved by Engineer will be credited to fulfill the specified minimum services.
- .5 When specified in individual specification sections, manufacturer's onsite services shall include:
 - .1 Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction for Contractor's assembly, erection, installation or application procedures.
 - .2 Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
 - .3 Revisiting the site as required to correct problems and until installation and operation are acceptable to Engineer.
 - .4 Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
 - .5 Assistance during functional and performance testing and facility startup and evaluation in accordance with Section 01800 – Equipment Testing and Starting of Systems.
 - .6 Training of City's personnel in the operation and maintenance of respective product in accordance with Section 01830 - Training.

2.3 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

- .1 When specified in individual Specification section, submit manufacturer's certificate of compliance prior to shipment of product or material.
- .2 Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by acceptable certification of compliance.
- .3 Certificates of compliance shall be signed by product manufacturer certifying that product or material specified conforms to or exceeds specified performance. Attach supporting reference data, affidavits and certifications, as appropriate.

- .4 Certificates of compliance may reflect recent or previous test results on material or product, if acceptable to Engineer.

2.4 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

- .1 When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by the equipment manufacturer's representative.
- .2 Such form shall certify that the signing party is a duly authorized representative of the manufacturer, is empowered by the manufacturer to inspect, approve and operate their equipment and is authorized to make recommendations required to assure that the equipment is complete and operational.

2.5 SUPPLEMENTS

- .1 Refer to forms listed in Part 3.

PART 3 FORMS

3.1 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

CITY: _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with Manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Comments: _____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

END OF SECTION

**SECTION 01705
HEALTH AND SAFETY**

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**SECTION 01705
HEALTH AND SAFETY**

PART 1 GENERAL

1.1 REFERENCES

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations.
- .2 Province of Ontario: Occupational Health and Safety Act and Regulations.
- .3 General Condition 4.2.

1.2 DOCUMENTATION

- .1 Make documentation available for review by the Consultant. Documents are to be in a clearly visible location inside the Contractors site trailer and work area as required.
 - .1 A daily sign-in/out log for all persons who will be entering the construction areas within the Transfer Station.
 - .2 A Health and Safety Plan is to be made available during the entire contract period. The plan is to include at minimum:
 - .1 Results of site-specific safety hazard assessment including confined space.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation.
 - .3 Construction Safety Checklists after completion.
 - .4 Reports or directives issued by Federal and/or Provincial health and safety inspector(s).
 - .5 Copies of incident and accident reports.
 - .6 On-site Contingency and Emergency Response Plan: Address standard operating procedures are to be implemented during emergency situations.
 - .7 Material Safety Data Sheets (MSDS).
 - .8 Personnel training requirements including names of personnel and alternates responsible for site safety and health, hazards present on site, and use of personal protective equipment.

- .9 Emergency numbers for police, fire and ambulance for the locale of the Work, as well as the names and after-hours numbers for key site personnel related to health, safety or security of the site.

1.3 SAFETY ASSESSMENT

- .1 Perform site specific safety hazard assessment related to project.
- .2 Submit hazard assessment report to the Consultant.

1.4 MEETINGS

- .1 Attend health and safety pre-construction meeting.
- .2 Arrange for Tool-Box safety meetings with Contractor's staff.

1.5 REGULATORY REQUIREMENTS

- .1 Comply with specified standards and regulations to ensure safe operations at site containing hazardous or toxic materials.

1.6 GENERAL REQUIREMENTS

- .1 The Contractor is to assume that they are the Constructor in their work area. Should the situation change during the term of the Contract and the City is required to be the Constructor, the Contractor will be notified of the change.
- .2 Develop written site-specific Health and Safety Plan based on hazard assessment prior to commencing any site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications. Health and Safety Plan should be prepared in accordance with Specific Conditions of Contract.
- .3 Correct deficiencies and re-submit Health and Safety Plan when so requested by the Consultant.
- .4 Submit all MSDS to the Consultant and Transfer Station of all chemicals brought onsite prior to use.

1.7 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, municipal, territorial, and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.8 COMPLIANCE REQUIREMENTS

- .1 Comply with Occupational Health and Safety Act, General Safety Regulation, Ontario.

1.9 UNFORSEEN HAZARDS

- .1 Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, immediately stop work and follow procedures in place for employee's right to refuse work in accordance with the applicable Acts and Regulations of Ontario. Advise Consultant verbally and in writing.

1.10 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by Consultant or designated safety inspector.
- .2 Provide Consultant with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Be aware that Consultant may stop Work if non-compliance of health and safety regulations are not corrected.

1.11 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.
- .2 Stop Work when necessary or advisable for reasons of health and safety.
- .3 Be aware that Consultant or designated safety inspector may stop Work when deemed necessary or advisable for reasons of health and safety.

PART 2 PRODUCTS

- .1 Not Used

PART 3 EXECUTION

- .1 Not Used

END OF SECTION

**SECTION 01710
CLEANING**

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PART 2	PRODUCTS (NOT USED)	2
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SECTION 01710 CLEANING

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section specifies the requirements for progressive and final cleaning of the Works.
- .2 The particular requirements of this Section set the standards to be met for the final condition of the whole of the Works.

1.2 PROJECT CLEANLINESS

- .1 Maintain the Works in tidy condition, free from accumulation of waste products and debris, other than that caused by the City or other contractors.
- .2 Remove waste material and debris from the Site and deposit in waste containers at the end of each working day.
- .3 Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.
- .4 Where required due to contractor activities, the Engineer may request a special clean be carried out by the contractor to protect City facility and equipment.

1.3 FINAL CLEANING

- .1 When the work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for the performance of the remaining Work.
- .2 Remove waste products and debris other than that caused by the City, other contractors or their employees, and leave the Works clean and suitable for the occupancy by the City.
- .3 Do not burn waste materials on site, unless approved by the proper authorities and submitted in writing to the Engineer.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Leave the Works broom clean before the inspection process commences.
- .6 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.

- .7 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls and floor.
- .8 Vacuum clean and dust building interiors, behind grilles, duct work, louvres and screens.
- .9 Wax, seal, shampoo or prepare floor finishes, as recommended by the manufacturer.
- .10 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .11 Broom clean and wash exterior walks, steps and surfaces.
- .12 Remove dirt and other disfiguration from exterior surfaces.
- .13 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .14 Sweep and wash clean paved areas.
- .15 Clean equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment.
- .16 Clean roofs, downspouts and drainage systems.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01760
WARRANTY WORK**

PART 1 GENERAL.....1

1.1 DESCRIPTION1

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE1

1.3 GENERAL1

1.4 SUBMITTALS.....1

1.5 INSPECTION AND DECLARATION OF FINAL COMPLETION1

1.6 WORK DURING WARRANTY PERIOD.....2

1.7 REPAIR BY CITY2

PART 2 PRODUCTS (NOT USED)2

PART 3 EXECUTION (NOT USED)2

**SECTION 01760
WARRANTY WORK**

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This Section specifies requirements for work during the Warranty Period.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

- .1 All Divisions and Sections are related to this Section.

1.3 GENERAL

- .1 Provide twenty-four (24) month warranties outlined in the Contract Documents from the later of the followings:
 - .1 Substantial Performance of the Works.
 - .2 Total Performance of the Works.
 - .3 Completion of all operational training.
 - .4 Submission of all outstanding submittals.
- .2 Perform warranty work required during progress of the work and during the Warranty Period.
- .3 Extend warranties on any component of the work that requires to be placed in operation prior to Substantial Completion for the purpose of complying with the sequence of construction.

1.4 SUBMITTALS

- .1 Inform the Engineer in writing of the arrangements made for carrying out warranty work during the Warranty Period.
- .2 Provide a telephone number and address for receipt of notices relating to matters requiring action by the Contractor during the Warranty Period.

1.5 INSPECTION AND DECLARATION OF FINAL COMPLETION

- .1 Request inspection for Final Completion no later than 10 working days before the expiry of the Warranty Period.
- .2 Participate in a joint inspection of the Works for the purpose of establishing Final Completion. Arrange for, coordinate and pay for any special access required to inspect the Works such as the confined space entry.

- .3 Review the status of all Warranty items carried out during the Warranty Period with the Engineer.
- .4 Complete all outstanding deficiencies, repair noted defects, complete all outstanding warranty items and obtain the Engineer's written agreement that all works are complete in accordance with the Contract Documents.
- .5 Apply for Final Completion.

1.6 WORK DURING WARRANTY PERIOD

- .1 Perform all warranty work required upon receipt of verbal or written notices from the Engineer.
- .2 Repair or make good settlements and defects on surfaces of backfilled trench or excavations.
- .3 Repair all damages to structures caused by settlement of ground adjacent to or over excavation.
- .4 Maintain all trees and shrubs either planted or relocated for the duration of the Warranty Period.
- .5 Failure to complete any required warranty work will result in repair by the City which will be charged to the contractor.

1.7 REPAIR BY CITY

- .1 The City will, without giving notice to the Contractor, repair defects that are dangerous in nature that constitute an extreme emergency or that affect the operation of the facility.
- .2 The Engineer will notify the Contractor of emergency work performed by the City.
- .3 The cost of labour, equipment and material to perform emergency work will be charged to the Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01770
CLOSEOUT PROCEDURES**

PART 1 GENERAL.....1

1.1 DESCRIPTION1

1.2 INSPECTION AND DECLARATION OF SUBSTANTIAL PERFORMANCE.....1

PART 2 PRODUCTS (NOT USED)2

PART 3 EXECUTION (NOT USED)2

**SECTION 01770
CLOSEOUT PROCEDURES**

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section specifies the administrative procedures preceding preliminary and final inspections of the Works for the purpose of issuance of Substantial Completion of the Works.

1.2 INSPECTION AND DECLARATION OF SUBSTANTIAL PERFORMANCE

- .1 Contractor's Inspection: The Contractor and all Subcontractors shall conduct an inspection of the Work, identify deficiencies and defects, and repair as required to conform to the Contract Documents.
- .2 Notify the Engineer in writing of satisfactory completion of the Contractor's Inspection and that corrections have been made and request the Engineer's Inspection.
- .3 The Engineer's Inspection: The Engineer and the Contractor will perform the inspection of the Work to identify obvious defects or deficiencies and the Contractor will correct the Work accordingly.
- .4 Completion: Submit a written certificate that the following has been performed:
 - .1 Work has been completed and inspected for compliance with Contract Documents.
 - .2 Defects have been corrected and deficiencies have been completed.
 - .3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
 - .4 All required documentation has been submitted.
 - .5 As-Built drawing have been submitted and approved by the engineer.
 - .6 Operation of systems has been demonstrated to the City's personnel.
 - .7 Performance testing commissioning and training.
 - .8 Work is complete and ready for Final Inspection.
- .5 Final Inspection: When items noted above are completed, request final inspection of the Works by the Engineer and the City.

- .1 Complete the outstanding work or deficiencies arising out of the final inspection that are deemed to affect issuance of Substantial Performance.
- .2 Agree to a list of outstanding work and deficiencies that do not affect Substantial Performance with the Engineer.
- .3 Apply for Substantial Performance.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01780
CLOSEOUT SUBMITTALS**

PART 1	GENERAL.....	1
1.1	DESCRIPTION	1
1.2	RELATED SECTIONS SPECIFIED ELSEWHERE	1
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PART 2	PRODUCTS (NOT USED)	6
PART 3	EXECUTION (NOT USED)	6

SECTION 01780 CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section specifies requirements for keeping and submission of as-built record drawing and specifications, operation and maintenance manuals, warranties and bonds during and at completion of Contract Work.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

- .1 Submittals – Section 01300
- .2 Operations and Maintenance Manuals – Section 01430
- .3 Quality Control – Section 01400
- .4 Closeout Procedures – Section 01770

1.3 SUBMISSION

- .1 Prepare closeout submissions instructions and data by personnel experienced in construction and in the maintenance and operation of described products and submit two (2) copies for the Engineer's review.
- .2 One (1) copy will be returned with comments and one (1) copy will be retained to assist the Engineer and will be returned after delivery of the final copies.
- .3 Revise the content of documents as required prior to final submittal.
- .4 Ensure spare parts, maintenance materials and special tools provided are new, are not damaged or defective, and of the same quality and manufacture as products provided in the Works.
- .5 If requested, furnish evidence as to type, source and quality of products provided.
- .6 Pay the costs of transportation related to replacement of defective products.

1.4 OPERATIONS AND MAINTENANCE MANUALS

- .1 Submit Operations Manuals in accordance with Section 01430 – Operations and Maintenance Manuals.

1.5 AS-BUILTS AND SAMPLES

- .1 Store record documents and samples in field office apart from documents used for construction.

- .2 Label record documents and file in accordance with Specification Section number. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .3 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .4 Keep record documents and samples available for inspection by the Engineer on a monthly basis.

1.6 RECORD DOCUMENTS

- .1 Record information on set of drawing prints provided by the Engineer.
- .2 Call attention to entry by "cloud" drawn around area or areas affected
- .3 Maintain separate colours for each major system, for recording information.
- .4 Record information concurrently with construction progress. Do not conceal work until required information is recorded.
- .5 Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
 - .1 Color Coding:
 - .1 Green when showing information deleted from Drawings.
 - .2 Red when showing information added to Drawings.
 - .3 Blue and circled in blue to show notes.
 - .2 Date entries.
 - .3 Call attention to entry by "cloud" drawn around area or areas affected.
 - .4 Legibly mark to record actual changes made during construction, including, but not limited to:
 - .1 Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
 - .2 Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.

- .3 Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
- .4 Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
- .5 Changes made by Addenda and Field Orders, Work Change Directive, Change Order, Written Amendment, and Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
- .5 Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as described in previous subparagraph above.
 - .1 Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
 - .2 Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
 - .3 Make identification so descriptive that it may be related reliably to Specifications.
- .6 Specifications: legibly mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and Contract Change Directives.
- .7 Other Documents: maintain manufacturers' certifications, inspection certifications, and field test records required by individual specifications sections.

1.7 EQUIPMENT AND SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications, final as-constructed diagram.
- .3 Include as-constructed installed colour coded wiring diagrams in the manual and also provide an electronic copy in AutoCAD and Microstation.

- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer where appropriate.
- .9 Provide original manufacturers' parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer where appropriate. Include copies in the manuals and provide an electronic version in AutoCAD and Microstation.
- .11 Provide coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturers' spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports.
- .15 Additional requirements: As specified in individual specification sections.

1.8 SPARE PARTS

- .1 Provide spare parts list, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site location and place in storage as directed by the City.
- .4 Obtain receipt for all delivered products from the City or Engineer and submit these receipts prior to Substantial Performance.

1.9 MAINTENANCE MATERIALS

- .1 Provide maintenance and extra materials list, in quantities specified in individual specification sections.

- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site location and place in storage as directed by the City.
- .4 Obtain receipt for all delivered products from the City or Engineer and submit these receipts prior to Substantial Performance.

1.10 SPECIAL TOOLS

- .1 Provide special tools list, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to site location and place in storage as directed by the City.
- .4 Obtain receipt for all delivered products from the City or Engineer and submit these receipts prior to Substantial Performance.

1.11 STORAGE, HANDLING AND PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturers' seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at the Contractor's own expense and to the satisfaction of the Engineer.

1.12 WARRANTIES AND BONDS

- .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers.
- .4 No warranty will commence until issuance when the work is concluded as specified on 01760-1.3. The warranty on items used during construction, with the City's permission, for the safe and orderly completion of the works will not commence until specified on 01760-1.3.

- .5 Verify that documents are in proper form, contain full information, and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties and bonds until time specified for submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01784
SPARE PARTS

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SECTION 01784 SPARE PARTS

PART 1 GENERAL

1.1 GENERAL

- .1 Specific requirements for maintenance materials, tools and spare parts are specified in individual specification sections.
- .2 Supply special tools, wrenches, and accessories that are required for removing worn parts, making adjustments, and carrying out maintenance works.
- .3 Deliver maintenance materials, special tools and spare parts in designated area as directed by the Consultant.
- .4 Prepare lists of maintenance materials special tools and spare parts for inclusion in operations and maintenance manuals.
- .5 For spare parts and special tools not identified in the base scope of work throughout the Contract Documents, a provisional allowance is provided in the Schedule of Pricing.

1.2 MAINTENANCE MATERIALS

- .1 Deliver specified items packaged to prevent damage.
- .2 Identify, on carton or package, colour, room number, system or area, as applicable, where items are to be used.

1.3 SPECIAL TOOLS

- .1 Assemble special tools as specified.
- .2 Include following:
 - .1 Identification tag reference.
 - .2 Identification of equipment or system for which tools are applicable.
 - .3 Instruction on intended use of tool.
 - .4 Identify special tools to indicate equipment or system for which tools are intended.

1.4 SPARE PARTS

- .1 Assemble spare parts as specified.

- .2 Include the following:
 - .1 Part number.
 - .2 Identification of equipment or system for which parts are applicable.
 - .3 Installation instructions as applicable.
 - .4 Name and address of nearest supplier.
- .3 Identify spare parts to indicate equipment or system for which parts are applicable.

PART 2 PRODUCTS

- .1 Not Used

PART 3 EXECUTION

- .1 Not Used

END OF SECTION

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EQUIPMENT TESTING AND STARTING OF SYSTEMS

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PART 2	PRODUCTS (NOT USED)	4
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SECTION 01800
EQUIPMENT TESTING AND STARTING OF SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section outlines the general requirements for start-up of the entire works, including all checks and tests necessary to verify all of the systems are installed as specified.
- .2 Initial operation will not commence until all systems have been demonstrated to the Engineer as being ready for operation in both manual and auto operating modes.

1.2 GENERAL

- .1 All test equipment gauges, thermometers, meters, analysis instruments, and other equipment used for calibrating or verifying the performance of equipment installed under this contract shall be provided by the Contractor.
- .2 Refer to specification Section 15990 for detailed testing, adjusting and balancing of all mechanical equipment and components.
- .3 All water, chemicals, fuel oil, lubricants and other materials required to start-up equipment shall be provided by the Contractor.
- .4 Contractor's Inspection: The Contractor and all Subcontractors and Suppliers will conduct an inspection of the work, identify deficiencies and defects; repair as required. Notify the Engineer in writing of satisfactory completion of the Contractor's Inspection and that corrections have been made. Request an Engineer's Inspection.
- .5 Engineer's Inspection: Engineer and the Contractor will perform an inspection of the Work to identify defects or deficiencies.
- .6 The Contractor will correct all critical deficiencies prior to start of initial operation.
- .7 Final Inspection: When the items noted above are complete, request a final inspection of the work by the City, the Engineer and the Contractor. If work is deemed incomplete, complete the outstanding items and request a re-inspection.

1.3 PRE-INITIAL OPERATION CHECKS AND TESTS

- .1 Pre-initial operation checks and tests are predominantly a construction phase activity and do not involve operations or production. It will confirm that equipment and devices are installed and connected correctly and are ready to be placed on line for initial operation.

- .2 Obtain all approvals and clearances from authorities prior to energizing any components.
- .3 Perform all necessary pre-initial operation checks and tests as per the following:
 - .1 Check installations are in accordance with manufacturer instructions.
 - .2 Check all piping connections and related piping systems are complete and pressure tested.
 - .3 Complete all leakage tests.
 - .4 Check all electrical, instrumentation and control cable connections and related power and control panels are complete and tested.
 - .5 Check and calibrate all related protective devices.
 - .6 Check all pre-run maintenance and installation conditions have been completed such as oil and grease addition.
 - .7 Clean and flush all related piping systems.
 - .8 Disinfect all related piping systems, if necessary.
 - .9 Check rotation of all rotating equipment.
 - .10 Obtain clearance from manufacturers to place equipment or systems in operation and obtain certificates of installation from manufacturers.
- .4 During the start-up pre-initial operation, the Contractor shall provide qualified personnel to operate the equipment, first in manual mode, followed by operation in auto mode, and shall supply and dispose of all water and chemicals and all else required to properly operate and set up the equipment at no extra cost to the City.
- .5 The Contractor shall be entirely responsible for the equipment and its operation during this period. Should any equipment be damaged during this period, the Contractor shall repair or replace such equipment to the satisfaction of the Engineer, at no extra cost to the City.

1.4 WITNESSED OPERATION CHECKS AND TESTS

- .1 The Contractor shall notify the Engineer in writing at least 48 hours in advance that all systems are ready for the Engineer's Inspection. A period of five (5) working days shall be allowed in the schedule for this inspection.
- .2 During the engineer witnessed operation, the Contractor shall make all changes and adjustments to the equipment at his own expense, and shall demonstrate to the Engineer that the equipment is capable of proper operation, and is ready for final operational checking with the City.

1.5 FINAL OPERATION CHECK AND TESTS

- .1 When the Contractor has demonstrated to the Engineer that the equipment and associated systems meet their operational intent the Contractor shall request that the City is present to complete the Final Operational check prior to the equipment entering service.
- .2 A period of five (5) working days shall be allowed in the schedule for this inspection.

1.6 SUBMITTALS

- .1 Submittal material, shall consist of the following:
 - .1 Copies of all factory test reports for components where factory testing was carried out.
 - .2 Copies of all signed certificates of installation.
 - .3 Copies of all calibration reports, I/O check sheets, electrical supply and distribution integrity test reports, piping and tank test reports, etc.
 - .4 Contractor's major deficiencies and corrective action report.

1.7 PERIOD OF OPERATION

- .1 Provide assistance during the initial period of operation prior to date of Substantial Performance of the Project.
- .2 When installation work has been completed and before any equipment is operated, commission the equipment. Provide the manufacturers' services, as specified under Section 01640, of a skilled technical representative for each major piece of equipment for a minimum period of two days (16 hours) to carry out the following work as a minimum requirement.
 - .1 Check the installation as to its workmanship.
 - .2 Check the operation.
 - .3 Check the interconnecting wiring of the safety devices (jumper wire tests at the sensor).
 - .4 Perform further tests as directed by the Engineer.
- .3 When installation work has been completed and the equipment has been commissioned, the Contractor will operate the equipment for a period of not less than fourteen (14) days uninterrupted service.

- .4 The Contractor will provide all necessary fuels required during the initial period of operation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01825
PERFORMANCE TESTING

PART 1 GENERAL.....1

1.1 INTENT OF SECTION.....1

1.2 QUALITY ASSURANCE1

1.3 PERFORMANCE TESTING – GENERAL2

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PART 2 PRODUCTS (NOT USED)3

PART 3 EXECUTION (NOT USED)3

SECTION 01825
PERFORMANCE TESTING

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 The Contractor recognizes and agrees that the Performance and Reliability Run is for the purpose of establishing that the works can be operated as intended and that it shall be successfully completed prior to Substantial Performance.

1.2 QUALITY ASSURANCE

- .1 Provide a calibration program for all instruments, pressure gages, flowmeters, and thermometers used for determining the performance of equipment and systems installed under this Contract.
- .2 Provide a testing plan detailing how all testing work required under this Contract will be implemented. The test plan shall be divided into process systems or areas for ease of preparation and implementation.
- .3 Provide a testing schedule detailing sequence, time and duration of performance and operational testing. The schedule shall follow a bar chart form and shall be updated as required to reflect changes.
- .4 The testing program shall include all tests necessary to demonstrate the specified performance for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this Contract.
- .5 Provide all documentation necessary to record the results of all equipment and system tests.
- .6 For the purposes of this section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The Contractor's Testing Manager shall co-ordinate the activities of all sub-contractors and suppliers to implement the requirements of this section.
- .7 All test equipment pressure gauges, thermometers, flowmeters, analysis instruments, and other equipment used for calibrating or verifying the performance of equipment installed under this Contract shall be calibrated to within plus or minus 2 percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale.
- .8 Pressure gauges shall be calibrated in accordance with ANSI/ASME B40.1 Thermometers shall be calibrated in accordance with ASTM E77. Certified calibration curves shall be furnished.

- .9 The Contractor shall assemble a team under the direction of the Contractor's Start-up Manager, an individual capable of operating the facility, organizing the required testing program, and duly authorized to commit the Contractor's personnel and resources to respond to requests for assistance on the part of the Engineer or, through the Engineer, the City. The team shall consist of representatives of the Contractor's mechanical, electrical, and instrumentation sub-contractors, and others as appropriate. The team shall be available at the site of the work during normal working hours (8 hours a day, 5 days a week (Saturdays, Sundays, and legal holidays excepted)) and shall be available within two (2) hours' notice at all other times upon notice by telephone. The team shall at all times be equipped and ready to provide for emergency repairs, adjustments, and corrections to the equipment and systems installed and modified as a part of this Contract.

1.3 PERFORMANCE TESTING – GENERAL

- .1 The roles and responsibilities during the performance and reliability run are defined as follows:
- .1 The Contractor: The Contractor will place all systems on-line ready for continuous operation and complete all cleaning, disinfection and preparatory works to permit the works to be operated and tested as intended.
 - .2 The Engineer: The Engineer will monitor the performance and reliability run on behalf of the City. The Engineer will assess whether any abnormalities affect the integrity of the test during this period.
 - .3 The City: The City will assist the Contractor for reading instruments, recording notes and making measurements and observations during the tests. The City's will report any abnormalities to the Engineer promptly throughout the test period.
 - .4 System Programmer: The programmer of the control system will ensure that the control programs are placed on-line ready for continuous operation and will provide support to operations staff throughout the test as required to maintain the control systems in full time operation.
- .2 Abnormalities and/or component failures during the performance and reliability run may result in the entire test being repeated or extended or components being repeated or extended at the discretion of the Engineer.
- .3 The Scope of Work of this Contract includes the performance and reliability run and Substantial Performance is conditional on completion of this test period to the satisfaction of the Engineer.

1.4 PERIOD OF PERFORMANCE TESTING

- .1 Upon satisfactory completion of the initial operating period, and when the equipment has been adjusted to the satisfaction of the Engineer, and all critical deficiencies corrected, the Contractor shall operate the equipment continuously for a two (2) week period.
- .2 The Contractor shall notify the Engineer in writing at least 72 hours in advance of starting the “performance tests” period. Operation shall not be initiated until written approval from the Engineer is received.
- .3 If the performance tests demonstrate, in the opinion of the Engineer, that the equipment or any part of it or any of the appurtenances, fails to meet any of the specified guarantees and other performance requirements of the Specifications of this Contract, the Contractor shall at his own expense, if directed by the Engineer modify, replace or reconstruct any and all defective parts of said equipment and appurtenances to fulfill all of said contract requirements including retesting.
- .4 After the performance tests have been completed, and after all required adjustments, repairs changes, replacements and reconstruction have been made to the satisfaction of the Engineer and City, the Contractor shall place all parts of the equipment and all appurtenances in smooth running order, and thereupon the Contractor shall apply for Substantial Performance.
- .5 Without limiting the scope of the above, the Contractor is referred to other sections of these Specifications for specific requirements for performances testing of equipment supplied under this Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01830
TRAINING**

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SECTION 01830 TRAINING

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section contains requirements for training the City's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.
- .2 Training on the generators and ancillary equipment shall be separated from the main training sessions and be performed as a separate training sequence.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

- .1 Manufacturers Services – Section 01640
- .2 Closeout Submittals – Section 01780

1.3 DESCRIPTION

- .1 The City will provide a list of personnel to receive instructions.
- .2 The City will pay the City's staff for all costs associated with demonstrations and training, including time, travel lodgings, etc. The City reserves the right to deduct the cost of any cancellations or repeat sessions necessary as a result of the Contractor's actions from any monies due to the Contractor under this Contract.
- .3 Contractor to allow for a total of two (2) separate full training sessions for all new equipment within the facility.
- .4 Contractor to allow for a total of two (2) separate full training sessions for generator and ancillary equipment training.

1.4 QUALITY ASSURANCE

- .1 The Contractor shall provide on-the-job training of the City's personnel for all equipment. The training sessions shall be conducted by qualified, experienced (two years minimum), factory-trained representatives of the various equipment manufacturers. Training shall include instruction of operating personnel in equipment operation and preventive maintenance and instruct plant mechanics, electricians, and electronics technicians in normal maintenance up to major repair.

1.5 SUBMITTALS AND SCHEDULE

- .1 The following information shall be submitted to the Engineer. Due to phased testing and start-up activities, separate submittals can be prepared for equipment

items or systems. The material shall be reviewed and accepted by the Engineer no later than 15 working days prior to initial operation.

- .1 All factory training programs, if required, shall be completed prior to starting of systems and use equipment similar to that being supplied.
- .2 Where the same personnel are used for starting of system and for training, ensure that the starting of system work is completed to the satisfaction of the Engineer and City before the training commences and that sufficient time is set aside to complete the training.
- .3 Lesson plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
- .4 Allow sufficient time in the construction schedule and test plan for completion of training.
- .5 Co-ordinate attendance of training specialists with availability of City's personnel.
- .6 Date, time, and subject of each training session and identity and qualifications of individuals to be conducting the training.
- .7 All training shall be completed prior to performance testing. Feedback training sessions may be required at a later date.
- .8 All field training programs shall be fully coordinated with construction and initial operation.
- .9 All training sessions will be conducted Monday to Friday 0800 hrs. to 1500 hrs.
- .10 Maintain a record of all attendees for demonstration and training sessions and submit to the Engineer, along with a report on all sessions prior to Substantial Performance.

PART 2 PRODUCTS

2.1 GENERAL

- .1 The Contractor shall conduct training sessions for the City's operation and maintenance personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Vendor operation and maintenance manuals shall be available to the City personnel at least 30 days prior to the date scheduled for initial operation.

- .2 Training shall be required for all new systems but not limited to the following: new equipment generator system, fuel system, diesel exhaust system, all new HVAC systems, all new process valves, all new switchgears/breakers, and all new lighting fixtures.

2.2 LOCATION

- .1 Field training sessions shall take place at the site of the equipment. The Contractor shall provide a training facility with a capacity for at least 12 persons for classroom training.

2.3 LESSON PLANS

- .1 Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject. The Contractor shall furnish as required copies of necessary training manuals, handouts, visual aids and reference materials at least one (1) week prior to each training session.

2.4 MATERIALS FOR TRAINING

- .1 Electronic copies of all training material (presentations, supporting material, manuals, etc.) to be provided for the City's review two (2) weeks prior to the scheduled training session.
- .2 All training materials to be approved by the City and Engineer.
- .3 Course Materials: Provide sufficient written materials to support all training sessions.
- .4 All materials provided for training shall conform to the following:
 - .1 Paper: 8.5 x 11 inches 20-lb minimum, white, for typed pages.
 - .2 Text: Manufacturer's printed data, or neatly word processed, designed specifically for learning. Ample space to be provided for note taking.
 - .3 Double-sided.
 - .4 Drawings and Sketches:
 - .1 Provide reinforced punched binder tab, bind in with text.
 - .2 Reduce larger drawings to a size not larger than 11 x 17 inches and fold to size of next pages.
 - .3 Use colour prints to highlight key elements.

- .5 Cover to include:
 - .1 Contract number.
 - .2 Title of project.
 - .3 Identify separate structures or systems as applicable.
 - .4 Identify of general subject matter covered in the manual.
 - .5 Locations or facility names.
 - .6 Publication date.
 - .7 Revision number.
- .6 Binder shall be:
 - .1 Commercial quality (D-ring) binders with durable and cleanable plastic covers.
 - .2 Maximum post width: 2 inches.
 - .3 When multiple binders are used, the Contractor shall correlate the information into related consistent groupings and clearly number all volumes.
- .7 Recorded Training Material:
 - .1 The use of standard recorded materials will be considered provided it is professionally produced, and reviewed and approved by the City prior to its use. Recordings shall be in DVD format and shall become the property of the City.
 - .2 The use of this material shall be viewed as an enhancement to the required face-to-face training and not a substitute.
 - .3 The City reserves the right to videotape all training sessions.

2.5 FORMAT AND CONTENT

- .1 Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, a training session shall cover the following topics for each item of equipment or system:
 - .1 Purpose and function of equipment.
 - .2 Safety items and procedures.

- .3 Operation.
- .4 Troubleshooting.
- .5 Preventive maintenance, including special details on lubrication, maintenance and corrosion protection of the equipment and ancillary components.
- .6 Corrective maintenance.
- .7 Parts.
- .8 Local representatives.
- .9 Operation and maintenance manuals.

2.6 TRAINING SESSIONS

- .1 Provide sufficient demonstration to cover start up, operation, control adjustment, calibration, trouble-shooting, servicing, maintenance and shut down of all components of the works.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- .1 Training shall be conducted in conjunction with initial operation. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence.
- .2 Given the shift-work nature of the City's operation and maintenance staff, the training sessions may be staggered across several weeks to ensure all staff shifts receive the training.
- .3 Training to take place no later than 20 working days after commissioning.

3.2 OPERATOR CLASSROOM TRAINING

- .1 As a minimum, classroom equipment training for operations personnel will include:
 - .1 Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
 - .2 Purpose and plant function of the equipment.
 - .3 A working knowledge of the operating theory of the equipment.

- .4 Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
- .5 Identify and discuss safety items and procedures.
- .6 Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
- .7 Operator detection, without test instruments, of specific equipment trouble symptoms.
- .8 Required equipment exercise procedures and intervals.
- .9 Routine disassembly and assembly of equipment if applicable (as judged by the City on a case-by-case basis) for purposes such as operator inspection of equipment.

3.3 OPERATOR HANDS-ON TRAINING

- .1 At a minimum, hands-on equipment training for operation personnel will include:
 - .1 Identify location of equipment and review the purpose.
 - .2 Identifying piping and flow options.
 - .3 Identifying valves and their purpose.
 - .4 Identifying instrumentation:
 - .1 Location of primary element.
 - .2 Location of instrument readout.
 - .3 Discuss purpose, basic operation, and information interpretation.
 - .5 Discuss, demonstrate, and perform standard operating procedures and round checks.
 - .6 Discuss and perform the preventative maintenance activities.
 - .7 Discuss and perform start-up and shutdown procedures.
 - .8 Perform the required equipment exercise procedures.
 - .9 Perform routine disassembly and assembly of equipment if applicable.
 - .10 Identify and review safety items and perform safety procedures, if feasible.

3.4 MAINTENANCE CLASSROOM TRAINING

- .1 Classroom equipment training for the maintenance and personnel will include:
 - .1 Theory of operation.
 - .2 Description and function of equipment.
 - .3 Start-up and shutdown procedures.
 - .4 Normal and major repair procedures.
 - .5 Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the “pass” and “no pass” test instrument readings.
 - .6 Routine and long-term calibration procedures.
 - .7 Safety procedures.
 - .8 Preventive maintenance such as lubrication; normal maintenance such as belt, seal, and bearing re-placement; and up to major repairs such as re-placement of major equipment part(s) with the use of special tools, welding jigs, etc.

3.5 MAINTENANCE HANDS-ON TRAINING

- .1 Hands-on equipment training for maintenance and repair personnel shall include:
 - .1 Locate and identify equipment components.
 - .2 Review the equipment function and theory of operation.
 - .3 Review normal repair procedures.
 - .4 Perform start-up and shutdown procedures.
 - .5 Review and perform the safety procedures.
 - .6 Perform City-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.
 - .7 Review and use equipment manufacturer’s manuals ‘in the hands-on training.

END OF SECTION

DIVISION 2

SITE WORKS

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SECTION 02051 DEMOLITION

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 Section includes removal, salvage, and modifications of pavements as indicated on the Contract Drawings.
- .2 Refer to Contract Drawings for Temporary Shoring and Environmental Protection Plan requirements prior to proceeding with any removal works.

1.2 MEASUREMENT AND PAYMENT

All costs associated with the work of this Section shall be included in the price for Item No. 9 in the Bid Form.

1.3 GENERAL

Coordinate the work with the Consultant and the City to minimize disruptions to operations of the facility. Include the sequence of removals in the project schedule for review by the Consultant.

- .1 Do not begin removals except in accordance with the approved sequence of construction and until approval has been given by the Consultant in writing two weeks prior to removal.
- .2 All removed materials as indicated in the Contract Drawings shall be disposed of by the Contractor unless marked in the field by the City. The City has the first right of refusal. The Contractor shall request that the City to mark items to be salvaged, at least two weeks prior to their removal.
- .3 All facilities in the work area which are not to be removed must be protected and remain in continuous use during the work.
- .4 Removal and salvage work shall create minimum interference with the City's operation and inconvenience to the City.
- .5 Blasting is not permitted.
- .6 Perform non-destructive testing (NDT) (scanning and/or x-ray) of all concrete slabs scheduled for removal.
- .7 Perform non-destructive testing (NDT) (scanning or x-ray) on all portions of concrete walls or slabs that are specified to have holes/penetrations or sufficient modifications made to them.

SECTION 02051 DEMOLITION

1.4 COORDINATION

Coordinate all removal and modification work with any new work to be performed to facilitate completion. Any removal cannot start until the construction area is released to the Contractor. Coordination is required with the Consultant and the City's operation staff.

- .1 Coordinate modification work to allow continuous, uninterrupted operation of the existing facility.

1.5 REGULATORY REQUIREMENTS

Comply with applicable requirements of CSA S350 "Code of Practice for Safety in Demolition of Structures".

- .1 Comply with all applicable Ontario regulations for Waste Management under the Environmental Protection Act.

1.6 SUBMITTALS

Contractor shall retain a Professional Engineer who is specialized in structural removal work to provide demolition sequence and procedure, removal plan, method of statement for the City and Consultant to review prior to any commencement of work.

- .1 Where required by the Ontario Building Code, or where required or requested by the Consultant, submit for approval drawings, diagrams or details showing sequence of disassembly work or supporting structures and underpinning. Drawings for structural elements shall bear seal and signature of the Professional Engineer.
- .2 Prepare and submit a waste reduction work plan. Describe management of removed wastes. Identify materials which can be reused, recycled and indicate method proposed for reducing, reusing recycling wastes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

Ensure that affected building areas are protected with the use of screens, partitions, and hoardings prior to start of removal work.

- .1 Ensure that all electrical equipment within removal areas, either to be removed or retained, is appropriately protected from weather, damage, dust and anything else which may cause damage during the demolition works.

SECTION 02051 DEMOLITION

- .2 Verify that existing services in areas affected by removal are disconnected, capped, removed or protected prior to start of work.

3.2 GENERAL DEMOLITION REQUIREMENTS

The general area in which the removal work is to be performed shall be left clean and free of debris at the end of each shift; access routes must always be kept clear. If required, the general area shall be graded as required to provide a uniform appearance.

- .1 Remove existing work as indicated and as required to accommodate new work.
- .2 Remove work in a safe and systematic manner, from top to bottom.
- .3 Remove in a manner to minimize dusting. Keep dusty materials wetted but prevent flooding and/or contaminated runoff.
- .4 Remove concrete elements in small sections. Carefully remove and lower structural framing and other heavy and large objects.
- .5 At all times leave work in safe condition, so that no part is in danger of uncontrolled toppling or falling.

3.3 CONCRETE STRUCTURES DEMOLITION

Contractor shall be responsible for the removal and disposal off-site of existing concrete structures as indicated on the Contract Drawings.

- .1 Prior to any concrete removal works, the Contractor shall perform non-destructive testing (NDT) of concrete to ensure no gas networks, underground hydro line, sanitary, storm or water network, telephone line, fibre optic or any other utilities are inside the pavement slab.
- .2 Existing concrete structures, as noted, shall be removed to the limits indicated.
- .3 Existing concrete to be removed shall be cut into fragments and reduced in size as required to facilitate removal and disposal.

3.4 SITE WORK DEMOLITION

The construction phasing guidelines that are recommended to maintain facility operations shall be as per contract drawings.

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3.5 REPAIR OF EXISTING CONSTRUCTION

Where structures to be removed are connected to structures to remain, remove the existing construction in a careful manner so that adjacent construction, piping, and facilities to be left in place are not cracked or otherwise damaged.

- .1 The Contractor will be held responsible for any damage thereto because of its operations.
- .2 Use temporary supports where and as required for the support of existing facilities.
- .3 Holes and damage resulting from removal operations shall be filled, reconstructed, repaired, and finished to match and conform to adjacent surfaces and construction as determined by the Consultant.

3.6 ELECTRICAL EQUIPMENT AND WIRING REMOVAL

- .1 Remove all lighting fixtures, control switches, wall mounted receptacles, disconnect switches, and manual starters from existing Quonset hut.
- .2 Removed electrical equipment shall first be offered to the City and if the City refuses right to ownership, the equipment shall be removed for disposal.

3.7 ITEMS TO BE SALVAGED BY THE CONTRACTOR

Removal and salvage of any item of equipment or facility includes removal and salvage of all accessories, piping, wiring, supports, associated electrical starters and devices, base plates, and frames, and all other appurtenances, unless otherwise directed.

- .1 Existing materials and equipment to be removed by the Contractor and reused as a part of the work shall remain the property of the City.
- .2 The Contractor shall carefully remove, in a manner to prevent damage, all materials and equipment specified herein or indicated to be salvaged and reused or to remain the property of the City.
- .3 The Contractor shall store and protect salvaged items specified or indicated to be reused in the Work.
- .4 Any items damaged in removal, storage, or handling through carelessness or improper procedures shall be replaced by the Contractor with new items at no cost to the City.

SECTION 02051 DEMOLITION

- .5 All other existing materials and equipment removed by the Contractor shall not be reused in the work, shall become the property of the Contractor, and shall be removed from the jobsite.

3.8 CONCRETE MODIFICATIONS

Remove existing concrete where such removal is indicated on the Drawings or directed by the Consultant.

- .1 Remove all dust, grease, curing compounds, impregnations, waxes, foreign particles, and disintegrated material.
- .2 If chipping is necessary, the edges shall be perpendicular to the surface or slightly undercut. Feather edges will not be permitted.
- .3 Remove all defective existing concrete down to sound concrete where indicated on the Drawings or as directed by the Consultant.
- .4 Where existing concrete is to be removed, fill, repair, and finish the surfaces smooth and flush with adjacent undisturbed surfaces.
- .5 Unless otherwise indicated on the Drawings or directed by the Consultant, clean and leave in place existing reinforcing exposed during concrete removal operations.
- .6 Any reinforcement bars the Consultant allows to be cut shall be cut off not less than 25 mm inside the finished and repaired surface. All anchor bolts, piping, and other hardware projecting from concrete surfaces after piping and equipment have been removed shall be cut 25 mm inside the finished or repaired surface and protected with epoxy paint. Reinforcement bars and other steel construction to be removed may be flame-cut.
- .7 Remove concrete bases of existing equipment that have been relocated or removed, down to the reinforcing steel of the supporting slab. Initiate removal of curb base with a concrete saw, cutting around the perimeter, taking care not to chip or spall the surface of remaining structure. After existing materials have been removed, exposed reinforcing steel and structural slab shall be cleaned and filled with new concrete, finished to match the surrounding surface.
- .8 Concrete materials and placement and grouting shall be in accordance with Section 03300 - Cast-in-Place Concrete.
- .9 Provide dust control by water systems or vacuum system and tarping to limit any dust migration during any concrete removal works.

SECTION 02051 DEMOLITION

3.9 DISPOSAL AND CLEAN-UP

All materials, rubbish and debris resulting from removal work that are not marked by the City shall become the Contractor's property and shall be removed from the Site and legally disposed of unless specifically indicated otherwise.

- .1 Do not allow removed materials to accumulate on-site. Promptly, as work progresses, remove and legally dispose of materials away from the Site.
- .2 Provide on-site facilities for collection, handling and storage of anticipated quantities of reusable and/or recyclable materials.
- .3 Locate containers in locations to facilitate deposit of materials without hindering daily operations.
- .4 Collect, handle, store on-site and transport off-site, salvaged materials, salvaged for reuse and/or recycling in separate condition. Transport to authorized reuse/recycling location.
- .5 Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to a disposal facility licensed by MECP.
- .6 Burying, burning and selling waste materials on-site is prohibited.
- .7 Disposal of liquid wastes into waterways or sewers is prohibited.
- .8 Clean up work, storage and waste collection areas as work progresses.

3.10 DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS

Ensure adherence to safety standards related to asbestos management during the removal of asphalt and concrete pavements

- .1 See soil screening memo prepared by WSP dated March 15, 2024, and geo-technical report prepared by WSP dated Sep 13, 2024, for information on subsurface conditions, asbestos, and general conditions
- .2 Disassembly and removal of structural elements shall be carried out under the supervision of a Professional Engineer.

END OF SECTION

SECTION 02232
TREE PRUNING

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1.2 REFERENCES.....1

1.3 SCHEDULING OF THE WORK1

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SECTION 02232 TREE PRUNING

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 02911 – Topsoil and Finish Grading

1.2 REFERENCES

- .1 ANSI A300-2008 (R2014), generally accepted industry standards for tree care practices. Tree Care Operations
- .2 Highway Traffic Act R.S.O. 1990 c.H8
- .3 Plant Protection Act S.C.1990, c.22
- .4 Canadian Food Inspection Agency Regulation D-03-08 Phytosanitary Requirements to Prevent the Introduction Into and Spread Within Canada of the Emerald Ash Borer, *Agrilus planipennis* (Fairemaire) (4th Revision)

1.3 SCHEDULING OF THE WORK

- .1 Prior to commencing the pruning work:
 - .1 Schedule the timing of the Work with the Consultant.
 - .2 Notify the Consultant a minimum of 7 Days in advance of the commencement of the pruning work.
 - .3 Review the extent of the pruning work with the Consultant.
- .2 The Contractor shall employ only trained and capable workers with the following qualifications:
 - .1 Arboriculture Canada Chainsaw Safety & Cutting Techniques, or Workplace Safety North Certified Professional Chainsaw Operator, or Infrastructure Health and Safety Association (IHSA) Chainsaw Operation and Maintenance, or equivalent.
 - .2 Tree Rescue and Fall Arrest for Climbers
 - .3 Aerial Bucket Rescue for Aerial Device Operators

**SECTION 02232
TREE PRUNING**

- .3 The Contractor must be qualified to perform work within 3.05 metres (10 feet) of exposed energized power lines operating at various voltages up to 50,000 volts. All persons working within 3.05 metres (10 feet) of an electrical apparatus shall have the following training:
 - .1 IHSA Three Day Safety and Awareness for Line Clearing.
- .4 The Work must be performed by employees who are competent and in accordance with the Electrical Utility Safety Rules (published by the Infrastructure Health & Safety Association, revised January 2024) for work in close proximity to energized power lines and equipment.

1.4 MEASUREMENT AND PAYMENT

- .1 All costs associated with the work of this Section shall be included in the price for Item No. 16 in the Bid Form.
- .2 Payment shall be made at the applicable price in the Bid Form, including the Site restoration and shall be full compensation for all labour, material and equipment required to complete the work of this Section.

1.5 FIELD SAMPLE

- .1 Perform sample pruning which is acceptable to the Consultant in order to identify:
 - .1 Knowledge of the target areas, including branch bark ridge and branch collars.
 - .2 The technique for selection process and pruning used to establish the desired form and shape for each species.
- .2 Acceptance of the pruning work will be determined by the Consultant from the field sample.

PART 2 PRODUCTS

2.1 DISINFECTANT

- .1 The disinfectant shall be a 20% solution of sodium hypochlorite or 70% solution of ethyl alcohol.

SECTION 02232 TREE PRUNING

PART 3 EXECUTION

3.1 GENERAL

- .1 Prune in accordance with ANSI A300 standards and in accordance with good arboricultural practices. In the event of conflict between the ANSI A300 standards and the requirements of the Contract Specification Sections, the more stringent requirements shall apply.
- .2 Tool maintenance:
 - .1 Ensure that tools are clean and sharp throughout the pruning operation. Do not use tools that crush or tear bark.
 - .2 Disinfect tools before each tree is pruned.
 - .3 On diseased plant material, disinfect tools before each cut.
- .3 Notify the Consultant immediately of any conditions detrimental to the health of plant material or operations.
- .4 Prune during the plant's dormant period or after leaves have matured. Avoid pruning during leaf formation, at time of leaf fall, or when seasonal temperatures drop below - 10°C.
- .5 Prune heavy bleeder species such as Acer, Betula, Gleditsia, Tilia, Ulmus, Populus only when in full leaf.
- .6 Retain the natural form and shape of the plant species.
- .7 Do not:
 - .1 Flush cut branches.
 - .2 Crush or tear bark.
 - .3 Cut behind the branch bark ridge.
 - .4 Damage branch collars.
 - .5 Damage branches which are to remain.
 - .6 Tear roots or branches with excavation equipment.

3.2 PRUNING

- .1 General Pruning

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TREE PRUNING

- .1 All pruning practices shall be carried out according to proper arboricultural practices including, but not limited to, the following:
 - .1 No spurs shall be used when climbing live trees.
 - .2 Where reasonable, pruning will not disrupt the natural form of the tree.
 - .3 The removal of any more than twenty-five percent (25%) of the foliage producing structure at any one time shall be avoided.
 - .4 Pruning shall be carried out in such a way as to leave the foliage evenly distributed throughout the tree crown.
 - .5 The smaller of the two abrading branches will be removed unless such action will disrupt the natural form of the tree.
 - .6 The stubbing of major branches or the trunk of the tree known as “pollarding” or “topping” will not be permitted and all cuts shall be made at the nodes or crotches.
 - .7 Site lines and street sign clearance must be maintained in accordance with section 184 of the Highway Traffic Act.
 - .8 Streetlights shall be cleared in such a way as to permit maximum illumination of roadways and sidewalks while still maintaining the trees’ structural integrity.
 - .9 In pruning for clearance from lights, utility lines and structures, the stripping of one side of the tree will be avoided.
 - .10 All broken branches shall be pruned back to the nearest suitable trunk, crotch or lateral.
 - .11 To promote optimum wound closure, all pruning cuts will be made semi-flush with the lateral, main branch or trunk or on twigs and small branches no more than one-half inch above any buds.
 - .12 Where limbs are to be shortened, the Contractor will not cut back to “suckers” (epicormic growth).
 - .13 Where ropes are to be snubbed around healthy trunks or limbs in lowering and felling operations, care will be taken to ensure that no bark damage occurs.

SECTION 02232 TREE PRUNING

- .14 Where trees are known to be diseased, pruning tools will be disinfected with 70% denatured ethyl alcohol to prevent transmitting the disease on tools.
- .15 When lowering the height of a deciduous tree, especially under utility lines, utilize drop crotch pruning where possible to minimize the likelihood of suckering.
- .16 Where major drop crotch pruning is being carried out, ensure that the new leader can carry the sap flow increased by the removal of the old terminal.
- .17 Where a major cut has been made, where minor rot problems occur, or where bark is frayed, damaged, ripped or lifted, tracing will be carried out. All loose or damaged bark will be removed to the sapwood and all decaying wood, if any, will be removed.
- .18 Epicormic sprouting (suckering) on or around tree stems or old stumps shall be removed.

.2 Removal of Material

- .1 The Contractor shall be responsible for the complete removal and disposal of all material (including trunk wood, limb wood, fine branches, wood chips, leaves and stumps). No material is to be left on-Site overnight.
- .2 Material from trees in regulated areas and quarantined zones is to be disposed of in accordance with Canadian Food Inspection Agency (CFIA) regulations.
- .3 The City may from time to time restrict the movement of wood from trees removed under this contract.

.3 Clean up

- .1 The Contractor shall be responsible for complete Site restoration and general Site clean up to the satisfaction of the Consultant. Site restoration shall include, but is not limited to, the clean-up of all sawdust, small branches and leaves.
 - .1 Material from trees in regulated areas and quarantined zones is to be disposed of in accordance with Canadian Food Inspection Agency (CFIA) regulations.

.2 Tree Defects

**SECTION 02232
TREE PRUNING**

- .1 Where the Contractor discovers an unanticipated major defect in a tree scheduled for pruning that warrants the removal of the tree, the Contractor shall notify the City for further instruction.
- .2 If an unanticipated major defect in a tree scheduled for pruning poses an immediate hazard to the Contractor's forces, utility lines, vehicles or structures within the fall area, the portion of the tree above the decay point will be removed immediately. If practical, the remaining portion of the tree will be saved and pruned into a natural form, or so that it can grow into a natural form. Where the remaining portion cannot be trained into a suitable form or where mutilation will result, the Contractor shall notify the City for further instructions.

END OF SECTION

SECTION 02300
EXCAVATION AND BACKFILLING

PART 1 GENERAL..... 1

1.1 SUMMARY1

1.2 RELATED SECTIONS.....1

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PART 2 PRODUCTS 2

2.1 GENERAL2

PART 3 EXECUTION 2

3.1 OPSS AMENDMENTS2

SECTION 02300 EXCAVATION AND BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

- .1 This Section covers the work for excavation, backfill and grading for structures, including:
 - .1 Excavating;
 - .2 Subgrade preparation and protection;
 - .3 Sheathing, shoring and bracing;
 - .4 Fill and backfill;
 - .5 Rough grading; and
 - .6 Disposal of material.

1.2 RELATED SECTIONS

- .1 Section 02911 – Topsoil and Finish Grading
- .2 Section 02725 – Hot Mix Asphalt
- .3 Section 02515 – Concrete Curb and Pavement

1.3 REFERENCES, CODES AND STANDARDS

- .1 Ontario Provincial Standard Specifications (OPSS):
 - .1 OPSS.MUNI 539 (Nov 2014) Temporary Protection Systems
 - .2 OPSS. MUNI 902 (Nov 2019) Excavation and Backfilling - Structures

1.4 GENERAL

- .1 OPSS. MUNI 902 shall be amended as follows:
 - 902.04.02 Submission Requirements** is amended by the addition of the following:
 - .1 Submit to the Consultant, 20 Working Days prior to commencement of the Work, the following:
 - .1 Design calculations and drawings and all supporting data for the sheathing, shoring, bracing and underpinning

SECTION 02300 EXCAVATION AND BACKFILLING

systems, all stamped and signed by the Contractor's design Professional Engineer.

902.04.02.1 Measurement and Payment

- .2 All costs associated with the work of this Section shall be included in the prices for Item No. 19 and 20 in the Bid Form.
- .3 The work outlined in this Section will be included in the unit prices as indicated in the Bid Form for:
 - .1 Section 02701 – Aggregates - General

PART 2 PRODUCTS

2.1 GENERAL

- .1 OPSS 902 shall be amended as follows:

902.05.01 Granular is to be deleted and replaced with:

Granular material to be used for backfill, bedding, and frost tapers shall be according to Section 02701 Aggregates - General.

PART 3 EXECUTION

3.1 OPSS AMENDMENTS

- .1 OPSS.MUNI 902 shall be amended as follows:

902.07.03 -Protection Systems is amended by the addition of the following:

- .1 Protect existing and new works and undertake construction work in the manner necessary to protect the surrounding area which is not part of the Work.
- .2 Where Work is to proceed, the Contractor shall:
 - .1 Review drawings of the existing work to ensure that the construction team understands the anticipated existing conditions.
- .3 Should damage of any kind, including settlement or lateral movement of adjacent structures, utilities or surface features occur as a result of the Work, such conditions and any resultant damage

SECTION 02300
EXCAVATION AND BACKFILLING

shall be immediately rectified to the satisfaction of the Consultant at the Contractor's own expense.

.4 Protection of Structures and Utilities

.1 Protect existing and new works and undertake construction Work in the manner necessary to protect the surrounding area which is not part of the Work.

.2 Where Work is to proceed the Contractor shall:

.1 Review drawings of the existing work to ensure that the construction team understands the anticipated existing conditions.

.3 Should damage of any kind, including settlement or lateral movement of adjacent structures, utilities or surface features occur as a result of the Work, such conditions and any resultant damage shall be immediately rectified to the satisfaction of the Consultant at the Contractor's own expense.

.2 **902.07.05 Excavation**

902.07.05.01 General is amended by the addition of the following:

.1 Strip topsoil after the area has been cleared. Do not mix topsoil with subsoil.

.2 Pre-clear areas of proposed excavation to ensure that no existing piping or buried utilities are present.

.3 Excavate in accordance with the Contract Drawings to the appropriate depth.

.4 Excavate and remove materials by mechanical means. Blasting is not permitted.

.5 Excavate clean, and level. Remove loose material.

.6 Do not place granular or concrete before examination of the excavation has occurred and the acceptance of the Consultant have been obtained.

.7 Construct each structure on stable ground where structures at different elevations occur adjacent to each other.

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EXCAVATION AND BACKFILLING

- .8 Stockpiling is not permitted on site. Do not place excavated material so as to cause pressure on newly placed structures, or where it may cause soil slippage.
- .9 Dispose of excess and unsuitable material off-Site.
- .10 Over-excavation beneath structures, where such over-excavation was not authorized by the Consultant, shall be backfilled with unshrinkable fill, or other suitable material as approved by the Consultant at the Contractor's own expense.
- .11 All uncovered excavations must be secured by fencing at the end of each work day. Plating, where used to cover excavations, must be recessed to match existing grade and shall not protrude or form a lip on any surface.
- .12 Have sub-grades inspected prior to proceeding with construction. Notify the Consultant a minimum of one working day prior to when sub-grades will be ready for inspection, so that the inspection can be arranged.
- .13 Moisten or dry, if necessary, when the sub-grade below foundations and slabs on grade is not rock. Scarify and compact to 100 percent Standard Proctor Density before placing the granular base, foundations or slabs.
- .14 Protect sub-grades from the deleterious effects of the weather and adverse construction activities.
- .15 Restore or repair any damage.
- .16 Provide necessary means for thawing frozen ground and for snow removal when required.
- .17 Maintain sub-grade to a temperature of at least 10°C prior to placing concrete.

.3 902.07.06 Backfilling

902.07.06.01 General is amended by the addition of the following:

- .1 Do not proceed with backfilling operations until the Consultant has inspected and approved installations.
- .2 Areas to be backfilled must be free from debris, snow, ice, water and frozen ground.

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EXCAVATION AND BACKFILLING**

- .3 Do not use backfill material which is frozen or contains ice, snow or debris.
- .4 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Place unshrinkable fill or fill concrete in areas as indicated on the Contract Drawings. Consolidate and level unshrinkable fill with internal vibrators:
 - .1 Place bedding and surround material as specified on the Contract Drawings.
 - .2 Place layers simultaneously on both sides of installed Work to equalize loading.

.4 902.07.06.02 Compaction is amended by the addition of the following:

- .1 Compaction Tests
 - .1 Where compaction of sub-grade, backfill or fill is specified, the Consultant may order compaction tests by an independent testing company. Tests will be arranged for by the Consultant and paid for by the City.
 - .2 If the compacting work does not meet the specified requirements, the Contractor shall perform further compacting work until the specified requirements are met and pay the cost of further testing to establish proof of the specified compaction.
 - .3 For fill or backfill compaction, tests will be made at every 450mm maximum depth, after three 150mm lifts have been placed.
 - .4 Co-operate with the Consultant and testing company by scheduling the placing and compacting of fill and backfill so tests can be progressively taken.
- .2 Rough Grading
 - .1 Rough grade, compact and grade the Site, in accordance with the Contract Drawings, to within a tolerance of 50 mm, to receive finish grading. Remove soft areas in the sub-grade and replace with suitable material as directed by

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EXCAVATION AND BACKFILLING

the Consultant. Provide additional suitable material if necessary.

- .2 Grade and maintain rough grades, including slopes and ditches, to provide proper drainage.
- .3 Restoration
 - .1 Upon completion of Work, remove excavated waste materials and debris, trim slopes, and correct defects as directed by the Consultant.
 - .2 Clean and reinstate areas affected by Work and restore as indicated on the Contract Drawings.
 - .3 Reinstate pavement and sidewalks to elevation that existed before excavation or as indicated on the Contract Drawings.
 - .4 Use temporary plating to support traffic loads over unshrinkable fill for the initial 24 hour curing period.

END OF SECTION

SECTION 02315
TRENCHING, BACKFILLING AND COMPACTING

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SECTION 02315
TRENCHING, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 02631 – Maintenance Holes, Catch Basins, Ditch Inlets and Valve Chambers
- .2 Section 02701 – Aggregates General

1.2 REFERENCES

- .1 Ontario Underground Infrastructure Notification System Act, 2012
- .2 Ontario Provincial Standard Specifications (OPSS)
 - .1 OPSS.MUNI 180 (Nov 2016) – Management of Excess Materials
 - .2 OPSS.MUNI 401 (Nov 2018) – Trenching Backfilling and Compacting

1.3 MEASUREMENT AND PAYMENT

- .1 All costs associated with the work of this Section shall be included in the prices for Item No. 11 in the Bid Form.

PART 2 MATERIALS

- 2.1 Comply with the requirements of OPSS. MUNI 401 and Section 02701 - Aggregates General.

PART 3 EXECUTION

3.1 LOCATES

The Contractor shall be deemed an “excavator” under the Ontario Underground Infrastructure Notification System Act, 2012, and shall comply with all applicable requirements of the Act. The Contractor shall obtain locates of underground infrastructure from Ontario One Call prior to commencing an excavation or dig.

OPSS.MUNI 401 IS AMENDED AS FOLLOWS:

401.07.01- General is amended by the addition of the following:

- .1 Stockpile fill materials in areas approved by the Consultant.

SECTION 02315
TRENCHING, BACKFILLING AND COMPACTING

- .2 Stockpiling should not occur near natural features, catch basins, or road side ditches.
- .3 Stockpile granular materials in a manner which will prevent segregation.
- .4 Protect all grounds and material within the Site from contamination or exposure to potentially hazardous material.
- .5 Protect stockpiles from erosion and control run off with silt protection.

401.07.02 -Site Preparation is amended by the addition of the following:

- .1 Remove any obstructions, ice and snow, from all surfaces to be excavated within the limits indicated on the Contract Drawings.
- .2 Cut pavement or sidewalk neatly along the limits of the proposed excavation so that the surface may break evenly and cleanly. Obtain consent from the Local Municipality prior to performing such cutting work.
- .3 Commence topsoil stripping after the area has been cleared.
- .4 Strip topsoil to the depths as indicated on the Contract Drawings or to the actual depth of topsoil encountered on Site, whichever is the deepest. Do not mix topsoil with subsoil.
- .5 Stockpile in locations as approved by the Consultant.
- .6 Dispose of unused topsoil to the designated disposal site.

401.07.03 - Preservation and Protection of Existing Facilities is amended by the addition of the following:

- .1 Existing buried utilities and structures:
 - .1 The size, depth and location of existing utilities and structures indicated on the Drawings are for guidance only. The completeness and accuracy of this information is not guaranteed.

Prior to commencing any excavation work, notify the City and/or the utility companies and establish the location and state of the use of any buried utilities and structures in

SECTION 02315
TRENCHING, BACKFILLING AND COMPACTING

accordance with the Ontario Underground Infrastructure Notification System Act, 2012.

- .2 The utility owners are to clearly mark the locations in order to prevent the disturbance of buried utilities and structures during the performance of the Work.
- .3 Maintain and protect from damage all water, sewer, gas, electric, telephone and other utilities and structures encountered as indicated on the Contract Drawings.
- .4 Record the locations of any maintained, rerouted and abandoned underground lines.

.2 Existing buildings and surface features:

Conduct, with the Consultant, a condition survey of all existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by the performance of the Work. Protect all existing buildings and surface features from damage while the Work is in progress. In the event of damage, immediately complete the necessary repairs to the approval of the Consultant.

401.07.04 - Removals is amended by the addition of the following:

The Contractor shall arrange for the disposal of any surplus excavated materials.

- .1 The Contractor shall obtain written agreements from the owners of any private properties where materials are to be placed prior to the disposal of materials setting out the terms, conditions and ultimate responsibility for the materials as placed. The agreements shall constitute a transfer of ownership of the material from the City to the private property owner.
- .2 Keep all disposal site(s) stable and place materials in a manner so as not to cause a nuisance, injury or inconvenience to any private property owners.
- .3 Comply with the requirements of OPSS. MUNI 180.

401.07.05 - 401.07.06 - Support Systems is amended by the addition of the following:

- 1. Protect any existing features in accordance with Section 02260 - Excavation Support Systems and Section 02261 - Excavation Temporary Support Systems.

SECTION 02315
TRENCHING, BACKFILLING AND COMPACTING

2. Engage the services of a professional engineer who is licensed in province of Ontario, to design and inspect any cofferdams, shoring, bracing and underpinning required for the Work.
3. Submit the design and all supporting data to the Consultant for review a minimum of 15 Working Days prior to commencing the Work of this Section.
4. The design and supporting data submitted is to bear the stamp and signature of a professional engineer licensed to practice in the Province of Ontario.

401.07.07 - Temporary Protection Systems is amended by the addition of the following:

.1

- .1 Obtain a permit from the City, the Local Municipality and the applicable Conservation Authority having jurisdiction for the temporary diversion of a water course.
- .2 Construct temporary work to the depths, heights and locations as approved by the Consultant.
- .3 During backfill operations:
 - .1 Remove sheeting and shoring from excavations, unless otherwise indicated in the Contract Documents or directed by the Consultant.
 - .2 Do not remove bracing until backfilling has reached the respective levels of such bracing.
 - .3 Consultant to inspect work prior to concealment.
 - .4 Pull sheeting in increments that will ensure that the compacted backfill is maintained at an elevation at least 500 mm above the toe of the sheeting.
- .4 When sheeting is required to remain in place, cut off the tops at the elevations as indicated in the Contract Documents.

401.07.08 -Removal of Frozen Ground is deleted in its entirety and replaced by the following:

Obtain the prior, written consent of the Consultant before starting excavation in frozen ground. Written authorization from the Consultant must be obtained for all methods to be used to carry out such work.

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- .5 The method used for removal of frozen ground shall not cause damage to adjacent structures or Utilities.
- .6 All excavations shall be protected to prevent frost from penetrating the ground below the foundations. Any footing or structure laid on frost which, in the opinion of the Consultant, has been injured through the Contractor's failure to adhere to the requirements of this subsection or any other Specification Section, shall be removed and made good by the Contractor at the Contractor's own expense.
- .7 Backfilling shall not be performed with frozen material and no fill shall be placed over material which is already frozen.
- .8 All sub base and excavated ground must be tested and inspected by the Consultant prior to backfilling.
- .9 Replace any excavated frozen material with suitable backfill material at no additional cost to the City. Frozen material may be stockpiled for use after it has thawed if it has been deemed acceptable for use by the Consultant.

401.07.09 - Trenching is amended by the addition of the following:

- .1 Excavate to the lines, grades, elevations and dimensions as indicated on the Contract Drawings.
- .2 Do not disturb soil within the branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with a sharp axe or saw.
- .3 Do not leave trench excavations open more than 15 m at the end of any Working Day's operations.
- .4 Dispose of all surplus and unsuitable excavated material off Site.
- .5 Do not obstruct the flow of surface drainage or natural watercourses.
- .6 Earth bottoms of excavations shall be comprised of undisturbed soil, level and free from loose, soft or organic matter.
- .7 Notify the Consultant when the bottom of the excavation is reached.
- .8 Obtain inspection and approval from the Consultant of subbase excavation before proceeding with backfilling of approved non-shrinkable materials

SECTION 02315
TRENCHING, BACKFILLING AND COMPACTING

- .9 Remove unsuitable material from the trench bottom to the extent and depth as directed by the Consultant.
- .10 Correct any unauthorized over excavation as follows:
 - .1 Fill under bearing surfaces and footings with fill concrete.
 - .2 Fill under other areas with Type 2 fill compacted a minimum of 95% of Standard Proctor Maximum Dry Density (SPMDD).
- .11 Hand trim, make firm and remove all loose material and debris from excavations. Where material at the bottom of an excavation is disturbed, compact the foundation soil to a density at least equal to that of the undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to the approval of the Consultant.

401.07.10.01 - General is amended by the addition of the following:

- .1 Use fill of the types as indicated on the Contract Drawings.
 - .1 Exterior side of perimeter walls: use Type 3 fill to subgrade level. Compact to 95 % SPMDD.
 - .2 Under concrete slabs: provide a 150 mm compacted thickness base course of Type 1 fill to the underside of the slab. Compact the base course to 100% SPMDD.
 - .3 Place unshrinkable fill in the areas as indicated on the Contract Drawings.

401.07.10.03 - Bedding is amended by the addition of the following:

- .1 Place and compact granular material for the bedding and surround of underground services as indicated on the Contract Drawing C013
- .2 Place bedding and surround material in unfrozen conditions.
- .3 Place bedding and surround material as specified on the Contract Drawings.

401.07.10.05 - Backfill is amended by the addition of the following:

- .1 Do not proceed with backfilling operations until the Consultant has inspected and approved all installations.

SECTION 02315
TRENCHING, BACKFILLING AND COMPACTING

- .2 Areas to be backfilled shall be free from debris, snow, ice, water and frozen ground.
- .3 Do not use backfill material which is frozen or which contains ice, snow or debris.
- .4 Place backfill material in uniform layers not exceeding 150 mm of compacted thickness up to the grades indicated in the Contract Documents. Compact each layer before placing the subsequent layer.
- .5 Place unshrinkable fill in the areas as indicated on the Contract Drawings. Consolidate and level unshrinkable fill with internal vibrators.

401.07.12 -Site Restoration is amended by the addition of the following:

- .1 Upon completion of the Work in a limited area, and before proceeding to the next area , remove all waste materials and debris, trim slopes, and correct all defects as directed by the Consultant.
- .2 Place topsoil as indicated on the Contract Drawings.
- .3 Reinstate pavement and sidewalks to the elevations that existed before excavation or as indicated on the Contract Drawings.
- .4 Clean and reinstate any areas affected by the Work to the satisfaction of the City.
- .5 Use temporary plating to support traffic loads over unshrinkable fill for the initial 24 hour curing period.

END OF SECTION

**SECTION 02362
DUST CONTROL**

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3.1	OPSS. MUNI 506 IS AMENDED AS FOLLOWS:	2

SECTION 02362 DUST CONTROL

PART 1 GENERAL

1.1 REFERENCES

- .1 Ontario Provincial Standard Specifications (OPSS)
 - .1 OPSS.MUNI 506 Dust Suppressants (Nov 2017)

1.2 DELIVERY STORAGE AND HANDLING

- .1 Supply water and/or calcium chloride in quantities and at times as required in order to mitigate the impacts of dust, or as directed by the Consultant.
- .2 Store bags of calcium chloride solid in weather proof enclosures a minimum of 30m away from ditches and swales.

1.3 MEASUREMENT OF PAYMENT

- .1 All costs associated with the work of this Section shall be included in the price for Item No. 5 in the Bid Form.

PART 2 MATERIALS

2.1 OPSS. MUNI 506 IS AMENDED AS FOLLOWS:

506.04.01 - Submission Requirements The first sentence of the second paragraph is deleted and replaced by the following:

Dust suppressants shall not contain waste material.

506.05.02 -Calcium Chloride Solid, Calcium Chloride Solution, and Calcium Magnesium Chloride Blend The first sentence is deleted and replaced by the following:

Calcium chloride solid and calcium chloride solution shall be according to OPSS 2501. Calcium-magnesium chloride blend shall not be used on City's projects.

506.05.03 -Magnesium Chloride Solid and Magnesium Chloride Solution is deleted in its entirety and replaced by the following

Magnesium chloride solid and magnesium chloride solution shall be according to OPSS 2503. Magnesium chloride solution may be substituted for magnesium chloride solid.

**SECTION 02362
DUST CONTROL**

PART 3 EXECUTION

3.1 OPSS. MUNI 506 IS AMENDED AS FOLLOWS:

506.07.01 - General - The third sentence of is deleted and replaced by the following:

Approved dust suppressants other than water, calcium chloride solid and calcium chloride solution blend shall be applied according to the manufacturer's guidelines and application rates.

506.07.01 -General is further amended by the addition of the following:

- .1 *Imminent Precipitation* Do not apply products if precipitation is occurring or forecast to occur before the product sets or cures.
- .2 *Proximity to Water* Ensure that dust suppressants do not enter and contaminate waterbodies, including surface and groundwater. Do not allow the product to leave the roadway.
- .3 *Sensitive Environments* Application rates near sensitive environments (e.g. marshes) *must* be closely monitored.
- .4 *Flooding* Do not apply products to areas of roads that are subject to flooding.

506.10 - Basis of Payment is amended by the addition of the following:

No extra compensation will be paid for any sweeping, cleaning, or the application of calcium chloride or water ordered and applied on Saturdays, Sundays or holidays.

END OF SECTION

SECTION 02515
CONCRETE CURB AND PAVEMENT

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SECTION 02515
CONCRETE CURB AND PAVEMENT

PART 1 GENERAL

1.1 REFERENCES

- .1 Latest version of references and standards to be used.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM C 117, Standard Test Method for Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D 260, Standard Specification for Boiled Linseed Oil.
 - .4 ASTM D 698-[00ae1], Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600 kN-m/m³).
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-3.3, Kerosene, Amend. No. 1, National Standard of Canada.
 - .2 CAN/CGSB-8.1, Sieves, Testing, Woven Wire, Inch Series.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/ Methods of Test and Standard Practices for Concrete.
 - .2 Concrete Construction/ Methods of Test and Standard Practices for Concrete.
- .5 TS 3.70, Construction Specification for Concrete Sidewalk and TS 3.50, Construction Specification for Concrete Curb & Gutter Systems.
- .6 All concrete sidewalk, island and curb works are to meet the standards and specifications of the City of Toronto.

1.2 SUBMITTALS

- .1 Submit concrete mix design to the Consultant for approval at least twenty (20) days prior to any concrete placement on-site.

SECTION 02515
CONCRETE CURB AND PAVEMENT

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Concrete mixes and materials shall be in accordance with City of Toronto standards (TS 1350).
- .2 Curing Compound: In accordance with TS 1350.
- .3 Non-staining mineral type form release agent: chemically active release agents containing compounds that react with free lime to provide water-soluble soap.
- .4 Boiled linseed oil: to ASTM D 260.
- .5 Kerosene: to CAN/CGSB-3.3.

PART 3 EXECUTION

3.1 GRADE PREPARATION

- .1 Complete subgrade preparation work in accordance TS 501.

3.2 GRANULAR BASE

- .1 Obtain Consultant's approval of subgrade before placing compacted Granular A base for sidewalk and pavement.
- .2 Place granular base material to lines, widths, and compacted depths required.
- .3 Compact granular base in maximum 150 mm layers to 100% Standard Proctor Density.

3.3 CONCRETE

- .1 Obtain Consultant's approval of granular base prior to placing concrete.
- .2 Concrete strength for pavement and curb to be a minimum of 32 MPa.
- .3 Provide edging as indicated with 10 mm radius edging tool as necessary.
- .4 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work will be acceptable to the Consultant and can be demonstrated. Hand finish surfaces when directed.
- .5 The supply and placement of all concrete material shall conform to City specifications TS 3.40, TS.3.50 and TS.1350.

SECTION 02515 CONCRETE CURB AND PAVEMENT

- .6 Concrete pavement and curbs to have minimum compressive strength of 32 Mpa (Exposure Class C-2)

3.4 TOLERANCES

- .1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

3.5 EXPANSION AND CONTRACTION JOINTS

- .1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals of 6 m.
- .2 Install expansion joints at intervals as required per requirements.

3.6 ISOLATION JOINTS

- .1 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings, or permanent structures.
- .2 Seal isolation joints with sealant approved by the Consultant.

3.7 CURING

- .1 As per TS 1350.
- .2 Cure concrete by adding moisture continuously in accordance with CSA-A23.1/A23.2 to exposed finished surfaces after placing, or sealing moisture in by curing compound
- .3 Where burlap is used for moist curing, place two prewetted layers on concrete surface and keep continuously wet during curing period.
- .4 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.8 BACKFILL

- .1 Allow concrete to cure for seven (7) days prior to backfilling.
- .2 Backfill to designated elevations.
 - .1 Compact and shape to required contours as indicated.

SECTION 02515
CONCRETE CURB AND PAVEMENT

3.9 CLEANING

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

SECTION 02631
MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS AND VALVE
CHAMBERS

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**SECTION 02631
MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS AND VALVE
CHAMBERS**

PART 1 GENERAL

1.1 SCOPE OF WORK

- .1 This Section covers the requirements for the adjustment of frames and covers for maintenance holes, catch basins, ditch inlets and valve chambers during the pavement reconstruction at Dufferin Transfer Station.
- .2 The contractor shall adjust all structures to suit proposed pavement elevations including breaking down and removal of portion of top of structures to allow for any/all adjustments.

1.2 RELATED SECTIONS

- .1 Section 01300 – Submittals
- .2 Section 02315 – Excavation, Trenching and Backfilling
- .3 Section 02701 – Aggregates - General

1.3 MEASUREMENT FOR PAYMENT

All costs associated with the work of this Section shall be included in the price for Item No. 16 in the Bid Form.

- .1 Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

1.4 REFERENCES

- .1 OPSS.MUNI 1850 [November 2020], Material Specification for Frames, Grates, Covers, and Gratings.
- .2 CAN/CSA A5 [M88], Portland Cement.

SECTION 02631
MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS AND VALVE
CHAMBERS

1.5 SUBMITTALS

- .1 Material Certification: Submit the manufacturer's test data and certification at least 10 Working Days prior to commencing the Work. Certification is to be marked on the units.

PART 2 PRODUCTS (NOT USED)

END OF SECTION

**SECTION 02701
AGGREGATES**

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SECTION 02701 AGGREGATES

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 02315 –Trenching, Backfilling and Compacting
- .2 Section 02720 – Untreated Granular Subbase, Base, Surface and Shoulder

1.2 MEASUREMENT AND PAYMENT

- .1 The work of this Section will not be measured separately for payment. All costs associated the work of this Section shall be included in the Contract Price.

1.3 REFERENCES

- .1 Ontario Provincial Standard Specifications (OPSS)
 - .1 OPSS.MUNI 1010 Aggregates- Base, Subbase, Select Subgrade and Backfill Material (Apr 2013)

PART 2 MATERIALS

2.1 OPSS.MUNI.1010 SHALL BE FOLLOWED WITH THE FOLLOWING AMENDMENTS:

1010.05 MATERIALS

- .1 **1010.05.01 General** is amended by the addition of the following:

If the Contractor wishes to use reclaimed concrete material (RCM) prior to delivery of the material to the Site, it must obtain the Consultant's written approval. The RCM must be in full compliance with the requirements of OPSS 1001 and OPSS.MUNI 1010. The Contractor shall provide a full submission indicating the following:

- .1 The sources of the reclaimed concrete material.
- .2 The production plant.
- .3 Stockpile location.
- .4 Date of production.
- .5 Quantity of material in stockpile.
- .6 Test results for RCM in accordance with Table 1 and Table 2 of OPSS.MUNI 1010.

SECTION 02701 AGGREGATES

- .7 Written confirmation that no deleterious building construction and demolition waste material is present in the stockpile.

Submittals shall also include a petrographic analysis of coarse aggregate (in accordance with MTO Laboratory Testing Manual LS-609) and fine aggregate (in accordance with MTO Laboratory Testing Manual LS-616) with specific emphasis on deleterious building construction and demolition waste materials such as drywall and gypsum.

Approval will be considered on a 'stockpile-basis' only. Additional submittals and approval will be required, should the stockpile(s) or source(s) change.

- .2 **1010.05.02 Granular A, Granular M, and Granular S and 1010.05.03 Granular B** are amended by the addition of the following:

The combined amount of deleterious material shall not exceed a total of 1% by total mass (total of coarse and fine aggregate).

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02720
UNTREATED GRANULAR SUBBASE BASE SURFACE AND SHOULDER

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SECTION 02720
UNTREATED GRANULAR SUBBASE BASE SURFACE AND SHOULDER

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 02701 – Aggregates – General
- .2 Section 02725 – Hot Mix Asphalt
- .3 Section 02515 – Concrete Curb and Pavement

1.2 REFERENCES

- .1 Ontario Provincial Standard Specifications
 - .1 OPSS. MUNI 314(Nov 2023) Untreated Granular Subbase, Base, Surface, Shoulder And Stockpiling
 - .2 OPSS.MUNI 1010 Aggregates- Base, Subbase, Select Subgrade and Backfill Material (Nov 2013)

1.3 MEASUREMENT AND PAYMENT

- .1 All costs associated with the work of this Section shall be included in the price for Item No. 14 and 15 in the Bid Form.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Granular base: material in accordance with Section 02701 - Aggregates - General

PART 3 EXECUTION

3.1 OPSS AMENDMENTS

- .1 OPSS.MUNI 314 shall be followed with the following amendments:

314.07 CONSTRUCTION

- .1 **314.07.01 Granular Subbase, Base, and Surface** is amended by the addition of the following to the first paragraph:
 - .1 The Contractor shall not use heavy vehicles such as tractor trailers to haul gravel if the subgrade becomes deformed. The subgrade or granular surface shall be shaped and proof rolled to ensure even

SECTION 02720
UNTREATED GRANULAR SUBBASE BASE SURFACE AND SHOULDER

and smooth surface free of dips and humps before placement of subsequent layer of material.

.2 **314.07.06 Tolerances** is amended by the addition of the following:

- .1 The tolerances specified in this section are working tolerances only and it is expected that the Contractor will use them as such and not keep the grade consistently high or low to replace other material.

.2 314.08 QUALITY ASSURANCE

.1 **314.08.01 General** is amended by the addition of the following:

- .1 The Contractor shall supply a person to assist the Consultant's inspector in checking the grade when requested by the Consultant.
- .2 Place the granular base after the sub-base surface is inspected and approved by the Consultant.

.3 314.09 MEASUREMENT FOR PAYMENT

.1 **314.09 Measurement for Payment** is amended by the addition of the following:

- .1 Payment for supply, placement and compaction (including water required to obtain desired compaction requirements) of granular base shall be made under Item No. 14 and 15 in the Bid Form. Refer to Contract Drawings for quantities of granular 'A'.

.4 314.10 BASIS OF PAYMENT

314.10.01 is amended by the addition of the following:

- .1 The Contractor shall repair or replace any granular material lost through washouts or bladed-off the roadway and no additional payment will be made for this Work. The applicable unit prices in the Schedule of Prices for Granular 'A' and Granular 'B', Type I, shall apply when additions or deletions requested by the Commissioner cause changes in the tender quantities.
- .2 No measurement or payment will be made for water used for compaction or dust control. Payment for water shall be included in the Contract unit price of the tender item(s) for the material to be placed or the Work to be carried out.

SECTION 02720
UNTREATED GRANULAR SUBBASE BASE SURFACE AND SHOULDER

- .3 The tender quantities will be the pay quantities unless any additions or deletions are requested by the Consultant. Any additions or deletions shall be calculated from field tape measurements agreed to by the Consultant and the Contractor.
- .4 The Contractor shall be responsible for any granular material required to maintain access. As the cubic metre payment for granular materials is based on the theoretical quantity calculated as specified, the Contractor shall make its own allowances in its Contract unit prices for any loss of Granular 'A' into the Granular 'B', Type I, and for any Granular 'A' required for maintenance of traffic. The Contractor shall also make allowances in its Contract unit prices for any losses of Granular 'B' during its operations.

END OF SECTION

**SECTION 02725
HOT MIX ASPHALT**

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SECTION 02725 HOT MIX ASPHALT

PART 1 GENERAL

1.1 SUMMARY

This Section outlines Hot Mix Asphalt pavement construction for roadway reconstruction, asphalt sidewalks, and other paved surface restoration.

1.2 RELATED SECTIONS

- .1 Section 02051 - Demolition
- .2 Section 02315 – Trenching, Backfilling and Compacting
- .3 Section 02701 – Aggregates – General
- .4 Section 02720 – Untreated Granular Subbase, Base, Surface and Shoulder

1.3 REFERENCES

- .1 OPSS.PROV 308 [April 2012], Construction Specification for Tack Coating and Joint Painting
- .2 OPSS.MUNI 310 [Nov 2017], Construction Specification for Hot Mix Asphalt.
- .3 OPSS.MUNI 1101 [Nov 2016], Material Specification for Performance Graded Asphalt Cement.
- .4 OPSS.MUNI 1103 [Nov 2019], Material Specification for Emulsified Asphalt.
- .5 OPSS.MUNI 1151 [April 2018], Material Specification for Superpave and Stone Mastic Asphalt Mixtures.
- .6 OPSS.MUNI 311 [Nov 2018], Construction Specification for Asphalt Sidewalk, Driveway, and Boulevard and for Sidewalk Resurfacing.
- .7 OPSS.MUNI 510 [Nov 2018], Construction Specification for Removal.
- .8 OPSS.MUNI 341 [April 2018], Construction Specification for Routing and Sealing Cracks in Hot Mix Asphalt Pavement.

1.4 MEASUREMENT AND PAYMENT

- .1 All costs associated with the work of this Section shall be included in the price for Item No. 14 and 15 in the Bid Form.

SECTION 02725 HOT MIX ASPHALT

The price for Hot Mix Asphalt (HMA) shall include the supply of the Performance Graded Asphalt Cement (PGAC). The grade of the asphalt cement for the Superpave mixes shall be PGAC 64-28 unless specified otherwise in the Contract Documents.

Each course of asphalt shall be placed to the specified thickness. If the specified placement rate is exceeded, payment may be withheld for the excess material placed.

Payment at the Contract price for Driveway shall be full compensation for all labour, equipment and material necessary to do the Work including the hot mix asphalt, the excavation and disposal of all material, curb cutting at intersection, transit stops, the supply, placing, watering and compacting of all foundation materials and the removal of this temporary asphalt sidewalk in order to complete the Work as specified in the Contract.

Payment for these items shall be made at the applicable price in the Bid Form and shall be full compensation for all labour, equipment and materials necessary to complete this work.

1.5 GENERAL

Category	Surface Course Asphalt	Base Course Asphalt	Existing Granular 'A' Base	Existing Granular 'B' Sub-base
Scale House Area	40mm Superpave 12.5 FC1 Surface Course, PGAC 64-28, Category 'D'	70+70 (2 lifts) Superpave 19.0 Binder Course PGAC 64-28 Category 'D'	190mm Granular 'A'	150mm Granular 'B', Type 1
Existing Ramp from Tipping Floor	40mm Superpave 12.5 FC1 Surface Course, PGAC 64-28, Category 'D'	70+70mm (2 lifts) Superpave 19.0 Binder Course PGAC 64-28 Category 'D'	140mm Granular 'A'	210mm Granular 'B', Type 1
Area around Building 500	40mm Superpave 12.5 FC1 Surface Course, PGAC 64-28, Category 'D'	70+70mm (2 lifts) Superpave 19.0 Binder Course PGAC 64-28 Category 'D'	220mm Granular 'A'	110mm Granular 'B', Type 1
Yard Waste Drop off	40mm Superpave 12.5 FC1 Surface	70+70mm (2 lifts) Superpave 19.0 Binder	295mm Granular Base	

**SECTION 02725
HOT MIX ASPHALT**

	Course, PGAC 64-28, Category 'D'	Course PGAC 64-28 Category 'D'	
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The Contractor shall submit all required asphalt mix designs to the Consultant for review and acceptance a minimum of 10 Business Days before asphalt paving is scheduled to be undertaken. If for any reason the asphalt material is changed during the performance of the Work, the new mix design must be submitted to the Consultant for review and acceptance before the new hot mix asphalt is incorporated into the Work. The Contractor shall provide ample notice to the Consultant 2 Business Days in advance of paving operations to schedule testing and sampling.

All Performance Graded Asphalt Cement (PGAC) used in the hot mix asphalt must be compliant with the requirements outlined in Table 11 of OPSS.MUNI 1151.

Superpave asphalt mixes shall be designed to provide a minimum PGAC content as follows:

Mix Type	Minimum PGAC Content
SP12.5FC1	5.1%
SP19.0	4.8%

If the granular base is exposed following grinding (for base repairs and roadways where there is only one lift of asphalt), the granular base shall be fine graded and compacted to the satisfaction of the Consultant before any asphalt is placed. All faces of the pavement in the excavated area shall be painted with a thin, uniform and continuous coating of tack coat.

Under no circumstances shall top course asphalt paving take place after November 30th unless prior written permission has been received from the Consultant. Where required, the Contractor shall be responsible for the cost to provide the asphalt late season heating levy for asphalt placed in the winter months after November 30th and before spring of the next year.

**Payment Adjustment for Variations in Asphalt Cement in HMA – Bid AC
Bidding Requirements**

The asphalt cement content of mix designs for bidding purposes shall be those shown in Table 1 below (Asphalt Cement Content for Bid Purposes (%), or Bid AC).

The minimum asphalt cement content for the mix design must be equal to, or greater than, those shown in Table 1.

The maximum asphalt cement content to be considered for payment adjustment for each mix shall be those shown in Table 1.

**SECTION 02725
HOT MIX ASPHALT**

**TABLE 1 - Superpave Asphalt Cement Content for Bid Purposes (%)
Bid AC, Minimum AC for Mix Design, and Maximum AC Content for Payment
Adjustment**

Mix Type	Asphalt Cement Content for Bid Purposes (%)	Minimum Asphalt Cement Content for Mix Design (%)	Maximum Asphalt Cement Content for Payment Adjustment (%)
SP 12.5	5.1	5.1	5.5
SP 19.0	4.8	4.8	5.3

Price Adjustments

The Contractor shall submit a request for payment adjustment to the City. The price used to calculate the payment adjustment shall be based on the actual AC incorporated into the HMA based on the QA results and the applicable AC Bid % specified in Table 1.

Note: Payment adjustments to be paid to the Contractor will apply up to the maximum AC content as specified in Table 1.

The payment adjustment calculated using this formula shall be full compensation for any and all PGAC grades specified.

Actual AC shall be defined as the average AC content obtained from samples taken during paving operations minus the AC content of the Reclaimed Asphalt Pavement (RAP) in the asphalt mix design.

The AC Price shall reflect the Ministry of Transportation's (MTO) PGAC price index appearing monthly in the MTO's Contract Bulletin.

Actual AC Calculation - Example 1:

Asphalt Specified = SP12.5 PGAC 64-28

Asphalt Qty = 10,000 tonnes

Average AC content obtained from QA samples = 5.3% of Asphalt Qty = 530 tonnes

Actual AC = Average AC from samples = 530 tonnes

Actual AC % = (530 tonnes / 10,000 tonnes) x 100 %

Actual AC % = 5.3% of PGAC

Actual AC Calculation - Example 2:

Asphalt Specified = SP19 PGAC 64-28

Asphalt Qty = 10,000 tonnes

Asphalt mix design RAP = 15% = 1,500 tonnes

AC Content of RAP = 4% of asphalt mix design RAP = 60 tonnes

Average AC content obtained from QA samples = 5.3% of Asphalt Qty = 530 tonnes

Actual AC = Average AC from samples – AC Content of RAP = 530 – 60 = 470 tonnes

Actual AC % = (470 tonnes / 10,000 tonnes) x 100 %

Actual AC % = 4.7% of PGAC

SECTION 02725 HOT MIX ASPHALT

HMA Quantity shall be defined as the actual amount of hot mix asphalt placed and accepted into the Work in tonnes.

The Contractor shall bid the hot mix asphalt item(s) using the content of PGAC specified.

An asphalt payment adjustment will only be considered for those items for which the unit of measurement specified in the Bid Form is “tonne (t)”.

The City will use the Ministry of Transportation’s PGAC price index issued the month prior to tender closing to determine the adjustment(s), if any:

Payment adjustment* = HMA Qty x (Actual AC – Bid AC) x AC Price

*Negative value indicates payment to the City.

PART 2 PRODUCTS

2.1 **OPSS.MUNI 1101 SHALL BE FOLLOWED WITH THE FOLLOWING AMENDMENTS:**

1101.02 References is amended by the deletion of the following:

ASTM International

D3665-12 Standard Practice for Random Sampling of Construction Materials

1101.04.01.01 PGAC Test Documentation is deleted and replaced by the following:

For each grade of PGAC specified in the Contract Documents, the Contractor shall supply the following to the Consultant a minimum of 14 Days prior to the first use of each Product, or concurrently with the submission of the asphalt mix design, whichever is earlier:

- a) The PGAC supplier and the facility type and location that the Product will be supplied from.
- b) Test results for the Product demonstrating compliance with the requirements of the Contract Documents.
- c) Applicable mixing and compaction temperatures for the Product.
- d) Documentation setting out the construction, storage and handling requirements, including the material safety data sheet, re-compaction temperature, mix discharge temperature, and recommended extraction procedure.
- e) When the PGAC contains any Polyphosphoric acid (PPA) and a liquid anti-stripping additive is incorporated into the PGAC at the PGAC supplier’s depot:
 - i) information on how much anti-stripping additive was added to the PGAC, and;
 - ii) documentation from the PGAC supplier confirming that the PPA modified PGAC with the liquid anti-stripping additive added at the PGAC supplier’s depot will meet all asphalt cement material requirements specified in the Contract

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Documents and American Association of State Highway and Transportation Officials (AASHTO) M320 for the PGAC grade specified in the Contract.

- f) A copy of all LS-227 documentation demonstrating that the Product complies with the requirements of the Contract Documents.
- g) Low temperature limiting grade along with a copy of all of the LS-308 documentation demonstrating that the Product complies with the requirements of the Contract Documents.
- h) Average of the critical crack tip opening displacement (δ_I) as determined according to LS-299 along with a copy of all of the LS-299 documentation demonstrating that the Product complies with the requirements of the Contract Documents.

For test documentation required under f), g), and h) above, the independent laboratory conducting the PGAC testing shall have participated in the most recent AASHTO Materials Reference Laboratory proficiency sample correlation program for PGAC and shall have obtained proficiency ratings in the program, satisfactory to the City.

The Consultant shall review the test results submitted and provide written confirmation of conformance of the PGAC, or advise the Contractor of any non-conformance, within 10 Business Days from the date of delivery of the samples and test documentation. The mix shall not be placed until the Consultant provides written confirmation of conformance of the PGAC to the requirements of the Contract Documents, based on the submitted test results and possible QA testing. The Consultant's confirmation of conformance of the submitted PGAC properties does not constitute any guarantee that the mix can be produced, constructed, or both, in accordance with the Contract requirements, and shall not relieve the Contractor of its responsibility for ensuring the specified quality of materials and workmanship.

2.2 **OPSS.MUNI 1151 SHALL BE FOLLOWED WITH THE FOLLOWING AMENDMENTS:**

1151.02 References is amended by deleting the reference to OPSS 1101 Performance Graded Asphalt Cement from the list of **Ontario Provisional Standard Specifications, Material** and replacing it with "OPSS.MUNI 1101 Material Specification for Performance Graded Asphalt Cement as modified by these Specifications".

1151.02 References is amended by the addition of the following to the list of **MTO Laboratory Testing Manuals** under the **Ontario Ministry of Transportation Publications**:

LS – 227 Determination of Ash Content

LS – 299 Determining Asphalt Cement's Resistance to Ductile Failure Using Double Edge Notched Tension Test (DENT)

LS – 308 Determination of Performance Grade of Physically Aged Asphalt Cement Using Extended Bending Beam Rheometer (BBR) Method

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1151.02 References is further amended by the addition of the following to the list of **American Association of State Highway and Transportation Officials (AASHTO) Standards**:

M 332-14 Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test

1151.05.01 Asphalt Cement is amended by deleting the reference to OPSS 1101 in the first sentence and replacing it with “OPSS.MUNI 1101 as modified by these Specifications”.

PART 3 EXECUTION

3.1 OPSS.MUNI 310 SHALL BE FOLLOWED WITH THE FOLLOWING AMENDMENTS:

310.02 References is amended by deleting the reference to OPSS 1101 Performance Graded Asphalt Cement from the list of **Ontario Provincial Standard Specifications, Material** and replacing it with “OPSS.MUNI 1101 Material Specification for Performance Graded Asphalt Cement as modified by these Specifications”.

310.02 References is amended by the addition of the following to the list of **MTO Laboratory Testing Manuals** under the **Ontario Ministry of Transportation Publications**:

LS-227 Determination of Ash Content

LS-299 Determining Asphalt Cement’s Resistance to Ductile Failure Using Double Edge Notched Tension Test (DENT)

LS-308 Determination of Performance Grade of Physically Aged Asphalt Cement Using Extended Bending Beam Rheometer (BBR) Method

310.02 References is further amended by the addition of the following to the list of **American Association of State Highway and Transportation Officials (AASHTO) Standards**:

M 332-14 Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test

310.05.01 Hot Mix Asphalt is deleted and replaced by the following:

The materials used in the production of HMA shall be in accordance with OPSS.MUNI 1151 for Superpave mixes.

The RAP content allowed in the various hot-mix asphalt mix types is as follows:

Mix Type	Maximum RAP Percentage Allowed
All Surface Course Mixes	0%
SP 19.0 and SP 25.0	15%

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The use of recycled shingle tabs in any mix is not permitted.

The use of slag as an aggregate in any mix is not permitted.

The requirements of Appendices 1003-D and 1003-E of OPSS.MUNI 1003 shall apply to this Specification.

310.07.01 Quality Control is amended by the addition of the following:

Testing of materials and of compaction requirements for compliance with technical requirements of the Specifications shall be the duty of a testing laboratory provided by Contractor. The laboratory performing testing shall have CCIL (Canadian Council of Independent Laboratories) Type B Certification.

Testing of asphalt shall be in accordance with OPSS.MUNI 310 and include tests to meet compliance with 310.08.02, 310.08.03 and 310.08.04.

Sampling and testing frequency of hot mix asphalt shall meet or exceed the requirements of Table 6 of OPSS.MUNI 310. The Contractor shall deliver to their testing laboratory for Quality Control testing, samples of hot mix asphalt with a minimum mass of 10 kg. The Contractor shall obtain Quality Control and referee samples using a Quartermaster sample splitter, or equivalent.

The use of testing service shall in no way relieve the Contractor of his responsibility to furnish materials and construction in full compliance with the Contract Documents. To facilitate testing service, the Contractor shall:

1. Secure and deliver to the testing laboratory representative samples of the materials proposed for use and are required to be tested.
2. Furnish such casual labour as is necessary to obtain and handle samples at the Site or at other sources of material.
3. Advise the testing laboratory and Consultant sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

All quality control test results, samples and reports shall be made available to the Consultant within 5 Days after receipt of the results.

The Contractor is responsible for the interpretation of test results and determination of actions to be taken to ensure conformance with the Contract Documents.

310.07.04 Transportation of Hot Mix Asphalt

Schedule delivery of material for placing in daylight hours, unless otherwise approved by the Consultant. Deliver material to paver at a uniform rate and in an amount within capacity of paving and compacting equipment.

Deliver loads continuously and immediately spread and compact.

Before unloading asphalt at the Site, provide Consultant a delivery ticket (with each batch of asphalt) on which is printed, stamped or written the following information:

1. Name and location of batch plant.

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2. Date and serial number of ticket.
3. Name of Contractor.
4. Specific designation of job (name and location).
5. Approved job mix formula.
6. Amount of asphalt in tonnes.
7. Truck number, cumulative total, and/or load number.
8. Time truck was loaded.

Provide space for the following information, which shall be registered by producer's representative on at least two copies of the delivery ticket, after discharge has been completed:

1. Time that load arrived on the Site.
2. Time load was discharged.

310.07.05.01.01 General is amended by deleting all references to OPSS 1101 and replacing them with “OPSS.MUNI 1101 as modified by these Specifications”.

310.07.05.01.02 Frequency and Location is deleted and replaced by the following:

A minimum of one sample shall be randomly chosen for each asphalt cement type used on the Contract. Additional samples shall be provided by the Contractor when requested by the City.

310.07.05.02.01 General is amended by deleting the first sentence and replacing it with the following:

The Consultant will be conducting QA testing, using the requirements of OPSS.MUNI 310, OPSS.MUNI 1101 and OPSS.MUNI 1151 as guidelines. The Contractor shall obtain QC, QA and referee HMA samples using a Quartermaster sample splitter.

310.07.06.02 Operational Constraints is amended by the addition of the following:

The placement of the surface course asphalt will not be permitted until all trimming and placement of topsoil, sod and seed is completed.

The temperature of the mixture, as it is discharged from the mixer, shall be controlled within a temperature range of 135°C to 150°C.

310.07.11.01 General is amended by deleting the second paragraph and replacing it with the following:

Longitudinal and transverse butt or stepped joints between the new HMA pavement and the previously paved pavement shall be constructed by trimming the previously paved pavement edge to a straight, clean, vertical surface of at least 50 mm.

310.07.11.03 Transverse Joints is amended by the addition of the following:

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All transverse construction joints and mat terminations shall be temporarily ramped to minimize the bump. Transverse joints between new and existing pavement shall be prepared no more than 24 hours in advance of paving tie-ins unless the joint is adequately ramped to the satisfaction of the City. Existing paved entrances shall be connected to new construction using an appropriate full depth butt or ground step joint to ensure a smooth transition to the satisfaction of the City.

310.08.01 General is amended by deleting all references to OPSS 1101 and replacing them with “OPSS.MUNI 1101 as modified by these Specifications”.

310.08.01 General is amended by the addition of the following: The Consultant will be conducting QA testing, in accordance with the requirements of OPSS.MUNI 310 and OPSS.MUNI 1151. The Consultant will also be checking Superpave HMA Volumetric Properties for acceptance against the Contractor’s mix design and the requirements of OPSS.MUNI 1151 as follows:

Voids in Mineral Aggregate (2) shall be +/- 1.0% from the submitted mix design and not more than 0.5% below the design minimum.

For the purpose of hot mix sampling and testing, one lot will be deemed to be the total of each Day’s production.

310 Table 10 Minimum Pavement Compaction Based on Maximum Relative Density is deleted and replaced by the following Table:

Mix	Acceptable %	Borderline %	Rejectable %
Superpave 12.5 FC1	92.0 to 96.5	96.6 to 97.5	<92.0 or >97.5
Superpave 19.0	91.0 to 96.5	96.6 to 97.5	<91.0 or >97.5

The Contractor shall furnish rollers, tampers, and other compaction equipment to provide the specified compaction in restricted areas with the approval of the Consultant.

At pavement installations adjacent to curbs, maintenance holes, valve boxes, and other structures not accessible to rollers, the Contractor shall compact thoroughly by means of hot tampers.

3.2 TACK COAT

OPSS.PROV 308 shall be followed with the following amendments

308.07 CONSTRUCTION

308.07.01 Application of Tack Coat is amended by the addition of the following:

Tack coat shall be applied to all previously paved surfaces regardless of whether or not they have been open to traffic.

SECTION 02725 HOT MIX ASPHALT

Where the asphalt surface course is placed in two lifts, the surface of the first lift shall be thoroughly cleaned of dirt by sweeping with a power broom, hand brooming and scraping where necessary. The asphalt surface shall be free of standing water. A tack coat shall then be applied prior to installation of the second course. Tack coat shall be applied by means of an approved pressure distributor.

The Contractor shall consider the use of alternative products for nighttime operations and cold temperatures. The use of any alternative product by the Contractor requires prior acceptance by the Consultant.

3.3 ASPHALT SIDEWALK, DRIVEWAY & BOULEVARD

OPSS.MUNI 311 shall be followed with the following amendments:

311.05 MATERIALS

311.05.01 Hot Mix Asphalt is amended by replacing with the following:

The hot mix asphalt for this work shall be according to OPSS MUNI 1151 for SP12.5 and SP19.0

311.07 CONSTRUCTION

311.07.01 General is amended by the addition of the following:

Asphalt paving shall be carried out in accordance with OPSS MUNI 310. Granular placement shall conform to Section 02701 – Aggregates – General and Section 02720 - Untreated Granular Subbase, Base, Surface and Shoulder.

Driveways and boulevards shall be paved on granular ‘A’ as specified on the Contract Drawings. Existing paved entrances shall be connected to the new construction where necessary using the Hot-Mix asphalt SP 12.5 and SP 19.0 per OPSS MUNI 1151.

Thickness of granular and the Hot Mix asphalt shall be as specified on the Contract Drawings. The Contractor shall ensure a smooth transition from the new construction to the existing entrance.

Traffic

Keep vehicular traffic off newly paved areas until the pavement surface temperature has cooled below 38 °C.

No stationary loads shall be permitted on either the asphalt binder or surface courses of pavement until 24 hours after paving.

Ensure traffic controls are approved and Contractor’s Traffic Control personnel is arranged where traffic movements through signalized intersections are impacted, in accordance with Section 01550 - Traffic Control.

Ensure ramping, warning signs, and marking of raised surfaces are in proper order prior to re-opening for traffic.

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3.4 REMOVALS

The Contractor shall perform grinding, milling and asphalt removals in accordance with **OPSS.MUNI 510**.

When the day's work for asphalt pavement removal is completed, normal traffic flow in each direction shall be resumed. In order to restore normal traffic flow, any grade differences between adjacent pavements (existing and milled) in transverse directions shall be ramped with hot mix asphalt. Ramps in the transverse direction shall be sloped at 20:1. The Contractor shall ensure that there are no grade differences between adjacent pavements (existing and milled) in longitudinal directions. The Contractor is advised that in order to open all side streets to all lanes of traffic at the end of each Day, temporary ramping will be required around maintenance holes, catch basins, and valve chambers within the roadway after the milling operation has been performed. All temporary ramps around the manholes, catch basins, and valve chambers shall be completely removed prior to placement of the new base or surface course asphalt. As an alternative to this ramping, at the Contractor's discretion, all maintenance holes, catch basins, etc., may be lowered to match the grade of the freshly milled surface, then adjusted to the new final grade before the new surface asphalt is placed. No additional payment will be made for these adjustments.

Maintenance Holes

Following all asphalt removal work, and prior to opening the transfer station road to traffic, the Contractor shall install temporary maintenance hole safety ramps at all maintenance holes, until the surface course of asphalt is placed.

Equipment

The asphalt removal work shall be performed using a pavement-cutting machine of a type that has performed successfully on other work comparable to that proposed to be done under this Contract. The Contractor shall not draw any water from areas which are considered to be environmentally sensitive.

Cutting Equipment

The cutting-machine to be used to perform work under this Contract shall be designed and built for this type of work, be self-propelled and shall have, in combination, the means for cutting the old surface and blading the cuttings into one windrow.

The machine shall be able to cut flush to all curbs and gutters, manholes and catch basins.

3.5 ROUTING AND SEALING JOINTS

OPSS.MUNI 341 shall be followed with the following amendments:

The Contractor shall perform routing and sealing of joints in accordance with **OPSS.MUNI 341** at all joints between new pavement and existing pavement or in the locations deemed appropriate by the Consultant.

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Joint Sealant – Reinstatement Tape

Prior to placing the surface course of Hot Mix Asphalt, the Contractor shall install a cold applied polymer modified bituminous strip in order to provide a smooth, lip free joint.

The tape shall be 2 mm x 50 mm "Denso North America, Inc." brand reinstatement tape (described below) or equivalent. The Contractor shall install the tape according to the supplier's instructions which may include the use of special primers and/or special equipment.

The supplier's instructions can be downloaded at:

<http://www.densona.com/pdfs/DensoRoadProducts/Denso-Re-Instatement-Tape.pdf>

In conjunction with the suppliers' placement instructions the Contractor shall rake off any large aggregates present on the edge of the repair area prior to the final rolling application. Large aggregates that are raked off shall be removed, and disposed of, and shall not be placed back on the new asphalt patch. The reinstatement tape shall overlap sufficiently in order to achieve a water tight joint. All edges of placed asphalt, including around all valve chambers, maintenance holes, catch basins, valve boxes, along the concrete curb and gutter, and at the transverse cold joints at the paving limits shall receive this treatment.

341.05 MATERIALS

341.05.01 Crack Sealant is amended by the addition of the following:

The crack sealant compound shall be as specified in ASTM D-6690 Type IV Modified and shall have a resilience of 30% to 60%.

341.05.02 Limestone Screenings is added to the Specification:

Limestone screenings to be used as a dusting sealant shall have 100 percent passing through the 1.18 sieve and not greater than 25 percent passing through the 0.075 sieve.

341.05.03 Crack Sealant Barrier Material is added to the Specification:

The crack sealant barrier material to be used for this Contract shall be Glenzoil 20 Plus or Equivalent with prior written authorization from the City.

341.06 EQUIPMENT

341.06.02 Heating Kettle is amended by the addition of the following:

The heating kettle shall meet the requirements of the Technical Standards and Safety Authority.

341.06.04 Air Compressor is added to the Specification

The air compressor used to supply the hot-compressed air lance shall be equipped with oil and moisture filters and shall provide a minimum pressure of 700 kPa at a minimum air volume of 4.25 cubic metres per minute (150 cfm).

341.07 CONSTRUCTION

341.07.03 Cleaning of Routed and Unrouted Cracks is amended by the addition of the following:

The Contractor shall take all necessary precautions to prevent the hot lance from charring or burning the asphalt surface of the joints.

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HOT MIX ASPHALT**

341.07.05 Sealant Dusting is deleted and replaced by the following:

Where traffic is to be maintained during joint sealing, the surface of the sealant compound shall be dusted with limestone screenings in accordance with the requirements of subsection 341.05.02, in order to eliminate any tackiness, prior to allowing any traffic to travel over the joint sealed area.

END OF SECTION

SECTION 02911
TOPSOIL AND FINISH GRADING

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**SECTION 02911
TOPSOIL AND FINISH GRADING**

PART 1 GENERAL

1.1 SUMMARY

- .1 This specification covers the requirements for stockpiling, supplying, finish grading and placing topsoil.

1.2 RELATED SECTIONS

- .1 Section 02701 – Aggregates - General

1.3 MEASUREMENT AND PAYMENT

The Work outlined in this Section will be measured and paid for at the unit price as indicated in the Bid Form Item 6 and 16.

PART 2 PRODUCTS

2.1 TOPSOIL

- .1 Topsoil for seeded areas and planting beds: a mixture of particulates, micro organisms and organic matter which provides a suitable medium for supporting the intended plant growth.
 - .1 Soil texture based on The Canadian System of Soil Classification, to consist of 20 to 70 % sand, 15-30% clay, and containing 2.5 to 5 % organic matter by weight.
 - .2 Shall contain no toxic elements or growth inhibiting materials.
 - .3 Finished surface shall be free from:
 - .1 Debris and stones over 75 mm in diameter.
 - .2 Course vegetative material, 25 mm in diameter and 100 mm in length, occupying more than 2% of the soil volume.
 - .4 Consistence: friable when moist.
 - .5 Do not use topsoil that is in a frozen or muddy condition.
 - .6 Imported topsoil shall be screened.

2.2 SOIL AMENDMENTS

- .1 Fertilizer:

SECTION 02911
TOPSOIL AND FINISH GRADING

- .1 Fertility: major soil nutrients present in the following amounts:
 - .1 Nitrogen (N): [20] to [40] micrograms of available nitrate per gram of topsoil.
 - .2 Phosphorus (P): [10] to [60] micrograms of phosphate per gram of topsoil.
 - .3 Potassium (K): [80] to [250] micrograms of potassium per gram of topsoil.
 - .4 Calcium, magnesium, sulphur and micro nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.
 - .5 pH value: 6.0 to 7.8
- .2 Sand: washed coarse silica sand, medium to coarse textured.
- .3 Fertilizer: industry accepted standard medium containing nitrogen, phosphorous, potassium and any other micronutrients suitable to the specific plant species or application or as defined by the soil test.

2.3 SOURCE QUALITY CONTROL

- .1 The Contractor will be responsible for obtaining soil test analysis and determining any requirements for soil amendments for topsoil. The Consultant is to be provided with a copy of the analysis.
 - .1 Advise the Consultant of the sources of topsoil and manufactured topsoil to be utilized with sufficient lead time for testing.
 - .2 The Contractor is responsible for amendments to supply topsoil as specified in the Contract Documents.
 - .3 Provide soil testing results by a recognized testing facility acceptable to the Consultant for pH, P, K, and organic matter.
 - .4 Independent testing of topsoil will be carried out by a testing laboratory designated by the Consultant. Soil sampling, testing and analysis is to be in accordance with applicable Provincial standards. The City will pay for all costs for these tests.

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TOPSOIL AND FINISH GRADING

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

- .1 Commence topsoil stripping of the Site as indicated on the Contract Drawings, and as directed by the Consultant, after the area has been cleared of brush, weeds and grasses and removed from Site.
- .2 Strip topsoil to the depths as indicated on the Contract Drawings, or as directed by the Consultant. Avoid mixing topsoil with subsoil where the textural quality will be moved outside of the acceptable range for the intended application.
- .3 Stockpile in locations as directed by the Consultant. The stockpile height is not to exceed 1.4 metres.
- .4 Stockpiles that will be in place for an extended period shall be seeded to protect against erosion.
- .5 Dispose of unused topsoil off Site.
- .6 Protect stockpiles from contamination and compaction.

3.2 PREPARATION OF EXISTING GRADE

- .1 Verify that grades are correct. If discrepancies occur, notify the Consultant and do not commence the Work until instructed by the Consultant.
- .2 Grade the soil, eliminate uneven areas and low spots, and ensure positive drainage.
- .3 Remove debris, roots, branches and stones in excess of 50 mm in diameter and other deleterious materials. Remove soil contaminated with calcium chloride, toxic materials and petroleum products. Remove debris which protrudes more than 75 mm above the surface. Dispose of removed material off Site.

3.3 PLACING AND SPREADING OF TOPSOIL/PLANTING SOIL

- .1 Place topsoil after the Consultant has approved the subgrade.
- .2 Remove all stones, roots, and other debris from the stockpiled topsoil during placement.
- .3 Spread topsoil in uniform layers not exceeding 100 mm.
- .4 Keep topsoil 15 mm below the finished grade in sodded areas.

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TOPSOIL AND FINISH GRADING

.5 Spread topsoil as indicated in the Contract Documents to the following minimum depths after settlement.

.1 150 mm for seeded areas

.2 135 mm for sodded areas

.3 300 mm for flower beds

.4 500 mm for shrub beds

.6 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

3.4 FINISH GRADING

.1 Grade to eliminate rough spots and low areas and to ensure positive drainage. Prepare loose friable bed by means of cultivation and subsequent raking.

.2 Consolidate topsoil to the required bulk density using equipment approved by the Consultant. Leave surfaces smooth, uniform and firm against deep foot printing.

3.5 ACCEPTANCE

.1 The Consultant will inspect and test topsoil in place and determine acceptance of the material, depth of topsoil and finish grading.

.2 Topsoil test to include PK. Level of PK will be used to determine fertilizer requirements and application rates and / or amendments.

3.6 SURPLUS MATERIAL

.1 Dispose of surplus materials not required off Site.

END OF SECTION

**SECTION 02933
SODDING**

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SECTION 02933 SODDING

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 02701 – Aggregates – General
- .2 Section 02911 – Topsoil and Finish Grading

1.2 REFERENCES

- .1 Ontario Provincial Standard Specifications (OPSS)
 - .1 OPSS.MUNI 803 Sodding (Apr 2018)

1.3 MEASUREMENT AND PAYMENT

- .1 All costs associated with the work of this Section shall be included in the price for Item No. 16 in the Bid Form.

PART 2 MATERIALS

1.1 OPSS.MUNI 803 SHALL BE FOLLOWED WITH THE FOLLOWING AMENDMENTS:

803.05.01 Sod is amended by the replacement of the first paragraph with the following:

Sod shall be a Number One Turfgrass Nursery that has been especially sown and cultivated in nursery fields as turfgrass crop. Sod shall be either of the following:

- 1. Number One Kentucky Bluegrass Sod-Fescue Sod: grown solely from a seed mixture of cultivars of Kentucky Bluegrass and Chewing Fescue or Creeping Red Fescue, containing not less than 40% Kentucky Bluegrass cultivars and 30% Chewing Fescue or Creeping Red Fescue cultivar(s).
- 2. Number One Named Cultivars: Nursery Sod grown from certified seed.

PART 3 CONSTRUCTION

1.2 OPSS.MUNI 803 SHALL BE FOLLOWED WITH THE FOLLOWING AMENDMENTS:

803.07.01 Operational Constraints is amended by the addition of the following:

SECTION 02933 SODDING

The placement of the asphalt surface course will not be permitted until all sodding and seeding has been completed.

Areas where the ground cover has been damaged by the Contractor beyond the slope limits shall be restored at the Contractor's expense and shall not be included in the area measured for payment.

803.07.04 **Placement of Sod** is amended by the replacement of the second last sentence of paragraph two with the following:

Sod shall be placed to the mid-point of the shoulder rounding on rural cross-sections.

Placement of Sod is amended by the addition of the following:

The Contractor shall roll the sod in front of residential areas and other areas where the grass is cut.

803.07.05 **Maintenance of Completed Sodding** is amended by the addition of the following:

The Contractor shall water the sod as required in order to obtain growth acceptable to the Consultant.

The Contractor will be responsible for the mowing and protection of all sodded areas. This protection shall include the repair of sodded areas with additional sod, including the restoration of the slope itself and the supply of additional topsoil, until the Total Performance of the Work, subject to the following paragraph.

If sodding has not been completed by October 1st of any year, such areas will not be accepted until at least May 15th of the following year when it can be determined that acceptable growth has taken place; unless it is obvious to the Consultant that acceptable growth has taken place.

This period of maintenance will apply even if the Contract is completed, but the sodding is not completed by the date specified above and the Contractor shall allow for such repair work in its Contract unit prices.

803.08 **QUALITY ASSURANCE**

The term Contract Administrator shall be replaced with Consultant.

Certification of compliance from sod supplier of seed mix and seed mix proportions shall be supplied to Consultant.

803.09 **MEASUREMENT FOR PAYMENT**

803.09 **Measurement for Payment** is amended by the addition of the following:

If the Contractor requests a re-measurement of the sodded area and the re-measured area is less than or equal to the area measured for proposed payment, then the re-measured area will be used for payment and the

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SODDING

Contractor will pay all costs for the re-measurement and recalculation of the quantity.

If the re-measured area exceeds the area measured for proposed payment, the re-measured quantity will be used for payment and the City will bear all costs of re-measurement and recalculation.

All costs associated with the work of this Section shall be included in the price for Item No(s). 16 in the Bid Form.

END OF SECTION

TORONTO MUNICIPAL CODE
CHAPTER 880, FIRE ROUTES



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2021-09-07

Chapter 880

FIRE ROUTES

- § 880-1. Definitions.**
- § 880-2. Application for designation of private road as fire route.**
- § 880-3. Consideration of application.**
- § 880-4. Disposition of application.**
- § 880-5. Appeals.**
- § 880-6. Designation of private road as fire route.**
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- § 880-13. Maintenance.**
- § 880-14. Parking prohibition.**
- § 880-15. Offences and administrative penalties.**
- § 880-16. Removal and impounding.**
- § 880-17. Other remedies.**
- § 880-18. Power of entry.**
- § 880-19. Service.**

[Schedule A, Fire Route Designations](#)

[Schedule B, Fire Route Signs](#)

[History: Adopted by the Council of the City of Toronto October 28, 2004 by By-law 987-2004.¹ Amendments noted where applicable.]

¹ Editor's Note: This by-law was passed under the authority of section 7.1 of the Fire Protection and Prevention Act, 1997, S.O. 1997, c. 4. Section 3, Transition and repeal, of this by-law provided: A. Subject to Subsection B of Section 3, this by-law repeals By-law 647 of the former Borough of East York and all related amendments; Chapter 134, Fire Routes, of the Municipal Code of the former City of Etobicoke and all related amendments; By-law 29704 of the former City of North York and all related amendments; §§ 400-8, 400-45 and 400-87 and §§ 400-2B(5), 400-10C, 400-52C(1)(c) and, in respect of fire routes only, §§ 400-3A, 400-10A(1), 400-10E(1), 400-11B(1)

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General References

Idling of vehicles and boats - See Ch. 517.
Use of streets and sidewalks - See Ch. 743.
Parking machines and meters - See Ch. 910.
Parking on private or municipal property - See Ch. 915.
Permit parking - See Ch. 925.
Traffic and parking - See Ch. 950.
Building Code Act, 1992 - See S.O. 1992, c. 23.
Condominium Act, 1998 - See S.O. 1998, c. 19.
Fire Protection and Prevention Act, 1997 - See S.O. 1997, c. 4.
Highway Traffic Act - See R.S.O. 1990, c. H.8.
Repair and Storage Liens Act - See R.S.O. 1990, c. R.25.

§ 880-1. Definitions.

- A. As used in this chapter, unless the context otherwise requires, the following terms have the meanings indicated:

ADMINISTRATIVE PENALTY - As defined in Chapter 610, Penalties, Administration of.
[Added 2017-07-07 by By-law 805-2017²]

APPEAL - An appeal to the Committee of the decision on an application or of an order, as the case may be, under § 880-5.

APPLICATION - An application made under § 880-2 for the designation of a private road as a fire route under this chapter.

BUILDING - A building as defined in the Building Code Act, 1992 that is used for Group A or assembly occupancy, Group B or care or detention occupancy, Group C or residential occupancy, Group D or business and personal services occupancy, Group E or mercantile occupancy, or Group F or industrial occupancy, as each such occupancy is classified and defined in the Building Code, and includes any such building owned by the City.

CITY SOLICITOR - The chief legal officer of the City as appointed by the Council of the City of Toronto from time to time and includes authorized designates.

CLERK - The Clerk of the City as appointed by the Council of the City of Toronto from time to time and includes authorized designates.

COMMITTEE - A community council established under Chapter 27, Council Procedures.

and (3) of the Municipal Code of the former City of Toronto and all related amendments; By-law 13897 of former City of Scarborough and all related amendments; By-law 3387-79 of the former City of York and all related amendments; any other by-law (or part of it) and all related amendments and any resolution of any of the six old area municipalities of the former Metropolitan Toronto relating to the designation of private roads as fire routes and not expressly mentioned in this Subsection A, but only to the extent to which it pertains to the designation of fire routes; B. A fire route by-law or resolution repealed by Subsection A of Section 3 of this by-law shall survive only to the extent required to permit, and otherwise for the limited purpose of enabling, the City or anyone so authorized under this chapter to enforce compliance or prosecute or otherwise remedy non-compliance with: (1) Pursuant to § 880-7A of the Municipal Code, the conditions for the designation of fire routes or the like established under such repealed by-law or resolution; and (2) Pursuant to § 880-10A of the Municipal Code, the requirements for the design and location of fire route signs established under such repealed by-law or resolution.

Section 4 of this by-law stated that it comes into force upon the date of approval by the Regional Senior Justice of the set fines required for the offences created by this by-law; the date of said approval was December 19, 2005.

² Editor's Note: By-law 805-2017 came into effect August 28, 2017.

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FIRE CHIEF - The Fire Chief appointed by the Council of the City of Toronto under the Fire Protection and Prevention Act, 1997 for the Fire Department of the City of Toronto and includes, in the absence of the Fire Chief, a Deputy Fire Chief, and, except for the purposes of §§ 880-2C, 880-2E(3), 880-3A(1), 880-4C, 880-4D, 880-9C(7), 880-9C(11) and 880-17A and for the purposes of prescribing anything under § 880-2E or 2E(1), also includes such fire prevention officer or other officer employed in the Fire Department as the Fire Chief may designate in writing to do anything that the Fire Chief is authorized to do under this chapter.

FIRE DEPARTMENT - The Fire Department of the City of Toronto established under Chapter 79, Fire Services, and includes its officers and members.

FIRE DEPARTMENT EQUIPMENT - Any Fire Department equipment, regardless of whether owned or leased by or under the control of or in the possession of the Fire Department of the City or not.

FIRE DEPARTMENT VEHICLE - Any Fire Department vehicle, regardless of whether owned or leased by or under the control of or in the possession of the Fire Department of the City or not.

FIRE PROTECTION SERVICES - The same meaning as in the Fire Protection and Prevention Act, 1997.

FIRE ROUTE - Subject to § 880-7A, that part or those parts of a private road or roads set out on a site plan filed with the Fire Chief, in respect of a municipal address set out in Schedule A, and designated as a fire route under § 880-6. **[Amended 2005-12-07 by By-law 1048-2005]**

FIRE ROUTE SIGN - A road, curb or sidewalk marking or other device prescribed by this chapter that is required to be placed, erected or installed on a fire route for the purpose of identifying the fire route and regulating, warning or guiding traffic in relation to the fire route for the safety of the public, and includes signs replacing existing fire route signs.

OCCUPANT - When used in relation to Subsection (6) of the definition of owner:

- (1) The tenant of the property or part of it whose authority shall extend only to the control of the land held by the tenant;
- (2) The spouse or same-sex partner of the tenant;
- (3) A person or a municipality, or a local board of the municipality, having an interest in the property under an easement or right-of-way granted to or expropriated by the person, municipality or local board whose consent shall extend only to the part of the property that is subject to the easement or right-of-way; or
- (4) A person authorized in writing by the occupant as defined in Subsection (1), (2) or (3) of this definition to act on the occupant's behalf for the purpose of requesting the enforcement of this chapter.

OWNER - When used in relation to property on which a private road or fire route is situated:

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- (1) The registered owner of the property;
- (2) The registered owner of a condominium unit, but only in relation to the owner's unit and any parking spaces allotted to the owner by the condominium corporation or reserved for the owner's exclusive use in the declaration or description of the property;
- (3) The spouse or same-sex partner of the owner described in Subsection (1) or (2) of this definition;
- (4) Where the property is included in a description registered under the Condominium Act, 1998, the board of directors of the condominium corporation;
- (5) A person authorized in writing by the owner as defined in Subsection (1), (3) or (4) of this definition to act on the owner's behalf for making an application for the designation of a private road as a fire route; or
- (6) An occupant or a person authorized in writing by the owner as defined in Subsection (1), (2), (3) or (4) of this definition to act on the owner's behalf for the purpose of requesting the enforcement of this chapter.

OWNER - When used in relation to a vehicle, the registered owner of the vehicle and includes a person who has leased or rented a vehicle under written contract.

PARK or PARKING - When prohibited, the standing of a vehicle, whether occupied or not, except when standing temporarily for the purpose of and while actually engaged in loading or unloading merchandise or passengers.

PENALTY NOTICE - As defined in Chapter 610, Penalties, Administration of. **[Added 2017-07-07 by By-law 805-2017³]**

PRIVATE ROAD - Any private road, lane, ramp or other means of vehicular access to or egress from a building or structure and includes a private roadway or yard as referenced in the Building Code in connection with Fire Department equipment access to buildings, and may include part of a parking lot.

VEHICLE - Includes a motor vehicle, trailer, traction engine, farm tractor or road-building machine.

VEHICLE OWNER - As defined in Chapter 610, Penalties, Administration of. **[Added 2017-07-07 by By-law 805-2017⁴]**

- B. A term not defined in Subsection A shall have the same meaning as the term in the Building Code Act, 1992 or in the Building Code or the Fire Protection and Prevention Act, 1997.

³ Editor's Note: By-law 805-2017 came into effect August 28, 2017.

⁴ Editor's Note: By-law 805-2017 came into effect August 28, 2017.

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§ 880-2. Application for designation of private road as fire route.

- A. The owner of a private road to a building may apply in writing to the Fire Chief requesting that the private road be designated, in whole or in part, as a fire route under this chapter.
- B. Where the Building Code requires that a building be provided with access routes for Fire Department vehicles or that access for Fire Department equipment be provided to a building by private roadway or yard and the Fire Chief so orders, the owner of the private road to a building shall make an application for the designation of the private road as a fire route under this chapter.
- C. Where the Fire Chief, having regard to his or her responsibility for the delivery of fire protection services under the Fire Protection and Prevention Act, 1997, determines that a private road or any part of it requires a fire route for the delivery of fire protection services and the Fire Chief so orders, the owner of a private road to the building shall make an application for the designation of the private road as a fire route under this chapter.
- D. An application required under Subsection B or C shall be made within two months from the date of the receipt of the Fire Chief's order.
- E. The application shall be in such form as the Fire Chief may prescribe from time to time and shall include:
 - (1) Two copies of a site plan of the private road to the building in the form and size prescribed by the Fire Chief, clearly showing:
 - (a) The location of every building and structure on the site;
 - (b) The location of all pedestrian walks, parking areas, parking aisles, and driveways on the site;
 - (c) The location, number and proximity to the building of all fire hydrants and Fire Department connections on the site;
 - (d) The location and design of the proposed fire route; and
 - (e) Proof of compliance with the requirements in the Building Code as required in § 880-3A(2).
 - (2) Proof of ownership of the private road and building.
 - (3) Such other information as the Fire Chief, having regard to his or her responsibility for the delivery of fire protection services under the Fire Protection and Prevention Act, 1997, may prescribe in writing from time to time.

§ 880-3. Consideration of application.

- A. In considering the application, the Fire Chief shall determine whether there is compliance with the following conditions for the designation of a fire route:
 - (1) Having regard to his or her responsibility for the delivery of fire protection services under the Fire Protection and Prevention Act, 1997, the designation of the private

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road or any part of it as a fire route is necessary for the delivery of fire protection services.

- (2) Where the Building Code requires that access routes for Fire Department vehicles or equipment be provided to a building by private roadway or yard, and in all other cases, the private road has or can provide:
 - (a) The minimum width capable of allowing any Fire Department vehicle or Fire Department equipment unobstructed access to the building;
 - (b) The minimum centre line radius capable of allowing any Fire Department vehicle or Fire Department equipment unobstructed access to the building;
 - (c) Sufficient overhead clearance to allow any Fire Department vehicle or Fire Department equipment unobstructed access to the building;
 - (d) A gradient change ratio sufficient to allow any Fire Department vehicle or Fire Department equipment unobstructed access to the building;
 - (e) The capacity of supporting loads imposed by any Fire Department vehicle or Fire Department equipment;
 - (f) A concrete, asphalt or other surface designed for year-round accessibility;
 - (g) Turnaround facilities where the private road has a dead-end that exceeds 90 metres and such facilities are considered necessary for the proper operation of any Fire Department vehicle or Fire Department equipment; and
 - (h) A direct connection to a public thoroughfare.
 - (3) The application otherwise complies with this chapter and the policies and other by-laws of the Council and any other conditions imposed by the Council in respect of such applications or in respect of fire prevention, including the prevention of the spreading of fires.
- B. In determining whether there is compliance with the condition set out in Subsection A(2), the Fire Chief may obtain the assistance of any other official of the City, including the local councillor, as the Fire Chief considers advisable.
- C. The Fire Chief may call a public meeting to seek input on the details of the proposed fire route if he or she so requires, prior to final approval under § 880-4.

§ 880-4. Disposition of application.

- A. Where the Fire Chief, acting in accordance with this chapter, determines that the application complies with all the conditions set out in § 880-3A, the application shall be approved, and the owner of the private road shall be so notified in writing.
- B. Subject to § 880-5, where the Fire Chief determines that the application does not comply with all the conditions set out in § 880-3A, the application shall be refused, with reasons, and the owner of the private road shall be so notified in writing.

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- C. Where the Building Code does not apply to the construction of a private road or a related building that is the subject of an application and where the application may be refused under Subsection B for the reason that it does not comply with a condition set out in § 880-3A(2) in whole or in part, the Fire Chief, having regard to his or her responsibility for the delivery of fire protection services under the Fire Protection and Prevention Act, 1997, and to the extent that the Fire Chief is not prevented from doing so by the Building Code Act, 1992 or any other legislation, may, prior to making a final determination on the application, request or order, in writing, the owner of the private road to take such measures as are necessary to comply with the condition.
- D. The measures referred to in Subsection C shall be taken at the owner's own expense and shall be completed within such time as the Fire Chief may specify in writing.

§ 880-5. Appeals.

- A. Where the application has been refused under § 880-4B, or where the owner of the private road objects to an order made under § 880-2C or 880-4C, the decision on the application or the order may be appealed to the committee, but such appeal must be submitted to the Fire Chief for the consideration of the committee within two months of receipt of notice of the decision or of the order, unless the Council enlarges or extends the period to allow or provide for the appeal.
- B. The appeal shall be made to the committee that is the community council representing the urban area where the private road that is the subject of the application is situated.
- C. Where the appeal is of an order, the order is stayed until the final disposition of the appeal.
- D. An appeal shall be in writing and set out the reasons why the application complies or does not comply with the conditions set out in § 880-3A or why the order made under § 880-2C or 880-4C should be rescinded, as the case may be.
- E. Where an appeal is made, the Fire Chief shall forward a report on the application to the committee setting out the grounds of refusal or approval or the reasons for the order, as the case may be.
- F. Upon hearing the representations of the owner of the private road and considering the report and representations of the Fire Chief, the committee, having regard to the conditions set out in § 880-3A, shall: **[Amended 2007-03-06 by By-law 176-2007⁵]**
 - (1) Recommend to the Council whether to approve or refuse the application or to confirm or amend the order, as the case may be; or
 - (2) Under delegated authority, approve or refuse the application or confirm or amend the order, as the case may be.

⁵ Editor's Note: By-law 176-2007 stated that the amendment to this subsection would come into force upon a Regulation being filed prescribing the Acts under which these powers are exercised as Acts under which the City may delegate its legislative or quasi-judicial power. The delegation for fire routes came into effect on March 2, 2018 under Ontario Regulation 57/18 which amended Ontario Regulation 447/07.

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- G. The decision of the Council, or of the community council under delegated authority, shall be final and shall not be appealable or reviewable. **[Amended 2007-03-06 by By-law 176-2007⁶]**

§ 880-6. Designation of private road as fire route.

[Amended 2005-07-21 by By-law 683-2005; 2005-12-07 by By-law 1048-2005; 2007-03-06 by By-law 176-2007⁷]

- A. Where an application is approved under § 880-4, or an appeal is approved under § 880-5G, and upon the enactment of a by-law to that effect, that part or those parts of the private road or roads shown on the site plan filed with the Fire Chief in respect of the municipal address set out in the by-law shall be designated as a fire route for the purposes of this chapter.
- B. Any person may view the site plan filed with the Fire Chief in respect of a fire route designated under § 880-6A and may obtain a photocopy of it.
- C. (Reserved)
- D. The Fire Chief shall notify the owner of the private road and the Toronto Police Service of the designation of any private road as a fire route under Subsection A.

§ 880-7. Fire route designated under prior by-laws.

- A. A private road designated or established as a fire route or the like under a by-law of an old area municipality, of the former Metropolitan Toronto, preceding the enactment of this chapter shall be conclusively considered for all purposes to be a fire route under this chapter, and the municipal address in relation to the fire route shall be listed in Schedule A as if originally designated under this chapter, despite the repeal of such by-law by section 3 of By-law 987-2004 and despite the fact that such route does not comply with the conditions established under this chapter for the designation of a private road as a fire route, so long as (and subject to Subsection B) that route continues to comply with the conditions established under such old area municipal by-law for the designation of such routes. **[Amended 2005-12-07 by By-law 1048-2005]**
- B. Nothing in Subsection A precludes the owner of a private road to a building from making an application under this chapter for designation of the private road as a fire route under this chapter.

⁶ Editor's Note: By-law 176-2007 stated that the amendment to this subsection would come into force upon a Regulation being filed prescribing the Acts under which these powers are exercised as Acts under which the City may delegate its legislative or quasi-judicial power. The delegation for fire routes came into effect on March 2, 2018 under Ontario Regulation 57/18 which amended Ontario Regulation 447/07.

⁷ Editor's Note: By-law 176-2007 stated that the amendment to this subsection would come into force upon a Regulation being filed prescribing the Acts under which these powers are exercised as Acts under which the City may delegate its legislative or quasi-judicial power. The delegation for fire routes came into effect on March 2, 2018 under Ontario Regulation 57/18 which amended Ontario Regulation 447/07.

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§ 880-8. Fire route costs.

The City shall not be responsible in any way for the design, construction or maintenance of a private road or part of it as a fire route or for any cost incurred by the owner of a private road relating to the designation of the private road or part of it as a fire route under this chapter, unless, in either case, the City is the owner of the private road, or for any costs incurred by any person in connection with any application, order, objection, comment, appeal, decision or other action or thing made or taken in relation to the designation of the private road or part of it as a fire route under this chapter.

§ 880-9. Fire route signs.

- A. The owner of a private road designated as a fire route under this chapter shall erect or cause to be erected, at the owner's own cost, fire route signs on the fire route in accordance with the requirements set out in this chapter.
- B. Fire route signs required to be erected under Subsection A shall be erected on the fire route no later than 10 days after service on the owner of the private road designated as a fire route of notice of the designation of the fire route under § 880-6.
- C. A fire route sign shall:
 - (1) Be a permanent structure.
 - (2) Be legible in appearance.
 - (3) Not be obstructed by any structure or vegetation.
 - (4) Be sized in accordance with Schedule B of this chapter.
 - (5) Prominently bear the symbol and show the wording, colour and numbers as indicated in Schedule B of this chapter.
 - (6) Where the owner of a private road designated as a fire route intends to act under § 880-16B to cause the removal of any vehicle parked or left along the fire route and such vehicles will be removed and impounded by persons not acting under the immediate supervision of a police officer or police cadet, have posted immediately below the fire route sign a sign of the same width as the fire route sign that contains a clearly visible statement that vehicles parked or left in contravention of this chapter are subject to being removed from the premises at the owner's expense and a clearly visible reference to a service and its telephone number answerable 24 hours of each day where the driver or owner of the vehicle may determine the location of the impounded vehicle, and such second sign shall be considered as forming part of the fire route sign for the purposes of this chapter.
 - (7) Include such other information as the Fire Chief, having regard to his or her responsibility for the delivery of fire protection services under the Fire Protection and Prevention Act, 1997, may determine.
 - (8) Be affixed to a building, pole or other structure in accordance with Schedule B.

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- (9) Be installed and located in accordance with Schedule B of this chapter.
 - (10) Be at all locations where the continuity of the fire route is interrupted by any highway, private road, public or private lane, intersection, or ramp.
 - (11) Be at such other locations as the Fire Chief, having regard to his or her responsibility for the delivery of fire protection services under the Fire Protection and Prevention Act, 1997, may determine.
- D. No person shall erect a fire route sign unless an application for a fire route has been made and approved under this chapter or a fire route by-law of an old area municipality. **[Added 2011-12-01 by By-law 1405-2011; amended 2012-07-13 by By-law 1012-2012⁸].**

§ 880-10. Fire route signs under prior by-laws.

- A. Any sign placed, erected or installed for the purpose of identifying or regulating, warning or guiding traffic on a fire route or the like under a by-law of an old area municipality of the former Metropolitan Toronto preceding the enactment of this chapter shall be conclusively considered for all purposes to be a fire route sign under this chapter, despite the repeal of such by-law by this chapter and despite the fact that such sign does not comply with the requirements established under this chapter for the design and location of fire route signs, so long as (and subject to Subsection B) it can be demonstrated that the sign was erected in compliance with the by-law of the former area municipality; and any reference on such sign to the old area municipal by-law shall be conclusively considered to be a reference to this chapter, and such signs on fire routes existing on the day of the enactment of this chapter shall not require replacement until physical deterioration, damage or loss require their replacement and such replacement shall be in accordance with § 880-9.
- B. Nothing in Subsection A precludes the owner of a private road designated as a fire route from replacing a sign authorized under an old area municipal by-law with a fire route sign authorized under this chapter.

§ 880-11. Fire route sign costs.

The City shall not be responsible in any way for the erection or maintenance of fire route signs or for any cost incurred by the owner of a private road designated as a fire route relating to the fire routes, unless the City is the owner of the private road.

§ 880-12. Interference with fire route signs.

Except as otherwise provided in this chapter, no person shall, without the prior permission of the Fire Chief, place, erect, install, alter, move, remove or deface or in any manner obstruct or interfere with a fire route sign or in any manner change the design of or the content identified in a fire route sign.

⁸ Editor's Note: By-law 1405-2011, as amended by By-law 1012-2012, has received set fine approval and came into force January 23, 2014.

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§ 880-13. Maintenance.

- A. The owner of a private road designated as a fire route shall at the owner's own expense maintain the fire route in accordance with the Fire Code.
- B. The owner of a private road designated as a fire route shall at the owner's own expense maintain any fire route sign erected on the fire route:
 - (1) In compliance with the requirements for fire route signs under this chapter;
 - (2) In good repair;
 - (3) Clear of snow and ice; and
 - (4) Free of blockage by any means or obstruction of any kind.

§ 880-14. Parking prohibition.

- A. No person shall park or leave a vehicle in a fire route.
- B. Subsection A does not apply to the owner or driver of an ambulance, police, Fire Department, public utility or other emergency, rescue or repair vehicle or other equipment while actually engaged in emergency, rescue or repair activities or operations, as the case may be.

§ 880-15. Offences and administrative penalties.

[Amended 2011-12-01 by By-law 1405-2011; 2012-07-13 by By-law 1012-2012⁹; 2017-03-29 by By-law 311-2017¹⁰; 2017-07-07 by By-law 805-2017¹¹]

- A. Every person who contravenes any provision of this chapter is guilty of an offence or is liable to an administrative penalty.
- B. Unless at the time of the contravention the vehicle was in the possession of another person without the vehicle owner's consent, if a vehicle has been left parked, standing or stopped in contravention of § 880-14A, the vehicle owner shall, upon issuance of a penalty notice, be liable to an administrative penalty.
- C. Every person convicted of an offence under this chapter, other than an administrative penalty under § 880-14A, is liable to a fine as provided for in the *Provincial Offences Act*.

§ 880-16. Removal and impounding.

- A. A police officer, police cadet, municipal law enforcement officer acting in the circumstances and the manner set out in Subsection D, or an officer appointed for the carrying out of the provisions of the Highway Traffic Act, upon discovery of any vehicle

⁹ Editor's Note: By-law 1405-2011, as amended by By-law 1012-2012, has received set fine approval and came into force January 23, 2014.

¹⁰ Editor's Note: By-law 311-2017 removed the fixed fine system for all parking ticket offences and came into effect April 10, 2017.

¹¹ Editor's Note: By-law 805-2017 came into effect August 28, 2017.

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parked or left in contravention of this chapter, may cause it to be moved or taken to and placed or stored in a suitable place, and all costs and charges for removal, care, and storage of the vehicle, if any, are a lien against the vehicle, which may be enforced in the manner provided by the Repair and Storage Liens Act.

- B. Subject to Subsection D, where the owner of a private road designated as a fire route has erected fire route signs in accordance with this chapter, any vehicle parked or left along the fire route in contravention of this chapter may be removed and impounded, and the owner of the vehicle shall be responsible for any expenses incurred in removing and impounding the vehicle.
- C. Any lien against a vehicle removed under Subsection A or any charges for the expense of removing and impounding of a vehicle parked or left in contravention of this chapter and removed and impounded under Subsection B may be enforced by the person who has care and control of the vehicle after the vehicle has been removed and impounded.
- D. No owner of a private road designated as a fire route shall, in acting under Subsection B, cause to be removed or impounded any vehicle parked or left in contravention of this chapter, unless the owner of the private road designated as a fire route:
 - (1) Requests a police officer or police cadet or municipal law enforcement officer acting under the supervision of a police officer or police cadet to supervise the removal and impounding of the vehicle; or
 - (2) Requests a municipal law enforcement officer not acting under the supervision of a police officer or police cadet to remove or cause to remove, or impound the vehicle, or both, in which case the owner of the private road designated as a fire route shall ensure that:
 - (a) The vehicle is removed to or impounded in an area that is secured by fences locked to the public and with respect to which security personnel are present 24 hours of each day;
 - (b) A clearly visible sign or signs are posted in the immediate vicinity of the fire route, which sign shall state that vehicles parked or left in contravention of this chapter are subject to being removed from the premises at the owner's expense and indicating a service and its telephone number, answerable 24 hours a day of each day, that the owner or driver of any motor vehicle that has been removed may call to determine the location of the vehicle; and
 - (c) Prior to requesting any municipal law enforcement officer not acting under the supervision of a police officer or police cadet to remove or cause to remove, or impound the vehicle, or both, the owner's property has been inspected by the Toronto Police Service to ensure the requisite towing signage has been posted and the sign has been approved by the Toronto Police Service.

§ 880-17. Other remedies.

- A. Where any person defaults in doing what this chapter directs or requires the person to do or to have done and where the Fire Chief, having regard to his or her responsibility for the

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delivery of fire protection services under the Fire Protection and Prevention Act, 1997, considers the matter or thing necessary for the delivery of fire protection services by the Fire Department and where no appeal is available under this chapter to the person in default or, if an appeal under this chapter is available, the time within which the appeal is to be made has expired, the City may, in addition to any other remedy available under this chapter or otherwise at law or in equity or by statute and in addition to any penalty that may be imposed under this chapter, do or cause to have done such matter or thing at the expense of the person in default and the City may recover any costs incurred by the City in doing it or having it done by legal action, or by adding the costs to the municipal tax roll and collecting them in the same manner as taxes.

- B The costs incurred by the City under Subsection A shall include interest at a rate of 15 per cent or such lower rate determined by the City commencing on the day the City incurs the costs and ending on the day the costs, including the interest, are paid in full.

§ 880-18. Power of entry.

- A. The Fire Chief and any person employed by the City as a fire prevention officer in the Fire Department are appointed as officers for the purpose of entering upon the land or into the structures to which this chapter applies at any reasonable time to inspect the land or structures or both to determine whether this chapter is being complied with.
- B. Any person who has been appointed by the City for the purpose of determining whether any other by-law of the City or other law regulating fire prevention or fire safety has been complied with and whose appointment has not been suspended or revoked is also appointed as an officer for the purpose of exercising the power given under Subsection A.

§ 880-19. Service.

- A. Any notice, invoice or other things required to be given or served under this chapter may be served personally, by regular letter mail, by electronic transmission, by telephone transmission of a facsimile or by some other method that allows proof of receipt.
- B. Service by regular letter mail under Subsection A shall be deemed to be received by the person on the fifth day after mailing unless the person establishes that the person did not, acting in good faith, through absence, accident, illness or other cause beyond the person's control receive a copy until a later date than the deemed date of receipt.
- C. Service by electronic transmission or by telephone transmission of a facsimile under Subsection A shall be deemed to be received the day after it is sent or, if that day is a Saturday or holiday, on the next day that is not a Saturday or holiday, unless the person establishes that the person did not, acting in good faith, through absence, accident, illness or other cause beyond the person's control receive a copy until a later date than the deemed date of receipt.

TORONTO MUNICIPAL CODE
CHAPTER 880, FIRE ROUTES
SCHEDULE B, FIRE ROUTE SIGNS

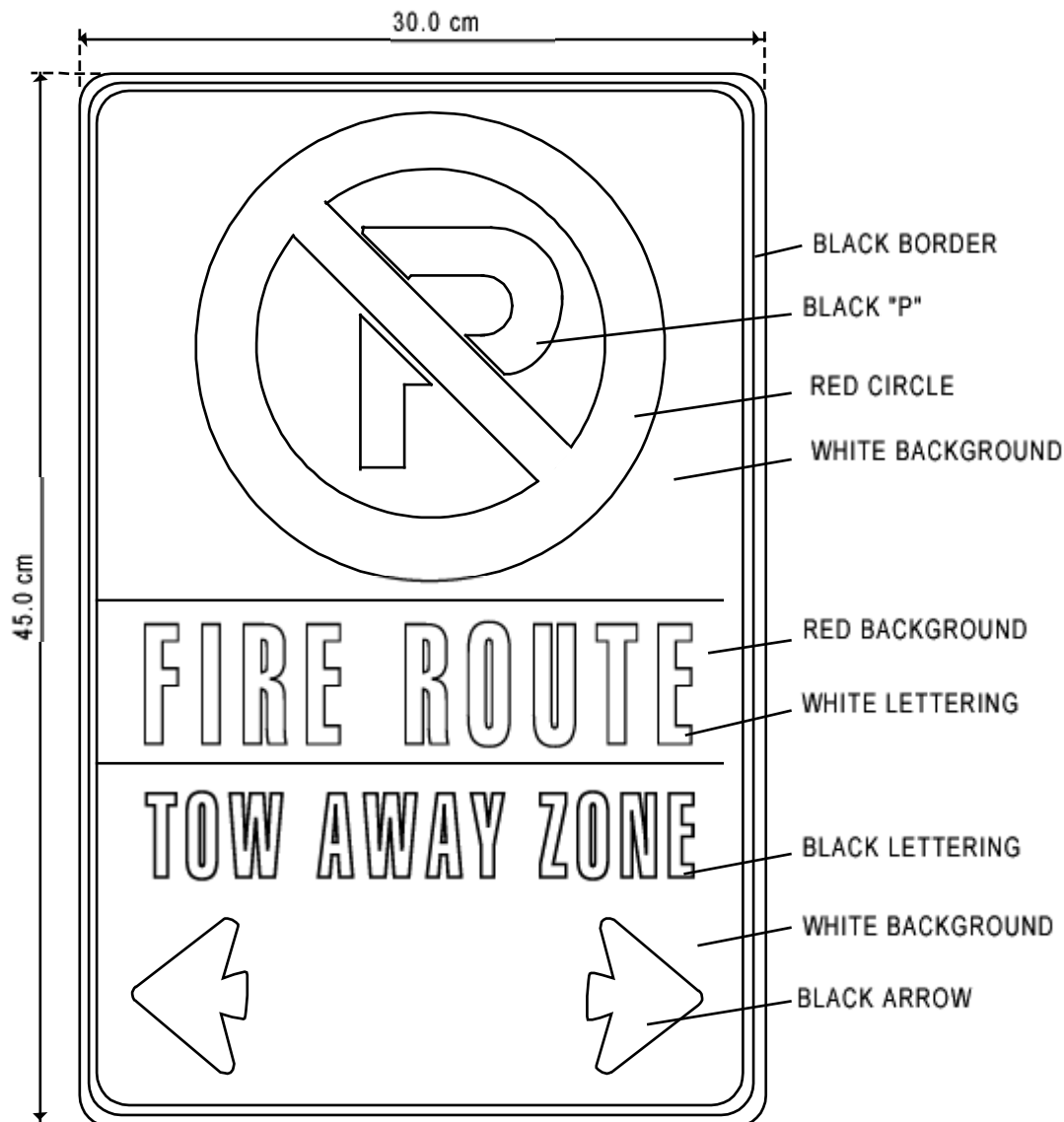


Symbol and Wording, Colour, Numbers and Posting Specifications

CERTIFIED TRUE COPY
John D. Elvidge, City Clerk

Digitally signed document
Use PDF reader to verify

2021-09-07



FIRE ROUTE SIGN REQUIREMENTS
[Added 2005-07-21 by By-law No. 683-2005]

Fire route signs shall be located:

- (i) At intervals of not more than 30 metres along the fire route;
- (ii) At all locations where the continuity of the fire route is interrupted by any highway, private road, public or private lane, intersection, or ramp;
- (iii) So that one is at each limit of the fire route;

TORONTO MUNICIPAL CODE
CHAPTER 880, FIRE ROUTES
SCHEDULE B, FIRE ROUTE SIGNS

- (iv) At all curves having a change of direction greater than 45 degrees; and
- (v) As may be determined during inspection to ensure visibility.

Fire route signs shall be erected:

- (i) No less than 2.2 metres from grade to bottom of sign;
- (ii) No higher than three metres from grade to top of sign;
- (iii) Parallel to the fire route;

and directional arrows shall be masked with appropriate material on signs at the limits of the fire route.

DIVISION 3

CONCRETE

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**SECTION 03100
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SECTION 03100 CONCRETE FORMWORK

PART 1 GENERAL

1.1 SCOPE

- .1 This Section specifies the requirements for supply and installation of all formwork, specified herein and as required to complete the work.

1.2 REFERENCES

- .1 The following is a list of standards which may be referenced in this section:
 - .1 American Concrete Institute (ACI): 347, Formwork for Concrete
 - .2 Canadian Standards Association (CSA):
 - .1 A23.1 Concrete Materials and Methods of Concrete Construction.
 - .2 S269.1 Falsework for Construction Purposes.
 - .3 S269.2-M Access Scaffolding for Construction Purposes.
 - .4 S269.3-M Concrete Formwork.
 - .3 National Lumber Grades Authority (NLGA): Standard Grading Rules for Canadian Lumber.
 - .4 Ontario Provincial Standards Specification (OPSS): 919 Formwork and Falsework.

1.3 DESIGN REQUIREMENTS

- .1 Design formwork in accordance with CSA S269.1, S269.2-M, and S269.3-M to provide specified finishes. Design formwork and falsework to carry dead loads and construction live loads.
- .2 When high range water reducer (superplasticizer) is used in concrete mix, design forms for full hydrostatic pressure.
- .3 Make joints in forms watertight.
- .4 Limit deflection of formwork to limits specified in CSA S269.3-M.

1.4 SUBMITTALS

- .1 Shop Drawings:

- .1 Submit formwork and falsework drawings bearing seal and signature of a Professional Engineer for record purpose.
- .2 Formwork and falsework shop drawings will not be reviewed for structural adequacy.
- .3 Be fully responsible for the design, construction, and maintenance of formwork and falsework.
 - .1 Show design criteria as specified in Clause 6.5.2 Drawing for Formwork CSA A23.1-04.
- .4 Indicate design loads, materials of construction, general arrangement and dimensions and elevations.
- .5 Indicate:
 - .1 For walls and columns on top of slabs and beams
 - .1 Shoring shall be left in place for at least 7 days for concrete walls and columns.
 - .2 Lateral bracing system.
- .6 Layout of panel joints, form liners, and tie hole pattern.
- .7 Shop drawing will be reviewed for general conformance only and will be used for on-site verification and record purpose.
- .2 Product Data Sheets:
 - .1 Submit manufacturer's product data sheets including materials, allowable loading, installation, application, and maintenance instructions for:
 - .1 Proprietary scaffolding.
 - .2 Shoring beams.
 - .3 Lumber for formwork and falsework.
 - .4 Plywood for formwork and falsework.
 - .5 Formwork for curved surfaces.
 - .6 Tubular column forms.
 - .7 Form release agent.
 - .8 Form ties.

- .9 Controlled permeability form liner.
- .3 Samples: One each as follows:
 - .1 Form ties.
 - .2 Form liners.
- .4 Informational Submittals:
 - .1 Statement of qualification for formwork designer.

1.5 QUALIFICATIONS

- .1 Formwork, Falsework, and Shoring Designer: An Engineer licensed in the province of Ontario.

PART 2 PRODUCTS

2.1 FORM MATERIALS

- .1 General:
 - .1 Materials:
 - .1 Lumber for Formwork and Falsework: Grade-marked sawn lumber graded in accordance with NLGA.
 - .2 Plywood for Formwork: CSA A23.1; high density overlay (plastic overlay) grade plywood. Plywood may be of lower finish grade when use in conjunction with form liner.
 - .3 Fibreglass or steel forms in undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
 - .2 Circular Structures:
 - .1 Conform forms to circular shape of structure.
- .2 Form Liners:
 - .1 Controlled Permeability Form Liner:
 - .1 Controlled pore size, maximum 0.08 mm to permit drainage of excess water; water permeability at 200 mm water head of 20 L per square metre per second.
 - .2 Liner must be non-compressible under wet concrete pressure.

- .3 Manufacturer and Product: Frank; Zemdram MD Type III CPF Liner.
 - .4 Or approved equivalent.
 - .3 Painted Surface Forms: High density overlay plywood surfaces.
 - .4 Form Release Agent:
 - .1 Material: Release agent that does not bond with, leave residue on, stain, or adversely affect concrete surfaces, and does not impair subsequent treatments of concrete surfaces when applied to forms
 - .2 Freezing point minus 15 degrees C maximum.
 - .3 Manufacturers and Products:
 - .1 Master Builders, Inc.; Rheofinish.
 - .2 Cresset Chemical Company; Crete-Lease 20-VOC.
 - .3 NCA/Acrow-Richmond Ltd.; RICH-COTE.
 - .4 W.R. Meadows of Canada Ltd.; Sealtight Duogard.
 - .5 Euclid Admixture Canada, Inc.; Eucoslip VOX.
 - .6 Or approved equivalent products.
 - .5 Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.
 - .6 Form Ties:
 - .1 Material: Steel.
 - .2 Spreader Inserts:
 - .1 Conical or spherical type.
 - .2 Design to maintain positive contact with forming material.
 - .3 Furnish units that will leave no metal closer than 25 mm to concrete surface when forms, inserts, and tie ends are removed.
 - .3 Wire ties not permitted.

- .4 Flat bar ties for panel forms, furnish plastic or rubber inserts with minimum 25 mm depth and sufficient dimensions to permit patching of tie hole.
- .5 Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade.
 - .1 Orient water stop perpendicular to tie and symmetrical about center of tie.
 - .2 Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
 - .3 Through bolt ties are not permitted for water-holding, or exterior below grade structures.
- .6 Through-Bolts: Tapered minimum 25 mm diameter at smallest end.
- .7 Elastic Vinyl Plug:
 - .1 Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming watertight seal.
 - .2 Manufacturer and Product: Dayton/Richmond Co., A58 Sure Plug.

PART 3 EXECUTION

3.1 FORM SURFACE PREPARATION

- .1 Remove water, snow, ice, laitance, curing compound, loose soil and other debris and thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants prior to coating surface.
- .2 Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by the manufacturer.
- .3 Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.
- .4 Form Liners: Provide liners with full sheets and place seams at horizontal and vertical grooves. Prepare as recommended by manufacturer.
 - .1 Use anchorage systems recommended by manufacturer to anchor liner to formwork.
 - .2 Do not use form release agent on formwork.

3.2 ERECTION

.1 General:

- .1 Unless specified otherwise, follow applicable recommendations of CSA S269.1, S269.2-M and S269.3-M.
- .2 Align form joints and make watertight. Keep number of joints to a minimum.
- .3 Laterally brace formwork and falsework and prevent displacement during concrete placement.
- .4 Form chases, openings, projections, recesses, expansion joints and construction joints.
- .5 Form around pipes, mechanical, and electrical equipment which penetrate the concrete structure.
- .6 Incorporate frames, castings, pipes, sleeves, and similar items into formwork.

.2 Beveled Edges (Chamfer):

- .1 Form 20 mm bevels at concrete edges, unless otherwise shown.
- .2 Where beveled edges on existing adjacent structures are other than 20 mm, obtain Engineer's approval of size prior to placement of beveled edge.

.3 Wall Forms:

- .1 Do not reuse forms with damaged surfaces.
- .2 Locate form ties and joints in an uninterrupted uniform pattern.
- .3 Inspect form surfaces prior to installation to assure conformance with specified tolerances.
- .4 Do not use through-the-wall removable form ties for walls of liquid holding structures and exterior walls below grade.
- .5 Where excavation shoring system is used as formwork, fasten form tie to shoring in a suitable manner to withstand applied loads.

.4 Formwork with Form Liners:

- .1 Construct forms to structurally withstand deflection, movement, leakage, high hydraulic pressures resulting from rapid filling and heavy-high frequency vibration.

- .2 Lay out form joints and ties in uniform pattern, unless otherwise shown.
- .3 Controlled permeability form liner applications:
 - .1 Provide liner at all vertically formed surfaces as indicated on the Contract Drawings unless noted otherwise.
 - .2 Liner shall not be used at locations where capillary waterproofing is specified.
 - .3 Provide liners in full sheets. Place seams at regular horizontal and vertical pattern. Prepare as recommended by the manufacturer.
 - .4 CPF may be used a maximum of 3 times, but only where the integrity of the form liner has not been compromised.
- .4 Use anchorage systems recommended by the manufacturer to anchor liner to formwork.
- .5 Do not use form release agent on formwork.
- .5 Forms for Curbs, Sidewalks, and Driveways:
 - .1 Provide standard steel or wood forms.
 - .2 Set forms to true lines and grades, and securely stake in position.
- .6 Form Tolerances: Comply to tolerances of CSA A23.1, S269.1 and S269.3-M.
- .7 Fasteners: Use only galvanized nails and fasteners when such fasteners will be left in place in the permanent structure.
- .8 Shoring Under Walls or Columns:
 - .1 When constructing concrete walls or columns on top of slabs or beams, provide shoring under these slabs or beams to carry the total construction load.
 - .2 Leave shoring in place until the compressive strength of the concrete in the wall above has reached 75 percent of its 28-day compressive strength.
- .9 Lateral Supports: Where required, brace walls until permanent lateral supports are in place.
- .10 Formwork at Construction and Expansion Joints: Provide formwork incorporating waterstop in joint.

3.3 FORM REMOVAL

- .1 Do not disturb formwork until the concrete has sufficiently set. Do not remove the struts, shoring etc. unless this portion of the concrete has reached the strength to safely support its own weight as well as the applied construction loads.
- .2 Adequately shore those parts that will be subjected to additional loads during construction in order to protect them against any damage.
- .3 Obtain authorization of the Engineer prior to removal of falsework.
- .4 Where permitted, re-shore in accordance with ACI Standard 347. The minimum length of time that forms shall remain in place shall be:
 - .1 Wall forms removed – 7 days.
 - .2 Sides of beams – 7 days.
 - .3 Columns – 7 days.

END OF SECTION

SECTION 03150
CONCRETE JOINT AND ACCESSORIES

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SECTION 03150
CONCRETE JOINT AND ACCESSORIES

PART 1 GENERAL

1.1 SCOPE

- .1 This Section specifies requirements for the supply and installation of all expansion joints and joint material associated with concrete work and as indicated on the Contract Drawings, specified herein and as required to complete the work. It also includes protection of expansion joints for future expansion at joints, supply of labour, tools and equipment to anchor and install items to be built into/on concrete and supplied under other Sections of the Specifications.

1.2 REFERENCES

- .1 The following is a list of standards which may be referenced in this section:

- .1 Canadian Standards Association (CSA):
 - .1 A23.1-19 Concrete Materials and Methods of Concrete Construction.
 - .2 G30.18-09 Carbon-Steel Bars for Concrete Reinforcement
 - .3 G40.21-13 Structural Quality Steels.

1.3 SUBMITTALS

- .1 Shop Drawings:

- .1 Master Plan(s) of Concrete Placements
 - .1 Before submitting shop drawings of formwork, falsework, and reinforcing bars, submit master plan(s) showing separate concrete placements and locations of construction joints, including proposed construction joints in addition to those indicated on the Drawings.
- .2 Joints: Expansion, Construction, and Control
 - .1 Submit detailed shop drawings of each joints type. Submit an elevation or section taken through the plane of the joint showing the walls and slabs at the joint.
 - .3 Construction and Control Joints: Layout and location for each type.
 - .4 Details of joint fillers, sealant, adhesives, and other appurtenances.

- .2 Samples:

- .1 Joint fillers.
- .2 Water Stops.
- .3 Expansion Joints.
- .3 Product Data Sheets
 - .1 Submit three copies of manufacturer's product data sheets including installation, application, and maintenance instructions for:
 - .1 Formed PVC joint filler.
 - .2 Preformed joint filler.
 - .3 Water Stop.
 - .4 Control joint former.
 - .5 Control joint sealant.
 - .6 Concrete inserts.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Acceptance at Site: Verify that delivered materials are in accordance with Specifications and manufacturer's product data sheets prior to unloading and storing onsite.
- .2 Storage: Store materials under tarps to protect from oil, dirt, and sunlight.

PART 2 PRODUCTS

2.1 BOND BREAKER

- .1 Polyethylene tape, or coated paper

2.2 TAPE FOR JOINTS

- .1 Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape, same width as joint, that will adhere to premolded joint material or concrete surface.

2.3 WATER STOP

- .1 PVC waterstop by SIKA
- .2 Or approved equivalent.

2.4 PREFORMED CONTROL JOINT

- .1 One-Piece, Flexible, Polyvinyl Chloride Joint Former:
 - .1 Manufacturer and Product: Greenstreak Plastic Products; Style Number 854 Transverse Control Joint.
 - .2 Or approved equivalent.
- .2 Furnish in full-length, unspliced pieces.

2.5 ACCESSORIES

- .1 Joint Sealants: As specified in Section 07900, Joint Sealants.
- .2 Nonshrink Grout: As specified in Section 03600, Grout.
- .3 Roofing Felt: CSA A123.3, Type 2, No. 30 asphalt-saturated felt.
- .4 Reinforcing Steel: As specified in Section 03200, Reinforcing Steel.
- .5 Nails: Galvanized, as required for securing premolded joint filler.
- .6 Masking Tape: As required to temporarily adhere to concrete at each side of joint to receive filler.
- .7 Galvanized Rebar at Control Joints: CAN/CSA-G30.18-M Grade 400W prior to galvanizing.
- .8 Loop ferrule inserts: Inserts with plastic setting plugs; SLFW by NCA/Acrow-Richmond Ltd., or F-42 by Dayton Superior Canada Limited (Or approved equivalent).

PART 3 EXECUTION

3.1 WATERSTOP INSTALLATION

- .1 Follow supplier recommendation.

3.2 SETTING ANCHOR BOLTS FOR EQUIPMENT, FITTINGS AND STRUCTURAL STEEL

- .1 Receive, handle, and set anchor bolts in accordance with the requirements of the trade supplying them. Protect anchor bolts after setting to maintain correct alignment and level.

3.3 ELECTRICAL CONDUITS IN SLABS AND WALLS

- .1 Install conduits where required in slabs and walls in accordance with requirements of CSA A23.1[-04], Clause 6.7.5 - Conduits and Pipes Embedded in Concrete.
- .2 Use of aluminum conduits is not permitted.

3.4 FRAMES FOR COVERS AND OPENINGS

- .1 Set frames at locations and required elevations.

3.5 EQUIPMENT CASTINGS AND PIPE FITTINGS

- .1 Set castings and pipe fittings at locations and elevations required.

3.6 REPAIR HOT-DIP GALVANIZED SURFACES

- .1 Coat surfaces damaged by welding, cutting, handling during shipping or erection, or otherwise by a zinc-rich paint. Dry film thickness on repairs to exceed original coating thickness by 25% minimum.

END OF SECTION

**SECTION 03200
REINFORCING GFRP BARS**

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**SECTION 03200
REINFORCING GFRP BARS**

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This Special Provision covers the requirements for the fabrication and placing of glass fiber reinforced polymer (GFRP) reinforcing bar as internal reinforcement of concrete components.
- .2 For the purposes of this Special Provision, the following definitions apply:
 - .1 Congruent Shape means shapes that are congruent in every way with the same number of bends and angles, except that the length of the straight portions could be different.
 - .2 Glass Fiber Reinforced Polymer (GFRP) means a fiber-reinforced composite with a polymeric matrix and continuous fiber reinforcement of glass.
 - .3 Glass Transition Temperature means the midpoint of the temperature range over which an amorphous material changes from a brittle and vitreous state to a plastic state or vice versa.
 - .4 Lot means glass fiber reinforced polymer reinforcing bars made from the same batch of resin from the resin supplier. In addition:
 - .1 Straight bars, bent bars and anchor headed bars shall be divided into separate lots;
 - .2 For straight bars, bent bars and anchor headed bars, a lot shall consist of bars of the same grade and diameter;
 - .3 Bent bars of congruent shape may be considered as the same lot for establishing the number of samples for QC and QA testing;
 - .4 Bars manufactured by different machines for multiple lines of production shall be considered as separate lots;
 - .5 Bars shall be considered as a separate lot if there is an interruption in production or change in batch of raw material;
 - .6 A lot shall consist of no more than seven 7 Days of continuous production

- .3 Structural Component means a major portion of a structure such as grade beams, slab on grade, barrier, wall, pier cap, etc.
- .4 Wet Glass Transition Temperature means the glass transition temperature, determined when the sample is fully saturated.

1.2 STANDARDS

- .1 Reinforcing work shall be according to the requirements of the following standards, specifications, or publications:
 - .1 Ontario Provincial Standard Specifications, Construction - OPSS 905 Steel Reinforcement for Concrete.
 - .2 Ontario Ministry of Transportation Publications:
 - .1 Structural Manual.
 - .2 Guidelines for Inspection and Acceptance of Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars.
 - .3 CSA Standards:
 - .1 S6-14 Canadian Highway Bridge Design Code.
 - .2 S806-12 Design and Construction of Building Components with Fiber- Reinforced Polymers.
 - .3 S807-10 Specification for Fiber Reinforced Polymers.
 - .4 ASTM International:
 - .1 D7957-22 Standard Specification For Solid Round Glass Fiber Reinforced Polymer Bars For Concrete Reinforcement.
 - .2 D 570 - 1998 (R2010) Standard Test Method for Water Absorption of Plastics D 578 - 2005 (R2011) Standard Specification for Glass Fiber Strands.
 - .3 D 2584 - 2011 Standard Test Method for Ignition Loss of Cured Reinforced Resins D 2734 - 2009 Void Content of Reinforced Plastics.

- .4 D 3171 - 2011 Standard Test Method for Constituent Content of Composite Materials D 3418 - 2012 Test Method for Transition Temperatures of Polymers by Thermal Analysis (DTA or DSC).
- .5 D 5028 - 2009 Curing Properties of Pultrusion Resin by Thermal Analysis.
- .6 D 5117 - 2009 Standard Test Method for Dye Penetration of Solid Fiberglass Reinforced Pultruded Stock.
- .7 D 7205 - 2006 (R2011) Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars.
- .8 D 7617 - 2011 Standard Test Method for Transverse Shear Strength of Fiber- Reinforced Polymer Matrix Composite Bars.
- .9 E 1131 - 2008 (R2014) Standard Test Method for Compositional Analysis by Thermogravimetry.
- .10 E 1640 - 2013 Standard Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis.
- .5 American Concrete Institute Publications:
 - .1 ACI 440.3R04 Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures
 - .2 AASHTO GFRP-2018
 - .3 AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete

1.3 SUBMITTALS

- .1 A Manufacturer's Certificate of Conformance and two copies of the GFRP Quality Control report for all materials delivered to the site shall be submitted to the Contract Administrator upon completion of the fabrication and prior to each shipment of the GFRP reinforcement from the plant. The GFRP Quality Control report shall contain the following information:
 - .1 Production information including:
 - .1 Supplier;
 - .2 Lot number of bars;

- .3 Batch number of resin;
 - .4 The start and end date of production for each production lot of material; and
 - .5 The total linear metres produced in each lot for straight bars or the total number of bars in each lot for bent bars and anchor headed bars.
- .2 Summary of all material test results listed in order as identified in Table 2 with the following information for each property:
- .1 The actual number of samples tested for each lot;
 - .2 The result of every test as specified in the Quality Control;
 - .3 The average and standard deviation of test results;
 - .4 The minimum result for tensile strength, tensile elongation, transverse shear strength and bend strength obtained from testing of the required samples.
- .2 Submit for review the layout plan and complete list of reinforcement.
- .3 Clearly indicate on the shop drawings, bar sizes, spacing, location and quantities of bar reinforcement, mesh, chairs, spacers, and hangers. Mark the bars with an identifying code to permit correct placement without direct reference to the Structural Drawings.
- .4 Indicate reinforcing bars that form part of an individual concrete placement and reinforcing bars that extends into adjacent placements.
- .5 For slabs, show a separate plan indicating concrete thickness, reinforcing bars, and dowels for walls and columns cast in slab.
- .6 For walls, show separate elevations indicating concrete thickness, reinforcing bars, and dowels for slabs and adjacent walls cast in wall.
- .7 Do not add new information on previously reviewed shop drawings.
- .8 Proceed with the substitution of different size bars to those shown on the Drawings only upon receipt of written approval by the Engineer.
- .9 One electronic copy of GFRP Working Drawings, including supporting documentation, shall be submitted to the Contract Administrator for information

purposes at least 7 Days prior to delivery of the bars. An Engineer's seal and signature shall be affixed on the working Drawings verifying that they are consistent with the Contract Documents.

- .10 The Working Drawings shall include the following information:
 - .1 Bar placing drawings that include quantity, bar size, location and spacing for all bars.
 - .2 Bar schedule that includes quantity, bar size, type, length and bending dimensions.
 - .3 The supporting documentation shall include the following information:
 - .1 Manufacturer's instructions on how to deliver, handle, store and protect the bars.
 - .2 Manufacturer's recommended materials and procedures for removal of unacceptable material present on the bars.
 - .3 A sealed and signed copy of the Working Drawings shall be kept at the site before and during the placing of bars.
- .11 Protection Plan for Placed and Partially Embedded Bars:
 - .1 At least 7 Days prior to the commencement of installation of the bars, a plan describing the methods to be used to protect bars shall be submitted to the Contract Administrator.
 - .2 The protection plan shall address the following hazards and situations:
 - .1 Movement of bars from concreting operations that will leave partially embedded bars out of tolerance for subsequent work.
 - .2 Protection from UV-Sun light if store mor than 40 Days.

1.4 QUALITY ASSURANCE

- .1 General:
 - .1 The acceptance of the bars shall be according to the requirements of this specification. Bars not meeting the requirements of the Contract Documents shall be rejected and shall not be included in the Work.
- .2 Sampling:

- .1 Prior to placing the GFRP, the Contract Administrator shall randomly select 5 samples for quality assurance testing from each lot. The straight bar samples shall be cut to a length of 1.5 m by the Contractor. If a lot of straight bars does not contain any pieces that may be cut down to a length of 1.5 m, then the length requirement shall be waived and samples shall be taken from the available lengths as supplied. For bent bars and anchor headed bars, the Contract Administrator shall select 5 samples at random from each lot. Samples are not required for bent bars of a particular diameter and shape or anchor headed bars, if the total number required in the Contract for each respective bar type is less than 150.
- .3 Testing:
 - .1 At the discretion of the Owner, quality assurance testing for any number of lots and for any number of properties listed in Table 2 for each lot, shall be conducted by a laboratory designated by the Owner. The testing shall be performed according to the methods and requirements listed in Table 2 and shall be performed on the 5 quality assurance samples. The results will be provided to the Contractor when they are available. All the test method shall follow CSA S807, S806 and ASTM D7957.
- .4 Defects or Deficiencies
 - .1 Test Results
 - .1 A GFRP lot shall be rejected if any one of the tested quality assurance samples fails to meet the limits in Table 2 for the tested property.
 - .2 Visual and Dimensional
 - .1 GFRP that does not meet the specified finishing, surface conditions or dimensional tolerances shall be rejected.
 - .2 Any GFRP with sand coating on top must be rejected. Sand must be tested to ensure there is no reaction with concrete.
- .5 Consequences of Rejection
 - .1 All rejected GFRP lots or bars shall be replaced or fixed if possible at the expenses of the manufacturer. The replacements shall be subjected to the requirements of this specification. If any work incorporates rejected GFRP lots or bars, then that work shall be rejected.

1.5 QUALITY CONTROL

.1 General:

- .1 All GFRP materials shall meet the mechanical, physical and durability properties specified in this specification

.2 Number of Samples:

- .1 The minimum number of samples required shall be 5 from each lot of straight bars, anchor headed bars and bent bars. If more than 5 samples are tested, then all the results are to be reported.

.3 Determination of Properties:

- .1 Manufacturers quality control test requirements for mechanical, physical and durability properties of the bars for various tests and reporting shall be determined as specified in Table 2.
- .2 The limits of the various properties shall be as specified in Table 2.

Table 1 Quality Control Test Requirements

Property	Standard for Test	Specified Limits
Cross-sectional area	CSA S806, Annex A, Determination of Cross-Sectional Area of FRP Reinforcement.	Minimum area not less than 95% of the nominal cross-sectional area. Maximum area not more than 120% of the nominal cross-sectional area for bar diameter 13 mm to 20 mm; 115% for bar diameter greater than 20 mm; and 145% for bar diameter less than 13 mm. Nominal cross-sectional area shall be according to CSAS807.
Longitudinal tensile strength for straight bars and straight portion of the bent bars	ASTM D 7205; or CSA S806, Annex C, Test Method for Tensile Properties of FRP Reinforcements.	Minimum values defined in Table 1
Longitudinal tensile modulus and ultimate elongation (for straight bars and straight portion of the bent bars).	ASTM D 7205; or CSA S806, Annex C, Test Method for Tensile Properties of FRP Reinforcements.	Minimum values of tensile modulus defined in Table 1; the ultimate elongation shall not be less than 1.2%.

Transverse shear strength of straight bars	ACI 440.3R-04, Test Method B.4, Test Method for Transverse Shear Strength of FRP Bars; or CSA S806, Annex L, Test Method for Shear Properties of FRP Rods; or ASTM D 7617.	≥ 180 MPa for Grade III
Longitudinal tensile strength of FRP bent bars at bend locations	ACI 440.3R-04, Test Method B.5, Test Method for Strength of FRP Bent Bars and Stirrups at Bend Locations (Note 1) or ACI 440.3R-04, Test Method B.12, Test Method for Determining the Effect of Corner Radius on Tensile Strength of FRP Bars.	Minimum strength at the bend shall be at least 600MPa.
Fiber content	The relevant of the following: ASTM D 3171 (Method I of Procedure G), ASTM E 1131 and ASTM D 2584.	Glass fiber content $\geq 70\%$ by Weight.
Water absorption at 50 °C for straight bars, straight portion and curved portion of bent bars and grids	ASTM D 570 Water Absorption of Plastics: Procedures 7.1 and 7.4, except that both tests shall be conducted at 50 °C (Note 2)	$< 0.25\%$ for 24-hour immersion $\leq 0.45\%$ after 1-week immersion (168 hours) for the long-term immersion test.
Cure ratio for straight bars, straight portion and curved portion of bent bars and grids	Test Method according to Appendix A of CSA S807; Calibration of DSC by Indium according to ASTM D 5028	$\geq 95\%$ of Cure Required for all straight bars and bent bars.
Wet glass transition temperature	ASTM D 3418 (Note 3) or ASTM E 1640	DSC ≥ 100 °C DMA ≥ 110 °C

Notes:

1. Test may be conducted with high early strength concrete after the concrete reaches 30 MPa strength.
2. Test is conducted at 50 °C for both 24-hour immersion and long-term immersion, in order to shorten the time required for the test.
3. Samples shall be saturated according to ASTM D 570, except that the temperature of 50 °C shall be used for conditioning. A hermetically sealed pan shall be used to prevent volatilization.

Minimum strength of straight portion according to Table 1.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Ship bundles of reinforcing bars identified by tags containing bar marks along with bar list.
- .2 Store materials in a manner which will prevent deterioration or contamination. Deteriorated or contaminated materials will be rejected and must be removed from site.
- .3 A Request to Proceed shall be submitted to the Contract Administrator upon completion of fabrication of the GFRP and prior to shipping from the plant.

- .4 The GFRP shall not be shipped from the plant until the Contract Administrator has received the manufacturer's Certificate of Conformance and GFRP Quality Control report, Request to proceed and issued a Notice to Proceed.
- .5 The Notice to Proceed shall be specific as to which reports were verified and include reference to lot numbers and bar sizes and other information, such as date of issue, where necessary for clarity.
- .6 Delivery, handling, storage and protection of the bars shall be according to the manufacturers instructions and the following to prevent damage:
 - .1 The bars shall be lifted, transported and stored using multiple support points to prevent damage to the bars from sagging. Support points shall be no more than 4.0 m from one another. Bars shall be lifted using nylon slings or padded wire rope slings. Lifting of bundles of bars shall be with a strong back, spreader bar, multiple supports or a platform bridge. Bars shall be bundled and supported to prevent damage during transportation. Bars shall be stored clear of the ground on suitable protective cribbing. Stacks or bundles of bars shall have adequate blocking to prevent contact between the layers of bundles. Bars shall be stored separately from reinforcing steel bars with the bar tags maintained and clearly visible until ready for placing;
 - .2 Bars shall not be struck by hammers or any other equipment at any time. Bars that have been subjected to any of the previous unacceptable actions or that show obvious signs of damage, shall be rejected, removed and replaced. Bars subject to removal shall be marked and removed in the presence of the Contract Administrator;
 - .3 The bars shall be covered with opaque white polyethylene during storage (if more than 1.5 months). Bars installed in the structure or formwork, including those partially embedded in concrete, shall be protected from the elements by covering with opaque white polyethylene sheeting or equivalent protective material when the exposure time is expected to exceed or exceeds thirty (40) Days. The protection shall be adequately supported and secured in place. This protection shall be maintained until its removal is required for preparation for subsequent concrete placement;
 - .4 The bars shall be protected from any abrasive blasting or pressure washing operation in their immediate vicinity by adequate covering or wrapping with protective material;
 - .5 The bars, after placing, shall be protected from construction operations and traffic such that the bar and its finishing are not damaged. The

surfaces shall be kept free of contamination and damage and the GFRP bars shall be protected from loading which may damage the bars.

.6 Surface Condition of Bars:

- .1 The bars shall be with integral rib to provide maximum bond strength to the concrete. Bars shall have a consistent ribs along the bar.
- .2 The bars shall be free of mud, and contamination shall be removed immediately while the concrete is still plastic without damaging the bars. Removal of other materials present on the bars shall be according to the materials and methods recommended by the bar manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Manufacturer:

- .1 MST Rebar Inc. (200A Hanlan Road, Woodbridge Ontario L4L 3P6) or
- .2 Approved equivalent.

.2 GFRP Bar Types:

- .1 Bars shall be grade III with minimum modulus of 60GPa. Bars should have an integral rib with minimum bond strength of 20 MPa to provide maximum adhesion.
- .3 All bars in the same structural component shall be supplied by the same manufacturer; there shall be no mixing of products from different manufacturers in a component unless permitted in the contract Documents.
- .4 Where the Contract Documents specify a particular product, there shall be no substitution unless approved by the Owner.
- .5 The GFRP bars shall be according to the qualification requirements in CSA S807 and Tables 1 and 2 of this specification. In case of discrepancies between CSA S807 and Tables 1 and 2, the more stringent requirement shall apply. The physical and durability properties of the bars shall meet or exceed the requirements for a durability classification of D1 as per CSA S807.

- .6 Binding material for the bars shall be composed of thermoset vinyl ester resin that is homogeneous throughout the cross-section of the bar. Fiber reinforcement in the bars shall be with boron-free glass fibers according to ASTM D 578.
- .7 GFRP Bar Identification: All bars to be used in the Work shall be legibly stamped by the manufacturer with the following information at no more than 2.0 m spacing for straight bars and at least once per piece for bent bars and anchor headed bars:
 - .1 Manufacturers name and symbol;
 - .2 Type of fiber;
 - .3 Designated bar diameter;
 - .4 Grade designation;
 - .5 Designated modulus of elasticity;
 - .6 Production lot or batch number.
- .8 Associated Hardware: Fastening of the bars shall be with coated tie wire, stainless steel wire or nylon ties. Bar chairs for supporting bars shall be plastic.
- .9 GFRP Workmanship and Finish: The bars shall be uniform in diameter/size and free of defects that would be detrimental to the mechanical properties and durability. The surface finish shall be uniform, free of voids and air pockets and similar to the product tested for qualification. Defects include, but are not limited to, exposed fibers, cracks, kinks, surface pitting and discoloration. Sand-coated bars are not permitted. Only bars with integral ribs can be used.
- .10 Material Property: All GFRP Bars shall conform to Table 1.

Table 2 Tensile Strength and Modulus of Grade III GFRP BARS

Straight Bars			Bent Bars (Note 1)		
Designated Bar Diameters	Minimum Specified Longitudinal Tensile Strength kN	Longitudinal Modulus of Elasticity GPa (Min)	Designated Bar Diameters	Minimum Specified Longitudinal Tensile Strength kN	Longitudinal Modulus of Elasticity GPa (Min)
10	71	60	10	71	50
13	130		13	130	
15	200		15	200	
20	284		20	284	
25	490				

Notes:

1. Tensile strength and modulus are given for the straight portion of the bent bar.
2. Strength of the bend shape should be minimum of 600MPa for all sizes.

2.2 FABRICATION

- .1 The Engineer will review the locations for reinforcement splices.
- .2 Fabricate the reinforcing GFRP bars within the prescribed tolerances and with approved shop drawings.

PART 3 EXECUTION

3.1 PREPARATION

- .1 Clean reinforcing bars prior to placing so as to remove any particle that may impede the proper bond.

3.2 PLACING

- .1 The bars shall be placed according to local provincial standard for rebar with the following modifications unless otherwise specified in the Contract Documents:
- .2 The bars shall be accurately placed in the positions shown in the Contract Documents and held in the correct location during the operations of placing and consolidating concrete;
- .3 Bars shall be tied at least at every third intersection;

- .4 The maximum untied length of any bar shall be 900 mm;
- .5 Bar support chairs shall not exceed 900 mm average spacing in each direction;
- .6 Bars within the formwork shall be secured to prevent movement during concrete placement. The bars shall be supported or tied to resist settlement, floating upward or
- .7 movement in any direction during concrete placement. For overlays and other horizontal placement where there is no bottom mat of reinforcement to tie down the GFRP, the GFRP mat shall be anchored down directly to the concrete or formwork to prevent it from floating upward;
- .8 Field bending shall not be permitted;
- .9 Field cutting of straight and bent bars will be permitted only with the approval of the Contract Administrator. The field cutting shall be with a high speed cutter, fine blade saw, diamond blade or masonry saw. The bars shall not be shear cut.
- .10 A Request to Proceed shall be submitted to the Contract Administrator upon completion of the placing of the GFRP.
- .11 The next operation after the completion of the installation of GFRP shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

3.3 INSPECTION

- .1 The Engineer will inspect the reinforcing bar once it has been placed and will check for conformity with the shop drawings and bar lists.
- .2 Notify the Engineer at least 48 hours in advance of the inspection.
- .3 The concrete pour will only be authorized after the Engineer reviews the placed reinforcing GFRP bars.
- .4 The Engineer's review does not relieve the Contractor of his responsibility of correctly placing and adequately supporting the reinforcing GFRP bars.

END OF SECTION

**SECTION 03300
CAST-IN-PLACE CONCRETE**

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SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SCOPE

- .1 The section specifies requirements for the supply of all labor, materials and equipment to complete concrete work as indicated on the Contract Drawings, specified herein and as required to complete the work.
- .2 Comply with requirements of Canadian Standards Association (CSA) 23.1/.2 except where noted otherwise in this Specification.
- .3 Comply with Division 1 – General Requirements and all other Specification Divisions except where noted otherwise in this specification.
- .4 Comply with Toronto Green Standard Version 4 (TGS V4).
- .5 Do not use materials that are toxic in installed condition. Do not use volatile organic compounds where not permitted by law. Where use of volatile organic compounds is permitted, provide adequate ventilation and take necessary safety precautions.
- .6 Section Includes
 - .1 Normal-density concrete.
 - .2 Repair of cracks and damage that develop in concrete.

1.2 REFERENCES

- .1 CSA A23.1 -24 Concrete Materials and Methods of Concrete Construction.
- .2 CSA A23.2 -24 Methods of Test for Concrete.
- .3 CSA A3001-24 Cementitious Materials for Use in Concrete
- .4 CSA A3002-24 Test Methods for Cementitious Materials for Use in Concrete
- .5 CSA A3003-24 Chemical Admixtures for Concrete
- .6 CSA A3005-24 Cementitious Materials Supplementary Specification for Use in Concrete
- .7 ACI 304.2R-08 Placing Concrete by Pumping Methods.
- .8 ASTM C260-22 Specifications for Air-Entraining Admixtures for Concrete.

- .9 ASTM C233-14 Standard Test Method for Air-Entraining Admixtures for Concrete.
- .10 ASTM C494-13 Specification for Chemical Admixtures for Concrete.
- .11 ASTM C900-14 Test Method for Pullout Strength of Hardened Concrete.
- .12 ASTM C1017-13 Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
- .13 ASTM C1074-11 Practice for Estimating Concrete Strength by the Maturity Method.
- .14 ASTM C109/C109M -13 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
- .15 ASTM C1610/C1610M Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique.
- .16 ASTM C1611/C1611M Standard Test Method for Slump Flow of Self-Consolidating Concrete.
- .17 ASTM C1621/C1621M Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Rong.

1.3 DEFINITIONS

- .1 Exposed Concrete: Concrete surfaces that can be seen inside or outside of structures regardless whether concrete is above water, dry at all times, or can be seen when structure is drained.
- .2 Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 5 mm; cracks 0.25 mm wide and larger in non-liquid holding and containment structures spalls, chips, air bubbles greater than 20 mm in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form pop outs, texture irregularities, and stains and other color variations that cannot be removed by cleaning.
- .3 New Concrete: Less than 60 days old.
- .4 Environmental Product Declaration (EPD): A document which transparently reports objective, comparable and third-party verified data about products and services' environmental performances from a life-cycle perspective.
- .5 Global Warming Potential (GWP): A metric which allows comparisons of the global warming impacts of different gases. Specifically, a measure of tonnes of CO₂e emitted per tonne of the material over its life cycle.

1.4 TESTS

- .1 In accordance with CSA-A23.2-24.

1.5 CONCRETE CRACK CONTROLS

- .1 Place concrete in accordance with the crack control provision of CSA A23. In addition, take preventive and protective measures in proportioning, placing and curing the concrete to minimize shrinkage cracks. Such measures shall include:
 - .1 Do not place concrete against any surface that is less than 7°C in temperature.
 - .2 Restrict the concrete temperature at delivery to the forms to a maximum of 25°C.
 - .3 Wet down the work area, including formwork and abutting existing concrete prior to placing the concrete.
 - .4 Restrict pour lengths in the plan of walls to no more than 15 m. Allow a minimum of four days to elapse before placing adjacent sections. Detail the horizontal rebar to avoid continuity of the same day staggered pours.
 - .5 The Engineer may direct the Contractor to employ any of the means for crack control during hot weather outlined in the ACI Report and CSA standards “Hot Weather Concreting”.

1.6 SUBMITTALS

- .1 Product Data Sheets
 - .1 Submit the manufacturer’s product data sheets including installation, application, and maintenance instructions for:
 - .1 Chemical admixtures.
 - .2 Air-entraining admixtures.
 - .3 Superplasticizing admixtures.
 - .4 Bonding agent.
 - .5 Repair materials.
 - .2 Submit Environmental Product Declaration (EPD) in a machine-readable format, or equivalent documentation, to disclose Global Warming Potential (GWP) and other environmental impacts for each product. EPDs or equivalent documents must be:
 - .1 ISO 14025:2006 Type III and ISO 21930:2017 compliant; OR

- .2 Generated by a software application that is validated as producing EPDs, that are compliant with ISO 14025:2006 Type III and ISO 21930:2017 and uses input data produced using plant-specific, regional or Canadian industry-specific Life Cycle Inventory (LCI) data; OR
- .3 Developed using similarly robust LCA methods that comply with ISO 14040:2006 and ISO14044:2006 or ISO 14067:2018 and that are documented and validated by a third party accredited Professional in a Letter of Assurance.

.2 Concrete Mix Design

- .1 Submit the proposed concrete mixes, aggregate grading curves, and the supplier's applicable standard deviations at least two weeks prior to any concrete placement.
- .2 Indicate contents of the cement, cementitious hydraulic slag, coarse and fine aggregate, water, water reducing and air entrainment agents, and other admixtures, air content, slump, and locations of use for each mix.
- .3 Submit detailed plan for cold weather curing and protection of concrete placed and cured in weather below 5°C.
- .4 Or submit detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 25°C.
- .5 Concrete mix designs will be reviewed for conformance with requirements of the Specifications and will be returned with Engineer's comments.
- .6 Submit completed Embodied Carbon Project Disclosure Form for each eligible product and approved EPD, demonstrating a minimum 10% reduction in GWP from the Industry Average Baseline.

.3 Source Quality Control Submittals

- .1 Provide certification that source for fine, coarse and trap rock aggregates are not subject to deleterious expansion.
- .2 Chemical admixtures, used in the production of concrete for potable water structures, shall be certified as safe product from recognized approving authorities
- .3 Submit certification that the cement and supplementary cementing materials do not contain regulated metals and no hazardous waste derived fuels were used in the production of the cement(s).

.4 Quality Control Submittals

- .1 Submit Concrete quality control plan for the project. Provide the following:
 - .1 Certification from concrete producer that a Professional Engineer has designed the mix based on the requirements of the Specification and that concrete mix will meet the performance requirements.
 - .2 Identify the Company and contact names of subcontractors, material suppliers and testing companies involved with concrete manufacture and placement.
 - .3 Identify concrete requirements for each element of the project.
 - .4 Identify all tests that will be used for material acceptance and indicate minimum specification requirements for each test.
 - .5 Identify the frequency of testing for each test.
 - .6 Identify the course of action to be taken if the testing program indicates that specification requirements have not been met.
 - .7 Concrete quality control plan shall not take precedence over any other Contract documents.
 - .8 Concrete finishers: Skilled personnel with a minimum of five years proven satisfactory experience finishing concrete of comparable size and scope.
 - .9 Engage manufacturers' representative for fulltime onsite supervision prior to, during, and after applications. Verify that specified products are correctly applied; amount and finishing procedures comply with manufacturer's printed instructions for project.
- .2 Submit concrete delivery records.
- .3 Submit a correlation curve of pullout strength test to standard cylinder strength test. Submit a correlation curve of strength of concrete at given time in hours to 56-day strength.
- .5 Concrete Placing Schedule
 - .1 Submit a detailed concrete placing schedule, including mix by type and location of proposed pour or application.
 - .2 Provide notice of intent to pour a minimum of two (2) business days prior to the intended pour or application day.

- .3 Provide a completed Concrete Pour Release Form (appended) prior to each pour.
- .4 Do not order concrete until the Concrete Pour Release Form has been signed by the Engineer.
- .6 Certificates
 - .1 Submit certificate of Ready Mixed Concrete Production Facilities.
 - .2 Submit certification that aggregates will not, nor have the potential to, react with cement to result in deleterious expansion in the concrete.
 - .3 Submit certification that deleterious substances in aggregate are within limits specified in CSA A23.1-24, Table 12 - Limits for Deleterious Substances and Physical Properties of Aggregates.
 - .4 Submit certification that proposed performance mix will produce concrete meeting the requirements of Specifications.
 - .5 Submit certification that proposed mix design strengths have been selected allowing for the supplier's standard deviations as indicated in CSA A23.1-24, Clause 4.4.6 - Compressive Strength.
 - .6 Submit certification that bonding agent, if used, will meet the requirements of Specifications.
 - .7 Submit certification that crack injection/repair materials are suitable for continuous submersion.

1.7 QUALITY ASSURANCE

- .1 Ready Mixed Concrete Producer: Certified member in good standing of the local Ready Mixed Concrete Association.
- .2 Concrete finishers: Skilled personnel with a minimum of five years of proven satisfactory experience finishing concrete of comparable size and scope.
- .3 Engage manufacturers' representative for full-time onsite supervision prior to, during, and after applications. Verify that specified products are correctly applied; amount and finishing procedures comply with the manufacturer's printed instructions for the project.
- .4 Installation of new concrete finishes shall be according to the manufacturer's recommendations and requirements.
- .5 Installation of new concrete finishes shall be witnessed and approved by the manufacturer's representative.

.6 Concrete Testing:

- .1 Testing of concrete for materials and compression will be done by agencies paid for by the Owner.
- .2 Pay for additional testing required because of changes in material or the mix proportions, as well as any extra testing of concrete or materials occasioned by their failure to meet the specification requirements.
 - .3 The use of testing services does not relieve the Contractor of his responsibility to provide materials and construction in compliance with the Drawings and Specifications.

.7 Pre-placement Meeting

- .1 Hold a meeting at least four weeks prior to the initial placement of concrete to review the detailed requirements for preparing the concrete design mixes, finishes, and procedures for concrete placement for the structures.
- .2 Arrange for the attendance at the meeting of the Engineer, Owner, and of concrete subcontractors, manufacturers, and suppliers including, but not limited, to the following:
 - .1 Contractor's superintendent.
 - .2 Ready-mix concrete producer.
 - .3 Admixture manufacturer(s).
 - .4 Concrete pumping and conveying equipment supplier.
 - .5 Concrete formwork and finishing subcontractors.
- .3 Notify the Engineer at least ten (10) working days prior to the scheduled date of the meeting.
- .4 The Engineer will set an agenda for the meeting at least five working days prior to the scheduled date of the meeting.

1.8 WARRANTY

- .1 Any submission shall be in accordance with Section 01300 of this contract document.

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Comply with manufacturers' recommendations for delivery, storage, and handling.

- .2 Store materials in a manner that will prevent deterioration or contamination. Deteriorated or contaminated materials will be rejected and must be removed from site.

1.10 SITE CONDITIONS

.1 Cold Weather Control Requirements:

- .1 The following requirements are in addition to CSA A23.1-24, Cold Weather Concreting.
- .2 Provide temperature-controlled enclosures for areas where concrete is placed whenever ambient air temperature is 5°C or lower.
- .3 Protect concrete from the adverse effects of space-heated enclosures including local overheating and combustion products.
- .4 Heat mix-water and, if necessary, aggregates when air temperature is at or below, or predicted to go below, 5°C at any time during the next 24 hours.
- .5 Maintain temperature of reinforcing bars and forms above 10°C prior to placing concrete.
- .6 Maintain temperature of concrete when deposited in forms not less than 15°C and higher than 25°C.
- .7 Maintain temperature of concrete at surfaces at least 10°C for a minimum period of five days after placing and achieving minimum 75% of specified strength. Concrete temperature may then be lowered to ambient air temperature at a rate of 1/2°C per hour or 10°C per day
- .8 Use additional protection if full 56-day compressive strength is required at an early age.
- .9 Keep concrete continuously moist during the curing period. See section 03350 for details.
- .10 The temperature difference for the concrete is being placed and the concrete being poured against is of primary importance during winter concreting. Therefore, the temperature of the surface of the previously poured concrete must be within 5°C of the concrete being placed but must not be lower than 7°C.

.2 High-Temperature Control Requirements

- .1 The following requirements are in addition to CSA A23.1 -24, Hot Weather Concreting.

- .2 Limit peak temperature during the curing period to 32°C maximum. Placing temperature that will satisfy this requirement depends on ambient temperature, humidity at the time of placing, thickness of the concrete, and curing methods employed.
 - .3 Consider use of retarders, low-heat cement, slag replacement, ice in mixing water, pre-cooling of aggregates, cooling of concrete through continuous wet curing, and similar methods in order to prevent concrete temperatures from exceeding 32°C at any time.
 - .4 Monitor concrete temperatures for walls and slabs 500 mm or more in thickness. After concrete temperature has peaked, control rate of cooling to ambient air temperature at a rate of 1/2°C per hour to prevent cracking.
 - .5 Notwithstanding requirements of subparagraphs .1 and .2 above, do not place concrete with temperature higher than 25°C. Concrete with temperature in excess of 25°C on arrival at the site will be rejected. Remove rejected concrete from the site.
- .3 Concrete Protection
- .1 Protect freshly placed concrete from damage due to construction operations and from cold, heat, rain, snow, running water, drying winds, and any other circumstances which would likely cause deterioration of concrete quality.
 - .2 Use waterproof insulated covers or other suitable materials to enclose freshly placed concrete under these conditions.
- .4 Influence of Ambient Concrete Temperature on Concrete Crack Control
- .1 To minimize the formation of thermal cracks during placement and curing, maintain previously cured concrete and concrete that will be placed against it at the same temperature.
 - .2 Do not place concrete against any surface, which is less than 7°C in temperature.
 - .3 The Engineer may direct the Contractor to employ any of the means for crack control during hot weather outlined in ACI Report “Hot Weather Concreting”, at no additional cost to the Contract.
 - .4 Failure to minimize temperature differential between adjacent pours will result in temperature induced cracking. Repair such cracks as specified in this Section.
- .5 Service Loads Restrictions

- .1 Verify that concrete in slabs, including slabs on grade, and support components have reached specified compressive strengths before subjecting slabs to service loads.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Cements

- .1 Type GU “General Use” conforming to CSA A23.1/2.

.2 Supplementary Cementing Material

- .1 Cementitious hydraulic slag: CSA A3000-13 “Cementitious Materials” and comply with the following conditions and requirements:

- .1 For use with Type MS cement.

- .2 Maximum 25%

- .2 Hydraulic slag cannot be used in the concrete mix with the slab

.3 Aggregates

.1 Normal-density Concrete

- .1 Coarse aggregate: CSA A23.1; rough and angular gravel or crushed stone.

- .2 Fine aggregate: CSA A23.1; natural sand.

.4 Admixtures

- .1 Compatible with each other and with other concrete materials.
- .2 Calcium chloride, thio-cyanates, or admixtures containing more than 0.05% chloride ions are not permitted.
- .3 Air-entraining admixture: ASTM C260; non-detergent type.
- .4 Water-reducing admixtures: ASTM C494; Type A.
- .5 Set-retarding admixture: ASTM C494; Type B.
- .6 Superplasticizing admixture: ASTM C494; Type F 1 or G 2 [ASTM C1017, Type 1 or 2.]
- .7 Corrosion inhibitor: ASTM C494; Type C; DCI by:

- .1 W.R. Grace Co. of Canada Ltd.
- .2 Rheocrete CNI by Master Builders Technologies, Ltd.
- .8 Corrosion inhibitor dosage: 10 L/m³
- .5 Water: CSA A23.1; clear and free from oil, acid, alkali, organic matter, or other deleterious substances with a maximum soluble chloride ion content of 0.10% by weight.
- .6 Bonding agent: Suitable for conditions of service and performance requirements of this Section.
- .7 Epoxy injection resin for sealing cracks: See Section 03920 Concrete Repairs.
- .8 Polyurethane injection resin for sealing cracks: See Section 03920 Concrete Repairs.
- .9 Colour:
 - .1 Add red pigment to the new structural concrete overlay slab.
 - .2 Submit colour samples for approval.
- .10 Self-Consolidating Concrete
 - .1 Portland Cement: Shall conform to ASTM C 150/C 150M, Type I.
 - .2 Aggregates: Fine and coarse aggregates shall conform to ASTM C 33/C 33M.
 - .3 Water: Shall conform to ASTM C 1602/C 1602M.
- .11 Unshrinkable fill: proportioned and mixed to provide:
 - .1 Maximum compressive strength of 0.4 MPa at 28 days.
 - .2 Maximum Portland cement content of 25 kg/m
 - .3 Minimum strength of 0.07 MPa at 24 h.
 - .4 Concrete aggregates: to CAN/CSA A23.1.
 - .5 Portland cement: Type GU.
 - .6 Slump: 160 to 200 mm.

2.2 CONCRETE MIXES

- .1 General

- .1 Establish proportions of cementing materials, aggregates, water, and admixtures required to produce consistent workable concrete that is watertight, durable concrete with strength and other properties specified. Comply with CSA A23.1-24 Volume Stability Considerations.
- .2 Use same type and brand of cement throughout.
- .3 Place no concrete whose mix design has not been reviewed by the Engineer.
- .4 Provide the concrete with a consistency so that the concrete can be placed satisfactorily in the forms, but the mixture shall not be so wet as to segregate during placing.
- .5 In no case will it be permitted to exceed the slumps specified without the written permission of the Engineer.
- .6 For the type of cementing material, use a blend of Type MS Portland Cement and cementitious hydraulic slag to a minimum of 75% Type MS Portland Cement by weight of total cementing materials content.
- .7 Four test cylinders for each Type of concrete will be taken from each day's concreting or from every 100 m³ placed whichever is the greater. One of the cylinders will be tested at 7 days, one tested at 28 days and the other two cylinders will be tested at 56 days.
- .8 The cost of the concrete required for making the above test cylinders shall be borne by the Contractor.
- .9 Comply with and allow for the supplier's Standard Deviation as specified in CSA A23.1-24, Compressive Strength Requirements.
- .10 Use high-slump concrete by addition of super plasticizing admixture for walls.
- .11 The concrete for all slabs and walls shall be 'low-shrinkage concrete' as defined in CSA A23.1-24.
- .12 Measure all aggregate by weighing. All measuring devices shall permit rapid adjustments of the mix.
- .13 Source quality control
 - .1 Testing by an independent laboratory in accordance with CSA A23.1 and CSA A23.2, where test results less than one year are not available, to determine:
 - .1 Chemical composition and physical properties of aggregates.

- .2 Presence and quantity of deleterious substances in aggregates.

.2 Mixes for Standard Concrete

.1 Type of Concrete (Exposure Class A-1):

- .1 Type A: Concrete for footings, foundation mats, walls and slabs.
- .2 Select a mix complying with the table below and submit the complete details of sieve analyses of aggregates and proportions of all ingredients by weight to the Engineer for review.
- .3 Base the tender price on providing concrete with cement, water content and strength as follows:

Type of Concrete	Required Minimum Compressive Strength at 56 Days	Maximum Water-Cement Ratio	Slump (mm)	Maximum Aggregate Size (mm)
A	35 MPa	0.40	100 ± 25	19

.1 Cementing Materials Content

- .1 Except where higher quantities are needed to meet strength or other requirements, provide the following minimum cementing materials contents.
- .2 320-330 kg/m³ minimum, for nominal 20 mm to 5 mm coarse aggregate.

.2 Slump

- .1 Provide slump consistent with placement, consolidation methods equipment and site conditions. Ensure concrete do not segregate during placement. Comply with CSA A23.1-24.
- .2 Maximum slump before addition of the super plasticizer: 25 to 50 mm.
- .3 Maximum slump after addition of the super plasticizer: 150 mm. Super plasticizer, Master Builders Pozzolith 400N and compatible with the other ingredients or approved equal.

.3 Air Content

- .1 Comply with CSA A23.1-24, Table 4 - Requirements for the Air Content Categories.
 - .2 Provide air content Category 1, unless noted otherwise.
 - .3 Provide air content Category 1 for loading bays, parking areas, surge pit slab and liquid holding structures.
 - .4 Provide 3% maximum air content for concrete forming floors where concrete topping will be casted overtop.
- .4 Admixtures
- .1 All concrete shall contain an approved water reducing agent compatible with the plasticizer and conforming to ASTM C494, Type A.
 - .2 Provide an air entrainment agent conforming to CSA-23.1-14 compatible with the water reducing agent used.
 - .3 All concrete shall contain an approved shrinkage reducing admixture conforming to CSA-A23.1-24.
 - .4 Provide a retarding admixture to Type B concrete as/if required to allow for monolithic installation of floor topping.
 - .5 The admixtures shall be formulated by the manufacturer for the job area and weather conditions and shall be added to the concrete in accordance with the manufacturer's written recommendations.
 - .6 Except for the plasticizer, admixtures only are to be added at the plant in a liquid form.
- .5 Use of Plasticizer
- .1 Use of the plasticizer shall conform to CAN3-A266.6-M85 "Super-plasticizing Admixtures for Concrete".
 - .2 The specified plasticizer shall be added to the concrete mix for every pour.
 - .3 The manufacturer's instructions shall be followed regarding the storage and handling of materials, dosages, mixing and the timing of the placement.
 - .4 The manufacturer's representative shall attend the Site at the start of the concrete placement and provide the above-

noted instructions. The representative shall be available throughout the course of the concrete work for further guidance and solution of problems that may arise during the use of the plasticizer.

- .5 The approved plasticizer shall be added to the concrete mix on Site by a person knowledgeable, qualified, and experienced in the use of plasticizers.
- .6 Complete and accurate records of all additions to the concrete mix shall be kept and submitted to the Engineer. Small amounts of plasticizer may be added at the plant with the written approval of the Engineer.

.3 Mix for Wall Grout

- .1 Grout shall be placed on all horizontal construction joints to a minimum thickness of 75 mm and shall have a mix design conforming to the following specifications:
 - .1 Minimum content of cementing materials: 600 kg/m³.
 - .2 Coarse aggregate: None.
 - .3 Fine aggregate: CSA A23.1; natural sand.
 - .4 Water/cementing materials ratio (W/C): 0.40 maximum.
 - .5 Slump: Matching Type A concrete.
 - .6 Air content: Matching Type A concrete.
 - .7 Admixtures: Use water-reducing admixture.
 - .8 Structural concrete mix containing super plasticizing admixtures can be used in lieu of wall and column grout provided approval is obtained from the Engineer.

.4 Mix for Pumped Concrete

- .1 Comply with ACI 304.2R-08, Placing concrete by pumping methods and this Specification.
- .2 Fine aggregate with uniform grading curve and fineness modulus of 2.65 ±0.20.
- .3 Use coarse aggregate with uniform grading curve.
- .4 Super plasticizing admixture must be used for pumped concrete.

.5 Do not use bleeding promoting admixtures.

.5 Mixes for Self-Consolidating Concrete

.1 Water-to-cement ratio shall not exceed 0.40 by mass.

.2 Supplementary Cementitious Materials: The weight of SCM shall not exceed the percentages listed in the following table.

Material	Maximum percent of total cementitious materials by mass
Fly ash or other pozzolans	25
Slag cement	50
Silica Fume	10
Total of fly ash or other pozzolans and silica fume	35*
Total of fly ash or other pozzolans, slag cement and silica fume	50*

.3 Slump:

.1 Slump shall be measured in accordance with ASTM C1611/C1611M.

.2 Typical ranges in slump are outlined in the following table:

Type of Construction	Range of Slump Flow Values	
	inches	mm
Slabs	20-30	500-750
Wall, lightly reinforced	20-30	500-750
Column or wall, densely reinforced	24-30	600-750

.3 The design slump of the SCC mix shall be established after consideration of the project requirements and the Contractor's proposed location of use.

.4 The slump of SCC used on the project shall be the design slump plus or minus 50 mm.

.4 Compressive Strength: 35 MPa at 56 days.

2.3 CONSTRUCTION JOINTS

- .1 Provide construction joints in the locations designated on the Drawings and where required for construction. Agree with the Engineer in writing before construction work is commenced, regarding the position of joints necessary for construction but not shown on the Drawings.
- .2 Construct all joints in accordance with the details shown on the Drawings, true to line with sharp, unbroken edges.
- .3 Install water stops in all construction joints and/or joints subject to liquid pressure.
- .4 Place grout on all horizontal construction joints to a thickness of 75 mm before placing the concrete.

PART 3 EXECUTION

3.1 PREPARATION

- .1 General
 - .1 Determine requirements of other trades, inform concerned trades, and assume responsibility for location, installation, and quality of items, which affect the work of this Section.
- .2 Preparation of Surfaces
 - .1 Remove water, laitance, curing compound, wood, and other debris from surfaces on or against which new concrete will be placed.
 - .2 Roughen and clean surfaces of previously placed concrete against which subsequent concrete will be placed.

3.2 PLACING CONCRETE

- .1 General
 - .1 Do not commence concrete placing until sufficient manpower and equipment is available to complete the placement expeditiously preventing the formation of cold joints, and to produce specified surface finish.
 - .2 Provide standby equipment for critical items in case of equipment failure.
 - .3 Verify that cast-in-place accessories, inserts, and reinforcement are set correctly and are not disturbed during concrete placement.
 - .4 Place concrete on dry and clean substrate.

- .5 Place concrete between expansion or construction joints in one continuous operation.
- .6 Internal vibrators shall be of the high frequency type with 7000 minimum to 12000 maximum vibrations per minute when immersed in concrete.
- .7 External vibrators shall have a minimum frequency of 36000 vibrations per minutes.
- .8 Equipment made of aluminum material shall not come in contact with the concrete.
- .9 The mixer for the bonding agent shall be a stationary mixer, power driven, and capable of uniformly mixing the materials.
- .10 Bull floats shall be commercially made of magnesium or wood.
- .11 Straight edges shall be metal, 3,000 mm and 500 mm long and commercially made.
- .2 Depositing
 - .1 Limit free drop of concrete to 1500 mm maximum in accordance with requirements of CSA A23.1-24.
- .3 Time Limitations on Concrete Placement
 - .1 Do not use concrete after a period of one and half hours (1.5hr) has passed since first mixing of ingredients.
 - .2 Do not use high-slump concrete after slump falls below 100 mm for non-flowing concrete and 125 mm for flowing concrete. Where permitted, retemper in accordance with manufacturer's printed instructions. Monitor, and correct if required, air content of concrete that has been retempered.
- .4 Adverse Weather Conditions
 - .1 Make suitable arrangements to prevent damage to fresh concrete, under adverse weather conditions.
 - .2 Do not allow rain, sleet, or snow to increase mixing water or damage surface finish.
 - .3 Plan placement frequency such that lift lines will not be visible in exposed concrete finishes.
 - .4 Provide windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.

- .5 Do not place concrete when ambient temperature is below 5°C or approaching 5°C and falling, without special protection.
- .6 Do not place concrete against frozen earth or ice, or against forms and reinforcement with frost or ice present.
- .7 Provide heated enclosures when air temperatures are below 5°C.
- .8 Maintain surface temperature of concrete above 5°C.
- .9 Provide maximum and minimum thermometers placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work.
- .10 External Heating Units:
 - .1 Vent heating units to atmosphere and do not locally heat or dry concrete. Where water cure is specified, maintain wet condition.
 - .2 Do not exhaust heater flue gases, directly into enclosed area.
- .5 Wall and Column Grout
 - .1 Deposit 75 mm of wall and column grout evenly along horizontal construction joints in bottom of form through an elephant trunk immediately before placing wall or column concrete.
- .6 Time Interval between Concrete Placements
 - .1 Construction Joints: Seven days wet cure continuously.
 - .2 Control Joints: Six days.
 - .3 Expansion Joints/Contraction Joints: One day.
 - .4 Wait at least two hours after depositing concrete in long columns and walls thicker than 200 mm before depositing concrete in beams, girders, or slabs supported thereon.
 - .5 For columns and walls 3 m in height or less, wait at least 45 minutes prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon
 - .6 Walls and columns may be placed on slabs and vice versa as soon as initial placing has sufficient strength but not sooner than 12 hours.
- .7 Consolidation

- .1 Consolidate the concrete during and immediately after depositing, thoroughly and uniformly by means of tamping, hand tools, finishing machines, and vibrators in order to obtain dense, watertight, homogeneous concrete well bonded to reinforcing bars.
- .2 Carefully vibrate concrete around the conduits, waterstops, and gas-stops to make sure thorough contact.
- .3 Bend edge of horizontal waterstops , slightly upward allowing concrete to flow under and completely fill space below the waterstop . Verify no air is trapped below waterstop and concrete is in contact with waterstop over its entire surface area.
- .4 Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
- .5 Vibration consolidation not to exceed distance of 1 m from point of placement.
- .8 Maximum Size of Concrete Placements:
 - .1 Limit size of each placement to allow for strength gain and volume change due to shrinkage
 - .2 Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
 - .3 Should placement sequence result in cold joint located below finished water surface, install water stop in joint.

3.3 CURING

- .1 Concrete curing shall be carried out immediately after finishing of the concrete surface a in accordance with CSA A23.1 and shall be maintained for a period of seven (7) days at 10 Celsius and for the time to attain 70% of the specified strength. Rate of evaporation is depending on relative humidity, concrete temperature and winds velocity; for rate of evaporation of moisture from concrete surface covered with water see CSA A23.1 Appendix D.
- .2 Cure the exposed fresh concrete by covering the surface with two layers of wet burlap. On top of the wet burlap shall be plastic (polyethylene) sheets to ensure that the burlap remains wet. Strips of burlap shall overlap by at least 150 mm. New burlap shall be thoroughly soaked for 24 hours before use.
- .3 The plastic sheets shall be not less than 0.10 mm (4 mils) thick, and shall be standard commercial quality, free from snags, tears or any other visible flaws, providing a tough, pliable moisture - barrier. The plastic sheets shall be lapped a minimum of 150 mm and shall be securely held in place against displacement by wind or other means. Protect concrete against vibration and loading, as far as

practical, and restrict all construction traffic, until the 70% specified strength has been achieved.

- .4 The burlap for curing shall conform to OPSS 1306. Moisture vapour barrier shall be white, opaque, polyethylene film, at least 100mm thick conforming to OPSS 1305.
- .5 The Contractor shall ensure that the burlap is maintained in a wet condition throughout the entire curing period.
- .6 Cover newly poured slabs with burlap as soon as they can be walked on and keep them continuously wet with water throughout the curing period.
- .7 Loosen the formwork for walls and columns and saturate the concrete within the first 24 hours after placing.
- .8 After stripping the wall forms apply a non-toxic curing compound meeting the requirements of ASTM C309. Apply the curing compound at the thickness recommended by the manufacturer after a minimum of 24 hours of moist curing. If a curing compound is not applied, continue moist curing for an additional five days.

3.4 COLD WEATHER CONCRETE

- .1 In cold weather conform to the cold weather concrete provisions of CSA-A23-24, except where modified by these Specifications.
- .2 The methods of protecting the concrete are to be approved by the Engineer and will be such as to prevent local drying. Open flame heaters will not be permitted.
- .3 Provide suitable holes through the forms and in the concrete for the purpose of placing thermometers to determine the adequacy of heating and protection.
- .4 The addition of chemicals to the concrete to prevent freezing will not be permitted.
- .5 Provide in the tender price for all costs incurred in heating forms, aggregates, water, etc. during winter construction and in protecting all concrete from damage by the elements at all times.

3.5 REPAIR OF TEMPERATURE AND SHRINKAGE INDUCED CRACKS

- .1 Propose the method of any repair to the Engineer for approval.
- .2 Repair any cracks in the completed structures employing a suitable epoxy injection or gravity feed technique to make sure cracks are completely watertight after repair.
- .3 Remove surface injection materials following completion of the work and finish affected areas to match the surrounding concrete.

- .4 Remove and replace honeycomb or embedded debris in concrete as directed.
- .5 Patch existing concrete surfaces where damaged by cutting or drilling.
- .6 Any surface that needs patching up has to be inspected and approved by the Engineer before the patching work commences.
- .7 Cost of all repair work to be borne by the Contractor.

3.6 CONCRETE REPAIRING AND FINISHING

- .1 As soon as the face forms are removed, repair and finish the surfaces of all concrete as set out below:
 - .1 Repairing
 - .1 Cut back the metal form ties not less than 25 mm from the surface. Fill the holes with non-shrinking grout, In-Pakt as supplied by C.C. Chemicals Ltd., and then finish as specified below.
 - .2 Cut honeycomb and other defective areas at right angles and at least 25 mm deep.
 - .3 Saturate all areas to be patched with water.
 - .4 Fill saturated areas immediately with mortar having the same general composition as the mortar in the concrete.
 - .5 After completely filling the cavities, finish the concrete to match adjacent surfaces.
 - .2 Finishing
 - .1 Concrete Finish S1 (Exterior surface below finish grade)
 - .1 Remove all ties, bolts, nails and other metal to a depth of 25 mm and fill the holes. Chip off and rub all fins and other projections until flush with the general surface.
 - .2 Concrete Finish S2 (General concrete finish)
 - .1 Provide the concrete finish S1 plus fill with mortar all air-voids larger than 5 mm in any direction.
 - .3 Concrete Finish S3 (Sack-rubbed Finish)
 - .1 Provide the concrete finish S2 plus apply sack-rubbed finish for interior walls available for viewing.

- .2 Colour match repairs on exposed surfaces by adding white Portland Cement to the mix used for patching.
- .3 Where honeycombing requires repairs deeper than 50 mm use In-Pakt grout for repair and stop 15 mm back from the finished wall surface. Use Portland Cement Mortar to fill the final surface and rub the whole area with a carborundum brick.

3.7 CONCRETE FLOOR FINISHES

- .1 Finish the top or final surface of all concrete by one or more of the operations of screeding, floating, trowelling, or grinding as specified by the Engineer. Dusting of the wearing surfaces with dry materials to absorb moisture or to stiffen the mix will not be permitted. Strike off floor slabs true to the required level of slopes shown on the Drawings.
- .2 Protect the floor finishes from damage after placing by laying protective timbers over the areas and keeping traffic to a minimum. Should the floor be damaged, the Engineer may require the damaged portions to be cut out and replaced with a separate hardened floor finish, at no extra cost to the City.
- .3 Wood Float Finish: Screed and finish with a wood float all earth-covered slabs, all walkways, and where specified. Do not start floating until some stiffening has taken place in the concrete surface.
- .4 Steel Trowel Finish: Screed all floors unless otherwise specified, then finish with a wood float to present a reasonably true uniform surface and then further finish with a steel trowel.
- .5 Non Slip Finish: After initial finishing, floating, and first trowelling provide nonslip surface finish by swirl-trowelling the surface in accordance with CSA A23.1, Clause 7.5.6.1 - Nonslip Surfaces. Provide nonslip swirl-trowel finish for surfaces like platforms, walkway slabs, loading docks, and the tipping floor slab.
- .6 Broom Finish: After initial finishing, floating, and first trowelling, provide nonslip surface finish by brooming the surface in accordance with CSA A23.1, Clause 7.6 - Nonslip Surfaces with application of steel or fibre brooms at least 450 mm. Pull broom gently over the surface from side to side at right angles to direction of traffic, with adjacent strokes slightly overlapping. Produce a broom finish surface free from porous spots, irregularities, depressions, or rough spots with uniform corrugations less than 3 mm.

3.8 CONCRETE BONDING

- .1 Horizontal Construction Joints in Reinforced Concrete Walls:
 - .1 Thoroughly clean and saturate surface of joint with water.
 - .2 Limit wall and column grout placement to 50 mm maximum thickness, 25 mm minimum thickness.

- .3 Do not deposit grout from pump hoses or large concrete buckets, unless specified placement thickness can be maintained and verified through inspection windows close to joint.
- .4 Limit concrete placed immediately on top of slurry concrete to 300 mm thick. Thoroughly vibrate to mix concrete and grout together.
- .2 To Existing Concrete:
 - .1 Thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 10 mm minimum.
 - .2 Saturate surface with water for 24 hours prior to placing new concrete.

3.9 ABRASION RESISTANT BONDED CONCRETE FLOOR TOPPING

- .1 Refer to Section 03530 Concrete Floor Toppings.
- .2 The manufacturer's written instructions shall be followed regarding the storage and handling of materials, mixing, placement, finishing curing and sealing of the floor topping.
- .3 The manufacturer's written instructions shall be followed for the substrate surface preparation, bonding, joints and edges.
- .4 The manufacturer's written instructions shall be followed for environmental controls during all stages of surface preparation, installation finishing and curing.
- .5 All work shall be completed in strict accordance to the manufacturer's full-time site representative instructions.
- .6 After the preparation of the surfaces, the topping systems shall be used to build up the floor to its **final** elevations and contours.
- .7 Finish the topping in accordance with Section 3.7.5 Non-slip Finish.
- .8 To prevent surface cracking, cure the floor topping as soon as possible with a curing compound, approved in writing by the topping product manufacturer.

3.10 FIELD QUALITY CONTROL

- .1 General
 - .1 Tests will be made throughout progress of the Work and will be paid for by the Owner to determine concrete quality. Tests will be in accordance with CSA A23.1 and CSA A23.2. Provide labour, concrete, and other facilities for making the test specimens.

- .2 Provide and maintain facilities for storing and initial curing of test cylinders, and provide suitable crates for shipping test cylinders in accordance with CSA A23.2-24, Test Method A23.2-3C - Making and Curing Concrete Compression and Flexural Test Specimens.
- .3 The testing laboratory shall provide the test results to the Owner, Engineer, Contractor and material supplier within 5 days of availability. For test that fails to meet the Specification inform Engineer, Contractor and material supplier within 48 hours.
- .2 Standard Strength Tests
 - .1 Provide concrete for one standard strength test consisting of four cylinders for each 100 m³ of concrete of each type placed in any day. If the amount placed, for each type of concrete is less than 100 m³ in a day, provide concrete for one standard strength test. One cylinder will be tested at 7 days, one at 28 days and two at 56 days.
- .3 Linear Shrinkage Tests
 - .1 Provide linear shrinkage tests for every 1,000 m³ (maximum) of concrete used on the project to ensure conformity to approved mix designs.
 - .2 Provide linear shrinkage tests for any pour greater than 150 m³ or for each construction stage.
- .4 Concrete Temperature Monitoring
 - .1 Provide and keep in working order sufficient Taylor Instrument pocket biotherm thermometers model 6097-1 to monitor concrete temperatures in each pour.
 - .2 Install 12 mm diameter by 150 mm deep copper tubes crimped at bottom end into concrete at each monitoring location. Fill tube with water.
 - .3 Monitor concrete temperature at corners and in the centre of each concrete placement.
- .5 Air Content Tests
 - .1 Testing agency will carry out air content tests in accordance with CSA A23.1 and CSA A23.2.
- .6 Slump Tests
 - .1 Testing agency will carry out slump tests in accordance with CSA A23.1 and CSA A23.2.
- .7 Failure to Meet Strength, Air Content, or Slump Requirements

- .1 When measured slump or air content falls outside of required limits, carry out a check test immediately on another portion of the same sample. In the event of a second failure, the concrete will be considered to have failed to meet the requirements. Remove the whole batch, from which the samples were taken, off the site.
 - .2 When the strength requirement provisions are not met, carry out one or more of the alternatives of CSA A23.1 - Failure of Standard Cured Cylinder Test Results to Meet Requirements.
 - .3 When, after carrying out these requirements, there is still doubt about the adequacy of the concrete, strengthen or replace, as directed, portions of the Work which failed to develop the required strength.
- .8 Uniformity of Mixed Concrete
- .1 If the results of slump, air content or density for any mix design do not comply with CSA A23.1, Table 13 - Determination of Within-Batch Uniformity, alter mixing operations and equipment until tests indicate that the requirements are satisfied.
- .9 Concrete Delivery Records
- .1 Submit with each batch of concrete before unloading, a typed delivery ticket prepared at the ready mix plant containing following information:
 - .1 Name of ready-mix batch plant.
 - .2 Serial number of ticket.
 - .3 Date and truck number.
 - .4 Name of the Contractor.
 - .5 Name of Job.
 - .6 Specified 56-day strength of concrete with identifying mix number.
 - .7 Time loaded or of first mixing of cement and aggregates.
 - .8 Temperature of Fresh Concrete
- .10 Keep records of the time when each load arrives at the site and when discharge is completed.

END OF SECTION

CONCRETE POUR RELEASE FORM		Submission No.
PROJECT NAME - _____		
OWNER'S PROJECT NO. - _____		
LOCATION OF POUR _____		
DATE OF POUR _____ TIME OF POUR _____		
* NOTE: Consulting Engineer is to be given 24 hours notice before time of pour _____		
1. All items of work have been completed for this pour and the following foremen have approved their work ready for inspection:		
REBAR STEEL: _____	DATE : _____	TIME :
MECHANICAL SLEEVE INSERTS AND PIPING: _____	DATE : _____	TIME:
ELECTRICAL SLEEVES INSERTS AND PIPING: _____	DATE : _____	TIME :
ANCHOR BOLTS AND STRUCTURAL INSERTS: _____	DATE : _____	TIME :
LINE AND LEVELS: _____	DATE : _____	TIME:
2. The formwork has been inspected by the formwork design engineer or his authorized designate for conformance to the formwork design.		
Formwork Design Engineer	DATE	TIME
3. I have checked all items for this pour and request your inspection before pouring.		
Contract Superintendent	DATE	TIME
4. The items of work have been inspected: The pour may proceed subject to the Contractor being responsible for the work in accordance with the Contract. <div style="display: inline-block; vertical-align: middle; margin-left: 20px;"> <input type="checkbox"/> (Check) </div> <div style="text-align: center; margin-top: 5px;">or</div> Corrections are required as noted below <div style="display: inline-block; vertical-align: middle; margin-left: 20px;"> <input type="checkbox"/> (Check) </div>		
Resident Supervisor	DATE	TIME
NECESSARY CORRECTIONS AND REMARKS:		

SECTION 03600
GROUT

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SECTION 03600 GROUT

PART 1 GENERAL

1.1 REFERENCES

- .1 The following is a list of standards which may be referenced in this section
 - .1 American Society for Testing and Materials (ASTM):
 - .1 C230, Standard Specification for Flow Table Use in Tests of Hydraulic cement.
 - .2 C827, Standard Test Method for Change in Height at Early Ages in Cylindrical Specimens.
 - .3 C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - .4 C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

1.2 SUBMITTALS

- .1 Shop Drawings:
 - .1 Product data of grouts including installation, application, and maintenance instructions.
 - .2 Proposed method for keeping existing concrete surfaces wet prior to placing hydraulic cement grout.
 - .3 Forming method for fluid grout placements.
 - .4 Curing method for grout.
- .2 Quality Control Submittals:
 - .1 Manufacturer's Written Instructions:
 - .1 Cement-water ratio of grout topping.
 - .2 Mixing of grout.
 - .3 Adding fiber reinforcing to batch.
 - .2 Manufacturer's proposed training schedule for grout work.
 - .3 Manufacturer's Certificate of Compliance:

- .1 Grout free from chlorides and other corrosion-causing chemicals.
- .2 Nonshrink hydraulic cement grout properties of Categories II and III, verifying expansion at 3 or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
- .3 Manufacturer's Certificate of Proper Installation.
- .4 Statements of Qualification: Nonshrink grout manufacturer's representative.

1.3 QUALIFICATIONS

- .1 Nonshrink Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

1.4 GUARANTEE

- .1 Manufacturer's Warrantee containing disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished will not be accepted.
- .2 Manufacturer guarantees participation with Contractor in replacing or repairing grout found defective due to faulty materials, as determined by industry standard test methods.

PART 2 PRODUCTS

2.1 NON-SHRINK HYDRAULIC CEMENT GROUT SCHEDULE

- .1 Furnish non-shrink hydraulic cement grout for applications in grout category in the following schedule:

Application	Temperature Range	Max. Placing Time	
	4 to 38 deg C	20 min	Greater than 20 min
Filling tie holes	I	I	I
Wall extension	II	II	II
Precast joints	II	II	II
Through-bolt openings	II	II	II
Filling wall openings	II	II	II

2.2 NON-SHRINK HYDRAULIC CEMENT GROUT

.1 Category I:

- .1 Non-metallic and non-gas-liberating.
- .2 Pre-packaged natural aggregate grout requiring only the addition of water.
- .3 Test in accordance with ASTM C1107:
 - .1 Flowable consistency 140 percent, five drops in 30 seconds, in accordance with ASTM C230.
 - .2 Flowable for 15 minutes.
- .4 No bleeding of grout at maximum allowed water.
- .5 Minimum strength of flowable grout, 20 MPa at 3 days, 35 MPa at 7 days, and 48 MPa at 28 days.
- .6 Manufacturers and Products:
 - .1 Stoncor Canada; Five Star Construction Grout.
 - .2 Chemrex, Inc.; Set Grout.
 - .3 Euclid Chemical Co.; NS Grout.
 - .4 Or approved equivalent products.

.2 Category II:

- .1 Non-metallic, non-gas-liberating.
- .2 Pre-packaged natural aggregate grout requiring only the addition of water.
- .3 No segregation or settlement of aggregate at fluid consistency at specified times or temperatures.
- .4 Test in accordance with ASTM C939 and ASTM C1107, Grade B:
 - .1 Fluid consistency 20 to 30 seconds using flow cone method.
 - .2 Temperatures of 5, 27, and 38 degrees C.
- .5 One hour after mixing, pass fluid grout through flow cone with continuous flow.
- .6 Minimum strength of fluid grout, 25 MPa at 1 day, 30 MPa at 3 days, and 52 MPa at 28 days.

- .7 Maintain fluid consistency when mixed in 1 to 7 m³ loads in ready-mix truck.
- .8 Manufacturers and Products:
 - .1 Stoncor Canada; Five Star Construction Grout.
 - .2 Chemrex, Inc.; Master Flow 928.
 - .3 Euclid Chemical Co.; Hi Flow Grout.
 - .4 Or approved equivalent products.

PART 3 EXECUTION

3.1 NON-SHRINK GROUT

- .1 General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's representative's training instructions.
- .2 Form Tie or Through-Bolt Holes: Provide nonshrink hydraulic cement grout, Category I and II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes, coordinate dry pack dense grout application with vinyl plug and bonding agent in Section 03300, CAST-IN-PLACE CONCRETE.

3.2 FIELD QUALITY CONTROL

- .1 Evaluation and Acceptance of Nonshrink Hydraulic Cement Grout:
 - .1 Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
 - .2 Perform flow cone and bleed tests, and make three 50 mm by 50 mm cubes for each cubic metre of each type of nonshrink grout used. Use restraining caps for cube.
 - .3 For large grout applications make three additional cubes and one more flow cone test. Include bleed test for each additional cubic metre of nonshrink grout placed.
 - .4 Consistency: As specified in Article Nonshrink Grout. Grout with consistencies outside range requirements will be rejected.
 - .5 Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates will be rejected.

- .6 Tests must show that strength attained by nonshrink grout cubes is equal to or greater than minimum strength specified.
- .7 Strength Test Failures: Remove and replace nonshrink grout work failing strength tests.
- .8 Perform bleeding test to demonstrate grout will not bleed.
- .9 Store cubes at 21 degrees C.
- .10 Independent testing laboratory to prepare, store, cure and test cubes.

3.3 MANUFACTURER'S SERVICES

.1 General:

- .1 Coordinate demonstrations, training sessions, and applicable site visits with grout manufacturer's representative.
- .2 Provide and conduct onsite, demonstration and training sessions for all measurements, testing, application, and curing for each category and type of nonshrink grout.
- .3 Ensure necessary equipment and materials are available for demonstration.
- .4 Grout manufacturer's representative to train Contractor to perform grout work.
- .5 Establish location at site and schedule time for grout manufacturer's demonstration and training session of proposed nonshrink grouts. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, e.g., baseplates and tie holes to provide actual on-the-job training.
- .6 Training to include methods for curing grout.

END OF SECTION

CAST-IN-PLACE CONCRETE

Project:	DU PAVING AND DUT MATERIAL STORAGE
Client:	SOLID WASTE MANAGEMENT SERVICES - CITY OF TORONTO
Location:	35 VANLEY CRESCENT TORONTO M3J 2B7
PO Number:	
General Contractor:	
Log Date:	
Reviewed By:	

Engineer to complete for baseline

Engineer to complete for baseline

Supplier to complete for project (actual)

Calculated from inputs

[illegible]

DIVISION 5

METALS

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SECTION 05010
MISCELLANEOUS METALS

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This section specifies the requirements for supplying and installing metal materials including all steel support brackets as shown on the contract drawings.

1.2 FABRICATION AND WORKMANSHIP

- .1 Construct miscellaneous metal items in accordance with CAN/CSA S16-19 including all current supplements.

1.3 WELDING

- .1 Weld materials in compliance to the appropriate standards as follows:
 - .1 CSA W59-18 - Welded Steel Construction and using welders certified by Canadian Welding Bureau
 - .2 CSA W47.1-19 – Shop Certification

1.4 FINISH

- .1 Finish members to be true to lines, free from twists, bends, open joints, sharp corners and sharp edges, to a high quality finish product.

1.5 RESPONSIBILITY FOR DIMENSIONS

- .1 The general dimensions and details of the metal fabrications are shown on the Drawings where practical.
- .2 Assume all responsibility for the correctness of the actual detail dimensions used in fabrication and carefully check the same, by field measurement wherever possible, in order to avoid possible errors.
- .3 Variations from suggested details are subject to approval in writing by the Engineer. Such approval does not in any way waive the above-mentioned responsibility.

1.6 SUBMITTALS

- .1 Submit shop drawings of all metal fabrications and details thereof for review before fabrication commences. Shop drawings shall be signed and sealed by a Professional Engineer licensed in the Province of Ontario.

- .2 Do not construe the Engineers' failure to note errors, omissions or interference modifications during review of the shop drawings as approval of such errors, omissions or modifications.
- .3 Submit CWB shop welding certificate and copies of CWB tickets of all site welders.

PART 2 PRODUCTS

2.1 MATERIALS (WHERE APPLICABLE)

- .1 Where anchors, lifting hooks, screws, bolts, nuts, washers, hangers and other fasteners are not specifically shown or specified, provide the same having at least the strength and corrosion resistance properties of the metal fabrication for which they are required.
- .2 Provide all fabrications to be constructed from materials as follows:
 - .1 Structural Steel Sections - CSA G40.21-M, Grade 350W.
 - .2 Steel - General Purpose - ASTM A36.
 - .3 Abrasion Resistant Plate – ASTM A514 ENDURA Weldable.
 - .4 Stainless Steel - Types 304, 316, 304L or 316L.
 - .5 Bolts for Connections - Types 304, Stainless Steel to ASTM A193 and A194 Grade 8A.
 - .6 Cast in Anchor Bolts - ASTM A307.
 - .7 Anchors in Existing Concrete - Hilti HIT-HY 200 Adhesive Anchorage System with rod anchors or approved equivalent.
 - .8 Abrasion-resistant Plate:
 - .1 Grade: AR400F Weldable to ASTM A514.
 - .2 Yield Strength: 1200 MPa.
 - .9 Steel Plate Flashing (at push wall) - CSA G40.21-M, Grade 300W.
 - .10 Floor Drain Grate – Type 316 Stainless Steel.

2.2 COATINGS

- .1 Following completion of fabrication of any item, grind all rough edges smooth and remove all mill scale and rust.

- .2 Where noted on the drawings, galvanize all steel materials after fabrication in accordance to CSA G164. Leave galvanized surfaces clean and smooth, free of slag and other impurities. Prevent damage to galvanized surfaces during handling and installation. Refer to Section 09900-Painting for applicable finish system. All field welding to be cleaned by grinding and cold galvanized to a thickness and quality matching the original specified finish.
- .3 All steel not noted on the drawings, except existing strengthened steel framing and steel liner plate of push wall, shall be paint finished. All paint-finished steelwork is to be sandblasted to SSPC SP-6 Commercial Sandblast with a surface profile of 2 mils prior to painting. Refer to Section 09900-Painting for applicable finish system. All field welding to be cleaned by grinding and touch up painted to a thickness and quality matching the original specified finish.

PART 3 EXECUTION

3.1 INSTALLATION GENERAL

- .1 Install all miscellaneous metal work accurately and secure properly in place.
- .2 Shimming of steel members will only be permitted when approved by the consultant.

3.2 INSTALLATION OF ANCHORS, BOLTS AND LIFTING HOOKS

- .1 Unless noted otherwise on the drawings, use Hilti HIT-HY 200 Adhesive Anchorage System or equivalent for fastening to existing concrete unless otherwise noted on the contract drawings.

END OF SECTION

**SECTION 05120
STRUCTURAL STEEL**

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SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.1 SUMMARY

.1 Section Includes

- .1 Supply, fabrication, and erection of structural steel for the Works, including but not necessarily limited to:**
 - .1 Rolled sections and built-up members.**
 - .2 Hollow structural steel (HSS) sections.**
 - .3 Structural sections for encased beam or pile construction (not applicable)**
 - .4 Column bases and beam bearing plates.**
 - .5 Connections and splices.**
 - .6 Connection lugs for masonry ties welded to structural steel columns and beams. (not applicable)**
 - .7 Steel shapes, plate separators, fasteners, anchor bolts, pipe sleeves, shims, stiffener plates, and other detail fittings necessary for the work.**
 - .8 Bracing:**
 - .1 Permanent members as indicated.**
 - .2 Temporary members for construction.**
 - .9 Shop welded shear connectors and anchor bars.**
 - .10 Special bearings: Fixed or sliding.**
 - .11 Alterations to existing structural steel.**
 - .12 Surface preparation prior to shop coating.**
 - .13 Hot-dip galvanizing of structural steel shapes, bolts, nuts, washers, and anchor bolts.**
 - .14 Shop coating and touch-up after erection.**

- .15 Temporary shoring of existing construction to facilitate execution of new construction.
- .16 Welding.
- .2 Products Supplied But Not Installed Under The Work Of this Section (not applicable)
 - .1 Anchor bolts for structural steel.
 - .2 Embedment plates with welded anchors for structural steel.
 - .3 Loose lintels and shelf angles.
- .3 Substitutions
 - .1 When deliveries of structural steel make it impossible to complete the construction on time, alternative structural sections may be accepted by the Engineer. Satisfactory proof that the specified structural shapes are not available must be produced in order to qualify for such consideration.
 - .2 Alternative sections shall have equal or greater factors of safety and deflections no greater than the original sections.
 - .3 Where dimensions of alternative sections necessitate changes in layout or design, the cost of redesign may be deducted by the City from the monies due to the Contractor.
- .4 Cost of Supplementary Structural Steel
 - .1 Quantities of additional structural steel not included in the Contract but which will be required to complete the Contract will be calculated based on the net theoretical finished weight.

1.2 REFERENCES

- .1 The “Code of Standard Practice for Structural Steel for Buildings” of the CISC shall govern this work except as otherwise noted on drawings or in specifications.
- .2 The following is a list of standards which may be referenced in this Section:
 - .1 Canadian Standard Association (CSA):
 - .1 CAN/CSA-G40.20-M General Requirements for Rolled or Welded Structural Quality Steel
 - .2 CAN/CSA-G40.21-M Structural Quality Steels

- .3 CAN/CSA-G164-M Hot Dip Galvanizing of Irregularly Shaped Articles
- .4 CAN/CSA-S16-01 Limit States Design of Steel Structures
- .5 CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures
- .6 CSA W48.1
 - .1 CSA W48.1-M Carbon Steel Covered Electrodes for Shielded Metal Arc Welding
 - .2 CSA W48.2-M Chromium and Chromium-Nickel Steel Covered Electrodes for Shielded Metal Arc Welding
 - .3 CSA W48.3 Low Alloy Steel Covered Electrodes for Shielded Metal Arc Welding
 - .4 CSA W48.4 Solid Carbon Steel Filler Metals for Gas Shielded Arc Welding
 - .5 CSA W48.5-M Carbon Steel Electrodes for Flux- and Metal-Cored Arc Welding
 - .6 CSA W48.6 Fluxes and Carbon Steel Electrodes for Submerged Arc Welding
- .7 CSA W59-M Welded Steel Construction (Metal Arc Welding)
- .8 CAN/CGSB-1.181 Ready-Mixed Organic Zinc-Rich Coating
- .2 ASTM International (ASTM):
 - .1 A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Steel Piling
 - .2 A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - .3 A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .4 A143, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement
 - .5 A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

- .6 A325, Standard Specification for High-Strength Bolts for Structural Steel Joints
- .7 A384, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
- .8 A385, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- .9 A490, Standard Specification for Heat-Treated Steel Structural bolts, 150 ksi Minimum Tensile Strength
- .10 A563, Standard Specification for Carbon and Alloy Steel Nuts
- .11 A572, Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel
- .12 A588, Standard Specification for High-Strength Low Alloy Structural Steel With 50 ksi Minimum Yield Point to 4 in. Thick
- .13 A673, Standard Specification for Sampling Procedure for Impact Testing of Structural Steel
- .14 A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- .15 A992, Standard Specification for Steel for Structural Shapes for Use in Building Frames
- .16 B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- .17 F436, Standard Specification for Hardened Steel Washers
- .18 F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
- .3 American Welding Society (AWS): D1.1, Structural Welding Code-Steel
- .4 The Society for Protective Coatings- SSPC-SP10

1.3 DESIGN REQUIREMENTS

- .1 Connections – General
 - .1 Design in accordance with CAN/CSA-S16, Clause 21. - Connections.
 - .2 Connections may be bolted or welded

- .3 For structural steel encased in masonry, design connection system so that it is totally concealed within the masonry.
 - .4 For openings, including but not limited to doors and windows, design connection system so that it does not encroach into clear opening.
 - .5 Where connection details are shown on drawings, conform to the drawing as a minimum.
 - .6 Design connections for end reactions from torsion, bending moment, shear, and axial load where indicated. Use standard connections as per CISC Handbook where possible.
 - .7 Where no end reaction is indicated, design connection on the basis of simple construction for the end reaction of a laterally supported beam of a given span under a uniformly distributed factored load that has attained its maximum moment capacity in accordance with Standardized Shear Connections published by Canadian Institute of Steel Construction (CISC).
 - .8 For beams with intersecting bracing members design connections for beam reaction plus reaction from the bracing members.
 - .9 For non-standard connections, submit signed and stamped sketches and design calculations prepared by a Professional Engineer registered in the Province of Ontario.
- .2 Bolted Connections
- .1 Unless noted otherwise, use bearing-type connections with snug-tightened bolts. Minimum 2 M20 – ASTM-A325M/A490M bolt connections.
 - .2 Where indicated, use slip-critical connections.
 - .3 Use high-strength bolts in accordance with CAN/CSA-S16, Clause 22. – Design and Detailing of Bolted Connection.
 - .4 Use pre-tensioned bolts in accordance with CAN/CSA-S16, Clause 22.2.2 – Connections Using Pre-tensioned High-Strength Bolts for:
 - .1 Slip-critical connections.
 - .2 Connections of members resisting crane loads.
 - .3 Connections supporting running machines or other live loads that produce impact or cyclic loads.
 - .4 Connections where bolts are subject to tensile axial loads.

- .5 Connections using oversize or slotted holes, unless designed to accommodate movement.
- .5 Use clipped double angle connections where beams of similar size are bolted to both sides of a column at a common location.
- .3 For bracing and other tension and compression members, design connections, if not finished to bear, to develop the force due to full factored loads where indicated. Otherwise, design for 50 percent of strength of the member, in tension or compression, whichever governs.
- .4 Design splices for the full strength of the member in torsion, bending, shear, and axial load unless noted otherwise.
- .5 Provide pair of bearing stiffeners on beams and girders at point of concentrated loads, such as at columns, monorail beams, and equipment supports.

1.4 SUBMITTALS

- .1 Action Submittals:
 - .1 Provide Shop Drawing details showing:
 - .1 Submit shop drawings, connection design, erection diagrams and erection procedures based on actual field conditions, field measured by the Contractor.
 - .2 All shop drawings shall be submitted bearing the signed and dated seal of a professional engineering licensed in the Province of Ontario.
 - .3 Submit copies of shop and erection drawings to the inspection and testing company for their information.
 - .4 Indicate fabrication details including cuts, copes, connections, bolt tension, holes, bearing plates, threaded fasteners, shop coatings, galvanizing, or other surface treatments, and welds on shop details. Indicate welds using American Welding Society (AWS) welding symbols in accordance with ANSI/AWS A2.4.
 - .5 On erection diagrams, mark each member with a number corresponding to the drawing containing the shop details of the member.
 - .6 Submit shop details and erection diagrams together for each structure or part of structure in accordance with CAN/CSA S16.1.
 - .7 Shop drawings will be reviewed for general arrangement and material specifications.

- .8 Shop drawings bearing seal and signature of a Professional Engineer registered in the Province of Ontario will not be reviewed for structural adequacy.
 - .9 Dimension shop drawings in S.I. metric units.
- .2 Informational Submittals:
 - .1 Mill Certificates of tests made in accordance with ASTM A6.
 - .2 Direct Tension Indicators (DTIs): Furnish manufacturer's test report meeting requirements of ASTM F959.
 - .3 Tension Control (TC) Bolts: Furnish manufacturer's test report meeting requirements of ASTM A325 and ASTM F1852.
- .3 Certificates
 - .1 Submit two (2) copies of steel producer certificates in accordance with CAN/CSA-G40.20-M.
 - .2 Submit an affidavit stating that connections designed on the basis of simple construction are in accordance with Standardized Shear Connections published by CISC.
 - .3 Submit an affidavit stating that the materials and products used in fabrication are in accordance with the applicable material and product Standards.
 - .4 Submit welding certificate in accordance with CSA W47.1.
 - .5 Submit certification of compliance for hot-dip galvanizing in accordance with CAN/CSA-G164-M.

1.5 QUALITY ASSURANCE

- .1 Identification:
 - .1 Marking:
 - .1 Heat number, producer's name or brand mark materials to comply with CAN/CSA-G40.20-M.
 - .2 For member identification do not use die stamping.
 - .3 Shop mark all members for fit and match.
 - .4 If steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection.

- .5 Mark galvanized materials with a stamp or wire-on tag indicating the name of the galvanizer, the applicable code, and the weight of zinc coating.
- .2 Welding Qualifications: Perform welding only by a fabricator certified under the CSA qualification code W47.1-(latest edition) and in accordance to CAN/CSA W59. Execute work of this Section only by a structural steel fabricator who is fully accredited and is a current member of the Canadian Institute of Steel Construction, or who has received approval in writing from the Engineer no less than (1) week before tender closing.
- .3 Only specially trained personnel to install shear studs.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.
- .2 Storage:
 - .1 Protect structural steel members and packed materials from corrosion and deterioration.
 - .2 Store in dry area and not in direct contact with ground.
 - .3 Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.
- .3 Handle materials to avoid distortion or damage to members or supporting structures.
- .4 Provide delivery schedules seven (7) days prior to shipping.
- .5 Store structural steel materials on wood blocking so that no portion of steel comes into contact with ground. Cover and protect steel from snow, rain, and ground splatter.
- .6 Use nylon or padded cables for handling galvanized steel.

1.7 SITE CONDITIONS

- .1 Field Measurements
 - .1 Verify dimensions on site.
 - .2 Promptly notify the Engineer if apparent discrepancies are found.
- .2 Existing Conditions

- .1 If Work includes alterations or modifications to existing steelwork, or connecting new steelwork to existing steelwork or other existing work, arrange with the City to visit the proposed work site during the tendering period to review existing conditions including access and interference with existing installations.
- .2 Take full responsibility for doing work under the given existing conditions including any temporary work such as shoring and underpinning, which may be required in order to execute construction of the permanent Works.
- .3 Protection of Existing Equipment and Services
 - .1 Where structural steel will be installed in close proximity to and around existing equipment, building services and utilities, the Contractor shall protect the existing equipment and take precautions necessary to prevent damage to it.
- .4 Coordinate work under this Section with work to be done and equipment to be supplied under other Sections.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 W-Shapes:
 - .1 CAN/CSA-G40.21-M Grade 350W.
- .2 Shapes Except W-Shapes, Rolled plates and bars:
 - .1 CAN/CSA-G40.21-M Grade 300W.
- .3 For finishing and coating materials, see Section 09960 – High Performance Coatings.

2.2 FASTENERS

- .1 Anchor Rods: As specified in Section 05550 – Anchorage in Concrete and Masonry.
- .2 High-Strength Bolts: ASTM A325 or ASTM A490, bolt type.
- .3 Nuts: ASTM A563, type to match bolt type and finish.
- .4 Hardened Steel Flat and Beveled Washers: ASTM F436, type to match bolt finish.
- .5 Plastic or metal void forms: Wilson Anchor Bolt Sleeve by NCA/Acrow-Richmond Ltd. or D-1-S Anchor Bolt Sleeve by Dayton Superior Canada Limited or approved equivalent.

- .6 Headed stud anchors: ASTM A108; Headed shear stud connectors by Continental Studwelding Ltd. or TRW Canada Ltd or approved equivalent.
- .7 Deformed bar anchors: ASTM A496; Deformed bar anchor by Continental Studwelding Ltd. or TRW Canada Ltd or approved equivalent.
- .8 Zinc-rich primer for repair of galvanized surfaces: CAN/CGSB-1.181; Sealtight Galvafruid Zinc-Rich Coating by W.R. Meadows Ltd. or Z.R.C. Cold Galvanizing Compound supplied by Kerry Industries Limited or approved equivalent.
- .9 Welding electrodes: CSA-W48 Series; Low hydrogen E480 series.

2.3 ANCILLARY MATERIALS

- .1 Shop paint primer: To meet the requirements of CICS/CPMA standard 2-27 except that:
 - .1 Surface preparation to be commercial sandblasting to SSPC SP-6.
 - .2 Refer to Section 09900 - Painting for applicable finish system.
 - .3 Primer under fireproofing shall refer to Section 07811-Applied Fireproofing.
- .2 Grout: As specified in Section 03600 - Grout.

2.4 FABRICATION

- .1 General:
 - .1 Fabricate as shown and coordinate with work of all other sections in accordance with CAN/CSA-S16 and CISC Code of Standard Practice for Structural Steel Buildings and Bridges.
 - .2 Mark and match mark materials for field assembly.
 - .3 Complete assembly, including bolting and welding of units, before start of finishing operations.
 - .4 Field measure before fabrication.
- .2 Welding
 - .1 Weld in accordance with CSA W59-M. Comply with dimensional tolerances of CSA W59-M and ANSI/AWS D1.1.
 - .2 Shop weld unless noted otherwise.

- .3 Apply for acceptance of supplementary welding.
- .4 Do not weld at locations where weld is not specified.
- .5 Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.
- .3 Shop Installed Shear Connectors
 - .1 Install headed shear stud connectors in accordance with following requirements:
 - .1 The steel surface, to which stud is welded, is free of loose mill scale, heavy rust or paint.
 - .2 Space studs evenly over full length of member unless noted otherwise.
- .4 Connections:
 - .1 Shop Connections: Weld or bolt.
 - .2 Meet requirements of CAN/CSA-S16.
 - .3 Meet OSHA requirements for one independent bolt at beams framing in to column web connections.
- .5 Interface With Other Work:
 - .1 Holes:
 - .1 As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.
 - .2 No flame-cut holes will be permitted without prior approval of Engineer.
 - .2 Weld threaded nuts to framing, and other specialty items where shown or required to receive other Work.
 - .3 All open ends are to be capped with 6 mm plate, fully welded and ground smooth.
- .6 Finish
 - .1 Finish members true to line, free from twists, bends, open joints, sharp corners and sharp edges.

- .2 Weld and fabricate structural steel members which are permanently exposed at the exterior of the completed structures, such as lintel plates and built-up members, and interior members exposed in architecturally finished areas, such as door frames, cover plates, and similar items, in accordance with the following requirements:
 - .1 Clean appearance.
 - .2 Snug fit between parts composing built-up members.
 - .3 Continuous welds ground smooth.
- .7 Fabrication Tolerances
 - .1 Allowable tolerance for bolt holes:
 - .1 Match bolt holes so that a gauge with a diameter matching the nominal diameter of the fastener will pass freely through the assembled members at right angles to such members.
 - .2 Finish holes a maximum of 2 mm in diameter larger than diameter of bolt in accordance with CAN/CSA-S16.1, Clause 28. Holes for Bolts or Other Mechanical Fasteners, unless noted otherwise.
 - .3 Limit centre-to-centre distance between two adjacent holes a maximum of 1 mm from dimensioned distance between such holes.
 - .4 Limit centre-to-centre distance between any groups of holes to the following:

Centre-to-Centre Distance (Metres)	Tolerance \pm (mm)
Less than 10	1
10 to 20	2
Greater than 20	3
 - .2 Do not correct mispunched or misdrilled members. Apply for permission of corrective measures.
- .8 Shop Paint Primer:
 - .1 Do not shop prime the following surfaces, unless indicated otherwise:
 - .1 Faying surfaces of slip critical bolted connections.
 - .2 Within 50 mm of field-welded connections.

- .3 Steel members to be completely encased in reinforced concrete.
- .2 Surface to receive finish top coats or paint, one coat of prime paint. Apply shop primer to top flange surfaces of composite steel beams unless indicated otherwise.
- .3 Shop primer for steel members to be coated with fireproofing material shall be compatible with fireproofing as specified.
- .9 Hot-dip Galvanizing
 - .1 Galvanize structural steel where noted in accordance with CAN/CSA-G164-M – min. G600 coating designation (600g/m²) unless noted otherwise.
 - .2 Galvanize bolts, nuts, washers, and anchor bolts for connections to galvanized steel in accordance with CAN/CSA-G164-M.
 - .3 Complete fabrication, and prepare surfaces of steel by removing rust, weld spatter, flux and residue, burrs, and surface defects before galvanizing.
 - .4 Tap threads of nuts after galvanizing.
- .10 Finish Coating
 - .1 Paint or high-performance coating for steel members in accordance with Section 09900 – Painting and Section 09960 – High Performance Coatings.

PART 3 EXECUTION

3.1 ERECTION

- .1 Meet requirements of CAN/CSA S16 and CISC Code of Standard Practice for Structural Steel.
- .2 Install Contractor's designed temporary construction bracing to provide necessary support until components are in place and construction is complete. Failure to make adequate provision for erection shall be the sole responsibility of the Contractor.
- .3 High-Strength Bolted Connections:
 - .1 Tighten in accordance with CAN/CSA S16 Clause 23 Installation and Inspection of Bolted Joints.
 - .2 Tighten pretensioned bolts, where noted, in accordance with CAN/CSA-S16.1 Clause 23.8.

- .3 Do not reuse bolts that have undergone tightening and loosening more than two (2) times. Replace such bolts with new ones.
- .4 Hardened Washers:
 - .1 Provide at locations required by use of washers section of CAN/CSA S16, to include slip critical connections using slotted or oversized holes or A490 bolts.
 - .2 Use beveled style and extra thickness where required by CISC Specification.
 - .3 Use square or rectangular beveled washers at inner flange surfaces of Canadian Standard beams and channels.
 - .4 Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.
 - .5 Install galvanized washer under bolt head and nut when using galvanized bolts.
- .5 For bearing-type connections not fully tensioned (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.
- .4 Fully Tensioned Bolted Connections:
 - .1 Use DTIs or TC bolts at slip critical (SC) and fully tensioned (FT) bearing-type connections.
 - .2 DTIs:
 - .1 Position within bolted assembly in accordance with ASTM F959.
 - .2 Install bolts, with DTIs plus hardened washers as required, in all holes of an assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.
 - .3 Final tighten bolts, beginning at most rigid part of bolted connection and progressing toward free edges, until final twist-off of TC bolts or until DTIs have been compressed to an average gap equal to or less than shown in Table 2, ASTM F959.
- .5 Field Welding
 - .1 Fit parts together true to line and level.
 - .2 In cold weather, preheat parts prior to welding.

.6 Field Splicing

- .1 Provide adequate temporary supports for continuous members, which are spliced in the field to prevent erection stresses from being built into the member(s).

.7 Anchor Bolts

- .1 Provide anchor bolts for beams, columns, joists, and other similar items.
- .2 Include the necessary setting templates and instructions for accurate installation.
- .3 Where bolts are installed by another trade, provide supervision during installation.
- .4 Tighten anchor bolts to a snug-tight condition.

.8 Alterations in the Field of Shop Fabricated Members

- .1 Do not alter or cut structural members in the field without written permission.

.9 Plumbing of Steel Frame

- .1 After framing members are in place, plumb up the steel work accurately.
- .2 Complete permanent connections including bracing connections and field constructed moment connections.
- .3 Weld permanent diaphragms in place where applicable.

.10 Shimming and Grouting of Base Plates

- .1 Shim base plates and adjust steel members to proper level.
- .2 Use plastic shims of bearing area as required to carry safely the imposed erection loads.
- .3 Verify that grouting under base plates is finished after completion of structural steel erection.

.11 Touch-up damaged primed surfaces at completion of erection with shop paint primer.

.12 Repair hot-dip galvanized surfaces damaged by welding, cutting, handling during shipping or erection, or otherwise, in accordance with ASTM A780 using a zinc-rich coating. Dry film thickness on repairs to exceed original coating thickness by 25% minimum.

3.2 SETTING BASES AND BEARING PLATES

- .1 Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.
- .2 Clean bottom surface of base and bearing plates.
- .3 Set loose and attached baseplates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling plates where indicated.
- .4 Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washers to base plates where indicated.
- .5 Grout Under Baseplates: As specified in Section 03600, Grout, prior to placing loads on structure.

3.3 FIELD ASSEMBLY

- .1 Set structural frames accurately to lines and elevations shown.
- .2 Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.
- .3 Align and adjust various members forming a part of a complete frame or structure before permanently fastening.
- .4 Level and plumb individual members of structure within tolerances shown in CAN/CSA S16 Clause 29.7 Erection Tolerances.
- .5 Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.
- .6 Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.
- .7 Splice members only where indicated and accepted on shop drawings.

3.4 MISFITS BOLTED CONNECTIONS

- .1 Where misfits in erection bolting are encountered, immediately notify Engineer for approval of one of the following methods of correction:
 - .1 Ream holes that must be enlarged to admit bolts and use oversized bolts.

- .2 Plug weld misaligned holes and redrill holes to admit standard size bolts.
 - .3 Drill additional holes in connection, conforming with CSA Standards for bolt spacing and end and edge distances, and add additional bolts.
 - .4 Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.
- .2 Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

3.5 MISFITS ANCHOR BOLTS

- .1 Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved submittal.
- .2 Do not flame cut to enlarge holes without prior approval of Engineer.

3.6 GAS CUTTING

- .1 Do not use gas cutting torches in field for correcting fabrication errors in structural framing.
- .2 Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Engineer.
- .3 Finish flame-cut sections equivalent to sheared and punched appearance.

3.7 REPAIR AND CLEANING

- .1 Immediately after erection, clean field welds, bolted connections, and abraded areas of shop primer.
- .2 Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.
- .3 Remove weld back-up bars and grind smooth.
- .4 Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application.

3.8 FIELD QUALITY CONTROL

- .1 Materials and fabrication will be subjected to inspection by a testing agency retained by the City. This will in no way affect the Contractor's responsibility regarding the provision of work that fully complies with the specifications.
- .2 Advise the Engineer sufficiently in advance of operations to allow for assignment of personnel for shop and field inspection of material, workmanship, erection,

- tolerances, and connections. Provide facilities to enable inspection to be carried out.
- .3 Inspection of field welded and bolted connections will be done by a testing agency paid for by the City.
 - .4 The inspection does not relieve the Contractor of his responsibility to supply materials and construction in compliance with the Drawings and Specifications.
 - .5 High-Strength Bolted Connections:
 - .1 An independent testing agency will be retained by City to perform the following inspection and testing in accordance with CAN/CSA S16:
 - .1 Marking identification and conformance to ASTM standards.
 - .2 Alignment of bolt holes.
 - .3 Placement, type, and thickness of hardened washers.
 - .4 Tightening of bolts.
 - .2 Bearing-Type Connections Not Fully Tensioned (N, X): Snug tight condition with plies of joint in firm contact.
 - .3 Fully Tensioned (FT) Bearing and Slip Critical (SC) Connections:
 - .1 Conduct preinstallation test.
 - .2 Monitor installation and tightening of DTIs or TC bolts.
 - .3 Monitor condition of faying surfaces for slip critical connections.
 - .4 Preinstallation Test:
 - .1 Conduct jobsite test prior to start of work using a bolt tension measuring device.
 - .2 Select representative sample of not less than three bolts of each diameter, length, and grade.
 - .3 Include DTIs and flat hardened washers as required to match actual connection assembly.
 - .4 Conduct test in accordance with Specification for Structural Joints Using ASTM A325 or A490 Bolts.

- .5 Nondestructive Testing (NDT) Report: Prepare and submit a written NDT report identifying location of inspected bolted connections and summary of corrections as required to meet code acceptance criteria.
- .6 Defective Connections: Correct and re-inspect defective and improperly tightened high-strength bolted connections. Retest fully tensioned bolts as necessary to demonstrate compliance of completed work.
- .6 Welded Connections:
 - .1 An independent testing agency will be retained by City to perform the following inspection and testing of field welds.
 - .1 Groove Welds:
 - .1 Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.
 - .2 Use RT only for butt joint groove welds.
 - .2 Fillet Welds Larger Than 8 mm: Liquid penetrant (PT) or magnetic particle (MT) for 10 percent of randomly selected welds, unless otherwise indicated.
 - .3 All Welds: 100 percent visually inspected (VT).
- .7 Repair and retest defective welds as specified in accordance with CAN/CSA W59. Shall be on the contractor's expense.

END OF SECTION

**SECTION 05500
METAL FABRICATIONS**

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**SECTION 05500
METAL FABRICATIONS**

PART 1 GENERAL

1.1 DESCRIPTION

- .1 This Section specifies the requirements for the supply and installation of all miscellaneous metal fabrications, as indicated on the Contract Drawings, specified herein and as required to complete the work.
- .2 Without in any way limiting the scope of the foregoing, the work shall consist in general of the following:
 - .1 Ladders
 - .2 Removable grating, grating, anchors and frames
 - .3 Access and Equipment hatch
 - .4 Bolts and nuts
 - .5 Miscellaneous support beams, angles and frames
 - .6 Handrails
 - .7 Safety Chain
- .3 Include supplying and installing all necessary angles, brackets, metal inserts, rivets, anchor bolts and frames set in concrete or otherwise, and all adjusting screws, metal parts, bolts, gaskets and nuts necessary for the complete installation of the work herein specified.
- .4 Design miscellaneous metal items in accordance with applicable standards.
- .5 Design work of this Section, which will support other items or will be required to support structural loads of any nature, by a Professional Structural Engineer licensed in the Province of Ontario. Affix professional seal and signature to the Shop Drawings for such items including but not limited to:
 - .1 Ladders
 - .2 Access and equipment hatch
 - .3 Removable grating, grating, anchors and frames
 - .4 Handrails
 - .5 Safety Chain

- .6 Design connections and splices using high-strength bolts or welds. Use bearing type bolts for bolted connections.
- .7 Design connections for moments, shears and axial loads indicated or specified.
- .8 Where no comments, shears or axial loads are indicated design in accordance with CAN/CSA-S16.1-M requirements for Simple construction. Design connection for greater than half the shear capacity of member unless indicated otherwise.
- .9 Design connection for Hollow Structural Sections to develop full strength of member in tension or compression.
- .10 Unless design loads are indicated, design splices for full strength of member in bending, shear and axial loads.
- .11 Unless design loads are indicated, design end connections and/or splices in bracing members for full axial strength of the member.
- .12 Where overlapping or contacting surfaces cannot be avoided, completely seal weld these surfaces. Where there is evidence of rusting or deterioration of finish in such areas, carry out remedial steel welding and refinishing.
- .13 Design aluminum work to CSA S157-M and CSA W59.2-M.
- .14 For a structure categorized as a post-disaster building, refer to the structural general notes for the importance category, the non-structural components and equipment and their connections attached to the structure should be designed and detailed as per the seismic requirements stated in OBC 4.1.8.18. This includes masonry veneer, mechanical, electrical, process units. All connector shop drawings should be signed and sealed by a Professional Engineer licensed in the Province of Ontario, and submit to engineer for review before installation.

1.2 WORKMANSHIP

- .1 Conform to the requirements for structural steel as specified in CSA-S16.1-94, unless otherwise indicated herein.

1.3 SUBMITTALS

- .1 Shop Drawings: Submit shop Drawings before fabrication commences of each metal fabrication item, showing in large scale fabrication details, thickness, anchors, location and finishes.
- .2 Submit welding procedure specification for each type of material.
- .3 Submit sample of aluminium railing including a welded joint to the Engineer for acceptance. Commence fabrication only after acceptance has been obtained.

- .4 Samples: Submit two samples of each finish.

1.4 WARRANTY

- .1 Submit a 5-year warranty for prefinished aluminum work against defects in materials and workmanship including but not limited to fading or non-uniformity of colour, cracking, peeling or other corrosion.

1.5 POST DISASTER DESIGN REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS AND EQUIPMENT

- .1 Design all supports and anchorage of non-structural components and equipment as post-disaster
- .2 Use importance factor of IE of 1.5 for the design
- .3 Design all architectural, mechanical, and electrical components for the in-structure horizontal and vertical seismic accelerations in accordance with the more stringent of OBC section 4.1.8.18, element of structures, non-structural components and equipment, or CSA S832-14 seismic risk reduction of operational and functional component (OFCS) of buildings and standard details.
- .4 Contractor is to retain a professional engineer licensed in province of Ontario to design all mechanical and electrical equipment supports and anchorage of non-structural components as post-disaster and submit the stamped shop drawings for approval.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Structural mild steel bars and shapes: to CSA-G40.21-92, Grade 350W.
- .2 Bolts, nuts: to ASTM A307.
- .3 Structural Aluminum: to Alcan 6061-T6.
- .4 Anodized Aluminum: means that the aluminum be anodized in accordance with Alcan CE/AN film thickness as noted.
- .5 Stainless Steel: to Type 316.
- .6 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m² to CSA G164-M1981 after fabrication.
- .7 Zinc primer: zinc rich, ready mix to CGSB 1-GP-181M.
- .8 Grating: as shown on drawings.
- .9 Grating anchors: standard DB saddle clips.

- .10 Handrails: as shown on drawings.
- .11 Ladders: as shown on drawings.
- .12 Safety Chain: as shown on drawings.
- .13 Welding materials and electrodes to: CSA W59 and W48 respectively.

2.2 FABRICATION – GENERAL

- .1 Build work square, true, straight and accurate to required size, with joint closely fitted and properly secured.
- .2 Fabricate items from stainless steel, steel or aluminum as shown on the Contract Drawings.
- .3 Where possible, fit and shop assemble work, ready for erection.
- .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.
- .5 File or grind exposed welds smooth and flush. Do not leave grinding marks. Construct internal and external corners with sharp lines. Provide continuous welds unless otherwise accepted by Engineer in writing. Brighten and buff aluminum and stainless steel welds to match appearance of adjacent surface.
 - .1 Remove weld spatter and slag. After finish grinding and smoothing welds, passivate welds with pickling paste.
 - .2 Preheat members thicker than 19 mm before welding.
- .6 Weld aluminum in accordance with CSA W47.2.
 - .1 Use weld rod No. 5356 for clear anodized aluminum of 6063-T5 alloy.
- .7 Weld steel and stainless steel in accordance with CSA W47.1 and W59-M.
- .8 Fabricate metal work complete with components required for anchoring to concrete; bolting or welding to structural steel frames; standing free; or resting in frames or sockets, in safe and secure manner.

2.3 FABRICATION – RAILING

- .1 Design railing system in accordance with Ontario Building Code and using the material indicated on the Contract Drawings.
- .2 Fabricate all railings of:
 - .1 42 mm outside diameter nominal size tubing schedule 40.

- .2 Top rail: a minimum 1070 mm above the floor or platform.
- .3 38 mm nominal size steel pipe posts schedule 80 of one length are to be located:
 - .1 at corners;
 - .2 within 300 mm of either side of the corners;
 - .3 at centres 1000 mm for exits and stairs;
 - .4 1500 mm on platforms.
- .4 Expansion sleeve spacing: 8000 mm on centre maximum.
- .5 Pickets – 19 mm diameter schedule 40 pickets at 100 mm o/c spacing maximum.
- .6 Design railing arrangement to eliminate tubing projections at the upper and lower ends.

2.4 FABRICATION – LADDERS

- .1 Design ladders using the material indicated on the Contract Drawings.
- .2 Fabricate ladders with the following features:
 - .1 Lengths: required in accordance with the Contract Drawings.
 - .2 Construction: welded.
 - .3 Stringers: 13 mm x 64 mm.
 - .4 Rungs: 25 mm wide x 19 mm deep top-fluted.
 - .5 Stringer spacing: minimum 400 mm apart.
 - .6 Rung spacing: 300 mm centres.
 - .7 Fabricate anchors to space ladder 150 mm minimum from finished wall surface.
 - .8 Locate bottom rung no higher than 300 mm above floor or platform.
 - .9 Welds: grind smooth.
 - .10 Weld anchorage pieces to stringers, at top and bottom of each ladder and at intermediate points for spacing not more than 1200 mm.

- .11 Reinforce stringer extensions above platforms to provide rigid support for personnel using ladder.

PART 3 EXECUTION

3.1 ERECTION

- .1 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .2 Provide suitable means of anchorage acceptable to the Engineer such as dowels, anchor clips, bar anchors, expansion bolts and shields and toggles.
- .3 Make field connections with bolts to CSA S16.1-94, or weld.
- .4 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .5 Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection.
- .6 Touch-up galvanized surfaces with zinc primer where burned by field welding.

3.2 STEEL GRATING AND FRAMES

- .1 Dimensions and arrangement layouts as per the Contract Drawings.
- .2 Supply all gratings in such length and width that the total weight does not exceed 35 kg with neatly welded angle frames.
- .3 Edge band all grating and band all gratings at cutouts, required for piping, etc., trim band with bars, having the same size and thickness as the bearing bars.
- .4 Arrange sections to fit around piping, valves, etc., for easy removal and placing without disturbing any other section, pipe, valve or equipment.
- .5 Where two (2) or more units of grating are installed together match the pattern of their bearing bars and cross bars unless noted otherwise on the Contract Drawings.
- .6 Fasten down all gratings with manufacturer's standard fasteners and saddle clips.
- .7 All bolts, nuts, fasteners and washers to be stainless steel and conform to requirement of ASTM A307.
- .8 Fabricate anchors, angle and channel frames from stainless steel to conform to the requirement of ASTM A307.
- .9 Size and arrangements layouts of anchors, channel and angle frames as indicated on the Contract Drawings.

3.3 STEEL REMOVABLE GRATING

- .1 Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners as recommended by manufacturer for attaching to supports.
 - .1 Provide not less than four weld lugs for each grating section, with each lug shop welded to two bearing bars.
 - .2 Finish threaded bolts with nuts and washers for securing grating to supports.
 - .3 Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
 - .1 Edge-band openings in grating that interrupt four or more bearing bars with bards of the same size and material as bearing bars.
 - .4 Do not notch bearing bars at supports to maintain elevation.
 - .5 Attach removable units to supporting members as recommended by grating manufacturer.

3.4 LADDERS

- .1 Install access ladders in locations as indicated.
- .2 Erect ladders 150 mm minimum clear of wall on bracket supports.

3.5 RAILING

- .1 Supply and install railing where noted in accordance with the detail shown.
- .2 Railings to be neatly curved at stair ends, at change in direction and the like, with no posts directly placed at such change of direction.
- .3 Provide safety chain wherever shown or required.
- .4 Anchor railing to concrete with stainless steel anchors, bolts, nuts and washers.

3.6 STEEL SAFETY CHAIN

- .1 Bolt the safety chain in location as shown on the Contract Drawings.

3.7 BOLTS AND NUTS

- .1 Stud, tap and machining bolts to be Type 316, stainless steel as shown on the Contract Drawings, unless otherwise specified. Use hexagonal nuts of the same quality of metal as the bolts. Clean cut all threads in accordance with Canada

Institute of Steel Construction standards. Extend threaded portion of bolts beyond bearing points complete with washers to allow nuts to be tightened.

- .2 All anchor bolts to be stainless steel and conform to the requirements of ASTM A307.

3.8 MISCELLANEOUS SUPPORT BEAMS, ANGLES AND FRAMES

- .1 Miscellaneous angles, brackets and frames are to be structural steel. Fasten to concrete using self- drilling anchors and stainless steel bolts unless otherwise specified.

3.9 WORKMANSHIP

- .1 The surface of metals shall be clean and free from mill scale, flake rust and rust pitting. The work shall be well formed, with sharp lines and angles and smooth surfaces. Finish welds and rivets flush and smooth on surfaces that will remain exposed to view after installation. Make joints necessary in the work that will not weaken the whole.
- .2 Make joints that will remain exposed to view tight and closely fitted, and inconspicuously as possible by grinding or otherwise to ensure close and even connections.
- .3 Keep joints to the minimum by using members in as long lengths as is practical.
- .4 Use flat head type screw fasteners that will remain exposed to view after installation and fit into countersunk holes.

3.10 PROTECTION FROM CORROSION

- .1 Paint all steel work subject to corrosion unless otherwise specified.
- .2 Paint with two coats of an approved bituminous paint, any aluminium work to be embedded or to be in contact with concrete.
- .3 Where aluminium comes in contact with steel, coat the contact areas with aluminium impregnated caulking compound immediately prior to assembly.
- .4 Thoroughly clean all steelwork, not to be galvanized, of loose scale, rust, oil and dirt and paint with one shop coat of 13-Y-602 Epoxy Ester Phenolic Primer having a dry film thickness of 37-50 μm . Finish painting under Division 13.
- .5 Touch-up all field welds and galvanized surfaces where burnt or scratched with Galvafroid as manufactured by W.R. Meadows or with an approved alternative.

END OF SECTION

**SECTION 05550
ANCHORAGE IN CONCRETE**

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SECTION 05550
ANCHORAGE IN CONCRETE

PART 1 GENERAL

1.1 SECTION INTENT

- .1 This section refers to the procurement and installation of anchors in concrete and masonry. It includes cast-in-place anchor bolts, adhesive anchors, expansion anchors, and epoxy-grouted anchor bolts specified herein and as required to complete the work.

1.2 GENERAL

- .1 Unless otherwise specified or indicated on the drawings, all anchors and anchor bolts shall be cast-in-place anchor bolts with forged heads or embedded nuts and washers. Unless otherwise indicated, bolts in concrete shall have a diameter of at least 20 mm, and bolts in grouted masonry shall have a diameter of at least 13 mm.
- .2 Unless otherwise indicated on the drawings, anchors and anchor bolts used in the following locations and applications shall be of the indicated materials. Other anchors and anchor bolts shall be as indicated on the drawings. Where stainless steel is indicated, use Type 316 stainless steel.

- .1 Cast-in-Place Anchor Bolts:

- .1 Submerged locations: Stainless steel.
- .2 Locations subject to splashing: Stainless steel.
- .3 Buried locations: Stainless steel.
- .4 Anchorage of structural steel columns: Galvanized steel.
- .5 Other exterior locations: Galvanized steel.
- .6 Other interior locations: Carbon steel.

- .2 Threaded Rod and Expansion Anchors:

- .1 Submerged locations: Stainless steel.
- .2 Locations subject to splashing: Stainless steel.
- .3 Buried locations: Stainless steel.
- .4 Anchorage of structural steel columns: Stainless steel.

- .5 Other exterior locations: Stainless steel.
- .6 Other interior locations: Carbon steel.
- .3 Adhesive anchors and expansion anchors may be used instead of cast-in-place anchors where specifically indicated or permitted on the drawings or with the specific acceptance by the Consultant.

1.3 SUBMITTALS

- .1 Letters of certification indicating the manufacturer and types of adhesive anchors, expansion anchors and epoxy grouts to be supplied shall be submitted in accordance with Section 01330 – Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Materials shall be handled, transported and delivered in a manner that will prevent damage or corrosion. Damaged materials shall be promptly replaced at the Contractor's expense if they are at fault. Materials shall be shipped and stored in original manufacturer's packaging.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Materials shall be as indicated below:
 - .1 Expansion Anchors: Hilti "Kwik-Bolt"; ITW Ramset/Red Head "Trubolt Wedge Anchor"; Powers Fasteners "Power-Stud Anchor" or approved equivalent.
 - .2 Anchor Bolts and Nuts:
 - .1 Carbon Steel: American Society of Testing and Materials (ASTM) A307 or grade 300 rod, with compatible nuts.
 - .2 Stainless Steel: Bolts, ASTM F593-02e.2, Alloy Group 2 (316 SS); nuts, ASTM F594, Alloy Group 2.
 - .3 Galvanized Steel: Carbon steel bolts and nuts; hot-dipped galvanized, ASTM A153/A153M-05 and ASTM A385-05.
 - .4 Flat Washers: American National Standards Institute (ANSI) B18.22.1; of same material as anchor bolts and nuts.
 - .3 Threaded Rod Anchors and Nuts:
 - .1 Carbon Steel: Grade 300W rod, with compatible nuts.

- .2 Stainless Steel: Rods, ASTM F593, Alloy Group 2 (316 SS); nuts, ASTM F594-02, Alloy Group 2.
- .3 Galvanized Steel: Carbon steel rods and nuts; hot-dipped galvanized, ASTM A153 and ASTM A385-05.
- .4 Adhesive Anchors for Concrete and Grout Filled Masonry:
 - .1 Threaded Rods and Nuts: As specified for Threaded Rod Anchors and Nuts and as recommended by the adhesive manufacturer.
 - .2 Adhesive: Hilti “HIT HY 150 MAX-SD”, “HIT HY 150 MAX”, “HIT-ICE”, “HIT RE500”, or “HVA” Systems or approved equivalent.
- .5 Epoxy Grout for Reinforcing Bars, Threaded Rod Anchors and Anchor Bolts:
 - .1 Adhesive for Floors and Horizontal Surfaces: Sika “Sikadur 35, Hi-Mod LV”; ChemRex “Concresive Liquid LPL”; Sika “Sikadur 32 Hi-Mod”, Hilti “HIT RE500” or approved equivalent.
 - .2 Adhesive for Vertical Surfaces and Overhead Applications: Sika “Sikadur 31 Hi-Mod Gel” or approved equivalent.
 - .3 Aggregate: As recommended by the epoxy grout manufacturer.
 - .4 Water: Clean and free from deleterious substances.
- .6 Adhesive Anchors for Hollow Masonry System:
 - .1 Threaded Rod Anchors and Nuts: As specified for Threaded Rod Anchors and Nuts and as recommended by the adhesive manufacturer.
 - .2 Adhesive: Hilti “HIT HY 20” System; ITW Ramset/Redhead “Epcon Ceramic 6” System or approved equivalent.
 - .3 Screen Tubes: As recommended by the manufacturer.

2.2 ANCHORS

- .1 Cast-in-Place Anchor Bolts: Cast-in-place anchor bolts shall be delivered in time to permit setting before the structural concrete is placed. Anchor bolts shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or the supporting template. Two nuts, a jam nut, and a washer shall be furnished for cast-in-place anchor bolts indicated on the drawings to have locknuts; two nuts and a washer shall be furnished for cast-in-place anchor bolts without locknuts.

- .2 Adhesive and Expansion Anchors: When adhesive or expansion anchors are indicated on the drawings, only acceptable systems shall be used. Acceptable systems shall include only those systems and products specified or specifically indicated by product name on the drawings. Alternative anchoring systems may be used only when specifically accepted by Consultant. An acceptable adhesive anchor system may be used as an alternative in locations where epoxy grouted anchor bolts and epoxy grouted threaded rod anchors are specified or indicated.
 - .1 Threaded rod anchors in adhesive anchor systems shall be furnished with a sufficient length to provide an embedment depth of at least 15 rod diameters and free of coatings that would weaken the bond with the adhesive. Unless otherwise required, single nut and washer shall be furnished for threaded rod anchors, adhesive anchors and expansion anchors. Anchor bolts and threaded rod anchors that are to be epoxy grouted shall be clean and free of coatings that would weaken the bond with the epoxy.
 - .2 Adhesive anchors in hollow masonry shall utilize screen tubes as recommended by the manufacturer.
- .3 Epoxy Grouted Anchor Bolts and Reinforcing: Epoxy grout for installing reinforcing steel dowels and anchor bolts not indicated to be adhesive anchors shall consist of a two-component liquid epoxy adhesive of viscosity appropriate to the location and application and an inert aggregate filler component, if recommended by the adhesive manufacturer. Components shall be packaged separately at the factory and mixed immediately before use.

PART 3 EXECUTION

3.1 PREPARATION

- .1 Prior to the erection of the formwork, verify all the dimensions and locations for the anchor bolts.

3.2 GENERAL

- .1 Anchor bolts shall be installed at the locations indicated on the drawings.
- .2 Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchors immediately before final installation and tightening of the nuts.
- .3 Anchors shall be located at least 100 mm away from conduits, sleeves and drains bodies at their largest point measured on top of the slab above the anchor, and the like, embedded in the concrete.
- .4 Anchors shall be installed in drilled holes with a minimum depth and diameter specified by the manufacturer unless noted otherwise.

- .5 If, when drilling the holes for the anchors, reinforcement is encountered and the hole must be shifted to clear the reinforcement, the abandoned hole shall be patched with non-shrink grout of similar properties as the base concrete.

3.3 CAST-IN-PLACE ANCHORS AND ANCHOR BOLTS

- .1 Cast-in-place anchors and anchor bolts shall be carefully positioned with templates and secured in the forms prior to placing concrete.
- .2 Contractor shall verify that anchorage devices are positioned in accordance with the design drawings and with applicable equipment submittal and Approved Shop Drawings.
- .3 Anchors and bolts shall be positioned sufficiently in advance of the concrete placement so that an on-site representative of Consultant or Waste Management of Canada Corporation (WMC) will have sufficient time to inspect the bolts prior to placing concrete. If special inspection of the anchor bolts is required by the local building code, anchorage shall be placed in sufficient time and with sufficient notification so that such inspection can take place without delaying progress of the work.
- .4 Threads, bolts and nuts spattered with concrete during placement shall be cleaned prior to final installation of the bolts and nuts.

3.4 EPOXY GROUT

- .1 Epoxy grout components shall be packaged separately at the factory and shall be mixed immediately before use. Proportioning and mixing of the components shall be done in accordance with the manufacturer's recommendations.
- .2 An acceptable adhesive anchoring system may be used where epoxy grouted threaded rod anchors are indicated on the drawings.
- .3 Preparation: Where indicated on the drawings, anchor bolts, threaded rod anchors and reinforcing bars shall be epoxy grouted in holes drilled into hardened concrete. Diameters of holes shall be as follows:

Item	Diameter of Hole
Reinforcing Bars and Threaded Rod Anchors	3mm larger than the outside diameter of the bar or the rod
Headed Anchor Bolts	Bolt diameter plus 50mm and sufficient to clear the bolt head.

- .4 The embedment depth for epoxy grouted anchor bolts, threaded rod anchors and reinforcing bars shall be at least 15 bolt, rod or bar diameters, unless otherwise indicated on the drawings.

- .5 Holes shall be prepared for grouting as recommended by the epoxy grout manufacturer.
- .6 Installation: Anchor bolts, threaded rod anchors and reinforcing bars shall be clean, dry and free of grease and other foreign matter when installed. The bolts, rods and bars shall be set and positioned and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with epoxy grout, without voids.

3.5 ADHESIVE ANCHORS

- .1 When adhesive anchors are indicated on the drawings, only an acceptable system shall be used. Alternative anchoring systems may be used only when acceptable to Consultant. An acceptable adhesive anchor system may be used as an alternative in locations where epoxy grouted anchor bolts and threaded rod anchors are specified or indicated. The embedment depth for adhesive anchors shall be at least 15 rod diameters unless a greater depth is indicated on the drawings or as required by the product manufacturer.
- .2 Adhesive for adhesive anchors shall be statically mixed in the field during application. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.
- .3 Anchors shall be installed in holes drilled into hardened concrete or grout filled masonry. Diameter of holes shall be 3mm larger than the outside diameter of the rod unless recommended otherwise by the anchor system manufacturer. Holes shall be prepared for insertion of the anchors by removing all dust and debris using procedures recommended by the adhesive manufacturer.
- .4 Adhesive anchors and holes shall be clean, dry and free of grease and other foreign matter at the time of installation. The adhesive shall be placed, the rods shall be set and positioned and the adhesive shall be finished, all in accordance with the recommendations of the material manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with adhesive, without voids and remain filled with adhesive until completion of the curing period. Adhesive shall be cured in accordance with the recommendations of the adhesive manufacturer.

3.6 EXPANSION ANCHORS

- .1 When expansion anchors are indicated on the drawings, only an acceptable expansion anchor shall be used. The minimum distance between the centre of any expansion anchor and an edge or exterior corner of concrete shall be at least six times the diameter of the bolt. Unless otherwise indicated on the drawings, the minimum distance between the centres of expansion anchors shall be at least 12 times the diameter of the bolt.

3.7 QUALITY CONTROL

- .1 Implement a system of quality control to ensure that the required standards specified herein are attained.
- .2 Bring to the attention of the Consultant any defects in the work or departures from the contract documents that may occur during construction. The Consultant will decide upon corrective action and give their recommendations in writing.
- .3 The Consultant's general review during construction and inspection and testing by independent inspection and testing agencies reporting to the Consultant are both undertaken to inform the WMC of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

3.8 NOTIFICATION

- .1 Prior to commencing significant segments of the work, give the Consultant and independent inspection and testing agencies appropriate notification, so as to afford them reasonable opportunity to review the work. Failure to meet this requirement may be cause for the Consultant to classify the work as defective.

3.9 INSPECTION AND TESTING

- .1 Appointment of Independent Inspection and Testing Companies:
 - .1 The WMC will appoint the independent inspection and testing companies to make inspections or perform tests as the Consultant directs. The independent inspection and testing companies shall be responsible only to the Consultant and shall make only such inspections or tests as the Consultant may direct.
 - .2 When defects are revealed, the WMC may request, at the Contractor's expense, additional inspection or testing to ascertain the full extent of the defect.
- .2 Tests on Installed Anchors:
 - .1 Anchors: The independent inspection and testing company may test up to ten per cent of some of the installed anchors to the manufacturer's specified working load. Should defective anchors or under-capacity installations be found, all anchors will be tested, with all associated costs paid for by the Contractor.

3.10 DEFECTIVE MATERIALS AND WORK

- .1 Where evidence exists that defective work has occurred or that work has been carried out incorporating defective materials, the Consultant may have tests, inspections or surveys performed, analytical calculations of structural strength

made and the like in order to help determine whether the work must be repaired or replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor's expense.

- .2 All testing shall be conducted in accordance with the requirements of the Ontario Building Code, except where this would in the Consultant's opinion cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.
- .3 Materials or work which fails to meet specified requirements may be rejected by the Consultant whenever found at any time prior to final acceptance of the work regardless of previous inspection. If rejected, defective materials or work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the WMC.

END OF SECTION

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SECTION 13342
FABRICATED METAL BUILDINGS

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SECTION 13342
FABRICATED METAL BUILDINGS

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes
 - .1 This Specification is intended to be used for the following Prefabricated Metal Buildings:
 - .1 Storage Building –Normal Importance
 - .2 Refer to the drawings for additional information.

1.2 GENERAL

- .1 Provide building certification and guarantee.
- .2 Prefabricated metal building structures to be complete assemblies, suitable for the intended purpose and the local environmental conditions. The scope of work shall include, but not be limited to:
 - .1 Structural design of steel building system, including primary and secondary framing.
 - .2 Design of anchor bolts (quantity and diameter only).
 - .3 Design of metal cladding and roofing.
 - .4 Preparation of shop drawings.
 - .5 Supply and erection of steel building system, including primary and secondary framing.

1.3 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - .1 ASHRAE 90.1(I-P Edition), Energy Standard for Buildings except Low-Rise Residential Buildings.
- .2 ASTM International Inc.:
 - .1 ASTM A36/A36M, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

- .3 ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Services and Other Special Purpose Applications.
- .4 ASTM A307, Standard Specification for Carbon Steel Bolts, and Threaded Rod, 60,000 PSI Tensile Strength.
- .5 ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength.
- .6 ASTM A325M, Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric).
- .7 ASTM A490M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .8 ASTM A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .9 ASTM A992/A992M, Standard Specification for Structural Steel Shapes.
- .10 ASTM A1011/A1011M, Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low Alloy with Improved Formability, and Ultra-High Strength.
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-85.10, Protective Coatings for Metals.
- .4 Canadian Standards Association (CSA International):
 - .1 CSA A660, Certification of Manufacturers of Steel Building Systems.
 - .2 CSA G40.20-13/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel.
 - .3 CSA-G164, Hot-Dip Galvanizing of Irregularly Shaped Articles.
 - .4 CSA-S16, Limit States Design of Steel Structures.
 - .5 CSA-S136, North American Specifications for the Design of Cold Formed Steel Structural Members.
 - .6 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
 - .7 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum.

- .8 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
- .9 CSA W55.3, Certification of Companies for Resistance Welding of Steel and Aluminum.
- .10 CSA W59, Welded Steel Construction (Metal Arc Welding).
- .5 Canadian Sheet Steel Building Institute (CSSBI):
 - .1 CSSBI 30M, Standard for Steel Building Systems.
 - .2 CSSBI B15, Snow, Wind and Earthquake Load Design Criteria for Steel Building Systems.
- .6 National Research Council (NRC)/Institute for Research in Construction (IRC):
 - .1 Construction Technology Update No. 9, Evolution of Wall Design for Controlling Rains Penetration.
 - .2 Construction Technology Update No. 17, Pressure Equalization in Rainscreen Wall systems.
 - .3 Construction Technology Update No. 34, Designing Exterior Walls According to the Rainscreen Principle.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed Product literature and data sheets for sealants, insulation, and building materials and include Product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit a digital copy of WHMIS SDS in PDF format, for the following.
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary joints.
- .2 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada in the employ of the prefabricated steel building system manufacturer to signify that the manufacturers' responsibilities with respect to design have been completed and reviewed for compliance with the Contract Documents.

- .1 Submit drawings for fabricator designed assemblies, components and connections.
- .2 Shop Drawings shall be reviewed and accepted in accordance with the Contractor's Quality Plan prior to be forwarded to the Consultant.
- .3 Shop Drawings to include the following:
 - .1 Erection drawings showing foundation loads, anchor bolt setting details, part numbers, connections, and assembly details.
 - .2 Indicate plans and grid lines, structural members and connection details, bearing and anchorage details, roof cladding, wall cladding, framed openings, accessories, schedule of material and finishes, camber, loads and reaction forces, fasteners and welds, sealant locations and details.
 - .3 Indicate shop and erection details including cuts, copes, connections, holes, threaded fasteners, rivets and welds. Indicate welds by CSA welding symbols.
 - .4 Indicate on Shop Drawings related provisions required for mechanical, electrical, overhead travelling crane, snow guards, and other work.
- .3 Provide certification that the steel building system manufacturer is certified to CSA-A660.
- .4 Provide certification from prefabricated steel building system manufacturer that erector is qualified to erect building system.
- .5 Submit certified mill test reports for structural steel prior to fabrication. Mill test reports to show chemical and physical properties and other details of steel to be incorporated in the project.
- .6 Submit CSA-A660 Certificate of Design and Conformance with OBC stating design criteria used and loads assumed in design. Certificate shall be signed and sealed by a Professional Engineer registered in the Province of Ontario.
- .7 Do not commence fabrication until complete set of Shop Drawings has been reviewed and accepted by the Consultant. Where fabrication is initiated prior to such review, all subsequently required revisions shall be at no cost to the Owner.
- .8 Manufacturer's Instructions: Submit application instructions for caulking, tape and sealant.
- .9 Manufacturer's Field Reports: Submit to Consultant manufacturer's written report, within three (3) days of review, verifying compliance of work, as described in PART 3 - FIELD QUALITY CONTROL.

1.5 SYSTEM DESCRIPTION

- .1 Provide building structure and enclosure to physical dimensions as indicated.
- .2 Building occupancy as defined by Ontario Building Code is Group F, Division 3.
- .3 Generally, building is intended to enclose storage. Refer to architectural plans.
- .4 Type: Rigid frame braced bays as indicated.
- .5 Roof slope: Minimum to meet or exceed manufacturers requirements.
- .6 Wall system: Concealed fastener insulated metal panels.
- .7 Roof system: insulated metal panels by Prefabricated Building supplier.
- .8 Crane supports: steel corbel and runway beams for 5 Ton crane in Maintenance Facility by Prefabricated Building supplier.

1.6 DESIGN REQUIREMENTS

- .1 Design in accordance with Ontario Building Code 2024 and the NBCC 2020 Structural Commentaries.
- .2 Maximum deflection for roofing under full specified live load: 1/240 of clear span.
- .3 Maximum deflection for exterior cladding under full specified exterior wind induced loads: 1/180 of clear span.
- .4 Maintain following tolerances for building structure and enclosure elements:
 - .1 Maximum variation from plane or location shown on Shop Drawings: 1 mm / 1 m of length and up to 1 mm / 5 m maximum.
 - .2 Maximum offset from true alignment between two adjacent members abutting end to end, in line: 0.75 mm.
- .5 Dead loads shall include the self-weight of the structure and all permanent materials of the building construction, including dead load allowance for suspended lighting.
- .6 Collateral loads shall include mechanical and electrical equipment, sprinkler systems, suspended ceilings, and all other removable parts of the structure.
- .7 Live loads shall include superimposed loads on the structure due to the following:
 - .1 Use and occupancy loads.
 - .2 Snow, rain, and ice effects.

- .3 Maintenance and construction loads.
- .4 Wind Loads.
- .5 Earthquake Loads.
- .6 Thermal Loads.
- .7 Differential foundation settlement.
- .8 Crane Loads.
- .8 Refer to Attached Drawings for dimensional requirements, minimum load requirements and building importance factors.
- .9 For the calculation of individual structural member deflections and rigid frame sidesway, only the individual member properties or frame member properties may be considered. Assumptions of composite action by panel and structural member will not be permitted to demonstrate conformity to stiffness requirements.

1.7 QUALITY ASSURANCE

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting one (1) week prior to beginning work of this Section and on-site installation, with Contractor's representative and Consultant to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building construction subtrades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.
- .2 Quality Plan:
 - .1 Develop and implement a Quality Plan that verifies the erection of the prefabricated steel building system and the installation of the associated components are in conformance with the requirements of this Section. The Quality Plan shall include Quality Control inspections and testing in accordance with CSA-S16. Quality Control inspections and testing will be paid for out of a cash allowance.
 - .2 Submit details of Quality Plan to the Consultant for review.

- .3 The Owner will develop a Quality Assurance Plan for the purpose of verifying that the work of this Section meets with the specific requirements of the project. The Owner's Quality Assurance Plan may include inspection and testing in addition to that implemented by the Contractor's Quality Plan.

1.8 INSPECTIONS

- .1 Shop and site inspections to ensure conformance with this Section will be conducted by an inspection company appointed by the Contractor. Shop and site inspections to be performed only by a firm certified by the Canadian Welding Bureau for the requirements of CSA Standard Q178 for buildings by visual methods.
- .2 Inspection company services will be paid for out of a cash allowance.
- .3 All inspection procedures to be as outlined in CAN/CSA S16.
- .4 Shop inspections shall be conducted to visually inspect welding and fabrication procedures for conformance with reviewed Shop Drawings and welding standards.
- .5 Site inspections, in general, will be to check installation of high strength bolts, field welding procedures, and alignment and plumbness of framing after erection.
- .6 Supply all necessary cooperation to facilitate shop and site inspections. Provide all necessary cooperation and safe access and working areas for inspection and testing on site
- .7 Following final erection of steel structure, final inspection and correction of any deficiencies, provide a letter of general conformance for the prefabricated steel building. Letter of general conformance to be prepared by a licensed engineer appointed by the Contractor. Letter shall be stamped and sealed by a Professional Engineer license in the Province of Ontario.

1.9 COORDINATION OF QUALITY PLAN WITH WORK ON SITE

- .1 Pre-erection Meeting: Convene a pre-erection meeting one (1) week prior to commencing erection of prefabricated steel building system.
 - .1 Ensure key personnel and Consultant attend.
- .2 Ensure field inspection processes are carried out in conformance with the Quality Plan.
- .3 Provide the Consultant with a seven (7) day 'look-ahead' schedule of planned erection of steel building system throughout the duration of the project.

1.10 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect components and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

1.11 EXTENDED WARRANTY

- .1 Contractor warrants work of this Section is in accordance with General Conditions of the Contract, but extended for 10 years after date of Substantial Performance.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Structural Steel:
 - .1 Hot rolled structural sections and bars: Grade 350W to CAN/CSA G40.21 unless indicated otherwise.
 - .2 Angles and Plates: Grade 300W to CAN/CSA G40.2 unless indicated otherwise.
 - .3 Rod: Grade 300W to CAN/CSA G40.21.
- .2 Bolts: High strength to ASTM A325M with suitable nuts and hardened steel washers.
- .3 Anchor Bolts: Mild steel to ASTM A307 with suitable nuts and hardened steel washers, 20 mm / ¾" diameter (minimum) unless indicated otherwise. Provide template for trade responsible for installation.

- .4 Welding Materials: Conforming to W48 and suitable for use intended.
- .5 Paint:
 - .1 Shop and touch-up paint to CISC/CPMA 2-75.
 - .2 Colour of shop applied primer: Grey.
- .6 Galvanizing:
 - .1 Galvanizing to stricter requirements of ASTM A123/A123M or CAN/CSA-G164, minimum zinc coating 600 g/m².
 - .2 Zinc-rich touch-up coating: Ready mixed to CAN/CGSB-1.181.
Acceptable Product: 'Galvafrid' by Fosrock or approved alternate.
- .7 Screws: Corrosion resistant purpose made, head colour to match attached sheet.
- .8 Insulation and Tape: Coordinate with Prefabricated Building Manufacturer.
- .9 Insulation Adhesive: Purpose made for insulation type and steel liner sheet, incombustible after initial set.
- .10 Vapour Barrier and Sealing Tape: As recommended by insulation manufacturer.
- .11 Sealants: As recommended by sealant manufacturer for intended application.

2.2 COMPONENTS

- .1 Wall System:
 - .1 Exterior Wall: Premanufactured insulated metal panels. Minimum 150 mm thick.
 - .2 Exterior Corners-Wall: Of material to match finish, thickness and profile of adjacent cladding material, shop cut and brake formed to corner angle.
 - .3 Accessories to Exterior Wall Cladding: Brake or bend to shape, of material and finish to match wall cladding comprising cap flashings, drip flashings, internal corner flashings, coping and closure for head, jamb, sill and corners.
 - .4 Sub-girts and Clips: Factory preformed steel minimum 2 mm base steel thickness zinc coated.
- .2 Roof System:
 - .1 Exterior Roof: Premanufactured insulated metal panels. Minimum 150 mm thick.

- .2 Accessories to Roof Cladding: Brake or bend to shape, of material and finish to match roof cladding or wall cladding where applicable, comprising cap flashings, drip flashings, coping and closures for corners, fascia, and soffit.
- .3 Sub-purlins and Clips: Factory preformed steel sheet minimum base steel thickness 2 mm, zinc coated.
- .4 Gussets, Lateral Spacers: Factory preformed steel sheet, minimum 2 mm base steel thickness, zinc coated shop cut and formed to profile from manufacturer's standard.
- .3 Gutters and Downspouts:
 - .1 Form gutters and downspouts from minimum 24 ga. base steel thickness, material, and finish to match wall cladding material to size and profile with outlets as indicated. Provide supports traps and fastenings, flute fillers and sealants, leaf screens and dams for outlets, snow guards.

2.3 FINISHES

- .1 Clean, prepare surfaces and shop prime structural steel to CAN/CSA-S16, except where members are zinc coated or zinc-aluminum alloy coated or are to be encased in concrete.
- .2 Roof panels, wall panels, liner panels, and accessories to be pre-finished as per CCSBI S8 using the 10000+ series paint system. Colour to be selected by City of Toronto from manufacturer's standard range. Submit colouring samples before fabrication for approval.
- .3 All exposed steel in Wash Bay of Maintenance Facility to be galvanized per Section 2.1

2.4 FABRICATION

- .1 Fabricate structural members in accordance with Shop Drawings and to CSA-S16. Tolerances not to exceed those specified in CSA-S16.
- .2 Provide holes and anchor points for attachment of other work, as indicated.
- .3 Reinforce openings to maintain design strength.
- .4 All structural steel shall be new unused steel free of loose mill scale, rust, dirt, oil, and other deleterious matter.
- .5 Framing members shall be shop fabricated for bolted field assembly to the greatest extent possible. Cutting, drilling, or welding in the field shall be minimized, and when required shall be clearly noted on Shop Drawings.

- .6 Maintain air and vapour and thermal barrier throughout building enclosure elements.
- .7 Locate vapour barrier on warm side of thermal insulation.
- .8 Locate air barrier as detailed.
- .9 Complete enclosure assembly with exterior skin, glass units, access units doors, inner air/vapour seal membrane, thermal insulation and interior finish.
- .10 Accurately fit and rigidly frame together joints, corners and mitres:
 - .1 Match components carefully to produce continuity of line and design.
 - .2 Make joints and connections toward exterior weathertight.
 - .3 Provide hairline joints for materials in contact.
 - .4 Coordinate location of visible joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for prefabricated building erection installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 ERECTION

- .1 Do prefabricated metal building Work to CSSBI 30M.
- .2 Erect structural frame in accordance with Shop Drawings and to CSA-S16. Erection tolerances not to exceed those specified in CDDBI 30M and CSA-S16.
- .3 Structural bolts at connections subject to tension loads to be tightened by turn-of-nut method and bolts are to be marked to indicate completion of procedure.
- .4 Contractor shall be responsible for the stability of the structure during its erection. Temporary bracing and guys shall be used to maintain structural integrity and to keep structural members plumb and true during erection.

- .5 Prepare galvanized structural steel surfaces for field welding by removing zinc before welding. After welding, chip away flux and prime. Touch-up welded areas with zinc-rich primer.
- .6 Obtain written permission of Prefabricated Building Manufacturer prior to field cutting or altering of structural members.
- .7 Touch-up with shop primer bolts, welds, and burned and scratched surfaces where exposed at completion of erection.
- .8 Install wall cladding assemblies ensuring a completed installation.
- .9 Secure roof-cladding sheets to structural purlins and beams. Terminate sheet ends over structural supports.
- .10 Install roof assemblies ensuring a completed installation.
- .11 Install interior roof and wall panels to ensure continuous vapour and air barrier.
- .12 Install all necessary closures, gaskets, caulking sealants, and flashing.
- .13 Install insulation and vapour barrier to maintain continuity of thermal and moisture protection to building elements and spaces.
- .14 Fit insulation closely around and behind electrical boxes, pipes, ducts, frames, and other objects in or passing through insulation.
- .15 Keep insulation away from hot surfaces and gas vents.
- .16 Do not compress insulation to fit into spaces.
- .17 For roof system, apply insulation in ceiling to form continuous thermal barrier.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer's verifying compliance of Work, in handling, installing, applying, protecting and cleaning of Product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of Product use recommendations and periodic site visits for inspection of Product installation in accordance with manufacturer's instructions.
 - .3 Ensure manufacturer's representative is present before and during critical periods of installation, construction of field joints and testing.

.4 Schedule site visits:

- .1 After delivery and storage of Products, and when preparatory work is complete but before installation begins.
- .2 Twice during progress of work at 25% and 60% complete.
- .3 Upon completion of work, after cleaning is carried out.

3.4 PROTECTION

- .1 Protect finished surfaces with strippable coatings, strippable wrappers, plywood, or sheet materials as required before acceptance of work.
- .2 Protect installed Products and components from damage during construction.
- .3 Repair damage to adjacent materials caused by sealants, insulation, and building materials installation.

END OF SECTION

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PART 3 EXECUTION (NOT USED)2

SECTION 15000
SCOPE OF MECHANICAL WORK

PART 1 GENERAL

1.1 INTENT

- .1 The Contractor shall furnish, install and commission all equipment, labour, materials, tools, and provide all necessary supervision and other services as required to execute the work and to realize the intent of the project.
- .2 The supply and installation of mechanical items must be in accordance with the Specifications and Drawings of this contract.
- .3 The Specifications and Drawings and Addenda constitute the full scope of the project. All items required but not shown on the Drawings or not mentioned in the Specifications that are necessary for a complete mechanical installation shall be regarded as included in the project requirements.
- .4 The Contractor shall furnish all equipment and accessories specified herein including all other accessories and details not specifically mentioned or fully detailed, but which are reasonably required to make a complete and well-integrated product within the scope of this Specification.

1.2 SCOPE OF WORK

- .1 The sites must be maintained in a dry, clean and secure state. The Contractor is responsible for coordinating the supply of temporary power, water, heat, ventilation, compressed air, etc., provision of all necessary materials to safely power the equipment, and relocation of such supply as required throughout the construction period.
- .2 Contractor is to take direction from the Engineer.
- .3 Major components required to complete this project include the items detailed in Contract Drawings, Division 15 and the following:
 - .1 Supply and installation of:
 - .1 Remove all indicated equipment, materials and systems and legally dispose of site and abide to all applicable Bylaws and Codes.
 - .2 As indicated in the drawing schedules, supply, deliver, unload, store, install, program, test, demonstrate, commission and certify ALL new equipment and materials:

- .2 Supply and installation of miscellaneous works and materials to install mechanical equipment as specified in drawings and engineering specifications.
- .3 Supply and installation of electrical work and controls for mechanical system operation in accordance with Divisions 13 and 16.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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ELECTRIC HEATING**

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SECTION 15500 ELECTRIC HEATING

PART 1 GENERAL

1.1 SCOPE

- .1 This section specifies the design, shop drawing submission, supply, manufacturing, installation, testing, training and commissioning of electrical unit heaters.
- .2 Furnish all labour, materials, tools and equipment for the installation of Heating Systems generally as shown on the drawings and specified herein.
- .3 Furnish and install unit heaters in locations and elevations as shown on the drawings.
- .4 Provide and install controls, thermostats and accessories needed to complete a fully functioning system.

1.2 GENERAL REQUIREMENTS

- .1 Refer to General Conditions and Division 1.
- .2 All equipment shall be CSA approved and ULC listed.

1.3 REFERENCE STANDARD

All referenced Standards and Codes shall be of the latest editions.

- .1 Electrical Wiring and Equipment - CSA C22.1 with Ontario Hydro Amendments.
- .2 NFPA #58 – Liquefied Petroleum Gas Code.
- .3 Heating and Vent - NFPA 90A and B.
- .4 ANSI/ASHRAE Standard 70-1991.
- .5 ANSI/NFPA 70 – National Electric Code.
- .6 ASTM E90, Method of Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
- .7 ANSI/ASHRAE Standard 70-1991.
- .8 NFPA-90A.
- .9 ULC- S505.

- .10 ANSI/ASHRAE/IESNA 90.1-1999 – Energy Standard for New Buildings Except Low-Rise Residential Buildings.
- .11 ASHRAE Standard 51.
- .12 ASHRAE Standard 62.
- .13 AMCA Standard 210.

1.4 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 15990 – Testing, Adjusting, Balancing.
- .2 Division 13 and 16.

1.5 SHOP DRAWINGS

- .1 Provide shop drawings according to Division 1 requirements and as listed below.
- .2 Product data to include: Mounting methods, physical size, layout and diagrams of unit heaters kW rating, voltage, phase, finish.
 - .1 Unit heaters:
 - .1 Specification, descriptive drawings, catalogue cuts and descriptive literature which shall include make, model, dimensions, electrical / control schematics, and weight of equipment.
 - .2 Complete performance data that will indicate full compliance with the specifications.
 - .3 Detail instruction on recommended procedure for the protection and handling of materials prior to installation.
 - .4 List of recommended spare parts.
 - .5 Compliance with the Codes.
 - .6 Operating and maintenance manuals and maintenance summary.
 - .2 Thermostats.

1.6 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

PART 2 PRODUCTS

2.1 ELECTRIC UNIT HEATERS

- .1 Refer to drawings for heater schedules and locations.

- .2 Unit heaters shall have an automatic and a manual reset thermal cutouts for overtemperature protection, controlling magnetic contactor and 24 volt control circuit transformer housed in a NEMA 4 enclosure.
- .3 Cabinet shall be provided with adjustable outlet louvers having minimum opening safety stops.
- .4 Fan motor shall include permanently lubricated ball bearings and built-in thermal overload protection. Motor to operate at line voltage and be prewired to the control enclosure to eliminate the need for separate field wiring to the motor.
- .5 Heater shall be Dirty Duty Corrosion-Resistant Construction including epoxy-coated motor; Heresite® coated heat exchanger, cabinet and fan blade; NEMA 4X, terminal box.
- .6 The heater shall be provided with an Heatrex accessory mounting kit designed to bear the weight of the heater assembly mounted to ceiling or wall as shown in contract drawings.
- .7 The following factory installed and prewired controls are to be supplied:
 - .1 Thermostat
 - .2 Disconnect switch with external handle.
 - .3 Manual reset thermal cutout with backup contactor
 - .4 Two-position auto/fan selector switch for fan only control Built-in
 - .5 “Heater On” pilot light to indicate when heating elements are energized.
 - .6 “Warning” pilot light to indicate when thermal cutouts have tripped and heater needs to be serviced.
- .8 Detailed wiring diagram shall be attached to heater casing.
- .9 Acceptable Manufacturer:
 - .1 Heatrex HX-238-UT05Z-DLT
 - .2 Or approved equivalent

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install unit heaters as indicated, and to manufacturer’s instructions.
- .2 Install heaters only after wall is finished, primed and painted (if applicable).

- .3 The installation height is as recommended by supplier (to be confirmed on site).

3.2 HEATERS

- .1 Install heaters in locations shown, without interference and ensure all mounting brackets, hardware, etc. are securely attached.
- .2 Ensure that manufacturer's instructions are followed, air passages are clean, motors operate freely and controls operate properly.
- .3 Refer also to Division 13 and 16 for general requirements for installation of equipment specified herein.

3.3 EQUIPMENT SUPPORTS

- .1 Mount equipment supported above floors on approved welded galvanized structural steel framework with diagonal bracing and floor and wall plates.
- .2 Unless otherwise shown on the Drawings, construct framework of 75 x 75 x 6 mm angles hot dip galvanized after fabrication.
- .3 Hang suspended equipment on 13 mm minimum diameter galvanized hanger rods attached to the building structure.

3.4 DEMONSTRATION

- .1 Demonstrate to the Engineer the proper operation of all systems.
- .2 Instruct the Owner's staff in the proper operation and maintenance of the equipment using the Equipment Manufacturer's printed material.

3.5 TESTING AND BALANCING

- .1 Prior to unit startup, all system components shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory operation. The Manufacturer's representative shall inspect the installation of equipment including mechanical and electrical connections, necessary lubrication and adjustments, and provide certification that the unit have been installed correctly and it is ready for operation.
- .2 Test all heaters and measure current draw and provide a written report.
- .3 Test to include checks for excessive vibration, correct operation of control systems and equipment, motor power input, acceptable normal running noise, speed and direction of rotation.
- .4 Test to demonstrate that the equipment and work is not defective electrically, mechanically, or otherwise and is safe and satisfactory.

- .5 Check calibration of thermostatic controls are set as per drawing requirements.
- .6 Check operation of all safety and over-temperature cut-outs.

3.6 COMMISSIONING

- .1 Commission equipment in accordance with Division 1
- .2 In addition, provide the services of a factory-trained and **certified** technician for one (1) day to calibrate and confirm the correct installation, operation and written certification of the equipment. Modify the installation as per his recommendations (if any).
- .3 Schedule time for startup and commissioning. Provide instruments, meters, equipment and personnel. Demonstrate unit operation. The system shall be tested in all operational modes. Carry out tests in the presence of Engineer and Owner.
- .4 Certify commissioning in accordance with Divisions 1.

3.7 TRAINING

- .1 Training shall be provided in accordance to Division 1 requirements.
- .2 Allows one (1), 2-hour session for each system. The schedule shall be discussed with and approved by the Owner. The sessions shall be completed prior to commissioning.

3.8 MANUFACTURERS SERVICES

- .1 Manufacturer's representative for the equipment specified shall be present at each jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance and training of the owner's personnel, for the period of (per each job site):
 - .1 Minimum of 8 hours – installation, assistance & certification.
 - .2 Minimum of 4 hours – testing.
 - .3 Minimum of 4 hours – training.
- .2 Minimum number of trips two (2).

END OF SECTION

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SECTION 15810 DUCTWORK AND ACCESSORIES

PART 1 GENERAL

1.1 SCOPE

- .1 Supply, install, and satisfactorily operate a complete ducting and ventilating system equipment to the full intent of the Drawings and Specification.

1.2 RELATED SECTIONS

- .1 Fans and Accessories: Section 15815
- .2 Electrical: Division 16

1.3 SHOP DRAWINGS

- .1 Submit shop drawings of duct fittings for approval;
 - .1 Plenums and plenum related items showing physical dimensions, joints, sealants, door construction and hardware.
 - .2 Factory fabricated ducts, fittings and joining systems (FRP and Metal).
 - .3 Firewall duct penetrations; fire and smoke dampers; access doors.
 - .4 Dampers (all types)
 - .5 Louvers
 - .6 Grilles/Diffusers
- .2 Submit control-wiring diagrams for automatic dampers and other automated ductwork accessories.
- .3 Sound Attenuator Certified Test Data:
 - .1 Dynamic insertion loss
 - .2 Self noise power levels
 - .3 Static pressure loss
 - .4 Dimensions and weights
- .4 Coordination drawings: provide plans drawn to scale, on which the following items are shown and coordinated with each other, using input from installers on the items involved:

- .1 Duct installation in congested spaces, indicating coordination with general construction, building components and other building services. Indicate proposed changes to duct layout.
- .2 Suspended ceiling components.
- .3 Structural members to which duct will be attached.
- .4 Penetrations of smoke barriers and fire-rated construction.
- .5 Submit changes or alteration in ductwork layout, with supporting calculation showing that the modified design will not increase total pressure, before work commences. Submittals for proposed changes shall be stamped for approval by the engineer prior to commencement of work.

1.4 REFERENCES

- .1 Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein.
 - .1 American Society for Testing Materials (ASTM)
 - .1 C 582: Contact-moulded Reinforced Thermosetting Plastic (RTP) Laminated for Corrosion-Resistance Equipment
 - .2 D 2310 – Machine-Made Reinforced Thermosetting Resin Pipe.
 - .3 D 2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
 - .4 D 2996: Filament-Wound ‘Fiberglass’ (Glass Fiber Thermosetting Resin) pipe and Fittings.
 - .5 D 3982: Contact-Moulded ‘Fiberglass’ (Glass Fibre Reinforced Thermosetting Resin) Duct and Hoods.
 - .6 E 84: Standard Test Method for Surface Burning Characteristic of Building Materials.
 - .7 C518 – Standard TEs Method for Steady-State Thermal Transmission, Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .2 National Fire Protection Association (NFPA)
 - .1 90A: Standard for Installation of AC and Ventilation Systems
 - .2 90B: Standard for Installation of Warm Air Heating and AC Systems

- .3 255: Building Materials, Test of Burning Characteristics (same as ASTM E84)
- .3 Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - .1 HVAC Duct Construction Standards – Metal and Flexible
 - .2 HVAC Duct Systems Design
 - .3 Thermoset FRP Duct Construction Manual
 - .4 Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
- .4 ASHRAE:
 - .1 ASHRAE Standard 51.
 - .2 ASHRAE Standard 62.
- .5 Underwriters Laboratories (UL)
 - .1 UL 181: Factory Made Air Ducts and Air Connectors
 - .2 UL 555: Standard for Safety Fire Dampers
 - .3 UL 723: Test for Surface Burning Characteristics of Burning Materials (ASTM E84)
 - .4 S102: Standard Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies
- .6 Canadian General Standards Board (CGSB)
 - .1 41.22: Fiberglass-Reinforced Plastic Corrosion-Resistant Equipment

1.5 REGULATIONS

- .1 Conform to all codes, by-laws, etc. of Provincial and Municipal authorities having jurisdiction.
- .2 No additional compensation will be awarded for carrying out any conditions embodied in such regulations.
- .3 When the work as shown and as specified exceeds the minimum requirements of such regulations, the Drawings and/or Specifications shall govern.
- .4 Provide all permits, inspections, and certificates required for this Section.

1.6 GENERAL ARRANGEMENT

- .1 All mechanical equipment, ductwork and fittings specified herein, in related sections above and shown on the Drawings indicates the general arrangement.
- .2 Co-ordinate the work under this Section with all other trades, in particular the structural work and make all necessary changes or additions to the runs to accommodate structural conditions, piping, ductwork, mechanical equipment, etc.
- .3 Install the systems and apparatus in a practical and first-class manner and guarantee all work and apparatus against defects of workmanship and material and make good any and all defects that may develop.

1.7 QUALITY ASSURANCE

- .1 Industry Standards:
 - .1 Unless otherwise indicated or specified in the Contract Documents, sheet metal ductwork shall be constructed and installed in accordance with the SMACNA duct construction standard relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated in the Contract Documents.
 - .2 Comply with the ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated in the Contract Documents.
 - .3 NFPA Compliance: NFPA 90A and NFPA 90B.
- .2 Manufacturers: Firms regularly engaged in manufacture of ductwork products of the types, materials, and sizes required, whose products have been satisfactorily used in similar service for a minimum of 5 years.
- .3 Suppliers of duct and fitting components shall provide on request the following information:
 - .1 Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
 - .2 Laboratory performance data for fittings, including zero length dynamic losses.
- .4 The installer shall be a firm with a minimum of 3 years' experience of successful installation on ductwork systems similar to that required for this Contract.
- .5 Changes or alterations to layout or configuration of duct system shall be:
 - .1 Specifically approved in writing by the Consultant.
 - .2 Proposed layout shall provide original design results, without increasing system total pressure.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Protection:
 - .1 Use all means necessary to protect pipes and appurtenances before, during, and after installation and to protect the installed work of other trades from the work of this Section.

- .2 Replacements:
 - .1 In the event of damage to piping and appurtenances, immediately make all repairs necessary to the approval of the Consultant, at no additional cost to the City.
- .3 Protect ductwork from dirt, water, and debris. During storage on the Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.
- .4 Deliver sealant materials to the Site in their original unopened containers labeled with the manufacturer, Product name and designation, colour, expiration period for use, pot life, curing time, and mixing instructions for multi component materials.
- .5 Store and handle sealant materials in compliance with the manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- .6 Deliver and store stainless steel sheets with mill applied adhesive protective paper, maintained through fabrication and installation.

1.9 REGULATIONS

- .1 Conform to all applicable codes (including but not limited to. those listed in subsection 1.4). No additional compensation will be awarded for carrying out any conditions embodied in such regulations.
- .2 When the requirements of the Contract Documents exceed the minimum requirements of such regulations, the requirements of the Contract Documents shall govern.
- .3 Provide all permits, inspections, and certificates required for this Section.

1.10 WORKING DRAWINGS AND EQUIPMENT MANUALS

- .1 Submit working Drawings for review for all items included in this Section.
- .2 Submit all manuals required under this section.

PART 2 PRODUCTS

2.1 DUCTWORK GENERAL

- .1 Ductwork located in dry well and control rooms shall be stainless steel. Ductwork located in wet wells, supply and exhaust ductwork from the wet well shall be Thermoset FRP.
- .2 Install ductwork as shown on the Drawings. Duct sizes shown on the Drawings are clear internal dimensions.
- .3 Ductwork to be adequately strong and sufficiently rigid to resist all normal shocks, reinforced at all points where necessary to prevent vibration or movement, and securely fastened in place.
- .4 Ensure ducts are airtight and all joints gasketed or caulked and made in accordance with the best standards of the trades.
- .5 Elbows and other changes in ductwork direction to have centreline radius at least equal to the duct depth or diameter. Where possible, all transitions in duct size will be made with an angle not exceeding 30 degrees. Supply and install dampers in all ducts as indicated.
- .6 Install flexible duct connector where the ductwork connects to ventilation equipment (i.e. Fan). Acceptable manufacturer: Duro Dyne Canada Inc “Or Approved Equivalent”.
 - .1 Insulated Ductwork: Metal Fab with Insulflex connector.
 - .2 Uninsulated Ductwork: Metal Fab with Canflex connector.

2.1 DUCTWORK PRESSURE CLASS

- .1 Construct duct systems to pressure classifications indicated in Ductwork Schedule.
- .2 Where no specific duct pressure designations are indicated in Specifications, Schedules or on Drawings, 500 Pa pressure class shall be basis of Contract.

2.2 RECTANGULAR DUCTWORK

- .1 Fabricate rectangular ducts in accordance with SMACNA, unless specified otherwise.
- .2 Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 480 mm and larger and are 20-gauge or less, with more than 1.0 square meter of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

2.3 RECTANGULAR DUCTWORK FITTINGS

- .1 Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA.
- .2 Elbows:
 - .1 Fit square-turn elbows with vane side rails.
 - .2 Shop fabricate double-blade turning vanes of same material as ductwork.
 - .3 Fabricate with equal inlet and outlet.
 - .4 Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
 - .5 Manufacturers and Products:
 - .1 Elgen; All-Tight.
 - .2 Duro-Dyne; Type TR.
 - .3 Or Approved Equivalent

2.4 RIGID ROUND DUCTWORK

- .1 Construct rigid round ducts in accordance with SMACNA, unless specified otherwise.
- .2 Basic Round Diameter: As used in this Article, is diameter of size of round duct that has circumference equal to perimeter of a given size of flat oval duct.
- .3 Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction.
- .4 Fabricate round ducts with spiral seam construction, except where diameters exceed 1800 mm. Fabricate ducts having diameters greater than 1800 mm with longitudinal butt-welded seams.
- .5 Single Wall Ductwork: Unless otherwise indicated, rigid round shall be of single wall construction.
- .6 Double Wall Ductwork:
 - .1 As indicated on Drawings or in Ductwork Schedule.
 - .2 Constructed as follows:
 - .1 Inner liner:

- .1 Solid sheet metal, same material as outer pressure shell, unless indicated otherwise.
- .2 Void space between liner and outer pressure shell shall be filled with fiberglass insulation, minimum 25 mm thickness or greater as indicated on Drawings or in Ductwork Schedule.
- .3 Outer shell gauge shall be based upon actual outer shell dimensions.
- .7 Provide insulation ends where internally lined ductwork connects to single wall ductwork or to any non-insulated component.

2.5 RIGID ROUND DUCTWORK FITTINGS

- .1 Construct rigid round ductwork fittings in accordance with SMACNA unless otherwise specified.
- .2 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.
- .3 Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- .4 Elbows:
 - .1 Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.
 - .2 Segmented Elbows: Fabricate with welded construction.
 - .3 Round Elbows 200 mm and Smaller:
 - .1 Stamped elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees configuration.
 - .2 Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 90 and 115 mm) elbows with segmented construction.
 - .4 Round Elbows 225 mm Through 350 mm:
 - .1 Segmented or pleated elbows for 30, 45, 60, and 90 degrees.
 - .2 Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 240 and 265 mm) elbows with segmented construction.
- .5 Aluminum Square Plaque Diffusers
 - .1 Applicable to Air Terminal Types:

- .2 Description:
 - .1 Furnish and install aluminum square plaque ceiling diffusers of sizes designated by the plans and schedule.
- .3 Construction:
 - .1 Diffusers shall be steel construction, and shall consist of a seamless, one-piece, precision formed backpan that incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.
 - .2 An inner plaque assembly shall be incorporated and shall drop no more than ¼ inch below the ceiling plane to assure proper air distribution performance.
 - .3 The inner plaque assembly shall be completely removable from the room side to allow for full access to any dampers or other ductwork components located near the diffuser neck.
 - .4 The diffuser shall integrate with all duct sizes shown on the plans without affecting the face size and appearance of the unit.
 - .5 The face panel shall have smooth edges and rounded corners to blend with the back cone.
- .4 Paint Specification:
 - .1 All components shall have a baked-on powder coat finish.
 - .2 The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 - .3 The paint film thickness shall be a minimum of 2.0 mils.
 - .4 The finish shall have a hardness of 2H.
 - .5 The finish shall withstand a minimum salt spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
 - .6 The finish shall have an impact resistance of 80 inch-pounds.
- .5 Mounting Frame:
 - .1 The diffuser mounting frame shall be suitable for lay-in or surface mount applications with the following frame style:

- .1 Surface Mount
- .6 Options:
 - .1 Insulated Back pan:
 - .1 R6 – The diffuser back pan shall be externally insulated with a molded heavy-duty foil/scrim vapor barrier with an R-value of six. The insulation shall meet the requirements of UL 181 and NFPA 90A.
 - .2 Damper:
 - .1 The diffuser shall be supplied with a steel volume control damper:
 - .1 Full flow damper, diffuser mounted (VCR8E)
- .7 Acceptable Manufacturers:
 - .1 EH Price
 - .2 Nailor
 - .3 Tuttle and Bailey
 - .4 Or Approved equivalent

2.6 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
> 1000	A
750	B
500	C
250	C
125	C

- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
 - .3 Class C: transverse joints and connections made air tight with gaskets, sealant tape or combination thereof. Longitudinal seams unsealed.

2.7 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.

2.8 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.9 DUCT LEAKAGE

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

2.10 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius or five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct or 45° entry on branch.
 - .2 Round main and branch: enter main duct at 45° with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with volume control damper.
- .5 Transitions:
 - .1 Diverging: 20° maximum included angle.
 - .2 Converging: 30° maximum included angle.
- .6 Offsets:
 - .1 Full short radiused elbows as indicated.

- .7 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

2.11 MECHANICAL LINER AND FASTENERS:

- .1 Liners: Internal duct liners shall be 1 inch thick fiberglass Type I or II per ASTM 1071 and have a thermal conductivity (k-value) of 0.26 at 75 deg. F. Liners shall comply with NFPA 90A and 90B and with NAIMA AH124 and have a maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84. Liners shall be treated with an EPA approved biocide to resist bacterial and fungal growth. All surfaces exposed to the air stream shall be coated to prevent erosion of glass fibers.
- .2 Mechanical Fasteners: stainless steel, suitable for adhesive, mechanical or welding attachment (self-stick adhesive fasteners are not permitted). Provide fasteners that will not damage the liner when applied as recommended by the manufacturer, that do not cause leakage within the duct and that will sustain a 50-pound tensile dead load perpendicular to duct wall.
- .3 Liner Adhesive: Non-oxidizing, vinyl acrylic, water-based adhesive used to bond insulation to sheet metal surfaces. Operational temperature range -20 to +160°F; curing time 24 hours. Manufactured by United McGill, type Uni-Tack. Comply with NFPA 90A and 90B and with ASTM C916

2.12 LOUVERS

- .1 General:
 - .1 Refer to drawings for intake and exhaust louver locations and size.
 - .2 Finish: Full strength fluoropolymer coating (Kynar 500 PVDF resin), colour to be selected by Owner from manufacturers standard colour chart.
 - .3 Submit comprehensive louver performance data including airflow resistance, water penetration, Sound Transmission Class (STC), Outdoor Indoor Transmission Class (OITC) and free area for approval.
- .2 Stationary Louvers
 - .1 Furnish and install stationary drainable louvers of the size and shape indicated on the drawings. The louvers shall be constructed entirely of extruded aluminium (2.06 mm wall thickness) assembly; alloy 6063-T5 extruded 150 mm aluminium blades (2.06 mm wall thickness) positioned at a 35° angle; including integral flange for mounting on wall.
 - .2 Welded Assembly: Join stationary blade, head, sill and jamb frames with fillet welds concealed from view. Louver blades shall be joined to each jamb frame with fillet welds produced with the Pulsed Gas Metal Arc Welding (GMAW/Mig) process.

- .3 High performance frame system with drainable head to collect and remove water; drain gutter in each blade.
- .4 Louver performance shall be based on test and procedures in accordance with AMCA publication 511 and comply with the requirements of the AMCA Certified Rating Program
- .5 Louvers shall be designed to withstand a 25-psf-wind load.
- .6 Each louver shall be fitted with a removable 13mm mesh bird screen. Bird screen shall be expanded aluminium construction and suitable for interior mounting.
- .7 Minimum free area: 57% based on 48 in. wide x 48 in. high.
- .8 Louvers shall be supplied with continuous blade section to give the appearance of invisible mullions.
- .9 Acceptable manufacturer: Airolite K6096, Arrow United EA605, Ruskin ELF6375, equivalent from E.H.Price "Or Approved Equivalent"

2.13 BLANK OFF PANELS

- .1 Provide blank off panels with 50mm thick polystyrene attenuation/insulation as indicated on drawings.
- .2 Panels shall be fabricated 0.063" aluminium panel, finished with two coats of paint to match wall colour.
- .3 Panels installed in Wet Wells and Pump Rooms shall be coated with 4 mil PVC. Coat all end cuts with PVC coating to maintain a fully coated surface. All bolts, nuts and screws shall be cadmium plated and PVC painted after installation.

2.14 MOTORIZED DAMPERS

- .1 Dampers to be automatic (motorized) as shown on the Drawings and installed in louver frames, wall sleeves or transition boxes as required.
- .2 All internal duct dampers to be of aluminum construction. Blades to be parallel action with blade linkage. Frames and blades to be a minimum 2.05mm (0.081") 6063-T6/T52 extruded aluminium. Blades to be a single unit foil design, 100mm (4") wide with the pin-lock an integral section within the blade core. Overlap blades and seal with extruded silicon fitted into dovetail shaped slots in both frames and blades. Frames to be 6063-T6/T52 extruded aluminium channel with reinforcing bosses and groove inserts for silicon seals. Linkage hardware is to be of non-corrosive reinforced material or cadmium plated steel.

- .3 Acceptable Manufacturer: Arrow United Industries Model OBDAF-207, Tamco series 1000 from T.A. Morrison Co., or equivalent from Ruskin. Or Approved Equivalent
- .4 Dampers installed behind exterior louvres, building walls or roof to be of insulated construction. Damper blades shall be 150mm (6") wide, double walled, 6063-T6/T52 extruded aluminium 2.05mm (0.081") nominal wall thickness. Blades shall be injected with two part polyurethane (CFC) free foam and de-bridged for thermal isolation. The insulation shall have a minimum R-value of 1.3. Frame shall be 125mm (5") wide, 6063T6/T52 extruded aluminium channel, 2.05mm (0.081") nominal, thermally broken. Provide extruded silicone rubber blade edge seal that fits into a ribbed groove insert in blades with extruded polycarbonate seal at jambs.
- .5 Acceptable Manufacturer: Arrow United Industries Model AFDTI-25LT, Tamco Series 9000 by T.A. Morrison Co., CDTI-50BF by Ruskin "Or Approved Equivalent".
- .6 Dampers to be duct-mounted, front-mount or rear-mount according to the airflow and as per the drawings.
- .7 Accessories: electrical actuator.

2.15 SUPPLY GRILLE

- .1 Furnish and install air supply grilles of the sizes and mounting types indicated on the plans and outlet schedule.
- .2 The grille shall have individually adjustable blades on 3/4" centers. All construction shall be of #316 stainless steel with a 1-1/4" wide border on all sides with mitered corners. The front set of blades shall run parallel to the long dimension of the grille. The grille shall be available with countersunk screw holes for a clean, unobtrusive appearance.
- .3 The finish shall be Satin Polish (SP).
- .4 The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled stainless steel. The damper shall be operable from the register face. The damper shall be 316 S.S.
- .5 The manufacturer shall provide published performance data tested in accordance with ANSI/ASHRAE Standard 70-1991 at isothermal conditions.
- .6 Acceptable Manufacturer:
 - .1 Tuttle & Bailey
 - .2 EH Price,

- .3 Titus,
- .4 Ruskin.
- .5 Or Approved equivalent

2.16 RETURN GRILLE

- .1 Furnish and install air return grilles of the sizes and mounting types indicated on the plans and outlet schedule.
- .2 The grille shall have provide 45 degrees fixed blades on 3/4" centers. All construction shall be of #316 stainless steel with a 1-1/4" wide border on all sides with mitered corners. The front set of blades shall run parallel to the long dimension of the grille. The grille shall be available with countersunk screw holes for a clean, unobtrusive appearance.
- .3 The finish shall be Satin Polish (SP).
- .4 The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled stainless steel. The damper shall be operable from the register face. The damper shall be 316 S.S.
- .5 The manufacturer shall provide published performance data tested in accordance with ANSI/ASHRAE Standard 70-1991 at isothermal conditions.
- .6 Acceptable Manufacturer:
 - .1 Tuttle & Bailey
 - .2 EH Price,
 - .3 Titus,
 - .4 Ruskin.
 - .5 Or Approved equivalent

2.17 ROUND GRILLE

- .1 Wall mounted type, all heavy gauge aluminium construction, mill finish, S.S. hardware.
- .2 Acceptable product:
 - .1 Price, Model RPG (SMP Frame), Tuttle & Bailey, Greenheck, or approved equivalent.

2.18 INSTRUMENT TEST PORTS

- .1 Duro-Dyne of Canada #1P1 or 1P2 (to suit the thickness of the insulation) or approved equivalent, leak-proof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug.

2.19 DUCT INSPECTION DOORS

- .1 General:
 - .1 Insulated, gasketed, and at least 375 mm by 375 mm when duct dimensions are large enough.
 - .2 On ductwork where largest side dimension is less than 400 mm, furnish inspection doors at least 200 mm by 200 mm.
 - .3 Complete with necessary hardware.
 - .4 Fabricated of same material as ductwork.
 - .5 Quantity: one door for each air leg.
- .2 Round Spin in Type Access Doors:
 - .1 Size: 450 mm and 600 mm diameter will be acceptable in lieu of comparably sized square or rectangular access doors specified herein.
 - .2 Complete with insulation, spin in frame, inner door, attachment cable, gaskets, three latches, and pull ring.
- .3 Casing and Plenum Access Doors:
 - .1 Size: 1425 mm high by 600 mm wide minimum where possible.
 - .2 Complete with hardware, hinges, seals, and latch handles.
- .4 Manufacturers:
 - .1 Same as air duct manufacturer.

2.20 DUCTWORK HANGERS AND SUPPORTS

- .1 General:
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500 mm.
 - .2 Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.

- .3 Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
- .4 Wire hangers are not acceptable.
- .5 Hangers: Stainless steel angle to following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)	Spacing (mm)
Up to 750	25 x 25 x 3	6	3000
751 to 1050	40 x 40 x 3	6	3000
1051 to 1500	40 x 40 x 3	10	3000
1501 to 2100	50 x 50 x 3	10	2500
2101 to 2400	50 x 50 x 5	10	2500
2401 & over	50 x 50 x 6	15	2500

- .2 Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, base plates, rods, hangers, straps, screws, bolts shall be as follows:
 - .1 Indoors and Outdoors: Stainless steel, Grade 316L.
 - .2 Aluminum Ductwork Indoors and Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
 - .3 Stainless Steel Ductwork Indoor and Outdoors: Stainless steel, same ASTM Grade as ductwork.
- .3 Building Attachments:
 - .1 Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
 - .2 Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 102 mm thick.
 - .3 Upper Attachment (Concrete):
 - .1 Drive pin fastener and expansion nail anchor may be used for ducts up to 450 mm maximum dimension.
 - .2 Threaded stud fastener may be used for ducts up to 900 mm maximum dimension.
 - .3 Concrete attachments shall be made of stainless steel.

- .4 Acceptable Product: Myatt, Grinnell, Hunt “Or Approved Equivalent”.
- .4 For steel joist: manufactured joist clamp steel plate washer.
 - .1 Acceptable Product: Myatt, Grinnell, Hunt. Or Approved equivalent
- .5 For steel beams: manufactured beam clamps:
 - .1 Acceptable Product: Myatt, Grinnell, Hunt. Or Approved equivalent
- .4 Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Paragraph DUCTWORK FASTENERS.
- .5 Trapeze and Riser Supports: Stainless steel shapes conforming to ASTM A276 / A276M.

2.21 DUCT SEALING MATERIALS

- .1 General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.
- .2 Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.
- .3 Solvent-Based Sealants:
 - .1 Ultraviolet light resistant.
 - .2 Mildew resistant.
 - .3 Flashpoint: Greater than 21 degrees C, SETA CC.
 - .4 Manufacturers and Products:
 - .1 Hardcast, Inc.; Versagrip 102.
 - .2 Rectorseal; AT-33.]
 - .3 Or Approved equivalent
- .4 Water-Based Sealants:
 - .1 Listed by manufacturer as nonflammable in wet and dry state.

- .2 Manufacturer and Product: Rectorseal; Airlok 181 Or Approved Equivalent.
- .5 Tape: Polycoated, flame retardant, 50 mm wide.
 - .1 Thickness and elongation: 0.3 mm and 12%.
 - .2 Tensile strength: 535.7 kg/m width.
 - .3 Acceptable product:
 - .1 Shurtap PC-21F.
 - .2 MACtac-PAF.
 - .3 Or approved equivalent

2.22 INSULATION

- .1 Refer to Section 15080 – Mechanical Insulation.
- .2 Provide insulation jacket for internal and external ducts as specified.

PART 3 EXECUTION

3.1 MATERIALS

- .1 Safely deliver materials to the site.
- .2 Handle materials at all times with care to avoid damage.
- .3 Load, unload, and move materials into place by means of hoists, ropes or skidways in such a manner as to avoid shock.
- .4 Do not drop or roll materials against one another.
- .5 Properly store equipment on site.
- .6 Protect equipment against weather, damage and theft to the satisfaction of the Engineer.

3.2 DUCTWORKS

- .1 Install ducts straight and plumb, following building lines.
- .2 Do not install in front of equipment or controls in such manner as to interfere with operation, servicing or repairs.
- .3 Provide ductwork adequately strong and sufficiently rigid to resist all normal shocks, reinforced at all joints where necessary to prevent vibration or movement, and securely fastened in place.

- .4 All ducts to be airtight and all joints caulked and made in accordance with the best standards of the trade.
- .5 Where possible make all transitions in ductwork size with an angle not exceeding 15 degrees.
- .6 Provide elbows and other changes in ductwork direction having centreline radius at least equal to 1.5 times the duct depths.
- .7 FRP ductwork shall be installed in accordance with SMACNA FRP Manual and Manufacturer's instructions.
- .8 Penetrations:
 - .1 Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
 - .2 Clearances:
 - .1 For un-insulated ducts, allow 25 mm clearance between duct and sleeve, except at grilles, registers, and diffusers.
 - .2 For insulated ducts, allow 25 mm clearance between insulation and sleeve, except at grilles, registers, and diffusers.
 - .3 Roof penetrations via roof curbs: seal the duct and roof curb clearance with flexible material (after installation) to be watertight. Provide galvanized flashing collar around duct and above roof curb. Refer to standard detail drawings.
 - .4 Closure Collars:
 - .1 Minimum 102 mm wide on each side of walls or floors where sleeves or prepared openings are installed.
 - .2 Fit collars snugly around ducts and insulation.
 - .3 Same gauge and material as duct.
 - .4 Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
 - .5 Use fasteners with maximum 152 mm centers on collars.
 - .5 Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.
- .9 Concealment:

- .1 Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
 - .2 Do not encase horizontal runs in solid partitions, except as specifically shown.
 - .3 Limit clearance to 25 mm where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.
- .10 Coordination with Other Trades:
- .1 Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
 - .2 Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
 - .3 Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
 - .4 Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

3.3 ULTRAVIOLET PROTECTION

- .1 All exposed to outdoor pipe, duct, and fittings shall be protected from ultraviolet rays by the addition of Cyasborn UV-9 to the wax coat of the product.

3.4 DUCTWORK SUPPORT

- .1 Material for ductwork support shall match ductwork.
- .2 Support all ductwork at intervals not exceeding 2300 mm.
- .3 Do not use perforated straps or similar hangers for the support of ductwork or equipment installed under this Section.
- .4 Do not use explosives to insert anchors.
- .5 Brace vertical ducts to walls with steel straps finished as required.
- .6 Support for FRP Ductwork shall be designed by FRP Ductwork manufacturer. Install in accordance with SMACNA FRP manual and Manufacturer's instructions.

3.5 LOUVERS

- .1 Coordinate exact location and size of louver openings with General Contractor and install level and in line with other building components. Seal perimeter of louvers and brick vents against building structure by packing any cracks with fire retarding insulation. Seal perimeter with silicone caulking, colour to match louver.
- .2 Provide insulated blank off panels as required and blank off air tight against louver and other duct sections or plenums.

3.6 GRILLES

- .1 Provide duct, where needed, to install grilles.
- .2 Fasteners: Stainless steel screws and nut, and resilient neoprene washers between aluminum and head of bolt or between nut, stainless steel washer and aluminum grille body.

3.7 DAMPERS

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and Manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Coordinate damper flange drilling patterns with the flange patterns of ducts and air handling equipment, before supply, or drill the holes in the field.
- .5 Upon system start up, ensure that dampers operate properly.
- .6 Install fire dampers in accordance with the requirements of Ontario Building Code (OBC) whether or not shown on the drawings and manufacturer's written instruction.
- .7 Provide access panels in ductwork to enable resetting of fire dampers.
- .8 Where dual speed fans are specified and a motorized damper is needed to obtain design flows, air balancing in both flow scenarios.
- .9 Installation of dampers must be in accordance with manufacturer's current installation guidelines, provided with each damper shipment.
- .10 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.

3.8 EQUIPMENT SUPPORTS

- .1 Mount equipment supported above floors on approved welded galvanized structural steel framework with diagonal bracing and floor and wall plates.
- .2 Unless otherwise shown on the Drawings, construct framework of 75 x 75 x 6 mm angles.
- .3 Hang suspended equipment on 13 mm minimum diameter stainless steel hanger rods attached to the building structure.
- .4 Equipment supports in Valve Chamber shall receive a final coat of PVS coating, minimum 2 mil thick.

3.9 SEALING

- .1 Apply sealant to outside of joint to Manufacturer's recommendations.
- .2 Apply in a neat way for ducting system appearance.
- .3 Taping of exposed ducts shall not be accepted.

3.10 FLEXIBLE DUCTS

- .1 Maximum length of flexible duct shall be 2 m.

3.11 FLEXIBLE CONNECTIONS

- .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
- .2 Length of connection: Not less than 100 mm.
- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .4 Install in accordance with recommendations of SMACNA.
- .5 When fan is running:
 - .1 Ducting on each side of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.

3.12 DUCT EXPANSION JOINTS

- .1 Install as a minimum of one (1) expansion joint in each outdoor and indoor exhaust run.

- .2 Support the duct immediately upstream and downstream from the duct expansion joint.
- .3 Insulate joints as specified.

3.13 INSTRUMENT TEST PORTS

- .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with Manufacturer's instructions.
 - .2 Locate probe inlets sufficient distance from elbows or transition sections to ensure stable readings of non-turbulent air and install 75 mm (3") from corners and at 150 mm (6") centres across long side of duct.
 - .3 Install probe inlets in ductwork at locations as specified under Part 2 - Products.
- .2 Locations:
 - .1 For traverse readings:
 - .1 At ducted inlets wall supply and exhaust fans.
 - .2 For temperature readings:
 - .1 At outside air intakes.

3.14 TURNING VANES

- .1 Install in accordance with recommendations of SMACNA.
- .2 Install where indicated.
- .3 Damper Actuators - Install where indicated.
- .4 Install in accordance with Manufacturer's instructions.
- .5 Provide channel fasteners or steel plate support for actuator mounting. Connect with damper mechanism. Adjust linkage and tighten connection points as required.
- .6 Upon system start-up, ensure that dampers operate properly without any tension caused by mechanical misalignment.

3.15 LEAKAGE TEST

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.

- .4 Install no additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three (3) branch takeoffs and two (2) 90° elbows.
- .6 Complete test before insulation or concealment.

3.16 SOUND ATTENUATORS

- .1 Install where shown and in accordance with applicable SMACNA Manual and manufacturer's recommendations.
- .2 Provide dielectric separation where attenuator material differs from connected duct system.

3.17 PAINTING

- .1 Clean and remove all rust, dirt, grease and oil from piping, ductwork, equipment and supports, whether such items are to be painted or not.
- .2 Except where otherwise indicated, shop paint all items of equipment supplied under this Section with one primer coat and two finish coats.
- .3 Except where otherwise indicated, paint all steel work, other than galvanized, plated, plastic coated or stainless steel. All painting will be performed under this Section.
- .4 Retouch all scratched and marred finish and primer coats at no cost to the City.
- .5 Paint the interior of all metal ductwork behind grilles and registers with one coat of flat black paint so that bare sheet metal cannot be seen through the grille or register.
- .6 Apply two coats of paint to exposed duct work in generator room the same colour as the walls.

3.18 BALANCING

- .1 The Contractor will demonstrate the satisfactory operation of each unit and system supplied under this Section to the satisfaction of the Engineer. Any unit or system may be rejected as not acceptable on the basis of failure to meet the Specifications, particularly with respect to capacity or performance, or by virtue of sub-standard workmanship in manufacturer or installation, or by virtue of un-repaired damage, or in the case of rotating machines by virtue of vibration or excessively rough or noisy operation. The Contractor will correct any flaw or fault to the satisfaction of the Engineer.
- .2 Balance the air systems to the satisfaction of the Engineer and submit a written report.

- .3 Balance the air systems using proper air metering instruments. Set all dampers, grilles, and belt drives to give the required capacity plus or minus five percent in any given determination.
- .4 Make air volume flow rate measurements with all fans and the heating and ventilating units operating according to the control requirements of this Specification.
- .5 Include in the balancing report the volumetric flow of all fans, grilles, fan static pressures, rpm of all rotating equipment and all motor amperages. The City may retain the services of an external Ventilation Engineering firm to verify the results of volumetric flow data submitted by the Contractor. If the Contractor's volumetric flow data deviates more than plus or minus five (5) percent from the Ventilation Engineering firm's results, the Contractor is required to make all required adjustments and/or modifications to the entire system to meet the intent of the contract. On completion, the Contractor is required to rebalance the system and resubmit a new report of the entire system. The Ventilation Engineering firm will retest the ventilation system to confirm the Contractor's results. The cost for the retesting by the Ventilation Engineering firm shall be borne by the Contractor.

3.19 DUCTWORK TESTING

- .1 After completion of installation, provide testing to demonstrate compliance with operating requirements.
- .2 Inspect and test ductwork for air leakage at joints and connections to equipment, under normal operating conditions. Provide systems leakage tests to SMACNA Class 12 requirements.
- .3 Test ductwork before ducts are insulated, painted or concealed.
- .4 Test to demonstrate that the equipment and work is not defective electrically, mechanically, or otherwise and is safe and satisfactory.
- .5 Immediately correct defects discovered during tests and retest systems to complete satisfaction of Consultant.

3.20 EQUIPMENT TESTING

- .1 After completion of installation, provide testing to demonstrate compliance with operating requirements.
- .2 Test to demonstrate that the equipment and work is not defective electrically, mechanically, or otherwise and is safe and satisfactory.

3.21 COMMISSIONING

- .1 Commission equipment in accordance with general requirements and in accordance with Division 1.

- .2 Certify commissioning in accordance with Division 1.

3.22 TRAINING

- .1 Training (non-consecutive days) – according to Section 01830, refer for details.
- .2 Allows one (1), 8-hour, session for each system. The schedule shall be discussed with and approved by the Owner. The sessions shall be completed prior to commissioning.

3.23 MANUFACTURER’S SERVICES

- .1 Manufacturer’s representative for the equipment specified shall be present at the jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance and training of the Counties personnel, for the period of (at each site):
 - .1 Minimum 8 hours - installation assistance and certification.
 - .2 Up to 8 hours – testing.
 - .3 8 hours – training.

END OF SECTION

SECTION 15815
FANS AND ACCESSORIES

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SECTION 15815 FANS AND ACCESSORIES

PART 3 GENERAL

.1 SCOPE

- .1** Design, supply shop drawings and equipment, install, and satisfactorily operate a complete ventilating system to the full intent of the Drawings and Specification.
 - .1** Refer to Division 16 – Electrical for all material specification (i.e. conduit, wiring, boxes, etc.), 575V power wiring and connections and for electrical installation/workmanship requirements.
 - .2** All electrical equipment must be CSA or equivalent approved.

.2 REFERENCES

- .1** Comply with the latest edition of the following statutes, codes, and standards and all amendments thereto.
 - .1** Air Movement and Control Association International (AMCA):
 - .1** 99, Standards Handbook.
 - .2** 201, Fans and Systems.
 - .3** 203, Field Performance Measurement of Fan Systems.
 - .4** 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .5** 211 - Certified Ratings Procedure - Air Performance.
 - .6** AFMBA - Method of Evaluating Load Ratings of Bearings (ASA - B3.1 1).
 - .7** 300, Reverberant Room Method for Sound Testing of Fans.
 - .8** 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - .2** ANSI/AMCA Standard 210 (air performance) and 300 (sound performance) AMCA 311 - Certified Ratings Procedure - Sound Performance.
 - .3** American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
 - .4** AFMBA - Method of Evaluating Load Ratings of Bearings (ASA - B3.1 1).

- .5 American National Standards Institute (ANSI): S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.
- .6 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): HVAC Applications Manual.
- .7 ANSI/AMCA 204-96 - Balance Quality and Vibration Levels for Fans.
- .8 ASTM International (ASTM):
 - .1 B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - .2 D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
 - .3 D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - .4 D3363, Standard Test Method for Film Hardness by Pencil Test.
 - .5 D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
 - .6 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .7 ASTM D4167-97 – Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
- .9 SMACNA:
 - .1 Fibrous Glass Duct Construction Standards, 6th Ed., 1992
 - .2 HVAC Systems-Application, 1st Ed., 1986
 - .3 HVAC Systems-Testing, Adjusting & Balancing, 2nd Ed., 1993
- .10 National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
- .11 National Fire Protection Association (NFPA): 45, Fire Protection for Laboratories Using Chemicals.
- .12 Ontario Occupational Health and Safety Act (OHSA).
- .13 Society for Protective Coatings (SSPC):
 - .1 SP 3, Power Tool Cleaning.

- .2 SP 5, Joint Surface Preparation Standard White Metal Blast Cleaning.
- .3 SP 6, Joint Surface Preparation Standard Commercial Blast Cleaning.
- .4 SP 10, Joint Surface Preparation Standard Near White Blast Cleaning.

.14 Underwriters Laboratories Inc. (UL/ULC): 507, Electric Fans.

.3 RELATED SECTIONS

- .1 Mechanical General Requirements - Section 15010
- .2 Basic Mechanical Materials and Methods - Section 15050
- .3 Controls: Division 13
- .4 Electrical: Division 16

.4 SHOP DRAWINGS

- .1 Submit unit performance data including: capacity, nominal and operating performance.
- .2 Submit Mechanical Specifications for unit and accessories describing construction, components and options.
- .3 Submit shop drawings indicating overall dimensions as well as installation, operation and servicing clearances. Indicate lift points recommendations and centre of gravity. Indicate unit shipping, installation and operating weights including dimensions.
- .4 Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.
- .5 Shop drawings submitted for approval shall be accompanied by a copy of the purchase agreement between the Contractor and an authorized service representative of the manufacturer for check, test and start up and first year service.

.5 REGULATIONS

- .1 Conform to all codes, by-laws, etc. of Provincial and Municipal authorities having jurisdiction. No additional compensation will be awarded for carrying out any conditions embodied in such regulations.

.2 When the work as shown and as specified exceeds the minimum requirements of such regulations, the Drawings and/or Specifications shall govern.

.3 Provide all permits, inspections, and certificates required for this Section.

.6 GENERAL ARRANGEMENT

.1 Co-ordinate the work under this Section with all other trades, in particular the structural work and make all necessary changes or additions to the runs to accommodate structural conditions, piping, ductwork, mechanical equipment, etc.

.2 Install the systems and apparatus in a practical and first-class manner and guarantee all work and apparatus against defects of workmanship and material and make good any and all defects that may develop.

.7 QUALITY ASSURANCE

.1 Performance Ratings: Tested in accordance with AMCA 210.

.2 Sound Ratings: Tested in accordance with AMCA 300.

.3 Fabrication: In accordance with AMCA 99.

.4 Performance ratings: Conform to the requirements of AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air and sound performance seal.

.5 Classification for Spark Resistant Construction: Conform to the requirements of ANSI/AMCA 99.

.6 Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).

.7 Comply with the National Electrical Manufacturers Association (NEMA) standards for motors and electrical accessories.

.8 The Finite Element Analysis (FEA) is the results from the CFD and it can accurately predict the stress, strain, and deflection resulting from high wind loads.

.8 DELIVERY, STORAGE, AND HANDLING

.1 Delivery: Deliver materials to Site in the manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

- .2 Storage: Store materials in a dry area indoor, protected from damage, and in accordance with the manufacturer's instructions. For long term storage follow the manufacturer's Installation, Operations, and Maintenance Manual.
- .3 Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.
- .9 WORKING DRAWINGS AND EQUIPMENT MANUALS
 - .1 Submit working Drawings for review for all items included in this Section.
 - .2 Submit all manuals required under this section.
- .10 APPURTENANCES, FITTINGS, CONNECTING PIPING AND DUCTING AND ACCESSORIES
 - .1 Supply and install all appurtenances, fittings, ductwork and accessories necessary for the proper functioning of the system or reasonably inferable from the Drawings with the equipment, whether indicated on the Drawings or specified herein, or not.

PART 3 PRODUCTS

- .1 FANS - GENERAL
 - .1 Capacity, static pressure, revolutions per minute, power, model size, sound power data and as indicated on schedule.
 - .2 Sound rating: Designed for the residential area application. Comply with AMCA (Air Moving and Conditioning Association) 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
 - .3 Ratings: Based on tests performed in accordance with ANSI/ AMCA 210; units shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.
 - .4 Impellers, propellers, etc.: Statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .5 Motors: sizes as specified. All Motors smaller than 375 watts to be 120 Volts, single phase, 60 Hz or otherwise as specified.
 - .6 Bearings: Equip with heavy duty grease lubricated ball or roller bearings of self-aligning type with oil retaining, dust excluding seals and 100,000 hours service in accordance with AFBMA B9 and B11 life standard and standard for fan manufacturers for duty concerned. Bearings shall be suited for service condition.
 - .7 Accessories and hardware:

- .1 Motorized-type damper (Where Scheduled), to be compatible with vertical or horizontal operation (refer to drawings), size equal to fan size (unless indicated in the drawings), galvanized frame (dry well application) with pre-punched mounting holes or all FRP construction for the wet well application; balanced for minimal resistance to flow
 - .1 Provide actuators with a power supply that is Suitable and self-adaptable to 24-240 VAC / VDC power sources, 100% overload protected.
 - .2 The actuator to have Aluminum housing NEMA4X / IP66 with a 39.4" cable. Actuator housing must also allow for direct mounting to dampers via manufacturer approved coupling and be rated for hazardous area installation without the use of a separate, cast metal, bolted enclosure.
 - .3 Actuator to include a mechanical, spring-return mechanism for failsafe operation with an option for fast acting spring return speed (3 seconds). Actuator parameters such as run time, torque and spring return speed shall be fully adjustable and programmable by means of DIP switch programming stick.
 - .4 Visual position indication must be visible on actuator face at all times
 - .5 The actuator is to be rated for -40°F to +104°F with an Integral heater
 - .6 Actuator Model: InMax/C, CSA, UL certified.
 - .7 Acceptable manufacturers: Schischek
 - .8 Or approved equivalent

.2 DIRECT DRIVE WALL FAN, PROPELLER

- .1 General:
 - .1 Factory-assembled propeller wall fan; including frame, propeller, drive assembly, motor and accessories.
 - .2 Bearing AMCA Certified Ratings Seal for sound and air performance.
- .2 Compliance:
 - .1 Classified under AMCA Standard 205.

- .2 Provide units listed in accordance with UL/cUL 705.
- .3 Frame:
 - .1 Fan panels and motor mount assemblies shall be constructed of heavy gauge steel for durability and appearance.
 - .2 Formed square tube steel supports bolted to steel panel with formed inlet venturi and pre-punched holes for mounting anchors. Motor mounting plate bolted to frame tubes.
- .4 Fan Propeller:
 - .1 Cast aluminum blades in cast aluminum hub. Hub secured to motor shaft with tapered bushing.
- .5 Accessories: Provide as scheduled in Equipment Schedule.
 - .1 Gravity Backdraft Damper: Gravity operation, adjustable counterweight, aluminum construction.
 - .2 Wall Box: 16 Ga galvanized steel, sized to match dimensions of fan panel, with mounting flange and pre-punched mounting holes. Suitable for attachment of motor guard, motorized damper, weather hood, and disconnect switch.
 - .3 Single Point Wiring: Provides a single location for making connections to the damper actuator and disconnect switch.
 - .4 Motor Side Guard: Hinged, constructed of galvanized steel sides and galvanized wire screen.
 - .5 Motorized Damper: Parallel-blade type. Fabricate frame from galvanized steel. Fabricate blades from aluminum, mill finish, with vinyl edge seals. Damper actuator suitable for 115V
 - .6 Disconnect switch, unfused NEMA 3R. Factory mount and wire disconnect switch.
 - .7 Spark Resistant Construction: Classification: AMCA 99-0401 Type as scheduled.
 - .8 Corrosion Protection Coating:
 - .1 Provide factory-applied epoxy coating on these fan components:
 - .1 Propeller.
 - .2 Frame.

.3 Wall box and guard.

.4 Interior surfaces in contact with airstream.

.6 Acceptable Manufacturers and Products:

.1 Twin City Fan; Model: TCWP

.2 New York Blower

.3 Or approved Equivalent

3. EXECUTION

.1 GENERAL

.1 Comply with the requirements for testing, start-up and commissioning in accordance with Section 15990 – Testing, Adjusting, and Balancing.

.2 Refer also to Division 13 and 16 for general requirements for installation of equipment specified herein.

.2 INSTALLATION

.1 Install fans where indicated, in accordance with manufacturer's instructions, complete with resilient mountings as required by manufacturer's instructions.

.2 Secure the units in place, level and plumb. Coordinate installation with other trades. Coordinate location of control panel before installing.

.3 Install in accordance with recommendations of SMACNA.

.4 Where indicated connect to ducting system.

.5 Co-ordinate fan and fan curb installation with structural and roof trades.

.6 Maintain clearances as recommended by manufacturer to permit performance of service maintenance.

.7 Check final location with Engineer prior to installation. Should deviations beyond allowable clearances arise, request and follow Engineer's directive.

.8 Install fans with 100 mm flexible connection on inlet ductwork and on discharge ductwork. Ensure metal bands of connectors are parallel with minimum 75 mm flex between ductwork and fan during running.

.9 Upon system start up, verify rotation and ensure that fans operate properly and safely.

- .10 Provide access panels in ductwork to enable access to motorized dampers where indicated.
 - .11 Where dual speed fans are specified and a motorized damper is needed to obtain design flows, provide air balancing in both flow scenarios.
 - .12 Do not use units during construction unless approval has been given by the County. If units were used during construction, units must be thoroughly cleaned before final testing.
 - .13 Interlock exhaust or intake fans with their dampers and heaters (if applicable).
- .3 IN-LINE DUCT FAN INSTALLATION
- .1 Provide in-line duct fans where shown.
 - .2 Rigidly secure the fan assembly and accessories in place in accordance with manufacturer's instructions. Install sleeve from fan to back-draft damper.
 - .3 Fan shall be accessible from the existing top landing. Coordinate fan installation and support with structural trades and existing structural and process elements.
 - .4 Provide transition fittings and flex connections in supply & discharge from fan to air ductwork.
 - .5 Install fan speed control unit close to the entry door, in wall.
 - .6 When installation is complete, check and test fan operation and make any required adjustments.
 - .7 Air duct shall be connected to fan with 45 degrees eccentric transition pieces. Transition piece shall be continuation of the duct and be of round to round, round to rectangular or rectangular to rectangular in shape. Shape of transition piece shall be coordinated with the duct shape/size and fan port shape/size before fabrication.
- .4 ADJUSTING
- .1 Adjust exhaust fans to function properly.
 - .2 Adjust Belt Tension (if applicable).
 - .3 Lubricate bearings.
 - .4 Adjust drive for final system balancing.
 - .5 Check wheel overlap.

.5 BALANCING OF AIR HANDLING SYSTEMS

- .1 Balance air handling systems in accordance with Section 15990 – Testing and Balancing of Mechanical Systems and as specified herein.
- .2 Retain independent firm of Testing Specialists to balance air handling fans subject to approval of Consultant.
- .3 Balancing Specialists shall provide instruments required to test and balance systems, and co-operate with associated trades involved in adjustment of equipment to obtain design performance. Balancing Specialists shall select location of probe inlet fittings in ductwork to assure proper readings. Balance systems in accordance with design requirement shown on Drawings. Immediately report to Engineer deficiencies in systems or equipment performance, which results in design requirements being unobtainable.
- .4 On completion of testing, adjusting and balancing of systems, Balancing Specialists shall submit to Engineer typewritten report (4 copies) of his findings, including complete data of fan performance, static pressures, air quantities, final readings at outlets, and ampere readings of all motors, taken at motor terminals when equipment is operating under full load conditions.
- .5 Balancing Specialists shall submit with each copy of report, complete sets of duct layout prints with locations at which test readings were taken, air volume, velocity and static pressure in each supply and return duct, and final reading at outlets neatly marked in red ink.

.6 TESTING

- .1 Refer to Section 15990 Testing, Adjusting, and Balancing
- .2 After completion of installation, provide testing to demonstrate compliance with operating requirements.
- .3 Test to demonstrate that the equipment and work is not defective electrically, mechanically, or otherwise and is safe and satisfactory.

.7 COMMISSIONING

- .1 Commission equipment in accordance with general requirements and in accordance with Division 1.
- .2 Provide the services of a factory-trained and certified technician for one day (1) to calibrate and confirm the correct installation, operation and written certification of the equipment. Modify the installation as per his recommendations (if any).
- .3 Certify commissioning in accordance with Division 1.

.8 TRAINING

- .1 Training (non-consecutive days) – according to Section 01830, refer for details.
- .2 Allows one (1), 8-hour, session for each system. The schedule shall be discussed with and approved by the Owner. The sessions shall be completed prior to commissioning.

.9 MANUFACTURER’S SERVICES

- .1 Manufacturer’s representative for the equipment specified shall be present at the jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance and training of the Counties personnel, for the period of (at each site):
 - .1 Minimum 8 hours - installation assistance and certification.
 - .2 Up to 8 hours – testing.
 - .3 8 hours – training.

END OF SECTION

SECTION 15990
TESTING, ADJUSTING, AND BALANCING

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SECTION 15990
TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SUMMARY

- .1 Section includes:
 - .1 Component check
 - .2 System balancing
 - .3 Operating tests and training.

1.2 RELATED SECTIONS

- .1 Ductwork and Accessories – Section 15810
- .2 Fans and Accessories – Section 15815
- .3 Electrical – Division 16

1.3 REGULATIONS

- .1 Conform to all codes, by-laws, etc. of Provincial and Municipal authorities having jurisdiction.
- .2 American National Standards Institute (ANSI)
 - .1 ANSI S12.1 Physical Measurement of Sound
- .3 Associated Air Balance Council (AABC)
 - .1 AABC 12173 National Standards for Field Measurements and Instrumentation — Total System Balance.

1.4 SUBMITTALS

- .1 Testing and Balancing Report: All test forms shall be standard 8-1/2 x 11-inch (A4 size), good-quality paper, bound to form a complete report. All forms shall be computer printed, typewritten, or legibly hand lettered; hand-made forms are not acceptable. Submit draft copies prior to final acceptance of the project. Refer to subpart 3.5 “Balancing Report” for specific requirements.
- .2 Submit all manuals required under this section.

1.5 QUALITY ASSURANCE

- .1 Obtain the services of a qualified balancing organization to perform testing, balancing, and component check at no additional cost to the Owner. The balancing agency shall be independent of the air-conditioning installer.
- .2 Perform checks before testing and balancing.
- .3 Perform balancing in accordance with AABC 12173.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

- .1 Ensure the balancing organization checks and reports defects or deficiencies that may affect balancing.
- .2 Provide sufficient time before completion date to balancing operations.
- .3 Provide immediate labour and tools to make corrections without delay.
- .4 Place heating, ventilating, and air-conditioning systems and equipment into full operation and continue operation for each working day of testing and balancing.
- .5 Advise balancing organization of changes made to the system during construction.
- .6 Install required test holes complete with removable and replaceable plugs.
- .7 Make necessary revisions to controls, dampers, and fan and pump drives, and consult with equipment manufacturers as required to achieve the specified system's performance.
- .8 Provide dampers as shown and where required to obtain final system balance.
- .9 Provide ladders, scaffolds, and tools and labour required to facilitate balancing, including removing ceiling tiles and guards, and adjusting pulleys and belts. Reinstall and adjust all items when balancing is finished.
- .10 Coordinate balancing operations with controls system installation when setting damper linkages and minimum-outside-air dampers. Readjust dampers and improperly calibrated controls as required.
- .11 Set pressure-regulating and reducing valves to operating conditions.
- .12 Check air filters immediately prior to air balancing.
- .13 Open fire dampers (if applicable).

3.2 EQUIPMENT CHECK

- .1 Check all equipment according to the manufacturer's instructions and the following checklist:
 - .1 Pre-Startup Inspection:
 - .1 Verify proper equipment mounting and setting.
 - .2 Verify that control, interlock, and power wiring is complete.
 - .3 Verify alignment of motors and drives.
 - .4 Verify proper piping connections and accessories.
 - .5 Verify that lubrication is completed.
 - .2 First Run Observations:
 - .1 Verify direction of rotation.
 - .2 Verify setting of safety controls.
 - .3 Monitor heat buildup in bearings.
 - .4 Check motor loads against nameplate.
 - .3 Equipment Check:
 - .1 Verify proper overload heater sizes.
 - .2 Verify function of safety and operating controls.
 - .3 Verify proper operation of equipment.
 - .4 Report on inspection, observation, and checking procedures.

3.3 CHECK ALL SUBSYSTEMS PRIOR TO SYSTEM BALANCING

- .1 Air distribution products installation is completed.
- .2 Filter installation is completed.
- .3 Instrumentation installation is completed.
- .4 Refrigeration systems have been leak tested, evacuated, and filled with refrigerant and fresh oil (if applicable).
- .5 Equipment check completed.

- .6 Rotation of electric motor and ratings of overload heaters have been verified.
- .7 Rotating equipment has been aligned and belt drive tension has been adjusted.
- .8 Control diagrams and sequences have been corrected to “as-built.”
- .9 Safety and operating control SET POINTS are as designed, and automatic control sequences have been checked.
- .10 Installation has been cleaned-up and temporary coverings, stickers, and tags removed.
- .11 Equipment and piping identification work has been completed with valve tags, schedules, and piping identification system.
- .12 One set of operating and maintenance manuals has been prepared especially for use by testing and balancing technicians.
- .13 Building operating and maintenance personnel have been instructed in all aspects of system operation and maintenance.
- .14 Graphic operational data such as start/stop instructions, valve tag schedules, and piping identification schedules have been provided where needed.

3.4 AIR-SYSTEM BALANCE PROCEDURE

- .1 Execute air systems balancing for each air system in accordance with AABC specifications and as described herein.
- .2 Make tests with supply, return and exhaust systems operating and doors and windows closed, or in their normal operation condition.
- .3 Test and adjust blower speed to design requirements.
- .4 Test and record motor full-load amps.
 - .1 Traverse main supply-air ducts, using a Pitot tube and manometer. Calibrate the manometer to read two significant figures in velocity pressure ranges. Take a minimum of 16 readings per traverse to measure the total air quantity supplied by the fan, and to verify air distribution per zone
- .5 Test and record required and measured system static pressures, filter differential, coil differential, and fan total static pressure.
- .6 Test and adjust systems for design recirculated airflow rates.
- .7 Test and adjust system for design volume flow rate of outside air (L/s).
- .8 Test and record entering-air temperatures.

- .9 Test and record leaving-air temperatures.
- .10 Adjust main supply and return ducts to proper design flow rates.
- .11 Inspect and confirm all fire dampers are open and have adequate access.
- .12 Adjust zones to proper design, supply and return flow rates.
- .13 Test and adjust each diffuser, grille and register to within 10% of design requirements.
- .14 Identify each diffuser, grille and register as to location and area.
- .15 Identify and list size, type and manufacturer of diffusers, grilles, registers and testing equipment. Use manufacturer's rating on equipment to make required calculations.
- .16 In readings and tests of diffusers, grilles and registers, include required velocity and test velocity (m/s) and required flow rate (L/s). Test after adjustment.
- .17 Control manufacturer shall set adjustments of automatically operated dampers to operate as indicated in cooperation with balancing firms.

3.5 BALANCING REPORT

- .1 Include types, serial numbers and dates of calibration of instruments.
- .2 Drawings, and submit copies upon completion of balancing.
- .3 Submit fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.
- .4 Index report as follows:
 - .1 Air
 - .2 Summary
 - .3 Procedure
 - .4 Instrumentation
 - .5 Drawings
 - .6 Equipment Summary
 - .7 Fan Sheets
 - .8 Fan Curves

- .9 Fan Profile Data
- .10 Static Data
- .5 Fire Damper Verification:
- .6 Duct Air Quantities:
 - .1 Duct sizes
 - .2 Number of pressure readings
 - .3 Sum of velocity measurements
 - .4 Average velocity
 - .5 Duct recorded airflow rate
 - .6 Duct design airflow rates
- .7 Air Inlets and Outlets:
 - .1 Outlet identification location and designation
 - .2 Manufacturer's catalogue identification and type
 - .3 Application factors
 - .4 Design and recorded velocities
 - .5 Design and recorded airflow rates
 - .6 Deflector-vane or diffuser-cone settings
- .8 Building Pressurization Data:
 - .1 Outside air temperatures
 - .2 Outside wind velocity
 - .3 Building pressures plotted with respect to systems
 - .4 Supply-air, return-air and exhaust-airflow rates
 - .5 Locations of pressure measuring points inside and outside building

END OF SECTION

DIVISION 16

ELECTRICAL

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SECTION 16010
ELECTRICAL GENERAL REQUIREMENTS

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SECTION 16010 ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section covers items common to Sections of Division 16 and supplements the requirements of Division 1.
- .2 In case of a discrepancy between statements and/or values in this General Requirements section and contract drawing(s), the more stringent statement and value takes precedence and shall govern.

1.2 DEFINITIONS

- .1 The following are definitions of terms and expressions used in the specification:
 - .1 “Inspection Department/Authority” means the agency having jurisdiction over construction and safety standards associated with any part of electrical work on site. For this project, the Inspection Departments/ Authorities is the Electrical Safety Authority (ESA).
 - .2 “Electrical Code” means the Ontario Electrical Safety Code latest Edition, and published bulletins.
 - .3 “Indicated” means as shown on contract drawings or noted in contract documents.
- .2 Refer to CSA C22.2 No.0 for “Definitions and General Requirements”.
- .3 Abbreviations for electrical terms shall be in accordance with CSA Z85-1983.

1.3 CODES AND STANDARDS

- .1 All equipment and installations including temporary works shall comply with the latest editions of the Canadian Electrical Code – CSA C22.1, the Ontario Electrical Safety Code and any local codes and requirements that govern the installation. Where these regulations conflict, apply the most stringent condition.
- .2 Install overhead and underground systems in accordance with CSA C22.3 No.1-M87 and No.7-M86 except where specified otherwise.
- .3 CAN3-C235-83 Voltages

1.4 TEMPORARY UTILITY SERVICES

- .1 Contractor is full responsibility to provide all necessary labour and materials to install and maintain any temporary services.

1.5 PERMITS, FEES AND INSPECTION

- .1 Submit to Contract Administrator necessary interim and final certificates of inspection and approval required by Inspection Authorities as evidence that work installed complies with laws and regulations of governing authorities.
- .2 Submit copies of plans and specifications required by Inspection and Supply Authorities.
- .3 Notify Inspection Authorities in sufficient time to inspect work.
- .4 Contractor to submit a request to the Electrical Safety Authority to notify them of the impending assignment for review and inspection requirements.
- .5 Provide Inspection Department any additional necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .6 Notify Contract Administrator of changes required by Electrical Inspection Department prior to making changes.
- .7 Pay all associated fees and costs. The contractor is responsible for all fees and costs including any changes, or additions in scope to the Electrical Safety Authority inspection fees.

1.6 CO-ORDINATION WITH OTHER TRADES

- .1 Be responsible and co-ordinate other sub-trade work with electrical requirements and ensure that there is no interference with or delay caused by such work to the electrical or other trades work.
- .2 Notify other sub-trades of all openings, inserts, anchors, sleeves, hangers, foundations, etc., necessary for electrical work, and be responsible that these are provided and correctly installed at the proper time.
- .3 Fully co-operate with all trades in the provision and maintenance of electrical power in all areas throughout the period of construction.

1.7 CONSTRUCTION/SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01300 – Submittals.
- .2 Submit data (drawings) for review prior to commencement of manufacturing or installing with the exception of conduit, standard conduit fittings and low voltage wiring.
- .3 Show all details of construction, dimensions, capacities, weights, and electrical performance characteristics of equipment or material.

- .4 Prepare composite construction drawings, fully dimensioned of cables, conduit, cable tray, bus duct, sleeves, clearances, pipes, ducts, etc., and equipment in mechanical and electrical equipment rooms, ceiling spaces and all other critical locations to avoid a conflict of trades. Base drawings on manufacturer's shop drawings. Drawings should be developed from consultation with and agreement of all trades involved.
- .5 Prepare drawings of equipment bases, anchors, slabs, floor and roof curbs, if needed, for the electrical work.
- .6 Include, but not necessarily limit to, the following:
 - .1 Single Line Diagram (SLD).
 - .2 Manufacturer's bulletins, leaflets and specifications of major electrical equipment.
 - .3 Lighting fixtures, including photometric data.
- .7 Indicate the number or letter used on the drawings/specifications as an identification symbol on product data for panelboards, light fixtures, and other equipment submitted.
- .8 Bind one complete set of construction/shop drawings showing "as built" conditions in each operating and maintenance instruction manual.

1.8 RECORD DRAWINGS

- .1 Before commencing work, obtain two sets of electrical drawings for showing "As Built" conditions. As job progresses, mark on field set of prints to indicate accurately all installed work. At completion stage, transfer all information onto master set of drawings and indicate "Contractors Certified Approval of Accuracy" before submitting to Contract Administrator for review and record use.
- .2 Indicate on record drawings "As Built" stamp.
- .3 Indicate on record drawings, location of all buried services. This information is to be certified correct by Contract Administrator before backfilling commences.

1.9 WORKMANSHIP

- .1 Install all equipment, bus ducts, cable trays, conduit and cables in a workmanlike manner to present a neat appearance and to function properly.
- .2 Install exposed systems and equipment neatly and grouped to present a neat appearance, without conflict to other services.
- .3 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance therefore, in terms of space and accessibility.

- .4 Include in the work all requirements of manufacturers shown on the shop drawings or manufacturers' installation instructions, and make provision for future plant and equipment as shown.
- .5 Replace without extra cost work unsatisfactory to the Contract Administrator.
- .6 Protect all equipment from damage during delivery to the site and during installation. Make good any damage or deterioration whatsoever and have it covered by replacement guarantee.

1.10 MATERIALS AND EQUIPMENT

- .1 Equipment and material must be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department. Pay all associated fees.
- .2 Factory assemble control panels and component assemblies.
- .3 Provide Canadian manufactured equipment and materials, except where specified otherwise or where Canadian made materials or equipment do not exist.

1.11 FINISHES

- .1 Shop finish all metal enclosure surfaces by application of rust resistant primer and at least two coats of finish enamel all in accordance with the directions of the coating manufacturer.
 - .1 Paint enclosures light grey to ANSI #61.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.12 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1, and other sections of the contract documents.
- .4 Use colour-coded wires in communication cables, matched throughout system.

1.13 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.

- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 10 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	<u>Prime</u>	<u>Auxiliary</u>
up to 250 V	yellow	
up to 600 V	yellow	green
up to 5 kV	yellow	blue
up to 15 kV	yellow	red
Telephone	green	
Other communication systems	green	blue
Fire alarm	red	
Emergency voice	red	blue
Other security systems	red	Yellow

1.14 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for copper conductors.

1.15 MANUFACTURERS AND CSA LABELS

- .1 Visible and legible after equipment is installed.

1.16 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Inspection Department and Contract Administrator.
- .2 Decal signs, minimum size 175 x 250 mm.

1.17 SINGLE LINE ELECTRICAL DIAGRAMS (SLD)

- .1 Submit “as-built” SLDs based on Contract drawing to Contract Administrator for review.
- .2 Contract Administrator will return a CD of drawings in ACAD (i.e. .dwg) format to Contractor.
- .3 Drawings: A1 size
- .4 Provide a framed SLD showing all devices.

- .5 Provide a second board mounted SLD (10 mm stiff board) with matte laminated finish for portable reference within the electrical room, hung in a prominent location.

1.18 LOCATION OF OUTLETS AND LIGHT SWITCHES

- .1 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .3 Locate light switches on latch side of doors.

1.19 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400 mm.
 - .2 Wall receptacles:
 - .1 General: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Fire alarm stations: 1500 mm.
 - .5 Fire alarm bells: 2100 mm.
 - .6 Exterior light fixtures (wall mounted): 2600 mm or directly above door.

1.20 LOAD BALANCE

- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers, oil-filled transformers, and switchgear

operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

1.21 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 rigid PVC, sized for free passage of conduit, and protruding 50 mm.
- .2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .3 Arrange for holes through exterior walls and roof to be flashed and made weatherproof. Co-ordinate with appropriate division.
- .4 Provide fire stopping for all penetrations through fire-rated walls.
- .5 Unless otherwise indicated, all cables to be installed in the classified areas shall be TECK rated for hazardous locations (complete full run).

1.22 INSERT, SLEEVES, FASTENINGS AND SUPPORTS

- .1 Provide all necessary inserts, hangers, fastenings, sleeves and curbs for electrical equipment, suspended from or passing through structural walls or floors, to suit the specific location, and as approved by the Contract Administrator.
- .2 Cables must be supported using “P” clips instead of tie-wraps.
- .3 Sleeves: allow 12 mm clearance over the O.D. of all cables and conduits, 25 mm horizontally and vertically for rectangular openings.
- .4 Finish sleeves flush with wall finish (each side) or the ceiling to curb top.
- .5 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields, properly sized for the load to be carried.
- .6 Secure equipment to poured concrete with expandable inserts, properly sized for the load to be carried.
- .7 Secure equipment to hollow masonry walls or suspended ceilings with factory made threaded or toggle type inserts, properly sized for the load to be carried.

1.23 CUTTING, PATCHING AND WELDING

- .1 Where installation of equipment by this section requires cutting or patching of new or existing work, the work shall be performed by, and under direction and supervision of, this section. Make good surface finishes to satisfaction of the Contract Administrator.

- .2 No cutting or welding of beams, columns or structural surfaces is permitted without approval of the Contract Administrator and all damage to finished or unfinished surfaces shall be made good to the satisfaction of the Contract Administrator.
- .3 Pay all costs for cutting and patching resulting from failure to co-ordinate timely installation of electrical inserts, sleeves, etc., into masonry structures.

1.24 FIREPROOFING

- .1 Where sleeves or openings are installed in walls, floors, roof or partitions to accommodate raceways, cables or bus duct, provide all necessary seals, fittings, barriers and fire-resistant materials to restore the installation to its original fire rating to the satisfaction of the governing authorities and the Owner's insurance underwriters. Minimum two (2) hour fire rating.

1.25 FIELD QUALITY CONTROL (TESTING)

- .1 General
 - .1 Prior to the Owner's acceptance, all electrical equipment, materials and systems installed shall be subject to an inspection and applicable performance tests supervised by the Contract Administrator to ensure that the operation of the system and components satisfy the requirements of the Contract Documents.
 - .2 Ensure that the system and its components are ready prior to the inspection and test for acceptance.
 - .3 Conduct all testing by fully qualified personnel only. Tests requiring initial power energization of a system shall not be made without notification of the Contract Administrator. Tests, checks and the like carried out by or on behalf of the Contractor shall be documented and certified at no additional cost to the Owner. Submit two copies of the test certificates to the Contract Administrator.
 - .4 Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.
 - .5 Manually operate alarms and control devices to check whether their operation during normal and abnormal operating conditions causes the proper effect.
 - .6 In addition to tests on purely electrical systems, supply the necessary labour and equipment for operational tests required by other Divisions where electrical services are involved and make final adjustments to the electrical controls at no additional cost to the Contract Administrator.

- .7 Perform tests on auxiliary or specialized systems with the assistance of the manufacturer's representative. Upon successful conclusion of the tests, obtain a certificate from the manufacturer stating that the system has been installed to their satisfaction and that it is in good working order.
- .8 Ensure circuit protection devices such as overcurrent trips, relays and fuses are installed to values and settings as indicated.
- .9 Replace at no additional cost all fuses, relays, or other devices destroyed during field quality control (testing).
- .10 Supply all instruments, meters and personnel required for the tests.
- .11 Clean equipment by vacuum. Clean, wax and polish all new exterior surfaces, check and tighten all electrical connections.
- .2 Cable and Wire – 1000 Volt and Below
 - .1 Limit all tests on cables in this voltage range to insulation resistance measurements using a megger: 500 V instrument for circuits up to 350 V systems; 1000 V instrument for 351-600 V systems.
 - .2 Record all test results in a log book and submit to the Contract Administrator for reference. Replace or repair all circuits, which do not meet minimum requirements specified in the governing Electrical Safety Code. Measure insulation resistance of the following circuits:
 - .1 Power and lighting feeders (with equipment disconnected): phase-to-phase, and phase-to-ground.
 - .2 Control circuits: measure to ground only.
 - .3 Do not perform megger tests on control circuits containing transistorized or solid-state components.
 - .4 Where power factor correction equipment is installed, it may be necessary to disconnect the capacitors from the system prior to testing to avoid overvoltage.
- .3 Transformers
 - .1 Measure primary and secondary voltages at each tap setting and verify nameplate values. No-load tap changers to be operated only when transformer is de-energized.
- .4 Grounding System

- .1 Test the ground system efficiency for compliance with CSA Standard C22.1 and Supply Authority requirements. Verify that the ohmic resistance values specified therein are not exceeded (refer to 16950).
- .2 If ohmic value of the grounding system is not satisfactory to the Contract Administrator or Supply Authority, install additional ground rods and ground conductor to rectify.
- .3 Notify inspection and Supply Authorities that they may be present to witness Contractor testing and provide any assistance required by these Authorities for their own testing procedures.

1.26 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure all protective devices ratings and settings are properly co-ordinated to suit the actual equipment supplied and/or installed or to which it is being connected.
- .2 Record and submit to Contract Administrator all protective devices settings as left.
- .3 Provide a system co-ordination time-current curves on Log-Log paper for all protective devices. Include but not be limited to the following:
 - .1 All protective devices on 600 V and 208/120 V systems.
 - .2 Supply authority's power cables and fuse curves.
 - .3 Damage curves – 3 phase, phase-ground, phase-phase and inrush current point for all transformers.
 - .4 600 V molded case circuit breaker trips – thermal and instantaneous.
 - .5 Starting current of largest motor on the system including the offset of the running load.
 - .6 Damage curves for 1 kV and 600 V power cables.
 - .7 Three-phase RMS bolted fault values, phase-to-phase and phase-to-ground (include generator's values).
- .4 Submit all data for review sufficiently in advance of equipment ordering.

1.27 APPROVED SUPPLIER SUBSTITUTIONS

- .1 Where Products are named specifically in the Contract Documents or by other specific details, the naming of the item is regarded as the standard to establish the type, function and quality required, and the Contractor's bid price shall be based on supply and installation of the First Named Equipment. After the award of the Contract, the Contractor may apply to the Engineer to substitute, as an "Approved

Equivalent / Acceptable Alternative", another item or group of related items. In all cases, the proposed substitution must be justified by the Contractor in a written application to the Engineer. Such written application shall indicate the reasons why the Contractor wishes a substitution (significant delay in delivery, strikes, unavailability, or improved performance, quality, delivery time, field service) and the credit offered. The application must be accompanied by sufficient descriptive and technical information, specifications, references and samples for the Engineer to thoroughly compare the items or the group of items with that specified. See Section 01630 – Substitutions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 16011
ARC FLASH AND SHOCK HAZARD
WARNING LABEL

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SECTION 16011
ARC FLASH AND SHOCK HAZARD
WARNING LABEL

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section 16011 describes the requirements for design and installation for arc flash and shock hazard labels.
- .2 Refer to Section 16015 – Electrical Systems Analysis for the requirements of electrical systems analysis, including a short circuit, protective device coordination, arc flash hazard protection and harmonic studies for all new, modified and — all downstream electrical equipment shown on the contract drawings.
- .3 Based on the Electrical System Analysis report, provide arc flash and shock hazard labels.
- .4 In case of a discrepancy between statements and/or values in this section and other sections or contract drawing(s), the more stringent requirement and value takes precedence and is to govern.

1.2 RELATED REQUIREMENTS

- .1 Contract Drawings including Single Line Diagram (SLD)
- .2 Division 1 – Summary of Work
- .3 Division 1 – Submittals
- .4 Division 1 – Training
- .5 Division 1 – Operation and Maintenance Materials
- .6 Section 16010 – Electrical General Requirements
- .7 Section 16015 – Electrical Systems Analysis
- .8 All sections of Divisions 1 to 16 inclusive, form part of the Contract Documents.

1.3 REFERENCES

Refer to the latest edition of the following standards:

- .1 Ontario Electrical Safety Code (OESC), Electrical Safety Authority (ESA) bulletins including amendments.
- .2 Canadian Standards Association (CSA) Group
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

- .2 CSA Z462, Workplace Electrical Safety
- .3 CSA Z321, Signs and Symbols for the Workplace
- .3 IEEE Standard 1584: Guide for Performing Arc-Flash Hazard Calculations
- .4 ANSI Z535.4: Product Safety Signs and Labels

1.4 SUBMITTALS

- .1 Submit in accordance with Division 1 – Submittal Requirements.
 - .1 Submit arc flash and shock hazard report stamped and signed by professional engineer licensed in the province of Ontario, Canada.
 - .2 Provide pdf file of individual arc flash and shock hazard labels for each equipment of the project, to the Contract Administrator/Consultant for review and approval. The arc flash and shock hazard label design shall be pre-approved by the Contract Administrator/Consultant before its printing/production.

1.5 STORAGE

The arc flash and shock hazard risk assessment report and label shall be based on the latest edition of CSA standard Z462 and IEEE standard 1584: Guide for Performing Arc-Flash Hazard Calculations.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver and affix the arc flash labels on the electrical equipment according to the Contract requirement. Examine the labels, record any damage or deficiency and report to the Consultant/Contract Administrator.
- .2 Replace defective or damaged label with new at no additional cost to the City.

PART 2 PRODUCTS

2.1 ARC FLASH AND SHOCK HAZARD LABEL REQUIREMENT

- .1 Provide/affix arc flash and shock hazard warning label for each cubicle section of the high voltage switchgear.
- .2 Provide/affix arc flash and shock hazard warning label for each Disconnect switches and Lighting Panel.

2.2 MATERIAL

- .1 Size: 4" x 6" (10 cm x 15 cm).

- .2 Color: The label shall include the word “WARNING” in safety black letters on a safety orange background.
- .3 Equipment tag on the label to be provided in accordance with latest/as-built Single Line Diagram and Solid Waste Management Systems Asset Tagging Standard.
- .4 Write the name of the consultant/company on each arc flash and shock hazard warning label which performed the arc flash study.
- .5 For "Contract/Project Number: " in the arc flash and shock hazard warning label, provide the contract/project number of the project for which the study has been performed.
- .6 Print the label on UV resistant vinyl labels with high quality self-adhesive back.
- .7 Refer to Figure 1, 2 and 3 within this section for examples of arc flash and shock hazard warning labels.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions:
 - .1 Verify that conditions of the equipment previously installed under other Sections or Contracts are acceptable.
 - .2 Inform Contract Administrator/Consultant, in writing, of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation/affixing of arc flash hazard label after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Provide arc flash and shock hazard label before energizing the equipment.
- .2 The person who will be producing and/or installing arc flash and shock hazard label should consult the latest edition of ANSI Z535.4 and CAN/CSA-Z321 to ensure that all applicable requirements are met.
- .3 The arc flash and shock hazard warning label shall be readily visible to the worker and alert the worker to the potential hazard in time to take appropriate action.
- .4 In case there are existing label on the equipment, remove the old label and install/affix new label.
- .5 Get the installation inspected by Contract Administrator/Consultant.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL EQUIPMENT AND MATERIALS

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SECTION 16050
BASIC ELECTRICAL EQUIPMENT AND MATERIALS

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section describes various low voltage (<1000V) electrical equipment that is common to a number of areas and systems.

1.2 SCOPE

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install all equipment and materials specified herein and on the drawings.

1.3 SHOP DRAWINGS

- .1 Submit shop drawing in accordance with Section 01300 – Submittals.
- .2 For each control panel and pushbutton station include all layout drawings, terminal blocks, control relays, wire numbering system, panel dimensions, enclosure rating, wiring arrangement, nameplates, etc.

PART 2 PRODUCTS

2.1 ENCLOSURE RATINGS

- .1 Indoor and dry locations: NEMA 12 unless otherwise noted.
- .2 Below grade, damp or outdoor locations: NEMA 4X, or NEMA 3R, as noted on drawings.

2.2 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch: size as indicated.
- .2 Voltage and Current Ratings: As shown on drawings.
- .3 Provision for padlocking in off switch position by three locks.
- .4 Mechanically interlocked door to prevent opening when handle is in ON position.
- .5 Fuses: size as indicated.
- .6 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .7 Quick-make, quick-break action, non-teasible mechanism with visible blade – dead front construction.

- .8 ON-OFF switch position indication on switch enclosure cover.
- .9 Early break auxiliary contact (switch), as indicated.
- .10 Disconnect Switch – Hazardous Location.

2.3 DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

- .1 Design
 - .1 Type: ANN, naturally air-cooled, high efficiency.
 - .2 Meeting the latest federal, provincial and local efficiency and losses standards.
 - .3 3 phase, kVA as indicated, 600 V input, 208/120 V output, 60 Hz.
 - .4 Voltage taps: 2 – 2½% FCAN, 2 – 2½% FCBN, silver plated.
 - .5 Insulation: Class H, 150°C temperature rise (maximum 220°C insulation class). For 30 kVA or less, 130°C temperature rise (maximum 200°C insulation class).
 - .6 Windings: copper.
 - .7 Angular displacement: secondary lagging primary by 30°C, as defined by IEC-DY-1.
 - .8 Basic Impulse Level (BIL): per CSA standards.
 - .9 Hipot: standard.
 - .10 Average sound level: 45-47 dB.
 - .11 Impedance: standard.
 - .12 Enclosure: Nema 1 ventilated, removable metal front panel.
 - .13 Mounting: Wall.
 - .14 Finish: in accordance with Section 16010 – Electrical General Requirements.
- .2 Manufacturer's nameplate to indicate: angular displacement, connection diagram and taps, polarity type, phase, kVA capacity, voltage ratio, frequency, LIL (BIL), impedance, insulation class, insulation and winding material, temperature rise, sound level, weight, serial number, date of manufacture, manufacturer, CSA label, etc.

.3 Acceptable manufacturers are:

.1 Hammond

.2 Or approved equivalent

2.4 POWER AND LIGHTING PANELBOARDS

.1 Panelboards: product of one manufacturer c/w built-in SPD.

.2 208/120 V panelboards: bus and breakers rated for 10,000 A (symmetrical) interrupting capacity or as per result of system study, whichever is greater.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two keys for each panelboard and key panelboards alike.

.6 Copper buses with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers.

.8 Trim and door finish in accordance with Section 16010 – Electrical General Requirements.

.9 Base panelboards on CSA C22.2 No. 29 – specification.

.10 Panelboard Breakers:

.1 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.2 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.3 Lock-on devices as indicated.

.4 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.

.5 Common-trip breakers: with single handle for multi-pole applications.

- .6 Ground fault protection circuit breakers: Class A type, 120 V AC, complete with automatic shunt trip, zero sequence transformer and facilities for testing and reset pushbuttons.
- .11 Acceptable manufacturers are:
 - .1 Eaton
 - .2 ABB
 - .3 Or approved equivalent

2.5 MOTOR STARTERS/CONTACTORS

- .1 General
 - .1 Starters: to EEMAC E14-1. Half size starters not acceptable.
 - .2 Enclosure ratings: suitable for applicable area.
 - .3 Voltage and Current Ratings: As shown on drawings.
 - .4 Complete with four (4) spare Form C auxiliary contacts, in addition to those used in the control circuitry, unless indicated otherwise.
- .2 Full Voltage Magnetic Starters
 - .1 Magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type rated heavy duty and long life.
 - .2 Interchangeable solid-state motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Power and control terminals.
 - .4 Elementary control diagrams as indicated on drawings, and located inside starter enclosure in visible location.
 - .5 Identify each wire and terminal for external connections, within starter, with permanent number marking.
 - .6 Minimum starter size: EEMAC Size 1.
 - .2 Magnetic starters to include motor circuit protector (MCP) – magnetic type circuit breaker properly rated for motor, with operating lever on outside of enclosure with provision for:

- .1 Locking in “OFF” position with up to 3 padlocks.
 - .2 Preventing switching to “ON” position while enclosure door open.
- .3 Heating/Lighting Contactors
 - .1 Contactors: to EEMAC No. 1CS latest edition.
 - .2 Permanent magnet latch type controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
 - .3 Complete with four (4) spare Form C auxiliary contacts, in addition to those used in the control circuitry, unless indicated otherwise.
 - .4 Contactor to include enclosure, disconnect switch – interlocked with enclosure door, control transformer with primary and secondary fusing, indicating lights, selector switches, pushbuttons, etc.
- .4 Ventilation and Air Handler starters
 - .1 Provide self-contained, full voltage magnetic starters.
- 2.6 CONTROL RELAYS (INSTANTANEOUS)
 - .1 General purpose plug-in type relays, low coil current heavy-duty contacts with multi-contact poles as indicated.
 - .1 Coil rating (Vac systems): 120 V, 60 Hz.
 - .2 Contact rating (Vac systems): 120 V, 10 A.
- 2.7 RELAY ACCESSORIES
 - .1 Overlap contact cartridges: supplied in pairs having NO contact that closes before NC contact opens (early make -late break).
- 2.8 TIMING RELAYS
 - .1 General purpose plug-in type relays, low coil current heavy duty contacts with multi-contact poles as indicated. Coil rating: 120 V, 60 Hz. Contact rating: 120 V, 10 A.
- 2.9 PUSHBUTTONS
 - .1 Momentary contact type: Heavy duty – oil tight, operator flush type, colour as indicated, 1-NO and 1-NC contacts rated 5 A at 120 V AC, labels as indicated.

- .2 Push-pull contact type: Heavy duty – oil tight, operator mushroom head type, red colour, provision for padlocking in “OFF” position, 2-NO and 2-NC contacts rated 5 A at 120 V AC, labels as indicated.
- .3 Pushbutton ratings:
 - .1 NEMA type 13 for indoor control panels.
 - .2 NEMA type 4 for outdoor control panels.

2.10 SELECTOR SWITCHES

- .1 Maintained contact type, 2 or 3 positions (as indicated), heavy duty – oil tight, operators standard knob, NO and NC contacts arrangement as indicated rated 5 A at 120 V AC, labels as indicated. The number of contacts as many as shown on the contract drawings,
- .2 Switch ratings:
 - .1 NEMA type 13 for indoor control panels.
 - .2 NEMA type 4 for outdoor control panels.

2.11 INDICATING LIGHTS

- .1 Heavy duty – oil tight
- .2 LED cluster, Push-To-Test type
- .3 Lens colour as indicated
- .4 Supply voltage: 120 V
- .5 Labels as indicated.
- .6 Indicating light ratings:
 - .1 NEMA type 13 for indoor control panels.
 - .2 NEMA type 4 for outdoor control panels.

2.12 CONTROL CIRCUIT TRANSFORMERS

- .1 Single phase, dry type.
- .2 Primary: as indicated, 60 Hz AC.
- .3 Secondary: 120V or 24V AC as indicated.

- .4 Rating: as required plus 20% spare capacity.
- .5 Secondary fuse kit (terminal block type chips) and fuse, size as indicated.

2.13 CONTROL PANELS – NON-HAZARDOUS AREAS

- .1 Shop fabricate electrical control panels from prime quality cold rolled 14 gauge steel, properly formed with continuous welded seams and suitably reinforced to provide adequate strength.
- .2 Provide doors with continuous stainless steel piano hinges permitting access to all internal components and wiring. Make provision for padlocking the enclosure.
- .3 For 575 V and 120 V equipment components a single housing with metal barriers and separate access doors can be employed, provided the installation complies with Electrical Code Inspection Authority regulations.
- .4 Control panel enclosure: as per Clause 2.1, constructed with permanently secured oil-resistant neoprene gasket. Mounting and sizing requirements as indicated on drawings.
- .5 Control devices: as indicated on contract drawings.
- .6 Control panel wiring: minimum #14 AWG, stranded copper, 600 V thermoplastic insulated, moisture resistant (TEW type).
- .7 Insulation colours: green-ground, white-neutral, black-phase, red-control.
- .8 Control panel finish in accordance with Section 16010 – Electrical General Requirements.
- .9 Provide inside terminal mounting board for each panel.
- .10 Control terminal blocks: 600 V – 20 A rating, #12 AWG max. wire size. Equal to Weidmuller type SAK2.5N.
- .11 Fused terminal blocks: 600 V – 15 A rating, #8 AWG max. wire size, blown-fuse neon indicator, fuse size as indicated. Equal to Weidmuller type SAKS6.
- .12 Acceptable Panel manufacturers:
 - .1 Hammond Manufacturing
 - .2 Or approved equivalent

PART 3 EXECUTION

3.1 INSTALLATION – GENERAL

- .1 Install and/or connect equipment as indicated.
- .2 Perform tests in accordance with Section 16010 – Electrical General Requirements and manufacturer's recommendations.

3.2 DISCONNECT SWITCHES

- .1 Install disconnect switches complete with fuses as indicated.
- .2 Provide all necessary mounting hardware.
- .3 Provide disconnect switches – surface mounted on brick, concrete or block walls with 3 mm thick insulated washers between enclosure and wall face.
- .4 Mounting height: 1500 mm above finish floor level to top of switch enclosure.
- .5 Nameplate: Refer to Specification 13040.

3.3 DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

- .1 Mount dry type transformers up to 75 kVA as indicated.
- .2 Mount dry type transformers above 75 kVA on floor pad.
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Nameplate: Refer to Section 13040.

3.4 POWER AND LIGHTING PANEL BOARDS

- .1 Refer to Lighting panel schedule drawing E3303.

END OF SECTION

SECTION 16062
GROUNDING AND BONDING - SECONDARY

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SECTION 16062
GROUNDING AND BONDING - SECONDARY

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section 16062 describes the requirements for the design, fabrication, inspection, testing, delivery, and installation of secondary grounding and bonding systems.

1.2 RELATED DOCUMENTS

- .1 Contract Drawings
- .2 Single Line Diagrams (SLD) and Control Schematic Drawings of the project
- .3 Section 16050: Basic electrical materials and methods.
- .4 Electrical Safety Authority (ESA) and Toronto Hydro requirements.
- .5 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents.

1.3 REFERENCES

- .1 Refer to the latest edition of the following standards
- .2 CSA C22.2 Grounding and Bonding Equipment
- .3 CSA C22.2 Bonding of Electrical Equipment
- .4 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE).
 - .1 ANSI/IEEE, Qualifying Permanent Connections Used in Substation Grounding.
 - .2 IEEE No. 80, IEEE Guide for Safety in AC Substation Grounding.
- .5 Ontario Electrical Safety Code (OESC) latest edition, including Electrical Safety Authority (ESA) amendments and published bulletins.

1.4 SUBMITTALS

- .1 Submit in accordance with Division 1- Submittal Requirements.
- .2 The equipment supplier/manufacturer shall provide a "specification compliance report" for the equipment. The report shall provide details which demonstrate that all the clauses of the specification, and contract drawings requirements are met. In case there is any deviation(s) then it shall be mentioned in the "specification compliance report", and it shall be reviewed and approved by the Engineer.

- .3 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit product data in accordance with all Division 16 requirements.
 - .4 Closeout Submittals
 - .1 Submit in accordance with Division 1 - Closeout Submittals
 - .2 Operation and Maintenance Data: submit operation and maintenance data for motor control center for incorporation into manual in accordance with Division 1
- 1.5 CSA COMPLIANCE
- .1 Product manufactured shall conform to CSA Standards and have applied CSA or equivalent approved listing mark recognized by the Electrical Safety Authority (ESA).
- 1.6 DELIVERY, STORAGE AND HANDLING
- .1 Deliver, store and handle materials in accordance with Division 1 requirements and as per manufacturer's written instructions.

PART 2 PRODUCTS

2.1 EQUIPMENT

- .1 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, soft annealed, size as required or as indicated on the contract drawings.
- .2 Rod electrodes: copper clad steel, 19 mm diameter by minimum 3 m long.
- .3 Grounding conductors: bare stranded copper, soft annealed, size as required or as indicated on the contract drawings.
- .4 Insulated grounding conductors: green, copper conductors, size as required or as indicated on the contract drawings.
- .5 Ground bus: copper, size as required or as indicated on the contract drawings, complete with insulated supports, fastenings, connectors.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant / Contract Administrator.
 - .2 Inform Consultant / Contract Administrator and the Owner, in writing, of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant / Contract Administrator.

3.2 INSTALLATION - GENERAL

- .1 Install complete permanent, continuous grounding and bonding system including electrodes, conductors, connectors and all accessories as indicated on the contract drawing, in accordance with the requirements of OESC and relevant ESA bulletins, and to requirements of Toronto Hydro.
- .2 Where metallic conduit is used, run ground wire in conduit.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Protect exposed grounding conductors from mechanical injury.
- .5 Make buried connections, and connections to electrodes, using copper welding by thermite process, permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Soldered joints are not permitted.
- .8 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .9 Install separate ground conductors to outdoor lighting standards.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.

- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Bond single conductor, metallic armored cables to cabinet at supply end, and load end.

3.3 MAINTENANCE HOLES

- .1 Install conveniently located grounding stud, electrode, size as needed/indicated on the contract drawing, stranded copper conductor in each maintenance hole
- .2 Install ground rod in each maintenance hole so that top projects through bottom of maintenance hole. Provide with lug to which grounding connection can be made. Confirm ground resistance satisfies OESC and ESA bulletin requirements.

3.4 ELECTRODES

- .1 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .2 Install rod or plate electrodes and make grounding connections as indicated on the contract drawings.
- .3 Bond separate, multiple electrodes together.
- .4 Use size 4/0 AWG copper conductors for connections to electrodes.
- .5 Make special provisions for installing electrodes that will give acceptable resistance to ground value.

3.5 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral of primary 4160V or 600V system, secondary 600V or 208 V system.

3.6 EQUIPMENT GROUNDING AND BONDING

- .1 Install grounding connections to typical equipment included in but not necessarily limited to following list. Service equipment, transformers, control panels, building steel work, distribution panels, outdoor lighting, cable trays.

3.7 GROUNDING BUS

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room and communication equipment room.

- .2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0AWG.

3.8 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 16080 – Electrical Testing.
- .2 Perform ground continuity and resistance tests using methods appropriate to site conditions and to the approval of the Consultant and ESA.
- .3 Perform tests before energizing electrical system.
- .4 Submit test results and inspection certificate to the Consultant / Contract Administrator.
- .5 Disconnect ground fault indicator during tests.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Division 1 Cleaning requirements.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Division 1 – Cleaning requirements.
- .3 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

SECTION 16105
UNDERGROUND DUCT SYSTEMS AND ACCESS HOLES

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SECTION 16105
UNDERGROUND DUCT SYSTEMS AND ACCESS HOLES

PART 1 GENERAL

1.1 GENERAL CONDITIONS

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 RELATED SECTIONS

- .1 Section 02315 - Trenching and Backfilling
- .2 Section 03200 – Reinforcing Steel
- .3 Section 03300 – Cast-in-Place Concrete
- .4 Section 16010 – Electrical General Requirements
- .5 Section 16062 – Grounding and Bonding - Secondary

1.3 SCOPE

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to supply and install the underground duct systems described herein.
- .2 Provide Hydro coordination for primary ductbank routing before installation of the ductbank.

PART 2 PRODUCTS

2.1 RIGID PVC DUCTS

- .1 Rigid PVC ducts, type DB2, encased in reinforced concrete or direct buried.
- .2 Schedule 40 pipe dimensions.
- .3 PVC ducts: to CSA C22.2 No. 211.1-M1984.

2.2 RIGID PVC DUCT FITTINGS

- .1 Rigid PVC, opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors, split ducts as required to make complete installation.
- .2 Expansion joints.
- .3 Rigid PVC 5 degrees angle couplings, 90 degrees and 45 degrees bends.
- .4 Solvent weld compound for all PVC duct joints.

2.3 PRECAST UNDERGROUND CONCRETE ACCESS HOLES AND JUNCTION BOXES

- .1 Precast concrete access holes, junction boxes and auxiliary sections fabricated in steel forms, as indicated on the drawings.
- .2 Aggregates: to CAN3-A23.1-M90.
- .3 Cement: to CAN3-A5-M88, Type 10.
- .4 Access holes: to CSA A257-M1992.
- .5 Steel welded wire fabric mesh reinforcing: to CSA G30.5-M1983. Openings and critical areas trimmed with steel reinforcing bars: to CSA G30.12-M1977.
- .6 Pulling inserts and bolts for racks integrally cast in concrete: to ANSI/ACI-347-78.
- .7 Neoprene gasket seals between access hole sections: to ASTM D1056-85.
- .8 Individual conduit entry sleeves to be of rigid PVC conduit.

2.4 DRAINAGE

- .1 Unless otherwise indicated, floor drain fittings in each access hole consisting of floor drain, back water valve, trap and pipe connection to drainage system.
- .2 Sump pit: 300 x 300 x 125 mm.

2.5 ACCESS HOLE (CHIMNEYS) NECKS

- .1 Concrete access hole (chimney) neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas, as indicated on the drawings.
- .2 Build up (chimney) neck with concrete to achieve above if necessary.

2.6 ACCESS HOLE FRAMES AND COVERS

- .1 Cast iron access hole frames and covers, as indicated on the drawings.

2.7 GROUNDING

- .1 Ground rods: to Section 16062 – Grounding and Bonding - Secondary
- .2 Grounding details: as indicated on the drawings.

2.8 CABLE RACKS

- .1 Hot dipped galvanized cable racks and supports.
- .2 12 x 100 mm preset inserts for rack mounting.

2.9 ACCESS HOLE, CABLE PULLING AND LADDER RUNG EQUIPMENT

- .1 Pulling iron and ladder rungs made of galvanized steel rods, size and shape as indicated.
- .2 6 mm stranded nylon pull rope tensile strength 5 kN continuous throughout each duct run with 3 m spare rope at each end.

2.10 DUCT SPACERS

- .1 Rigid interlocking plastic material, for the conduit diameters and spacing required on drawings.

2.11 CABLE PULLING EQUIPMENT

- .1 6 mm stranded nylon pull rope with tensile strength of 5 kN.

2.12 CABLE PROTECTION FOR 600VOLTS

- .1 Use 38 x 140 mm planks pressured treated.

2.13 MARKERS

- .1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.
- .2 Provide caution tape surrounding cable and duct runs during construction.

PART 3 EXECUTION

3.1 CONCRETE ENCASED DUCT BANKS

- .1 Supply and install the concrete encased underground duct banks indicated on the drawings. Supervise all excavation, formwork, reinforcement, concreting, and backfilling.
- .2 Build duct bank(s) and access holes on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density.
- .3 Open trench completely between access holes to be connected before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .4 Prior to laying ducts, construct “mud slab” not less than 75 mm thick.
- .5 Install ducts at elevations as indicated, with a minimum slope of 1 to 400.
- .6 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.
- .7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts horizontally and vertically as shown on drawings. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with concrete cover to elevation (or thickness) shown on drawings.
- .8 Make transpositions, offsets and changes in direction using 5 degrees bend sections, do not exceed a total of 20 degrees with duct offset.
- .9 Use bell ends at duct terminations in access holes or buildings.
- .10 Use conduit to duct adapters when connecting to conduits.
- .11 Terminate duct runs with duct coupling set flush with the end of concrete envelope when dead ending duct bank for future extension.
- .12 Cut, ream and taper end of ducts in field in accordance with manufacturer’s recommendations, so that duct ends are fully equal to factory-made ends.
- .13 Allow concrete to attain 50% of its specified strength before backfilling (minimum 24 hours after placing of concrete) unless otherwise authorized by Engineer. Ensure that backfill is placed in maximum 13 mm layers and compacted to the satisfaction of the Engineer.
- .14 Use anchors, ties and trench jacks as required securing ducts and preventing moving during placing of concrete. Tie ducts to spacers with twine or other

non-metallic material. Remove weights or wood braces before concrete has set and fill voids.

- .15 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.
- .16 Immediately after placing of concrete, pull through each duct a wooden mandrel not less than 300 mm long and of a diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .17 Install four 3 m lengths of 15M reinforcing rods, one in each corner of duct bank when connecting duct to access holes or buildings. Wire rods to 15M dowels at access hole or building and support from duct spacers. Protect existing cables and equipment when breaking into existing access holes. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.
- .18 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.
- .19 For long duct runs (greater than 50 m), install expansion couplings at 30 m intervals.
- .20 Provide removable watertight cap to seal each spare duct end. Install caps on all duct ends left open during construction.
- .21 Ensure that a responsible and competent supervisor is present during concreting operations, to protect against broken, damaged or disturbed ducts. Advise the Engineer in advance of concreting, so that he may inspect the ducts prior to pouring, and be present during the pour.
- .22 Provide waterproof seal at end of the ductbank (including existing ductbank) for protective water into electrical equipment/devices and building.

3.2 ACCESS HOLES

- .1 Install precast access holes, as indicated or as required during construction.
- .2 Build cast-in-place access hole (chimney) neck as indicated.
- .3 Place inserts for cable rack, pulling irons, drain, duct outlets, duct run dowels before casting walls. Make access hole to duct connection as indicated.

- .4 Provide deep window to facilitate cable bends in wall at each duct connection. Terminate ducts in bell-end fitting flush with window face. Provide four 15M steel dowels at each duct run connection to anchor duct run.
- .5 Install access hole frames and covers for each access hole. Set frames in concrete grout onto the access hole neck.
- .6 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.
- .7 Install cable racks, anchor bolts and pulling irons as indicated and required.
- .8 Grout frames of access holes. Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.
- .9 Ensure filling of voids in joint being sealed. Plaster with cement grout, walls, ceiling and neck.
- .10 Spray paint an "X" on ceiling of access hole above floor drain or sump pit.

3.3 RIGID DUCTS DIRECT BURIED

- .1 Rigid ducts for direct burial shall be of the type approved for direct burial.
- .2 Ensure that the trench bottom is of undisturbed soil or soil compacted to a density of 95% of the maximum dry density, free of stones and uniformly graded to give continuous support to the rigid ducts throughout their entire length.
- .3 Slope ducts with 1 to 400 minimum slope.
- .4 Ensure all couplings used to join PVC conduits are given a tight fit. Make connections with an approved PVC solvent supplied by the conduit manufacturer.
- .5 Provide protection covers or planks, where required or indicated.
- .6 Install pull cord in each duct with 3 m spare cord at each end and cap until ready for use.
- .7 Pull through each duct wooden mandrel not less than 300 mm long and of diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .8 Install markers as required.

3.4 DIRECT BURIAL OF CABLES

- .1 After sand bed is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .3 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.
- .4 Make splices and terminations in accordance with manufacturer's instructions using approved splicing kits.
- .5 Underground cable splices not acceptable.
- .6 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.
- .7 Cable separation:
 - .1 Maintain 75 mm minimum separation between cables of different circuits.
 - .2 Maintain 300 mm horizontal separation between low and high voltage cables.
 - .3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
 - .4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 155 mm between high voltage cables.
 - .5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
 - .6 Install treated planks on lower cables 0.6 m in each direction at crossings.
- .8 After sand protective cover is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks interlocking cable blocks as indicated to cover length of run.

3.5 UNDERGROUND JUNCTION BOXES

- .1 Install size and type of boxes indicated on the drawings.

- .2 Co-ordinate installation of sleeves, inserts and cover frame with formwork.
- .3 Make provisions for drainage as indicated, modified where required to suit site conditions.

3.6 MARKERS

- .1 Mark location of duct runs under hard surfaced areas not terminating in access hole with railway spike driven flush in edge of pavement, directly over run. Place concrete duct marker at ends of such duct runs. Construct markers and install flush with grade.
- .2 Mark ducts every 150 m along straight runs and changes in direction.
- .3 Where markers are removed to permit installation of additional duct, reinstall existing markers.
- .4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.
- .5 Provide drawings showing locations of markers.

3.7 INSPECTIONS

- .1 Advise Engineer so that he may inspect ducts prior to placing and be present during placement of concrete and clean-out.

3.8 CABLE INSTALLATION IN DUCTS

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

END OF SECTION

SECTION 16110
CONDUIT AND CABLETRAY SYSTEMS

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SECTION 16110
CONDUIT AND CABLETRAY SYSTEMS

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section describes the requirements for supply and installation of conduit and cabletray systems.

1.2 SCOPE

- .1 Contractor to make use of existing tray system unless the existing tray cannot support the additional cable run or the cable becomes de-rated below acceptable levels as per electrical code requirements.
- .2 Supply and install all conduits, cabletrays, fittings, supports, hangers and miscellaneous support materials and hardware required for the complete systems in accordance with the applicable codes and regulations and as specified herein and on the drawings.

1.3 LOCATION OF CONDUIT

- .1 Drawings do not indicate all conduit, cabletray and supporting runs. Those indicated are in diagrammatic form only.

1.4 SUBMITTALS

- .1 Contractor to provide a proposed layout drawing of cable tray and conduit network for approval by City and Consultant.
- .2 Layout drawings to include dimensions, sections, and interferences.
- .3 Submit shop drawings sealed and signed by a professional engineer licensed in the Province of Ontario and retained by the Contractor certifying that cable trays supports and anchorage are designed to the requirements of post-disaster facility as per the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for post-disaster structures.
- .4 After installation a professional engineer licensed in the Province of Ontario and retained by the Contractor shall complete a Site review and then submit a letter, sealed and signed, stating that the cable trays supports and anchorage are designed and installed to the requirements of post-disaster facility as per the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for post-disaster structures.

PART 2 PRODUCTS

2.1 CONDUITS

- .1 Unless otherwise noted, all conduits shall be rigid steel metal threaded conduit, hot dip galvanized inside and outside. Complies with CSA C22.2 No. 45-M1981.
- .2 Epoxy coated conduit: with zinc coating and corrosion resistant epoxy finish inside and outside. Use ETL-001 certified Plastibond Redhot by Eaton Crouse-Hinds conduits in wet well for all electrical and control wiring.
- .3 Rigid PVC conduit, manufactured to schedule 40 wall thickness. Solvent weld compound for all PVC joints. Complies with CSA C22.2 No. 211.2. For use underground and embedded in concrete.
- .4 Liquid-tight flexible metal conduit, spirally wound interlocked armour construction with overall PVC jacket. Complies with CSA C22.2 No.56.
- .5 Flexible PVC conduit, as indicated. Complies with CSA C22.2 No. 227.2.
- .6 Minimum conduit size: 19 mm.

2.2 CONDUIT FASTENINGS AND SUPPORTS

- .1 One-hole and two-hole hot dip galvanized steel straps for metal conduit.
- .2 Two holes PVC straps for PVC conduit.
- .3 Hot dip galvanized steel beam clamps.
- .4 Hot dip galvanized steel channel type supports, U-shape, size 41 x 41 mm, 2.5 mm thick.
- .5 6 mm diameter threaded galvanized steel rods to support suspended channels. Provide all necessary galvanized steel spring loaded bolts, nuts, washers and lockwashers.

2.3 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit. Fittings to incorporate nylon insulated throat or bushing.
- .2 Factory “ells” where 90 degrees bends are required for 25 mm and larger conduits.
- .3 Pressure type terminals for all rigid steel conduit grounding wire connections.

- .4 Rigid steel conduit hub type connectors in wet or outdoor areas: nylon insulated with recessed neoprene 'O' ring.
 - .5 Liquid tight flexible conduit fittings to incorporate a threaded grounding core, nylon compression ring and gland. Insulated throat, male thread and locknut or bushing with an integral 'O' ring seal.
 - .6 Locknuts bonding type with sharp edges for digging into metal wall of enclosure.
- 2.4 EXPANSION FITTINGS FOR RIGID CONDUIT
- .1 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
 - .2 Weatherproof expansion fittings for linear expansion at entry to panel.
- 2.5 FISH CORD
- .1 6 mm stranded nylon cord, tensile strength 5 kN.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Use rigid galvanized steel threaded conduit except noted on drawings otherwise.
- .3 Use epoxy coated conduit in damp and corrosive areas, as noted on drawings.
- .4 Use rigid PVC conduit underground only, in corrosive areas or as noted on drawings.
- .5 Use liquid tight flexible metal conduit for connection to all motors or vibrating equipment.
- .6 Use hazardous area (Class 1 – Zone 1 and Zone 2) flexible coupling for connection to explosion proof motors.
- .7 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .8 Install breathers on conduit system and control panels in Hazardous areas.
- .9 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over 19 mm diameter.

- .11 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .12 Install fish cord in empty conduits.
- .13 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.
- .15 Support equipment using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .16 Install expansion sleeves wherever conduits cross a structural expansion joint.
- .17 Install waterproof conduit system in designated wet areas.
- .18 Conduits shall not penetrate the roof of the MCC enclosure.
- .19 Extend spare conduits 100 mm into building and/or switchgear enclosure and seal with threaded cap for future use.

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on surface mounted channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .7 Do not use 'C' type clamps or perforated metal straps.
- .8 The maximum length of straight conduit run shall be 60 m between pull boxes or other terminations. Reduce this length by 15 m for each 90 degrees bend or 7 m for each 45 degrees bend or offset. Conduit runs to include not more than the equivalent of two 90 degrees bends between pull boxes except where indicated otherwise on the drawings.
- .9 Make no holes in building structural members for supporting conduits without the permission of the Contract Administrator.

- .10 Touch up and repair coated conduits and fittings on which the epoxy or PVC finish has been damaged; paint with a compound material supplied by the original conduit manufacturer.
- .11 Fasten exposed conduit to building construction or support system using straps.
 - .1 One-hole galvanized steel straps to secure surface conduits 50 mm and smaller.
 - .2 Two-hole galvanized steel straps for conduits larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .12 Suspended support systems
 - .1 Support individual conduit runs with 6 mm dia. threaded rods and spring clips.
 - .2 Support two or more conduits on channels supported by 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.
- .13 For surface mounting of two or more conduits use channels at 1 m o.c. spacing.
- .14 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit runs.

3.3 NEW OPENINGS IN EXISTING CONCRETE

- .1 Make new holes in existing concrete for piping, conduit, cables, or equipment, using either method described below:
 - .1 Chip with a hammer and chisel. Adjust the location of holes as necessary to avoid electrical conduits if encountered. Cut reinforcing steel after permission is received.
 - .2 Core-drill holes after radiograph procedures are followed.
- .2 Radiograph the existing concrete in the area of each proposed hole for 3 diameters around the centreline of the proposed penetration. If no structural steel, piping or electrical conduits are found, core the hole. If structural steel, piping or electrical conduits are found, select an alternative location and radiograph it, until a suitable coring location is identified. Include up to three (3) sets of Radiographs in base price.
- .3 Prior to commencing work, submit to the Contract Administrator a photocopy of the license issued under the Atomic Energy Control Board Regulations for radiography. Perform work in accordance with current Atomic Energy Control

Board Regulations for radiography. Be responsible for boundary controls, signs, etc. that protect the facility personnel and others from hazards in the radiograph work area. Inform the Contract Administrator in writing 48 hours prior to commencing any radiography.

END OF SECTION

**SECTION 16120
WIRES AND CABLES**

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SECTION 16120 WIRES AND CABLES

PART 1 GENERAL

1.1 INTENT

- .1 This section 16122 describes the main types of wires and cables to be installed in this project, as well as the governing conditions, requirements, references, product data, delivery, storage, handling, and power supply characteristics.

1.2 RELATED REQUIREMENTS

- .1 Contract Drawings including Single Line Diagrams (SLD) and Control Schematic Drawings. Refer to the Contract Drawings for location and size of wires and cables.
- .2 Where cables are not shown, provide the cables according to Ontario Electrical Safety Code (O.E.S.C.) and Electrical Safety Authority (ESA) requirements.
- .3 Division 1 – Operation and Maintenance Materials
- .4 Division 1 – Close-out documents (Record documents)
- .5 Section 16010 – Electrical General Requirements
- .6 Section 16050 – Basic Electrical materials and methods
- .7 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents.
- .8 Colour code single conductors forming part of a multiple conductor cable for phase identification

Line	Lighting & Power
Line 1	Red
Line 2	Black
Line 3	Blue
Neutral	White
Ground Wire	Green

- .9 Phase relationships and terminal arrangements

Left	Middle	Right
Line 1 Phase: Red	Line 2 Phase: Black	Line 3 Phase: Blue

- .10 Provide colour coding of insulated conductors conforming to the following:
- 1-conductor power - Black (phase conductors),

- 2-conductor control
 - White (neutral)
 - Red
 - 3-conductor cable
 - Black, white
 - 4-conductor cable
 - Red, Black, White (neutral)
 - 5-conductor cable
 - Red, Black, Blue, White
- .11 Multi-conductor cables
 - Manufacturer's standard
- .12 Refer to all other Divisions of the Specifications and drawings to determine their effect upon the work of this section.
- .13 Unless otherwise indicated, every cable run from a source to a load shall include an appropriately sized separate grounding and bonding wires. The following designations are used within the specifications and drawings:
 - .1 All cables designated as "3c" infers 3 conductor cable plus ground conductor, this may be equivalent to "4#".
 - .2 All cables in a 3 phase, 3 wire system designated as "4#", infers 3 branch conductors and one ground conductor of equal size as branch conductors.
 - .3 All cables designated as "4c" infers 3 conductor cables plus 1 neutral and 1 ground conductor, this may be equivalent to "5#".
 - .4 All cables in a 3 phase, 4 wire system designated as "5#", infers 3 branch conductors, one neutral conductor and one ground conductor, all conductors sized as the branch conductors.
- .14 Unless otherwise indicated, combine motor or electric heater branch power wiring (below 1000 V systems) and associated local operator control or field control device wiring into a common conduit between motor or heater and its starter or motor control centre, provided all of the following conditions are met:
 - .1 Motor circuit voltage does not exceed 600 V.
 - .2 Conductors and termination fittings for power and control circuits are rated 600 V minimum.
 - .3 Control circuits are designed to operate at 120 V AC or higher.
 - .4 Power conductors do not exceed #2 AWG in size.
 - .5 Control circuit wiring solely associated with respective motor or heater. Install wiring for control circuits of other equipment and systems, or wiring common to two or more pieces of equipment in separate conduits.
 - .6 Install wiring for control circuits operating below 120 V AC or with DC in a separate conduit system.
- .15 Supply spare conductors in control, communication and instrumentation cable circuits as follows:
 - .1 Up to four utilized conductors in one conduit or cable: one spare conductor.
 - .2 Five to eight utilized conductors in one conduit or cable: two spare conductors.

- .3 Nine or more utilized conductors: 20% or three spare conductors, whichever is greater.
- .16 No loose wiring or wire ends are accepted. Use manufacturer recommended connectors when installing cables. Use TECK cable connectors for TECK cable terminations. Grounding and attachment to Unistrut not acceptable.
- .17 "HL" rated cable and "HL" approved connectors shall be provided in all hazardous locations.
- .18 Do not use metal clamp for single conductor cable.

1.3

REFERENCES

REFER TO THE LATEST EDITION OF THE FOLLOWING STANDARDS:

- .1 CSA C22.2 No. 131- Type TECK 90 Cables.
- .2 CSA C22.2 No. 38 Thermoset Insulated Wires and Cables.
- .3 CSA C22.2 No. 174 Cables and Cable Glands for use in Hazardous Locations.
- .4 CSA C68.3 Shielded and Concentric Neutral Power Cables rated 5-46kV
- .5 CSA C21.1 600 V Control Cable.
- .6 CSA C21.2 300 V Control Cable.
- .7 CSA C68.10 Shielded power cable for commercial and industrial applications, 5-46 kV.
- .8 CSA C22.2 126.1 Metal cable tray systems.
- .9 C22.2 NO. 249-96 - Standard Tests for Determining Compatibility of Cable-Pulling Lubricants With Wire and Cable
- .10 CAN/CSA-C22.2 No. 62275 Cable management systems - Cable ties for electrical installations
- .11 Ontario Electrical Safety Code (OESC) and latest bulletins of Electrical Safety Authority (ESA)

1.4

SUBMITTALS

- .1 Submit in accordance with Division 1 – Submittal Requirements.
- .2 The equipment supplier/manufacturer, contractor shall provide a "specification compliance report" for the specifications provided in the tender document. The report shall provide details which demonstrate that each clause and sub clause of the specification, and contract drawing requirements are met. In case there is any deviation(s) then it shall be mentioned in the "specification compliance report", and it shall be reviewed and approved by the Contract Administrator/Consultant.
- .3 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for wires/cables and include detailed product characteristics, performance criteria, physical size, finish, and limitations.
- .2 Submit product data in accordance with all Division 16 requirements.
- .4 Cable Pulling Plan: The contractor to provide cable pulling plan for the cables in duct bank, conduit and cable tray. Prior to installing the cable the contractor/cable-contractor/manufacturer shall submit the calculation of the cable pulling tension for each cable to the Contract Administrator.
- .5 Shop Drawings:
 - .1 Submit shop drawings in accordance with Division 1 – Submittal Requirements and Section 16010 – Electrical General Requirements. Indicate on drawings all relevant engineering details including but not limited to Solid Waste Management Tag number, model/part number, installation location, dimensions, capacities, weights, and electrical performance characteristics.
 - .2 Submit drawings stamped and signed by professional engineer licensed in the Province of Ontario, Canada.
 - .3 Submit [three (3)] clearly legible hard copies of shop drawings and product data to the Contract Administrator/Consultant. Provide electronic copy (Native and searchable PDF files) of all shop drawings with each submission.
 - .4 Indicate on drawings:
 - .1 Bill of Materials
 - .2 Cable type and size
- .6 Certificates:

Submit manufacturer's test certificates.
- .7 Closeout Submittals
 - .1 Submit in accordance with Division 1 – Closeout Submittals.
 - .2 Operation and Maintenance Data: submit test results, operation and maintenance data for wires/cables for incorporation into operation and maintenance manual.

1.5 CSA COMPLIANCE

Product manufactured shall conform to Canadian Standards Association (CSA) Standards and have applied CSA or equivalent approved listing mark recognized by the Electrical Safety Authority (ESA).

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Division 1 requirement and as per manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage:
 - .1 Cap or seal cable ends to prevent water penetration into cable. Reseal after cutting length of cable.
 - .2 Cables stored with ends unsealed will be immediately removed from site at contractors cost. At no extra cost to the City, replace cables to the satisfaction of the Contract Administrator.
 - .3 Replace defective or damaged materials with new.

1.7 EXTRA MATERIALS

Supply maintenance materials in accordance with Division 1 – Spare Parts and Maintenance Materials.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- .1 High and Medium Voltage:
 - .1 MP Husky
 - .2 Nexin
 - .3 Prysmian
 - .4 Southwire
 - .5 United Wire & Cable
 - .6 Or approved equivalent
- .2 Low Voltage:
 - .1 Nexans
 - .2 Prysmian
 - .3 Shawflex (Shawcor)
 - .4 Southwire
 - .5 United Wire & Cable
 - .6 Or approved equivalent

2.2 POWER SUPPLY CHARACTERISTICS

- .1 High Voltage:
 - .1 27.6 kV, 3 phase

- .2 13.8 kV, 3 phase
- .3 4.16 kV, Resistive Grounded Wye
- .4 2.4 kV, Resistive Grounded Wye
- .2 Low Voltage:
 - .1 600V, 60 Hz, Grounded Wye, 3 phase
 - .2 208V, 60 Hz, Grounded Wye, 3 phase, 4 wires

2.3 HIGH VOLTAGE INSULATED CABLES (ABOVE 5 KV UP TO 35 KV)

- .1 Rating: Cables to be rated 35 kV where application is 27.6 kV and 15 kV where application is 13.8 kV. Refer to paragraph 2.2 "Power Supply Characteristics".
- .2 Insulation of the power cable shall be designed to safely withstand the ground fault of minimum 8 kA for duration of 3 seconds. Cable to be rated for operations having a maximum symmetrical phase-to-phase fault level of 800 MVA or 25 kA for duration of 1 second at 27.6 kV and 25 kA for 2 seconds at 13.8 kV.
- .3 Conductors: Stranded, annealed copper, class B stranding, size as indicated on the contract drawing.
- .4 Insulation: extruded cross-linked polyethylene (XLPE). Suitable for installation in wet areas and suitable for handling at minus 40°C ambient, 90°C maximum conductor temperature.
- .5 Insulation level: 133% for 15 kV and 100% for 35 kV.
- .6 Insulation shield: Semi-conducting thermosetting XLPE material applied over the insulation with two tinned copper tapes.
- .7 Metallic shield: Lapped copper tape or served copper wire.
- .8 Grounding conductor: Uninsulated, Class B stranded, soft bare copper conductor in multiconductor cable, concentric copper wires over insulation shield in single conductor cable.
- .9 Concentric Neutral: Where cable is indicated as C.N. or CN for Concentric Neutral, provide minimum 33% concentric neutral per conductor unless stipulated otherwise.
- .10 Armour: where indicated, TECK construction, interlocking aluminium armour over jacketed cable assembly, when the cable will be installed inside concrete encased duct-bank.
- .11 Inner and outer jacket: PVC, moisture and oil resistant, flame retardant composition, FT1, extruded, suitable for minus 40°C applications and of low acid gas evolution. Outer jacket colour: red.
- .12 Multi-conductor cables: Suitable fillers and binders.

2.4 HIGH VOLTAGE INSULATED CABLES/BUS (5 KV)

- .1 High Voltage Insulated Cables (for 41.6 kV & 2.4 kV)

- .1 Rating: Cables to be rated 5 kV where application is 4.16 kV and 2.4 kV, for operation having a maximum symmetrical fault level of 250 and 350 MVA phase-to-phase. Refer to paragraph 2.2 “Power Supply Characteristics”.
 - .2 Conductors: Stranded, annealed copper, class B stranding, size as indicated on the contract drawings.
 - .3 Insulation: extruded cross-linked polyethylene (XLPE) compound. Suitable for installation in wet areas and suitable for handling at minus 40°C ambient, 90°C maximum conductor temperature.
 - .4 Insulation level: 100% over each conductor.
 - .5 Insulation shield: Semi-conducting thermosetting XLPE material applied over the insulation.
 - .6 Metallic shield: Lapped copper tape or served copper wire.
 - .7 Grounding conductor: Uninsulated, Class B stranded, soft bare copper conductor in multi-conductor cable, concentric copper wires over insulation shield in single conductor cable.
 - .8 Armour: where indicated, TECK construction, interlocking aluminium armour over jacketed cable assembly.
 - .9 Non-Armoured cable: where indicated, Type RW 90 (or equivalent CSA approved designation).
 - .10 Inner and outer jacket: PVC, moisture and oil resistant, flame retardant composition, FT4, extruded, suitable for minus 40°C applications and of low acid gas evolution. Outer jacket colour: orange.
 - .11 Multi-conductor cables: Suitable fillers and binders.
- .2 Medium Voltage Cable Bus (for 4.16 kV Systems)
- .1 Rating: Cable Bus to be rated 5 kV where application is 4.16 kV, for operation having a maximum symmetrical fault level of 350 MVA phase-to-phase. Refer to paragraph 2.2 “Power Supply Characteristics”.
 - .2 Conductors: Stranded, annealed copper, class B stranding, size as indicated on the contract drawings.
 - .3 Insulation extruded cross-linked polyethylene (XLPE) compound. Suitable for installation in wet areas and suitable for handling at minus 40°C ambient, 90°C maximum conductor temperature.
 - .4 Insulation level: 100% over each conductor.
 - .5 Insulation shield: Semi-conducting thermosetting EPR material applied over the insulation.
 - .6 Metallic shield: Lapped copper tape annealed and uncoated.
 - .7 Cables to be FT4 rated and shall include a protective jacket.
 - .8 Grounding conductors: Uninsulated, Class B stranded, soft bare copper conductor.

- .9 Enclosure material: 6063-T6 corrosion resistant aluminum alloy meeting the requirements of CSA C22.2 126 (Latest Edition).
- .10 Enclosure ventilation: the enclosure to be completely enclosed on both sides, and both top and bottom of the enclosure shall be ventilated with vents that do not allow mechanical penetration at 90 degrees from each surface.
- .11 The enclosure system shall be certified as a continuous bonding conductor.
- .12 System bonding conductors shall be installed on the inside wall of the enclosure.
- .13 Weather proof plates and wall penetration fire seals are to be included with the cable bus system.

2.5 LOW VOLTAGE CABLES (1000 V AND BELOW)

.1 Armoured Wire and Cable (1000V and Below)

- .1 Construction: Stranded, annealed copper conductors, 1000 V rating, RW90 cross-linked polyethylene (XLPE) insulation, suitable for handling at minus 40°C ambient, 90°C maximum conductor temperature, flame test rated FT4.
- .2 Power cabling: TECK construction.
- .3 Control cabling: TECK construction.
- .4 Lighting and receptacle branch wiring: BX Armoured.
- .5 Minimum conductor size: Unless otherwise indicated, #12 AWG for power and current transformer circuits and #14 AWG for control and fire alarm circuits.
- .6 Grounding conductor: Stranded, soft, bare copper conductor in multiconductor cables, concentric copper wires over insulation in single conductor cable.
- .7 Multi-conductor cables: With inner jacket of suitable PVC (minus 40°C).
- .8 Interlocking armour: Flexible, galvanized steel for multi-conductor cables and aluminum for single conductors, spirally wound over inner jacket.
- .9 Outer jacket: PVC (minus 40°C), flame-retardant, FT4 flame test rated, low acid gas evolution, black outer jacket extruded over the armour.

.2 Unarmoured Wire and Cable (1000 V and Below)

- .1 Acceptable manufacturers:
 - .1 Nexans
 - .2 Prysmian
 - .3 United Wire & Cable
 - .4 Or approved equivalent
- .2 Construction: Stranded, annealed copper conductors, 600 V minimum rating for conductors #10 AWG and smaller and 1000 V rating for

- conductors larger than #10 AWG, RW90 cross-linked polyethylene (XLPE) insulation, suitable for handling at minus 40°C ambient, 90°C maximum conductor temperature, limited flame spread FT4, jacketed.
- .3 Installation in direct buried PVC conduit: Cross-linked polyethylene (XLPE), RWU90 insulation, 1000 V minimum rating, jacketed.
- .4 Minimum conductor sizes: Unless otherwise indicated, #12 AWG for power and current transformer circuits; #14 AWG for control circuits.
- .5 Multi-conductor cables: PVC flame retardant black jacket overall, suitable for handling at minus 40°C, flame test rated FT4.
- .6 Lighting wiring: GTF wire, 600 volt, 125°C, flexible copper conductor for connections between luminaries and outlet boxes.
- .7 Insulated ground conductors forming part of a multi-conductor cable assembly: Inspection Authority colour coding.

2.6 CONTROL CABLES

- .1 Type: LVT: soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic
 - .2 Sheath: thermoplastic jacket
- .2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated:
 - .1 Insulation: Thermoplastic
 - .2 Shielding: wire/braid/metallized tapes over conductors, as indicated on the drawings.
 - .3 Overall covering: PVC jackets
- .3 Type: 600V, stranded annealed copper conductors, sizes as indicated:
 - .1 Insulation: RW90 (x-link).
 - .2 Shielding: wire/braid/metallized tapes over conductors, as indicated on the drawings.
 - Overall covering: PVC jackets.
- .4 Colour code wiring for controls and intrinsically safe wiring: Refer to Toronto Water Instrumentation Specification Standards, Section 13320 (Panel Wiring).

2.7 INSTRUMENTATION WIRING

- .1 For instrumentation wiring refer to Toronto Water Instrumentation Specification Standards, Section 13305 (Field Wiring).

2.8 WIRING ACCESSORIES

- .1 Terminal blocks: 600 V, 25 A minimum rating, modular, 35 mm DIN rail mounted, provision for circuit number labelling, individually removable, sized to accommodate conductor size and circuit current. Sak Series by Weidmuller Ltd.,

- UK Series by Phoenix Terminal Blocks Ltd., WK Series by Wieland Electric Inc., Entrelec.
- .2 Field wiring terminations: Where screw-type terminal blocks are provided, supply insulated fork tongue terminals. Sta-Kon by Thomas & Betts Ltd., Scotchlok by 3M Canada Inc.
 - .3 Splice connectors for equipment pig-tail, lighting and receptacle circuits: For wire sizes #12 and #10 AWG inclusive, twist-on compression spring type. Wing-Nut by Ideal., Marrette Type II by Marr Electric Ltd.
 - .4 Moisture and waterproofing: In wet locations, with Liquid Tape by Ideal.
 - .5 Equipment pig-tail power circuit connections: For wire sizes #8 AWG minimum, split-bolt type, sized to suit number and size of conductors. Servit Type KS by Burndy Inc.
 - .6 High voltage (above 1000 V) cable terminations: Engineered termination kits, rated for conductor number, size and voltage class of cable, heat shrinkable type, stress relieving, with heat activated sealant. Supply outdoor skirts for outdoor terminations. Type HVT by Raychem Canada Ltd.
 - .7 5kV motor terminations: heat shrinkable connection kits, including compression lug connectors, sealant, cover caps and tubes. Type MCK-5 by Raychem Canada Ltd.
 - .8 Low voltage (1000V and lower) motor terminations: heat shrinkable connection kit, including sleeves, caps and sealant. Type MCK by Raychem Canada Ltd.
 - .9 TECK cable connectors in hazardous locations: Approved for application.
 - .10 TECK cable connectors in wet or outdoor areas: Watertight type.
 - .11 Cable pulling lubricant: Compatible with cable covering and not to cause damage or corrosion to conduits or ducts. Polywater J by Polywater, Yellow 77 by Ideal industries or CSA/ULc approved equivalent.

PART 3 EXECUTION

3.1 COORDINATION

- .1 Prior to installation of wires and cables, compare Contract Drawings with latest issue of Vendor shop drawings.
- .2 Report discrepancies promptly to Contract Administrator.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 16010 – Electrical General Requirements, 16080 – Electrical Testing and co-ordinate with Division 1 – Quality Control.
- .2 Perform tests using method appropriate to site conditions and to approval of Contract Administrator and local authority having jurisdiction over installation.

- .5 Acceptance Test: This test is performed after the installation of the cable, but before energization of the cable. It checks for installation defects of the complete cable system.
- .3 Refer to item 3.3 for cable installation and item 3.7 for "Inspection and Testing".
- .4 Perform tests before energizing electrical system.

3.3 CABLE INSTALLATION - GENERAL

- .1 [The Contract Administrator shall provide drawings of the cable installation and termination in the Contract drawings. It shall show the details of the cable terminations, including how each cable-end is going to be terminated, what is grounded, what is to be insulated and what is left floating so that no circulating current is allowed to flow in the armour and Neutral-wire.]
- .2 Cable installation shall meet the requirements of Toronto Hydro / Electrical-utility, Ontario Electrical Safety Code (O.E.S.C.), Electrical Safety Authority (ESA) and all applicable codes and standards.
- .3 For Single-Core TECK90 Cable Installation:
 - 1) Avoid using circular magnetic clamp around single conductor cable, which can produce eddy current in the clamp.
 - 2) Armour shall be single-point bonded, to eliminate the possibility of circulating current.
 - 3) Depending on the circuit length and cable loading levels, it require verification of outer jacket integrity and consideration of voltage limiting measures, to prevent the potentially harmful occurrence of armour over-voltages during steady-state or fault conditions.
 - 4) If the cable armour of single-core TECK90 cable are required to be multi-point bonded (e.g. due to requirements to minimize touch potential) then on-site measurement of armour resistance is required during installation and commissioning. The armour resistance measurement shall be done on the as-received cable reels as well following cable pulling. Increased armour resistance, measurement of overall armour resistance shall be assessed for anomalies (across phases and pre / post installation) and any needs for the further investigation.
 - 5) Minimize induced currents flowing in the armour and resulting I^2R heat losses to zero.
 - 6) Field measurement shall be undertaken of armour and neutral wire currents during operating conditions. If further required, consider some data logging / monitoring of armour (or neutral wire) circulating currents in real-time operating conditions.
- .4 Installation of cables shall follow the latest industry standards and all applicable codes.

- .5 Install cable in trenches in accordance with Section 16051 – Installation of cables in trenches and ducts.
- .6 Lay cable in cable trays in accordance with Section 16135 - Cable trays.
- .7 Armour and Neutral-wire of the all the TECK cables shall be single-point bonded, to eliminate the possibility of circulating current. The contractor shall perform field measurement of armour and neutral wire currents during operating conditions, submit the measurement record to the Contract Administrator.
- .8 Terminate cables in accordance with the requirements of this section and the industry standards.
- .9 Conductor length for parallel feeders to be identical.
- .10 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .11 Provide and install "Cable Tags" on each cable according to the requirement mentioned under section 3.8 Cable Tagging /Wiring Identification.
- .12 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .13 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .14 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.
- .15 The contractor shall get the cable installation inspected and approved by the Contract Administrator of the project.
- .16 Support all single and multi-conductor cables adequately including in manholes, meeting the code requirements.

3.4 UNDERGROUND INSTALLATION

- .1 Install the underground cable in accordance with Ontario Electrical Safety Code requirements.
- .2 Install direct buried cables in 75 mm (or as indicated on the drawings) layers sifted sand, free of rock, stone and other sharp objects, above and below.
- .3 Where indicated, protect direct buried cables with 50 mm thick concrete protection tiles. Extend protection 50 mm minimum on either side of cabling.
- .4 Install direct buried cable at depth of 600 mm minimum. Where rock is encountered and minimum depth cannot be attained, install cables in concrete encased ducts.
- .5 Install in suitably sized concrete encased duct where cables pass under roadway or area subject to vehicular traffic or heavy loads.

3.5 WIRING TERMINATIONS

- .1 Insulate equipment pig-tail power circuit connections with wire sizes #8 AWG and larger, with heat shrink sleeve termination kits.
- .2 Terminate armoured cables with accepted connectors suitable for application, size and type of cable.
- .3 Except where pulling tensions exceed allowable cable limits or where tap connections are required, only install splices in power, control and instrumentation cable runs with written permission of Contract Administrator. Where unavoidable, install splices in junction boxes only.
- .4 Make power (1000 V and below), control and instrumentation wiring taps, splices and terminations in junction boxes with labelled terminal blocks, securely fastened to avoid loosening under vibration or normal strain. Terminate lighting circuits and 120 V convenience receptacle circuits with twist on or split-bolt type connectors and insulating tape.
- .5 Terminate control, signal and instrumentation circuit conductors, including spares, on terminal blocks. Label terminal blocks with unique alphanumeric designation or as indicated.
- .6 Identify each conductor, including spares, by wire markers at each termination. Indicate circuit designation or unique wire number. Identify spare conductors as 'SP1', 'SP2', etc. Follow Toronto Water tagging standards.

3.6 HIGH VOLTAGE TERMINATIONS (ABOVE 1000 V)

- .1 Prepare high voltage cable ends. Assemble and install stress relieving cable terminations where necessary and in accordance with termination and cable manufacturers' recommendations. Utilize only personnel trained, experienced and qualified in this type of installation. Stress relieving cable terminations are required for all 4160 Cable bus terminations. For cables that are used on the 4160 or 2400 V systems and not requiring the stress relieving cable terminations, prepare terminations as required by the cable manufacturers' recommendations.
- .2 For motor terminations, provide compression lugs with bolt type connections on the motor leads and incoming conductors. Install cable stress relief termination kits and motor termination kits in accordance with manufacturer's recommendations. Prevent conductors and splices from coming into contact with enclosure walls.

3.7 INSPECTION AND TESTING

- .1 Refer to Section 16080 Electrical Testing for the testing requirements under this Contract. Follow all applicable NETA standard and procedures. Submit the cable test report to the Contract Administrator for review.
- .2 High Voltage Cable (Above 1000 Volts)

- .1 Install cable without making final connections so equipment (motors, switchgear, transformers, capacitors, and similar items) will not be subjected to test voltages.
- .2 While pulling the cable ensure the integrity of the cable is maintained, including the integrity of outer jacket, armour, inner jacket, concentric-neutral and insulation.
- .3 Measure end-to-end continuity of the conductors, armour and concentric neutral.
- .4 Measure the insulation resistance of the cable. Do not perform “Megger” tests on equipment containing solid-state components.
- .5 Disconnect power factor correction capacitors from system prior to testing.
- .6 Verify armour to concentric-neutral separation exist at the installation.
- .7 Armour and concentric-neutral of the cable shall be single-point bonded, to eliminate the possibility of circulating current. The contractor shall perform field measurement of armour and neutral wire currents during operating conditions, submit the measurement record to the Contract Administrator.
- .8 Test complete with cable termination fittings.
- .9 A competent independent testing agency specializing in this work to test cable and terminations, including High Potential tests, in accordance with the CSA standards.
- .10 Connect cable upon successful conclusion of tests. Submit two copies of certified test results to Contract Administrator.
- .11 Replace defective or substandard cable runs.
- .12 All tests to be witnessed and signed by the Contract Administrator. Recorded results to be submitted to the Contract Administrator for review and approval.
- .13 All test records to be included in the operational and maintenance manuals.

.3 Cable and Wire – 1000 Volt and Below

- .1 Conduct insulation resistance measurements using a “Megger” (500 V instrument for circuit up to 350 V systems, 1000 V instrument for 351-600 V systems).
- .2 While pulling the cable ensure the integrity of the cable is maintained, including the integrity of outer jacket, armour, inner jacket, concentric-neutral and insulation.
- .3 Measure end-to-end continuity of the conductors, armour and concentric neutral.
- .4 Measure the insulation resistance of the cable.

- .5 Verify armour to concentric-neutral separation exist at the installation.
- .6 Armour and concentric-neutral of the cable shall be single-point bonded, to eliminate the possibility of circulating current. The contractor shall perform field measurement of armour and neutral wire currents during operating conditions, submit the measurement record to the Contract Administrator.
- .7 Record test results in a log book and submit to Contract Administrator for review. Replace or repair circuits which do not meet Inspection Authority requirements. With equipment disconnected, measure insulation resistance of the following circuits:
 - .1 Power, lighting, heater and motor feeders: Phase-to-phase, phase-to-ground.
 - .2 Control circuits: To ground only.
- .8 Do not perform “Megger” tests on equipment containing solid-state components.
- .9 Disconnect power factor correction capacitors from system prior to testing.
- .10 All tests to be recorded and submitted to the Contract Administrator for review and approval.
- .11 All test records to be included in the operational and maintenance manuals.
- .4 Instrumentation and Thermocouple Extension Wiring
 - .1 Check continuity of each conductor using ohmmeter or DC buzzer. Megger or 120 volt filament lamp testing is not acceptable.
 - .2 Test thermocouple wiring for continuity and polarity in accordance with manufacturer’s recommendations
- .5 Post installation – Measure the current in the intentional grounded conductor (Cable armour, shield etc.) to confirm that there is no circulating current

3.8 WIRING SIGNAL LEVEL SEPARATION

- .1 The installation of cable shall meet OESC and ESA requirements. Comply with wiring separation and isolation guidelines recommended by instrument and computer/PLC equipment manufacturers.
- .2 To control or eliminate electrical noise in plant wiring systems, group wires of compatible signal or power levels together and run separately or electromagnetically isolated from wires of incompatible signal or power level. These groups are defined as levels.
- .3 In general, install low level analog signals, 50 V DC maximum or 4-20 mA, and digital signal operating at 50 V AC or DC maximum, in raceway electromagnetically isolated from higher power or signal wiring.
- .4 Levels

- .1 The following are representative of each of the Levels:
 - .1 Level 1 – Low Level (most sensitive to noise)
 - .1 General
 - .1 Analog Signals: Less than 50 V DC, 4-20 mA
 - .2 Digital Signals: 0-12 V DC
 - .2 Typical Examples
 - .1 All wiring connected to components associated with sensitive analog hardware less than 50 mV (e.g. strain gauges, thermocouples)
 - .2 ± 12 V or +5 V DC buses feeding sensitive digital hardware
 - .3 All signal wires associated with 12 V or 5 V digital hardware
 - .4 Digital tachometers
 - .5 4-20 mA and 0-10 V PLC input/output circuits
 - .6 CCTV circuits
 - .2 Level 2 – Medium Level
 - .1 General
 - .1 Analog signals 50 V DC or greater with less than 24 V AC ripple
 - .2 24 V DC lamp and low speed logic circuits
 - .2 Typical Examples
 - .1 24 V DC bus feeding digital relays, lights, and input buffers
 - .2 All wiring connected to 24 V input buffers, 24 V lights and 24 V relays
 - .3 Telephone circuits
 - .4 Analog tachos and pilots
 - .5 Public address system
 - .6 Fire alarm circuits
 - .3 Level 3 – High Level Signals and Small Power
 - .1 General
 - .1 AC feeders 20 amperes or less. DC switching signals greater than 24 V, analog signals greater than 50 V DC with more than 24 V AC ripple. Regulating signals greater than 50 V with current less 20 A. 110 V AC control circuits.
 - .2 Typical Examples
 - .1 Fused 250 V control bus.
 - .2 Indicating lights other than 24 V DC or 6 V, Ac.

- .3 Circuit breaker coils (less than 20 A).
- .4 Ground detector circuits.
- .5 All AC feeders less than 20 A.
- .6 Lighting and convenience outlets.
- .7 Recording meter chart drives.
- .8 Small motor drives (10 kW or less).
- .9 110 V digital logic control circuits.
- .4 Level 4 – Utilization Power (not generally sensitive to noise)
 - .1 General
 - .1 AC and DC circuits 0-7500 V with currents 20-800 A.
 - .2 Typical Examples
 - .1 Motor and feeder circuits.
 - .2 Primaries and secondaries of transformers above 5 kVA.
 - .3 Large contactor coil circuits.
- .5 Level 5 – Bulk Power (noise insensitive)
 - .1 Power greater than 600 V and/or 800 A.
- .5 Field Wiring
 - .1 General
 - .1 Field wiring is used to interconnect various pieces of equipment and is generally external to equipment enclosures. Group wiring conductors according to their signal levels, particularly since more noise sensitive control wires may run in parallel with other power wiring.
 - .2 Basic Installation Requirements
 - .1 Except as noted, run each level of wire in a separate tray or conduit; intermixing of levels is not acceptable.
 - .2 Comply with the recommended spacing between trays of dissimilar levels in accordance with Table 1.
 - .3 Level 3 may be run in a common tray with Level 4, but separated by a grounded steel barrier. Space other levels equivalent to Level 4.
 - .4 When provision of separate trays is impractical, install Level 1 and 2 cabling in a common tray, separated by a grounded steel barrier. Where Level 1 and 2 cables are run side by side in separate trays, maintain 25 mm minimum spacing between trays.
 - .5 Install Level 5 cables in separate conduits and trays. Do not mix cables of different voltages in same tray.

- .6 When cables of unlike signal levels must cross either in trays or conduits, install them to cross at 90 degree angles to each other at a maximum spacing. Where it is not possible to maintain a minimum spacing, provide a grounded steel barrier between the raceways at the crossover point.
- .7 Provide trays containing Level 1 and Level 2 wiring of galvanized steel construction with solid bottoms. Where cables are armoured, ventilation slots or louvres may be used on trays, provided perforation does not exceed 20% of total surface for Level 1 and 2. Install steel tray covers on Level 1 and 2 trays to provide complete shielding. Cover contact to side rails must be positive and continuous to avoid air gaps which impair shielding.
- .8 Do not route trays and conduits containing Levels 1 and 2 parallel to enclosures of high power equipment rated above 100 kVA at a spacing of less than 1500 mm for trays and 750 mm metres for steel conduit.
- .9 Where practical, for Level 4 and 5 wiring, route the complete power circuit between equipment in a continuous raceway system (no gaps with exposed conductors).
- .10 When the spacings previously listed are difficult to maintain (e.g. at entry to the equipment), maintain parallel runs to a minimum; do not exceed 1500 mm cumulative over the entire cable run.
- .11 All spacing given in Table 2 assumes that the Level 1 and 2 trays will be covered. Otherwise, utilize Table 1 spacing.
- .12 Where zero (0) is indicated as a tray or conduit spacing, the levels may be installed together but spacing with respect to other levels must be based on the most stringent criteria.
- .13 Do not run Level 3 in the same conduit as Level 4 or 5. Locate Level 1 and 2 trays and conduits closest to the control panels, Levels 3, 4 and 5 furthest.
- .14 Specific Routing of Levels
Comply with the following specific practices to attain a noise free installation.

.1 Pullboxes and Junction Boxes

- .1 Within the confines of pullboxes and junction boxes, keep levels separate and provide grounded barriers where necessary.
- .2 Tray to conduit transition spacings and separations are potential source of noise. Cross wires of dissimilar levels at right angles and maintain required separation. Protect transition areas in accordance with the Level recommendations.

.2 Conduits Around and Through Equipment Housings

- .1 Maintain Level spacing on both embedded and exposed conduit systems in and around the equipment. Minimize runs containing mixed levels to 1500 mm or less in the overall run.
- .2 For conduits running through and attached to equipment housings follow Level spacing recommendations. Co-ordinate with the equipment Vendor early in the project.
- .3 Where cables of different levels are running together for short distances, connect each group of cables according to Level by cord ties, barriers or some other method so that intermixing is avoided.

.3 Transition Areas

- .1 For cables entering or leaving conduits or trays, ensure that cables of dissimilar levels do not become intermixed.
- .2 Provide grounded metal barriers for level separation when parallel runs over 1500 mm overall becomes necessary.

3.9 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by cable installation.

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Division 1 – Cleaning Requirements.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Division 1 – Cleaning Requirements.
- .3 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

**SECTION 16130
ELECTRICAL BOXES**

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SECTION 16130 ELECTRICAL BOXES

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This section describes the requirements for the various electrical boxes required for splicing, connecting, and pulling conductors and cables.

1.2 SCOPE

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install all electrical boxes specified herein and on the drawings.

PART 2 PRODUCTS

2.1 ENCLOSURE RATINGS FOR ALL EQUIPMENT LISTED HEREIN

- .1 Indoor and dry locations: NEMA/EEMAC 12, unless otherwise noted on drawings.
- .2 Below grade, damp, subject to splashing, corrosive or outdoor locations: NEMA/EEMAC 4X, unless otherwise noted on drawings.

2.2 SPLITTERS

- .1 Reference: CAN Canadian Standards Association (CSA) C22.2 Number 76-M92.
- .2 Galvanize steel enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .3 Main, branch and ground lugs to match required size and number of incoming and outgoing conductors as indicated.
- .4 At least three spare terminals on each set of lugs in splitters less than 400A.
- .5 Lugs: insulator-copper construction.
- .6 Ampacity size as specified on drawings.

2.3 JUNCTION AND PULL BOXES

- .1 Reference: CAN CSA C22.2 No. 40-M1989.
- .2 Welded galvanize steel construction with screw-on flat covers for surface mounting and captive non-corroding chain.

- .3 Covers with neoprene gasket and 25 mm minimum extension all around, for flush-mounted pull and junction boxes.
- .4 Piano type hinges on boxes larger than 300 x 300 mm.
- .5 Junction boxes to be located in convenient accessible locations for maintenance and servicing.
- .6 Submersible Junction Boxes:
 - .1 Submersible junction boxes shall be suitable for TECK cable and conduit termination.
 - .2 Submersible junction boxes shall have cast iron and cast aluminium construction with minimum protection rating NEMA 6P (IP67 or higher) and be tested to withstand prolonged submersion under a 1.83 meter (6 feet) head of water for 24 hours.
 - .3 Submersible junction boxes shall be complete with mounting lugs suitable for Class 1, Zone 1 or 2 classified area.

2.4 OUTLET AND CONDUIT BOXES GENERAL

- .1 Reference: CAN CSA C22.2 No. 18-M1987.
- .2 Size boxes in accordance with CSA C22.1.
- .3 102 mm square or larger outlet boxes as required for special devices.
- .4 Gang boxes where wiring devices are grouped.
- .5 Blank cover plates for boxes without wiring devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.5 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster walls.

2.6 CONDUIT BOXES

- .1 Cast FS or FD boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.7 FITTINGS – GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

2.8 MANUFACTURERS

- .1 Acceptable manufacturers:
 - .1 Crouse-Hinds
 - .2 Or approved manufacturers

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .4 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.
- .5 Provide access panels in ceilings where junction and pull boxes are located in spaces not otherwise accessible.
- .6 Install boxes to clear all building and mechanical services equipment. Where two or more devices are shown at one location, utilize multi-gang boxes. Supply all outlet boxes with covers or plaster rings as required.
- .7 Size all boxes to accommodate the number of conduits, conductors and terminal blocks. Provide junction boxes with 20% spare terminal blocks.
- .8 Securely fasten surface-mounted boxes to the building or mounting structure and support independently of the conduits entering the box.

- .9 Install junction and pull boxes mounted on brick, concrete or block walls with 3 mm thick lead or nylon washers between box and wall face.
- .10 Provide all boxes sized to the Electrical Code requirements, in all conduit raceway systems to limit length of straight conduit runs to 60 m. Reduce this length by 15 m for each 90 degrees bend or 8 m for each 45 degrees bend or offset.
- .11 Mark location and size of all pull boxes on the record drawings.
- .12 Install boxes in hazardous locations as required and shown on the drawings. Provide conduit seals for all conduits entering enclosure.
- .13 Support boxes independently of connecting conduits.
- .14 Fill outlet and conduit boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .15 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .16 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

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WIRING DEVICES**

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SECTION 16140 WIRING DEVICES

PART 1 GENERAL

1.1 INTENT OF SECTION

- .1 This Section describes the requirements for convenience receptacles and lighting switches.

1.2 SCOPE

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the wiring and control devices specified herein and on the drawings.

1.3 DESIGN REQUIREMENTS

- .1 All equipment/devices shall have the proper electrical classification of the area in which they are installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- .1 First Named Manufacturers or Suppliers:
 - .1 Hubbell
 - .2 Or approved equivalent

2.2 SWITCHES

- .1 20 A, 120 V, single pole, double pole, 3-way, 4-way switches, as required or indicated.
- .2 Non-hazardous areas: manually-operated general-purpose AC switches. Colour to be advised by Contract Administrator.
- .3 Wet, damp, subject to splashing hosing down areas: use weather-proof switches.
- .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, with silver alloy terminals.
- .5 Manually-operated general purpose AC switches with following features:
 - .1 Terminal holes approved for Number 10 American Wire Gauge (AWG) wire.

- .2 Silver alloy contacts.
- .3 Urea or melamine moulding for parts subject to carbon tracking.
- .4 Suitable for back and side wiring.
- .6 All switches shall be illuminated when in the off position.
- .7 Switches of one manufacturer throughout project.
- .8 Acceptable manufacturers:
 - .1 Non-Hazardous Areas:
 - .1 Crouse-Hinds
 - .2 Or approved equivalent

2.3 MANUAL STARTER

- .1 120V, one phase, double pole, manual motor starter.
- .2 Non-hazardous areas: manually-operated general purpose single phase manual starter. Colour to be advised by Consultant.
- .3 Wet, damp, subject to splashing hosing down areas: use weather-proof manual starters.
- .4 Toggle lever operated fully rated for supplied motors.
- .5 Manual starters of one manufacturer throughout project.
- .6 Acceptable manufacturers:
 - .1 Crouse-Hinds
 - .2 Or approved equivalent

2.4 RECEPTACLES

- .1 Non-Hazardous areas: General purpose, 15 A-125 V AC rated, CSA type 5-15R configuration, U ground, single or duplex receptacle as indicated on drawings. Colour to be advised by Contract Administrator.

- .2 Wet, damp, subject to splashing hosing down areas: use weather-proof receptacles.
- .3 Duplex receptacles, CSA type 5-15 R, 125V, 15A, U ground, with following features:
 - .1 Ivory, brown urea moulded housing.
 - .2 Suitable for Number 10AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and riveted grounding contacts.
- .4 Single receptacles CSA type 5-15 R, 125V, 15A, U ground with following features:
 - .1 Ivory, brown urea molded housing.
 - .2 Suitable for Number 10 AWG for back and side wiring.
 - .3 Four back wired entrances, two-side wiring screws.
- .5 Receptacles to be sized according to related lighting panel branch circuit breaker.
- .6 Other receptacles with ampacity and voltage as indicated.
- .7 Receptacles shall be of one manufacturer throughout project.
- .8 Acceptable manufacturers:
 - .1 Non-Hazardous Areas:
 - .1 Crouse-Hinds
 - .2 Or approved equivalent
 - .2 Hazardous Areas:
 - .1 Crouse-Hinds, type ENR/ENP
 - .2 Or approved equivalent

2.5 GROUND FAULT INTERRUPTING RECEPTACLES

- .1 Receptacle; CSA 5-15R configuration, 125 V, 15 A, Class A type interrupter.

- .2 Integral solid state ground sensing device.
- .3 Integral “test” and “reset” pushbuttons.
- .4 Duplex, CSA type 5-15R.
- .5 Acceptable manufacturers:
 - .1 Crouse-Hinds
 - .2 Or approved equivalent

2.6 COVER PLATES

- .1 Cover plates for wiring devices.
- .2 Cover plates shall be from one manufacturer throughout project.
- .3 Provide brushed stainless steel cover plates for all switched and receptacles unless otherwise indicated.
- .4 Weatherproof double lift spring loaded cast aluminum cover plates, complete with gaskets for duplex receptacles or switches as indicated.
- .5 Weatherproof spring loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Switches
 - .1 Install single throw switches with handle in “UP” position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height specified in Section 16010 – Electrical General Requirements or as indicated.
- .2 Receptacles
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

- .2 Mount receptacles at height specified in Section 16010 – Electrical General Requirements or as indicated.
- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover Plates
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.

END OF SECTION

**SECTION 16505
LIGHTING EQUIPMENT**

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SECTION 16505 LIGHTING EQUIPMENT

PART 1 GENERAL

1.1 GENERAL CONDITIONS

- .1 All sections of Division 1 form a part of this Specification. Read and fully adhere to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this section.
- .3 All sections of Divisions 1 to 16 inclusive form part of the Contract Documents. Refer to Section 16010 for General Electrical Requirements related to this work.

1.2 RELATED REQUIREMENTS

- .1 Section 01760 – Warranty Work

1.3 SCOPE

- .1 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the lighting equipment specified herein and on the drawings.
- .2 Exit lights and emergency lighting units must be supplied by one manufacturer only throughout the project.

1.4 REFERENCES

- .1 The following is a list of standards which may be referenced in this Section:
 - .1 Institute of Electrical and Electronic Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
 - .2 Canadian Standards Association CSA C22.1 No. 141 Unit Equipment for Emergency Lighting.
 - .3 Certified Ballast Manufacturer (CBM).
 - .4 Illuminating Engineering Society of North America (IESNA).
 - .5 National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - .6 Underwriters Laboratories, Inc. (ULC):

- .1 NFPA No. 101 Life Safety Code.
- .2 Ontario Electrical Safety Code (OESC)-Latest Edition.

1.5 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01300 – Submittals.
- .2 Shop Drawings, information and data:
 - .1 Solid-State Light Fixture and Lighting Emitting Diode (LED) equipment (Drivers & Power Supplies) manufacturer data including:
 - .1 Type.
 - .2 Wiring diagram for power supplies and LED drivers.
 - .3 Photometric data measured per LM-79.
 - .4 Lumen Maintenance data per LM-80 at L70 and L50 at both 25°C and 50°C ambient temperatures.
 - .5 Installed Watts.
 - .6 Input voltage and power factor.
 - .7 Initial lumens and lumens per Watt.
 - .8 Colour temperature and Colour Rendering Index.
 - .9 Bin number requirements for colour temperature consistency.
 - .10 Temperature rating.
 - .11 Efficiency rating.
 - .12 Manufacturer shop drawing submittals to include:
 - .1 Catalogue data sheets and pictures.
 - .2 Luminaire finish and metal gauge.
 - .3 Lens materials, pattern, and thickness.
 - .4 Mounting, fastening, foundation, anchoring, suspension details and dimensions.
 - .13 Lighting controls including photocell, time switch and lighting control panel details.

- .1 All lighting control panels for dimming and relay shall be furnished by one manufacturer and are compatible with occupancy sensors, switches, preset controllers and photocell sensors. All lighting control panels shall be CSA certified.
- .14 Manufacturer warranty statement compliant with listed requirements.
- .2 Interior Luminaires:
 - .1 Catalogue data sheets and pictures.
 - .2 Luminaire finish and metal gauge.
 - .3 Lens material, pattern, and thickness.
 - .4 Candle power distribution curves in two or more planes.
 - .5 Candle power chart 0 to 90 degrees.
 - .6 Lumen output chart.
 - .7 Mounting details.
- .3 Exterior Luminaires:
 - .1 Catalogue data sheets and pictures.
 - .2 Luminaire finish and metal gauge.
 - .3 Lens material, pattern, and thickness.
 - .4 IESNA lighting classification and isolux diagram.
 - .5 Fastening details to wall.
 - .6 Ballast type, location, and method fastening.
- .4 Lamps:
 - .1 Voltages.
 - .2 Colours.
 - .3 Approximate life (in hours).
 - .4 Approximate initial lumens.

- .5 Lumen maintenance curve.
 - .6 Lamp type and base.
- .5 Ballasts and Driver:
 - .1 Type.
 - .2 Wiring diagram.
 - .3 Nominal watts and input watts.
 - .4 Input voltage and power factor.
 - .5 Starting current, line current, and re-strike current values.
 - .6 Sound rating.
 - .7 Temperature rating.
 - .8 Efficiency ratings.
 - .9 Low temperature characteristics.
 - .10 Emergency ballasts rating and capacity data.
- .6 Photo Time Control:
 - .1 Wiring diagram.
 - .2 Contact ratings.
- .7 Photocells:
 - .1 Voltage, and power consumption.
 - .2 Ampacity.
 - .3 Contacts and time delay.
 - .4 Operating levels.
 - .5 Enclosure type and dimensions.
 - .6 Temperature range.
- .8 Low Voltage Remote Control Wiring System:
 - .1 Type.

- .2 Switching capacity.
- .3 Voltage rating.
- .4 Wiring diagrams.

.3 Warranty

- .1 Provide a written five-year warranty on-site replacement material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products. Finish warranty must include warranty against failure or substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
- .2 Provide a written five-year replacement material warranty for defective or non-starting LED source assemblies from the date of substantial acceptance of the work. Include labour for replacing lamps and drivers in warranty.
- .3 Provide a written five-year replacement material warranty on all power supply units (PSUs).
- .4 Warranty period must begin as specified in Section 01760 – Warranty Work. The supplier will provide the Agent with appropriate signed warranty certificates. The Agent must receive certificates prior to final payment.

1.6 EXTRA MATERIALS

- .1 Furnish, tag, and box for shipment and storage the following spare parts and materials:
 - .1 Provide 10 per cent spare, as minimum one of each type replaceable devices including LED drivers and lamps or as recommended by manufactures.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Store in original cartons, in a dry and protected space.

PART 2 PRODUCTS

2.1 LUMINAIRES

- .1 Refer to Luminaire schedule in contract drawings.
- .2 Feed-through type or separate junction box.

- .3 Ballasts: Two-lamp when possible.
- .4 Wire Leads: Minimum 12 AWG.
- .5 Component Access: Accessible and replaceable without removing luminaire from ceiling.
- .6 LED Requirements: Luminaires must meet the following requirements:
 - .1 40 to 50 lumens per watt (6500°K).
 - .2 30 to 40 lumens per watt (3200°K).
 - .3 1.2 or 3 watts per LED.
 - .4 Bin number requirements for colour temperature consistency.
 - .5 Maximum temperature at the base of the “LED cap” mounted to the substrate shall be controlled to ensure full lamp life.
 - .6 Warranty: 5 years.
 - .7 Luminaire must be UL-listed for wet locations and wiring cavity must be field accessible for service or repair needs.
 - .8 Fully assemble and electrically test luminaires before shipment from factory.
 - .9 Luminaires must have locality-appropriate governing mark and certification.
 - .10 If a lens not integral to the LED is used, construct the luminaire optical enclosure (lens/window) of clear and UV-resistant polycarbonate, acrylic or glass.
 - .11 80% of the luminaire material by weight should be recyclable at end of life. Design luminaire for ease of component replacement and end-of-life disassembly.
- .7 Soffit Installations
 - .1 ULC Labelled: suitable for damp locations.
 - .2 Ballast: Removable, prewired.
- .8 Exterior Installations
 - .1 ULC Labelled: suitable for wet locations.

- .2 Ballast: Removable, prewired.
- .3 When factory installed photocells are provided, entire assembly shall have ULC label.
- .9 Hazards location
 - .1 ULC Labelled: suitable for Class 1 zone 1 or Zone 2 area.
 - .2 Ballast: Removable, prewired.

2.2 EMERGENCY LIGHTING UNITS

- .1 Emergency Battery Units
 - .1 Performance: In accordance with CSA 22.2-141.
 - .2 Design: packaged battery powered units.
 - .3 Batteries: 24 volt, sealed pure lead design, suitable for -20°C to 40°C ambient, with minimum capacity for carrying lamp loads plus 25 percent spare capacity (minimum 50 watts total) for one hour (based on ambient of 20°C), rechargeable, maintenance free type, with high impact material container.
 - .4 Battery Charger: Solid state, automatic, two rate with capacity to restore battery to full charge with 12 hours following one hour full rate discharge.
 - .5 Solid State Switching: Automatically connect lamps to battery upon failure of 120V AC power or when supply voltage drops below 90V. Supply a sealed type transfer relay and a low battery voltage disconnect circuit. Include a time delay where noted on the Luminaire Schedule.
 - .6 Accessories: Test switch and LED pilot lights to indicate when battery being charged and when battery fully charged.
 - .7 Lamps: See the Luminaire Schedule on Contract drawings.
 - .8 Enclosure type as per the Luminaire Schedule.
 - .9 Include 1220 mm long, three wire cord with U ground, twist-lock plug for connection to receptacle outlet. Coordinate plug and receptacle type and location to suit.
 - .10 Battery Life: 10 years minimum maintenance free. Warrant battery and charger for five years.

2.3 EXIT LIGHT

- .1 Refer to Luminaire schedule in contract drawings.

2.4 LAMPS

- .1 See the Luminaire Schedule on the Contract drawings.

2.5 BALLASTS

.1 General

- .1 Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
- .2 Certified by electrical testing laboratory to conform to Certified Ballast Manufacturer's specifications.

.2 LED Driver

- .1 Must have a minimum efficiency of 85%.
- .2 Must be rated to operate between -40°C to +50°C.
- .3 Input Voltage: capable of 120 to 240 ($\pm 10\%$) volt, single phase as required by the site.
- .4 Power supplies can be UL Class I or II output.
- .5 Operating frequency must be 50/60 Hz.
- .6 Drivers must have a Power Factor (PF) of: ≥ 0.90 .
- .7 Drivers must have a Total Harmonic Distortion (THD) of: $\leq 20\%$.
- .8 Drivers must comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- .9 Drivers must be compliant with Reduction of Hazardous Substances (RoHS) regulations.

2.6 LIGHTING CONTROL

.1 Photocell

- .1 Automatic with HAND/OFF/AUTOON/OFF selector switch for switching photo control.

- .2 Housing: Self-contained, die cast aluminum, unaffected by moisture, vibration, or temperature changes.
- .3 Setting: ON at dusk and OFF at dawn.
- .4 Time delay feature to prevent false switching.
- .5 Field adjustable to control operating levels.
- .6 Manufacturers:
 - .1 Tork Inc.
 - .2 Or approved equivalent

2.7 SPARE PARTS

- .1 Furnish, tag, and box for shipment and storage the following spare parts and materials:
 - .1 Provide a list of manufacturer recommended spare parts.
 - .2 Provide all necessary spare parts as recommended by manufacturer.

PART 3 EXECUTION

3.1 LUMINAIRES

- .1 General
 - .1 Locate and install luminaires and switches as indicated in accordance with manufacturer's recommendations
 - .2 Provide proper hangers, pendants, and canopies as necessary for complete installation.
 - .3 Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
 - .4 Install plumb and level
 - .5 Co-ordinate location of luminaires with all trades onsite.
 - .6 Connect luminaires and switches to lighting circuits as indicated.
- .2 Luminaire Supports
 - .1 For suspended ceiling installations support luminaires independently of ceiling.

- .2 Suspend luminaires at a height of no less than 2500 mm from the floor and below any piping attached to the ceiling.
- .3 Luminaire Alignment
 - .1 Align luminaires mounted in continuous rows to form straight line.
 - .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.2 LAMPS

- .1 Provide in each fixture, number and type for which fixture is designed, unless otherwise noted.

3.3 BALLASTS

- .1 Install in accordance with manufacturer's recommendations
- .2 Utilize all ballast mounting holes to fasten securely within luminaire.
- .3 Replace noisy or defective ballasts

3.4 LIGHTING CONTROL

- .1 Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

3.5 EXIT LIGHTS INSTALLATION

- .1 Install exit lights at locations indicated in the Contract Documents and as required, in accordance with NBC-1985.
- .2 Install exit lights as indicated,
- .3 Install wall mounted units 2250 mm above finished floor in office areas and 300 mm above door way opening in other areas.
- .4 Wire fixtures to exit light circuits as indicated.
- .5 Connect emergency lamp sockets to emergency circuits as indicated.
- .6 Ensure that exit light circuit breaker is locked in on position.

3.6 EMERGENCY LIGHTING UNITS INSTALLATION

- .1 Fill batteries delivered in dry state with electrolyte.
- .2 Provide integral and remote heads as specified and indicated

- .3 Install unit equipment and remote mounted heads (fixtures) as indicated, in accordance with manufacturer's recommendations.
- .4 Direct heads as indicated.
- .5 Connect exit lights emergency lamp to emergency lighting unit as indicated.
- .6 Provide permanent circuit connections with conduit and wire.
- .7 Connect to branch circuit feeding normal lighting in area ahead of all local switches.
- .8 Provide separate circuit wiring to luminaire.

3.7 CLEANING

- .1 Remove labels and markings, except ULC or CSA listing mark.
- .2 Wipe luminaires inside and out to remove construction dust.
- .3 Clean luminaire plastic lenses with antistatic cleaners only.
- .4 Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
- .5 Replace defective lamps at time of Substantial Completion.

END OF SECTION

SECTION 16671
SURGE PROTECTION DEVICE (SPD)

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SECTION 16671
SURGE PROTECTION DEVICE (SPD)

PART 1 GENERAL

1.1 GENERAL CONDITIONS

- .1 All sections of Division 1 form a part of this specification.
- .2 Refer to all other divisions of specifications to determine their effect upon the work of this section.

1.2 SCOPE

- .1 The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy transient voltage surge suppressors. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments (as tested by ANSI/IEEE C62).
- .2 The Contractor shall furnish and install the surge protection device (SPD) equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract drawings.

1.3 REFERENCES

- .1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
 - .1 Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45)
 - .2 American National Standards Institute
 - .3 Federal Information Processing Standards Publication 94 (FIPS PUB 94)
 - .4 National Electrical Manufacturer Association (prior to repeal NEMA LS-1 1992 Peak Current Testing)
 - .5 National Fire Protection Association (NFPA 70, 75 and 780)
 - .6 MIL Standard 220A Method of Insertion Loss Measurement
 - .7 National Electric Code
 - .8 Underwriters Laboratories UL 1283 and UL 1449 (most recent edition)
 - .9 Canadian Standards (cUL or cETL)

- .10 National Electrical Manufacturers Association (NEMA)
- .11 Occupational Safety and Health Act (OSHA)

1.4 ENVIRONMENTAL REQUIREMENTS

- .1 The operating temperature range shall be -40° to 70° C (-40° to 160° F).
- .2 The unit shall be capable of operation up to 13,000 feet above sea level.
- .3 No appreciable magnetic fields shall be generated.

1.5 SUBMITTALS

- .1 Product Data: Provide catalog sheets showing voltage, physical size, IEEE let through voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.
- .2 Submit product data for all components and accessories.
- .3 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.
- .4 List and detail all protection systems such as fuses, disconnecting means and protective features.
- .5 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA approvals.
- .6 Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with ANSI/IEEE C62.45.
- .7 Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds 40 dB at 100 kHz.
- .8 For retrofit mounting applications, provide electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

- .9 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.6 QUALITY ASSURANCE AND WARRANTY

- .1 The panel mounted SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of thirty (30) years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Additionally, the warranty shall state that during the applicable warranty period any SPD which fails due to any transient surge activity, including lightning, shall be repaired or replaced by the manufacturer without charge. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .2 Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this particular section. That is, the warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.
- .3 Provide electrically operated equipment specified in this Section that is listed and labeled. As defined in the National Electrical Code, Article 100, Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- .4 Comply with NFPA 70 and NEMA LS1.

1.7 MANUFACTURER QUALIFICATIONS

- .1 The SPD's shall be manufactured in the USA by a manufacturer that has been regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years. Manufacturers requesting product approval must meet or exceed the written specification contained herein. Manufacturers requesting approval must receive written verification of product acceptance by the specifying engineer 10 days prior to the bid date.

1.8 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01300 – Submittals.

- .2 Provide verification that the SPD device complies with the required UL 1449 2nd Edition.
- .3 Submit electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration and proposed mounting configuration.

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.10 OPERATION AND MAINTENANCE MANUALS

- .1 Submit Operation and Maintenance Manuals in accordance with Section 01730 – Operation and Maintenance Manuals.

1.11 WARRANTY

- .1 The manufacturer shall provide a full thirty (30) year unlimited free replacement warranty from the date of installation against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

PART 2 PRODUCTS

2.1 PERFORMANCE

- .1 General
 - .1 The SPD shall be listed by ETL, UL, or other nationally recognized test laboratory to UL's 1283 and UL's 1449 standards (latest edition, latest revision), and not merely the components or modules. All SPD's shall be Type 1 for use in Type 1 and Type 2 locations.
 - .2 The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.
 - .3 Obtain all surge suppression devices through one source from a single manufacturer.

- .4 The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 220 and 240V systems, and 115% for 277 and 600V systems.
 - .5 All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.
 - .6 All SPD's shall be Total Protection Solutions. No unit will be accepted as an "approved equal" unless it meets the warranty, strength, safety features, IEEE let-through levels, modes of discrete suppression circuitry, fusing, independent third party per mode surge testing, and all other requirements of this specification.
 - .7 If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a 200kA symmetrical fault current with 600 VAC applied.
 - .8 Each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing at an independent, nationally recognized test laboratory. To be considered for approval, the manufacturer must submit a test report on a unit which was tested with internal over current fusing in place. The test shall include a 1.2 X 50 μ sec 6000V open circuit voltage waveform and an 8 X 20 μ sec 500A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an approximated 8 X 20 μ sec waveform. To complete the test, another identical surge shall be applied to verify the unit's survival. Compliance is achieved if the suppression voltage found from the two impulses does not vary by more than +10%. Test data on an individual module is not acceptable.
- .2 Service Entrance Protection - MCC-0100
- .1 The SPD for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL1283 and UL 1449 Third Ed. Type 1 for use in Type 1 or Type 2 locations.
 - .2 Service entrance panels shall be protected by a Total Protection Solutions panel mounted SPD, model TK-ST200-600NN-L for 600V Delta (3W+G) volt panels.
 - .3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002,

categories C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

- .4 ANSI/IEEE C62.41-1991 Measured Limiting Voltage
 - .1 B3/C1 Impulse (6kV, 3kA)
 - .1 Voltage (Voltage Code): L-G, L-L
 - .2 600 delta (600NN): 2095V, 2098V
 - .2 C3 Impulse (20kV, 10kA)
 - .1 Voltage (Voltage Code): L-G, L-L
 - .2 600 delta (600NN): 2160V, 2470V
 - .3 UL Voltage Protection Ratings
 - .1 Voltage (Voltage Code): L-G, L-L
 - .2 600 delta (600NN): 2500V, 2500V
- .5 The unit shall have a peak surge current of no less than 200 kA/phase, 100 kA/mode, 8 X 20 us waveform, single impulse, independently verified.
- .6 Internal Fusing - Over current Protection
 - .1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.
 - .2 For arc quenching capability, minimization of smoke and contaminants in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
 - .3 Fusing shall be present in every mode, including Neutral-to-Ground.

- .4 The fusing shall be capable of interrupting up to a 200 kA symmetrical fault current with 600VAC applied.
- .7 The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .8 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 4 steel enclosure.
- .9 The SPD shall have an internal audible alarm with mute on front cover.
- .3 LIGHTING PANEL PROTECTION - 'LP-0001'
 - .1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL1283 and UL1449 Third Ed. Type 1 for use in Type 1 and Type 2 locations.
 - .2 Subpanels and lighting panels shall be protected by a Total Protection Solutions panel mounted SPD TK-LP080-3Y208-L-F for 120/208 (4W+G) volt panels.
 - .3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories A1 & A3 ring wave, 180 degree phase angle, category B3 Ringwave, and UL suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:
 - .1 ANSI/IEEE C62.41-1991 Measured Limiting Voltage
 - .1 A1 Ring Wave (2kV, 67A) Tested at 180 degree phase angle
 - .1 Voltage (Voltage Code): L-N, L-G, L-L, N-G
 - .2 120/208 (3Y208): 29V, 46V, 39V, 40V
 - .2 A3 Ring Wave (6kV, 200A) Tested at 180 degree phase angle
 - .1 Voltage (Voltage Code), L-N, L-G, L-L, N-G

- .2 120/208 (3Y208): 56V, 81V, 88V, 112V
- .3 B3 Ring Wave (6kV, 500A) Tested at 90 degree phase angle
 - .1 Voltage (Voltage Code): L-N, L-G, L-L, N-G
 - .2 120/208 (3Y208): 437V, 592V, 612V, 324V
- .4 UL Voltage Protection Ratings
 - .1 Voltage (Voltage Code): L-N, L-G, L-L, N-G
 - .2 120/208 (3Y208): 700V, 700V, 1000V, 700V
- .4 The unit shall have a peak surge current of no less than 80 kA/phase, 40 kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.
- .5 Internal Fusing - Overcurrent Protection
 - .1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.
 - .2 For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
 - .3 Fusing shall be present in every mode, including Neutral-to-Ground.
 - .4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.
- .6 The SPD shall be capable of attenuating internally generated ringing type transients and noise, and shall have an enhanced transient filter supported by a specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.
- .7 Because of space limitation, the enclosure shall not exceed 4.0 in. D x 4.0 in. W x 10.3 in. H to allow close-to-the load installation on flush

mount panels and between adjacent panelboard. For recessed panels, a flush mount cover plate shall be provided with each unit.

- .8 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 1 steel enclosure.
- .9 The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .10 The SPD shall have an internal audible alarm with mute on front cover.

2.2 MANUFACTURER

- .1 International Innovative Systems
- .2 Or approved equivalent

PART 3 EXECUTION

3.1 EXAMINATION

- .1 The manufacturer or his representative shall examine the installation to ensure the equipment provided and methods used meet the requirements of the application and shall provide a Certificate of Proper Installations.

3.2 INSTALLATION

- .1 Install the SPD's with the conductors as short and straight as practically possible.
- .2 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- .3 Main service entrance units shall be installed on a 60 amp breaker, or, where indicated, shall be installed on a non-fused disconnect switch provided by Total Protection Solutions, or other manufacturer, that meets or exceeds the fault current rating of the switchgear.
- .4 Distribution, branch panel, and motor control center units shall be installed on 30 amp dedicated circuit breakers, or, where indicated, shall be wired directly to the main lugs or feed through lugs, or wired directly to the bus bars.

- .5 When SPD cable lead lengths exceed four (4) feet, Low Impedance Cable must be used. Please follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual.
- .6 The Dry Contact Relay (DRC) for the alarm must be wired to a signaling device specified by the engineer.
- .7 The installing contractor shall comply with all applicable codes.
- .8 A pre and post installation inspection with a commissioning report must be performed and submitted by a factory trained agent.

END OF SECTION

DIVISION 32

Section No.		No. of Pages
321723	PAVEMENT MARKINGS	5

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Pavement Markings shall be constructed in accordance with OPSS.MUNI 710 and the following amendments.

**1.2 AMENDMENT TO OPSS.MUNI 710, NOVEMBER 2021 – CONSTRUCTION
SPECIFICATION FOR PAVEMENT MARKING**

OPSS 710.01 CONSTRUCTION

OPSS 710.07.01 General

Subsection 710.07.01 of OPSS 710 is amended by the deleting the fourth paragraph in its entirety and replacing it with the following:

Where the pavement marking scheme is not shown in the Contract Drawings, the Contractor shall supply and place all pavement markings to the same size and location as the existing pavement markings. The Contractor shall be responsible to make appropriate sketches prior to construction so that the existing pavement markings can be fully reinstated.

Pavement marking shall be completed prior to opening roadway to traffic within 24 hours after paving operation finished.

OPSS 710.07.02 Surface Preparation

Subsection 710.07.02 of OPSS 710 is amended by the addition of the following paragraph:

The Contractor shall provide a mechanical sweeper to clean the road surface prior to the application of pavement markings. Pavement marking shall only be performed by an experienced and qualified Subcontractor. The work shall also include all required layout in conformance with the *Manual of Uniform Traffic Control Devices for Ontario*.

OPSS 710.07.03 Pavement Marking Obliterating

Subsection 710.07.03 of OPSS 710 is amended by the deleting the entire paragraph and replacing it with the following:

Pavement marking shall be obliterated or removed using an approved water blasting method only.

OPSS 710.07.05 Temporary Pavement Marking

Subsection 710.07.05 of OPSS 710 is amended by the addition of the following paragraph:

Temporary markings shall include the removal of the markings to facilitate traffic control. Temporary markings that are to be covered with an asphalt layer do not require removal. Temporary markings shall be restored within 72 hours of detecting any failure of pieces to remain according to specifications.

OPSS 710.07.06 Short Term Pavement Marking

Subsection 710.07.06 of OPSS 710 is deleted in its entirety and replaced with the following:

Short term pavement marking is required when an existing paved roadway, which is not to be reconstructed or resurfaced, requires pavement markings in different alignments and/or colours than the existing pavement marking.

As part of the work of pavement marking, the Contractor shall apply short term pavement markings for all affected markings, including centreline, lane lines, crosswalks and stop bars.

Short term pavement markings shall be applied according to MUTCD and as amended by Table 1 for Type C markings. The length of time before permanent markings are placed does not apply to this specification. The pavement markings shall stay in place as required. The Contractor shall inspect all short term pavement marking at the beginning and end of each week. The Contractor shall replace any failed pieces immediately.

Short term pavement markings shall not conflict with existing pavement markings. If required, the Contractor shall remove and replace the existing pavement markings as required.

Short term pavement markings placed on existing or on the final surface course shall be of the removable type.

OPSS 710.07.08 Selection of Materials

Subsection 710.07.08 of OPSS 710 is deleted in its entirety and replaced with the following:

All permanent pavement markings shall be field reacted polymeric pavement marking material according to OPSS 1714.

All temporary pavement markings shall be organic solvent based traffic paint according to OPSS 1712.

All short term pavement markings shall be temporary preformed plastic pavement marking tape according to OPSS 1715.

OPSS 710.07.09.02 Organic Solvent Based Traffic Paint

Clause 710.07.09.02 of OPSS 710 is amended by the addition of the following paragraphs:

A “centre liner” shall be used for the application of all temporary pavement markings to demarcate centre and through lanes. Hand paint machines may be used for all transverse pavement markings and symbols.

All temporary pavement markings, required for less than a three month duration, shall require only a single application. Temporary pavement markings required for longer periods shall require two separate applications.

OPSS 710.07.09.05 Field Reacted Polymeric Pavement Marking Materials

Clause 710.07.09.05 of OPSS 710 is amended by the addition of the following paragraph to the end of the first paragraph:

Markings shall not be applied to any joints between the asphalt and any appurtenance. Markings shall not be applied to the surface of any utility frame and covers.

Clause 710.07.09.05 of OPSS 710 is amended by the addition of the following paragraph to the end of the last paragraph:

The Contractor shall follow the manufacturer’s guidelines for application on non-bituminous surfaces, that is to say concrete surface. Concrete surfaces require a primer/sealer to ensure adequate bonding of the permanent pavement marking.

OPSS 710.10 BASIS FOR PAYMENT

- OPSS 710.10.01 Pavement Marking - Item**
Pavement Marking Symbols - Item
Pavement Marking, Durable - Item
Pavement Marking Symbols, Durable - Item
Pavement Marking Temporary - Item
Pavement Marking Symbols, Temporary - Item
Pavement Marking Temporary Removable - Item
Pavement Marking Symbols, Temporary - Removeable - Item
Raised Pavement Markers, Temporary - Item
Pavement Marking Obliterating - Item























Subsection 710.10.01 of OPSS 710 is amended by the addition of the following paragraphs:



All costs associated with temporary pavement marking and short term pavement marking shall include the permanent removal of the markings and any and all interim removals and replacements due to the failure of pieces to remain in according to specifications. Payment shall be considered incidental to the traffic control item. No separate payment shall be made.

Payment for permanent pavement marking, when paid under the lump sum item for various locations, shall be paid upon final completion of each project location and shall be paid as a percentage based on the value of that project over the total value of the contract. If revisions to the pavement markings are required, the item shall be prorated based on the equivalent 10 cm line. To determine symbol equivalent 10 cm line lengths, see Table 1 below.

Payment for permanent pavement marking, when paid under a unit price item, shall be paid upon final completion of each project location.

RD419SS – Table 1

SYMBOL	DESCRIPTION	EQUIV. 10cm LINE	SYMBOL	DESCRIPTION	EQUIV. 10cm LINE
ROAD SYMBOLS			BICYCLE SYMBOLS		
	THROUGH LANE 3.5m x 0.75m	11.1		BICYCLE 2.0m x 1.0m	8.8
	TURN LANE 3.0m x 1.35m	15.0		LANE DIAMOND 3.5m x 1.0m	11.5
	TURN AND THROUGH LANE 4.9m x 1.6m	25.1		TURN ARROW 2.0m x 0.75m	5.5
	LEFT & RIGHT TURN 3.0m x 2.45m	25.0		THROUGH ARROW 2.0m x 0.5m	4.7
	ALL DIRECTION 4.9m x 2.5m	35.0		PEDESTRIAN 2.0m x 1.0m	7.0
	U TURN 4.35m x 3.7m	30.2		PXO 0.8m x 2.0m	5.8
	CATCH BASIN ARROW 0.2m x 0.38m	0.4		CHEVRON 1.8m x 1.0m	6.2
	HOV LANE 4.0m x 1.0m	13.1		SHARROW 3.6m x 1.0m	14.7
	PXO 2.5m x 6.0m	24.0		WAYFINDING SHARROW 3.6m x 1.0m	12.3
	SPEED HUMP ARROW 1.5m x 0.6m	4.5		20 CM BIKE DOTS SET OF 3	0.9
	RAILWAY CROSSING	36.2		SIGNAL DETECTOR 1.45m X .25m	8.9

SYMBOL	DESCRIPTION	EQUIV. 10cm LINE
ROAD SYMBOLS		
	SLOW 2.4m x 1.9m	21.4
	SCHOOL 2.4m x 2.9m	32.5

SYMBOL	DESCRIPTION	EQUIV. 10cm LINE
BICYCLE SYMBOLS		

END OF SECTION